

ENCYCLOPEDIA OF

HUMAN BEHAVIOR



SECOND EDITION

VOLUME ONE

A-D



ENCYCLOPEDIA OF **HUMAN BEHAVIOR**

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Volume 1

A-D

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University of California, San Diego, California

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V.S. Ramachandran, MD, PhD., is Director of the Center for Brain and Cognition and professor with the Psychology Department and the Neurosciences Program at the University of California, San Diego, and Adjunct Professor of Biology at the Salk Institute. Ramachandran trained as a physician and obtained an MD from Stanley Medical College and subsequently a PhD from Trinity College at the University of Cambridge, where he was elected a Senior Rouse Ball Scholar. Ramachandran's early research was on visual perception, but he is best known for his work in neurology.

He has received many honors and awards, including a fellowship from All Souls College, Oxford, an honorary doctorate from Connecticut College, a gold medal from the Australian National University, the Ariens Kappers Medal from the Royal Netherlands Academy of Sciences for landmark contributions in neuroscience, and the presidential lecture award from the American Academy of Neurology. He is also a fellow of the Neurosciences Institute in La Jolla and a fellow of the Institute for Advanced Studies in Behavioral Sciences at Stanford. He was invited by the BBC to give the Reith Lectures on 'The Emerging Mind' in 2003 and is the first physician/experimental psychologist to be given this honor since the series was begun by Bertrand Russell in 1949 – these lectures were subsequently published as *A Brief Tour of Human Consciousness: From Impostor Poodles to Purple Numbers*.

In 1995, he gave the Decade of the Brain Lecture at the 25th annual (silver jubilee) meeting of the Society for Neuroscience and more recently, the inaugural keynote lecture at the Decade of the Brain conference held by NIMH at the Library of Congress and a public lecture at the Getty Museum in Los Angeles. He also gave the first Hans Lucas Teuber lecture at MIT, the D.O. Hebb lecture at McGill, the Rudel–Moses lecture at Columbia, the Dorcas Cumming (inaugural keynote) lecture at Cold Spring Harbor, the Raymond Adams neurology grand rounds at Massachusetts General Hospital, Harvard, and the Jonas Salk memorial lecture, Salk Institute.

Ramachandran is a trustee for the San Diego Museum of Art and has lectured widely on art, visual perception, and the brain. Ramachandran has published over 120 papers in scientific journals (including three invited review articles in *Scientific American*), coauthor (with Sandra Blakeslee) of *Phantoms in the Brain* that has been translated into eight languages and formed the basis for a two-part series on Channel Four TV in the UK and a one-hour PBS special in the United States. His work is featured frequently in the major news media including BBC and PBS. *Newsweek* magazine recently named him a member of 'The Century Club,' one of the "hundred most prominent people to watch in the next century."

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David M. Buss received his BA from the University of Texas at Austin and his PhD from the University of California at Berkeley. He served in professorial positions at Harvard University, the University of Michigan, and the University of Texas, where he is currently professor of psychology. David Buss received the American Psychological Association (APA) Distinguished Scientific Award for Early Career Contribution to Psychology, the APA G. Stanley Hall Award, and the APA Distinguished Scientist Lecturer Award. The University of Texas awarded Buss the President's Associates Teaching Excellence Award. He served as President of the Human Behavior and Evolution Society (HBES). He is currently Head of the Individual Differences and Evolutionary Psychology Area of the Psychology Department at the University of Texas at Austin.

Buss's books include *The Evolution of Desire: Strategies of Human Mating* (Basic Books; translated into 11 languages); *Evolutionary Psychology: The New Science of the Mind* (Allyn & Bacon); *The Dangerous Passion: Why Jealousy is as Necessary as Love and Sex* (Free Press; translated into 13 languages); *The Murderer Next Door: Why the Mind is Designed to Kill* (Penguin; translated into 12 languages); *The Handbook of Evolutionary Psychology* (Wiley), for which he served as editor; *Why Women Have Sex* (Holt; co-authored with Cindy Meston; translated into 16 languages); and *The Evolution of Personality and Individual Differences* (Oxford University Press). Buss has more than 250 scientific publications to his credit.

Buss has extensive cross-cultural research collaborations and lectures widely within the United States and abroad. His primary research interests include the psychology of sex differences, human sexuality, mating strategies, conflict between the sexes, why people kill, warfare, terrorism, stalking, and the psychology of prestige, status, and reputation.



Richard B. Buxton received his BS (1976) and PhD (1981) degrees in physics from the Massachusetts Institute of Technology, followed by a postdoc in biomedical imaging (PET and MRI) at the Massachusetts General Hospital. He has been on the faculty of the Department of Radiology at the University of California, San Diego, since 1990. Buxton's primary research is in functional magnetic resonance imaging (fMRI), focused on understanding the connections between neural activity, blood flow, and energy metabolism in the human brain. His experimental work combines arterial spin labeling (ASL) methods with blood oxygenation–level dependent (BOLD) methods to estimate changes in brain oxygen metabolism in response to a stimulus or a drug. His more theoretical work involves mathematical modeling of the imaging methods, the BOLD effect, and oxygen transport from blood to tissue. Buxton is based at the Center for fMRI and served as the center's founding Director (2000–2007). He has written a textbook on fMRI, now in its second edition, published by Cambridge University Press (2009).



Nicholas Christenfeld received a bachelor's degree in psychology and social relations from Harvard, and a doctorate in social psychology from Columbia, and joined the faculty at the University of California – San Diego and has remained there for two decades. His research program comprises multiple, changing, only partly overlapping areas. He has addressed such topics as why some people say 'um' so often, whether babies look like their mothers or their fathers, how we choose which box of cereal to buy, why a baseball season is ten times as long as a football season, which parts of the month carry the greatest risk of untimely death, whether the support of a woman is better for one's blood pressure than that of a man, what sort of music might be useful in stress reduction, whether some initials extend and some shorten the lives of their bearers, if people who live in, or even just visit, New York City are at risk of heart attacks, and whether story spoilers do spoil stories. Currently, Christenfeld is also exploring the role of forgiveness in poststress cardiovascular recovery, the impact of crying on hormones, and the nature of a sense of humor. An overarching theme, if one exists, might be the empirical exploration of the everyday phenomena of the world.



Orrin Devinsky is professor of neurology, neurosurgery, and psychiatry at New York University (NYU). He directs the NYU Epilepsy Center and St. Barnabas Institute of Neurology. His research on epilepsy includes phenomic-genomic relations, sudden unexpected death in epilepsy, surgical therapies, new medicines and devices, quality of life, cognition and behavior, and neuroinflammation. His research on behavioral neurology includes hyperfamiliarity, delusions, autonomic nervous function, and anterior cingulate cortex functions. He founded the organization Finding A Cure for Epilepsy and Seizures and cofounded epilepsy.com and the Epilepsy Therapy Project. He serves on the boards of these organizations and has served on the board of the American Epilepsy Society and Epilepsy Foundation. His other interests include the history of neuropsychiatry, evolution, anthropology, and animal intelligence.



Albert M. Galaburda is a cognitive neurologist and neuroscientist, specializing in developmental cognitive disorders in adults and children. He received his medical degree from Boston University in 1971, trained in neurology at Harvard Medical School from 1973 to 1976, and began his research on dyslexia in 1979, when with neuropathologist Thomas Kemper, he reported for the first time minor cortical malformations in the brain of an adult dyslexic who had died in an accident. Following that original report, he published several other cases with similar malformations and launched a research program modeling these malformations in rodent models, which continues to this date.

He uses RNAi and transgenic technologies in his present research to induce cortical malformations in rat and mouse brains, which in turn are tested anatomically, molecularly, and behaviorally in collaboration with Glenn Rosen, Joseph LoTurco, and Holly Fitch, respectively. This latest research has shown that manipulation of dyslexia candidate gene homolog's 1 rodent embryos results in molecular interference with neuronal migration, cell autonomous and noncell autonomous effects on cortical development that mimic the changes seen in dyslexic brains, and behavioral changes affecting auditory perception. *Ex vivo* imaging of the brains of genetically manipulated animals discloses changes in cortical circuits affecting corticocortical and corticothalamic relationships.

Galaburda is presently the Emily Fisher Landau Professor of Neurology at Harvard Medical School, and Head of the Cognitive Neurology Unit at Beth Israel Deaconess Medical Center in Boston. He has published more than 150 scholarly articles on various topics of cognitive anatomy, cognitive

neurology, and dyslexia, as well as several books on related topics. Galaburda has received the Pattison Prize in Neuroscience, the Neuronal Plasticity Prize from the IPSEN Foundation of France, Scientist of the Year from the Association for Children with Learning Disabilities (now, Learning Disorders Association), and has been elected to membership in the American Neurological Association. He has delivered the Rita Rudel Memorial Lecture, the Norman Geschwind Memorial Lecture, the Sylvio Conte Decade of the Brain Symposium Lecture, and the Curt von Euler Memorial Lecture, among others. His research is funded by the Eunice Kennedy Shriver National Institute of Child Health & Human Development. His teaching is funded by the National Institute of Neurological Disorders and Stroke.



William Hirstein is Professor and Chair of the Philosophy Department at Elmhurst College, Elmhurst, IL, USA. He received his PhD from the University of California, Davis, in 1994. He is the author of several books, including *On the Churchlands* (Wadsworth Publishing, 2004), *Brain Fiction: Self-Deception and the Riddle of Confabulation* (MIT Press, 2005), and *Mindmelding: Consciousness, Neuroscience, and the Mind's Privacy* (Oxford University Press, 2012). His other interests include autism, sociopathy, brain laterality, sense of self, and the misidentification syndromes.



William G. Iacono is Regents Professor of Psychology, Psychiatry, Law, and Neuroscience; Distinguished McKnight University Professor; Adjunct Professor of Child Development; and Codirector of the Minnesota Center for Twin & Family Research at the University of Minnesota.

He studies the development of common mental disorders, focusing on the genetic liability for substance abuse and antisocial behavior. He is past president of the Society for Psychophysiological Research (SPR). He has also received the Distinguished Contributions to Psychophysiology Award from SPR for his lifetime contributions to this field. In addition, he has been awarded the Distinguished Scientist Award from the Society for a Science of Clinical Psychology. His research is funded by grants from the National Institute of Mental Health, National Institute on Drug Abuse, and National Institute on Alcoholism and Alcohol Abuse. He currently holds a National Institute of Health MERIT (Method to Extend Research in Time) Award for his research achievement. He has published over 350 scientific articles.



John T. Jost is Professor of Psychology at New York University. His research, which addresses stereotyping, prejudice, political ideology, and system justification theory, has appeared in top scientific journals and received national and international media attention. He has published over 90 articles and chapters and coedited four books: *The Psychology of Legitimacy* (2001), *Perspectivism in Social Psychology* (2004), *Political Psychology: Key Readings* (2004), and *Social and Psychological Bases of Ideology and System Justification* (2011). Jost has received numerous honors, including the Gordon Allport Intergroup Relations Prize (three times), Erik Erikson Award for Early Career Research Achievement in Political Psychology, International Society for Self and Identity Early Career Award, Society for Personality and Social Psychology Theoretical Innovation Prize, Society of Experimental Social Psychology Career Trajectory Award, and the Morton Deutsch Award for Distinguished Scholarly and Practical Contributions to Social Justice.



Jerome Kagan is Emeritus Professor of Psychology at Harvard University. His research over the past 57 years has centered on the cognitive and emotional development of infants and children. During the last 30 years, he and his colleagues have concentrated on the temperamental biases called high and low reactivity in infants. He is a fellow of the American Academy of Arts and Sciences and a member of the Institute of Medicine in the National Academy of Sciences. He has received distinguished scientist awards from the American Psychological Association, the Society for Research in Child Development, and the Child-Mind Institute. Kagan received his PhD from Yale University in 1954 and taught at the Ohio State University and Antioch College before joining the Harvard faculty in 1964.



Leif Edward Ottesen Kennair, PhD, is Head of Department at the Department of Psychology, Norwegian University of Science and Technology, Trondheim, Norway. He graduated as a clinical psychologist from the University of Bergen, 1999, and is a specialist of clinical adult psychology (Norwegian Psychology Association), and a qualified cognitive therapist and supervisor of cognitive-behavioral therapy (Norwegian Cognitive Therapy Association). He has worked as a clinical psychologist/chief psychologist at the Nordfjord Psychiatric Centre and as a researcher at St. Olav's Hospital, Trondheim. His research interests span from mainstream clinical psychology efficacy research (generalized anxiety disorder, OCD) to evolutionary psychology (evolutionary psychopathology, the evolutionary psychology of war, mate choice and sexual behavior). Kennair's PhD thesis was on the topic of evolutionary clinical psychology. He has written an introduction to evolutionary psychology, which has been published in Norwegian and Danish. He lectures on evolutionary psychology, behavioral genetics, and personality psychology and is a much-used lecturer for training psychologists and psychiatrists on topics such as cognitive-behavior therapy and treatment of anxiety and OCD.



David E. Presti is a neurobiologist and cognitive scientist at the University of California in Berkeley, where he has taught in the Department of Molecular and Cell Biology for more than 20 years. For more than a decade (1990–2000) he also worked in the treatment of addiction and of posttraumatic stress disorder (PTSD) at the Department of Veterans Affairs Medical Center in San Francisco. His areas of expertise include the chemistry of the human nervous system, the effects of drugs on the brain and the mind, the treatment of addiction, and the scientific study of the mind and the consciousness. He has doctorates in molecular biology and biophysics from the California Institute of Technology and in clinical psychology from the University of Oregon. Since 2004, he has also been teaching neuroscience to Tibetan monks in India in a program initiated by the Dalai Lama. His primary research interest is the relation between mentality, consciousness, and brain physiology, the so-called mind-body problem.

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HOW TO USE THE ENCYCLOPEDIA

The *Encyclopedia of Human Behavior* is intended for use by students, research professionals, and interested others. Articles have been chosen to reflect major disciplines in the study of human behavior, common topics of research by professionals in this domain, and areas of public interest and concern. Each article serves as a comprehensive overview of a given area, providing both breadth of coverage for students and depth of coverage for research professionals. We have designed the encyclopedia with the following features for maximum accessibility for all readers.

Articles in the encyclopedia are arranged alphabetically by subject. Complete tables of contents appear in all volumes. The index is located in Volume 3. Because the reader's topic of interest may be listed under a broader article title, we encourage use of the index for access to a subject area, rather than use of the table of contents alone.

Each article contains a glossary, cross-references, and a further reading list. The outline allows a quick scan of the major ideas discussed within each article. The glossary contains terms that may be unfamiliar to the reader, with each term defined *in the context of its*

use in that article. Thus, a term may appear in the glossary of another article defined in a slightly different manner, or with a subtle nuance specific to that article. For clarity, we have allowed these differences to remain so that terms are defined relative to the context of each article.

Each article has been cross-referenced to other related articles in the encyclopedia. Cross-references will always appear at the end of an article. Where multiple cross-references apply to an article, the cross-references will be listed alphabetically. We encourage readers to use the cross-references to locate other articles in the encyclopedia that will provide more detailed information about a particular subject.

The further reading section lists recent secondary sources to aid the reader in locating more detailed or technical information. Review and research articles that are considered to be of primary importance to the understanding of a given subject area are also listed. The further reading lists are not intended to provide a full reference listing of all the material covered in the context of a given article, but are provided as guides.

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PREFACE

The social scientists have a long way to go to catch up, but they may be up to the most important scientific business of all, if and when they finally get to the right questions. Our behavior toward each other is the strangest, most unpredictable, and almost entirely unaccountable of all the phenomena with which we are obliged to live.

Lewis Thomas

Psychology, the study of the human mind, has made many rapid strides during the past four decades. There is now, more than ever before, a real need for a standard reference work covering all aspects of human behavior. The *Encyclopedia of Human Behavior* is the most up-to-date and comprehensive collection of reviews currently available. The essays will be of interest not only to clinical and experimental psychologists but also to students in fields such as psychiatry, neuroscience, philosophy, cognitive science, and medicine. Indeed, given the enormous range of topics covered, no one interested in human nature can fail to find something of interest in each volume. The format of the volumes lends itself just as readily to casual perusal as it does to serious inquiry.

My colleagues and I are often asked questions such as: What is the superego? What is repression? How reliable is eyewitness testimony? How much sleep do we need? What do we know of the psychology of laughter, language, cruelty, or politics? Or of love, cunning, and deceit? We have all experienced the frustration of not being able to answer such questions or find the answers quickly without recourse to extensive library research. This encyclopedia should prove to be an invaluable resource in such situations. Also, students of psychology and related health professions will find this collection of articles useful as a starting point when they embark on new research projects dealing with specific aspects of human behavior.

The study of human behavior is an enterprise that covers an enormous variety of subjects, ranging from the minutiae of neurophysiology to such familiar but poorly understood topics as Freudian psychology. Psychology is a science that is still very much in its infancy even though it has had a very long history, almost as long as that of physics and biology. Anyone interested in the history of ideas should be puzzled by the differences between advances in biology and advances in psychology. The progress in biology has been characterized by a number of landmark discoveries, each of which resulted in a breakthrough in understanding, for example, the discoveries of cells, Mendel's laws of heredity, chromosomes, mutations, and most recently DNA and the genetic code. Psychology, however, has until recently been characterized by an embarrassingly long sequence of 'theories,' each of which was really nothing more than a passing fad that rarely outlived the person who proposed it. I have always found this contrast to be quite remarkable and can think of no simple explanation for it other than the fact that human behavior is inherently more complex, quixotic, and difficult to fathom. Fortunately, the picture has changed radically over the past four decades, particularly in psychiatry and cognitive neuroscience. There are two reasons for this change: First, there has been a growing dissatisfaction with metaphorical explanations (Peter Medawar calls explanations of this kind "analgesics," for "they dull the ache of incomprehension without removing the cause") and a healthy trend toward replacing them with more mechanistic explanations. Second, progress has been aided by the advent of several new technological innovations for studying the structure and function of the human brain. This encyclopedia covers as many of these recent advances as possible within a three-volume set.

My own experience is mainly in neuropsychology, medicine, and visual science, and I am therefore indebted to the editorial advisory board, as they selected the authors in other areas and saw each essay through the long process of peer review, revisions, and copy-editing. Most of the entries are by acknowledged experts in the field.

Given the nature and scope of this enterprise, some degree of overlap among the essays was not only inevitable but also desirable since our goal was to ensure that each article was a self-contained summary of one specific aspect of human behavior. Given the space limitations, each author was encouraged to provide an overview and convey the general flavor of an area of research rather than attempt an exhaustive review. The result is a very stimulating and informative collection of essays.

I have no doubt that this work will prove useful to specialists. If it also succeeds in kindling a spark of interest in some aspect of human behavior among undergraduate and graduate students, then our efforts will have been amply rewarded, for no enterprise is more important to the future of our species than an understanding of human nature in all its diverse manifestations.

V S Ramachandran

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Academic Achievement

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Glossary

Big-fish-little-pond effect This effect refers to the fact that the evaluation of students' performance differs depending on the average achievement of the class. The same achievement will be perceived as better and will get a better grade when the average achievement of the class is low and will get a poorer grade when the average achievement is high. This effect is observed in teacher grades and makes it difficult to compare grades from different classes or schools.

Carrier variable A carrier variable is a factor that is just an indicator or proxy for other, more specific variables.

A typical example for a carrier variable is age, which is not in itself the cause of certain developmental events but encompasses psychological and biological processes that co-occur with age. Another example for a carrier variable is socioeconomic status which does not per se influence something else but is an indicator of education, intelligence, educational aspirations, and the like.

Organisation for Economic Co-Operation and Development (OECD)

OECD is a union of 30 countries around the world who are committed to democracy and the

market economy. The OECD provides their members with opportunities to compare policy experiences, seek answers to common problems, identify good practice, and coordinate domestic and international policies. Among other activities, the OECD collects data about educational systems and outcomes and commissions international comparative studies of scholastic achievement.

Socioeconomic status (SES) SES of a person or family indicates their possession of economic and social capital or resources. Most frequently SES is assessed by occupation, education, or income or a combination of all.

Standard deviation The standard deviation is a statistical parameter that characterizes the variability within a population or sample. It is the average difference of scores from the mean of the distribution. Together with the arithmetic mean, the standard deviation describes the distribution of scores. A small standard deviation indicates that the majority of scores scatter closely around the arithmetic mean whereas a large standard deviation indicates that the scores spread out widely.

Academic achievement is the general term for performance outcomes in intellectual domains taught at school, college, and university. By confining the definition to intellectual domains, fields such as music and sport are excluded for which certain motor abilities are more important than intellectual abilities. Academic achievement indicates the level of intellectual education of a person, a group, or a whole nation.

This article begins with pointing out the importance of academic achievement for individuals, societies, and as a field of psychological research. After this, it looks at different indicators for and the measurement of academic achievement. An important question refers to the prerequisites or predictors of academic achievement. Because of their special significance for academic attainment, this article focuses on individual characteristics, specifically intelligence, motivation, and personality. Finally, we deal with the issue of equal opportunities in education with regard to gender and socioeconomic status (SES).

Importance of Academic Achievement

The importance of academic achievement can be viewed from different perspectives. Here, we distinguish an individual and a societal perspective as well as the perspective of psychological and educational research.

On an individual level, academic achievement is the most important predictor of vocational careers and, therefore, individual socioeconomic prosperity. This is true because school grades and scholastic achievement tests are used as selection

criteria for jobs and higher education. The strength of the association between academic achievement and indicators of life success is moderate ($r = 0.40\text{--}0.50$). In undeveloped societies that do not use such selection criteria or have no formal education the association between education and individual life success is much weaker or nonexistent. Higher academic achievement opens choices as to what university and course of study one enrolls in and, later, what job one pursues, where, and with whom. These greater numbers of choices make it more likely that a person finds working conditions that fit his/her needs and contribute to personal well-being. At the same time, a higher level of education comes along with increased aspirations and expectations, so that higher academic achievement is not necessarily associated with higher life satisfaction.

On a societal level, the same is true as on an individual level: academic achievement is the most important prerequisite for societal prosperity. The more educated a society is, the higher the chances for a positive socioeconomical development. Because of this established association, the OECD (Organisation for Economic Co-Operation and Development) initiated worldwide comparative studies on scholastic achievement and provides their members with information to monitor their educational systems. National administrations use the results of international scholastic achievement studies to analyze strengths and weaknesses of their educational systems. These large-scale studies have led to an empirical turn in educational policy. Politicians in many countries ground their decisions on data from school achievement studies.

The high individual and societal importance makes academic achievement one of the most investigated issues in psychological and educational research. With the aim of finding ways to foster academic achievement, research tries to identify central prerequisites of learning. On the side of the individual learner, research focuses on characteristics such as intelligence, motivation, and personality. On the environmental side, research investigates how characteristics of the learning conditions to which the learner is exposed (e.g., teaching practices, media use) and characteristics of the overall educational system (e.g., early, late, or no separation into educational tracks) influence academic performance. Besides fostering learning and performance, one further aim of research on academic achievement is to close gaps between groups of learners and, thus, contribute to equal opportunities and a fairer educational system. Much research is done on the issue of the gender gap in education as well as on the gap between learners from different socioeconomic backgrounds.

Taken together, academic achievement is the most important prerequisite for personal and societal prosperity. Moreover, education empowers people to participate in and shape their cultures and societies which is vital for democracy. Therefore, it is an important issue of psychological and educational research to look for the prerequisites of education and ways to improve them. The overall aim is to maximize each learner's academic achievement according to their potentials. Interventions may either focus on individual prerequisites or on characteristics of the learning environment and educational system.

Indicators of Academic Achievement

Academic achievement can be measured in two different ways. On the one hand, there are grades and educational degrees. On the other hand, academic achievement can be measured by standardized achievement tests. Although both types of measurement capture mostly the same underlying characteristic, that is, educational achievement, they are not completely equivalent. It is important to understand the difference in what grades and standardized achievement tests measure because findings of empirical studies vary depending on the indicator of academic achievement.

Grades

Academic achievement in schools and higher education institutions is typically evaluated and quantified by grades. The grade point average (GPA) is the arithmetic mean of all grades that have been received during a certain time. Grades are ecologically valid measures of academic achievement because allocation and selection decisions for higher education and job positions are, to a large extent, based on grades. This makes grades a very important issue for psychological research.

The following box illustrates the functions of grades. As can be seen, grades are supposed to fulfill many different functions. Some of these functions demand that grades measure students' performance as accurately as possible (the functions of feedback, information, and allocation). Other functions might be fulfilled better if grades diverge slightly but

systematically from the actual performance level. For example, when teachers want to reward an increase in performance and motivate students, grades will not reflect the exact performance but will be slightly better. To evaluate the quality of grades, all different functions need to be taken into account. An overall judgment whether grades fulfill their functions also depends on the weight that is given to each function. A person who emphasizes the motivation function of grades will evaluate the quality of grades differently from a person who puts emphasis on the allocation function. This example illustrates that the question of how good grades fulfill their functions cannot be answered by empirical studies alone but that the answer depends on ideological points of view.

Functions of Grades

1. Give students feedback
 - Information about strengths and weaknesses
 - Familiarize with performance evaluations
2. Motivate students
 - Good grades are incentives to continue the good work
 - Poor grades are incentives to improve
3. Discipline students
 - Lack of discipline is reflected by poor grades
 - Some grades specifically evaluate learning behavior
4. Inform third parties
 - Parents, employees, and others get information about students' performance
5. Allocate, select, and legitimize
 - Grades are criteria for the allocation of desired resources (e.g., university admission, scholarships, jobs)

Much research has been devoted to the question of whether teachers' grades actually measure students' performance. The most convincing evidence for the validity of grades is their strong association with standardized achievement tests. Typically this correlation is between $r=0.60$ and 0.70 . Another strong evidence for the validity of grades is that they are the best predictors of future success in academic domains. For example, high school GPA is the best known predictor of college GPA. This is true although across classes and schools different grading standards are used. A major problem of grades is that they depend on the average achievement level of the class. When teachers evaluate students' performance, they use a standard that is adapted to the overall achievement level of the class. The same student will receive better grades in a low performing class and poorer grades in a high achieving class. This phenomenon is also known as a frame-of-reference effect, specifically the big-fish-little-pond effect.

Despite this known distortion of grades due to teachers' different grading standards, school grades are often found to outperform standardized achievement tests in the prediction of future success. This can be explained by the fact the GPA is a highly aggregated measure of performance collected from different teachers, over different subjects, and over a relatively long period of time. Many different single measures of student performance make the GPA very reliable. The fact that grades capture not only pure intellectual capacity but also motivational and personality aspects is not necessarily a disadvantage but contributes to the predictive validity of the GPA for future achievements.

Educational degrees

Educational degrees are another type of indicator of academic achievement. Educational degrees depend directly on the grades accumulated over the educational career. They are the most important prerequisite for admission to higher education and job positions. The first attempt to collect international data about educational outcomes was to compare graduation rates and educational degrees among nations. Because of the differences in the educational systems, such comparisons did not turn out to be very meaningful. Today, educational outcomes among nations are compared by means of standardized achievement tests. Nevertheless, graduation rates and educational degrees are also monitored by international studies on educational achievement because they are important ecologically valid indicators of educational outcomes. For example, the annual study *Education at a Glance*, commissioned by the OECD, reports international comparisons of indicators of the quality of education, such as who participates in education, what is spent on it, and how many students graduate in basic and higher education.

Standardized Achievement Tests

Standardized academic achievement tests measure abilities that are acquired in educational institutions or are important for future success in academic and other domains. Standardized achievement tests vary with regard to the degree to which they are curriculum based. A test that is meant to assess knowledge and skills that have been acquired at school has to be curriculum based, that is, include contents taught at school (e.g., SAT II Subject Tests). Other achievement tests are not curriculum based but assess whether certain competencies have been acquired at a certain age and whether certain criteria are met, that is, certain tasks are mastered. A well-known example of a standardized achievement test that is not curriculum-based is the SAT I Reasoning Test (formerly Scholastic Aptitude Test and Scholastic Assessment Test). The SAT I is designed to measure students' general ability or aptitude for learning. Many colleges in the United States of America base their admission decisions on SAT scores in combination with grades. Because there are wide differences between secondary schools in the United States, tests like the SAT are needed to compare applicants against a common standard.

Different from grades, the only function that standardized achievement tests have is to measure students' achievement as purely as possible. This means that other factors that influence teachers when grading students' performance, such as how much effort a student invested, or whether there is a positive trend that is worth rewarding, must not influence the results of an achievement test. Therefore, standardized achievement tests are a purer measure of achievement compared to grades.

Other examples of standardized achievement tests are the measurements within international large-scale studies of educational achievement (see following box). Typically these studies assess domain-specific abilities, which means that they have to be curriculum based to some extent. Nevertheless, the extent to which international large-scale assessments of scholastic achievement rely on the curriculum depends on the domain in question. In domains in which knowledge is especially dependent on school-based learning, such as in mathematics

and science, the tests are more strongly curriculum based. In other domains, such as languages, learning is relatively more influenced by experiences outside of the school, so that tests for reading comprehension need not be valid according to school curriculum to assess students' reading competencies.

International Large-Scale Assessments of School Achievement

Since the 1950, the OECD collects data about the educational systems and outcomes of their member countries. The data collected in these studies do not only guide educational policies but have made outstanding contributions to the scientific knowledge about academic achievement. This is both due to enormous sample sizes, which provide a solid basis for conclusions, and sophisticated methods that have been advanced in the context of these studies.

In the following, three of the largest and most important international large-scale assessments are listed and characterized by who and what is investigated:

PISA (Programme for International Student Achievement)

- Who: 15-year-olds
- What: Literacy in different domains (mother language, mathematics, science) and cross-curricular competencies (e.g., problem solving)

TIMSS (Third International Mathematics and Science Study)

- Who: Elementary school children, 7th–8th grades and students in last year of mandatory education
- What: Literacy in mathematics and science

PIRLS (Progress in International Reading Literacy Study)

- Who: 4th graders
- What: Mainly Reading Literacy

Do standardized achievement tests measure academic achievement or intelligence or both?

A comparison between results of large-scale assessments of school achievement and intelligence tests indicates a close correlation between the two. This is true both on the level of the individual student as well as on the level of nations. This imposes the question of whether large-scale studies such as PISA actually measure school achievement or whether, instead, they measure intelligence. This is an important question because if it were not mainly school-based learning outcomes that were measured but intelligence, then PISA and the like would not assess the quality of educational systems and would not inform countries about strengths and weakness of their schools. Because intelligence is known to have a strong genetic basis, which means that a large portion of the differences observed in intelligence can be traced back to different genetic endowments, intelligence is often considered to be a relatively stable characteristic. If international large-scale studies of school achievement measured a stable trait instead of educational outcomes, their results would be more of a verdict about which nations are smart and which are not and not a means to assure educational quality.

This line of argumentation is flawed in several ways. First, because of the definition of what intelligence is, it is not reasonable to assume that any complex cognitive performance, such as academic achievement, can be measured without also measuring intelligence. Second, intelligence tests and standardized achievement tests share many methodological characteristics which contribute to a strong association. Therefore, the close correlation does not only reflect shared contents but also shared methods. Third, if the correlation among intelligence

tests and school achievement tests are considered to be too high to justify two distinct constructs, this does not necessarily compromise the concept of academic achievement as measured in large-scale assessment but raises questions about whether intelligence tests function as they are supposed to. It might be argued that extant intelligence tests rely too heavily on school-based learning contents and fail to measure an underlying cognitive potential. Fourth, it is wrong to assume that intelligence is heritable but school achievement is not or less so. Intelligence and student achievement are heritable to a comparable extent. Fifth, there is a widespread misunderstanding according to which heritability means that something is not malleable. Because heritability is a characteristic of the population but not of a single individual, high heritability does not inform us about the limits of individual growth of intelligence or academic achievement given an optimal education.

In view of these considerations, it becomes apparent that the discussion about what exactly is measured with standardized achievement tests is an important one. After all, the answer to be found might be less critical for the measurement of school achievement but more so for the measurement of intelligence.

Standards-based assessment of students' achievement

Standards-based assessment is a special kind of standardized achievement testing. It has all the advantages of standardized tests and their results can be used instead of or as a supplement to traditional teacher grades. The emergence of standards-based assessments is closely related to international large-scale assessments of school achievement. As a consequence of the feedback from international comparative assessments, many countries have changed their educational policies from an input orientation to an output orientation. Input orientation means that the main instrument to assure the quality of education is a detailed description of the contents to be taught (i.e., the curriculum). In contrast, an output-oriented education puts emphasis on the competencies to be acquired and regularly evaluates these competencies by standardized tests. Because these standardized tests are developed with an aim to assess competencies according to educational standards, these tests are called standards-based assessments. Different than for grades, standards-based assessments are usually not or at least not only evaluated by the same teacher who taught the class.

Standards-based assessments have several advantages. Because the evaluation of students' achievement depends on a common, typically nation-wide standard, results of standards-based assessments are comparable across different classes and schools. Different from grades, standards-based assessments do not depend on the general level of achievement in the class. This makes allocation decisions on the basis of standards-based assessments fairer than decisions made exclusively on the basis of grades. Moreover, the evaluation by common standards can harmonize teachers' evaluations across different classes and schools and therefore make teacher-given grades better in terms of comparability. Furthermore, it is argued that standards-based assessments foster students' motivation and their sense of justice. This should be so because standards are more transparent than the evaluation by grades and students often perceive good grades as confined to only a few students. Because standards are based on task mastery rather than social norms, the notion is conveyed

that every student who reaches these criteria can get good evaluations. Finally, standards-based assessments evaluate not only students' performance but also the quality of the work of teachers and schools. If two schools, that are equally funded and whose students come with comparable prerequisites (e.g., SES) differ with respect to their results in standards-based assessments, then the conclusion might be drawn that these different outcomes are a result of better and poorer teaching. Therefore, standards-based assessments also fulfill the function to evaluate schools and to make the quality of schools comparable.

One important danger that is associated with standards-based assessment is the phenomenon called teaching-to-the-test. Once teachers realize what is measured in standards-based tests, they might focus too much on conveying only the knowledge and skills measured by the test and neglect other important areas of learning. Because the tests can only assess competencies that are testable by means of paper and pencil assessments, there is the threat that only these kinds of contents will be taught. As a matter of fact, it is especially difficult to measure cross-curricular competencies, such as complex problem solving or social competencies in a group-testing situation with paper and pencil. Therefore, teaching-to-the-test poses a serious problem for standards-based assessment.

Predictors of Academic Achievement

In the following section, we take a look at those factors known to be most closely related to differences in academic achievement. Because most of the underlying research uses designs that do not allow for unanimous causal interpretations, these factors are called 'predictors' rather than determinants or influences of academic achievement.

Individual Student Characteristics

Individual student characteristics are by far the most important predictors of differences in academic achievement. Taken together, individual characteristics such as intelligence, motivation, and personality explain about half of the differences in scholastic performance. Among these individual characteristics, differences in intelligence are responsible for half of the differences in scholastic achievement. This makes intelligence the most important single predictor of academic achievement. Intelligence explains about 25% of the differences in school achievement. The strength of association between intelligence and scholastic achievement differs depending on whether grades or standardized tests are used as indicators. Intelligence is more closely correlated with results from standardized tests than with grades.

Knowing the history of intelligence testing, the strong association between intelligence and school achievement is unsurprising. Intelligence tests have been developed with an aim to assess children's cognitive potential and guide decisions about the most adequate schools and treatments. Therefore, every new intelligence test has to prove its usefulness and validity by being a good predictor of school performance. But of course these associations cannot and must not be perfect because in such a case the test would not measure anything besides scholastic achievement. Instead, intelligence tests are meant to

assess the cognitive potential of a person largely independently from educational influences. Therefore, intelligence tests use tasks that should be largely free of prior knowledge and school-based learning, such as anagrams, matrices, and the like. Nevertheless, intelligence tests are not completely free of educational influences and any measurement of intelligence always assesses, to some extent, educational influences. It has been shown that attending school has positive effects on intelligence. Therefore, intelligence and academic achievement are closely related not only because intelligence influences academic achievement but also because academic achievements foster intelligence.

Besides cognitive abilities, personality plays an important role for academic achievement. Among the famous Big Five factors of personality (extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness), for some time now, the leading model to describe personality, conscientiousness has proved to be the best predictor of academic achievement. The other factors of personality show only weak or no association with academic achievement. A person who is conscientious can be described as planned, organized, achievement-oriented, ambitious, dependable, and persistent – all of which contributes to better scholastic achievement. Although the relationship between conscientiousness and academic achievement is consistently shown, it is far weaker than the relationship between cognitive abilities and performance. One reason for this is that the Big Five are meant to describe personality in all kinds of contexts and are not specifically designed to explain achievement-related behavior.

Besides these broad personality factors, psychologists who are especially interested in learning and achievement have identified personality dimensions that are more specifically important in achievement situations. These personality constructs can be subsumed under the term achievement motivation. Some of the most investigated constructs of achievement motivation are the need for achievement, ability self-concepts, self-efficacy, task values, interest, intrinsic and extrinsic motivation, and goals. Overall, there is a moderate association between the expression of these motivational constructs and academic achievement. Motivational characteristics are by and large independent of intelligence and are often found to contribute to the explanation of academic performance over and beyond cognitive ability. The strongest relationship is consistently found between domain-specific ability self-concepts and academic achievement. This association is often as strong as the association between intelligence and academic achievement. The relationship between interest or intrinsic motivation and academic achievement is moderately close. This might be surprising because both researchers and practitioners are often convinced that these motivational factors are of paramount importance for performance. It needs to be taken into account that in achievement contexts, learners are often not free to choose whether to engage in a subject or task but feel a pressure to do well regardless of their interest or intrinsic motivation. This explains why interest and intrinsic motivation are often to be found less predictive of academic achievement than expected.

Besides cognitive ability and personality, there is much research on the role of students' study behavior and attitudes, often subsumed under the term self-regulation abilities. Surprisingly, empirical studies often showed no or only weak

associations between the use of learning strategies and learning outcomes. A recent meta-analysis tries to clarify which study habits, skills, and attitudes actually are associated with better outcomes and what might be the reasons why so many studies fail to show these effects. For example, study habits, skills, and attitudes have been shown to be better predictors of college achievement than of earlier school achievement. Nevertheless, even in college the association between self-regulated learning strategies and achievement is weak.

Classroom Characteristics

Surprisingly few classroom and teacher characteristics show consistent positive associations with academic achievement. This is primarily due to difficulties separating single characteristics and investigating their effects. For example, regular and private schools often not only differ with respect to one single characteristic but in several respects (e.g., applied grading standards, teacher education and selection, pedagogical approach, financial, and other resources). Therefore, it is impossible to trace differences in students' academic performance back to one single classroom or teacher characteristic. A second reason is that different teaching styles might lead to similar results so that there is not just one way to enhance students' performance. Teachers might impress their students with their subject knowledge or might place great value on good student-teacher relations and both approaches might serve similarly to motivate students for school-based learning.

Nevertheless, there is one cluster of classroom or teacher characteristics that is consistently connected with differences in academic achievement: Students who attend a class with a high level of discipline and strict classroom management have better learning outcomes. A high level of order in the classroom allows teachers to spend more time-on-task and on contents rather than on nonsubject-related matters. Time-on-task is the single-most important classroom characteristic that explains differences in school achievement. Teachers who have good classroom management skills provide clear conduct rules and consistently sanction positive and negative student behavior. In well-managed classrooms, teachers formulate clear assignments so that students know what to do and do not lose time solving uncertainty. All of these characteristics contribute to better student learning and achievement.

Educational System Characteristics

International large-scale studies on student achievement provide solid data regarding the association between characteristics of the educational system and student achievement. However, the same problems that apply to comparisons of classrooms also apply to the level of the educational system. Educational systems usually differ in many aspects so that it is difficult to trace better student achievement back to one single characteristic of the educational system. Often only the combination of different characteristics goes along with enhanced achievement. For example, Finland – one of the leading countries with regard to student achievement – does not separate students into different tracks. Children with and without special needs are taught in the same class. Copying this characteristic would make no sense without also copying the small

class sizes and good student–teacher relation with extra special needs teachers. Neither a comprehensive school nor small classes are per se associated with better student performance; but in the right combination, these characteristics make a difference.

On the level of the educational system, there are some characteristics that are consistently associated with better mean levels of academic achievement. One of these is the percentage of children attending kindergarten and preschool: the more children get preschool education, the better a nation's mean level of student achievement later in school. Institutionalized preschool education is especially important for children who lack a stimulating environment at home. Preschool education helps to compensate unequal prerequisites and to detect special needs or other ability deficiencies, such as dyslexia or language problems, for which special aid can be given even before school age.

A second characteristic of the educational system that is consistently associated with better student achievement is the use of high-stakes tests, such as central exams and standards-based assessment. There are many ways to explain this association. One can argue that with a national curriculum and curriculum-based tests teachers have better goal clarity and place more importance on teaching what students need to know to do well on the tests. In its extreme, this goal clarity might turn into teaching-to-the-test, which is undesirable, because competencies not assessed in the test, that still might be important, are neglected. Therefore, teaching-to-the-test is a serious danger that comes along with high-stakes testing. Another reason for the association between use of high-stakes tests and better school achievement might be that countries employing high-stakes tests place more importance on education and invest more effort in raising the educational level. Establishing high-stakes testing is usually a consequence of a country's participation in international large-scale studies of academic achievement and the wish to monitor educational outcomes more closely. Therefore, a plausible explanation for the association between high-stakes testing and student achievement is that nations more concerned with the quality of education make more use of high-stakes tests. The last reason might be that the use of high-stakes tests trains students to do better on standardized achievement tests as used in international scholastic achievement studies. For example, the typical type of tasks and answering formats in high-stakes tests and standardized achievement tests are very similar, so that regularly taking high-stakes tests at school will train students to do better on standardized achievement tests.

Besides the mean level of student achievement, a second important indicator of educational quality is the extent of differences between students' achievement. It is desirable that students' achievement is not only high on average but also that the differences between students' achievement are not too large. This can be explained by the example of early tracking. One characteristic of the educational system that has been shown to enlarge differences between students is an early separation of children into educational tracks stratified for level of achievement. Empirical evidence indicates that in countries with an early separation into educational tracks, the standard deviation of scholastic achievement as measured with standardized achievement tests increases from elementary school to secondary school. In countries with late or no

separation into educational tracks, the standard deviation decreases over the school years. Another undesirable effect of earlier tracking is a stronger association between children's school achievement and family background characteristics such as SES. For example, Germany is one of the few countries that separate students as early as grade 4. In Germany, the upper and lower 5% of the achievement spectrum show the greatest divide compared to all other nations. At the same time, in Germany the association between children's school achievement and their families' SES is the strongest. These results from international school achievement studies have led to a discussion to abolish the early separation either by prolonging elementary school or by merging different types of secondary schools.

Equal Opportunities and Academic Achievement

One important aim of psychological research on academic achievement is to shed light on reasons for differences in education that come along with characteristics that, per se, have no bearing on education. As two examples for such characteristics, we pick gender and SES.

Gender Differences

At the end of the twentieth century, in many countries it is girls and not boys who earn better school grades and higher educational degrees. The gender gap in educational achievement is both a theoretically challenging and practically relevant topic. A connected question is why girls are not using their educational advantages and transferring them into higher achievements later in life. Women are still unrepresented in higher job positions and earn less than their male colleagues.

A variety of reasons for the gender gap in education have been put forward. The influences of changing cultures on children's educational outcomes are visible in similar trends taking place throughout the developed world: the more developed a country is and the more it aspires equal opportunities for both sexes, the better girls are at school. For example, in rural areas of China, girls are still found to do worse than boys in school. In Hong Kong, girls outperformed boys in school only after a Western outlook had been adopted in addition to the traditional Chinese culture. Evidence from international large-scale studies shows that the gender gaps in math and reading are associated with the degree of women's emancipation that is realized in a country. For example, in Scandinavian countries, which score high on women's emancipation, the gender gap for mathematics is smaller and in some cases even nonexistent, whereas in reading, girls have an even bigger head start than on OECD average. In contrast to this, in countries that have no culture of women's emancipation, such as Turkey, girls do markedly worse in math than boys and their advantage in reading is comparably small. Thus, girls' better school achievement is related to societal changes in attitudes toward equal opportunities for men and women.

Besides such societal influences, gender differences in individual characteristics, such as cognitive ability, personality, and motivation, have been proposed as explanations for the gender gap in academic achievement. Gender differences in cognitive

ability can be excluded as an explanation for girls' better academic attainment for several reasons. First, most researchers agree that there are no gender differences in general intelligence. If differences in general intelligence are found, then they are in favor of boys. Second, gender differences in specific intelligence components are too weak to explain the observed differences in school achievement. It is often found that girls have an advantage in verbal intelligence and boys' in numeric intelligence. Nevertheless, these ability differences are too small to explain the observed differences in school achievement. Third, even when differences in intelligence are statistically controlled, girls have been shown to get better grades. Therefore, differences in cognitive ability are not the explanation for gender differences in academic achievement.

The most promising candidates that explain gender differences in academic achievement are gender-typical differences in personality and motivation. Girls are typically more intrinsically motivated for school-based learning. Boys, on the hand, show on average lower school-related learning motivation and, at the same time, have fewer self-control resources to counterbalance their low motivation. Their higher self-control allows girls to regulate their emotions and behavior, and respond to demands at school even if they are not interested in what they have to do. Moreover, whereas in girls' peer groups it is absolutely acceptable to be good at school and conform to school rules, boys' peer groups rather reward oppositional behavior and sanction boys who do too well at school. Another assumption is that girls succeed in school because of their more agreeable personalities. Teachers are known to reward agreeable behavior with better grades. Taken together, these differences in girls' and boys' personality are important explanations for girls' better school achievement.

If a better fit of girls' personality and motivation to the school environment is the reason for girls' advantages in academic achievement, then there are two possibilities to enhance boys' achievement: either change boys' characteristics or change the school environment. According to the first alternative, interventions that enhance boys' intrinsic motivation for school-based learning and foster their self-regulatory competencies are a viable way. According to the second alternative, the school environment needs to be cleared of such characteristics that unfairly favor girls but do not actually foster or assess achievement. For example, if grades are used to reward agreeable behavior, then teachers need to be trained to keep their evaluations free of such influences and find other ways to ensure discipline in the classroom. Another way to ensure that boys conform to school rules is to sanction violations of rules consequently and strictly. If boys do not have the chance to violate rules, then the differences between girls' and boys' behavior become smaller and might, as a consequence, diminish differences in academic achievement. At this time, these suggestions are not tested empirically. More research is needed to see whether these are viable ways to decrease the gender gap in school achievement.

Socioeconomic Status

The SES of a person, family, or other social group indicates their possession of economic and social resources. Most frequently, SES is assessed by occupation, education, income, or a

combination of all. It is a general finding that the SES of a family is associated with children's academic achievement and their highest educational degrees. According to meta-analyses and international large-scale studies of school achievement, the strength of the association between SES and children's academic achievement is moderate ($r = 0.30-0.40$). The strength of association reported varies markedly depending on the indicators used to measure SES and academic achievement, age of children, and whether the full range or a restricted range of SES and achievement was investigated.

Because SES has per se no bearing on a child's achievement, the association between SES and academic achievement is commonly considered as evidence for social injustice and unequal opportunities. The most convincing evidence that SES actually is associated with injustice comes from studies showing that two students, one from a family with low SES the other from a high SES home, have different chances to acquire higher educational degrees even if they have the same ability according to standardized tests.

But why is the family SES associated with children's academic achievement? The way to find an answer to this question is to look behind the label SES and find those factors that are known to be prerequisites for academic achievement. SES itself is just a carrier variable that is associated with other factors that are actual causes of differences in academic achievement. For example, it is well established that a higher SES, on average, goes along with higher intelligence and higher aspirations and engagement for education. Parents who possess such favorable characteristics pass these on to their children, either by providing them a stimulating environment or via genes. Parents who have high aspirations for their children provide them with a more supportive environment and, at the same time, have children who are more likely to have high aspirations themselves. It can be shown that large parts of the association between family SES and children's school achievement are explained by parents' and children's sharing of personal and environmental characteristics that contribute to better academic achievement. This is an important finding because it shows that the association between family SES and children's achievement is not per se an indicator of social injustice. Instead, it indicates that desirable resources are distributed unequally among families and that societies must make deliberate choices whether to compensate for different starting positions or whether to let those differences become even larger.

What can be done to avoid unequal opportunities with regard to SES? On the level of the educational system, the evidence is clear that early tracking increases dependability of academic achievement on family attributes. One recommendation to reduce the association between SES and academic achievement is to keep students together in one type of school throughout middle school and even high school. Another recommendation is to use not only grades for admission decisions to the next level of education but also standards-based assessments. To assess something with different measures is always a good way to validate each single measure. On the one hand, teachers might be influenced by their knowledge of the families' background whereas standardized tests are not. On the other hand, some standardized tests are even more strongly associated with SES than grades. Therefore, it is important to base vital decisions on more than just one source of

information. Again, this is a field in which more research is needed to find the best way to produce equal opportunities with respect to families' social and economic background.

See also: The Behavior-Genetics of Intelligence; Cognition and Personality; Equity Theory; Genius, Eminence, and Giftedness; Human Intelligence; Motivation; Self-Efficacy; Studying; Sex Differences.

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Addictions and Adolescence

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Glossary

Cognitive-behavior therapy (CBT) A common type of counseling based on the belief that using both cognitive therapy and behavioral therapy is more effective than just one of these types. The two components of the therapy seeks to help the client identify and change harmful or dysfunctional thinking, emotional and behavior responses.

Diagnostic and Statistical Manual of Mental Disorders (DSM) The DSM is published by the American Psychiatric Association and provides a common language and standard criteria for the classification of behavioral and mental disorders, including the addictive disorders discussed in this article. The current version is the fourth edition, known as DSM-IV.

Nicotine dependence Nicotine is present in tobacco products (e.g., cigarettes, cigars, tobacco snuff) and like other physically addictive drugs such as alcohol and cocaine, can lead to dependence. Signs of dependence include frequent use, repeated urges to use, and withdrawal symptoms when the person cuts down or stops using a tobacco product.

Pathological gambling As defined by DSM-IV, pathological gambling is a persistent and recurrent maladaptive disorder that disrupts one's life as evidenced by five or more of the following diagnostic criteria: preoccupation with gambling; needing to gamble with larger amounts of money in order to achieve the same level of excitement; repeated unsuccessful attempts to cut down or stop gambling; feelings of restlessness or irritability when trying to cut back or stop gambling; gambling to escape problems or unpleasant emotions; chasing losses; lying to family member or hiding evidence of one's gambling; committing illegal acts to support one's gambling; jeopardizing significant relationships; and relying on others to relieve a desperate financial situation.

Problem gambling Whereas pathological gambling is a clinical diagnosis with specific diagnostic criteria, the term

'problem gambling' is a broader construct that identifies individuals who exhibit some problems with their gambling but who do not meet diagnostic criteria for pathological gambling. This level of problem severity is sometimes referred to as subthreshold or subclinical problem gambling.

Substance use disorders DSM-IV recognizes two substance use disorders (SUDs) Abuse and dependence. The two diagnoses are defined by distinct sets of symptoms. Substance abuse is generally considered to represent a milder SUD, compared to substance dependence, and its symptoms focus on life disruptions and negative consequences to the user. DSM-IV substance abuse requires meeting 1 of 4 criteria that represent recurrent psychosocial consequences related to substance use (e.g., school grades dropped due to substance use, interpersonal relations damaged due to substance use, substance-related legal problems), and hazardous substance use (e.g., driving when intoxicated). DSM-IV substance dependence requires meeting 3 of 7 criteria within the same 1-year period, and identifies a compulsive pattern of substance use despite the continuation of negative consequences. Dependence criteria include physical symptoms (i.e., a high level of tolerance, a recurrent withdrawal syndrome), prioritizing substance use over other activities (i.e., much time spent using, reducing activities in favor of drug use), and impaired control over use (i.e., used more or longer than intended, difficulty cutting down or abstaining from use, use despite adverse physical and psychological consequences of substance use). In keeping with the notion that dependence is a more severe condition than abuse, meeting criteria for dependence overrides a diagnosis of abuse for a given substance. Although there are differences across drugs in the extent to which certain criteria may be relevant, the same criteria are used across all substances, with the exception that DSM-IV does not include a nicotine 'abuse' diagnosis, and withdrawal is not a criterion for dependence on cannabis or hallucinogens.

Introduction

In the adolescent literature, the past 20 years have been characterized by a rapid growth of research in the understanding of developmental psychopathology and adolescent development. This emerging research area has greatly advanced our understanding of the extent and nature of addictive disorders among adolescents. We recognize that addictive behaviors, as they pertain to youth, represent a broad construct as it does

for adults. However, there are relatively large research literatures that address three broad domains of addictive disorders for adolescents: nicotine dependence, other substance use disorders, and pathological gambling. Thus we have organized this article around the description of the three addictive disorders from clinical, epidemiological, and treatment perspectives. But first we address several developmental considerations that pertain to the construct of addiction as applied to adolescents.

Developmental Issues

Historically, addictions have been defined with reference only to the compulsive – like the use of a psychoactive substance – disorders (including nicotine) that temporarily alter reward-based chemicals in the brain. Many experts now consider behavioral addictions as legitimate members of the spectrum of addictive disorders; these include ‘psychological dependencies’ on gambling, food, sex, and shopping.

All addictive disorders are reflected by individuals pursuing rewards or relief by substance use or other behaviors, and are characterized by impairment in behavioral control, craving, inability to consistently abstain, and diminished recognition of significant problems with one’s behavior and interpersonal relationships. Thus, the essence of addiction is the recurring compulsion felt by an individual to engage in some specific activity in the presence of harmful consequences to the individual’s health, mental state, or social life. Like other chronic diseases, addiction involves cycles of relapse and remission, and many individuals do not achieve stable recovery until after several courses of treatment. Also, some individuals obtain successful recovery without formal treatment.

Several issues are relevant here as we consider the importance of the context of adolescence and addictions. We briefly discuss the following three contextual issues: etiology, identification of clinical significance, and applicability of addiction diagnostic criteria for adolescents.

Etiology

A traditional view in the developmental literature is that adolescents may be more vulnerable than adults to addiction. Indeed, the vast majority of adults with an addictive disorder began their indulgence during the critical developmental period of adolescence. Also, recent and converging evidence suggest that the substance-based addictions develop more

quickly and with less exposure to the particular substance during adolescence compared to the same during adulthood. Multiple factors clearly play roles in fostering the development of addiction, including genetics, peer influence, management of stress, parenting, and the motivational push to explore the world to learn to be an adult. Also, delays in social and emotional functioning, diminished respect toward authority, and tendencies to be self-absorbed and to minimize negative consequences may contribute to involvement in addictive behaviors.

Brain Development

One emerging view is that adolescent vulnerability to addictive disorders is significantly influenced by the way their brain grows. Basic and clinical data support the stance that adolescence is a neurodevelopmentally critical period of great vulnerability for risk-taking, experimentation with substances, and acquisition of addictive disorders.

Recent studies on this subject support the view that the neurodevelopmental basis for this vulnerability is associated with the maturation of a particular region in adolescent brains. The region of the brain that monitors impulse and motivation, the frontal cortex, is not fully formed during adolescence (see [Figure 1](#)). Adolescent impulsivity and novelty seeking as a transitional trait behavior may be explained in part by maturational changes in the frontal cortical region. These developmental processes may not only advantageously promote learning drives for adaptation to adult roles, but may also confer greater vulnerability to the addictive actions of drugs. This brain region’s quick-fire change that is relatively unique to adolescence may translate to teenagers being more likely than children and adults to try out new experiences and to be more impulsive and take risks. These findings suggest that for adolescents, addictive disorders are neurodevelopmental disorders.

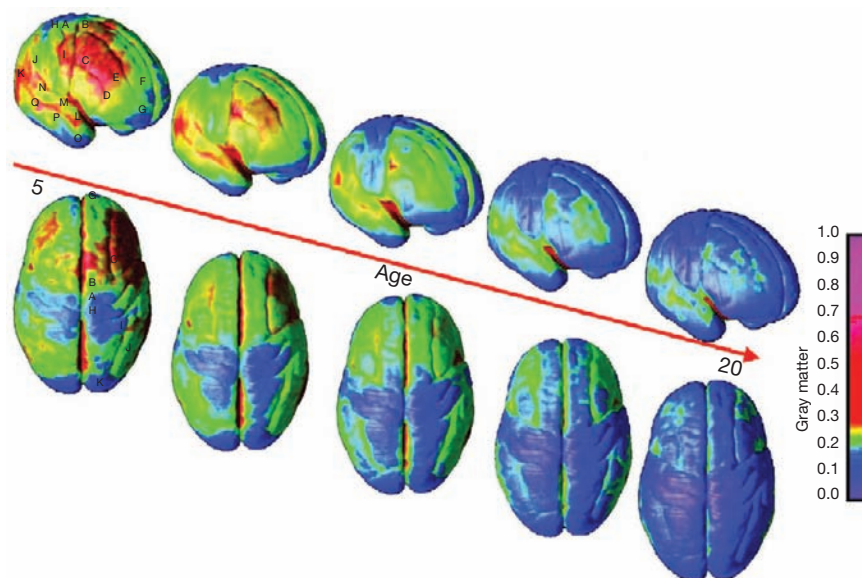


Figure 1 Gray matter maturation. Reproduced from Gogtay N, Giedd JN, Luck L, et al. (2004) Dynamic mapping of human cortical development during childhood through early adulthood. *Proceedings of the National Academy of Sciences of the United States of America* 101: 8174–8179.

Inherited Characteristics

A wealth of family and twin studies provide strong support to the fact that genetic factors play a major role in the development of addictive disorders. An additional support for this is the theory that states that during childhood, the genetic liability for addictive disorders manifests as an underlying deficit in the young person's ability to regulate and control impulses, often referred to as the dysregulation syndrome. This liability is also seen as an antecedent to several behavioral disorders that commonly coexist with addictive disorders, such as conduct disorder, oppositional defiant disorder, and attention-deficit hyperactivity disorder (ADHD). A related group of antecedents to addictive behaviors that may also have a genetic basis are negative affect disorders, such as anxiety disorders and depressive disorders. It has been hypothesized that young people suffering from these disorders engage in addictive behaviors to alleviate the underlying negative emotions of anxiety and depression.

Environmental Influences

Many nonbiological factors also influence the likelihood of developing an addictive disorder, and there is converging data indicating that these factors generalize across a range of addictive disorders. Key environmental factors that *increase* risk for an addictive disorder for youth are affiliation with delinquent peers, lack of involvement in prosocial activities (e.g., participation in extracurricular school activities), lack of conventional values, and poor parenting practices (e.g., distant relations with the child; poor supervision and monitoring; poor role modeling). Another environmental factor pertains to the ease of access and availability of the addictive 'agent' (i.e., drug, gambling venue, etc.). Two dramatic examples of this pertaining to youth in the United States are the following: (1) the substances abused the most by youth are those that are the most available and accessible to them – legal substances

such as tobacco and alcohol, and (2) the dramatic expansion of legalized gambling in the United States is consistent with the recent increase in gambling by teenagers.

Identifying Clinical Significance

It is true that relatively few teenagers who use drugs or gamble, even regularly, will become addicted. Nonetheless, it can be difficult to determine when involvement in addictive behaviors by adolescents will have no negative consequences, when it may involve short-term and minimal health effects, or when it may be associated with serious negative long-term repercussions. As will be discussed later in this article, the high prevalence rate of drug use and gambling by teenagers gives some credence to the notion that these behaviors are a normative part of youth. When adolescents use drugs, it is typical that they use legal drugs (alcohol or tobacco) and use them within a social context. Gambling by adolescents often occurs with peers and involves making informal, social bets (e.g., who will get the better test score). The large majority of drug-using youth will not progress beyond the use of the so-called gateway drugs of alcohol and tobacco, and we can say with similar certainty that most youth gamblers will not develop a gambling problem.

However, it is also the case that adolescence may be a particularly vulnerable period to develop an addictive disorder or an addition problem. For example, young people show higher rates of alcohol problems compared to older age groups. [Figure 2](#) below shows that among youth aged 15–20 years old, 12.2% met an official definition of an alcohol dependence disorder within the past 12 months. This rate was much higher than the other age groups.

There is a similar association between early onset gambling and increased risk for adult gambling problems. Data collected during 2001–2003 from the US National Comorbidity Survey Replication Study found that adults with a pathological gambling disorder reported first gambling significantly earlier than gamblers without a history of pathological gambling (mean

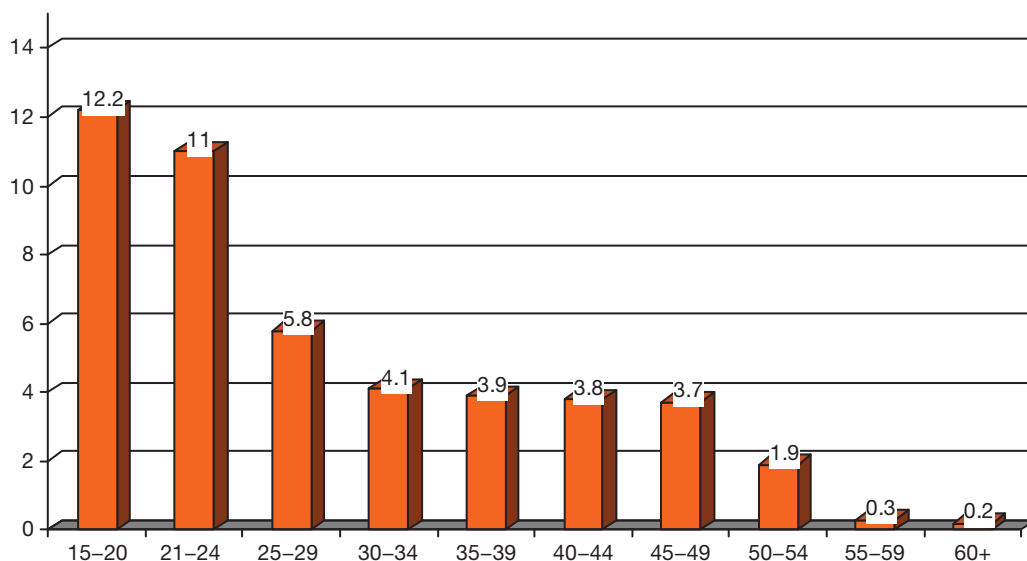


Figure 2 Prevalence of past year DSM-IV alcohol dependence: United States, 2000–2001. Reproduced from Grant BF, et al. (2004) *Drug and Alcohol Dependence* 74: 223–234.

age 16.7 vs. 23.9 years). Then there is the issue of *current* problems associated with addictive behaviors during youth. Later in this article we provide more details about prevalence rates, but in a general sense the rates among adolescents of each of our target addictive disorders are appreciable. One example: Based on the National Household Survey data, it is estimated that 11% of youth (12–18 year olds) meet a current DSM-IV diagnosis for a substance use disorder.

Applicability of Addiction Diagnostic Criteria for Adolescents

A related issue is the applicability of formal diagnostic criteria for addictive disorders to adolescents. The three addictive disorders we discuss in this article – nicotine dependence, substance use disorders and pathological gambling – are defined by DSM-IV. However, adolescent-specific definitions of these disorders do not exist in the DSM system, a concern that does not sit well with many experts who can point to some existing criteria that are not relevant for youth and can identify other symptoms that are adolescent specific and clinically relevant and yet are not included in the current diagnostic nomenclature. We will return to definitional issues in upcoming sections.

Three Adolescent Addictive Disorders

We now turn our attention to the three domains of adolescent addictive behaviors for which there is a relatively substantial empirical literature – nicotine dependence, other substance use disorders, and pathological gambling. Each subsection will provide an overview of clinical characteristics and definition, epidemiology, etiology, and treatment.

Nicotine Dependence

Clinical Characteristics and Definition

The primary tobacco product used by adolescents is the cigarette, so this subsection will focus solely on this source of nicotine. Experimentation with cigarette smoking is a common phenomenon among adolescents, with upward of 46% of high school seniors reported having previously tried smoking. While not all adolescents who try smoking progress to habitual smoking, data from the Monitoring the Future Study (MTFS) reveal that over 12.3% of high school seniors reported smoking daily. Rates of smoking continue to increase during late adolescence/emerging adulthood (from age 18 to 24), resulting in the highest rate of smoking (23.9%) among all age groups. Factors that influence progression beyond initial experimentation may be quite distinct from those that influence first trials with cigarettes. For example, social influence processes are well-established predictors of initial experimentation, but mood/emotional factors may be more important than social influences in determining progression beyond initial trials with smoking.

We know that the vast majority of current adult smokers began their smoking careers by the age of 18. Given the association between smoking in adolescence and subsequent health

problems in adulthood, the initiation and maintenance of smoking during adolescence and young adulthood represent genuine public health concerns. In addition, mounting evidence links smoking with health problems (e.g., respiratory and cardiovascular) during adolescence. The notion that adolescent smokers are addicted to nicotine and thus driven by compulsive drug-seeking behavior represents a serious concern above and beyond that posed by the associated health risks. Indeed, the Surgeon General in 1994 concluded in a published report that “most adolescents [who smoke] are addicted to nicotine and report that they want to quit but are unable to do so; they experience relapse rates and withdrawal symptoms similar to those reported by adults.”

The notion that most adolescent smokers are nicotine dependent should have a considerable impact on prevention, treatment, and policy at multiple levels. However, the vast majority of research on nicotine dependence has focused on adult smokers, and relatively few attempts have been made to document the emergence of nicotine dependence among adolescents. Indeed, Alexander Prokhorov and colleagues, nicotine research experts, speculated that “The lack of interest in the study of nicotine dependence in adolescents might be explained by the prime orientation of adolescent research on the prevention of smoking onset along with skepticism with respect to the ability to develop an appreciable degree of nicotine dependence during the relatively short period of adolescence.” More than a decade later a paradigm shift in the field is placing increasing attention on the need for research to identify the factors that may promote smoking behavior and to examine the emergence of nicotine dependence in young people.

Epidemiology

Reducing smoking prevalence is an important national health objective in the United States. Whereas cigarette smoking had steadily decreased between 1997 and 2004, the National Health Interview Survey (NHIS) indicates that cigarette smoking prevalence has remained steady at 20.8% since then. Smoking prevalence is higher among men (23.9%) than women (18.0%), and among different racial groups, those of Asian (10.4%) and Hispanic (15.2%) descent have lower smoking rates than Caucasians (21.0%), African-Americans (23.0%), or American Indians/Alaskan Natives (32.4%). There are also higher rates of smoking among those with the lowest socioeconomic status.

As noted earlier, smoking behavior most often begins in adolescence, with 20% of 8th graders reporting some experience with cigarettes. Although adolescents may under-report smoking behavior for a number of reasons, including social undesirability, fear of disclosure, or inaccurate recall, tobacco has remained the substance most often used on a daily basis by high school students for over 30 years, according to responses from successive cohorts of the MTFS. To track trends in cigarette smoking among adolescents and young adults, the MTFS researchers have administered a series of national surveys that assess cigarette, alcohol, and illicit drug use over time. Results show that in the 1980s, smoking rates remained steady among adolescent smokers, though they declined in adults. In the early 1990s, cigarette smoking among 8th and 10th graders

rose by 50% before declining steadily in the second half of the decade. The decline in smoking among high school students has decelerated in recent years, however, and most daily adolescent smokers report smoking half a pack or more per day.

A closer examination of these data reveals some factors that might go some way toward explaining such trends in cigarette smoking among youth. Increased cigarette prices reduce cigarette smoking among adolescents, and not smoking sharply reduces risk of using alcohol and illicit drugs. Importantly, men are more likely to progress from occasional to regular smoking, as are those who hold more positive smoking outcome and affect regulation expectancies.

Whereas regular (e.g., daily) smoking is a hallmark of nicotine dependence in adults, adolescent smokers can apparently exhibit symptoms of dependence with only occasional use, often before the onset of daily smoking. To date, despite various validated nicotine-dependence questionnaires, there is no universally accepted tool for identifying or measuring nicotine dependence in adolescents. Joseph DiFranza and his colleagues suggest that loss of autonomy over one's behavior might be the most salient feature of nicotine dependence in adolescents, rather than quantity or frequency of tobacco use. Indeed, the development of a single symptom of nicotine dependence appears to predict continued use, indicating that loss of autonomy and dependence might have a strong temporal (and perhaps causal) relationship.

Etiology

The conventional description of the natural history of dependent smoking is that individuals first try smoking in early to mid-adolescence and gradually escalate their frequency of smoking over a 2- or 3-year period to the point where they are smoking daily. Daily smokers continue to escalate cigarette use over the next several years as they develop into chronic, heavily dependent smokers. Though this description is consistent with national survey data, this pattern represents an average that does not convey the wide variety of patterns that can occur during the emergence of nicotine dependence. To date, little research has contradicted this pattern, though we expect this may be due to the expectation that heavy daily smoking is necessary for the emergence of nicotine dependence. That is, the vast majority of smoking studies have measured dependence symptoms *only* among respondents who meet clearly established smoking patterns (e.g., daily use), and this approach precludes the examination of dependence symptoms at nondaily levels of use. This approach derives from an implicit assumption governing the field; that is, that an isomorphism exists between smoke exposure (i.e., amount smoked) and symptoms of dependence. However, emerging evidence suggests the relationship between smoking exposure and the symptoms of withdrawal and dependence is far from perfect.

Research findings from the lab of one of the authors (Kassel and Conrad) bear on the question of whether adolescent smokers – even those who smoke relatively infrequently – manifest signs and symptoms of nicotine dependence. They assessed the acute effects of nicotine on positive (PA) and negative affect (NA) in a group of 15–18 year olds. A matched group of nonsmokers served as a comparison group. This is

probably the first study conducted in the United States in which nicotine was administered to adolescent smokers under controlled laboratory conditions. The findings conformed to a negative reinforcement model of nicotine effects and strongly suggested that, even among young (mean age = 17.5), light smokers (5.5 days a week smoked; 3.5 cigarettes a day), nicotine dependence and resultant withdrawal symptoms appear to serve as motivating factors governing smoking behavior.

Several interesting and important findings also emerged from correlational analyses. Craving was significantly correlated with nicotine dependence ($r = 0.60$), NA management expectancies ($r = 0.37$), boredom relief expectancies ($r = 0.53$), boost in expired air carbon monoxide (CO; an index of smoke exposure) derived from smoking the cigarette ($r = 0.40$), and pre-post-smoking reduction in NA ($r = -0.38$). In addition, the measure of nicotine dependence demonstrated significant correlations with recency of smoking (the more dependent the participant was, the more recently he or she had smoked; $r = -0.40$), number of cigarettes smoked on the study day ($r = 0.49$), and NA management expectancies ($r = 0.32$). Taken together, then, these findings suggest that even young, relatively light smokers exhibit signs and symptoms of nicotine dependence (albeit at low levels) and that symptoms of nicotine dependence are correlated in meaningful ways with other smoking-related characteristics.

Nevertheless, the pathways to becoming a smoker are clearly complex and governed by a host of genetic, social, pharmacological, and psychological determinants. While social factors (e.g., peer affiliations and peer socialization) have emerged as potent and reliable predictors of smoking initiation and experimentation, some evidence suggests that heightened levels of stress and negative affect, manifestations of psychopathology associated with affective distress and anxiety, are linked to progression in smoking status and nicotine dependence among adolescents. Thus, distinguishing the processes that govern smoking initiation and experimentation from those that underlie progression to nicotine dependence is of particular importance in examining smoking patterns in adolescents and young adults.

Findings from cross-sectional and longitudinal studies show that adolescents who experience significant levels of affective distress are more likely to smoke, and many researchers have inferred that these adolescents smoke because it alleviates negative affect. However, ascribing causal (within-subject) mechanisms based on results derived from cross-sectional (between-subject) analyses may not always be appropriate. Although only limited empirical work has been devoted to answering the question of whether smoking genuinely influences emotional response in adolescents, several studies do offer some insight into the motives associated with adolescent smoking. Though not a direct indicator of nicotine dependence, the subjective effects experienced by smokers are likely to reflect the role of nicotine (and other constituents of tobacco smoke) in governing smoking behavior. A number of studies point to the importance of affect management as motivation for smoking among young smokers. For example, several studies have found that adolescent smoking initiates commonly reported 'smoking to relax' and 'stress reduction' as important motives for smoking. More recent studies by Johnson and colleagues

also reveal significant endorsement of emotional reinforcement motives among adolescent smokers, with a large proportion attributing their smoking to its reputed ability to facilitate affect regulation. Correspondingly, a number of recent investigations found that smoking in response to negative affect was the most frequently endorsed motive among adolescent smokers.

Treatment

There are a number of obstacles to overcome when considering treatment options for adolescent smokers. First, intervention efforts are most often impeded by irregular smoking patterns among this group, as most teenagers smoke under limited circumstances and, perhaps most importantly, do not view their behavior as a serious problem. At this transitional life stage, adolescent smokers are also often concerned with privacy and autonomy. Most smoking cessation programs are tailored to adult regular smokers and are therefore less accessible to an adolescent occasional smoker. Ultimately, successful interventions are careful to tailor the treatment to the individual and protect confidentiality.

Currently, cognitive-behavioral therapy (CBT) is the treatment most often recommended for adolescent smokers who want to quit, in the absence of youth-specific treatment options. Previous research has focused on the frequency and duration of treatment sessions, comparing the effectiveness of longer sessions offered once per week to shorter sessions offered several times per week, often with a contingency management component that provides tangible reinforcement for maintaining abstinence. Studies show that abstinence rates do not vary as a function of session length or frequency. As such, this finding might represent an opportunity to tailor treatment to the individual, based on convenience and preference.

Medical-based or pharmacological treatments used in conjunction with CBT have also garnered increasing empirical scrutiny in adolescents. Generally, the nicotine patch appears safe to use with smokers as young as 13 years old. The patch, as compared with placebo, decreases cigarette craving and withdrawal symptoms, though it ultimately appears to have no effect on abstinence rates. Bupropion, an antidepressant deemed efficacious as a smoking cessation aid in adult smokers, has also been found effective in adolescent smokers, although it is usually employed in conjunction with brief counseling or family support.

Alternative smoking cessation programs have recently focused on using different media outlets to offer counseling services. In the short-term, Internet-based virtual reality applications, monitored by a trained counselor, result in enhanced 1-week abstinence rates, fewer smoking days in the past week, and fewer cigarettes smoked in the last week for those treated than those receiving no treatment. Web-assisted tobacco intervention programs that combine interactive quizzes with self-assessment and feedback show promising results in reducing intentions to smoke, increasing resistance to smoking, and decreasing heavy cigarette use.

Other studies indicate that brief visits with the pediatrician in a medical office setting can increase the adolescent's readiness to quit. One study offered four brief individual weekly sessions in the medical office, while a home-based Internet intervention was accessible for 24 weeks. Whereas no group differences in abstinence rates were observed, those who continued to smoke

showed fewer smoking days in the office condition compared to the Internet intervention. Most important was the rapid decline in accessing the Internet-based intervention: by week 3 of the study; access had dropped to less than one third of all participants. Among the most popular Web pages were those offering discussion support groups, followed by quit plan pages. Interaction pages were accessed more often than informational pages, and men accessed fewer interactive pages than women. These patterns of use hold important implications for the design of future Web-based applications and their inclusion as a component of smoking cessation treatment.

On an individual treatment level, brief self-help interventions appear generally effective with adolescent smokers who are less nicotine dependent. School-based programs, however, are both prevention and treatment focused in nature, and are thus able to target a larger range of smokers. Standard support within school settings usually comprises abstinence-based lessons. Adding eight, 1-hour no-smoking lessons over the course of 2 years, in addition to support from school nurses, reduces the likelihood that students will smoke regularly or at all in the past month. School-based tobacco use interventions are also effective in reducing overall smoking prevalence, smoking initiation, and smoking intentions in the short term. Unfortunately, relatively few studies perform long-term follow-up, and among those that have, little evidence has been found for school-based prevention programs. In light of these mixed findings, some researchers suggest that schools frame cigarette smoking as an example of a real-world problem in order to further develop critical thinking skills. The best school-based programs are interactive in nature and teach skills to resist drug offers and prodrug influences, correct misperceptions that drug use is normative, and increase social and personal competence.

On a more community-based level, previous studies indicate that well-funded mass-media campaigns targeted at the general population and implemented at the state level, in addition to a comprehensive tobacco control program (e.g., restricting easy access to tobacco products by removing cigarette vending machines; compliance checks at points of purchase to enforce the minimum age law) are associated with reduced smoking rates in adolescents. Also, as we noted above, raising the cost of tobacco products is generally associated with reductions in tobacco use among youth.

Other Substances Use Disorders (Excluding Nicotine)

Clinical Characteristics and Definition

Substance involvement ranges along a continuum of severity that includes abstinence, experimentation, occasional use, regular use, and heavy use and associated problems. Most of the population engages in minimal to occasional use, with increasingly smaller proportions involved in more regular and heavy, chronic levels of substance use. For individuals at the higher end of the substance involvement continuum, the presence of a substance use disorder (SUD) reflects a categorical determination (i.e., disorder is present or absent) that an individual's substance use results in significant impairment in functioning or subjective distress associated with need for treatment.

DSM-IV SUDs were developed based on clinical experience and research involving adults. When applied to adolescents,

DSM-IV SUDs have demonstrated validity as markers of an adolescent's level of substance involvement and associated impairment in functioning. However, certain limitations of DSM-IV SUDs when applied to youth also have been identified, highlighting the importance of developmentally informed assessment of substance-related problems. An important limitation of DSM-IV SUDs when applied to adolescents involves the threshold used to determine the presence of SUD. Some adolescents may report substance-related symptoms, but fall short of meeting criteria for a DSM-IV SUD, either because the symptoms reported are not included among the diagnostic criteria or because the number of symptoms does not meet the threshold for diagnosis. Some youth who report substance-related problems do not meet SUD criteria, and are known as 'diagnostic orphans.' The diagnostic orphans typically report one to two dependence symptoms, and do not meet criteria for a diagnosis of abuse. Research suggests that although diagnostic orphans do not meet criteria for a SUD, they report similar levels of substance use and impairment in functioning as youth with an abuse diagnosis. Diagnostic orphans appear to represent 'missed' cases of SUD that are particularly important to consider when assessing adolescent substance involvement.

Another limitation of DSM-IV SUD criteria when applied to adolescents involves adequate coverage of substance-related problems that are relevant to youth. For example, substance dependence criteria focus on failed attempts to quit or cut down, behaviors that are commonly reported among adults in addictions treatment. However, due to adolescents' typically shorter histories of substance use compared to adults, adolescent substance users may report a pattern of frequent, heavy substance use, that has not yet progressed to attempts to cut down or stop use. In this regard, DSM-IV SUD criteria are limited in capturing a compulsive pattern of use among those who have not yet tried to cut down or stop substance use, resulting in possible under-identification of youth who may benefit from intervention. As another example, the abuse criterion regarding substance use in a hazardous situation is often met by recurrent episodes of driving while intoxicated among adults. However, this criterion applies less to youth who are not driving or who have limited access to a vehicle. Among younger adolescents, symptoms such as recurrent substance-related blackouts, passing out, or risky sexual behavior, may indicate hazardous use, and although they are not explicitly included in DSM-IV SUD criteria, they need to be considered when evaluating adolescent substance users.

Developmentally informed assessment of substance involvement aims to minimize false positive and false negative symptom assignments in order to increase overall validity of SUD diagnoses, particularly when applied to adolescents. Specifically, certain SUD symptoms may manifest differently in adolescents (e.g., drop in school grades due to marijuana use), compared to adults (e.g., marijuana-related impairment in job performance). Other symptoms may have a different meaning in adolescents and adults due to the developmental context in which the symptom occurs. For example, youth may report the dependence symptom as 'spending much time trying to obtain alcohol, drinking, or getting over its effects' due to difficulties in obtaining alcohol as a result of their status as minors, rather than due to a compulsive pattern of use, which is the intended meaning of the symptom. In addition, some youth may report

symptoms of dependence (e.g., withdrawal) at relatively low levels of use. Careful querying is needed to ensure that the adolescent understands what is being asked, particularly for relatively complicated phenomena (e.g., clinically significant tolerance, withdrawal) in order to avoid false positive symptom assignments and over-diagnosis.

Epidemiology

The prevalence of substance use rises steadily over ages 12–21, then levels off after young adulthood. There are two periods of peak risk for substance use initiation. One risk period occurs in early adolescence, around ages 13–14, coincident with pubertal maturation, and the other period occurs during the transition from late adolescence to early adulthood, around ages 18–21. The substances most commonly used by adolescents (ages 12–18) include alcohol, tobacco, and marijuana. The sequence of substance use initiation typically begins with use of alcohol and tobacco, which may be followed by use of marijuana, and possible progression to use of other illicit drugs. The 'gateway hypothesis' has been proposed to explain the fairly predictable sequencing of substance use initiation, and states that use of a substance early in the sequence leads to the use of the next substance in the sequence. Support for the gateway hypothesis has been debated, since environmental factors such as drug availability may influence the sequence of drug use initiation for a given individual. Regardless of the actual temporal ordering of substance use initiation, progression to higher levels of use within a type of substance, or to the use of other types of substances, is probabilistic, and not inevitable.

Initiation of alcohol use by early adolescence (e.g., prior to age 15), although relatively infrequent, has been associated with greater risk for subsequent development of an alcohol use disorder. Results from Monitoring the Future (MTF), a national school-based survey, indicated that in 2009, 15% of 8th graders, 30% of 10th graders, and 43% of 12th graders reported alcohol use in the past month. Early exposure to alcohol may reflect alcohol use in a religious context, or only sips or tastes of alcohol. However, the particular concern with respect to early exposure is when a young person engages in a risky pattern of alcohol use, which involves consumption of five or more drinks in a row, a pattern described as 'heavy episodic drinking' or 'binge drinking.' Data from the 2008 National Household Survey on Drug Use and Health (NSDUH) indicate that 9% of youth (ages 12–17) reported an episode of heavy drinking in the past 30 days. Although the prevalence of episodic heavy drinking among adolescents has gradually declined in the past decade, the absolute prevalence of this risky pattern of alcohol use among youth in recent years remains cause for concern.

According to the 2008 NSDUH, the prevalence of illicit drug use among 12–17 year olds has declined significantly in recent years, from 12% in 2002 to 9% in 2008. However, 2009 MTF data suggest that the prevalence of marijuana use may be increasing slightly among adolescents, in tandem with a decline in adolescents' beliefs regarding the risks associated with marijuana use. Among illicit drugs, marijuana is the substance used most often by adolescents. In 2008, 7% of 12–17 year olds reported marijuana use, whereas use of cocaine or heroin was reported by <1% of youth. Although,

overall, marijuana is the illicit drug used most often by adolescents, there are important age differences in the type of substance most often used. Among 12–13 year olds, nonmedical use of prescription medication (e.g., pain relievers, tranquilizers) was slightly more prevalent than marijuana use (in 2008: 1.5% vs. 1.0%, respectively). In contrast, among 14–17 year olds, marijuana was the illicit drug most often used (in 2008: 5.7% among 14–15 year olds, and 12.7% among 16–17 year olds), followed by nonmedical use of prescription medication (3.0% among 14–15 year olds, and 4.0% among 16–17 year olds). The age differences in the relative prevalence of types of illicit drug use emphasize the importance of evaluating non-medical use of prescription medication, particularly among younger adolescents (ages 12–13), who may have access to prescription medications (e.g., opiate-based pain relievers, sedatives) in their homes.

Among adolescents who progress from initial use to SUD, the time to onset of SUD occurs, on average, within 3 years of first use of a substance. The relatively rapid progression to SUD among adolescents underscores the importance of early detection and intervention to prevent escalation of substance use. The prevalence of SUD increases with age through adolescence, and reaches a peak in young adulthood. In 2008, 7.6% of 12–17 year olds met SUD criteria in the past year, compared to 20.8% of 18–25 year olds. The most common SUDs among youth aged 12–17 involve alcohol, marijuana, and tobacco. From 2002 to 2008, the prevalence of alcohol abuse or dependence among 12–17 year olds declined from 5.9% in 2002 to 4.9% in 2008. Over the same time period, abuse or dependence on illicit drugs also declined from 5.6% to 4.6% among 12–17 year olds, primarily due to a decline in marijuana use disorders. Among past month cigarette users aged 12–17, one out of three adolescents was estimated to be dependent on nicotine. In addition to youth who met criteria for an SUD, an additional 17% of adolescents were estimated to be ‘diagnostic orphans,’ who reported substance-related problems, but did not meet criteria for a SUD. Limited information from national survey data exists on the proportion of youth who meet criteria for more than one SUD. Youth who meet criteria for at least one SUD may engage in a pattern of polysubstance use, typically involving use of alcohol, marijuana, and tobacco. Adolescent polysubstance use suggests a concentration of substance-related problems within a subgroup of youth who often experience problems with several substances that have negative effects on multiple areas of functioning (e.g., at home, at school, legal involvement).

The gender gap in substance use prevalence, whereby males generally had higher prevalence of substance use compared to females, has narrowed in recent years, particularly among adolescents. In the 2008 NSDUH, among 12–17 year olds, the proportion of current drinkers was similar for males and females (14.2% and 15.0%, respectively). Likewise, there was little difference in the prevalence of current cigarette smoking among males and females (9.0% and 9.2%, respectively) in this age group. Male and female youth also had similar rates of illicit drug use (9.5% and 9.1%, respectively). Although males had slightly higher prevalence of marijuana use compared to females (7.3% and 6.0%, respectively), females had higher prevalence of nonmedical use of prescription drugs (3.3% and 2.5%, respectively). With regard to prevalence of SUD, adolescent females

had slightly higher prevalence (8.2%) of past year substance abuse or dependence compared to males (7.0%), although there was little difference by gender in rates of illicit drug use. The narrowing of the gender gap in rates of substance use, with females surpassing males in rates of use for certain substances (e.g., misuse of prescription drugs) and in meeting criteria for SUD, calls for increased efforts to reduce adolescent substance use, particularly among adolescent females.

National survey data indicate some ethnic differences in substance use prevalence. Among 12–17 year olds, for most substances, American Indian and white adolescents generally had the highest rates of use, followed by Hispanic and black youth, and Asian youth tending to report the lowest rates of substance use. In 2008, 17.2% of American Indian adolescents and 16.3% of white adolescents reported recent alcohol use, compared to 14.8% of Hispanic youth, 10.1% of black adolescents, and 5.7% of Asian youth. For illicit drugs, past year use, which primarily involved marijuana, was reported by 31.3% of American Indian youth, 19.7% of white adolescents, 17.6% of black youth, 18.8% of Hispanic adolescents, and 9.8% of Asian youth. In parallel with the relative prevalence of substance use across ethnic groups, white adolescents had higher rates of past year SUD compared to black and Hispanic youth (9%, 5%, and 7% respectively). The higher rate of SUD among white youth reflects the higher prevalence of alcohol use disorders in this subgroup. Ethnic differences in the prevalence of substance use and SUDs suggest the potential utility of culturally tailored prevention and intervention efforts.

Etiology

Developmental contexts and transitions in biological, psychological, and social domains that are unique to adolescence influence the emergence and progression of substance involvement. In particular, ongoing brain development during adolescence involves a normative delay in the maturation of behavioral inhibitory systems in relation to neural systems associated with reward processing. The relative immaturity of inhibitory control systems during adolescence has been proposed to underlie a developmentally normative increase in risk taking and sensation-seeking behavior, such as substance use during adolescence. Pubertal maturation during early adolescence also may contribute to risk for initiating substance use, particularly among early maturers, who may have greater access to substances through affiliation with older peers. In addition, animal models suggest that adolescents tend to be less sensitive to the sedative effects of certain substances (e.g., alcohol) compared to adults. Adolescents’ lower sensitivity to alcohol’s sedative effects helps to explain the pattern of heavy episodic drinking observed among adolescents in both animal models and humans. These biologically based aspects of development, which occur during adolescence (e.g., relative immaturity of inhibitory control systems, early pubertal maturation, adolescent sensitivity to drug effects), foster conditions associated with peak risk for initiation to substance use. Although experimentation with substance use typically begins in adolescence, heavy substance use at a time when the brain is continuing to develop has been associated with possible neurocognitive impairment and multiple adverse outcomes (e.g., substance-related injury, impaired school performance).

A developmental model of substance involvement proposes that risk and protective factors influence the onset and escalation of substance use during adolescence. Risk factors (e.g., substance using peers) predict onset and progression of use, whereas protective factors (e.g., parental monitoring) interact with risk factors to delay the onset of substance use and reduce the likelihood that substance use will escalate. The main domains of risk and protective factors include those associated with the individual (e.g., genetic liability for substance use disorder, temperament, co-occurring psychopathology, reasons for use, stressful life events), family environment (e.g., parental substance use, availability of substances in the home), peer relations (e.g., substance using peers), and school and neighborhood contexts (e.g., drug dealing that occurs in the neighborhood). These factors are organized in a hierarchical, nested structure, such that some individual factors (e.g., temperament, attitudes toward substance use) are generally more strongly predictive of substance use than the immediate social environment (e.g., family, peer group), and the school or neighborhood contexts within which an adolescent is embedded. These interacting systems operate at multiple levels (e.g., ranging from public policies and media exposure to peer norms and family rules regarding substance use) in influencing an adolescent's risk for substance involvement over time.

Risk and protective factors interact dynamically to influence adolescent substance use. For example, risk and protective factors may evolve over time (e.g., parental monitoring may decrease with age), may have developmentally specific effects (e.g., transition to high school or college) or persistent effects (e.g., sequelae of sexual or physical abuse), or be differentially salient at certain points in development (e.g., increasing salience of peers, relative to family, with age). Some risk factors may be specific to a certain substance (e.g., positive attitudes toward alcohol use), whereas others may increase risk or protection across substances more generally (e.g., parental neglect). Factors that predict transitions between levels of use within a given substance also may differ (e.g., social reasons for use may predict early onset of substance use, whereas coping reasons for use may predict progression to heavy use). Some research suggests that the cumulative number of risk factors, more than any specific type of risk factor, predicts level of substance involvement in adolescents. A developmental model of substance use recognizes individual differences in the timing and pace of development, and multiple pathways toward and away from substance involvement. In addition, the risk and protective factors that influence the course of substance involvement may differ across subgroups, defined for example, by gender and ethnicity.

Treatment

Few adolescents meet criteria for a DSM-IV SUD report receiving treatment. Among youth ages 12–17, <1% received treatment for substance use, although 8% had a DSM-IV SUD. In part, the discrepancy between the proportion of youth with an SUD and the proportion who receive treatment occurs because adolescents seldom initiate treatment. Most youth in publicly funded treatment are court-mandated to treatment, or are referred by the school or family. In accord with typically short histories of substance use and emerging substance-related problems, the majority of adolescents are treated in

outpatient programs. Youth with more chronic, heavy patterns of substance use, who have not been able to reduce use as outpatients, may benefit from more intensive intervention offered in residential treatment. Adolescents (ages 12–17) represented 12% of admissions to publicly funded substance abuse treatment in 2007. Two out of three youth who presented to treatment for substance use in 2007 reported cannabis as their primary drug, 8% reported alcohol, 2% reported opiates, and 2% reported cocaine as their primary drug.

Substance use treatment for adolescents has largely been adapted from programs shown to be effective with adults. The most widely used treatments for adolescent substance use include the Minnesota Model, which is based on the Twelve Steps of Alcoholics Anonymous; CBT focused on relapse prevention, motivational enhancement interventions, and family-based interventions. Specialized programs, such as multi-systemic therapy, also have been developed to address the multiple treatment needs (e.g., family, psychiatric, legal) of substance using youth in the juvenile justice system. Studies of the effectiveness of pharmacological treatment for adolescent substance use are limited. No single type of treatment for adolescent substance use has been shown to be clearly superior to any others. The role of external pressure in bringing adolescents to treatment suggests the importance of increasing adolescents' readiness to change substance use behavior, and of motivational enhancement interventions in facilitating reductions in substance use. For youth who experience problems in multiple areas of functioning, a comprehensive and coordinated set of interventions is needed to facilitate positive outcomes. Adolescents may require more than one episode of treatment to facilitate the long-term maintenance of treatment gains.

Treated adolescents generally show reductions in substance involvement compared to pretreatment levels of use, as well as improvements in psychosocial functioning. However, individuals show different trajectories of posttreatment substance involvement. Following treatment, prototypical short-term trajectories of substance involvement include stable low, stable high, increasing, and decreasing patterns of use. Most youth are in stable low or decreasing use trajectories immediately following treatment. Longer-term trajectories treated youth followed into young adulthood include stable abstinence, infrequent use, gradually decreasing substance involvement ('slow improvers'), and persistent high substance involvement. Most adolescents who followed into young adulthood were 'slow improvers' or infrequent users, with smaller proportions in the stable abstinence and persistent high substance involvement trajectories. For polysubstance users, treatment tends to have a generalized, rather than substance-specific effect on substance use (e.g., alcohol and marijuana tend to change together). Individuals in stable abstinence and low substance involvement trajectories after treatment generally had better emotional, interpersonal, and family functioning in young adulthood compared to those in chronic use trajectories. Improvements in school functioning tend to occur early, roughly within a year after treatment, while improvements in other areas, such as family relations, tend to emerge 2 years after treatment. Although many treated adolescents show reductions in substance involvement and improvement in psychological and social functioning, treated adolescents continue to show greater overall impairment in functioning compared to a community

comparison sample over long-term follow-up. Adolescent-onset SUD can delay or disrupt the development of cognitive and social skills, with effects that persist into adulthood.

Predictors of adolescent treatment outcomes have been examined at the time of treatment admission, during treatment, and following treatment. At treatment admission, the presence of co-occurring psychopathology, such as conduct problems, depression, and symptoms related to sexual or physical abuse, signal risk for a persistent pattern of substance use. During treatment, factors that have been associated with better outcomes among adolescents include longer duration of treatment, treatment completion, greater readiness to change substance use, and family involvement in treatment. Although treatment may help to increase or maintain an adolescent's motivation to reduce substance use, the nature of the adolescent's environment (e.g., family, peers) and activities (e.g., leisure time activities) outside of treatment is essential to maintaining treatment gains over time. Posttreatment factors associated with better outcomes among adolescents include aftercare involvement, low levels of peer substance use, and continued commitment to abstain from substance use.

More chronic and severe trajectories of substance involvement may reflect the impact of co-occurring psychopathology (e.g., conduct problems, depression) in complicating the course of recovery. Not only does co-occurring psychopathology affect treatment outcomes, but it also may play a role in the timing of SUD onset, the rate of SUD development, severity, and duration. The co-occurring conditions most commonly associated with adolescent substance involvement include conduct problems, mood disorders (e.g., depression), ADHD, and physical or sexual trauma. A majority (roughly 60%) of adolescent substance users in a community sample were found to have a coexisting psychiatric condition, such as ADHD or conduct disorder. Among youth in substance use treatment, more than half are estimated to have one or more of these coexisting disorders. Comprehensive interventions that address the substance problems and co-occurring problems are indicated to support long-term positive outcomes in youth with coexisting conditions.

Pathological Gambling

Clinical Characteristics and Definition

Gambling is the act of wagering or betting money or something of value on an event with an uncertain outcome with the intent to win more money or things of value than was wagered. Gambling involves risking something of value, including money, for the chance of winning more than you risked. For adolescents, gambling is viewed as an adult activity that they can participate in fairly easily, such as playing poker for money with their friends, and without upsetting their parents too much, "Oh, they are only playing cards, good, I was afraid they were smoking or drinking." Gambling behavior among adolescents ranges from no gambling to experimentation to occasional or regular social gambling to excessive and problematic gambling. This continuum is skewed toward most youth gambling rarely or occasionally and some youth gambling excessively. Adults play commercial or legal forms of gambling such as slot machines at casinos or buy lottery

tickets, whereas youth tend to play informal games amongst themselves such as poker or betting on sports or games of skill such as video games. The legal age for gambling varies across jurisdictions but is most commonly between 18–21 years of age. Some youth celebrate reaching the legal gambling age birthdays by visiting a casino. Some underage youth play commercial games such as the lottery by obtaining lottery products from legal-age gamblers, including family members.

Adolescents can exhibit pathological gambling or gambling addiction. There is not a separate or different definition of pathological gambling for adolescents; however, it is exhibited slightly differently in youth. For example, an adult pathological gambler may be absent from work in order to gamble, whereas an adolescent may be absent from school in order to gamble. Adults may lie to their spouse about their gambling, whereas adolescents may lie to their parents about their gambling. Adults may spend their paycheck on gambling when the money is supposed to pay for food and housing, whereas Adolescents may wager their pocket money or their iPod or video game player. Adolescent gamblers cannot lose their house, or spouse or family, or file for bankruptcy, but they can exhibit adolescent-specific adverse consequences. Gambling at any group is considered to be a problem when it interferes with the individual's relationships with friends and family or their school and work obligations. Adolescent problem gambling has been characterized as persistent gambling behavior that leads to negative personal consequences, including the loss of money and things of value, and negative consequences to the person's social network including the alienation of family and friends. Not only can early gambling lead to later gambling problems, gambling during the formative years can lead to current gambling problems.

A small number of youth gambling assessment instruments have been developed to assist clinicians in identifying youth who may have a gambling problem. For example, a recently developed instrument was created specifically for adolescents, the Canadian Adolescent Gambling Inventory (CAGI). It contains items associated with symptoms of pathological gambling, such as preoccupation, loss of control, and chasing one's gambling losses by accelerating one's gambling involvement.

Epidemiology

It is important to examine the larger cultural context in which gambling occurs. The gambling industry has experienced unprecedented expansion in the past three decades. Commercial gambling in the United States has expanded out beyond Atlantic City, New Jersey and Las Vegas, Nevada to nearly every convenience store across America and nearly every computer with access to the internet. Gambling is advertized in all forms of media and youth are exposed to this promotion on a daily basis. The availability of gambling venues varies by region, such as state lotteries or tribal casinos, but commercial gambling has become much more accessible to the general public in the past 30 years. The gambling industry is also enjoying a more favorable public image as a socially acceptable activity for the general public as opposed to its public image in the past as a vice. Citizens are encouraged to gamble by their state

governments that benefit from the proceeds. With this rapid growth of the gambling industry and the shift from a negative to a positive public sentiment toward gambling have come concerns about youth gambling.

Most youth have gambled at least once in their lifetime. The National Research Council recently reviewed existing youth surveys and reported that between 39% and 92% of youth reported gambling at least once in their lifetime and that the median rate was 85%. In terms of recent gambling, the NRC concluded that between 52% and 89% of youth have gambled in the past year and that the median rate was 73%. Whereas the majority of youth have gambled in their lifetime and in the past year, most do not experience any adverse consequences from their gambling. Gambling for most youth is an infrequent and inconsequential past time. Gambling for some youth is part of adolescent experimentation with adult behaviors, for example, some adolescents celebrate reaching the legal gambling age with a visit to a casino.

While the literature is fairly consistent about the extent of youth gambling participation, there is much less agreement on the prevalence of problem and pathological gambling among youth. Rates of past year pathological gambling range from as low as 0.3% to as high as 9.5% with a median of 6%. Rates of combined past year problem and pathological gambling range from 11.3% to 27.7% with a median of 20%. The estimates of lifetime problem and pathological gambling range from 7.7% to 34.9% with a median of 15.5% (NRC, 1999). For lifetime PG only, estimates range from 1.2% to 11.2% with a median of 5%. These wide-ranging estimates are thought to be largely due to using different methodologies, such as telephone versus in-school survey administration, different assessment tools, and different cut scores.

Nevertheless, these and other surveys provide some consistent findings: the majority of youth have gambled in the past year, more boys engage in gambling than girls, older youth tend to gamble more than younger youth, a small percentage of youth are frequent gamblers, and an even smaller percentage may be considered problem or pathological gamblers.

A related epidemiological issue is whether rates of youth gambling is on the rise. A recent review of youth gambling surveys around the globe found that the evidence for changes in youth gambling rates over time is mixed and varies by location and methodology. For example, an examination of a series of youth surveys in the state of Minnesota concluded that there has been a decline in general gambling participation rates from 1992 to 2007. Another informative survey is from the Annenberg Foundation; since 2002 they have conducted annual telephone surveys of about 900 youth in the United States between the ages 14 and 22 (www.annenbergpublicpolicycenter.org). They recently reported weekly card playing among 14–17 year old boys peaked in 2005 and has continued to decline in 2006, 2007, and 2008. The Minnesota survey found a similar trend with respect to card playing. It would appear that youth gambling, including problem gambling, while showing occasional fluctuations for specific games, for the most part has not been on the rise over the past two decades. While this is good news, there still remains a small but significant portion of the youth population who are excessive gamblers and who are experiencing adverse consequences as a result of their gambling.

Etiology

Research into the etiology of youth problem gambling is in its infancy. The most common etiology studies are those that look at psychosocial correlates of youth problem gambling. These studies have found a number of correlates including being male, antisocial behavior, peer deviance, tobacco use, alcohol use, drug use, parental/familial gambling, school behavior problems and academic failure, and impulsivity.

Also, there is emerging evidence that genetic factors may contribute to adolescent gambling behavior. Family studies have shown that problem gambling is familial; adolescent problem gamblers are more likely to report having at least one parent with a history of problem gambling compared to nonproblem adolescent gamblers, and twin studies have shown that genetic factors influence gambling behaviors among young adult males.

Another etiological factor to consider with youth gambling is indirectly provided by research that has shown that youth problem gambling is associated with other psychiatric disorders, including other addictions, mood disorders, and ADHD. It is thought that problem gamblers seek out the stimulation of gambling because their natural resting state is one of being either under stimulated or over stimulated. For example, depressed individuals may seek out gambling for stimulation and hyperactive individuals may seek out gambling to calm their senses by focusing on the gambling activity. One study found that young problem gamblers also reported having ADHD symptoms and another study found that young adults with childhood ADHD symptoms that persisted into young adulthood reported greater gambling problem severity than young adults with no ADHD or those with childhood ADHD that did not persist into young adulthood. This research suggests that young problem gamblers may have impulse control deficits and these deficits may have a neurological or biological basis. Further research will be required to examine the neurological basis of impulse control deficits in young problem gamblers, but there appears to be a link between impulse control and executive function deficits and adolescent problem gambling.

Another possible determinant of youth problem gambling is the widespread and growing availability of legal forms of gambling. Gambling is now available in nearly every convenience store and every computer connected to the Internet. This widespread availability has the added effect of a growing social acceptance of gambling. Where gambling was previously considered a vice and participation was discouraged, it is now considered entertainment and participation is encouraged. While most jurisdictions have age restrictions for legal forms of gambling, underage adolescents have found ways to participate, such as having legal-age adults buy lottery tickets for them.

The adult etiological literature points to the importance of cognitive distortions or illusions in the development of problem gamblers, and these factors have been discussed in light of adolescent problem gambling as well. Cognitive distortions associated with gambling involve the following: an illusion of control where the individuals believe they can control the outcome of a gambling event; the false or mistaken belief that the person can win money playing games of chance; a failure to understand the laws of probability, odds, and independence of random events; and a tendency to underestimate one's losses and overestimate one's wins.

A final etiological consideration pertains to neurodevelopment. As we noted in the introduction, recent advances in understanding important neurodevelopmental events during adolescence occur in brain regions associated with motivation, reward, and decision making. It has been hypothesized that the relative immaturity of these developing brain regions may contribute to adolescent impulsivity and risk taking, including gambling. Clearly, a common factor thought to underlie gambling is the tendency toward general risk taking and a lack of control of one's impulses. Gambling is a risky activity, and in that respect is similar to other high-risk behaviors such as tobacco use, alcohol use, drug use, and unprotected sexual activity.

Treatment

There has not been much attention given to treatment for youth problem gambling in the literature. This would seem contradictory given that on the one hand, we have estimates of youth problem gambling that are higher than adult estimates. On the other hand, we have few if any adolescents presenting themselves for treatment services. There are several possible explanations for this disparity: youth problem gambling rates may be inflated due to biases in survey tools; youth are less likely to present themselves for treatment of any disorder, problem gambling included; and parents – a main referral source for teenagers receiving clinical care – are not very likely to recognize problem gambling in their child or they do not consider gambling as a risk behavior that merits concern. Regardless of the apparent discrepancy in youth and adult prevalence rates, there have been some efforts to examine adolescent treatment options for problem gambling. Treatment options for adolescents, like assessment tools, are typically adaptations of adult methods. Current research work in this area is on the development of behavioral treatment methods.

The reality is that there are few treatment programs for adolescent problem gamblers. However, there are several efforts to protect youth from the negative consequences of problem gambling with primary prevention efforts. These efforts have fallen into two camps, either abstinence or harm reduction. Abstinence approaches attempt to delay the onset of gambling in order to reduce gambling problems. Harm reduction approaches attempt to promote responsible gambling behavior and enhance skills needed to maintain control when gambling through teaching youth about the facts of gambling as well as the risks associated with gambling. This approach also addresses the cognitive distortions and misperceptions that youth may have about gambling, such as a belief that they are 'lucky' and therefore can win money gambling. Also, some programs take a broader approach by targeting a number of related high-risk behaviors such as tobacco use, alcohol use, drug use, along with gambling. Most youth problem gambling prevention programs have not been rigorously evaluated and therefore, there is a need for the systematic evaluation of these programs.

Summary

Adolescence is a developmental period that involves significant biological, psychological, and social changes, including rapid growth in physical and mental capabilities. This is also a period

of increased sensation-seeking behavior, such as use of drugs and alcohol. Nearly half of all teenagers have tried at least one illicit drug, and three out of four have used alcohol by their senior year.

Recent advances in developmental psychopathology have lead to a greater understanding of many knowledge areas of adolescent addictive disorders, including prevalence, clinical course, and treatment. We have focused here on three core addictive disorders for which a relatively large empirical literature exists – nicotine, other psychoactive substances, and gambling. Beyond these disorders, other adolescent behavioral 'indulgences' are emerging in the research and clinical literatures. These include internet addiction, excessive video game playing, and sex addiction. Clinical, epidemiological, and treatment perspectives on the full spectrum of addictive disorders in adolescents will benefit from continued research and clinical work.

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See also: Adolescence; Attention Deficit Hyperactivity Disorder; Childhood Mental Disorders; Developmental Psychopathology; Drugs, the Brain, and Behavior.

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<http://youthgambling.mcgill.ca/> – International Centre for Youth Gambling Problems and High-Risk Behaviors.

Adolescence

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Adolescence is the transitory period between childhood and adulthood. This period is characterized by biological, cognitive, social, and psychological development. Historically, this period of development has been described as tumultuous, which is sometimes attributed to increased emotions and an undeveloped prefrontal cortex. Empirical research has shown that adolescence is not characterized by the degree of 'storm and stress' that was once believed. Nonetheless, adolescence is a period in which there is a tremendous amount of growth and change in adolescents. The purpose of this article is to provide an accurate account of adolescent development. This article will review the primary changes that occur within an adolescent as well as the contextual factors that influence and facilitate those changes.

Primary Changes in Adolescence

During adolescence, youth experience a multitude of changes. These changes affect their physical appearance, cognitive development, and emotional development. Moreover, they not only affect the individual, but also the relationships and networks built with others. The first part of this article examines the primary changes that take place in adolescence, and the possible effects of those changes. It is important to note that although these changes apply to all adolescents, the rate and pattern of changes varies between individuals.

Biological Foundations

The transition from childhood to adolescence is clearly identified by the biological changes occurring on the inside and outside of a child's body. These hormonal and bodily changes make up the developmental stage called puberty, which typically occurs during early adolescence. The onset of puberty is predominantly determined by genetic patterns, but can also be affected by environmental factors. Historically, the onset of puberty has been known to begin between 9 and 16 years of age. Most commonly, puberty begins at age 11 for females and at age 12 for males. The onset of puberty has decreased markedly over the past decades but has recently leveled off.

Puberty is characterized by a fluctuation in hormones, which are chemicals secreted by the endocrine glands. The endocrine system controls the hormonal changes associated with puberty using a negative feedback system. When hormonal levels fall too low, the endocrine system reacts to the low level of hormones by causing the release of more hormones into the bloodstream. Specifically, the hypothalamus, located in the brain, responds to the decreased level of hormones in the blood system by releasing substances that stimulate the pituitary gland, which is also located in the brain. The pituitary gland then stimulates the gonads (the ovaries in females and the testes in males) to release more sex hormones. When the level of sex hormones falls too low, the

hypothalamus and pituitary gland stop stimulating the gonads and they stop producing sex hormones. With the onset of puberty, the levels of sex hormones in the body increase substantially. At puberty, the hypothalamus becomes desensitized to sex hormones and requires a significantly higher level of hormones in the body before the hypothalamus and pituitary gland stop stimulating the gonads to release more hormones.

There are two types of hormones that are known to affect puberty differently in males and females: androgens and estrogens. Androgens are male sex hormones and estrogens are female sex hormones. Testosterone, an androgen, plays a major role in male pubertal development; while, estradiol, an estrogen, plays a major role in female pubertal development. Nonetheless, both males and females have androgens and estrogens.

Weight, body fat, and a hormone called leptin are correlated with the onset of puberty. Higher weight and a higher percentage of body fat have been linked to early pubertal development, especially in females. Adolescents living in developing countries without enough food for adequate nutrition begin puberty earlier than adolescents in developed nations. Leptin is also thought to signal the beginning and the progression of puberty. Levels of leptin, which are higher in females than males, are linked to the amount of body fat in females and the amount of the hormone androgen in males. An increase in leptin is thought to signal an adequate amount of body fat for reproduction.

There are some sociocultural and environmental factors that have been linked to the onset of puberty. Researchers have found that cultural differences and early experiences may be correlated with the early onset of puberty. Empirical findings suggest that the absence of a father, geographic distance between family members, child mistreatment, and low socioeconomic status (SES) have also been linked to early onset of puberty.

Cognitive Development

The transition from childhood to adolescence is also marked by changes in cognitive development. There are distinct structural changes in the brain that occur during adolescence. These changes are seen in the corpus callosum, prefrontal cortex, and amygdala. The corpus callosum connects the right and left hemispheres. During adolescence, the corpus callosum thickens, which improves the adolescent's ability to process information. An adolescent's prefrontal cortex, which houses reasoning, decision-making ability, and self-control, continues to develop during adolescence. Responsible for emotion regulation, the amygdala matures earlier than the prefrontal cortex. Empirical evidence has shown that although adolescents experience a vast array of emotions, the prefrontal cortex continues to develop well into adulthood; therefore, adolescents may not have as much control over their emotions as they will when their prefrontal cortex is fully mature.

In the past, researchers thought that brain cells could not be generated after early childhood, but recent research has discovered that people produce new brain cells throughout their lives. Factors such as exercise can aid the brain in producing new cells. The adolescent brain also has some plasticity. In childhood as well as adolescence, the brain is able to repair itself. However, the earlier a brain injury occurs, the more likely that recovery will be successful.

Several theories have been used to explain brain development from childhood through adolescence. One of the most prominent theories, articulated and investigated by Jean Piaget, proposed that adolescents work to understand their world because the making of meaning is hardwired and serves a biological purpose. Adolescents construct their world using schemas, defined as mental concepts or frameworks that help organize and understand information. Adolescents use assimilation (incorporation of new information) and accommodation (the adjustment to new information) to organize their schemas.

Piaget articulated four stages that describe cognitive development: sensorimotor, preoperational, concrete operational, and formal operational stages. The formal operation stage is typically reached during adolescence. This stage consists of reasoning in abstract, idealistic, and logical ways and is characterized by the development of problem-solving skills and formation of hypotheses.

Lev Vygotsky introduced a theory that views knowledge as situated and collaborative. Specifically, Vygotsky believed that knowledge is distributed among people and their environments and knowledge can best be attained through interaction with others through cooperative activities. Vygotsky emphasized the social contexts of learning. One of his most important concepts is the zone of proximal development (ZPD). ZPD describes a range of tasks that require assistance from adults or mature peers.

In later years, other theories were developed that spoke of the use of information processing and psychometric testing to assess adolescents' cognitive development. However, Piaget and Vygotsky's theories are still commonly used to explain adolescent cognitive development. All of these views take into account the genetic as well as the environmental influence on adolescent cognitive development.

Identity

As puberty occurs and cognitive processes are developing, adolescents are also forming a sense of self. An adolescent's sense of self consists of his or her identity. Identity incorporates self-understanding, self-esteem, and self-concept. Self-understanding is an individual's cognitive representation of the self. The development of an adolescent's self-understanding is complex and can be affected by many internal and external factors. Adolescents, unlike children, describe themselves within various contexts. Research on adolescence has shown that an adolescent's sense of self can fluctuate. This sense of self can also be contradictory, because of the multiple roles adolescents play in different relationship contexts. One explanation for this contradiction can be found in the real versus ideal theory. This theory states that adolescents have an ideal or imagined self and this ideal view of themselves contradict their actual view

of themselves. Some theorists believe that this contradiction is maladaptive, while other theorists believe that this contradiction can provide motivation and drive toward future goals.

Adolescents, unlike children, often compare themselves to their peers, are more self-conscious, and more preoccupied with their self-understanding. Even though most adolescents employ introspection, they also look to their friends and other peers for self-clarification and self-definitions. In Eastern countries, adolescents may also tend to look to family members to aid with this process as their cultural norms place a high value on family relationships and social categories. This search for self-clarification and self-definition can affect the adolescent's self-esteem and self-concept. There is evidence to suggest that adolescents have a lowered sense of self-esteem when compared to children, and this decline usually occurs in middle school. Male adolescents usually report higher self-esteem than female adolescents, but this gender-gap typically decreases as adolescents move into adulthood.

Erik Erikson proposed a theory of human development that consists of eight stages. Most adolescents, he believed, fall within his fifth stage: identity versus identity confusion. Erikson proposed that during this stage, adolescents have to decide their identity, their goals and causes, and the direction of their life. Erikson believed that adolescents experiment with many different roles and identities while they are trying to 'find themselves'. He labeled this exploratory period as a moratorium period. If adolescents use adaptive methods to explore their identity, they will achieve identity formation. If adolescents use maladaptive methods to explore their identity or they do not explore their identity at all, they will experience identity confusion.

James Marcia empirically investigated Erikson's ideas and identified four statuses, which help to simplify Erikson's theory. The four statuses, identity diffusion, identity foreclosure, identity moratorium, and identity achievement, capture the adolescents' exploration of alternatives and commitments toward a direction in life. This construct of identity is biased toward the Western, masculine ideals of individualism, as opposed to relatedness. Adolescents from Western countries may conceptualize identity achievement as a self-directed objective in which individualization and independence is highly valued. However, adolescents from Eastern countries may conceptualize identity achievement as more relational and interdependent. Some research has shown that individual characteristics are valued in Eastern countries; however, these characteristics tend to be more collectivistic in nature and place higher values on attending to others, fitting in, and harmonious interactions.

Although different cultures place differing values on an individual's characteristics, the function of self-definition in regard to identity development can be seen across cultures. Recent views of identity development propose that it is a gradual process that continues into adulthood. It is important to study adolescent identity development because during adolescence, youth begin to integrate the physical, cognitive, and emotional development, forming a better understanding of their sense of self.

Moral Development

Moral development can be defined as thoughts, behaviors, and feelings regarding standards of right and wrong. There have

been numerous theories of adolescent moral development, but one of the most influential theories was created by Lawrence Kohlberg. Kohlberg's theory of moral development emphasizes adolescents' reasoning about moral issues. He proposed that the way in which an individual reasons changes throughout life and his model includes six sequential stages of moral development. Kohlberg studied the moral reasoning of fifty males over the course of 20 years and there was clear evidence that each participant followed the same developmental sequence through the stages of moral development. His participants did not skip any of the developmental stages and there was no regression. Empirical evidence also suggests that the stages are culturally universal, especially the first four stages. This research also suggests that the rate of development and the final stages that people achieve vary between individuals and groups.

Kohlberg's model consists of three levels of reasoning about moral issues: preconventional reasoning, conventional reasoning, and postconventional reasoning. Within each level are two stages. In the preconventional reasoning level, moral reasoning is controlled by external, concrete consequences. People functioning at this level of development make moral decisions based on whether they will be rewarded or punished by their decisions. Youth, in the beginning stages of adolescence, are usually at this preconventional level of reasoning. In the conventional reasoning level, moral reasoning is controlled by internal and external factors. Moral decisions at the conventional level are based on conforming to and upholding the rules, expectations, laws, and conventions of society. Most adolescents are said to be at this level of reasoning. The third level of reasoning, postconventional reasoning, is thought to be achieved at or after the age of 20. This level is characterized by moral principles that are internalized. Moral decisions at the postconventional level are based on understanding society's rules, then formulating and internalizing a personal moral code that emphasizes principles of justice: individual rights, equality, and human dignity and a concern for the welfare of the larger community.

Carol Gilligan has argued that Kohlberg's orientation toward justice represents a male perspective that is more commonly found in Western cultures. Gilligan proposed that moral development is built on a concept of care. This type of morality focuses on responsibility to others, values relationships, and seeks to help. The concept of care also emphasizes sensitivity to social context, whereas justice emphasizes the application of rules and principles. Gilligan believes that conceptualizations of morality as care based represents a more female perspective, as well as the perspectives of societies that value collectivism.

Other theories of moral development emphasize moral behavior instead of moral reasoning. The social cognitive theory of moral development assesses the difference between the adolescent's ability to produce moral behavior (moral competence) and his or her ability to implement moral behaviors in specific situations (moral performance). Social cognitive theorists believe that the adolescent's moral performance is not guided by abstract thinking, but by rewards, punishments, and motivation.

Behaviorists also emphasize moral behavior. These theorists use imitation, rewards, and punishment to explain why adolescents display different moral behaviors. When adolescents are

positively reinforced (rewarded) for a behavior that is considered moral, they are more likely to repeat that behavior. When adolescents are punished for a morally unacceptable behavior, they are more likely to decrease that behavior. There are other factors and situations that mediate these processes. Empirical research has found that adolescents will not display the same moral behavior when put in diverse social settings. For example, an adolescent is more likely to cheat if being pressured by a peer. Even though other factors may affect the outcome, overall adolescent moral behavior can be predicted by reinforcement.

Moral development, like so many other areas, does not begin in adolescence and will not end in adolescence. It is important to study moral development during adolescence because cognition, identity, and other parts of the adolescent are actively developing during this stage as well. Adolescence is an important developmental stage because there are so many internal and external influences that are at work during this period of life.

Contextual Areas of Interest Regarding Adolescent Development

Adolescent development can be affected by numerous contextual factors. The context in which an adolescent grows up, the experiences they face, and the situations they encounter will frame their development as they approach adulthood. Because adolescents will experience different contextual factors under different situations, it is important that each of these factors be explored. The remainder of this article highlights contextual factors regarding family, peers, romantic relationships, school, work, and cultural concerns.

Family

One of the most important contextual factors that can affect adolescent development is family dynamics. Research has shown that parents have a significant effect on the ways in which adolescents develop. Previously, adolescent relationships with parents were conceptualized as tumultuous and generally full of conflict. However, research over the past several decades has revealed that relationships are more positive and less tumultuous than previously considered. Although adolescence is a time of self-exploration and emerging autonomy, parents who respond in an understanding manner to the changes adolescents face generally experience less turmoil in the home. In addition, parents who expect that adolescence will be a tumultuous experience are more likely to have adolescents who experience more conflictual family relationships. The guidance provided by parents during this time period is crucial in helping the adolescent transition into becoming a responsible adult. Parents aid in this transition by helping the adolescent form his/her own moral standards, in addition to supporting, encouraging, and providing learning opportunities for them.

Parenting styles

Different parenting styles may be an important contextual factor in terms of adolescent development. Parenting styles have been

conceptualized into four different categories (authoritarian, authoritative, indulgent/permissive, neglectful) that range on levels of responsiveness and control. Authoritarian parents tend to take a more unresponsive, or parent-centered role, and are generally demanding while exerting a high level of control over their children. Their adolescent children tend to be dependent, submissive, and overly conforming in the presence of their parents and other authorities. However, when out of the presence of authorities, these adolescents tend to be rebellious, defiant, hostile, and resentful. In contrast to authoritarian parents, indulgent/permissive parents tend to take a more responsive, or child-centered role, and are generally undemanding while exerting a very low level of control over their children. Adolescent children of indulgent/permission parents tend to lack self-regulation skills, and often disregard rules and regulations. Because they are used to getting their way, they generally are not as socially adept as other adolescents. Neglectful parents are generally unresponsive to their children, while also being undemanding and showing little control. Adolescents who grow up in these families tend to suffer the most as they may get into a lot of trouble and engage in more risky behavior. These adolescents also tend to be self-rejecting and may feel inferior to others. In contrast to neglectful parents, authoritative parents are responsive, accepting, and child-centered, while also setting clear limits for their children. This authoritative parenting style has been found to be associated with more positive adolescent developmental outcomes. Adolescents from these families tend to be more socially and academically competent. They also exhibit higher levels of self-esteem and demonstrate more person control than other adolescents. It is important to note that these parenting styles are not always completely independent of one another. Parents may mesh different styles together and/or use different styles with different children. Interestingly, even within the same family unit, parents may be utilizing completely different parenting styles. For example, an indulgent/permissive mother, paired with an authoritarian father, may cause an adolescent to experience a great deal of uncertainty and confusion.

Attachment styles

During adolescence, early attachment styles begin to shift in accompaniment to adolescents' need for autonomy. Although, it is normal for adolescents to feel a desire to remain close to their parents, their emerging adolescent attachment style does not require as much dependency on their caretaker. However, having a secure base in which to return is key as adolescents make the journey toward becoming more autonomous, or independent. Early attachment theorists John Bowlby and Mary Ainsworth put forth that developing a secure attachment to caregivers as an infant serves as a foundation that adolescents use for healthy psychological development. The development of a secure attachment allows children to feel safe while exploring their environment. Insecurely attached adolescents avoid or distance themselves from their parents, show an unusual amount of fear toward their parents, or show ambivalence or resistance toward their parents. However, it is important to note that normal adolescent attachment functioning can falsely resemble this insecure attachment style (which has developed from infancy and early childhood). Adolescent attachment theorists highlight that adolescence is a period in which attachment styles transform from hierarchical

parent-child attachments to codependent peer-peer attachments (in which both persons offer and receive support). In adolescence, with the goal of autonomy and self-other differentiation in mind, attachments with peers become a main focus. Even under distressing situations, adolescents may purposefully resist seeking comfort from parents as they are striving for autonomy. This purposeful distancing may be experienced as uncomfortable by both parents and adolescents at times and represents a transforming shift in attachment style from infancy and early childhood. Because adolescents are in a transition period, this shift in attachment needs can be conflicting and confusing. As adolescents distance themselves from adult caregivers, they are able to explore more of their emotional interior and problem-solving techniques on their own. Knowing that adult attachment figures are readily available when necessary helps facilitate this process. Early attachment styles and adolescent attachment experiences with peers can color the way in which adolescents experience the world around them and typically guide adolescents' expectations regarding future relationships with other people. Adolescents who developed a secure attachment to their parents from early childhood show more self-confidence, have better peer and romantic relationships, and are less likely to engage in behavior problems such as juvenile delinquency and drug abuse compared with insecurely attached adolescents.

Siblings and birth order

Having siblings can greatly impact the development and experiences of an adolescent. In American households, about 80% of adolescents have siblings. Research has shown that siblings are often utilized as a source of support for adolescents. Communication between siblings usually occurs more naturally, and the exchange of information is more direct than with parents. Adolescents may confide in a sibling in order to discuss difficult or taboo topics, relying on the experience and/or opinions of a sibling. However, although siblings may serve as sources of support for each other, sibling conflict is not uncommon. Chronic conflict among siblings can have a negative effect on adolescent development, especially when the parent's relationship with the adolescent is also tumultuous. Studies have found that depression among adolescents is higher when sibling conflict is reported at greater frequencies. Sibling conflict tends to be higher when parents treat siblings very differently and favor one sibling over another. Sibling conflict tends to decrease in adolescence compared with childhood probably because siblings spend less time together during adolescence than in childhood. As adolescents begin to emerge into adulthood, conflictual relationships with siblings tend to further decrease, and the intensity of tension between siblings may diminish.

Birth order has also been noted by many for its impact on adolescent development. Although there is some inconsistency in the findings regarding the effects of birth order, a few trends are noteworthy. Typically, firstborns are held to a higher standard of social, academic, and professional accomplishments than their younger siblings. This is commonly felt and expressed by firstborns as a theme of their childhood and adolescent years. Conversely, lastborns tend to be perceived as the perpetual 'baby' of the family. Some siblings may complain about the lastborns' ability to become self-sufficient and

independent, especially when parents are indulgent toward their lastborn. In general, middle children are characterized as being the negotiators of the family. Additionally, middle children are generally noted to have problems gaining equal attention from their parents; thus, they may engage in more problematic or attention-seeking behavior. These trends in birth order are not always representative of all families, and many exceptions can be found across siblings.

Family structures: Divorce and stepfamilies

With the divorce rate being over 50%, many adolescents are reared in single-family homes, blended homes, or other non-traditional living situations. One study estimated that nearly 40% of children born into intact families will eventually become children of divorced families. Divorce can disrupt the connection between adolescents and parents, causing a rift during key adolescent developmental phases in which parent connection is desirable. Most research regarding adolescent development in the context of divorce has shown negative outcomes for adolescents, especially when compared to adolescents from intact homes. Although most adolescents go through a difficult period, in which their functioning is impaired immediately after the divorce, most return to normal functioning after a brief period of disruption. The majority of adolescents from divorced families are functioning and developing normally after adjusting to the family transition. However, small subsets of adolescents continue to experience prolonged distress. Research suggests that high continued parental conflict following divorce is associated with poorer adolescent functioning.

School

Adolescents spend a very large percentage of time at school with teachers and peers. The type of school an adolescent attends, and the experiences he or she derives from that school will have an effect on their development and future transition into adulthood. Specifically, school size, teachers, and peers are factors that may contribute to an adolescent's school experience. Previously, educational psychologists focused heavily on classroom climate and how students fit with their classmates. Now, researchers study the social climate of the school, in addition to individual factors that may affect students. For example, smaller schools have been linked to increased amounts of prosocial behavior. Arguably, smaller classrooms also provide an environment that encourages a higher standard of teaching and learning. Many students may feel lost in the crowd at very large middle and high schools. This feeling may overwhelm many students, discouraging them from finding their niche, or becoming involved in activities. Isolated students may be left behind educationally and socially, which leaves these students more susceptible to joining antisocial peer groups or cliques.

Teachers not only serve as persons who provide formal education for adolescents, but many times these individuals also serve as additional role models and mentors for students. Their classroom management strategies help students learn time management skills and self-monitoring techniques, in addition to learning actual classroom material. Skilled teachers

plan classroom activities in a manner that challenges students, and generally prevents academic and emotional problems. Adolescents who are in well-managed classrooms may show greater levels of autonomy, self-confidence, and academic achievement.

Peers make up a large amount of an adolescent's school experience. While it is not uncommon for adolescents to occasionally report feeling ostracized at school, or feeling isolated, it is of concern if these negative experiences become common. Peers may engage in teasing or other antisocial behaviors, especially in larger schools with less monitoring capabilities. Bullying is the act of physically or emotionally hurting another peer, generally at school. A national survey showed that approximately one-third of adolescents were either being bullied, or were themselves bullies. The most common form of bullying is disparaging comments about looks or speech. Almost equal to that, adolescent girls report being the subject of sexual comments and gestures. The effects of bullying can be harsh for some adolescents. A few studies have found that common consequences of continued bullying involved depression, lack of interest in school, suicidal ideation, somatic complaints, and/or avoidance techniques. Research has also found that a large number of boys who bully others in middle school are likely to be convicted of a criminal offense in early adulthood.

Although school can be a negative experience for many adolescents, these experiences may be altered with individual attention and focus on academic and social competence. This is especially true for adolescents from lower SES backgrounds. Because these adolescents may have underlying barriers to academic achievement, additional tutoring and social integration is required. Some students may find school difficult due to learning difficulties, or problems with attention disorders. While larger schools tend to be less desirable due to subsequent large classroom and less individualized programs, some larger schools may be able to provide more resources to students with these types of learning difficulties. In addition to the formal education process, schools are an important contextual factor regarding adolescence because they provide a platform for career exploration, friendship development, and extracurricular activities.

Work

Most late adolescents have a part-time job in addition to attending school. Working can allow adolescents to develop professional skills, a strong work ethic, and can help with money management. The money earned from a part-time job also can also provide adolescents the freedom to purchase personal consumer items (e.g., trendy clothes, music, etc.). Depending on the place of employment, working may also serve as another source of social integration. Many adolescents work in establishments that also employ many of their peers. Thus, work may allow adolescents the opportunity to socialize with peers who are not in their network of friends.

Despite the fact that numerous benefits to working exist, several negative factors are also associated with working. In general, for most adolescents, as the number of hours spent working increases, school grades suffer. This is especially true for adolescents working more than 20 h per week. Typically,

adolescents who must balance school and work often must sacrifice one for another. A homework assignment may go unfinished in order to work a shift; or conversely, a work shift may be skipped in order to pull an all-nighter on a homework assignment. Although having a balance between work and school can be beneficial, it starts to become problematic when ongoing sacrifices must be made in either domain. Adolescents who work may not be able to participate in extracurricular activities or sports that require a large time commitment.

Peer Relationships

Friendships

Peer relationships, including close friends and romantic partners, are an extremely important contextual factor for adolescents. Different from childhood, adolescents spend a much greater amount of time interacting with their peers. One study found that adolescents were spending about 2 times as much time with their peers than their parents, even over weekends, outside of formal school time. Adolescents have the most contact with their peers during school hours; however, they also spend time with friends after school, and may develop friendships through church, work, or extracurricular activities.

Peers relationships serve numerous purposes for adolescents. A basic purpose of peer interaction is social integration. It is important for adolescents to feel wanted and included in social groups. Persons who are socially integrated show fewer psychological signs of distress, including depression. Peer relationships also provide a context for developing social skills. Adolescents learn how to interact with others by learning how to maintain their own friendships. Peer relationships allow adolescents to navigate through conflict management, listening, empathy, and intimacy skill building.

The importance of friendship can be summarized within six basic domains: companionship, stimulation, physical support, ego support, social comparison, and intimacy. The variety of these domains demonstrates the importance of close friendships for adolescents. Contributing more heavily to the developmental goals for adolescence, ego support, social comparison, and intimacy are particularly noteworthy. Friends provide reassurance, support, and encouragement during times of uncertainty for many adolescents. This ego support allows adolescents to maintain a reasonable level of self-esteem. Friends also provide a source of social comparison, such that adolescents can gauge themselves against friends. Adolescents engage in social comparisons for a variety of reasons, including identity development, and may be interested in how their academic achievement, body image, popularity, and romantic involvement compares to others. Lastly, adolescents are starting to develop intimate, close relationships with their peers. These intimate relationships allow adolescents the ability to explore self-disclosure and trust.

Because adolescent peer relationships serve so many important functions, it is also important to understand why many adolescents do not achieve close friendships. Sociometric status refers to the degree to which adolescents are liked or disliked by their peers. This concept is gauged by asking participants to rank order and nominate other peers for 'most-liked' and 'least-liked' roles. Five different categorizations of peers have been established: popular, rejected, and

neglected. Popular individuals are often nominated as someone's best friend, and typically do not receive many 'least-liked' votes. They tend to be good communicators, enthusiastic, confident, and happy. Their internal states and external behaviors both contribute to their ease in developing close friendships. Conversely, rejected individuals receive many 'least-liked' votes and few best friend votes and tend to be characterized as aggressive, arrogant, tactless, and annoying. Neglected adolescents do not receive either 'best friend' or 'least-liked' votes and tend to be overly timid, shy, or lacking in enthusiasm. Rejected adolescents tend to be lonelier than neglected adolescents and are more likely to develop psychological problems. As loneliness is a rather subjective experience, some research suggests that there are cultural differences regarding how isolation is experienced. However, adolescents do universally demonstrate a need for belonging and acceptance.

Groups, crowds, and cliques can develop as a means of inclusion, and exclusion, for many adolescents. Groups tend to form around a similar purpose, activity, or special interest. For example, athletic teams, religious groups, and clubs can all make up a group. These groups have social norms and roles that members follow in order to be included. Groups can infuse a sense of companionship, purpose, and accomplishment among adolescents. Group membership may provide a certain level of intrinsic satisfaction, in addition to extrinsic rewards for participation. Groups comprising different clubs, organizations, and teams are typically associated with positive psychosocial developmental outcomes.

Crowds are entities that tend to form based on reputation, and membership may be involuntary. These classifications make up terms such as the, 'jocks,' 'goths,' 'preppies,' etc. Adolescents may belong to a crowd based on the type of behaviors they engage in (e.g., 'druggies'), their SES standing (e.g., 'preppies'), or their level of social integration (e.g., 'nobodies'). These large collections of individuals may not interact and/or socialize together, although smaller branches of friendships (groups or cliques) may develop within the crowd.

Cliques are smaller, more intimate, sets of friends that may have formed based on inclusion in a larger group or crowd. Cliques tend to involve no more than 12 people (typically about 5 or 6 people), and mostly comprise adolescents who attend school together. Both positive and negative outcomes can be associated with the development of cliques. Because of the in-group and out-group processes, some adolescents may feel socially isolated if they are not members of a social clique. Cliques may also encourage antisocial behavior, such as teasing, toward others who are not members of a particular clique. However, cliques do allow small groups of friends to become closer, which can serve as an additional support system for many adolescents.

Peer relations are also influenced by gender, SES, and culture. Adolescents tend to select friends who are similar to themselves in age, gender, SES, and ethnicity. Girls tend to focus more on interpersonal interactions within their friendship, striving to maintain high levels of intimacy and self-disclosure; while boys tend to focus more on activities, giving less attention to self-disclosure and intimacy. Adolescents from middle and upper SES groups tend to be more socially integrated and take more leadership roles within friend groups. Those from lower SES groups, or those from minority groups, may seek friendship

among themselves. Groups and cliques that form based on minority or cultural status may serve as a source of social integration and to ward off isolation.

Romantic relationships

In addition to the development of more intimate and consistent bonds with peers for the purpose of developing friendship, adolescence is a time in which peers can also serve as possible romantic partners. It is not uncommon for adolescents to identify themselves as 'dating,' 'having a boyfriend/girlfriend,' or 'going-out with someone.' One study found that among 17-year-olds, ~70% reported that they were currently in a romantic relationship, or had been within the previous year and a half. Thirty-six percent of 13-year-olds, and 53% of 15-year-olds, also reported romantic relationships in that study. Comparisons across studies have been difficult due to differing language usage among researchers. For example, some studies may ask, 'Are you in a serious relationship,' while other studies may ask, 'Are you involved romantically with another person?' These questions may elicit different responses, thus making the empirical comparison of data difficult. Nevertheless, numerous studies have emphasized the importance of understanding the development of romantic relationships in adolescence.

Adolescent romantic relationships are characterized as having many different functions. In addition to courtship for the purposes of marriage, these relationships can also serve as a platform to further explore the socialization process. Dating may also assist with building intimacy, companionship, identity, and achievement. Further, adolescent romantic relationships provide an arena for sexual experimentation and sexual identity development. Adolescence is a time of exploration within numerous fields, and romantic relationships can aid in that exploration process.

Early adolescents (ages 10–13) tend to spend more time simply thinking about potential romantic interests rather than actually interacting with them. At this time, adolescents are still acquiring basic skills regarding how to interact with potential romantic partners. As they are exploring their initial attractions to romantic partners in general, they are also making social comparisons to their friends' 'progress' in this dimension. Early adolescents who get involved early in dating and sexual relationships are at risk for problematic developmental pathways involving problems with alcohol, drugs, truancy, and educational underachievement. Middle (ages 14–17) and late (ages 18–21) adolescents tend to engage in more formal dating practices and sexual behaviors. Adolescents who begin dating later rather than earlier, and engage in sexual behaviors only in the context of dating relationships, are not more likely to show problematic behaviors than their nondating peers. Findings also have suggested that 'light' sexual behaviors (e.g., hugging, kissing, etc.) among adolescents are linked to more committed relationships and healthier relationships with parents. Heavy sexual behaviors (e.g., intercourse) were not linked to any higher levels of psychological distress or behavior problems in late adolescence. Late adolescents may engage in sexual behaviors as a sign of their commitment and intimacy.

Most research regarding adolescent romantic relationships and sexual behaviors focus on mixed-gender relationships. However, although many sexual minority adolescents in

same-gender romantic relationships will undergo similar experiences, these adolescents may also experience more difficulties interpreting their feelings and behaviors within the context of societal norms and expectations. Research has shown that many individuals identify their first same-sex experience (i.e., attraction, behavior, self-labeling) during adolescence. Unfortunately, many sexual minorities risk experiencing verbal and physical abuse, which may encourage sexual minority adolescents to feel uncomfortable proclaiming their romantic and sexual orientations.

Culture and Social Trends

From a holistic perspective, the concept of culture encompasses any specific group's way of thinking and being including their cultural norms, values, and beliefs that are passed on from one generation to the next. Not all individuals who associate with a particular culture will continuously identify with their group's norms, values, and beliefs. It is not uncommon for individuals to question or reject certain aspects of their cultural background. These rejections, or cultural violations, may not be well received by others within their cultural group. However, individuals may develop a strong sense of ethnocentricity especially during adolescence. In other words, they may begin to favor their own cultural group over others.

SES and ethnicity

Historically and globally, two groupings that have been commonly used to establish culture are ethnicity and SES. Ethnicity is typically based on an individual's race, religion, heritage, and/or language. An individual's SES, or class, is typically based on an individual's economic, occupational, and/or educational status. Because adolescents often have similar occupational and educational statuses, their SES classification is based upon their parent's status within these areas. Research has shown that an adolescent's ethnicity and SES may have an effect over their development. One study found that adolescents who come from impoverished families, and who reside in crime-ridden neighborhoods, are at greater risk for negative developmental outcomes, including higher levels of psychological distress and poor academic success. Additionally, research has also shown that parents from higher SES groups are less likely to utilize authoritarian parenting styles and physical punishment. Conversely, lower SES parents were found to utilize more directive parenting strategies and physical punishment.

The culture of SES can also affect an adolescent's development by encouraging or discouraging self-efficacy and self-gratification. For example, parents from higher SES groups are more likely to encourage their children to explore, take initiatives, and delay gratification. Self-exploration and delayed gratification expectations are likely to encourage children to stay in school longer, and obtain higher paying jobs that value critical thinking skills, autonomy, and creativity. Conversely, parents from lower SES groups are more likely to be concerned with conformity and discipline. These trends within lower SES communities may stem from concerns regarding employment, safety, and a general ability to care for self and family. Additionally, persons from lower SES communities typically hold jobs in

which autonomy and creativity are not valued. Therefore, the ability to conform and be disciplined is highly desirable. It is not uncommon for parents to pass these values and expectations, based out of SES backgrounds, onto their children. Notably, however, parents from lower SES groups who place a high value upon education are more likely to have children who achieve a high level of academic success, which can later provide higher paying careers.

In addition to SES, ethnicity also may play a significant role in adolescents' lives. Because ethnic minority groups are more likely to experience poverty, many issues surrounding ethnicity tend to be confounding factors that overlap with SES issues. Ethnic minorities may be unjustly categorized as 'inferior' in educational or occupational realms as a result of their ethnic makeup. However, it has been commonly found that environmental and economic factors account for a large amount of ethnic minorities' difficulties within these areas. Nevertheless, ethnicity within itself may also play a significant role in adolescents' lives. Ethnic minority adolescents are often at risk for experiencing the effects of negative stereotypes and prejudice. These experiences, which may include unwarranted teasing and harassment, can cause ethnic minority adolescents to experience greater levels of psychological distress and feelings of inadequacy.

Media

Today's adolescent is likely to be extraordinarily technologically savvy. Adolescents are large consumers of a variety of different media outlets, including television, computers, cell phones, video games consoles, CD/MP3 players, and digital cameras. Nearly a culture within itself, technology has shaped and guided the way in which adolescents experience the social world around them. With approximately two-thirds of adolescents having a television in their bedroom, it is not surprising that time spent watching television still takes up the greatest portion of an adolescent's daily activities outside of school. Increased levels of television consumption are generally associated with lower academic success, more passive learning styles, and less active lifestyles. Generally, late adolescents make a shift from television consumption toward other media outlets, such as computers and CD/MP3 players. Researchers have recently noted a significant increase in the amount of time adolescents spend on the Internet. Many adolescents use the Internet for a variety of reasons, including entertainment, social, and academic purposes. Although Internet use can be extremely beneficial to adolescents, certain concerns regarding exposure to inappropriate material exist. Among adolescents, about 44% have visited a sexually explicit adult website; and about 25% have visited a website containing racially motivated hate material. Many adolescents use the Internet to visit social networking websites, such as Myspace and Facebook. These websites allow adolescents the opportunity to socialize and interact with peers over an electronic format. Although enjoyed by the majority of adolescents, these websites can also facilitate passive-aggressive 'web-fights,' or cyber-bullying between peers, and may serve as a source of stress for a portion of adolescents.

Overall, culture and social trends not only have an effect on adolescent development independently, but also can affect how other contextual factors are manifested. Families, friendships, romantic relationships, work, and school can all be affected by

an adolescent's culture and prevailing social trends. For example, an adolescent's culture may dictate certain expectations regarding romantic relationships and dating scripts to which adolescents must adhere. Social trends, such as the popularity of cell phones, texting, and the use of social networking websites (i.e., Facebook and Myspace) greatly affect the manner in which adolescents communicate with parents and peers.

Summary

Adolescence is a transitory period in which an individual shifts from childhood into adulthood. For most, this period is a time of physical, social, and emotional changes. The development that occurs within adolescence is key in setting the stage for adulthood. The age range when an individual will experience adolescence will vary depending on maturity and cultural norms. However, researchers have recently begun to conceptualize adolescence as spanning more years than previously believed. Because adolescence is filled with ambiguity and uncertainty in many areas, self-exploration and identity development are important goals within this transitory period. Although a portion of adolescents will experience a significant amount of turmoil during this time that may interfere with healthy development, most will make the transition into adulthood successfully.

See also: Addictions and Adolescence; Family Systems; Friendship; Moral Development; Parent–Offspring Conflict; Risk-Taking Behavior (Young Male Syndrome); Social Development (Attachment, Imprinting).

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Adrenal Glands

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Glossary

Anabolic process A metabolic process that builds molecules from smaller units.

Catabolic process A process that releases energy in the form of ATP through the breakdown of larger molecules into smaller units.

Catecholamines A class of neurohormones, including epinephrine, norepinephrine, and dopamine, that are involved in various central and peripheral processes.

Glucocorticoids A class of steroid hormones that act to maintain glucose homeostasis and circadian rhythm, contribute to carbohydrate metabolism, and are involved in

arousal, stress response, and cognitive functions such as mood and memory.

Gluconeogenesis The production of new glucose molecules that are utilized in metabolic processes.

Hyperplasia Abnormal increase in proliferation of cells in organs or tissues that is above what is considered normal.

Metabolism The sum of all catabolic and anabolic processes that occur within an organism to help sustain life.

Type II diabetes A disorder that is characterized by insulin resistance brought on by chronically elevated blood glucose levels, stress, obesity, and other factors.

Introduction

The adrenal gland and its hormones are responsible for many functions that ultimately impact human behavior. The release of adrenal hormones into the peripheral bloodstream impacts global functioning, starting with changes in cellular metabolism and expanding to include alterations in mood, alertness, and attention that in turn lead to measurable changes in behavior. Examining the influence of hormones released from the adrenal gland on homeostatic processes, as well as the consequences of disease states that hinder normal adrenal functionality, demonstrates the importance of this endocrine gland and its many chemical messengers.

The purpose of this article is to discuss the role of the adrenal gland and its function in human behavior. An overview of the organization and anatomy of the adrenal gland is given, followed by an explanation of the hormones associated with the different parts of the adrenal gland. Hormone synthesis and release and the regulation of glucocorticoids, aldosterone, androgens, and catecholamines are described. The impacts of these hormones on metabolic functions, mood, and reproduction are also discussed.

Anatomy and Physiology of the Adrenal Gland

The adrenal glands are small endocrine organs located directly above the kidneys. The adrenal gland is made up of the inner adrenal medulla encased by the outer adrenal cortex. These regions are morphologically distinct and produce hormones that play important roles in essential physiological processes, including stress response, regulation of blood pressure, and production of sex hormones. The following sections discuss the hormones associated with the adrenal cortex and the adrenal medulla. The synthesis of these hormones and their receptors is discussed, as well as the connections of the adrenal cortex and adrenal

medulla to the hypothalamus–pituitary–adrenal (HPA) axis and the sympathetic nervous system (SNS), respectively (Figure 1).

Adrenal Cortex

The cortex of the adrenal gland is responsible for the synthesis and secretion of glucocorticoids, aldosterone, and dehydroepiandrosterone (DHEA). It consists of three layers: the zona glomerulosa, the zona fasciculata, and the zona reticularis. Each layer is responsible for different functions associated with the synthesis and release of certain hormones. The zona fasciculata is responsible for the storage and release of glucocorticoids; the zona glomerulosa is responsible for the synthesis and release of mineralocorticoids; and the zona reticularis is responsible for the release of androgens.

Glucocorticoids

Glucocorticoids (i.e., cortisol and corticosterone) are produced in the zona fasciculata of the adrenal cortex and are synthesized from plasma cholesterol. Glucocorticoids are vital to the circadian rhythm, glucose metabolism, arousal, and cognitive functions, such as memory and mood. Cortisol is also the main hormone associated with the physiological stress response in humans, whereas corticosterone is the hormone equivalent to cortisol in most rodents. However, in humans, corticosterone is a precursor in the synthesis of aldosterone, which is discussed later. When cortisol is synthesized, it begins with the conversion of cholesterol to pregnenolone and then it is converted to 17 α -hydroxypregnenolone. This is then converted to 17 α -hydroxyprogesterone and then to 11-deoxycortisol, which is converted to cortisol.

Glucocorticoids are released following activation of the HPA axis and are considered an integral part of the body's response to a stressor. Though there has been much debate about what a stressor is in relation to the individual, for the purposes of this article a stressor is defined as either an environmental or psychological occurrence that activates the stress response (i.e., the HPA axis and the sympathoadrenal

[†]Deceased.

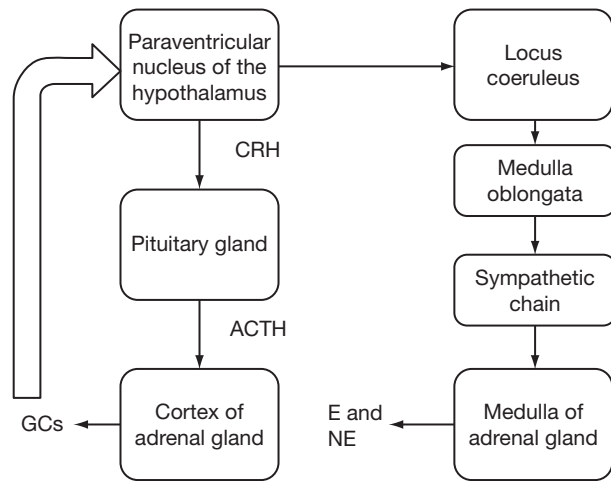


Figure 1 Overview of the hypothalamus–pituitary–adrenal axis and sympathetic nervous system in relation to the stress response. CRH, corticotropin-releasing hormone; ACTH, adrenocorticotropin hormone; GCs, glucocorticoids; E, epinephrine; NE, norepinephrine.

medullary (SAM) system). When a stressor is perceived, the paraventricular nucleus (PVN) of the hypothalamus is activated, causing the release of corticotropin-releasing hormone (CRH). CRH is released through the blood into the hypothalamic–pituitary portal system, where it travels to the pituitary gland. Once in the anterior pituitary gland, adrenocorticotropin hormone (ACTH) is released. ACTH travels via the bloodstream to the adrenal cortex where it binds to the melanocortin 2 receptors (MC2-R), activating glucocorticoid release via a second messenger pathway.

The release of cortisol from the adrenal cortex is regulated by the ACTH that is released from the anterior pituitary gland following release of CRH from the hypothalamus. When ACTH is released from the pituitary gland, ACTH binds to the MC2-Rs located on the zona fasciculata cells of the adrenal cortex. This receptor is a G protein-coupled receptor, which when activated causes an increase in intracellular cyclic adenosine monophosphate (cAMP) to activate protein kinase A (PKA). Activation of PKA causes two distinct cellular responses that allow for more cholesterol to be used for the synthesis of adrenal hormones. First, this converts cholesterol esters into free cholesterol that can be used for creating glucocorticoids. Second, the increase in free cholesterol increases the steroidogenic acute regulatory protein (StAR) expression, allowing for an increase in cholesterol being transported to the mitochondria, which is then converted into pregnenolone.

Once released from the adrenal cortex, glucocorticoids (primarily cortisol in humans; corticosterone in rodents) travel throughout the body via carrier proteins in the bloodstream. Normally, the vast majority of cortisol in humans travels bound to transcortin (also called corticosteroid-binding protein, CBP), an α globulin protein, or by serum albumin, a nonspecific steroid hormone carrier. These carrier proteins are produced primarily in the liver instead of the adrenal gland and can be influenced by liver disease as well as estrogen levels during pregnancy. In addition to cortisol, transcortin also binds to progesterone, aldosterone, and its precursor 11-deoxycorticosterone, while serum albumin is involved in

maintaining osmotic pressure as well as binding to substances such as fatty acids, thyroid hormones, and other fat-soluble compounds. Normally, cortisol remains bound and inactive until reaching the target tissue, with less than 10% of available hormone free to bind glucocorticoid receptors (GRs) so that the pool of available hormone remains steady in spite of changes in the level of hormone being released from the adrenal cortex. However, under conditions of severe stress or during certain disease states (such as sepsis), the level of glucocorticoid production may increase above the capacity of available carrier proteins, increasing the proportion of free hormone and enhancing its impact.

Once free glucocorticoids reach a target tissue, they bind to intracellular transcription factor proteins known as GRs, which are part of the family of nuclear receptors that bind steroid and thyroid hormones, as well as vitamin A metabolites. Typically, these receptors remain in the cytoplasm, bound to a hetero-oligomeric group of proteins that occlude the DNA-binding regions but leave the ligand-binding site open. When glucocorticoids enter the cell and bind to the GR, a transformational change occurs and the GR dissociates from the protein complex, exposing the DNA-binding regions. The receptor enters the cell nucleus and binds to the promoter regions of target genes that contain glucocorticoid-response elements (GREs) that influence the expression of several gene products such as those involved in immunosuppression, anti-inflammatory activities, and the creation of adipose cells. After binding has occurred, the receptor dissociates from the GRE and remains in the nucleus for an extended period before returning to the cytoplasm. There are also nongenomic effects of glucocorticoids, which occur rapidly and can affect cell membrane properties through activation of membrane-bound or intracellular GRs. Although the mechanisms of these effects are not entirely clear, studies of isolated synapses have revealed unique binding sites for steroid hormones in presynaptic terminals that could directly modify neurotransmitter release and other activities dependent on calcium levels directly. For example, the administration of exogenous glucocorticoids led to increased aggression in male rats and enhanced lordosis responses in females within minutes, an effect not seen when other steroid hormones were administered (such as testosterone or estradiol). Such effects are considered nongenomic because they occur much faster than processes that rely on the GR complex and because pharmacological blockades of GRs do not eliminate these effects.

Cortisol is one of the few hormones that have a circadian rhythm associated with basal levels. This hormone has an increase in levels just before a person wakes up in the morning, roughly 1–2 h before awakening. Cortisol levels continue to oscillate throughout the day, with their lowest levels being around the beginning of the sleep cycle, usually the beginning of the dark cycle. This rhythm was once believed to be regulated by the suprachiasmatic nucleus (SCN), which received input about the light/dark cycle via input from the retina. It has been shown that those who are completely blind do have circadian rhythms controlled by the SCN; however, their rhythms are usually either shorter or longer in duration than those who have functioning retinas. In addition, lesion studies of the SCN have shown that the cortisol circadian rhythm continues to occur, indicating that this circadian rhythm is

not solely regulated and controlled by the SCN. It is unclear how this particular rhythm is maintained without the SCN and what additional areas of the brain may be involved in the maintenance of circadian rhythms, specifically the cortisol rhythm.

The effects of acute stressors tend to differ from those seen following chronic stress. The stress response system was designed to maintain homeostasis during times of crisis, but when chronically activated, dysregulation and damaging effects may occur. The hippocampus is particularly vulnerable to the negative effects of chronic stress. Trauma in early life is associated with dysregulation of the HPA axis such that these individuals are more prone to high stress reactivity and blunted negative glucocorticoid feedback, as well as increased vulnerability to anxiety, mood, and substance abuse disorders. The extent of this dysregulation can be seen in animal subjects exposed to early life stress, where evidence of neuronal loss and reduced dendritic volume is present in the adult hippocampus. The loss of hippocampal neurons is also associated with chronic illnesses such as depression, where it is associated with cognitive dysfunction. Normally, the hippocampus can regenerate neurons and dendrites to repair damage following trauma, but in the brains of individuals under chronic stress or disease, these processes are blunted and damage persists.

Glucocorticoids and behavior

Glucocorticoids not only play a vital role in stress response but also produce widespread effects physiologically and behaviorally. As described earlier, the level of glucocorticoids in the bloodstream fluctuates based on circadian rhythms. The maintenance of a normal circadian pattern of glucocorticoid release is necessary for physical and mental health.

Individuals with inherited or acquired pathologies of the glucocorticoid system suffer from a variety of negative symptoms and physical effects. The following section examines the behavioral impact of glucocorticoids in normal individuals, as well as the consequences of disease states affecting this system.

Several genetic mutations that result in varying levels of transcortin deficiency, which either decrease the binding affinity for cortisol or result in complete loss of transcortin production, have been discovered in humans. Clinically, these individuals presented with depression, fatigue (especially when stressed), hypotension, and other symptoms of adrenal insufficiency, despite tests demonstrating that cortisol levels in the bloodstream were low-normal or normal. These genetic anomalies could be a possible factor in poorly understood conditions, such as chronic fatigue syndrome and some idiopathic chronic pain disorders, and the importance of maintaining normal free glucocorticoid levels should be emphasized in clinical settings.

Normal GR functionality is vital for an effective and timely response to glucocorticoid release. In humans, mutations in the gene coding for the receptor can selectively alter the binding properties of the GR, leading to glucocorticoid insensitivity in target tissues that express mutated GRs. This condition leads to excess activation of the HPA axis, increased levels of ACTH release, adrenal hyperplasia, and excessive production of all cortical steroids. In some of the milder cases, the mutation results in lower GR-binding efficacy and the effects are beneficial to the individual: increased glucocorticoid resistance,

enhanced insulin sensitivity, lower fasting blood sugar, lower cholesterol levels, and a lower risk of dementia, cardiovascular disease, and type II diabetes. In addition, male carriers of these types of mutation tend to be taller and more muscular while females tend to have smaller waist sizes and weigh less. On the other hand, mutations that lead to enhanced glucocorticoid sensitivity tend to be less beneficial, producing a metabolic phenotype that increases the risk of cardiovascular disease and is associated with higher BMI, elevated cholesterol levels, and lower bone density. Individual variation in GR sensitivity may have a profound effect on overall health, and further clinical examinations could reveal important targets for treatment in affected individuals.

Glucocorticoid effects on metabolic activity Although the behavioral response to glucocorticoids is difficult to isolate from the effects of catecholamines in humans, animal studies can examine the impact of exogenous glucocorticoids in adrenalectomized or normal subjects. Such studies have revealed important physiological and behavioral aspects of the glucocorticoid system. Under normal conditions, glucocorticoids influence metabolic processes and liver enzyme production. Depending on the target tissue, these activities may be anabolic (requiring energy) or catabolic (producing energy). In the liver, glucocorticoids increase the production of enzymes necessary for gluconeogenesis (an anabolic process) while the response in muscle and adipose tissue increases the breakdown of carbohydrates, proteins, and lipids for energy in the form of adenosine triphosphate (ATP) (a catabolic process). Glucocorticoids also inhibit the activities of insulin, preventing glucose from entering cells and enhancing catabolic processes as cellular glucose levels fall. The amino acids and/or fatty acids that are by-products of catabolic breakdown exit the cell and can be utilized in the liver for gluconeogenesis. Chronically elevated glucocorticoid levels (under chronic stress conditions or glucocorticoid resistance) lead to persistent hyperglycemia and increase vulnerability to insulin resistance and type II diabetes.

Glucocorticoids are necessary to maintain homeostasis and they also play an important role in recovery in the aftermath of injury or disease. Glucocorticoids are involved in catecholamine synthesis and reuptake in sympathetic nerve terminals, which regulate the level of vascular smooth muscle tension in response to changes in blood pressure and enable blood flow to reach active tissues (such as skeletal muscle) during acute stress. Glucocorticoids also demonstrate permissive effects on the sympathoadrenal system during acute stress, allowing norepinephrine (NE) and epinephrine (E) to exert full effects on the liver, blood vessels, and other tissues. The processes that occur during the initial alarm phase of acute stress require an adequate store of liver glycogen for breakdown; free fatty acids may be used to perform gluconeogenesis, but persistent activation of the HPA axis can lead to loss of muscle tissue, hyperglycemia (leading to type II diabetes), and deterioration of immune and vascular tissues.

Endocrine functions are also influenced by social factors in human and animal populations. In societies where a strict social hierarchy exists, lower-ranking members demonstrate adrenal hyperplasia, deterioration of immune tissues, and increased vulnerability to disease. In addition, excess release

of glucocorticoids impairs the functioning of the reproductive system. In females, high levels of cortisol are associated with increased risk of miscarriage and infertility, which influences individual reproductive success.

The impact of glucocorticoids on reproductive behavior involves both physiological and psychological effects. Glucocorticoids can act directly on the hypothalamus and pituitary gland to inhibit the release of gonadotrophins or gonadotrophin-releasing hormone or interact with gonadal tissues to alter the response to luteinizing or follicle-stimulating hormones. The administration of exogenous glucocorticoids is associated with decreased gonadotrophin release, an effect which also appears in response to chronic stress but is less consistent during acute stress. Cortisol has also been shown to enhance negative feedback from estrogens and reduce its enhancement of gonadotrophin-releasing hormone receptor expression.

In females, inhibition of luteinizing hormone (LH) activity leads to inconsistencies in the reproductive cycle, including an extended follicular phase and impaired uterine maturation during the luteal phase. These effects reduce the probability of egg fertilization and implantation. Higher levels of cortisol are also associated with an increased risk of miscarriage during early pregnancy. Increased glucocorticoid release also has a marked effect on sexual receptivity and proactive behaviors that are likely due, in part, to increased vigilance and anxiety during stress as well as decreased estrogen levels in the bloodstream. Normally, estrogen acts to facilitate genital sensitivity to tactile stimulation, which enhances sexual receptivity.

For pregnancies that are carried to term, maternal stress has been associated with shorter gestation periods and smaller babies. Infants born to mothers with high cortisol levels during the third trimester tend to show more signs of negative affect (negative facial expressions, crying/fussiness) and tend to be rated as more difficult by their mothers. Maternal behaviors are also altered, with several species demonstrating less affection and infant-directed behaviors in mothers with high glucocorticoid levels. The combination of prenatal stress and distant parenting also influences the stress reactivity of the infants, causing enhanced emotionality and anxiety during infancy and increased susceptibility to mood disorders and substance abuse in adulthood.

In males, the effect of glucocorticoids on the gonadal hormones is similar, with a significant decrease in testosterone as a result. Although deficits in testosterone are not sufficient to impair fertility, reproduction is inhibited by the disruption of erectile function. Inhibition of the parasympathetic system during stress also prevents the development of an erection, and excess sympathetic activity can result in premature ejaculation if an erection forms. These effects, in addition to decreased libido, have a severe impact on reproductive capacity in males.

Mood The HPA axis influences cognition and mood through GRs and MRs located in the prefrontal cortex, hippocampus, amygdala, and limbic system. While the administration of exogenous glucocorticoids or GR agonists has been shown to enhance acute cognitive performance in some laboratory tests, assessments following chronic administration produced evidence of impaired working memory, verbal memory, learning (as assessed by repeated administration of a verbal memory

task), and memory retrieval. The effects of acute administration may be a result of temporarily enhanced vigilance and attention that is associated with the acute stress response, while repeated administration mimics the detrimental effects that result from chronically elevated glucocorticoid levels. Glucocorticoids disrupt normal metabolic activity in the hippocampus, a process that increases neuronal loss following stroke or seizure and increases the rate of loss as an individual ages. Glucocorticoids have also been implicated in increased vulnerability to neurotoxins and glutamate excitotoxicity.

GRs in the limbic system and prefrontal cortex enable HPA axis activity to influence mood and other psychological states. Disturbances in the HPA axis and glucocorticoid system are associated with mood disorders, with multiple studies demonstrating elevated cortisol levels and impaired GR negative feedback in patients diagnosed with mood disorders. Although acute administration of glucocorticoids sensitizes serotonin (5-HT)-1A autoreceptors, chronically high levels of glucocorticoids lead to desensitization and impaired functioning of these receptors has also been identified in patients with mood and anxiety disorders. Elevated cortisol appears to be a sign of poor prognosis, and these patients seem to be particularly resistant to treatment and more vulnerable to relapse. The relationship between glucocorticoids and depression is of particular interest due to the pattern of HPA axis dysregulation seen in patients with major depression. While older depression models focus on serotonin and NE, more recent studies have presented clear evidence of the relationship between the HPA axis and depression, as well as many potential targets for novel treatment. Individuals with major depression demonstrate elevated blood cortisol levels as well as glucocorticoid resistance, a condition that interferes with normal negative feedback pathways. Experimental treatment with substances that alter HPA axis activity has demonstrated positive results, but further studies are needed to identify the best possible targets and to evaluate any potentially negative effects of long-term use. In addition to HPA dysregulation, major depression is also associated with progressive degeneration of the hippocampus, amygdala, and prefrontal cortex, seen in patients with major depression. These effects are likely mediated by a combination of excess glutamate activity induced by glucocorticoid activity and a loss of gamma-aminobutyric acid (GABA)ergic and serotonergic activity, which has been shown to protect against hippocampal neuronal loss in experimental subjects.

Aldosterone

Aldosterone is classified as a mineralocorticoid, and though it is produced in the adrenal cortex, its regulation is not through the HPA axis, but rather through angiotensin II and serum potassium levels. The purpose of aldosterone is to maintain fluid and electrolyte balances within the body. Aldosterone is produced in the zona glomerulosa of the adrenal cortex. Synthesis begins with the conversion of cholesterol to pregnenolone. Pregnenolone is converted to progesterone, which is then converted to 11-deoxycorticosterone. 11-Deoxycorticosterone is converted into corticosterone and then to aldosterone.

Aldosterone release is regulated by the renin-angiotensin system of the kidney. This system is activated in response to activation of the SNS. This process begins when NE is released from the SNS and acts on the juxtaglomerular (JG) cells of

the vascular arteriole of the renal glomerulus. This causes the release of renin, which is then converted into angiotensin II. Angiotensin II travels to the zona glomerulosa of the adrenal cortex and stimulates the release of aldosterone. When aldosterone is released, it causes an increase in sodium levels within the blood, causing an increase in blood pressure. This increase in blood pressure signals the JG cells of the kidney to decrease production of renin, which in turn reduces aldosterone secretion.

The mineralocorticoid receptors (MRs) are not well understood in terms of how they are activated or even their makeup. Due to the high affinity nature of glucocorticoids to these receptors, it is unclear how aldosterone binds to these receptors in competition with other hormones. In addition, the location of these receptors has been somewhat paradoxical. The studies that have been undertaken to understand MRs have found a greater number of these receptors in the hippocampus as opposed to the epithelial tissues that mineralocorticoid hormones would target. That is not to say that these receptors do not exist in the epithelial tissue; however, their number pales in comparison to those that have been found in the hippocampus. Additional research is needed to understand how aldosterone binds to MRs, given the lower circulating levels and lower affinity to these receptors compared to glucocorticoids.

Androgens

The innermost layer of the adrenal cortex releases androgens – steroid hormones that impact the development of male sex organs and secondary sexual characteristics. The primary androgen produced by the adrenal cortex is dehydroepiandrosterone (DHEA) (and the sulfate metabolite, DHEA-S), which is a precursor to sex hormones such as estradiol and testosterone. Isolating the role of DHEA has been difficult due to the significant impact of these metabolites and the fact that no specific nuclear receptor has been identified for DHEA. Originally, DHEA was thought to be biologically inactive, serving only as an alternative source of sex hormones, but research in the last few decades has revealed important systemic and behavior effects that result from the release of this hormone.

Early research indicated a possible role for DHEA as an antiglucocorticoid hormone when it was shown that the relative balance of DHEA to cortisol is modified by stress (in favor of cortisol) and that coadministration of DHEA and dexamethasone produces a decrease in the effect of glucocorticoids on cytokine release (IL-4 and IL-6) and lymphocyte suppression. Further, the administration of DHEA impairs fear conditioning in rats through activation of sigma-1 chaperone protein receptors. The role of DHEA in glucocorticoid antagonism appears to be a vital part of the body's antistress system, despite the absence of clear nuclear receptor activities. Though its role in sex hormone production is also essential for normal functionality, DHEA is by no means an inactive precursor.

The synthesis of DHEA in the brain appears to occur independently of the adrenal gland, but its activities may also impact global functioning and thus bear mentioning. In humans, levels of DHEA in the bloodstream peak in the second decade of life, declining thereafter throughout an individual's lifetime. Evidence of DHEA-S's neuroprotective activities in the hippocampus suggests that loss of this hormone through age or chronic stress may be related to increased risk of neuronal loss. In a small study of middle-aged and older adult

patients with depression and/or low blood DHEA levels, the administration of exogenous DHEA led to temporary improvements in depression scores and enhanced some cognitive abilities during the treatment period. Unfortunately, a number of double-blind, placebo-controlled studies employing exogenous DHEA in normal, healthy, older adult patients failed to detect cognitive improvements, suggesting that not all older individuals experience behavioral or cognitive declines as a result of age-associated decreases in DHEA. Further, individuals born with a mutation in the gene for the enzyme required for the conversion of pregnenolone to DHEA demonstrate sexual infantilism, hypertension, and hyperkalemia but do not suffer from cognitive deficiencies, indicating that exposure to maternal DHEA during early development is sufficient for normal brain development; however, older adults with this condition have not been closely studied. In rodents, DHEA was found to bind to the N-terminus of microtubule-associated protein 2 (MAP2) cytoskeletal proteins in the brain, which are involved in the extension of neuronal axons and dendrites. The involvement of DHEA in neural development and plasticity may be required during early life but becomes less important after childhood, when puberty-induced changes lead to increased conversion of DHEA to sex hormones involved in the expression of secondary sex characteristics.

In addition to MAP2 binding, DHEA and DHEA-S also act as noncompetitive antagonists at GABA subtype A receptors and enhance *N*-Methyl-D-aspartate (NMDA)-mediated release of NE in hippocampal neurons through activation of the chaperone protein sigma-1. The enhancement of NMDA activities may explain some of the improvements in memory functioning seen in depressed and elderly patients, but others have suggested that cognitive changes may be due to reduced anxiety from DHEA-mediated antiglucocorticoid effects. Indeed, it was shown that the administration of DHEA in ovariectomized rats reduced behavioral signs of anxiety and was associated with enhanced learning in several maze paradigms. There is also evidence of DHEA and DHEA-S neuroprotective effects following stroke or spinal cord injury. Mice and rats treated with DHEA demonstrated significantly less white matter loss in ischemic stroke models while mice treated with DHEA in conjunction with spinal cord injury showed significant improvements in motor functionality relative to vehicle controls. Moreover, DHEA has been shown to protect against neurotoxicity induced by glutamate or amyloid β protein, which may explain why significant declines in DHEA levels in the elderly and patients with depression or posttraumatic stress disorder (PTSD) are associated with increased cognitive decline and/or exacerbated symptomatology. Decreases in DHEA levels normally associated with aging have less of a direct impact, but may increase vulnerability to neuronal loss in the presence of cardiovascular disease and/or chronic stress. Interventions to reduce chronic stress have showed that cognitive – behavioral techniques prevented HIV-associated declines in DHEA and led to increases in available DHEA in normal, healthy adults, suggesting that tipping the balance of DHEA to cortisol in favor of the former may diminish some of the negative impacts of stress. More research is needed to fully understand the mechanisms leading to age-related DHEA declines, and why most healthy, older adults do not exhibit neurological impairment as they age.

Adrenal Medulla

The adrenal medulla is responsible for the storage and release of the catecholamines, NE, and E. This article focuses on the behavioral effects of NE and E. The adrenal medulla is made up of chromaffin cells that contain granules composed of catecholamines, adenine nucleotides such as ATP, proteins, and lipids. In humans, there are two types of these cells: E-storing cells and NE-storing cells. There are subtle differences between these two types of cells. For example, E-storing cells contain more glycoprotein compared to NE-storing cells. The ratio of E-storing cells to NE-storing cells differs among species.

The synthesis of catecholamines in the sympathoadrenal system occurs in the adrenal medulla. Synthesis begins when tyrosine is converted to dihydroxyphenylalanine (DOPA) that is then converted to dopamine. Dopamine is converted to NE by the enzyme dopamine β -hydroxylase, and NE is converted to E by the enzyme phenylethanolamine *N*-methyltransferase (PNMT). PNMT is an important enzyme in the conversion of NE to E, and its synthesis is controlled by cortisol. Although 80% of the catecholamines released from the adrenal medulla are E (and 20% NE), only about 10% of circulating catecholamines are E from the adrenal medulla, indicating that extra-adrenal sources of catecholamines, especially of NE, contribute more to circulating levels.

The adrenergic receptors are G protein-coupled receptors and contain two classes of adrenergic receptors: α and β . Within the α class, there are two main types of receptors: α_1 and α_2 ; and within the β class, there are three main types of receptors: β_1 , β_2 , and β_3 . The α class of receptors share dual roles, the most notable being that of causing vasoconstriction on arteries and veins, more specifically the arteries to the heart. The α_1 receptors are mainly responsible for contraction of smooth muscle and are located on the smooth muscle in the gastrointestinal system, blood vessels, and the bronchioles located in the lungs, to name a few. These receptors also aid in sodium reabsorption by the kidneys in connection with the renin-angiotensin system. The α_2 receptors are responsible for preventing release of insulin and glucagon from the pancreas. The β_1 receptors are mostly found in the heart, where they work to increase heart rate and contractility. They are also found in the kidneys, where they work to promote the release of renin to stimulate aldosterone release. The β_2 receptors are found on smooth muscle and work to decrease gastrointestinal motility, increase vasodilation to the skeletal and cardiac muscles, and increase bronchodilation. The β_3 receptors are found in adipose tissues and work to increase fatty acids in the blood.

Connection to the SNS

The adrenal medulla, the part of the adrenal gland responsible for catecholamine release, is directly innervated by the SNS. However, during a physiological stress response, the adrenal medulla is not the only source of catecholamines. The supraspinal structures responsible for the activation and release of catecholamines from the adrenal gland begin with activation of the PVN of the hypothalamus. The PVN has catecholaminergic and noncatecholaminergic projections to the locus coeruleus (LC), which then has catecholaminergic projections to the medulla oblongata. The medulla makes projections to preganglionic fibers of the dorsal and intermediolateral gray area of

the spinal cord. There are some projections to the ventral horn of the spinal cord from the medulla; however, this is somewhat minimal. The preganglionic fibers from the medulla have cholinergic projections to the postganglionic fibers of the sympathetic chain. These postganglionic fibers directly innervate the adrenal medulla, causing the synthesis and release of the catecholamines E and NE. Additional sources of NE are released following activation of the LC and the postganglionic fibers of the SNS to the target organs.

Catecholamines and behavior

The release of E and NE from the adrenal medulla and sympathetic ganglia rapidly elicits a number of measurable changes in an individual. Specific effects within a tissue tend to be associated with the type of adrenergic receptor that is expressed by the cells. While α receptors are associated with vasoconstriction in the circulatory system (increasing blood pressure), β receptors are associated with vasodilation of the bronchi of the lungs and increased heart rate and strength of ventricular ejection. Overall, sympathoadrenal activity leads to dilation of the pupils, piloerection, increased sweating, metabolic activity, and strengthening of muscles, as well as decreased activity in the gastrointestinal tract. Some cognitive functions are actually enhanced, including attention and memory formation. The interaction of the HPA axis, amygdala, and hippocampus during stressful situations or traumatic events allows for the formation of fear memories, which can be triggered upon exposure to a stimulus associated with the event. From an evolutionary perspective, these are necessary for animals to learn to avoid dangerous situations in the future, such as the location of a predator's den. Unfortunately, these memories can be quite resistant to extinction and under certain conditions may lead to posttraumatic symptomatology. In humans, for example, the continual immediate recall of these fear or traumatic memories can lead to the development of PTSD. Patients with this disorder experience symptoms associated with recalling these events, such as recurrent or intrusive thoughts and dreams about the event. Additionally, there may be environmental or psychological cues that give the individual a feeling that the event is recurring. Disturbances in sleep, appetite, and mood are not uncommon for individuals with PTSD. It is unclear how catecholamines interact with the HPA axis, hippocampus, and the amygdala, and what role they may play in the development and maintenance of PTSD.

Disorders of the Adrenal Cortex

Cushing's syndrome

The pathological condition of hyperadrenalism is known as Cushing's syndrome. Patients demonstrate adrenal hyperplasia, primarily in response to excess ACTH release from the anterior pituitary gland, as well as hypercortisolism and excess androgen production. Excess ACTH may be caused by pituitary adenomas, hypersecretion of CRH from the hypothalamus, or ectopic tumors that release ACTH (such as an abdominal carcinoma), while hypercortisolism can result from adrenal adenomas or chronic glucocorticoid treatment. Regardless of the source of the syndrome, Cushing's patients generally present with

abdominal and upper back (buffalo hump) fat deposits and a rounded, swollen appearance in the face (moon face) as well as problems with acne and hirsutism (excess facial hair). The majority of patients also demonstrate hypertension, elevated blood sugar, and protein deficiency in tissues other than the liver due to the metabolic effects of excess cortisol. Protein loss in the skeletal muscles causes severe weakness, and loss of lymphoid proteins severely compromises the immune system and increases vulnerability to infection. Many patients also develop collagen weakness and skin abnormalities, as well as osteoporosis.

Addison's disease

Hypoadrenalism, also known as Addison's disease, results from insufficient levels of adrenocortical hormones secondary to adrenal atrophy. The majority of cases are caused by autoimmunity against the adrenocortical tissue, although tuberculosis and some cancers may also destroy the adrenal tissue. Patients present with severely diminished extracellular fluid volume, hyponatremia, hyperkalemia, and slight acidosis as a result of aldosterone deficiency. Complete absence of mineralocorticoid secretion can lead to shock and death within days. The loss of cortisol inhibits the ability to maintain a normal resting glucose level between meals and slows metabolic functions throughout the body. Without cortisol, the body cannot respond normally to stress, and common infections may be lethal in Addison's patients. These patients may also present with characteristic pigmentation of the skin and mucous membranes in response to enhanced release of ACTH and melanocyte-stimulating hormone in the absence of normal negative feedback provided by the adrenocortical hormones. These patients can lead relatively normal lives if supplemental mineralocorticoids and glucocorticoids are provided on a daily basis.

Summary

The adrenal glands play a vital role in homeostatic mechanisms that are necessary for survival and recovery when the body is subjected to internal and external stressors. Although these organs exist outside the central nervous system, hormones released from the adrenal cortex and medulla have a significant impact on neurological processes and overt behavior, while also acting peripherally to alter metabolic and immunological processes. The significance of normal adrenal and HPA axis functionality is readily observed when dysregulation or disorders are present. Chronic, uncontrollable stress can lead to insulin resistance, blunted negative glucocorticoid feedback in the limbic system, elevated basal glucocorticoid levels, and

enhanced stress reactivity. Long-term exposure to elevated glucocorticoid levels is also associated with atrophy of the hippocampus and progressive cognitive dysfunction with aging. Pathological adrenal insufficiency is characterized by fatigue, slowed metabolic function, and abnormal electrolyte levels and blood pressure, and can lead to death if not treated. On the other hand, excess adrenal secretion leads to hypertension, elevated blood glucose, and protein insufficiency, which weakens skeletal muscles and collagen in the skin and increases vulnerability to osteoporosis. Continued research into the factors that influence adrenal gland functions and disease states is essential for the creation of novel therapies that could prevent dysfunction and the deleterious consequences of chronic stress and adrenal disorders.

See also: [Aging and the Brain](#); [Anxiety and Fear](#); [Anxiety Disorders](#); [Catecholamines and Behavior](#); [Crisis Management](#); [Depression](#); [Perceived Control](#); [Posttraumatic Stress Disorder](#); [Separation Anxiety](#); [Sleep, Biological Rhythms, and Performance](#); [Social Anxiety Disorder](#); [Stress and Illness](#); [Suicide](#).

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Aggression

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Glossary

Aggression Any behavior that is intended to harm another person who does not want to be harmed.

Antisocial behavior Any behavior that either damages interpersonal relationships or is culturally undesirable.

Aggression had existed for a long time before people became interested in studying it. Dinosaurs, birds, insects, Neanderthals, indigenous tribes, and almost our entire evolutionary lineage adopted aggression as a useful survival tool. Killing, violence, and intimidation proved quite useful in obtaining food, sex, territory, and other resources, among all the species. When humans evolved as hunters and gatherers and settled into smaller living communities, aggression became a particularly constructive asset. Males could use aggression to win mates, provide protection, and hunt other animals. Females could use aggression to defend offspring and guard domestic capital. In these ways, our most aggressive ancestors were also the most successful in passing on their genes to future generations, thus providing us with a highly effective blueprint for survival.

However, aggression became less and less adaptive as we continued to evolve. Small tribes transformed into complex societies. Individual effort was unable to compete with group success. Over millions of years, humans became (and continue to be) highly *social* creatures as they learned to bank on cooperation and interdependence for survival. In turn, aggression toward others seemed more likely to hinder group progress than promote it. Men and women were forced to resort to more accommodating behaviors in order to live longer, healthier lives, and ultimately increase their chances of making a splash in the gene pool.

It is both peculiar and astounding, then, that aggression has come to characterize so much of our subsequent history. The rapid rise of interpersonal violence within early societies, the widespread occurrence of murder throughout the Middle Ages, and the countless casualties from any one of the hundreds of wars, all demonstrate our consistent proclivity toward aggression and violence. In fact, we experienced only 26 days of world peace (defined as the absence of international wars) in all of the 40 years following the Second World War. Although numerous sources suggest that overall aggression has been on a steady generational decline, its occurrence and effects are considerably prevalent even today.

Why has something seemingly so maladaptive and detrimental to our survival not been left behind by evolution? How have we developed into such a socially dependent species while failing to learn from our most destructive social mistakes? What can we do to change our behavior before it becomes too late? Where can we find the answers?

Such is the pursuit of the psychological study of human aggression. Though the act itself is certainly not a recent phenomenon, modern scientific research on aggression has

revealed a great deal of insight into its many characteristics, causes, and means of reduction.

What Is Aggression?

In social psychology, aggression is typically defined as any behavior that is intended to harm another person who does not want to be harmed. It is distinct from violence, which is usually defined as extreme physical harm with injury or death as its goal. Violence is a specific form of aggression. All violence is aggressive; not all aggression is violent.

Importantly, this definition of aggression highlights three critical features. First, aggression must be an actual behavior. It is not an emotion, thought, or memory, but a real-life observable behavior, such as a punch or a verbal curse. Second, aggression must be purposeful and intentional. The person who uses aggression very much intends to harm the other person; it is not an accident or by-product. Third, aggression always involves undesired harm to the other party; the victim must not want to be harmed. Thus, autonomous behaviors such as masochism and suicide do not qualify as aggression.

Aggression takes a variety of forms and can vary in function. While its general definition remains constant, it is important to distinguish between these individual components.

Forms of Aggression

Aggression is often expressed in distinct forms, typically falling within each of three sets of criteria. First, aggression can be physical, verbal, or relational. Physical aggression refers to using physical behaviors to harm others, and includes behaviors such as hitting and shooting. It is the form of aggression most clearly linked with violence. Verbal aggression refers to using words to harm others, and includes behaviors such as screaming and cursing. Relational aggression, also known as social aggression, refers to harming a person's relationships, feelings of acceptance, or social inclusion, and includes behaviors such as talking about others behind their backs or intentionally excluding a person from one's own group of friends. The social pain involved in relational aggression can be more lasting than physical pain.

Second, aggression can be direct, indirect, or displaced. Direct aggression refers to an aggressive act against a person who is physically present while it occurs. This would include aggressive behaviors such as kicking another person or

yelling at a person to his or her face. In contrast, indirect aggression is expressed when the victim is absent. This would include aggressive behaviors such as destroying property or spreading rumors.

Sometimes people displace their aggression against an innocent substitute target. In the classic Freudian example of displaced aggression, a man is angered by his boss at work and kicks his dog when he gets home from work, rather than retaliating directly against the boss. In addition, the victim does not always have to be completely innocent. In triggered displaced aggression, the target commits some kind of minor offense, which in turn causes a person to aggress. For example, the man who was berated by his boss might come home to find that the dog has spilled some of its food on the floor. Displaced aggression is used primarily when the primary target is not available (e.g., when the man's boss leaves work early) or when retaliation against the target may result in undesirable consequences (e.g., the boss might respond by firing the man).

Third, aggression can be active or passive. Active aggression is expressed when the aggressor resorts to explicitly harmful behavior toward the victim, such as slapping or yelling. On the contrary, passive aggression refers to failure on the aggressor's part to act in a helpful way, or withholding some helpful behavior, such as 'forgetting' to inform someone of important information or deliberately showing up late for an important group meeting.

Direct and active forms of aggression can be quite risky, leading to injury or even death. Thus, most people prefer to use indirect and passive forms of aggression instead.

Functions of Aggression

Aggressive acts may also differ in their function. Consider two examples. In the first, a husband finds his wife and her lover together in bed. He takes his rifle from the closet, and shoots and kills both individuals. In the second, a 'hitman' uses a rifle to kill another person for money. The form of aggression is the same in both examples (i.e., physical aggression caused by shooting and killing victims with a rifle). However, the motives appear quite different. In the first example, the husband appears to be motivated by anger. He is enraged when he finds his wife making love to another man, so he shoots them both. In the second example, the 'hitman' appears to be motivated by money. The 'hitman' probably does not hate his victim. He might not even know his victim, but he kills the person anyway for the money. To capture different functions or motives for aggression, psychologists make a distinction between reactive aggression (also called hostile, affective, angry, impulsive, or retaliatory aggression) and proactive aggression (also called instrumental aggression). Reactive aggression is 'hot,' impulsive, angry behavior that is motivated by a desire to harm someone. Proactive aggression is 'cold,' premeditated, calculated behavior that is motivated by some other goal (obtaining money, restoring one's image, restoring justice).

Although the function of aggressive behavior is important to consider, recent research suggests that it is almost impossible to distinguish between reactive and proactive aggression. Real-life scenarios are typically not as distinct and unambiguous as the husband and hitman examples.

Measurement of Aggression

Aggression is scientifically measured inside and outside the laboratory. Field research conducted outside the lab looks at statistics to establish a correlation between aggression and predicting variables. Instances of violence and aggression such as school shootings or violent crimes are analyzed after they occur, and factors such as gender, poverty, and age are examined to determine what conditions might have led the aggressors to act in such ways.

Aggression is also studied behaviorally in the lab. Given the practical and ethical restraints of using human participants, researchers have developed a number of creative methods to address the issue. They cannot give the participants in their studies guns, knives, or even boxing gloves. Today, there are three primary ways in which laboratory aggression is measured. First, the 'hot sauce paradigm' measures aggression by requiring participants to indicate the amount of hot sauce an ostensible partner, who very much dislikes spicy food, should consume. Second, in the 'bungled procedure' paradigm, participants are asked to shoot a human target with a type of pellet gun, but before they are able to do so, the equipment experiences a 'malfunction' and they never actually use the gun. Aggression is measured by the type of gun and number of bullets chosen by the participant.

The third method is perhaps the most common. Participants are asked to participate in a competitive reaction time task, in which they press a button as quickly as possible in a series of trials with an ostensible partner. The 'loser' of each round is shocked by the opponent, who sets the degree of stimulation. The newer model uses blasts of noise through headphones, adapted from the original paradigm that used physical shocks. Noise levels are randomized throughout the task, and aggression is measured by analyzing the responses of the target participant when given the opportunity to 'blast' his or her partner. In other variations of the paradigm, participants earn money for participating in the study, and they can subtract money from their ostensible partner.

Why Do We Use Aggression?

It is indisputable that people use aggression in a wide variety of ways. In turn, many theories have been developed in an attempt to explain why we so often aggress against others. The main theories are summarized in the following sections.

Instinct Theories

Instinctive theories of aggression state that aggressive behavior is simply an innate survival tendency, inherent in many species. According to these theories, first advanced by Charles Darwin, violence and aggression are unmotivated, automatic forces that occur naturally and have been passed down as an adaptive evolutionary trait; we are wired to be aggressive in order to increase our chances of survival. We do not learn to be aggressive or become aggressive after certain life experiences. Rather, as political philosopher Thomas Hobbes stated, "we are naturally violent creatures."

Sigmund Freud believed that all humans are born with both a 'life instinct,' which creates, sustains, and promotes life, and a 'death instinct,' which destroys life. According to this

psychoanalytic view, we stop short of destroying ourselves because the life instinct overpowers the death instinct, and diverts our harmful urges outward toward others. Therefore, the basis of aggression lies within the internal battle to preserve our own life.

Building on Freud's ideas, ethologist Konrad Lorenz proposed that aggressive urges can build up, in much the same way that hydraulic pressure causes fluids to build up within a restricted space, and that these urges must be released in some way. Subsequently, we engage in aggressive behavior to release our natural pent-up levels of aggressive instincts.

Research refuting instinctive theories reveals that aggression does not seem to be completely unmotivated. There is even evidence to suggest that humans actually derive pleasure from harming others who have provoked them.

Frustration–Aggression Theory

Frustration–aggression theory, proposed in 1939 by a group of researchers from Yale University, was summarized in two bold statements: (1) “the occurrence of aggressive behavior always presupposes the existence of frustration” and (2) “the existence of frustration always leads to some form of aggression.” Whereas instinct theories focused on internal factors that increase aggression, the frustration–aggression theory focused on external factors. However, it readily became apparent that not all aggression results from frustration, and not all frustrations lead to aggression. Besides an inclination to aggress, frustrations actually stimulate a number of different inclinations such as an inclination to escape or to find a way around the obstacle to the goal. The revised theory proposed that the inclination that eventually dominates is the one that is most successful in reducing frustration. In other words, people learn through experience what actions are effective in reducing aggression. This idea opened the door for learning theory explanations of aggression (see next section).

The frustration–aggression theory provides a good explanation of why poverty is a consistent predictor of aggression and violence. It is frustrating not to be able to obtain basic needs such as food and shelter.

Fifty years later, Leonard Berkowitz revised the frustration–aggression theory by proposing that all unpleasant events – not only frustration – deserve to be recognized as important causes of aggression. The idea is that unpleasant events (including frustrations) automatically produce primitive fight or flight reactions. When we experience an unpleasant event, we want to stop it or leave. The occurrence of aggression depends on how the unpleasant event is interpreted and on the presence of aggressive cues. For example, if a person has just seen a violent movie and is pushed from behind while exiting the theater, he or she may very well act in an aggressive manner.

Learning Theories

The frustration–aggression theory was seminal to the development and popularity of other situational explanations of aggression. These explanations went against the assumption that people are aggressive because they are born that way.

Learning theories of aggression are based on both operant and classical conditioning. Operant conditioning, the defining

feature of behaviorism, proposes that behavior is motivated by pursuit of pleasure and avoidance of pain. Classical conditioning, as famously demonstrated by Ivan Pavlov's experiments involving dogs, proposes that behaviors are determined by the learned pairing of two or more stimuli.

Other learning theories of aggression go beyond simple conditioning. In his social learning theory (also called observational learning theory), Albert Bandura theorized that observation and imitation are at the root of aggressive behavior. In Bandura's studies, children who observed an actor hitting a 'bobo' doll (a large, inflatable toy clown) imitated the actor's aggressive behavior and also hit the 'bobo' doll. Bandura proposed that aggression is not simply a mindless mimicry of another's behavior, but also involves cognitive inferences, generalizations, and interpretations. For example, if a child sees one parent hit the other across the face following an altercation, the child may not only imitate the action, but may also conclude that it is acceptable to hit someone who provokes you. Recent research has revealed that this process of learning-from-imitation even has a neurological basis. 'Mirror neurons' identical to those that are fired when one is performing a behavior are fired also in response to observing someone else perform the behavior.

Social-Cognitive Theories

As learning theories increased in complexity, they gave rise to theories that focused on higher cognition and information processing. These social-cognitive theories focus on how thoughts influence behaviors. One social-cognitive theory, developed by Rowell Huesmann and colleagues, focuses on scripts. The term script is borrowed from theater. In a play or movie, a script tells the actor what to say and do. The fundamental element in a script is the vignette, defined as 'an encoding of an event of short duration,' consisting of both a perceptual image and a 'conceptual representation' of the event. A simple vignette might consist, for example, of an image of one person hitting another (image) in anger over something the other person has done (a conceptual representation). A script consists of a sequence of vignettes. Such scripts define situations and guide behavior: the person first selects a script to represent the situation and then assumes a role in the script. Once a script has been learned, it may be retrieved at some later time as a guide for behavior.

A second social-cognitive theory, developed by Kenneth Dodge and colleagues, focuses on attributions, which are the explanations people make about why others behave the way they do. For example, if a person trips you, a hostile attribution would be that the person did it on purpose to hurt you. Aggressive people tend to make hostile attributions.

A third social-cognitive theory, developed by Craig Anderson and colleagues, is called the General Aggression Model. According to this model, aggression is the result of situational and personality factors that influence internal states such as thoughts, feelings, and physiological arousal (e.g., heart rate).

What Causes Aggression?

While much is still unknown, research has shown that there are three major causes of aggression: nature, nurture, and the

environment. The factors are not mutually exclusive or even independent; often they act together.

Nature

Gender differences

Gender differences in aggression are apparent from a very early age, and appear to remain relatively consistent throughout life. By preschool, boys display higher levels of physical aggression than girls. This divide becomes more pronounced through childhood and adolescence, and is clearly demonstrated by the drastic gender difference in murder rates around the world. Research further shows that males are more likely than females to express aggression in order to ensure the sexual fidelity of their partners. For example, men often report higher levels of anxiety and dissatisfaction toward sexual infidelity than toward emotional infidelity (i.e., being in love with another person), whereas females show the opposite pattern. Females show higher levels of relational and indirect aggression than do males.

These gender differences highlight our evolutionary ties with aggression. A man can most effectively pass on his genes by making sure that a partner is carrying his child, and so he is able to use strength and power to suppress his mate's partners. A woman is most likely to pass on her genes by making sure that the man she mated with remains committed to her child, and so she uses indirect aggression to intimidate rival mates.

Age differences

Across cultures, aggressive behaviors appear very early in childhood. Infants display angry facial expressions by 4 months, and interpersonal aggressive behaviors develop quickly thereafter. The existence of aggressive behavior at such a young age suggests that there must be at least some inborn aggressive tendencies.

Research shows that toddlers 1–3 years old are the most aggressive group of humans on the planet. In daycare settings, about 25% of interactions among toddlers involve some kind of physical aggression (e.g., one child pushing another child down). No other group, not even violent youth gangs or hardened criminals, resorts to physical aggression 25% of the time. Fortunately, children cannot do much damage at that age!

After age 3, most people become less aggressive over time. However, a subset of people become more aggressive over time. The most dangerous years for this subset of individuals (and for society) are between ages 15 and 30, when violent crime rates are the highest.

Although these generalizations summarize the data accurately, exact developmental trends in general aggression are difficult to measure because aggressiveness manifests itself in different ways at different ages – for example, in taking things at age 4, fighting at age 8, telling lies about others at age 12, vandalism at age 16, and murder at age 27.

Personality traits

We all know that some people lash out aggressively at others at the slightest provocation, while other people hardly ever lash out. There is a 'dark triad' of personality that is linked to aggression, violence, and other antisocial behaviors: (1) psychopathy, (2) narcissism, and (3) Machiavellianism.

Psychopathy is a personality disorder marked by callous and unemotional affect and low empathy for others. Psychopaths often engage in antisocial behavior to gratify their own desires, and show little for their actions. They focus on immediate rewards rather than long-term consequences, and have difficulty learning from their past mistakes. The term narcissism comes from the mythical Greek character who fell in love with his own image reflected in water. Narcissists have a grandiose, inflated view of themselves, and a sense of entitlement. Narcissists lash out aggressively at others who criticize them. The term Machiavellianism comes from the Italian Renaissance diplomat Niccolò Machiavelli, who wrote *The Prince*, a guide for the prince to maintain his power and authority over subordinates by any means, including cunningness and force.

Biological factors

There are a variety of biological factors that appear to influence aggression. While most of them are insufficient to cause aggression and require some sort of situational trigger, they nonetheless increase the likelihood of aggression.

People with lower levels of arousal, such as blood pressure and heart rate, tend to exhibit more aggression than those with average (or higher) arousal ratings, perhaps because they seek to increase their arousal levels by engaging in antisocial behavior. In one experiment, men who responded very little physiologically to violent movie clips acted more aggressively than those who had a higher response.

Research has also established a strong link between low levels of the neurotransmitter serotonin and aggressive behavior. Serotonin is referred to as the 'feel good' chemical in our brains, and so when we lack a sufficient amount of it, we may be more inclined to behave aggressively. This relationship has been demonstrated causally using both animal and human participants. Moreover, the male sex hormone testosterone has been linked with increased aggression, but less consistently. Higher levels of plasma testosterone probably increase aggression slightly, but the outcome of winning and dominating affects testosterone levels just as much.

Overall executive functioning also has a significant impact on the likelihood of aggression. This type of higher-order cognitive functioning occurs toward the front of the brain just behind the forehead, called the prefrontal cortex. Damage to the prefrontal cortex has been shown to directly increase aggression levels. Prefrontal cortex damage can also create several problems that increase the likelihood of aggression, such as low IQ and the development of attention deficit hyperactivity disorder (ADHD).

Genetics

Although there is yet to be a conclusive demonstration of the heritability of aggressive inclinations in humans, research suggests that certain people have a genetic predisposition to behave aggressively. In one study, people with a particular variation of the gene that determines monoamine oxidase activity (MAOA) were at a significantly higher risk of becoming aggressive adults, but only if they had been abused in childhood. Abused children with lower MAOA became more aggressive adults than both nonabused children with MAOA depletion and abused children with normal MAOA. Another important

study showed that individuals who had a gene variation that lowered serotonin and dopamine activity were at a higher risk for antisocial behavior in adolescence.

Nurture

There is substantial support for the argument that aggression is, at least partly, determined by situational factors. For instance, although the sex differences discussed earlier may suggest that aggressive tendencies are innate, sex differences in aggression disappear under high levels of provocation. In fact, statistics show that female partners are actually more likely than their male counterparts to exhibit domestic physical aggression in heterosexual relationships (although males are likely to cause more physical injury or even death). Clearly, 'nature' cannot fully explain aggression.

Physical situation

Subtle unpleasant changes in our immediate surroundings often influence our levels of aggression. One salient correlate of aggression is heat. Research has consistently demonstrated a link between hot temperatures and aggression. Other nonsocial, unpleasant sensations such as noxious odors (e.g., smoke, pollution), and loud (particularly uncontrollable) noises have also been linked to aggression. Certain visual stimulation, including aggressive cues (e.g., weapons), can also trigger aggressive behavior.

It is also important to consider how the immediate situation influences aggression. For example, rates of aggression may increase among certain populations such as prisoners, not because those individuals are naturally more aggressive, but perhaps because the enclosed prison environment makes them more prone to aggressive behavior.

Social situation

Our social environment as well as our physical environment can contain unpleasant situational cues. Crowding, defined as the perception that there are too many people in the vicinity, can increase aggression.

When we are rejected by others in a social situation, we are also more prone to use aggression. For example, an analysis of school shooters found that 13 out of the 15 shooters had been rejected by a romantic partner prior to the shooting spree. The greater the degree of social rejection, such as in extreme cases like ostracism (being directly isolated or rejected by others), the more prone a person is to using aggression.

Aggressive arousal

Many factors that increase aggression (e.g., heat, violence in media) also increase physiological arousal. Thus, it is not surprising that arousal is linked to aggression. There are at least four reasons why arousal might increase aggression. First, high arousal might be interpreted as an aversive stimulus, which would trigger aggression in the same ways that other aversive stimuli have been shown to do. Second, arousal narrows attention. If aggressive cues are salient in the situation, then people will focus most of their attention on the aggressive cues. Third, arousal increases the dominant response, which is defined as the most common response in that situation. Thus, whatever people are normally inclined to do (including

behaving aggressively), they will be even more strongly inclined to do when they are physiologically aroused. Fourth, arousal from any source (e.g., exercise, coffee, an exciting movie) may be misinterpreted as feelings of hostility or aggression if people are later provoked, a process called excitation transfer. For example, a woman is accidentally bumped while walking to her car after a long workout at the gym. Her increased heart rate and perspiration from exercise might be mislabeled as anger at being bumped, if she yells at the person who bumped her.

Disinhibiting factors

All people have aggressive impulses, but most are able to inhibit these impulses. However, some situational factors can reduce aggressive inhibitions. One such factor is alcohol. To use an analogy, alcohol increases aggression by paralyzing the brakes, not by stepping on the gas. In murder cases, at least half of the perpetrators were intoxicated when they murdered the victims (often the victims were also intoxicated). Laboratory experiments have shown that alcohol seems to increase aggression in combination with other factors. Factors that normally increase aggression (e.g., frustration, provocation) have a stronger effect on intoxicated people than on sober people. If someone is insulted, his or her response will be more violent if he or she is drunk than when he or she is sober. When there is no provocation, however, the effect of alcohol on aggression may be negligible.

Similarly, anonymity has been consistently linked to increased aggression. When people are anonymous, they seem to lose their inhibitions against behaving aggressively. Perhaps this is why violent crimes are much higher at night than during the day time, and why bank robbers and members of the Ku Klux Klan wear masks when they commit violent crimes. Laboratory experiments show that aggressive behavior increases when people cannot be identified by name or appearance.

Environment

Apart from personality and situational influences, a person's overall environment can have quite a significant impact on aggression.

Family

Children from neglected or broken family backgrounds are more likely to become aggressive adults than children from stable families. Moreover, children are more likely to become aggressive adults if they witness a significant amount of domestic violence while growing up. Those who are physically abused at a young age are more likely to become physically abusive parents and romantic partners themselves.

Peers

As children grow, peer groups wield a greater influence on their behavior. Children who are rejected by their peers are more likely to behave aggressively later in life, and vice versa (aggressive children are likely to be rejected by their peers). Having antisocial peers is also a risk factor for aggression and violence.

Community

Beyond family and peers, a person's collective culture also influences aggression. Societal norms and expectations differ widely across cultures, and often impact on aggressive behavior. Violence and aggression are more acceptable in some cultures (e.g., cultures that place a large emphasis on honor) than in others. There are great regional differences in aggression in the United States, with violence levels being much higher in the South than in the North. Psychologists Richard Nisbett and Dov Cohen theorize that this discrepancy is a result of a southern culture of honor. Southern settlers typically came from herding families that relied on livestock to make a living, whereas Northern settlers relied on agriculture. Aggression is theoretically more practical and useful in protecting animals rather than crops, and so the idea of using aggression to preserve the honor and success of their family business became ingrained in individuals from the South. The overall condition of a particular community also affects aggression. Impoverished neighborhoods are often more conducive to crime and violent behavior. Similarly, communities that are characterized by high levels of racism, prejudice, or intolerance provide a breeding ground for aggression.

Media

Violence in the mass media can increase aggression and fear of victimization, and make people numb to the pain and suffering of others. Experimental studies have shown that violence in the mass media causes aggression, and longitudinal studies have shown that the effects can persist for decades. In fact, in 1972, the US Surgeon General issued a warning about the harmful effects of violence in TV programs and films. Violent video games, which were developed after the Surgeon General had issued his warning, may be even more harmful than violence in TV programs or films, for at least three reasons. First, video game play is active, whereas watching TV is passive. People learn better when they are actively involved. Suppose you wanted to teach a person how to fly an airplane. What would be the best method to use: read a book, watch a TV program, or practice on a video game flight simulator?

Second, players of violent video games are more likely to identify with the violent characters therein. If the game is a first-person shooter, players have the same visual perspective as the killer. If the game is third person, the player controls the actions of the violent character from a more distant visual perspective. In either case, the player is linked to a violent character. In a TV program, viewers might or might not identify with a violent character. Third, violent games directly reward violent behavior by awarding points or allowing players to advance to the next game level. In some games, players are also rewarded through verbal praise, such as the words 'Nice shot!' or 'Impressive!' after killing an enemy. It is well known that rewarding behavior increases its frequency. In TV programs, reward is not directly tied to the viewer's behavior. A recent Dutch study by Hanneke Polman and her colleagues provided the first evidence that playing violent games produces stronger effects than simply observing violence. In this study, some participants played violent games, whereas other participants watched the games being played, and the effects of aggression were stronger on the players than the watchers.

What Reduces Aggression?

Although aggressive behavior may never be eliminated from society, various treatments have been developed to reduce aggression. In all cases, any method of reduction is most effective when applied in early childhood before aggressive behavior becomes crystallized. In general, two primary approaches have been used to reduce aggression: behavior modification and cognitive-behavioral therapy.

Behavior Modification

The main goal of behavior modification is to reduce aggression by reinforcing the learning of nonaggressive behaviors. This method is most effective when applied to instances of proactive aggression. People often aggress in subtle, indirect ways, such as talking behind the back of a coworker or inviting all friends but one to a party. Proactive aggression involves a certain degree of planning, patience, and cunning in order to achieve one's goals, for example, trying to malign the reputation of a detested peer. In order to reduce this type of aggression, behavior modification principles use a technique called the differential reinforcement of alternative behavior. Rather than simply rewarding someone for not using aggression, this approach seeks to actively reinforce prosocial behaviors. In this way, aggression is decreased because prosocial behaviors are increased. For example, an aggressive child could be given a candy bar every time he helps his sister. Furthermore, it is especially helpful to reinforce positive social skills such as engaging in 'small talk' so that the child learns effective ways to achieve a goal without using aggression (e.g., accommodating, negotiating). The overall effectiveness of these methods is increased by the presence of prosocial role models, such as parents or celebrities, who reinforce and model prosocial, nonaggressive behaviors.

Cognitive-Behavioral Therapy

Cognitive-behavioral therapy is commonly applied to treat reactive, hostile aggression. Given that these cases are characterized by feelings of anger and rage, cognitive-behavioral techniques attempt to reduce emotional responses to provocation. Techniques typically involve meditation, relaxation, and concentration on peaceful imagery. In addition, people are trained to mentally prepare for future provocation by learning to interpret provocative events in a more benign manner. For example, in self-instructional training, people memorize nonaggressive thoughts like 'I know how to control my anger,' 'I will not lose control,' and 'Just continue to relax.' Individuals are trained to manage their aggressive thoughts by imagining a potential conflict and visualizing a calm, peaceful solution. When behavioral techniques like meditation and relaxation are combined with the rehearsal of nonaggressive cognition, reactive aggression is most effectively reduced.

Conclusion

Aggression is a complex and multifaceted behavior, and has been used by living species for millions of years to attain

desirable goals and resources. Aggression researchers have attempted to delineate the origins, causes, and defining characteristics of aggression. Over time, aggression and violence levels have declined. We hope that aggression research will help this trend to continue.

See also: Anger; Group Dynamics; Media Influence on Behavior; Personality Development; Social Development (Attachment, Imprinting).

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Relevant Websites

- <http://www.rcgd.isr.umich.edu/aggr/> – Aggression Research Program.
- <http://www.colorado.edu/cspv/> – Center for the Study and Prevention of Violence.
- <http://www.mediafamily.org/index.shtml> – National Institute on Media and the Family.
- <http://www.psychology.iastate.edu/faculty/caa/csv/index.htm> – The Center for the Study of Violence.
- <http://socialpsychology.org/> – The Social Psychology Network.

Aging and Cognition

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Glossary

Classical conditioning A form of learning that pairs a neutral stimulus to a conditioned stimulus in order to invoke a similar behavioral response when the neutral stimulus is present that is invoked by the conditioned stimulus.

Cognition A psychological function referring to the act of processing and manipulating information, including such processes as awareness, perception, reasoning, and learning.

Declarative memory Memory for facts or information that can be consciously stated or declared.

Executive function A broad term describing the higher order cognitive processes which are responsible for the most complex human functions. Within the brain, the frontal lobe is the brain region associated with executive functions.

Inhibition The cognitive ability that enables an individual to refrain from expressing a behavioral response.

Nondeclarative memory Memory for skills or procedures that does not necessarily require conscious awareness.

Priming The phenomenon that occurs when the presentation of a stimulus influences the response to a subsequently presented stimulus, usually occurring outside of an individual's immediate awareness.

Processing speed A measure of the time required to respond to and/or process information in one's environment.

Risky decision-making The decisional cognitive processes involved in the choice to engage in unsafe or risky behaviors.

Set-shifting A cognitive process that refers to the ability to shift one's attention back and forth between two tasks or two lines of thought.

Working memory The ability to temporarily store and manipulate information in one's mind for immediate use.

Introduction

Literally, thousands of studies now exist showing that various aspects of cognition change with age. Age-related declines in cognitive abilities such as learning, memory, attention, executive function, decision-making, and problem-solving have been detected using both cross-sectional and longitudinal designs. One controversy that has arisen when comparing results from these two types of designs is when cognition first starts to decline. Longitudinal studies generally place the beginning of decline later than cross-sectional studies. Earlier views tended to place the beginning of cognitive decline in the sixties or later with only a few studies suggesting that decline might begin as early as in the fifties. There is now compelling evidence that many aspects of cognition begin to decline in middle age and that a significant portion of individuals over 70 years of age living independently can be classified as having a significant cognitive impairment. In fact, 10–30% of individuals over 60 years of age have been found to have a diagnosable cognitive impairment as a result of various pathologies associated with aging. Similarly, ~22% of individuals over 71 years of age in the United States have been estimated as having a significant cognitive impairment without dementia. The prevalence of cognitive impairment without dementia is greater in men, older individuals, and individuals with a lower educational level.

In this article, changes in cognition will be examined from a lifespan perspective reviewing the available data on cognitive changes from early adulthood to old age. Until very recently, few studies examined cognition in middle-aged individuals. It is now recognized that it is important to know when change in cognition begins because if we wait until old age, precipitating or mediating causes may have disappeared or changed.

We will begin with the area of cognition that has received the most attention, memory.

Declarative Memory

Memory has been divided into the domains of declarative and nondeclarative memory systems, also frequently referred to as explicit and implicit memory, respectively. Declarative memories are facts that can be consciously stated, or declared. For example, the recollection that I drove to work yesterday would be a declarative memory. The skills and procedures required for the drive would be classified as nondeclarative memories. Many daily tasks, such as riding a bike, engaging in games or sports, or typing a paper at the computer, fall within the domain of nondeclarative memory. Performance on these procedural tasks, in which past experiences serve as an aid, do not necessarily require conscious awareness. In contrast, declarative memory occurs with conscious awareness. In the laboratory, declines in performance on both declarative and nondeclarative tasks have been observed in older individuals.

Tests of verbal and visuospatial material have been used to assess declarative memory across the lifespan. In an investigation of memory performance, children and older adults were found to exhibit poor recall on multitrial tests of both verbal and spatial information. For the verbal test, participants were administered five immediate trials of the Rey Auditory Verbal Learning Test (RAVLT). In this test, participants hear 15 concrete nouns on each trial, but in a different order. After each presentation, participants are instructed to recall as many words as they can remember. The number of words recalled on each trial is the measure of performance. For the spatial test, participants were administered a version of the game of

Memory Cards (also referred to as Concentration). Twenty-four cards are in a 4×6 matrix on the computer screen and participants are instructed to turn over two cards at a time for matches and attempt to get as few mismatches as possible. Five immediate trials are administered with the spatial location of the 12 matching pairs always in the same location. The percentage of matches out of all attempts is the measure of performance.

Latent growth curve analyses were used to examine performance across trials on both the RAVLT ($N=2124$) and Memory Cards ($N=1579$) tests for five age groups (5–12, 13–18, 19–39, 40–59, 60–92). In this analysis, the intercept (initial start of the learning curve), slope (rate of learning), and shape (change in rate of learning) were examined. Significant differences were detected for both tasks on the first trial (intercept), but not on the rate of learning on subsequent trials (slope). The spatial and verbal learning parameters were not significantly correlated. Thus, we propose that there is not a single general learning ability underlying these different task modalities.

An earlier version of this data set was used to show changes on the first trial of these two tasks for participants 15–89 years of age (age groups: 15–19, 20s, 30s, 40s, 50s, 60s, 70s, 80s). **Figure 1** shows age changes for performance on these two tasks with a sample size that has virtually doubled in size since the original report. An analysis of performance on the first trial of the RAVLT detected significantly poorer recall in individuals 50 years of age and older, while the 80-year-old individuals showed significantly poorer verbal recall than all younger age groups. A similar significant decline occurred for the Memory Cards task. That is, individuals 50 years of age and older

demonstrated poorer performance than individuals 15–29 years of age, and individuals in their 80s showed poorer spatial memory than all younger age groups. The decline of both spatial and verbal declarative memory by 50 years of age is consistent with other reports of significant declarative memory decline in middle-aged humans for both verbal and spatial information. Similar declines in midlife have been reported for declarative memory in rodents and nonhuman primates.

Nondeclarative Memory

Findings from classical conditioning studies of the eye-blink response and word-stem priming task will be described as both paradigms have been used to examine nondeclarative memory changes across the adult lifespan. Briefly, to exemplify the eye-blink procedure used in research studies, a conditioning stimulus tone is activated for 500 ms with onset of a mild puff of air to the eye as the unconditioned stimulus at 400 ms. A conditioned response is scored if the eye-blink occurs prior to delivery of the puff of air. That is, a conditional response occurs on a trial if there is an eye-blink between 29 and 400 ms after tone onset. A deficit in acquisition of the classical conditioned eye-blink response has been detectable in the 40–50-year-old subjects in previous research investigations. Similarly, declines in classical conditioning of the eye-blink response have been reported in rabbits and cats at ages equivalent to middle age in humans.

Word-stem priming has received the most attention in studies examining nondeclarative memory in older individuals. Priming is said to occur when the presentation of a

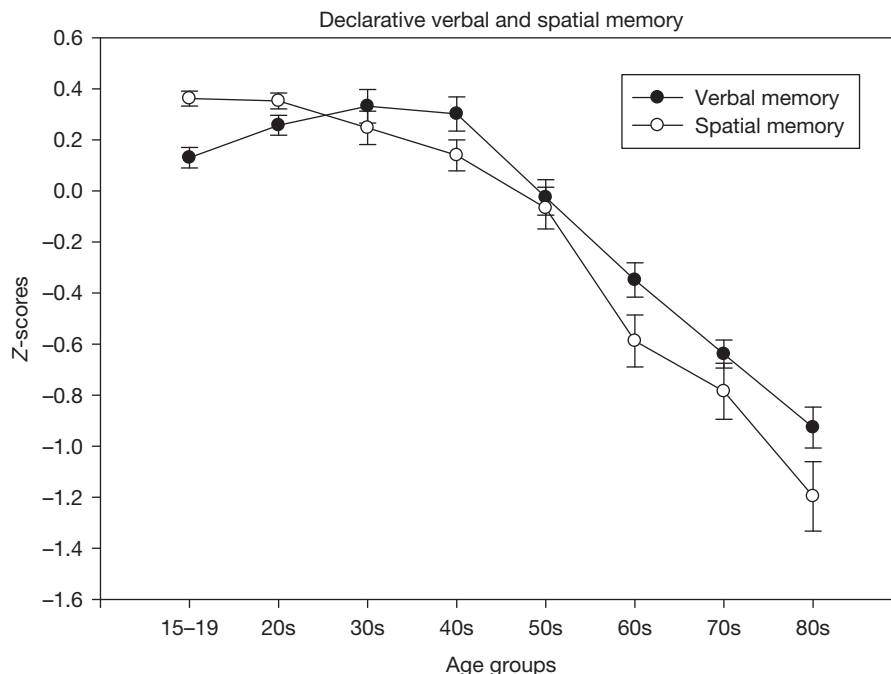


Figure 1 Standard Z-scores for performance on the first trails of the RAVLT and Memory Card task for participants from 15 to 89 years of age (RAVLT $N=2266$; Memory Cards $N=1518$). Adapted from Foster SM, Cornwell RE, Kisley MA, and Davis HP (2008) Cognitive changes across the life span. In: Qualls SH and Smyer MA (eds.) *Changes in Decision Making Capacity in Older Adults: Assessment and Intervention*, pp. 25–60. Hoboken NJ: Wiley.

stimulus influences the response to a subsequently presented stimulus. For example, when a person provides pleasantness ratings to a list of words that includes the word *motel*, and is later asked to complete the word stem *mot*, the probability that the subject answers *motel* is higher than for word stems that were not primed by the pleasantness rating (e.g., completing the baseline control stem *acc* with the nonpresented word *accord*). In one study, word-stem priming in each decade of life from the 20s through the 80s was assessed and individuals in their 70s and 80s scored significantly lower priming scores. No decline in priming was detected for younger age groups. However, priming scores for individuals in their 40s, 50s, and 60s tended to be intermediate between the younger and older age groups. The failure to detect a decline in priming by middle-aged individuals might have been due to the small group sizes. More recently and with larger age groups, impaired word-stem priming in a middle-age group (mid-30s to early 50s) as compared to a young adult group (late teens to mid-30s) was reported. Thus, significant nondeclarative memory deficits, like declarative memory deficits, are detectable in middle-age individuals with further decline occurring in the elderly (individuals in their 70s and 80s).

Executive Function

Executive function is a broad umbrella term that describes the higher-order cognitive processes which are responsible for the most complex of human functions and behaviors. Although there is much debate regarding the specific cognitive processes that should be defined as part of executive functioning, the literature seems to agree on the fact that executive control is necessary for goal-directed behavior, such as the formulation of a goal, devising strategies and plans to achieve the goal, and the execution and implementation of such plans. The underlying cognitive processes identified in the literature as executive functions include, but are not limited to, the following: focused and divided attention, inhibition, self-regulation, initiation of behaviors, working memory, planning, organization, problem-solving, information processing, and cognitive set-shifting.

Within the brain, the frontal lobes, specifically the prefrontal cortex, is the brain region associated with executive functioning. Executive functions are usually quite vulnerable to cognitive decline, as the frontal lobes are one of the initial brain regions to experience atrophy, or neuronal cell death, in response to natural age-related and pathological processes, including Alzheimer's disease and frontotemporal dementia. As a result, executive dysfunction can manifest itself in a myriad of cognitive and behavioral problems, including impulsivity, poor judgment and decision-making, perseveration, and an inability to switch back and forth between two lines of thought. Consequently, impairments in executive functioning can detrimentally affect older adults and their ability to live independently. Due to the multiple processes that underlie executive functioning, and the lack of agreement among researchers regarding the processes that should be defined as part of executive control, this section will focus on understanding age-related declines in executive functions for the following areas: cognitive set-shifting, inhibition, working memory, and problem-solving.

Cognitive set-shifting, also referred to as task-switching or mental flexibility, is an individual's ability to shift their attention between two tasks or lines of thoughts. Set-shifting is often assessed by two popular neuropsychological measures: the Trail Making Test (TMT) and the Wisconsin Card Sorting Test (WCST). The TMT has two parts: Part A and Part B. Part A requires an individual to connect 25 numbers in sequence as quickly as possible. Part B requires an individual to shift back and forth between connecting number and letters in alphabetical and numerical order as quickly as possible. Part B of the TMT, therefore, can detect problems in an individual's ability to shift set. In a study with a sample size of 680 participants ranging in ages from 18 to 89, age-related changes in performance on the TMT were found. As the participants' age increased, their performance on Part A and Part B declined. Furthermore, the age-related effects were more prominent for Trial B than A; the trial that required shifting. The results of this study suggest greater difficulty for individuals in their ability to set-shift with increasing age.

The WCST, another prominent test of executive functioning, assesses individuals' ability to set-shift, as well as their inhibitory control and planning abilities. The test requires an individual to sort a target card by placing it under one of four stimulus cards, which differ by shape, number, and color. An individual must determine the *rule* for sorting the cards (i.e., sorting them by shape, number, or color), and is given feedback regarding the correctness of each of their choices. After ten trials, the *rule* is changed, and the individuals must alter their decisions accordingly. This test will be used to exemplify changes in both set-shifting and inhibitory control as it requires an individual to shift cognitive sets and inhibit old responses when adjusting to the new *rule*.

In an investigation to study the age-related changes on WCST performance, 48 younger adults (18–38 years) and 49 older adults (60–86 years) completed a computerized version of the WCST. The level of education and health status of participants were statistically controlled to avoid potential confounding variables. Overall, the older adult participants performed more poorly on the task as compared to the younger adults. Additionally, the older adults were more likely to make perseverative errors than the younger adults. Perseveration refers to the inability to cognitively shift focus away and inhibit a prior way of responding. In the WCST, perseverative errors refer to the mistake of sorting cards by an old *rule* instead of the new *rule*. The results of this study further exemplify that individuals show deficits in their ability to set-shift, as well as in inhibition, as they age.

Inhibitory control is another cognitive process part of executive functioning that has been demonstrated to decline with age. Inhibition is often measured by the well-known Stroop task. The Stroop task requires participants to look at a card with four color names printed on it in conflicting colored ink. Instead of reading the words, individuals are asked to quickly name the color of the ink each word is printed in and their response is timed. Therefore, the test requires individuals to inhibit an overlearned response (i.e., reading the words) to respond in a novel way (i.e., stating the color of ink).

To investigate age-related changes in inhibition, a research investigation was conducted using a version of the Stroop task in a sample of 80 adult males of various ages across the

lifespan. Participants were given four trials. In trial 1, participants simply read a card with four color words on it as quickly as possible. In trial 2, participants saw four colors and were asked to name the color of the ink. In trial 3, participants read a card with four color words on it, but printed in conflicting colored ink. In trial 4, the inhibition condition, participants were asked to name the color of the ink the words were printed in and were told not to read the words. The results demonstrated that the older adult participants did not differ from the younger group on the simple reading task, yet were significantly slower during the inhibition condition, suggesting a deficit in inhibitory control. Other investigators have reported similar findings on the age-related changes on the Stroop test, but argue that this deficit is related to a general slowing of cognitive processing. However, differences among ages on the inhibition condition, but not the reading conditions, reveal that performance is affected by another process other than slowed reaction time. Regardless of the underlying cause, suggested as due to slowed information processing or natural age-related changes in the brain, the cognitive and behavioral manifestations of age-related changes produce deficits in the ability to shift cognitive sets and apply inhibitory control. Furthermore, as in the realm of memory, deficits in executive function are first detectable in middle age.

The Tower of Hanoi (TOH) and Tower of London (TOL) are two popular problem-solving tasks that have been used in hundreds of studies with young adult college students, various patient populations, and age groups varying from childhood to old age. The TOH has attracted the interest of cognitive psychologists because of its application to the development of solution strategies in problem-solving. It is a transformation puzzle that requires a repetitive strategy for the achievement of an optimal solution. The task consists of three pegs with a number of rings varying in size. Typically, at the start, the rings are stacked on the left peg with the largest disk on the bottom and the smallest on the top. The research subject is instructed to achieve the same disk arrangement on the right peg by moving one disk at a time and never placing a larger disk on a smaller disk. The minimal moves for an optimal solution are $2^n - 1$ where n represents the number of disks.

To explore problem-solving, individuals between the ages of 15–89 were tested on both a 3- and 4-ring puzzle ($N = 755$). [Figure 2](#) shows age changes for performance on the 3- and 4-ring TOH. On the 3-ring TOH puzzle, a significant increase in the number of moves to solve the puzzle was detectable in the 60s. On the 4-ring TOH, a significant decline in performance of individuals in their fifties was found. Thus, like memory, there is a decline in problem-solving by at least the 50s.

The TOL was developed to assess planning in individuals who sustained damage to the frontal lobes. The TOL is similar to the TOH in that one must move a set of objects (balls of differing colors) from a start arrangement on three or more pegs to a goal position in as few moves as possible with the constraints that balls cannot be stacked above the peg and only one ball at a time can be moved. [Figure 2](#) shows age changes for performance from 15 to 89 years of age on the TOL. A significant impairment was detected in individuals in their 60s and older. In addition, TOL performance in 300-plus individuals between 21 and 79 years of age was examined on the CANTAB test battery. Within this study, individuals in

the oldest age group (74–79 years) required more moves to successfully complete TOL problems.

Working memory refers to a cognitive process that involves the active manipulation of information while maintaining it in consciousness. For example, multiplying 16×18 in your head requires the active manipulation and holding of information in awareness. To assess this ability, performance on both a verbal and spatial n -back task for ~400 individuals was investigated. In the n -back task, participants are shown a series of stimuli and asked to indicate for each stimulus if it is identical to the stimulus n -back in the series (e.g., Is the present stimulus identical to the stimulus presented two presentations back?). Changes across the lifespan on a 3-back visuospatial and verbal task are present in [Figure 3](#). Individuals in their 60s and older demonstrated significantly poorer working memory performance than younger individuals. Similar results have been reported on several working memory tasks with significant deficits detectable in the 40s.

Decision-Making

As we age, we are faced with making decisions that can dramatically impact our quality of life. For example, ‘which Medicare supplement will provide the most benefit?’, or ‘what form of care will be best for my ailing spouse?’ are typical challenging decisions made by older individuals. A laboratory analog of risky decision-making is the Iowa Gambling Task. For this task, research participants are presented four decks of cards on a computer screen and asked to select from any deck. The goal of the game is to select cards that result in winning money and avoid losing money. Participants are told some decks are better than other decks and they can avoid losing if they stay away from the worst decks. The two bad decks have high rewards, but even higher loss. The two good decks have low rewards, but even lower loss. Participants play 100 trials. The results of this test for the last 25 trials of the Iowa Gambling task for 872 individuals between 15 and 89 years of age are displayed in [Figure 3](#). The individuals in their 80s made significantly poorer choices than young adults, which demonstrates a decline in decision-making abilities with age.

Processing Speed

Processing speed is a measure of the time required to respond to and/or process information in one’s environment. With increasing age, processing speed has been shown to slow dramatically. Thus, older individuals require more time to complete a cognitive task when compared to younger adults. Additionally, a speed of processing theory has been formulated within the cognitive aging literature that accounts for some of the age-related changes that occur in cognition. A large number of studies demonstrate that along with a common factor of age-related decline, processing speed is at least a partial mediator of age-related performance deficits in a variety of cognitive tasks. Thus, the slowing of individuals’ ability to process information inevitably impacts their memory, decision-making, and other cognitive functions.

This reduced, or slowed, speed of processing has been found to account for poorer performance by older adults on

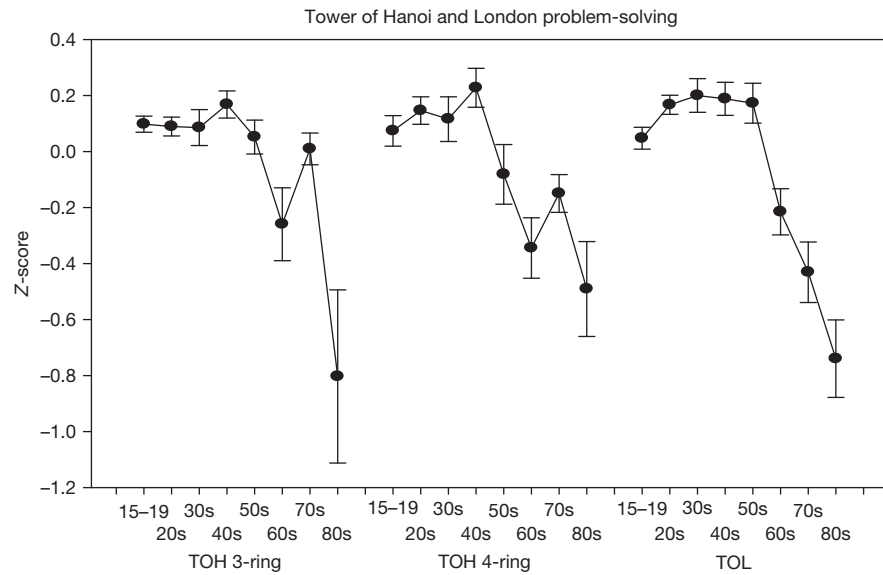


Figure 2 Standard Z-scores for performance on the average of five trials for the 3- and 4-ring Tower of Hanoi and moves on 21 trials on the Tower of London for participants between 20 and 89 years (Tower of Hanoi $N = 1293$; Tower of London $N = 2036$). Adapted from Foster SM, Cornwell RE, Kisley MA, and Davis HP (2008) Cognitive changes across the life span. In: Qualls SH and Smyer MA (eds.) *Changes in Decision Making Capacity in Older Adults: Assessment and Intervention*, pp. 25–60. Hoboken NJ: Wiley.

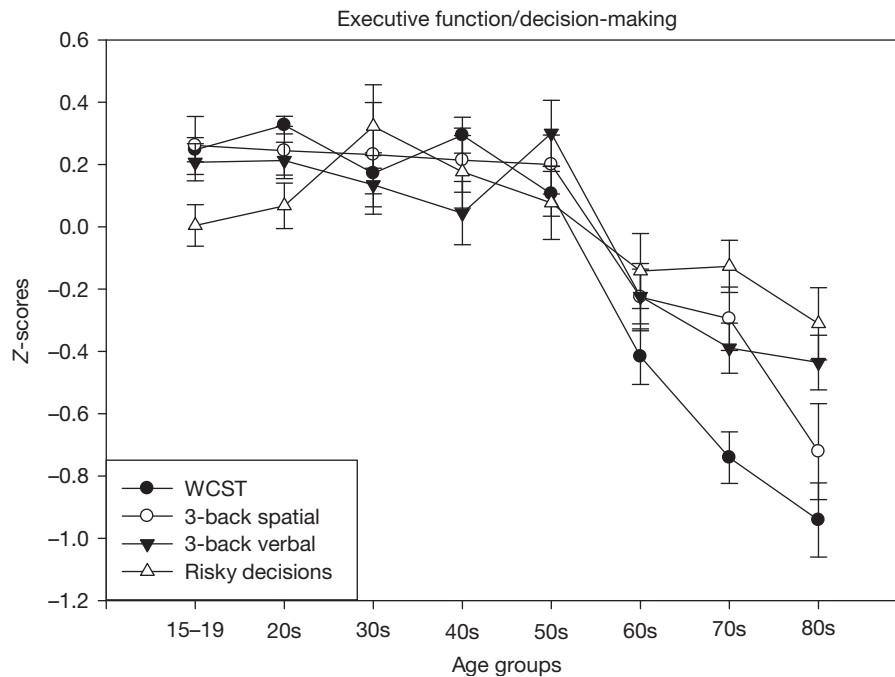


Figure 3 Standard Z-scores for number of category shifts in the Wisconsin Card Sorting Test (WCST), the percent correct responses on a verbal and visuospatial n -back task, and the number of choices from good decks minus bad decks in the Iowa Gambling Task for participants from 15 to 89 years of age (WCST $N = 1874$; n -back verbal and spatial $N = 745$; Iowa Gambling Task – Risky Decision $N = 872$). Adapted from Foster SM, Cornwell RE, Kisley MA, and Davis HP (2008) Cognitive changes across the life span. In: Qualls SH and Smyer MA (eds.) *Changes in Decision Making Capacity in Older Adults: Assessment and Intervention*, pp. 25–60. Hoboken NJ: Wiley.

a complex decision-making task. For example, an investigation compared young and elderly adults on three risky decision-making tasks (Iowa Gambling Task, Cambridge Gambling Task, and Balloon Analogue Risk Task). One goal of this

study was to determine if a participant's age directly influenced their performance, or if the effect was indirect via age-related changes in processing speed and/or memory. A path analysis found that speed of processing fully mediated performance on

the Cambridge Gambling Task and the Balloon Analogue Risk Task, and that memory acted as a full mediator of performance on the Iowa Gambling Task. These findings were the first demonstration that age effects on decision-making can be fully mediated by cognitive factors such as processing speed or memory. This path analysis approach provides a promising avenue for examining the possibility that age-related deficits on other tasks will be either fully mediated (age effect disappears) or partially mediated (age effect significantly reduced) by processing speed or other cognitive variables.

The Relationship Among Cognitive Functions

The examination of cognition across the adult lifespan reveals normal age-related declines in almost all areas, including memory, executive functioning, decision-making, and processing speed. Although each of these cognitive functions are discussed as separate entities, declines in one area of cognition are highly correlated to declines across other cognitive domains as a factor of natural aging processes. In other words, the various areas of cognition are thought to be related to each other. This suggests that changes in several areas of cognitive functioning may be accounted for by changes in one area of cognition, such as speed of processing or fluid intelligence. Although most areas of cognition do decline with age, an individual's ability to retain general knowledge or information acquired over time remains intact. The amount of acquired knowledge, known as crystallized intelligence, has been found to not only remain stable over time, but also may continue to increase with age.

Cognitive Rehabilitation: Behavioral Interventions and Their Impact on Cognition

Natural aging processes can negatively impact our cognitive functioning as the literature suggests. As a result, these changes in cognition manifest themselves in the ability of older adults to function in everyday life, which can not only influence their quality of life but also their ability to live independently. Aside from natural aging, older adults are at a high risk for the development of dementia, including Alzheimer's disease and vascular dementia. Despite the high rate of individuals developing dementia-related cognitive impairment annually, little is known about the cause of these fatal neurodegenerative diseases. However, in recent years, much research has been focused on finding preventative measures to reduce the risk of cognitive decline among the older adult population.

Certain behaviors, such as solving daily crossword puzzles or playing strategic board games, have long been suggested as having a positive effect on cognition and may thwart age-related cognitive decline. Empirical research has begun to explore the impact of behavioral interventions on cognitive functioning, which has been referred to as cognitive enrichment. According to the cognitive-enrichment hypothesis, engaging in certain behaviors, such as intellectually stimulating activities, physical exercise, and socialization, can advantageously affect cognitive functioning in older adulthood. Despite the mainstream popularity of the 'use it or lose it' mentality, which is encompassed by the cognitive-enrichment hypothesis, much controversy and

debate surrounds this theory. Therefore, the empirical evidence for and against this hypothesis will be reviewed.

Training the brain through mental exercise has been compared to training the physical body through physical exercise. Conceptualizing the brain and mental activity in this manner has produced multiple lines of research aimed at determining if mental training can improve mental functioning and decrease the rate of cognitive decline. Due to the plasticity of the human brain, or its ability to alter and change functionally and physically, researchers speculate that the brain is capable of learning and changing over one's entire lifespan. Based on this idea, a research study investigated the effects of a brain training program on normal age-related memory loss in older adults. For this study, a large sample of older adults was recruited and randomly assigned to one of three experimental conditions: an experimental training group, an age-matched control group, and a no-contact control group. Participants in the experimental training condition used a cognitively demanding computer program for 1 h a day over a period of 8–10 weeks, which required them to engage in intense auditory and language exercises. At the end of the study period, all participants were compared on a battery of neuropsychological tests to determine if the brain training generalized to other broad measures of memory. The results showed that the participants who received the daily training exercises had made significant improvements in their global auditory memory score as compared to participants in the control groups. After a 3-month follow-up, the participants in the experimental condition continued to outperform the control group participants on a digit span forward test. Upon completion of this study, the researchers concluded that a plasticity-based training program can improve memory functioning among seniors.

Other research studies have reported similar findings regarding the benefit of training interventions on cognitive functioning. For instance, over 2500 older adult participants were recruited to determine if a cognitive training procedure would improve their overall cognition. Participants were assigned to either an experimental condition in which they received cognitive training in memory, reasoning, or visual search, or they were assigned to a control group. The results demonstrated that participants who received training in a particular domain (i.e., memory training) also demonstrated improvement in a 2-year follow-up in the same domain they received training as compared to the control group. Overall, the study demonstrated that this type of intervention does have benefits to the specific domain targeted by training, but may not generalize to other cognitive domains. A similar, large-scale study which investigated the generalizability of the effects of brain training on a sample of over 11 000 adults found that although the training resulted in improvement on the specific cognitive tasks, the effects did not generalize to tasks that were not used during training.

Based on the available literature, cognitive training has been found to benefit an older adult's cognitive functioning albeit, in most cases, limited to the cognitive domain receiving the training. In addition to cognitive training, the effects of engaging in mentally stimulating activity on cognition in older adulthood have also been studied. According to the cognitive-enrichment hypothesis, individuals who have greater rates of engagement in cognitively demanding activities should have a reduced risk for cognitive decline compared to those who do

not actively engage in these types of activities. In order to investigate this phenomenon, the methodologies within these studies rely on the use of self-report measures of cognitive activity. The researchers conducting these studies also vary in their interpretation of stimulating or intellectually demanding cognitive activity, such as reading a book or playing chess. Regardless, the empirical evidence within the literature strongly supports the cognitive-enrichment hypothesis; higher rates of engaging in stimulating cognitive activity among older adults has been associated with a reduced risk of cognitive decline.

Although there is strong supporting evidence for the cognitive-enrichment hypothesis, others question the reliability and the generalization of these findings. Two major limitations have been reported within the cognitive training studies that have tested the enrichment hypothesis. First, the effects of the training are narrow and often do not generalize to other areas of cognition. For instance, memory training exercises may not benefit reasoning or decision-making, they benefit only memory. Second, the majority of cognitive training studies do not monitor or investigate long-term effects. Therefore, it is difficult to determine the long-lasting effects of these interventions or whether or not the improvements continue at a steady rate over a period of time. Third, the research methodology investigating the effect of engagement in stimulating mental activity on cognition has been questioned. Self-report measures, for example, can be unreliable due to inaccurate estimations of one's own mental activity level. Also, a desire to maintain a positive self-image, also known as a desirability bias, can distort an individual's portrayal and report of their actual level of activity. An additional limitation within this body of research is the variability among researchers regarding the conceptualization of mental activity and mental exercise. Researchers have defined it as anything from attending lectures to watching television, while making arbitrary inferences to the level of cognitive demand each activity requires.

Other major criticisms regarding the research finding a relationship between level of mental activity and cognitive functioning is that it is correlational, making it impossible to determine the direction of causality within these studies. An opposing hypothesis to the conclusions drawn by the cognitive-enrichment research is that a reduction in the level of stimulating mental activity in older adults can be an early indication of a dementing process. In other words, the disease process is driving the level of mental activity, not that the mental activity is driving the lack of or presence of a disease process. Additionally, another rival explanation to the findings of the cognitive-enrichment studies explains that older adults who report high levels of mental activity may have always engaged in intellectually demanding activity and may, therefore, have had a higher socioeconomic status than their counterpart. Thus, having the advantage of a higher economic status may have afforded them a higher quality health care, better nutrition, better educational opportunities, or other unknown variables that could have influenced their cognitive functioning in old age.

The influence of educational attainment and other early environmental factors on late life cognition has been referred to as the cognitive reserve hypothesis. Models of cognitive reserve have been discussed as both passive and active processes; active processes refer to the brain's attempt to repair or

cope with damage, whereas passive models refer to the brain's capacity to withstand damage or atrophy. A common passive model of cognitive reserve is the threshold model which indicates that all individuals experience cognitive decline as they age; however, individuals who have higher levels of cognitive functioning in their young adulthood will decline, but their cognitive performance may never drop to clinically significant degrees of impairment. For example, in a longitudinal study of cognitive performance over time, individuals of varying degrees of education and knowledge demonstrated decline in cognitive performance at similar rates. Therefore, this finding is more conducive to understanding cognitive reserve through a threshold paradigm. In other words, individuals with greater educational attainment and higher cognitive abilities in their youth will experience similar rates of cognitive decline as those who have less education and cognitive abilities. However, due to the fact that their premorbid level of functioning was higher, the time it takes for these individuals to reach functional levels of impairment may be longer than the average individual. Thus, they are typically able to function independently without problems despite some degree of cognitive decline.

Besides the literature on cognitive fitness, the cognitive-enrichment hypothesis also extends to the use of other behavioral interventions that may reduce the risk of cognitive decline, including exercise. A substantial body of research has been dedicated toward exploring the effects of physical exercise on cognitive functioning. One particular study aimed to determine the effects of an aerobic fitness program on older adults' cognition. A total of 124 older adults were placed into two groups: an aerobic exercise group and a nonaerobic exercise group. Before completing the exercise training, all participants were tested on a variety of cognitive measures to obtain baseline measures. The participants in the aerobic group walked for a period of 1 h three times per week over 6 months, whereas the nonaerobic group simply engaged in stretching and toning exercises over the same period. At the end of the testing period, the participants in the aerobic fitness group had demonstrated specific improvements on several cognitive measures compared to the participants in the nonaerobic group.

Likewise, a meta-analysis reviewing the relevant research that investigated the implementation of an aerobic exercise program on older adults' cognition was conducted. After analyzing 18 relevant research articles, the authors of the meta-analysis reported a large effect size of 0.48. The data was consistent with the view that an aerobic exercise training program can have an advantageous effect on an older adult's cognitive functioning. Overall, the research in this area suggests that engagement in aerobic exercise may thwart cognitive decline or reduce the risk of dementia among older adults.

The research testing the cognitive-enrichment hypothesis suggests that certain behaviors and interventions, specifically cognitive training fitness programs, mental activity, and aerobic exercise, can help an older adult's cognitive functioning. In addition to the behaviors examined in this brief review, the cognitive-enrichment hypothesis also extends to and explores other behaviors and their relation to cognitive functioning among older adults, including socialization and mental health practices. Despite the findings supporting cognitive enrichment, much debate exists on the validity and the interpretation of this body of research. Although this area of research remains

new, the preliminary findings are encouraging regarding the possibility of delaying and reducing normal age-related cognitive decline in older adulthood. Interpretations of the cognitive-enrichment hypothesis, however, should be done with caution due to the fact that these behaviors may only delay normal age-related decline and may not influence the outcome of a pathological dementing process. However, future studies should continue to explore and examine the cognitive-enrichment hypothesis in an effort to validate and understand its implications.

See also: Aging and the Brain; Clinical Psychology: An Information Processing Approach; Cognition and Personality; Decision Making (Individuals); Memory; Personality Development; Problem Solving; Social Cognition.

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Aging and the Brain

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Glossary

Calcium hypothesis of aging The hypothesis that cognitive and memory deficits associated with aging are due to dysfunction of mechanisms for regulating levels of calcium in neurons.

Cholinergic hypothesis of aging Pathological aspects of aging, such as Alzheimer's disease and cognitive impairments, are due to the selective loss of neurons in the basal forebrain that produce the neurotransmitter acetylcholine.

Dementia with lewy bodies (DLB) The second leading cause of dementia behind Alzheimer's disease. The primary

characteristic of DLB is the presence of Lewy bodies which are small clumps of protein that are found within the intracellular fluid of cells in the brain.

Nonsteroidal anti-inflammatory drugs (NSAIDs)

NSAIDs, such as ibuprofen, aspirin, and naproxen, are nonnarcotic analgesics that have anti-inflammatory effects that may be beneficial in coping with harmful effects of aging.

Oxidative stress Cellular damage resulting from the accumulation of reactive oxygen species – molecules produced by the mitochondria in cells as a byproduct of energy metabolism.

For much of the history of modern brain science, it has been widely held that the mammalian brain undergoes significant developmental changes early in life, followed by a steady, and occasionally precipitous, decline across the life span. At the heart of this thinking is the assumption that plasticity – the ability to change structure and function – is a feature of the developing brain but not of the adult brain. This and other long-held assumptions have been challenged in recent decades, and we are coming to a new understanding of the brain's amazing ability to remain plastic and to change across the life span. For example, the common belief that we lose significant numbers of neurons as we age has been reconsidered. Indeed, it is now well established that the adult brain retains the ability to produce new neurons. In this article, we first examine prominent theories of brain aging at the cellular level of analysis. These include the cholinergic hypothesis, oxidative stress, the calcium hypothesis, and genetic models of aging. Then, we discuss some of the age-associated changes in the vascular system and neuron numbers in the various systems of the brain. Next, common age-associated neuropathological conditions and therapeutic interventions are explained (excluding Alzheimer's disease which is addressed in a separate article). We conclude with some rather encouraging evidence that it may be possible to maintain a healthy brain well into advanced age.

Major Neuronal Theories of Brain Aging

Cholinergic Hypothesis of Aging

The cholinergic hypothesis of aging states that loss of function among cholinergic neurons is a primary contributor to Alzheimer's disease and loss of cognitive function as we age. Neurons of the basal forebrain are the primary source of the neurotransmitter acetylcholine, and they extend processes throughout the brain to regions that include the limbic system and the neocortex. The cholinergic hypothesis is supported by reports of relationships between the integrity of basal forebrain

cholinergic neurons and the degree of age-related impairment in both animal and human subjects. These correlational results, however, do not establish the contribution of age-related changes in the basal forebrain cholinergic system to cognitive impairments. Evidence that supports a functional link comes from two main sources: treatments targeted at improving cholinergic function relieve impairment in aged subjects, and sensitivity to anticholinergic agents increases with aging. Evidence that is not consistent with the cholinergic hypothesis includes reports that selective removal of cholinergic neurons in the basal forebrain of a rodent model of aging fails to reproduce impairments commonly found in aged subjects. Moreover, therapeutic interventions that target the cholinergic system, which included until recently all drugs approved by the Food and Drug Administration for use for the treatment of Alzheimer's disease, produce modest effects, at best. Thus, while the cholinergic hypothesis has generated considerable research and revealed targets for therapeutic intervention, it is now widely held that other types of neurons, in addition to cholinergic neurons, are likely to contribute to age-associated deficits. In the next section, we consider some of the theories that describe why and how other types of neurons might become dysfunctional or die off as we age.

Oxidative Stress

In this section, we discuss a series of hypotheses on the causes of brain aging that are all centered on the theme of oxidative stress. Oxidative stress is the gradual accumulation of reactive oxygen species (ROS) within the cells of the body as we age (ROS is a subset of 'free radicals'). ROS are biological compounds such as superoxide anion radical (O_2^-), hydrogen peroxide (H_2O_2), and the hydroxyl ions (OH^-). These molecules are produced in mitochondria, which are energy-producing components found inside the cells of the body. If not kept in check, ROS can lead to the oxidation of lipids, proteins, and DNA that can cause their destruction, malfunction, or mutation. Accordingly, the body has a host of systems designed to

watch over ROS. These usually take the form of enzymes (such as superoxide dismutases) and metabolites (such as vitamin C). The body has two main pathways with regard to ROS: one that produces ROS and one that breaks ROS down. The oxidative stress theory proposes that some process or combination of processes causes an imbalance in these two pathways, which leads to an increase in oxidative damage and what we know as aging. ROS are utilized by various leukocytes, also known as white blood cells, in the body to mount an immune response when faced with pathogens. The production of ROS by mitochondria and the antagonistic response by the immune system represent two distinct pathways, and also two distinct aspects of the oxidative stress theory of aging that we discuss next.

Inflammation is a natural part of the body's defenses against invading pathogens and injury. The brain contains a collection of cell types, including microglia, that are ready to respond to potential threats. When a pathogen is detected, microglia are activated and proinflammatory cytokines – proteins secreted by cells of the immune system to carry signals between cells – such as tumor necrosis factor α , interleukin-1, and interleukin-6 are released. These in turn activate more microglia, which attack invading cells, destroy debris, and call in cellular reinforcements. Once the threat is eliminated, they then return to an inactive state until they are called upon again. There is mounting evidence that, as we age, microglia tend to remain in the active state and do not return to their inactive state. This may lead to a prolonged or increased immune response and consequently, an increase in oxidative stress. The respiratory burst system is an important immune response in the brain in which activated microglia use an enzyme known as NADPH oxidase to rapidly produce large amounts of the ROS superoxide, which is used to kill the intruding cells via oxidative damage. In addition to an increase in ROS production, activated microglia can also damage the body in the form of autoimmune attacks. Activated microglia have been implicated in the neuronal death associated with Alzheimer's and Parkinson's diseases among others. Given the link between inflammation and degenerative disease, it is easy to see why researchers would want to investigate the use of anti-inflammatory medication to treat these symptoms as we discuss later in this section.

The mitochondrial DNA theory of aging proposes that an accumulation of mutations and deletions in mitochondrial DNA contributes to aging processes. Mitochondrial DNA is the DNA found in the mitochondria – a structure in cells that generates adenosine triphosphate (ATP), which provides a source of chemical energy for cells. Mitochondrial DNA is involved in functions such as cellular metabolism, calcium storage, and oxidative phosphorylation – a metabolic process that uses energy released by the oxidation of nutrients to produce ATP. Oxidative phosphorylation results in reactive oxygen species (ROS), which can be damaging to cells as described previously. Because of their role in oxidative phosphorylation, mitochondrial DNA uses oxygen at a very high rate and thus produces the majority of reactive oxygen species in a cell. The accumulation of ROS can have harmful effects on the brain's neurons, leading to oxidative damage and cell death. There is evidence that aged animals have higher levels of ROS in comparison with younger animals, suggesting again that aging is a consequence of the damage done by the accumulation of free radicals in cells.

In addition to promoting free radical production, mitochondrial DNA is more susceptible to mutations than DNA found in the nucleus of cells, and has lower DNA repair. Mitochondrial DNA is not fully protected by histones – the proteins that package DNA – and this makes the DNA more susceptible to free radicals and mutations. One current theory suggests a cyclic mechanism for mitochondrial DNA mutations and cell death due to ROS. Because mitochondrial DNA is highly susceptible to mutations, the accumulated mutations are thought to impair cellular oxidative phosphorylation, leading to increased levels of ROS. Increased ROS, in turn, leads to further mutations and the cycle continues. Mutations in mitochondrial DNA have been shown to increase with age as well as in the presence of neurodegenerative disorders. In addition, mice with point mutations in mitochondrial DNA as well as full deletions showed reduced life span and early onset of age-related characteristics. Also, human studies show that mitochondrial DNA deletions increase with age and some research indicates that these deletions occur in cells with higher levels of oxidative damage. ROS are not the only molecules implicated in the aging process. In the next section, we see what role calcium is believed to play in the aging process.

Calcium Hypothesis

While it is well known that calcium helps promote healthy bone structure, it also plays an important role within neurons. Calcium molecules often serve as 'second messengers' within neurons by helping to pass along messages received from other neurons via receptors. One way in which they pass messages is through a type of channel in the neuron's membrane that opens in response to signals sent from neighboring neurons. This channel allows calcium ions to enter the cell. The calcium ions that enter the cell are highly regulated as only a minute amount will activate a host of cellular processes. As one might expect, if the cell is particularly sensitive to calcium, then dysregulation of calcium ions may be responsible for what we call aging. This line of investigation is referred to as 'the calcium hypothesis.' As we get older, there is an increase in the concentration of L-type voltage-gated calcium channels and more calcium tends to enter the cell each time the calcium channels are opened. The age-associated increase in calcium channels is correlated with decreased cognitive function in aged animals whereas blocking these channels improves animals' memory.

In addition to the dysregulation of extracellular sources of calcium, aging may also be due to dysfunction of intracellular calcium release. Each cell contains an organelle that is called the endoplasmic reticulum, and one of its many functions is to store calcium reserves until needed. When called upon, the endoplasmic reticulum can release the calcium by way of either ryanodine receptors or IP₃ receptors. Chronic elevation of intracellular calcium is related to excitotoxicity – a form of cell death – in tissue cultures. The ryanodine receptors mediate a process known as calcium-induced calcium release in which calcium from the endoplasmic reticulum is released when the receptor detects calcium. When ryanodine is administered to the ryanodine receptors, it binds in the place of calcium and this has been shown to help maintain calcium levels.

Understanding the roles of cellular and molecular mechanisms of aging may eventually prove useful in combating their

negative effects. In order to investigate how specific molecular changes influence development across the life span, scientists have come up with several different kinds of genetic models; we now look at those models that focus on aging.

Genetic Models

Certain strains of mice are often inbred to create a population of animals with similar characteristics so that a specific phenomenon or characteristic can be studied in a controlled manner. The senescence accelerated mouse (SAM) model of aging provides a rodent model of aging and aging-related disorders and is comprised of two main strains: accelerated senescence-prone (SAM-P) and accelerated senescence-resistant (SAM-R) mice. They were developed in 1973 when Dr. Toshio Takeda and his research group noticed that, while maintaining a colony of a specific strain of mice, some litters would show accelerated characteristics of aging and had a shorter life span. When compared to their SAM-R counterparts, the SAM-P mice have shorter life span, hearing impairments, brain atrophy, learning and memory impairments, cataracts, osteoporosis, and immune system impairments. SAM-P mice also have higher levels of ROS. Some researchers attribute this fact to functional impairments in mitochondrial DNA, resulting in increased output of ROS. As stated previously, increased levels of ROS are one potential mechanism by which age-related neurodegeneration and cell death can occur. SAM-P mice also show accelerated age-related decline in some important cellular functions such as cell survival and proliferation. This impairment of cellular function can lead to degeneration of tissues.

SAM models provide a useful research tool for aging studies. One strain of SAM-P (SAMP-8) shows learning and memory deficits from early in development. This particular strain shows higher levels of ROS early on and is of particular interest to researchers in the dementia field because SAMP-8 mice show early onset of development of β -amyloid plaques, which are implicated in Alzheimer's disease and other forms of dementia. SAM-P strains can be useful in the development of drug therapies and treatments for age-related disorders because of their varying diversity. For example, while one strain may show a deficit in learning and memory, another strain may show osteoporosis, while yet another strain would demonstrate frontal lobe atrophy. Given the variety of age-related disorders present in strains of the SAM-P mice, they are a useful and effective tool for aging research. Now that we have covered some prevailing ideas about aging on a cellular-molecular level, we discuss aging-related changes at a broader neuroanatomical view in the paragraphs that follow.

Systems-Level Anatomical Changes in the Brain with Age

Vascular Changes

The brain needs a constant supply of blood to carry oxygen and essential nutrients to the neurons in the brain in order for them to function properly. The carotid arteries are the two main arteries that carry blood to the brain, while other arteries within the brain carry the blood to specific regions. If blood

supply to a region of the brain is cut off, then surrounding neurons will begin to die and the area will become damaged in what is commonly known as a stroke. Stroke can cause permanent damage to brain regions, leading to serious disabilities or death. Given that the incidence of stroke increases with age, it is important to be well informed about the associated risk factors for a stroke.

The vast majority of strokes are classified as ischemic strokes. These occur when blood flow in the brain becomes blocked. This blockage is usually made up of a fatty deposit known as an atheroma or a plaque. The plaque builds up in arteries, causing the blood vessel walls to harden and shrink in size, which is a condition known as atherosclerosis. The buildup becomes larger as more blood platelets aggregate together in the area, contributing to the formation of a blood clot. An ischemic stroke can be further classified as either a thrombotic or an embolic stroke, depending on where the clot initially forms. If the clot forms inside the blood vessels of the brain, then it is classified as a thrombosis; if it forms elsewhere in the body before traveling to the brain, then it is considered an embolism. An intracerebral hemorrhagic stroke is a less common type of stroke in which a weak spot on a blood vessel known as an aneurysm enlarges and bursts. Blood spills out into the brain when the aneurysm ruptures, causing an increase in pressure and extensive damage to surrounding areas. A subarachnoid hemorrhage is similar to an intracerebral hemorrhage, but the blood vessel bursts near the brain's surface and the blood spills out into the region between the skull and the brain known as the subarachnoid space.

Several risk factors can increase the likelihood of having a stroke, one of which is age. Even though a stroke can occur at any age, the majority of strokes happen after middle age and the incidence increases the older one gets. High blood pressure puts a person at greater risk of having a stroke because it causes stress on the heart and blood vessels that can lead to atherosclerosis or rupturing of an aneurysm over time. High blood pressure and high cholesterol are very unhealthy for the cardiovascular system. Maintaining a healthy cardiovascular and circulatory system can greatly reduce the chance of having a stroke. High blood pressure and high cholesterol can be treated through exercise, weight loss, regulation of diet, and with medication if necessary. Having a condition known as atrial fibrillation increases the risk of stroke. An atrial fibrillation occurs when the top two chambers of the heart (the atria) beat irregularly, causing blood to pool in the heart and clots to form. This can result in an embolic stroke if one of the clots moves to the brain. Diabetics are at greater risk for having a stroke because they tend to have high blood pressure; furthermore, the damage to the brain during a stroke is greater when blood sugar is very high. Smoking dramatically increases the chance of a stroke, since smoking reduces oxygen levels in the blood and causes the heart to work harder. A transient ischemic attack (TIA) or 'mini-stroke' is caused by temporary blockage of the blood vessels. It does not cause permanent damage but should be recognized as a warning sign of a future stroke.

Diagnostic tests need to be run before administering treatment to a person who has had a stroke. Blood thinners are an effective treatment for ischemic stroke but if the stroke is hemorrhagic, then administering blood thinners would increase bleeding and damage. Most physicians use X-ray and

brain imaging techniques such as CT (computed tomography) and MRI (magnetic resonance imaging) to find the blockage or area of bleeding. An angiogram is an X-ray technique in which dye is injected into arteries to more accurately locate obstructions and aneurysms. An angiogram can be used as a screening tool to look for abnormal blood vessels. Once a diagnosis is made, treatment can begin. For ischemic strokes, the primary medical treatments are administering a clot-dissolving tissue plasminogen activator (tPA), anticoagulant drugs, antiplatelet drugs, and low dose aspirin. The main surgical treatments used for ischemic strokes are a carotid endarterectomy (removing the blockage from the artery), performing an angioplasty to reduce plaque buildup, and setting up a stent to improve blood flow in the vessel. The primary treatment for hemorrhagic strokes is through surgical interventions to stop the bleeding and repair the damaged blood vessels.

Neuron Loss

As reviewed in the previous sections, most theories of brain aging are built around the notion that the most likely cause of age-associated cognitive decline is the widespread loss of neurons. This view is changing rapidly due to development of new techniques for assessing neuron numbers and better methods for early diagnosis of pathological conditions. Two regions of the brain have come under close scrutiny – the neocortex, which is responsible for higher order cognition, and the hippocampus, which is implicated in long-term memory. It has been known since the 1950s that the hippocampus is important for memory, and memory impairments associated with aging are similar to those caused by damage to the hippocampus. However, it is now known that there is no significant age-associated loss of neurons in the hippocampus, even among aged subjects with severe memory impairments. This fact was supported by a rodent model of aging and a newly developed technique for unbiased counts of neuron numbers. These findings have since been confirmed among both nonhuman and human primates.

The assumption that neurons are lost in the cerebral cortex as we age is also coming under increasing challenge. When pathological conditions such as Alzheimer's disease are controlled for, it appears that there is little loss of cortical neurons in a variety of regions including visual and motor cortex, and the prefrontal cortex, which is an area important for using experience to guide choices about current situations. This finding is encouraging as it suggests that there may be a useful distinction between 'successful' and 'pathological' aging. In addition, instead of focusing exclusively on age-associated neuron loss, investigators are beginning to test hypotheses about how changes in connectivity between neurons may account for deficits associated with aging, particularly in the prefrontal cortex, an area strongly implicated in age-associated cognitive decline. In specific, recent evidence suggests that there is a decrease in both excitatory and inhibitory synapses, the points of communication among neurons, in certain regions of the prefrontal cortex. In addition, there is evidence that the vesicles that contain neurotransmitters at certain synapses may change with age and this may be related to cognitive status among the elderly. These and other functional changes in communication among neurons will continue to be a promising focus of investigation.

Age-Associated Neurological Disorders

Parkinson's Disease

Parkinson's disease is a chronic, progressive, degenerative disorder of the central nervous system. Common symptoms of the disorder include muscle rigidity, tremor, bradykinesia (slowing of movement), postural instability, and cognitive problems. The primary symptoms of Parkinson's disease are a result of decreased stimulation of the motor cortex by the basal ganglia, a group of nuclei in the forebrain associated with motor control as well as motor and cognitive habits. The decreased signal from the basal ganglia is due to degeneration of neurons in the substantia nigra, a nucleus of cells in the midbrain that release the neurotransmitter dopamine. Dopamine is a catecholamine neurotransmitter that plays an important role in sleep, cognition, motivation, learning, attention, and movement. Within the basal ganglia, there is a direct pathway that provides an excitatory signal to the cortex and facilitates voluntary movement and an indirect pathway that provides an inhibitory signal to the cortex and inhibits movement. The ultimate result of neuronal damage in Parkinson's disease is inhibition of the direct pathway and excitation of the indirect pathway, both leading to the classic symptoms of tremor, muscle rigidity, slow movement, and postural instability.

The cause of cell loss in the substantia nigra is unknown, and Parkinson's disease is considered to be idiopathic (having no known cause). However, in recent years, theories have emerged as to the etiology of neuronal degeneration. One proposed mechanism of cell death in Parkinson's results from the accumulation of a protein common to neural tissues, α -synuclein, as a complex which forms what are known as Lewy bodies (described in the next section). Another proposed mechanism of cell death involves the oxidative stress model of aging which we described previously. In this case, cell death is a result of iron accumulation in the substantia nigra. Cells in the substantia nigra have a large amount of melanin, resulting in the dark color that gives the structure its name ('black substance'). The iron binds to neuromelanin and ultimately results in accumulation of reactive oxygen species (ROS) which are toxic to cells and can result in cell death.

There is currently no cure for Parkinson's disease, although treatments can be effective at managing symptoms. The most widely used treatment is levodopa (L-Dopa), which is the biological precursor to dopamine and increases the levels of dopamine in the brain. L-Dopa is often given in conjunction with dopa-decarboxylase inhibitors. Dopa-decarboxylase is the mechanism by which L-Dopa is metabolized into dopamine, and the inhibitors help to prevent it from being metabolized elsewhere in the body before it reaches the brain. Even with dopa-decarboxylase inhibitors as a part of treatment, only about 1–5% of L-Dopa reaches dopaminergic neurons. Although L-Dopa is the most commonly used line of treatment, other therapies are available such as agents that act by stimulating dopamine receptors. In addition, there are drugs available that inhibit the breakdown of dopamine, such as monoamine oxidase-B inhibitors. These drugs interfere with the naturally occurring enzyme that breaks down excess dopamine in the brain, effectively increasing levels of dopamine in the brain.

In addition to therapies that pharmacologically enhance the dopaminergic system, there are also surgical treatments. The most widely used surgical treatment of Parkinson's disease is deep brain stimulation, or DBS. DBS involves the surgical implantation of what has been likened to a 'brain pacemaker' that sends electrical pulses to specifically targeted areas of the brain including the internal capsule and the subthalamic nucleus. The direct effect of DBS on neurotransmitter release and overall brain physiology is not fully known or understood, but it can provide relief from major Parkinson's symptoms. However, DBS is only used in the most extreme cases, typically after other lines of therapy have failed. Other surgical therapies that are not widely used but have shown some promise as potential treatments are lesions of the subthalamic nucleus and the globus pallidus. Though other options exist, DBS remains the most commonly used surgical therapy for Parkinson's disease.

Lewy-Body Dementia

Dementia with Lewy bodies (DLB), often referred to as Lewy body dementia, is the second leading cause of dementia behind Alzheimer's disease. The primary characteristic of DLB is the presence of Lewy bodies in the brain, named after Dr. Friederich Lewy in 1912. Lewy bodies are small clumps of protein that are found within the intracellular fluid of cells in the brain. The primary protein that makes up these Lewy bodies is known as α -synuclein, which is a naturally occurring protein believed to be used in the formation of vesicles, which help store neurotransmitters used for cellular communication. It is not currently known exactly what causes the α -synuclein protein to go rogue, but one theory is that the body can start to overproduce α -synuclein. Another is that some malfunction eventually makes the protein insoluble and more able to clump together. One theory even proposes that Lewy bodies might actually be 'good,' and are made by the body to inactivate rogue α -synucleins that have not been properly eliminated.

In addition to the production of Lewy bodies, DLB also leads to a decrease in certain neurotransmitter systems such as acetylcholine and dopamine. Similar to Parkinson's disease, a dysfunction of these chemical messengers can lead to symptoms such as slow movement, rigidity, and a shuffling gait. Along with Parkinson-like symptoms, people with DLB typically exhibit a fluctuating level of cognitive impairment. One day the patient may seem alert and active but the next day will be sluggish and easily confused. Another common symptom of those with DLB is frequent hallucinations, which are thought to be related to the formation of Lewy bodies in the temporal lobe. Unfortunately, there is currently no known cure for DLB. One commonly prescribed treatment is a group of drugs known as cholinesterase inhibitors, which stop the breakdown of acetylcholine, allowing it to remain active longer. Caution must be used when medicating DLB patients with neuroleptics (antipsychotics) because they have been shown to be sensitized to these treatments and may develop the aptly named neuroleptic malignant syndrome. This syndrome is characterized by various homeostatic imbalances such as muscle rigidity, fever, and autonomic dysfunction.

Interventions

One potential intervention for age-related functional decline is caloric restriction. Caloric restriction involves reducing the amount of calories consumed, either by reducing overall food intake or by reducing the caloric content of the food without altering overall consumption. Reducing a nutritious diet by 20–50% can result in beneficial effects such as: increased life span, increased protection from harmful effects of stress, and slowed onset of many age-related diseases. Additionally, reduced calorie diets show lowered risk for disorders such as Parkinson's disease and Alzheimer's disease. Caloric restriction has been shown in animal models to be an effective strategy for combating age-related cognitive decline. Mouse models of Alzheimer's disease show slowed progression of the disease when the caloric intake is reduced 30–40%. Also, squirrel monkeys put on a reduced calorie diet have fewer β -amyloid plaques, a congregation of misfolded proteins and amino acids widely thought to be a main contributor to Alzheimer's disease. Additionally, long-term studies of rhesus monkeys show that animals kept on a restricted diet chronically (about 30% of control animals) show better health overall when compared on measures such as rate of aging and incidence of disease.

Though caloric restriction has been shown to be a promising potential intervention for age-related health decline, in practice, it proves slightly more difficult. For example, issues with implementation may come about as it can be difficult to maintain a chronically restricted diet. Additionally, quality of life can be affected by such a change in one's dietary intake. To combat these issues, research is now focused on areas of caloric restriction mimetics. This area of research is aimed at development of compounds, such as resveratrol, that can mimic caloric restriction by targeting both stress and metabolic pathways.

Caloric Restriction Mimetics

Resveratrol is a polyphenolic phytoalexin produced in plants and is primarily found in the skin of grapes, which is a constituent of red wine. It is also found in blueberries, peanuts, pistachios, and groundnuts in lower concentrations. It has been investigated extensively for its cardio-protective, cancer preventive, estrogenic, anti-inflammatory, and antioxidant effects. Resveratrol has been implicated as a possible antiaging drug because of its similarities with caloric restriction in improving overall health. Resveratrol circulating in the blood stream is rapidly metabolized by the body and has a short half-life of decay. The chemical products of resveratrol's metabolism have a much longer half-life than resveratrol in its unconjugated form. Accordingly, it is difficult to tell how much resveratrol is actually accumulating in the tissues of the body before being broken down. Resveratrol has been shown to lower the risk of cardiovascular disease by increasing vasodilation and reducing the aggregation of platelets in blood vessels. Since resveratrol selectively inhibits COX1 (see section on the role of cox1), it decreases the likelihood of restricted blood flow due to blockage. Resveratrol also promotes vasodilation by improving nitric oxide signaling, which is an important mechanism for protecting against ischemic damage. Since resveratrol can cross the blood brain barrier, it promotes vascular

protection in the brain from cerebral ischemias, which are a major cause of stroke. Research with rodents has demonstrated that resveratrol can decrease motor damage and the amount of tissue death following a stroke.

In addition to regulating vascular homeostasis, COX enzymes play an important role in the body's inflammatory and immune response. Resveratrol has been shown to decrease inflammation by selective COX inhibition and by decreasing superoxide formation in rats. Resveratrol has also been shown to reduce reactive oxygen species (ROS) damage as well as promote antioxidant effects and reduce inflammation. The exact mechanisms by which resveratrol reduces oxidative stress are not fully understood and are still under investigation.

In aging research, resveratrol has been described as a possible mimetic for caloric restriction. Early research yielded exciting results indicating that the life span of lower organisms could be extended by manipulations of the gene for silent information regulator 2 (Sir2). However, these increased longevity results were not replicated in rodent models. Sir2 is part of a class of proteins called sirtuins that are histone deacetylases. Extra copies of Sir2 have been correlated with increased life span in yeast, worms, and flies. Mammals have seven sirtuins and SIRT1 is the mammalian homolog of Sir2. Resveratrol has been shown to activate SIRT1 in mammals, but this has not been shown to extend life span in rats. Resveratrol has numerous protective qualities that are beneficial to maintain good health and mimic metabolic changes associated with caloric restriction.

Nonsteroidal Anti-Inflammatory Drugs

In addition to caloric restriction, nonsteroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, aspirin, and naproxen, can be beneficial in coping with harmful effects of aging. These drugs are nonnarcotic analgesics that have anti-inflammatory effects and fever-reducing abilities. NSAIDs block the synthesis of prostaglandins, which cause inflammation at the site of an injury to protect from infection and cause increased pain sensitivity. Nonselective NSAIDs prevent the release of prostaglandins by directly inhibiting the enzymes Cyclooxygenase 1 (COX1) and Cyclooxygenase 2 (COX2). These enzymes play an important role in the body's inflammatory response as well as in regulating vascular homeostasis. COX1 synthesizes thromboxane A2, which promotes clot formation through increasing platelet aggregation. In addition, thromboxane A2 constricts blood vessels in order to raise blood pressure and retain heat. Prostacyclins are synthesized by COX2 to prevent platelet aggregation and dilate the blood vessels. Together, the inhibition of these compounds reduces inflammation and associated pain. In high doses, nonselective NSAIDs have negative side effects on the upper and lower gastrointestinal (GI) tract that can result in painful ulcers. The inhibition of COX1 with NSAIDs diminishes the protection of the GI tract's mucosa lining. Selective NSAIDs called COX2 inhibitors were created in an attempt to reduce inflammation and pain without damaging the mucosa lining of the GI tract. Early clinical trials demonstrated that COX2 inhibitors significantly decreased gastrointestinal problems associated with NSAIDs. However, the results of these clinical trials also demonstrated an increased risk of cardiovascular problems. The strongest

COX2 inhibitors, such as rofecoxib, were significantly correlated with cardiovascular complications when compared with placebos and nonselective NSAIDs. Currently, celecoxib is the only COX2 inhibitor available in the United States and FDA changed its label to include warning about possible cardiovascular problems.

The majority of individuals taking high doses of NSAIDs are those suffering from arthritis, which causes inflammation in the joints and considerable pain. The incidence of osteoarthritis is correlated with age, so it is important to understand the risks and benefits of using high doses of NSAIDs. Low dose aspirin has been shown to possess cardio-protective effects and it is highly recommended that the elderly and those individuals at high risk for heart attack and stroke take low dose aspirin. Aspirin irreversibly inhibits the ability of individual platelets to produce thromboxane A2, and therefore decreases the likelihood of dangerous clots forming in the blood vessels. Ibuprofen has been shown to interfere with the irreversible binding of aspirin to platelets, resulting in reduced platelet aggregation. Therefore, it is important to be knowledgeable about possible drug interactions when taking low dose aspirin.

Another type of inflammation, called neuroinflammation, is a pathological characteristic of Alzheimer's disease (AD) in affected brain regions where damage is sustained. Misfolded proteins called β -amyloid plaques and neurofibrillary tangles develop in the brain of individuals with AD. These plaques and tangles prevent the communication between neurons and eventually lead to neuronal cell death. Neuroinflammation is concentrated around these β -amyloid plaques and neurofibrillary fibers. This finding supported the hypothesis that anti-inflammatory drugs may aid in the prevention or treatment of AD. Epidemiological evidence demonstrated a lower incidence of AD in individuals with arthritis who were currently taking high doses of NSAIDs. Subsequent clinical trials, however, did not support this hypothesis and some trials were suspended due to health concerns over using high doses of NSAIDs. It is too early to recommend the use of NSAIDs for AD prevention based on current research, but scientists are still investigating the relationship between neuroinflammation and AD.

Maintaining a Healthy Brain

Successful Aging

There are many things one can do to help prevent or prolong the onset of age-related deficits. One of the most effective methods observed thus far is readily accessible and inexpensive: exercise. Cardiovascular health can be a strong predictor of mental health as we age, and several studies have shown a link between increased blood pressure in mid-life and diminished cognitive functions in later life. Studies have also linked antihypertensive treatment with reduced cognitive decline in people with hypertension compared to those who remain untreated. Another major cardiovascular concern linked to cognitive decline is dyslipidemia, an abnormality in the amount of lipids (such as cholesterol) in the blood. Studies have shown a relationship between cognitive decline and high levels of cholesterol for both high-density and low-density cholesterol. There is not yet strong evidence to support the

use of statins to treat cognitive decline related to dyslipidemia. Type 2 diabetes has been implicated in a more rapid cognitive decline when compared to nondiabetics. The duration of diabetes has also been shown to correlate with increased risk of cognitive decline. There has been modest success thus far with the use of antidiabetic medication to ameliorate the symptoms. Finally, a link has also been shown between hyperinsulinemia, or excessive levels of insulin in the blood, and cognitive decline.

Exercise does more than just improve the brain through cardiovascular health. Exercise has also been shown to increase the levels of a protein in the brain known as brain-derived neurotrophic factor, or BDNF. BDNF is one of many chemicals known as neurotrophins that encourage the growth and survival of neurons within the brain. In rats, lack of exercise can decrease the expression of BDNF whereas as little as a week's exposure to exercise has been shown to greatly increase BDNF levels. Not only does exercise increase BDNF but it also increases the production of new neurons in the hippocampus, a brain structure associated with learning and memory. Exercise has also been shown to facilitate the induction and maintenance of long-term potentiation, a phenomenon in which two cells are better able to communicate with one another as the result of activation. On a more practical level, exercise has also been shown to improve rats' performances on the Morris water maze in which they are tasked with finding a platform that is hidden below the surface of the water. The improvement seen in the Morris water maze and other such memory tasks can be abolished if the animal has its BDNF signaling blocked, implicating BDNF as a likely component of this pathway.

Many studies have shown that our ability with language and verbal manipulation is also implicated in aging. One study, sometimes referred to as the 'Nun Study,' included several members of the convent of the School Sisters of Notre Dame in a long-term study of their cognitive abilities, and the nuns agreed to donate their brains for examination upon their deaths. One benefit of conducting an aging study among a convent of nuns is that from the time they entered (with the average age being 22) each nun has lived a relatively similar life and thus from then on, most nonbiological differences between them were kept to a minimum. Before taking their vows, each nun was required to write an autobiography of their life up to that point. When the brains were analyzed, there was a strong correlation between those nuns that aged successfully and idea density scores (the ability to express a large amount of ideas in a small amount of words) and grammatical complexity in their autobiographies written several decades earlier. One evaluation of the data even suggests that those nuns that had a more positive outlook on life were healthier and lived longer.

In this article, we have discussed many of the important mechanisms of aging and age-related decline in brain function, as well as potential therapies for combating these negative aspects of aging. There is still much debate about whether what we consider aging is a pathological condition or if there are simply various degrees of severity to the declines and deficits associated with the aging process. While aging is often viewed with emphasis on the degenerative diseases (Alzheimer's disease, Parkinson's disease, dementia with Lewy bodies), several of the theories presented here involve a more gradual accumulation of damage as part of a general aging process. At the cellular level, aging is currently thought to be largely due to accumulation of ROS and their harmful effects on cells. In addition to ROS, calcium dysregulation may play a significant role in the age-associated cognitive deficits. Research in the field of aging has led to the development of major theories of brain aging centered on the cholinergic system, oxidative stress, mitochondrial DNA, and calcium dysregulation. To combat the consequences of aging, researchers have studied genetic models like the senescence accelerated mouse (SAM) model of aging as well as possible interventions that include caloric restriction, resveratrol, and NSAIDs. Current research has provided us with many ways to intervene and potentially stave off the aging process, but there is still much to be explored. As the average life span and the number of aged individuals increases (especially with a looming, aging 'baby boomer' generation), our efforts to understand the mechanisms of brain aging are increasingly coming to the forefront of scientific research.

See also: Aging and Cognition; Alzheimer's Disease; The Brain; Brain Chemicals; Global Projections of Ancient Aromatic Neurotransmitters; Brain and Behavior Relationships; Memory; Memory, Neural Substrates.

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Agnosia (including Prosopagnosia and Anosognosia)

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Glossary

Focal deficit This expression indicates a symptom that depends on a circumscribed (opposite to diffuse) brain damage.

Modularity In neuropsychology, the term modularity refers to the idea that cognition and consciousness have a composed structure made up of relatively independent and domain-specific processing components.

Neuropsychology It is a multidisciplinary scientific approach to the study of cognitive brain functions in normal and brain-damaged subjects through paradigms derived from Psychology and Neurology.

Presemantic memory It is the collection of visual-structural knowledge about stimuli in the absence of knowledge about their identity and function.

Processing stage It is the result of a transformation of the information entering a biological or nonbiological system from one status to another.

Semantic memory It is the collection of knowledge, meaning, and concepts that have been acquired over the course of the life span.

Vestibular reflex The vestibuloocular reflex is elicited by irrigating cold or warm water into the external auditory canal. This maneuver evokes reflex eye movements, and it is commonly used to evaluate the function in the peripheral vestibular system or, together with other tests, to evaluate brain stem death. More recently, it has been employed for temporally reactivating brain circuits partially affected by a brain damage.

Visual Agnosia: Overview

Visual agnosia refers to the general impairment of stimulus recognition in the visual modality in the absence of perceptual deficits, memory problems, and general intellectual impairment. Individuals with visual agnosia demonstrate normal recognition of objects through modalities other than vision (touch, audition, and verbal description of objects function). Agnosia does not necessarily impair the recognition of all visual stimuli, but can selectively affect certain categories of percepts (objects, faces, colors, written words, body parts, environmental scenes), leaving others intact. Patients are well aware of their predicament. In 1889, Freund, a German neurologist of Breslau, described a case of visual recognition deficit that he named optic aphasia and he interpreted as a consequence of the disconnection of visual from language areas. A year later (1890), Lissauer, a colleague of Freund, published a paper where he clearly distinguished two different forms of agnosia: apperceptive agnosia, or inability to construct a good perceptual representation from the visual input, and associative agnosia, or inability to access the stored knowledge related to the percept. Despite these two authors being the first to report documented cases of agnosia, the term *agnosia* was coined by Freud in 1891 to describe object recognition problems in some individuals. Although it is a relatively rare neurological symptom, with some 100 cases published between 1890 and 1990, its study has greatly contributed to our understanding of how the process of visual recognition is organized in the human brain. As already mentioned, the most common form of agnosia is agnosia for objects, but forms of agnosia specific for a category of objects are also possible (e.g., agnosia for faces (prosopagnosia), agnosia for colors (color agnosia), agnosia for words (pure alexia or agnosic alexia), agnosia for scenes). Here, we briefly review these different forms of agnosia.

Object Agnosia

Although there is no standard taxonomy of object agnosias, most neuropsychologists agree on Lissauer's original distinction between apperceptive and associative agnosia, depending on the processing stage of visual information affected by the brain lesion. Because this account has continued to be employed in the neuropsychological literature to the present day, we will use it as a general framework for our present purpose. As we will see, however, this classical dichotomy captures well the cases at one end and the other of the agnosia spectrum, but not the variants falling in between.

Apperceptive Agnosia

This kind of agnosia is evident when patients are unable to recognize objects because they cannot see them properly, in the absence of elementary visual deficits. This type of agnosia is thought to arise from a breakdown at relatively early stages of visual processing, where the elementary features of the stimulus are processed. Object recognition through verbal description by the examiner is preserved, instead. These patients have relatively good visual fields, visual acuity, brightness discrimination, color vision, depth, and motion perception. Despite this, shape perception is abnormal in such a way that patients cannot recognize or copy pictures, letters, and even simple geometric shapes. Some authors consider a prerequisite for differentiating these patients from those showing deficits in the early stages of perception that they are normal on figure-ground discrimination tests but fail on Efron's test (judge whether two pairs of simple geometrical figures are same or different). If tested, identification of object orientation in space may become pathological, despite the preserved visuomotor ability to mimic object orientation based on the same visual information (this finding has been taken as evidence

supporting a dual stream model of visual perception, which attributes to the occipitotemporal ventral pathway ('what' pathway) object identification and to the occipitofrontal pathway ('how' pathway) object-directed action control). Recognition of real objects appears to be better than recognition of geometric shapes, possibly because of the availability of cues such as size and surface properties such as color, texture, and specularity rather than object shape. In most cases of apperceptive agnosia, the brain damage is diffuse, often caused by carbon monoxide poisoning. In the rare cases with circumscribed brain lesions, the damage primarily affected the ventral occipitotemporal cortex bilaterally. According to a widely accepted interpretation, apperceptive agnosia can be considered a deficit of shape perception resulting from defective perceptual grouping of object local features into a global percept. However, clinical findings show that apperceptive agnosia covers a wide spectrum of disorders, some of which fall in between apperceptive and associative agnosia. Hence, two neuropsychologists, Riddoch and Humphreys, proposed to differentiate between distinct subtypes of apperceptive agnosia, each corresponding to a defective processing stage along the hierarchically organized stream of visual information processing leading to conscious object perception (according to Marr's computational model of vision): *Shape agnosia* and *integrative agnosia*, which are 'closer' to the apperceptive type; *transformational agnosia* and *agnosia due to impairment of internal object representation*, which are 'closer' to the associative type. *Shape agnosia* results from a deficit of the initial processing stage of visual recognition and consists in the inability to organize the sensory input into a unified percept: these patients complain of blurred or unclear vision and are unable to discriminate stimulus boundaries from the background or other contiguous or overlapping shapes, as well as its orientation and size. *Integrative agnosia* consists of the inability to integrate single object features into a global shape, in the presence of the ability to identify single object details. This deficit is more severe when object shape is defined by high frequency details or when overlapping figures must be identified, but is reduced when silhouettes of objects with reduced internal details are used for discrimination. *Transformational agnosia* is a deficit of perceptual categorization (first described in 1982 by E. Warrington), which occurs when patients can recognize objects presented in a canonical view, but fail when they are presented in noncanonical views. What is lost is the ability to manipulate the mental representation of the object to match it with its perceptual image. *Agnosia due to impairment of internal representations of objects* occurs when a structural description of the object is formed normally, but its internal representation stored in presemantic memory cannot be accessed through a given route to match on-line descriptions encoded by the visual system.

Associative Agnosia

This type of agnosia occurs when patients can form a structural description of the visual object (object copy is preserved), yet being unable to recognize it. Associative agnosic patients cannot identify objects even by nonverbal means (e.g., by pantomiming their use or grouping together dissimilar objects from the same semantic category); however, recognition is preserved

in the tactile modality (by touching the object) or from a spoken definition. It is still debated whether cases of relatively pure associative agnosia are possible, that is, without a concomitant apperceptive deficit. Intrahemispheric location of the lesion is generally occipitotemporal, unilateral (with the prevalence of left hemispheric lesions), or bilateral. Following a left-sided lesion, associative agnosia can be present in both visual hemifields, probably because the semantic role played by this hemisphere is greater than that of the right hemisphere. Associative agnosia has been explained as a deficit of arousal of the semantic associations related to the visual percept: patients, despite being able to form a normal visual representation of the stimulus, are unable to grasp its meaning and therefore cannot name it. In visual naming tasks, errors tend to be semantic (e.g., 'knife' for 'fork') or totally unrelated to the stimulus (e.g., 'horse' for 'chair') or consist of the identification of the superordinate ('flower' for 'daisy'). Miming the use of a visually presented object is also impaired, whereas it is not if it follows a verbal description of the object. Patients also fail in semantic categorization and association tasks, as well as in the description of the semantic attributes of an object. According to one view, associative agnosia is the consequence of a disconnection between visual areas and other brain centers responsible for language or memory. This hypothesis, however, does not account for the inability of agnosic patients to convey information nonverbally and to access old knowledge through vision. A different interpretation, perhaps the most widely accepted, assumes that stored visual memory representations have been damaged in such a way that the newly formed visual percepts cannot be matched against them and therefore recognition is impossible. Associative agnosia must be differentiated from optic aphasia and semantic amnesia. In the former, a visual stimulus is recognized but cannot elicit naming, whereas in the latter, semantic knowledge and naming of the stimulus are inaccessible, irrespective of the sensory modality which conveys the information.

Face Agnosia (Prosopagnosia)

The term *prosopagnosia* (from the Greek *prosopon*, meaning face, and *agnosia*, meaning ignorance) refers to the inability to recognize familiar faces. The symptom was first reported by the Italian ophthalmologist Quaglino in 1867, but the term prosopagnosia was adopted only in 1947 by the German neurologist Joachim Bodamer. The deficit is confined to the identification of physiognomic traits, as shown by the fact that identification is preserved through nonphysiognomic cues such as voice, a particular item of clothing, a scar, and gait. In the most severe cases, patients cannot recognize their own faces at the mirror or that of closest relatives. In the milder forms, the deficit may be limited to friends, acquaintances, and to famous people. Perceptual categorization of the stimuli is preserved (patients know that a face is a face) as well as the ability to differentiate faces by sex, race, age, and emotional expressions. What is lost is the ability to identify a face as a known face. Psychophysical and neuropsychological studies on face recognition abilities in normal and brain-damaged patients have revealed that *familiar and unfamiliar face* processing follow dedicated routes in the left and right hemisphere, respectively. Nonrecognition of familiar

faces is more likely to occur after a left brain lesion, whereas nonrecognition of unfamiliar faces is more likely to occur after a right brain lesion. This distinction led the neuropsychologist A.L. Benton (1980) to differentiate between two independent face processing deficits produced by brain damage: *apperceptive prosopagnosia*, which refers to a defective perceptual processing of face information and is brought out by unfamiliar face tasks, and *associative prosopagnosia*, which involves an additional mnemonic component and is elicited by familiar face tasks. Recent fMRI data have located a specific area of the fusiform gyrus in the ventral part of the inferior temporal cortex called the fusiform face area (FFA), which is activated more strongly in response to face stimuli than other stimulus categories. Lesion-producing prosopagnosia often involve the FFA and are more frequent in the right side of the brain or are bilateral. The degree of domain specificity of FFA for face processing is currently object of debate.

Apperceptive and Associative Prosopagnosia

According to the model of visual recognition proposed by Bruce and Young (1986), the identification of a face is the final stage of a sequence of operations made by distinct, hierarchically organized, information processing modules distributed along the occipitotemporal ventral pathway of the brain. At the earlier stages, perceptual face processing results in the construction of an object-centered, tridimensional *structural description of the face*. If this processing level is damaged, patients are unable to recognize familiar faces (*apperceptive prosopagnosia*) as well as other categories of familiar stimuli. At later processing stages, the structural description of the face activates an abstract representation of it stored in *recognition units* responsible for the feeling of familiarity. Then, the information gains access to the semantic memory sectors (*identity nodes*) containing biographical, relational, and other information about the familiar face. From the identity nodes, information finally has access to the modules containing the person's *name*. The anatomofunctional independence of the names module is confirmed by the existence of anomia for proper names following left brain damage and by the frequent inability experienced by normal subjects to retrieve the name of an otherwise well-known person. *Associative prosopagnosia* is normally consequent upon an impairment either at the level of recognition units or of identity nodes, or both: patients pass the tests involving face identification, but fail recognition of familiar faces, though they show good semantic knowledge of the persons to whom the faces refer. Prosopagnosia must be distinguished from the impairment of retrieving from semantic memory any type of information related to an individual and/or an entity (loss of semantic knowledge for individual entities).

Specificity of the Face Deficit

A recurrent issue of debate in the neuropsychological literature is whether prosopagnosia is specific to faces or extends to other categories of objects. This latter view is supported by documented cases of prosopagnosic patients who also had difficulties in discriminating among the members of other stimulus categories, for example, a chair from an armchair, car makes, and

mammals of similar shapes. Moreover, there have been cases of farmers who had found it difficult to differentiate among their own cows, and an ornithologist who had lost the ability to discriminate birds of different species. However, there have been an equivalent number of reports of prosopagnosics with a preserved ability of differentiating exemplars of the same category when they are not faces. So, the question is whether faces are special stimuli with special features requiring a dedicated brain-processing module, or it is the nature of the processing they undergo which differs from that applied to other classes of stimuli (e.g., words and objects). Authors supporting this latter view – for example, Farah – claim that faces require an holistic processing mode to be identified for which would be responsible the right hemisphere, whereas words require an analytical processing mode, for which would be responsible the left hemisphere, and objects share both processing modalities. So, depending on the severity of the deficit, the global mode, the analytical mode, or both can be impaired, resulting in different patterns of recognition deficit involving mostly faces (mild deficit of global perception), words (mild deficit of analytical perception), and objects (more severe deficit of global and/or local perception). This theory, however, has been challenged by the reports of patients with agnosia for faces and words but not for objects, and agnosia for objects without impairment of either faces or words. Further support of the theory that faces are a special class of stimuli comes from neurophysiological recordings in the monkey and fMRI data in man. The former revealed the existence in the inferior temporal cortex of the monkey brain of neurons selectively activated by familiar faces or by face details; the latter has shown the existence in the human fusiform gyrus of the inferior temporal cortex of one area predominantly activated by face stimuli (fusiform face area (FFA)), and a different area, located in the parahippocampal region, predominantly activated by scenes depicting places or buildings, called parahippocampal place area (PPA), and unresponsive to faces. Lesions to this area can give rise to a different form of agnosia for landmarks and the environment called *topographic agnosia* (see section 'Agnosia for Landmarks and Environment (Topographic Agnosia)').

Unconscious Face Recognition

This behavior consists in the fact that some prosopagnosic patients react differently to famous faces that they deny recognizing and to unfamiliar faces, thus showing some degree of implicit knowledge of the famous faces. Implicit identification of explicitly nonrecognized familiar faces can be evidenced by psychophysiological and neurophysiological measures, such as electrodermal skin conductance, pupillometry, event-related brain potentials, and by psychological paradigms, such as forced choice, reaction times, and priming (the improvement in performance, which occurs in a decision task when a target stimulus is preceded by a nontarget semantically related to the target). When implicit recognition is probed by these means, it is possible to see an increment in these indirect measures of recognition when familiar faces stimuli are presented relative to when unfamiliar ones are presented. Perhaps the most convincing interpretation of this phenomenon is that conscious recognition requires a higher activation threshold from the visual input than implicit recognition. According to this

view, if the lesion producing prosopagnosia completely impairs the function of recognition units, both implicit and explicit recognition will be impossible. If the impairment is only partial, instead, the output from recognition units will be sufficient for unconscious recognition but insufficient for overt recognition.

Color Agnosia

Color agnosia describes a deficit in color naming and/or color-object associations that cannot be accounted for by aphasia or dyschromatopsia (impaired color discrimination). Such patients perceive colors correctly, but are unable to name them, to retrieve their name when given the name of an object of a given color, to match a color with an object, or to sort colors according to their hue. Some patients are agnosics for colors only when they have to make a visuoverbal match (naming a visually presented color and pointing to a color named by the examiner); others are agnosics only when are asked to retrieve colors from semantic memory (e.g., what color is a banana?, coloring in a drawing of an apple). This dissociation has been related to two different forms of color agnosia: *color anomia* or *aphasia* and *color amnesia*, respectively. *Color anomia* is considered a visuoverbal disconnection deficit. Patients are unable to match verbal with visual color information, but are capable to retrieve color information from semantic memory. The interpretation of this behavior is framed in anatomical terms: patients have a left occipital lesion which causes right hemianopia and, hence, confines accessible visual information in the left hemifield/right visual areas. Color naming requires callosal transfer of information to the left hemisphere, which is interrupted by the lesion of the fibers connecting the visual areas of the right hemisphere with the language areas of the left hemisphere where the names of colors are stored. *Color amnesia* is shown by patients who not only are unable to name colors, but are also unable to retrieve color information from semantic memory (e.g., when they have to name the color of an object from memory (what color is a panther?) or color in the drawing of the same object). The disconnection hypothesis cannot account for this behavior, which is more correctly described as a defective access to, or degradation of, the semantic memory sector where associations between objects and colors are formed. The brain damage responsible for color amnesia is in the territory of the temporo-occipital branch of the left posterior cerebral artery, or is bilateral.

Tactile Agnosia

Tactile agnosia is the inability to recognize objects through palpation in the absence of elementary sensory deficits such as ahylognosia (inability to identify substance features) and amorphognosia (failure to recognize shape haptically). Recognition through the visual modality is preserved. The locus of the lesion involves the posterior-inferior portion of the parietal lobe and can be unilateral or bilateral. When the lesion involves the right hemisphere, only the contralateral hand is agnostic, whereas both hands can be affected when the lesion

involves the left hemisphere. This latter condition parallels that described in the visual modality for associative agnosia following a left hemispheric lesion, and can be ascribed to the apparently dominant semantic role of the left hemisphere. The prevalence of tactile agnosia is much lower than the prevalence of visual agnosia, but the difference may be more apparent than real because of the features of cortical vascularization of the parietal lobe. The available evidence does not permit to differentiate between apperceptive and associative forms of tactile agnosia. The deficit is interpreted as a failure of the associative-semantic system to match the tactile features identifying an object with its meaning. Tactile agnosia must be differentiated from *tactile aphasia*, which is shown by patients who cannot name objects they are handling but can show that they have recognized them either by miming their use or by passing association or categorization tests. Tactile aphasia can be considered a disconnection deficit between tactile information about an object and its name, and is observed in patients with callosal resection and in those with damage to the left parietal lobe.

Agnosia for Words

Agnosia for words is also known as pure alexia, perceptual word-form agnosia or pure word-form blindness and is usually discussed in the context of language impairments. However, given that these patients present a language impairment limited to visually presented words (e.g., reading), but not to auditory presented stimuli, it can also be treated as an agnostic symptom. These patients may be able to spell words out loud and to write well, but fail in reading their own handwriting of the same words. Their reading is typically extremely slow and characterized by the processing of one letter at a time ('letter by letter reading'). This deficit has also been called ventral simultanagnosia, to indicate the failure in reading multiple letters simultaneously. It remains controversial whether this form of agnosia is limited to words or extends to other classes of visual objects. The lesion site in these patients is typically in the ventral occipitotemporal cortex.

Agnosia for Landmarks and Environment (Topographic Agnosia)

This type of agnosia refers to the inability to recognize familiar landmarks, scenes, and/or buildings, and can be differentiated from other disorders affecting spatial orientation. These patients, unsurprisingly, get easily lost and are unable to learn new routes, despite being able to read and draw maps, describe familiar routes, and provide directions. The lesions giving rise to topographical agnosia usually follow bilateral or right posterior artery infarction and may implicate the parahippocampal place area in the parahippocampal gyrus.

Anosognosia

'Is there anything wrong with you?' 'No, I am fine.' 'So why are you in the hospital?' 'I felt unwell.' 'Is there anything wrong

with your left arm or leg?’ ‘No, they are all right.’ This might seem a normal conversation between a doctor and a patient, but it has, in fact, an extraordinary feature which affects the significance of the patient’s answer: despite her claim, the patient was completely plegic on one side of the body. A stroke caused a permanent damage to the right side of the brain and the motor abilities reliant on the integrity of that hemisphere were impaired. As a consequence, the patient was not able to move the part of the body contralateral to the affected side of the brain. The striking thing was that the patient claimed that there was nothing wrong with her, and if she was asked more stringent questions about the affected limbs, she firmly denied her motor problem. This remarkable, well-known phenomenon, first described in scientific papers by Austrian, German, and Swiss neurologists at the turn of the nineteenth century, was named anosognosia in 1914 by the French neurologist Joseph Babinski. The term, derived from Greek, means ‘lack of knowledge for the illness,’ and since then it is used to indicate the behavior of patients who firmly deny their pathological conditions. Anosognosia can be observed in association with different brain diseases, ranging from denial of complex mental and neurodegenerative disorders, such as schizophrenia and Alzheimer disease, to the denial of more focal neurological and neuropsychological deficits such as motor, sensory, and cognitive disorders. Interestingly, patients affected by anosognosia can show different degrees of knowledge of their neurological deficits, ranging from a resolute denial of the disease, even when overtly faced with the negative consequences of their symptoms, to attenuated forms of awareness where the patients’ behavior suggests that some ‘dim knowledge’ of their status is present but not directly available for explicit report. Another important aspect of anosognosia, both theoretically and clinically, is its specificity. When a patient, following a brain damage, has many co-occurrent neurological impairments, the lack of knowledge is, in most cases, segregated to only one pathological domain. For instance, if a right hemisphere stroke has caused left hemiplegia, left hemianesthesia, and cognitive impairments, the lack of knowledge is often related to only one of these symptoms, with the patients denying a specific impairment, but admitting the others.

Selective-Specific Form of Anosognosia: The Case of Anosognosia for Hemiplegia

One of the most studied forms of impaired knowledge for the disease is anosognosia for hemiplegia (AHP) where, as indicated earlier, patients deny their contralesional motor problems. This disturbance is frequent after damage to the right hemisphere, with a prevalence ranging from 20% to 50% of hemiplegic patients, depending on the studies, the differences being related to the time of evaluation (acute vs. chronic phase of the illness) and selection criteria. We take this form of anosognosia as paradigmatic to indicate the selective and specific aspect of denial of illness. Other forms of anosognosia will be briefly discussed after the description of AHP. AHP patients, if inquired about their potential capability of performing actions either with the right or with the left hand, or even bimanual actions, claim that they can perform any kind of movement equally well. Patients’ false belief of still being able to move remains unchanged even when, having been

requested to actually perform different kinds of actions, sensory and visual evidence from the affected motionless side should suggest that no movement has been performed. To better grasp the manifold aspects of AHP, a collage of a conversation with a patient showing an intractable denial is reported subsequently. The patient typically suffered from a right hemisphere stroke and, as a consequence, she was left with contralesional complete hemiplegia. The patient was evaluated approximately 1 month after the brain infarct.

E: Where are we?
P: In the Hospital
E: Which hospital?
The patient answered correctly.
E: Why are you in the hospital?
P: Because I had a stroke.
E: What is a stroke?
P: I do not know.
E: How is your left arm?
P: Fine.
E: Can you move it?
P: Yes.
E: Would you be able to raise your left arm up in the air?
P: Yes, I would.
E: Would you be able to lift the telephone receiver with your left hand?
P: Yes, I would.
E: Would you be able to open a bottle, using both hands?
P: Yes, I would.
E: Would you be able to brush your hair handling the hairbrush with your left hand?
P: Yes, I would.
E: Would you be able to wash your face using both your hands?
P: Yes, I would.
(The patient was then asked to actually perform some movements.)
E: Could you touch my hand with your right hand?
P: (The patient does it without any problem.)
E: Could you touch my hand with your left hand?
P: (Although she seems to try the movements, she cannot raise the arm and reach the examiner’s hand. Nonetheless, after a while she says ‘Done.’)
E: Have you done it?
P: Yes, I think so.
E: Could you touch your left hand with your right hand?
P: (She does it without any problem, thus showing that she knows what and where is the left plegic limb).
E: Could you open this bottle for me, please?
P: (The patient attempts to do it using only the right hand.)
E: Can you manage?
P: No.
E: Why?
P: Because it does not open.
E: How do you open a bottle?
P: With one hand I hold the bottle, with the other I unscrew the cap.
E: Are you doing it?
P: Yes.
E: Can you put your left hand on your left shoulder?
P: Yes, I can.
E: Then please do it.
P: (the patient seems to try the movement: she also overtly looks at the left motionless arm and at the shoulder. After that, she looks at the examiner as if she had finished performing the requested action).
E: Have you done it?
P: Yes, I think so.
(The patient, on the wheelchair, is taken to the bathroom and placed in front of the basin.)
E: Could you wash your face using both hands, please?

P: (The patient takes the bottle of the liquid soap with the right hand and attempts to soap her left hand as if the left hand was actually over the basin, near the midline. However, the left hand was not there because it was lying on her lap. After having soaped the 'ghostly' hand, she started to move the right arm/hand forward and backward as if she was washing the two hands, one against the other. Finally, she washed the face using the right hand.)

E: Are you washing both your hands?

P: Yes, I am.

E: Are you washing your face?

P: Yes, I am.

E: With both hands?

P: Yes, I think so.

(Then the patient was asked to brush her hair handling the hairbrush with the left hand. The hairbrush was on the table and the left hand was lying motionless on the table as well. She took the hairbrush with the right hand and forced it below the left hand. While 'holding' the hairbrush with the left hand, she moved the head as if she was actually brushing the hair. After a while, she looked at the examiner and seemed satisfied with her performance.)

E: Have you done it?

P: Yes, I have, but only on the left side (!).

Possible Interpretation

Although anosognosia was first reported by neurologists who tried to interpret the impairment as a direct consequence of the brain damage, in the second half of the last century, one of the most accepted interpretations of anosognosia was based on a motivational account according to which denial was considered a defensive mechanism against the stress caused by the illness. This caused a lack of studies investigating the cognitive process affected in AHP, because the motivational interpretation considered the disorder not directly due to the brain lesion, and therefore as the direct effect of a damage to a specific cognitive system, but as the consequence of the activation of a normal psychodynamic reaction. At the end of the last century, however, this interpretation was questioned on the basis of many clinical observations which were not predicted by a pure motivational/psychodynamic account. As already mentioned, anosognosia is often selective in patients with multiple pathologies who may deny one deficit, but spontaneously report another. Also, the time course of AHP is at odds with the idea of a psychodynamic reaction. Indeed, anosognosia tends to ameliorate with time, and it is observed much more frequently in the first period after the stroke than during the chronic phase. A defense mechanism would, again, predict the opposite temporal pattern, insofar as time is needed for establishing a psychodynamic reaction. Interestingly, during the amytal testing (a diagnostic tool that, through a pharmacologic intervention – the injection in the brain circulation of a barbituric – produces a temporary functional suppression of the activity of one hemisphere, also causing a temporary hemiplegia contralateral to the injected hemisphere), anosognosia appears immediately after the amytal injection and mainly when it is the right hemisphere that is knocked down. Another striking, opposite effect of a physiological manipulation is seen when the injection of cold water into the left ear of the AHP patient provokes an instantaneous, although temporary, remission of the denial. This effect, triggered by a vestibular reflex, lasts a few minutes during which a left side nystagmus (left side reflexed ocular movement) is observed. In such cases,

the patients astonishingly admit their paralysis but again 'forget' it when the effect of the stimulation is over. Again, a psychodynamic reaction should not be influenced by a physiological manipulation. These and many other clinical and experimental data suggested that AHP might be better explained within a neuropsychological framework that would consider the denial not as a normal functional reaction triggered by the emotional strain, but as a specific cognitive deficit caused by the brain damage. New approaches to the interpretation of AHP explain the denial behavior by referring to a cognitive model of motor production and motor control. In these models, a comparator system has to match the congruity between the intended movement and the sensory consequences of the actually executed movement. When an intended movement is not performed, the comparator should detect the mismatch between the movement/no-movement conditions. Within this context, two different proposals have been put forward. According to some views, the comparator does not work because the patient, as a consequence of the brain damage, has lost the intention to move and therefore cannot discover that he/she is plegic. On the basis of anatomoclinical correlations, other views consider anosognosia as a failure of the comparator that, directly damaged by the brain lesion, does not detect the mismatch between a desired action and the actual status of the sensorimotor system (leading to altered motor awareness), in the face of an intact capacity of programming movements and forming sensorimotor predictions. This hypothesis would imply that the brain activity leading to the construction of a conscious intention of action is normal. Moreover, it can also explain the neural base of the 'false belief' of being still able to move. In this view, the false belief would not be a mere confabulation but would express the patient's feeling of action related to the 'normal' or quasinormal activation of the intention programming system. Although more studies are needed for verifying the 'motor' hypothesis of AHP, this approach to the study and interpretation of AHP was very innovative because, for the first time, anosognosia was not considered as a secondary disorder due to the presence of other neurological/neuropsychological symptoms, but instead a specific disorder of motor consciousness. The study of the anatomical localization of the lesion has shown that patients with AHP, compared to patients with hemiplegia without anosognosia, show damage in frontal premotor areas, suggesting that motor production and motor control share common anatomical substrates. These findings are directly relevant for models of motor control and, more generally, for accounts of consciousness. Indeed, the involvement of premotor areas in self-monitoring of action implies that, at least for motor functions, monitoring is neither the prerogative of some kind of central executive system, hierarchically superimposed on sensory-motor and cognitive functions, nor a function that is physiologically and anatomically separated from the primary process that has to be monitored. Instead, the anatomical correlates of anosognosia show that monitoring can be implemented in the same neural network responsible for the process that has to be controlled. It is worth noting that recently the idea that AHP might be somehow related to a motivational reaction has been again proposed on the evidence that anosognosic patients may show some sort of implicit knowledge of being plegic. This might imply that the anosognosic behavior is the result of a

repression mechanism. However, although the demonstration of an implicit knowledge is necessary for admitting a psychodynamic account of the disorders, its presence is not sufficient for establishing a direct causal relation. For instance, it is plausible that the impaired operation is not completely abolished but instead damaged to a degree that allows an implicit but not an explicit processing of the information that therefore would not reach a sufficient strength for an overt recognition of the disease. Although a motivated defense reaction may contribute to some cases of denial of illness and may shape the severity and the way in which anosognosia manifests itself, more research is needed to better understand the involvement of defense mechanisms in AHP and the possible interaction between motivational repression and conscious control of action.

Other Specific Forms of Anosognosia

As already pointed out, selective anosognosia can be observed for other neurological/ neuropsychological conditions that further suggest its specific and selective nature. Interestingly, many reports of selective forms of anosognosia also point to the possibility that the disturbance can be considered a modular deficit of a monitoring/controlling system. Constructional apraxia (CA), for example, is a disorder often associated with right brain damage in which drawing, copying, and block construction are severely impaired. This disorder can be conceived as the motor expression of a more pervasive disorder in combinatory and organizing activity, and it has recently been associated with damage to the dorsolateral prefrontal cortex, extending to subcortical structures like the putamen, the insula, and the caudate nucleus. Interestingly, when the patients are profoundly anosognosic (i.e., they are totally satisfied with their abnormal constructional performance), lesion in Area 44 is additionally found. Area 44 is one of the premotor areas which, as reported previously, is also affected in hemiplegic anosognosic patients. The anatomoclinical correlation between anosognosia for CA and premotor lesion has been taken as further evidence that in the motor domain, patients' unawareness for their motor impasse can be the consequence of inefficiency in comparing intended and anticipated action to real action execution due to a lesion of a motor-monitoring system implemented in the same area of motor programming. Conceptually analogous findings have been reported for unawareness of a different sensory disturbance. Cerebral acromatopsia is a rare disorder of color vision caused by bilateral damage to the occipitotemporal cortex. Patients affected by this disorder see the world in black and white and are usually aware of their visual deficit. However, a fascinating single case of acromatopsia showed that patients can be anosognosic even for this very specific form of visual impairment; despite verbal and nonverbal/perceptual testing clearly demonstrating the presence of severe color blindness, the patient claimed that his color vision was completely normal, denying any problems even when faced with his errors in naming colors. Moreover, color vision improved with time and a parallel improvement in awareness was observed. The simultaneous occurrence of acromatopsia and anosognosia, their parallel recovery, and the lesion site in visual areas suggest that both deficits were due to dysfunction of the same brain region, implying that normal perception and normal monitoring share common anatomical

substrates. In the sensory domain, anosognosia has been reported also for tactile anesthesia, and even in this domain, the unawareness of the disorder seems to be related to lesion intrinsic to somatosensory areas. The notion that the conscious perception of the presence or absence of a sensorimotor experience depends on the same system involved in the processing of the primary function giving rise to that experience, can be seen as evidence in favor of a modular structure of consciousness.

Anosognosia for More Generalized Cognitive Impairment

As mentioned earlier, unawareness of dysfunctions can be observed for more complex neurocognitive disorders such as those characterizing Alzheimer deficits or schizophrenic symptoms. In these multicomponential pathologies, is very hard to individuate a common core explaining the different denial behaviors. The fact that in many instances there is a severe intellectual impairment is of course a confounding factor. However, a shared feature in Anosognosia for Alzheimer (AA) and Anosognosia for Schizophrenic disorder (AS) is the damage to frontal lobe circuits. In AA, a significant association with brain areas, which are considered to be responsible for tracking the physiological state of the body (like the right hemisphere ventromedial prefrontal cortex) has been found. This would be generally consistent with the role of medial and orbital frontal structures in signaling the deviations from expected outcomes. In the case of AA, the deviation to be detected would be the divergence between one's own actual versus expected performance. This interpretation of AA prompts the idea of a comparator system whose dysfunction generates different degrees of unawareness for the patient's deficit. Therefore, similar to other more specific forms of anosognosia, AA might seem to be the result of the incapability of detecting a mismatch between a desired state and the actual status of the system. Other interpretations of AA point to the possibility that memory or executive dysfunctions, typical of this disease, may affect the immediate ability to update and judge cognitive performance in a domain-specific manner. Also, this interpretation seems to explain the possible different forms of anosognosia observed in Alzheimer disease as a result of an intramodular impairment.

As for schizophrenia, the presence of anosognosia is frequently associated with bilateral volume reduction in different areas of the frontal lobes. Awareness in these patients can be fractionated in awareness of illness and awareness of cognitive impairments and functioning, and some studies have shown that awareness of schizophrenic symptoms can be relatively poor while insight into cognitive deficits can be better or even preserved. It is interesting to note that memory functioning is a strong predictor of awareness of memory deficits in schizophrenic patients and that worse memory is associated with overestimation of function. This seems to be again consistent with the neuropsychological findings such as those discussed earlier that cortical systems underpinning awareness of a deficit are related and anatomically close to those underpinning the function whose deficit is studied. Whatever explanation will turn out to be true for explaining denial of illness, we would like to conclude this section with a quotation from George Prigatano: "Understanding the biological and neuropsychological mechanisms responsible for anosognosia in its various forms may reveal important insights into brain

organization and how human consciousness (subjective awareness of the self and the environment) is possible. The comparative study of anosognosia in patients with identifiable brain disorders in comparison to patients with psychiatric disorders may provide rich insight into the body-mind problem."

See also: Aphasia; Sleep, Biological Rhythms, and Performance.

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Agoraphobia and Panic Disorder

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Glossary

Cognitive therapy A system of psychotherapy focused upon identifying and restructuring dysfunctional thoughts and schemas linked to psychopathology.

Exposure in vivo The structured treatment of anxiety disorders by systematic confrontation of feared external situations to reduce avoidance behavior and anxiety.

Exposure to somatic cues Extends the methods of exposure in vivo to those internal cues and bodily sensations associated with panic attacks.

Limited symptom attack An anxiety episode with a few subjective anxiety symptoms, insufficient in number to qualify as a panic attack.

Panic attack A discrete period of intense fear, not explained by a continuing organic factor, that arises rapidly with at least 4 anxiety symptoms from a 13-item list specified in the DSM-IV-TR.

Agoraphobia and panic disorder are anxiety disorders that are formally classified into three overlapping syndromes in the current psychiatric taxonomy: panic disorder without agoraphobia, panic disorder with agoraphobia, and agoraphobia without history of panic disorder.

Agoraphobia is characterized by marked fear of entering crowded, public places; of traveling away from home, especially by public transportation; of feeling trapped or confined; and of being separated from a place or person associated with safety. Sudden, brief episodes of extreme anxiety – panic attacks – are commonly associated with agoraphobia and may lead to avoidance of situations in which they occur. Often there is a ‘fear of fear’ pattern, in which the bodily sensations of mounting panic are themselves a source of anxiety. Generally more debilitating than specific or social phobias, agoraphobia causes some people to remain entirely housebound. As a syndrome of anxiety elements in physiological, behavioral, and subjective domains, agoraphobia represents a distinct disorder with a typical clinical presentation and course.

Panic disorder has been formally recognized since 1980 as an anxiety syndrome marked either by repeated, unexpected panic attacks that are associated with distress and behavioral impairment or by significant apprehension about having future panic attacks.

Since the 1970s, clinical researchers have developed effective pharmacological and psychological treatments to reduce or eliminate agoraphobic avoidance behavior and panic attacks.

Agoraphobia and Panic: Past and Present

The term agoraphobia was introduced by the German psychiatrist C.F.O. Westphal (1822–1890) in a classic monograph of 1871, *Die Agoraphobie*. The term derives from the Greek *agora*, referring to a marketplace or place of assembly. Westphal described the abnormal fears of a series of three men who experienced anxiety episodes when walking alone in public places. Feared situations included city squares, concert halls, churches, open streets and fields, crowded rooms, and traveling by carriage, bus, or train; typical anxiety symptoms were

trembling, heart palpitations, and ‘an immediate breakout of intense anxiety.’

The development of behavior therapy in the 1950s by Joseph Wolpe and others was closely connected with the study of phobias and other anxiety disorders. Interest in agoraphobia revived with American and British research on systematic desensitization and related methods in the 1960s, and with the publication of Isaac Marks’ *Fears and Phobias* in 1969. Systematic desensitization produced disappointing outcomes with agoraphobia, but treatment based on exposure to relevant situations was successful in reducing avoidance behavior and anticipatory anxiety.

Progress in psychological and pharmacological treatment of agoraphobia in the 1970s influenced the diagnostic classification itself in the United States, so that in 1980, agoraphobia appeared for the first time as a distinct category. Further developments gave prominence to the panic attack as the central feature of agoraphobia in panic disorder with agoraphobia; panic disorder without agoraphobia was the parallel syndrome not marked by phobic avoidance of situations.

In recent years, psychological treatment of the agoraphobia and panic disorder syndromes has focused on therapeutic exposure to panic sensations, on encouraging patients to make more realistic and benign ascriptions as to the source of their anxiety, and on helping them to question their essential premise that thoughts or concerns about emotional distress must necessarily engage one’s attention and activate affective arousal. Exposure to somatic cues, breathing retraining, systematic confrontation of feared external situations, and cognitive therapy have become the leading psychological interventions.

Descriptive Psychopathology, Diagnosis, and Epidemiology

Description of Agoraphobia

People with agoraphobia usually fear, and often avoid, situations in which it would be difficult or embarrassing to obtain help if overwhelmed by anxiety. Such situations include (1) traveling away from home, especially by bus, train, or car;

(2) crowded, public places, such as government buildings, supermarkets, concert halls, shopping malls, and places of worship; and (3) confined places, such as elevators, the dentist's or beautician's chair, and – when driving – passing through tunnels, over bridges, or along a limited-access highway. Agoraphobia is commonly associated with panic attacks that often arise in the situations typically feared and avoided. Some people with agoraphobia restrict their lives substantially, sometimes to the point of remaining housebound, to avoid the anxiety or panic aroused by entering public places.

Dysphoric mood, somatoform disorders, interpersonal conflict, or substance abuse may accompany agoraphobia. Untreated, agoraphobia tends to follow a chronic, fluctuating course. It is common for people with agoraphobia to experience daily variations in anxiety severity. For some, there may be weeks or months of near-normal functioning followed by a resurgence of the original symptoms. For others, gradual improvement leading to complete recovery may occur without professional intervention, but this is not typical.

Description of Panic Attacks

Panic attacks are recurrent, distinct episodes of extreme anxiety or distress, not explained by the presence of a continuing organic factor. Panic attacks include at least 4 of a 13-item list of typical anxiety symptoms, which are initially unexpected and not produced in response to stimuli associated with specific or social phobias. (Panic attacks are categorized as unexpected or uncued, situationally bound or cued, or situationally predisposed; only unexpected panic attacks are used in the diagnosis of panic disorder.) Because individuals who have unexpected panic attacks may also report situational attacks, clinicians are careful to discern the focus of anxiety – the panic attack itself or concerns about becoming embarrassed.

The list of typical symptoms in a panic attack includes shortness of breath, dizziness, heart palpitations or rapid heart rate, trembling or shaking, sweating, the sensation of choking, depersonalization or derealization, and fear of dying, losing control, or developing an acute mental illness. The anxiety symptoms in a panic attack arise suddenly and rapidly increase in intensity. An organic factor may have been influential in early panic attacks (e.g., the patient may have experienced dizziness as a result of a viral infection of the vestibular system, or depersonalization following ingestion of an illicit drug) but, by definition, the attacks will have continued despite successful treatment or removal of the initiating organic factor.

Diagnostic Classification: Historical Context

Before 1980, neither agoraphobia nor panic disorder was listed as a distinct disorder in the DSM classification. Agoraphobia could be found among lists of the Greek names for specific phobias in textbooks on psychiatry and abnormal psychology. It is now clear that agoraphobia is in no sense a specific phobia – its prevalence, its resistance to treatment by systematic desensitization, its distressing and disabling consequences, and the broad range and severity of its symptoms – most often including panic attacks – all clearly set it apart from such focal fears as phobias of heights, snakes, blood, or the number 13.

Patients with agoraphobia show various specific patterns of avoidance, and there is no standard list of situations that must be feared for the diagnostic criteria to be met. The current view is that what is chiefly feared in agoraphobia is the absence of safety signals, not the presence of disturbing objects. Most recently, the DSM-IV-TR has cited as a central feature of panic disorder with agoraphobia fear of situations from which it would be difficult to escape, or in which help may be unavailable, in the event of a panic attack, leading to avoidance or marked distress. Alternatively, in agoraphobia without history of panic disorder, patients fear limited symptom attacks or circumscribed anxiety episodes.

Anxiety restricted to social situations in which the person fears embarrassment or humiliation under the evaluative scrutiny of others is better construed as social phobia.

The DSM-IV-TR Classification

Agoraphobia appears twice in the DSM-IV-TR, as panic disorder with agoraphobia and as agoraphobia without history of panic disorder. Similarly, panic disorder appears twice, the second panic syndrome being panic disorder without agoraphobia. All three syndromes are listed as anxiety disorders. The DSM-IV-TR lists separate criteria sets, not diagnostic categories in themselves, for panic attack and for agoraphobia.

Panic disorder with agoraphobia

The essential elements of this diagnosis are the presence of panic attacks and agoraphobia, as defined in the criteria sets.

Agoraphobia without history of panic disorder

A person with this disorder has never had problems that meet criteria for panic disorder. Instead, he or she fears, and may avoid, situations in which it would be difficult or embarrassing to leave in the event of the sudden onset of anxiety, which may represent a 'limited symptom attack' that would not include the range of symptoms associated with a panic attack.

Panic disorder without agoraphobia

Patterns meeting criteria for panic disorder but not agoraphobia are classified as panic disorder without agoraphobia.

Epidemiology

Appropriate methodology requires assessing the prevalence and correlates of the syndromes in the general community as well as in clinic samples (which tend to be unrepresentative). Because of changes in the taxonomy, allowance has to be made for the different terms and criteria in studies conducted in different decades. The most informative studies use accurate community survey techniques.

In community studies, about half of the respondents with agoraphobia are also classified as having panic disorder. In clinical samples of agoraphobia, as many as 95% have the combined syndrome panic disorder with agoraphobia. In the Epidemiological Catchment Area study reported in the 1980s, the ratio of women to men with agoraphobia was 2.7:1.

Estimates of the prevalence of agoraphobia have been consistent across countries and cultures in studies using the same instrument and careful sampling procedures, but more recent

studies give lower prevalence estimates. The lifetime prevalence of agoraphobia, with or without panic, was cited as about 5% in the late 1980s and as about 2.5% in the 1990s.

Agoraphobia is associated with more severe impairment than other phobias and is strongly associated with dysphoric mood. Comorbidity rates for major depressive disorder in patients with a panic disorder syndrome range from 10% to 65%, and in about a third of the cases, depression precedes the development of panic attacks. In the other two-thirds of cases, major depressive disorder occurs concurrently with or subsequent to the development of panic disorder.

In the agoraphobia syndromes substance abuse, hypochondriasis, somatization disorder, and personality disorders are often present. The usual course is chronic. The age at onset in agoraphobia varies but is usually in the 20s or 30s with a mean of about 28 years. There is no general agreement on an association between agoraphobia and specific childhood experiences. Maternal overprotection has been studied, but findings are mixed.

Lifetime prevalence estimates for panic disorder increased from 3.5% in the mid-1990s to about 4.7% in 2005. The rate for panic disorder without agoraphobia is cited in the National Comorbidity Survey Replication as 3.7%, and for panic disorder with agoraphobia as 1.1%. The lifetime prevalence rates for isolated panic attacks without agoraphobia are much higher at 28%.

The typical age of patients at the onset of panic disorder is 24 years. Women are 3 times more likely to be diagnosed with panic disorder with agoraphobia than men, and twice as likely with panic disorder without agoraphobia. Although few theories or models address gender issues, recent research has focused on gender-specific stressors (e.g., premenstrual distress, sexist events) for women that may account for more severe symptoms.

The estimated morbidity risk of anxiety disorders in the first-degree relatives of patients with agoraphobia is 32%. Concordance rates for either of the panic syndromes are significantly higher in monozygotic than in dizygotic twins; a Norwegian study showed 31% concordance in 32 monozygotic twins but 0% in 53 dizygotic twins. Such results have been taken to indicate some genetic predisposition for agoraphobia and panic disorder.

Theories of Etiology and Maintenance

Biological Theories

The observations that anxiety syndromes run in families and that pharmacological treatment can be helpful have led to considerable interest in possible biological mechanisms – though it has to be noted that successful pharmacotherapy would not logically confirm a biological etiology. Attention has been paid to the heritability of agoraphobia and to possible physical vulnerability factors.

A predisposition toward agoraphobia and panic may be inherited, but it is not possible to predict who will develop a disorder even among people with a number of close relatives with agoraphobia or panic syndromes. Those syndromes probably conform to a diathesis–stress model in which an inherited vulnerability is necessary, but not sufficient, for the eventual

appearance of a disorder, which would require the additional operation of certain environmental factors.

Physiological variables distinguishing agoraphobia from normal functioning, and from less pervasive anxiety disorders like specific phobia, include resting heart rate and forearm blood flow (both higher in agoraphobia) and skin conductance (higher and more variable in agoraphobia). However, such findings have not produced clear conclusions with implications for etiology or treatment.

Inherited vulnerability factors include personality traits such as neuroticism, which is thought to result from lability of the limbic system, of the autonomic nervous system, or of specific neurotransmitter processes. One study showed that rats bred for emotionality had more brain benzodiazepine receptors than rats bred normally. Malcolm Lader noted that many of the data on panic may be explained by an instability or hypersensitivity of central noradrenergic mechanisms centering on locus coeruleus function. Yet, few definite conclusions may be drawn from the many physiological and endocrine studies. The best-supported generalization is that patients with agoraphobia and related anxiety disorders have chronically overaroused central nervous systems and are slow to habituate to noxious stimuli.

Several physiological processes and physical disorders produce symptoms like those of panic, arousing interest in possible mechanisms for the disorders. These include hyperventilation, asthma, limbic seizures, abnormal thyroid function, heart disease, hypoglycemia, and mitral valve prolapse. Of interest has been the provocation of panic by sodium lactate infusions; people with a history of panic disorder, but not those without prior experience of panic, tend to react to the infusion with panic. Furthermore, pharmacological treatment by means of imipramine can abolish the lactate provocation of panic. Although such observations may appear to confirm a biological basis for panic disorder, the mechanism is a subtle one that interacts with environmental and cognitive factors, given that the lactate provocation of panic can also be blocked by psychological treatment.

Other biological challenges that typically produce panic-like symptoms include the inhalation of air containing greater than normal proportions of carbon dioxide. Recent research indicates that healthy women during the premenstrual phase are more likely to report panic-like symptoms in reaction to a CO₂ challenge than healthy women in the follicular phase.

No particular biological variant explains all of the features of agoraphobia. An inherited predisposition probably interacts with behavioral and cognitive mechanisms to produce panic and agoraphobic syndromes. David Barlow has pointed out that “The fact that language and meaning structures are the most common stimuli for anxiety in humans requires a complex neurobiological system.”

Social, Interpersonal, and Personality Factors

From a psychodynamic viewpoint, patients’ inner representations of other people are especially relevant to agoraphobia. Disturbed ‘object relations’ make the person vulnerable to insecurity and anxiety.

From an experimental perspective, Susan Mineka and others have shown that in humans and animals, early separation from parents can be linked to agoraphobia-like behavior.

An integrative theory put forward by Alan Goldstein and Dianne Chambless in 1978 sought to explain many of the phenomena of agoraphobia and panic, including typical personality factors and interpersonal styles. Goldstein and Chambless argued that the person with agoraphobia (1) fears panic attacks rather than particular places; (2) has difficulties with self-sufficiency, independence, and assertiveness; (3) is unable to trace the antecedents of emotional feelings when they arise; and (4) develops the initial symptoms of agoraphobia in a climate of interpersonal conflict. The interaction of these factors produces agoraphobia. This theory is consistent with the observations that some agoraphobia clients have assertiveness difficulties and troubled marital relationships. It also gave prominence to panic attacks in what was termed the complex agoraphobia syndrome.

Similar points have been made recently by Steven Hayes and others in the context of developing acceptance and commitment therapy (ACT), which recasts older conditioning terminology, such as stimulus generalization, into the language of stimulus equivalence and the verbal classes to which anxiety-relevant situations belong. Hayes illustrated this by describing a client with agoraphobia who had initially felt trapped at a checkout counter at the mall, and later started to worry about being trapped in an unsatisfactory marriage and an unfulfilling job. Hayes cited evidence that clients who were especially likely to avoid rather than confront challenging situations developed additional anxiety symptoms later. Behavioral avoidance and attempts to suppress dysphoric private experiences led to increased, not decreased, distress.

Behavioral and Cognitive Theories

Conditioning theories

Early behavioral theories of the etiology of agoraphobia called attention to classical conditioning as a possible mechanism, and treatments designed to replicate extinction procedures have been notably successful. Exposure in vivo, in which one learns to confront agoraphobic situations without leaving at the onset of anxiety, helps patients overcome a pattern of avoidance of situations and can attenuate panic attacks. However, the success of such treatments cannot confirm that conditioning experiences cause agoraphobia.

Panic attacks could result at least partly from conditioning processes. A panic attack may be viewed as the result of a vicious circle or upward spiral in which, at each point, internal stimuli associated with anxiety, such as those produced by increases in heart rate, elicit conditioned anxiety responses themselves in a process known as interoceptive conditioning. It follows from this view that it will be helpful therapeutically for the patient to confront anxiety sensations specifically rather than simply the external situations in which they arise. The exposure principle predicts that systematic confrontation of sensations such as breathlessness will ultimately diminish their power to evoke anxiety.

If any arousal of anxiety leads inexorably to a vicious circle that culminates in a panic attack, then people with panic disorder would never experience limited episodes of mild or moderate anxiety. However, it is usual for panic disorder patients to display moderate levels of generalized anxiety between their panic attacks. Unadorned conditioning theories

do not easily explain why mild anxiety does not always escalate into panic attacks. The cognitive therapy approach attempts to address this problem.

Cognitive theories

Aaron Beck's cognitive therapy rests upon theoretical assumptions that center upon the individual's appraisal of events. Such appraisals range from fleeting automatic thoughts in the form of accessible, though covert, verbalizations (e.g., "Oh, no. I knew I'd get anxious if I came to the mall, and I feel slightly dizzy already!") to deeper and more enduring cognitive schemas, not necessarily verbalized, reflecting a more fundamental attitude (e.g., strange feelings could indicate an impending medical crisis).

Central to the application of cognitive therapy to panic attacks is the patient's appraisal of the bodily sensations or somatic cues connected with mounting anxiety. David Clark has argued that people with panic disorder have developed cognitive schemas concerning vulnerability to medical catastrophes, and he and others have demonstrated that people with panic disorder show cognitive biases in that direction. This model complements the conditioning of somatic cues model by indicating who is vulnerable to panic and why not all anxiety episodes culminate in panic. Variations in cognitive appraisals between and within individuals may account for the unpredictability of panic attacks. In Clark's model, patients make catastrophic misinterpretations of bodily sensations related to anxiety, viewing them as signals of a medical disaster such as a heart attack. The misinterpretation itself arouses increased anxiety, and the vicious circle continues when further alarming appraisals are made.

One of our clients associated a sense of warmth, especially in her face, with the onset of a panic attack. On entering an overheated consulting room she said: "Oh no! Is it hot in here?" When the therapist remarked that it was, stiflingly so, the client was relieved. She said: "Thank goodness! I thought I was having a panic attack!" The therapist reflected that simply stating that the room was hot was enough to forestall a panic attack for this client, which led immediately into a fruitful discussion of the rationale for cognitive therapy.

Experimentation in the tradition of cognitive psychology has produced intriguing findings about the attentional and interpretive biases that are associated with, and may play a role in maintaining, anxiety syndromes. Two experimental procedures in which potentially disturbing words, such as 'choking' or 'fainting,' are presented to research participants on computer screens – the emotional Stroop task and the dot-probe task have been used most frequently to assess visual attentional biases toward threatening information. The Stroop task calls for naming the color in which a word is printed, and the dot-probe task calls for signaling when a symbol on the screen replaces a significant word; delays in color naming, and rapid responses to a probe, indicate that the word is emotionally poignant for the respondent. Studies employing these two tasks provide evidence that individuals with panic disorder exhibit selective attentional biases for panic-relevant stimuli. Research has demonstrated that individuals with panic disorder have a tendency to interpret ambiguous bodily sensations and external (environmental) stimuli as threatening. Similarly, they tend to overestimate aversive consequences following

panic-relevant stimuli; that is, they exhibit a covariation bias. Furthermore, individuals with panic disorder tend to remember panic-related situations and panic-related words especially well compared to healthy controls.

It is important to note, however, that most studies have relied solely on self-report, and the findings, thus, are vulnerable to experimental demand and response bias. To overcome these limitations, researchers have recently started to employ online, indirect indicators of cognitive biases. One study, for example, used the contingent negative variation (CNV), a neurophysiological measure of expectancy, to examine covariation bias in panic disorder. The late CNV component was higher for panic-relevant pictures compared to both phobic-relevant (but panic-irrelevant) and neutral pictures in individuals with panic disorder; this, however, was not the case in healthy controls. A recent functional magnetic resonance imaging (fMRI) study replicated previous findings that individuals with panic disorder exhibit longer latencies to name the color of panic-related words. More importantly, this study demonstrated that the latency to color name panic-related words correlated with increased activation of the right amygdala, hippocampus, and prefrontal areas. Thus, neuropsychological evidence seems to corroborate the self-report findings that individuals with panic disorder tend to engage in biased processing of panic-relevant stimuli.

A comprehensive model

David Barlow's comprehensive theory suggests that panic results from activation of an ancient alarm system, and represents the basic emotion of fear, while anxiety is a more general cognitive-affective structure. Panic occurs in response to true alarms (panic attacks elicited by genuine danger), false alarms (panic attacks in the absence of objective danger that result from a genetically determined predisposition in interaction with an accumulation of general stress), and learned alarms (panic attacks that are triggered by external or internal cues). False and learned alarms are relevant to the panic and agoraphobia syndromes. Anxious apprehension also plays a part; a cognitive schema containing propositions concerning anxiety elicits negative affect when triggered, resulting in directing attention to internal self-evaluations, increased arousal, narrowing of attention, and hypervigilance concerning sources of apprehension.

Barlow's model of agoraphobia is his model of panic disorder with the addition of the development of agoraphobic avoidance. Biological vulnerability interacts with objective stress to produce an initial uncued panic attack, or false alarm. The connection of the panic attack with interoceptive cues leads to the development of cued learned alarms. As a result, there is a psychological vulnerability characterized by anxious apprehension about future panic attacks. Next, panic attacks are triggered unpredictably by a combination of autonomic and cognitive symptoms of anxiety with additional somatic cues. Avoidance behavior may develop, giving rise to the panic disorder with agoraphobia syndrome.

Clinical Assessment

In assessing clients with the agoraphobia and panic syndromes, the first step involves establishing the appropriate

diagnosis. Second, identifying the specifics of a patient's levels of distress and impairment allows development of an individualized treatment plan. Third, evaluating concomitant problems permits employment of adjunct treatments or influences the sequence in which treatments are provided. Fourth, monitoring the patient's progress throughout the course of therapy is essential in determining response to treatment and alerting the clinician to needed procedural changes.

Diagnosis

People with agoraphobia and panic disorder syndromes may self-refer for treatment, having made a self-diagnosis after reading a magazine article or viewing a television presentation. Patients may be referred to a mental health professional by emergency room staff after one or more visits for urgent treatment during panic attacks. Because many people with agoraphobia are either entirely housebound or have a limited range of travel, clinicians working with this disorder become accustomed to making home visits, at least in the early stages of assessment and treatment.

Because there are several physical conditions that give rise to symptoms like those of agoraphobia and panic, it is important that patients receive a physical examination before mental health interventions begin. If anxiety persists despite successful treatment of a precipitating or complicating physical condition, then treatment of the anxiety disorder proceeds.

Assessment is needed to identify comorbid psychiatric disorders. Also relevant for assessment are issues like marital conflict, social skills deficits, and difficulty with personal autonomy that may not require a formal diagnosis but may yet be important foci for intervention. Not all people who experience anxiety when in public places or who have had panic attacks show patterns that meet diagnostic criteria for agoraphobia or panic syndromes.

Assessing the Range and Extent of Anxiety and Avoidance Behavior

Simply applying the appropriate diagnostic label is insufficient to guide treatment. The clinician seeks to know the patient as a unique individual, and accordingly conducts the usual psychosocial history and mental status examination. Beyond that, the nature and extent of the anxiety problems will need to be charted in sufficient detail to allow formulation of an appropriate individual treatment plan and continued evaluation of progress toward treatment goals.

Developed by David Barlow and his colleagues, the Anxiety Disorders Interview Schedule-IV (ADIS-IV) allows detailed and accurate characterization of the person's anxiety problems and permits authoritative diagnosis in DSM-IV-TR terms. The instrument is primarily employed in research trials to ensure uniformity of diagnostic practices. Although the complete protocol is too lengthy for routine clinical use, subsets of the ADIS-IV may be used appropriately and conveniently in most clinical settings.

Clients are asked to self-monitor general anxiety, panic attacks, and agoraphobic avoidance daily. Individualized forms may be used so that details of the specifics of the patient's situation may be accommodated. For example, daily ratings

may be made of avoidance of, fear in, and self-efficacy concerning each item in a customized graded hierarchy of feared situations. Daily ratings of the frequency and intensity of panic attacks allow the patient to record the circumstances surrounding each episode – situational, cognitive, and interpersonal.

A hierarchically ordered behavioral test may be designed for patients with agoraphobic avoidance patterns. This takes the form of an unaccompanied journey – walking, driving, or using public transportation – to take in as many situations relevant to the patient's fear and avoidance as is feasible. The clinician asks the patient to proceed as far as possible, and takes the distance actually traveled as a helpful datum in sampling current levels of agoraphobic avoidance.

Physiological monitoring has been a customary component of research trials designed to provide generalizable information on treatment effectiveness, but is far less common in routine clinical practice. Typically, measures of anxiety in the different domains – self-report, behavioral observation, and psychophysiological – do not covary as might be predicted. When all such measures are available, it is recommended that treatment proceed until clear reductions have been seen in each measurement modality.

Treatment

Pharmacological Treatment

Pharmacological treatment has several advantages for the patient, and significant progress has been made in this area since 1970, improving the general outlook for agoraphobia and panic disorder. Medication is readily available and convenient to use. However, concerns arise from medication side effects, from high relapse rates when the medication regimen is discontinued, and – in the case of minor tranquilizers – from the possibility of substance dependence.

Antidepressants

Medications initially developed to treat depression can also be helpful in the management of anxiety disorders. The term antidepressants may be misleading in this context because there is controversy about their role in treating agoraphobia and panic syndromes (do they attenuate dysphoric mood, facilitating other treatments, or do they act specifically to block panic attacks?).

Antidepressants often used to treat panic disorder include selective serotonin reuptake inhibitors such as fluoxetine (Prozac), sertraline (Zoloft), escitalopram (Lexapro), and citalopram (Celexa). Tricyclic antidepressants such as imipramine (Tofranil) continue to be helpful. Early studies showed that imipramine reduced panic attacks, but patients continued to avoid agoraphobic situations. Later studies demonstrated imipramine's superiority to placebo medication and indicated that it brought additional benefit when added to behavioral treatment. However, this was not attributable to the blockade of panic. When imipramine is used in conjunction with the antitherapeutic recommendation to avoid confronting feared situations, improvement in mood, but not in agoraphobia, is the result. Imipramine plus exposure therapy seems more effective than either treatment alone. Inconsistencies in

research findings with imipramine may result from marked differences in dosage across studies.

Monoamine oxidase inhibitors such as phenelzine (Nardil) are also used. Whereas some studies have shown little if any difference between phenelzine and placebo in application to agoraphobia, another has shown that phenelzine reduces general disability and avoidance behavior. In that study, phenelzine was more effective than imipramine. For reasons that are unclear, phenelzine appears to potentiate self-initiated exposure.

Benzodiazepines

The benzodiazepines are minor tranquilizers that have been extensively prescribed for various forms of anxiety and stress reactions, clinical and subclinical, for decades. Donald Klein's initial work on imipramine had suggested that it is specific for blocking panic, whereas the benzodiazepines are effective only with generalized or anticipatory anxiety. Later work suggests that high doses of benzodiazepines may be effective in treating panic attacks. The development of high-potency benzodiazepines like alprazolam (Xanax) and lorazepam (Ativan) has brought clear benefit in the treatment of agoraphobia and panic. Alprazolam has been the subject of a multicenter worldwide double-blind study of people with panic disorder (with and without agoraphobia). Fifty percent of the alprazolam patients and 30% of placebo patients were panic-free 3 weeks after the start of the trial.

Strong withdrawal reactions after discontinuance of alprazolam pose a significant problem, as does the phenomenon of rebound panic in which a minority of patients may experience even worse panic attacks after withdrawal from medication than before treatment.

Summary

Antidepressants and benzodiazepines are helpful in the treatment of agoraphobia and panic. Concerns include side effects, rebound panic after withdrawal from the drug, and chemical dependency. Since the late 1990s, the selective serotonin reuptake inhibitors and other new medications have been widely prescribed for people with agoraphobia, and there is a ferment of pharmacological research activity. The mechanisms underlying successful pharmacological treatment are unclear.

Psychological Treatment

Psychodynamic approaches to agoraphobia and panic have received far less attention than biological, behavioral, and cognitive approaches in recent decades, and there is no corpus of empirical research on psychodynamic formulations of etiology or on the results of psychodynamic treatment. Behavior therapists have progressed from desensitizing anxiety to treating avoidance behavior and panic attacks.

Treatment of agoraphobic avoidance behavior

Despite initial enthusiasm for Joseph Wolpe's technique of systematic desensitization as a therapeutic breakthrough for phobias, its application to agoraphobia in controlled clinical trials in the 1960s brought disappointing results. Developments in the 1970s established flooding in fantasy and graded practice in real life as effective treatments. Researchers in

Vermont led by Stewart Agras and Harold Leitenberg showed that graded practice – with or without praise for specific accomplishments – could quickly reduce agoraphobic patients' avoidance of unaccompanied journeys away from the clinic. This work converged with that of Isaac Marks, Andrew Mathews, and others in the United Kingdom to identify exposure in vivo as the central ingredient of psychological treatment for agoraphobic avoidance.

Procedural variations such as brief or prolonged exposure duration, massing or spacing of treatment sessions, and terminating exposure at the point of increasing or decreasing anxiety were examined assiduously by clinical researchers, but the consensus is that these technical details are less important than the general recommendation to confront, rather than avoid, feared situations. This exposure principle is as well founded as any in the entire field of mental health work.

Treatment of panic

The essential technique in the psychological treatment of panic is exposure to somatic cues, or reproduction of and confrontation by the bodily symptoms that the patient associates with panic attacks. The patient is asked to create sensations of panic deliberately during and between treatment sessions. Running in place, voluntary hyperventilation, and spinning around in a swivel chair are examples of procedures for creating such sensations. Clinicians match particular procedures to patients' most troublesome symptoms; someone who is most alarmed by dizziness will practice spinning around, while someone disturbed by the sensations of a rapid heart rate will run up and down the stairs.

In early trials, this approach brought the most impressive results yet seen in the treatment of panic and agoraphobia, the success rates approaching 100% in some studies. Advances in methodology that have allowed the daily monitoring of panic attacks have permitted accurate tracking of panic attack frequency. 'Percentage of patients panic free' has become a standard datum to report in contemporary treatment trials.

The efficacy of exposure to somatic cues has been attributed to various theoretical processes. These include the exposure principle, possibly resting upon the extinction or habituation of conditioned anxiety responses to panic sensations, or upon the development of coping skills by the patient. The success of the method is consistent with the specific hypothesis that chronic hyperventilation underlies panic disorder. It is also consistent with the cognitive therapy view that the patient makes catastrophic misinterpretations of the bodily sensations of panic, ascribing to them morbid significance as harbingers of a medical emergency.

Parallel to exposure to somatic cues is cognitive therapy in the contemporary treatment approach to panic. Consistent with David Clark's model of an interaction of sensitivity to somatic cues and the catastrophic misinterpretation thereof, patients are engaged in a cognitive treatment process of collaborative empiricism in which implicit schemas construing panic sensations as signals of dire illness are carefully assessed, gently challenged, and empirically tested. Cognitive therapy involves exploring, in a sympathetic and accepting way, the specific idiosyncratic cognitions that are assumed to underlie emotional distress. Real-life 'experiments' are undertaken in attempting to challenge unrealistic assumptions. There is no standard,

structured format that must be applied systematically to all patients; rather, the principles of cognitive therapy guide a creative treatment approach with each individual. The results of preliminary trials of cognitive therapy have been as encouraging as those of exposure to somatic cues, and the combination of these treatments has brought the best outcomes.

Guidelines by the National Institute for Health and Clinical Excellence in the United Kingdom state that cognitive-behavior therapy is now accepted as, and should be employed as, the treatment of choice for panic disorder. Structured treatment protocols for the comprehensive treatment of anxiety and panic have been developed and researched by Michelle Craske and David Barlow. Therapist guides and client workbooks are available.

Comprehensive treatment of agoraphobia

In addition to the central psychological treatment approaches of exposure in vivo, exposure to somatic cues, and cognitive therapy, relaxation training, and breathing retraining have been found helpful in the treatment of agoraphobia and are recommended as optional components of a treatment plan. There is a consensus that in the typical case of panic disorder with agoraphobia, treatment should proceed employing all of these techniques in sequence, beginning with self-paced exposure in vivo. Experts argue that, because it is not associated with deleterious side effects or complications from withdrawal, psychological treatment should be used first, and pharmacological treatment brought in as necessary subsequently.

Alternatively, using short-acting anxiolytic medication to help patients with severe agoraphobia embark upon an in vivo exposure venture, and then prolonging the exposure while the effects of the medication wane, has been validated in controlled studies by Marks and his associates as an ideal method for combining the advantages of both treatments rationally in a carefully structured treatment program.

Conclusions and Prospects

Although agoraphobia is fragmented by the current nomenclature into two distinct disorders, it is a coherent syndrome with a range of symptomatology extending far beyond the limited compass of specific phobias. Panic disorder, which overlaps with agoraphobia in one of the syndromes, is associated with a degree of distress similar to that seen in the mood disorders. Agoraphobia and panic disorder have yielded in recent years to effective pharmacological, behavioral, and cognitive treatments.

Currently in need of further attention by clinicians and researchers are the following. Whereas pharmacological treatment is readily available, it is difficult for many patients to gain access to specialized psychological treatment, especially in rural areas. Innovations in service delivery are needed, and studies should address the viability of psychological treatment of agoraphobia from remote sites by means of the latest communications technology. Many communities are underserved by mental health professionals, and individuals who are housebound by agoraphobia have even greater difficulties than most people in gaining access to needed psychological services. Encouraging developments in this context include the recent finding in the United Kingdom that brief training for

primary care therapists in cognitive therapy for panic disorder produced significantly better outcomes than treatment as usual. Self-directed treatment with limited therapist contact has been shown to be effective for clients in rural areas with sparse professional resources.

See also: Anxiety and Fear; Anxiety Disorders; Clinical Assessment; Cognitive Behavior Therapy; Depression; Phobias.

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Agraphia and Alexia

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Glossary

Cognitive architecture The component processes and their interconnections that make up a more complex mechanism involved in a task like reading single words aloud or writing words to dictation.

Grapheme The smallest combination of letters associated with an elementary sound unit. Graphemes can be as small as a single letter. For example, the letter P corresponds to the pronunciation 'puh' while the letter pair PH (a bigram) corresponds to 'fuh.'

Hemifield One half of the field of view defined according to retinal coordinates.

Hemispatial neglect A neuropsychological condition that affects attention, exploration, and awareness of the hemispace opposite the damaged hemisphere. Clinical manifestations of neglect include bumping into objects and walls, ignoring objects, persons, and sounds coming from the affected side, forgetting to shave (or applying make-up) to one part of the face, etc.

Modular Refers to the idea of separable cognitive components working together to carry out a task. For example, the orthographic lexicon is a component that is modularly distinct from the phonological lexicon. Modularly distinct components can be independently affected by neurological damage.

Orthographic lexicon The stored representation of the spelled form of words in the reader's vocabulary. The orthographic lexicon maintains each word as a sequence of abstract letter identities.

Phonological lexicon The stored representation of the pronunciation of the words in a speaker's vocabulary.

Retinocentric A spatial coordinate system centered on the retina.

Syndrome In cognitive neuropsychology, the term refers to a cluster of impairments on a number of different tasks, and the co-occurrence of symptoms reflects a theoretically important principle. The term is not applied to impairments that co-occur simply because neurological damage has fortuitously affected a number of unrelated processes.

The advent of the visual word as a means of communicating ideas and preserving knowledge is of fundamental importance to human development. Because of the crucial role played by written language in so many domains it is no surprise that learning how to fluently read and spell occupies much of our initial efforts at school. As a general rule, good readers are also good spellers, while bad readers have a harder time producing the correct form of written words. This correlation suggests that these two tasks share common substrates. But given the demands specific to each task, reading and writing cannot depend on exactly the same underlying mental processes. For example, the rapid identification of a letter string depends on certain mechanisms unique to vision, whereas the retrieval and execution of letter shapes require motor processes specific to handwriting.

The main goal of this chapter is to describe and understand how certain neurological lesions can induce deficits in reading and writing (i.e., alexias and agraphias). What these different pathologies can tell us about the organization of the mental processes responsible for reading and writing in normal individuals will also be addressed. Neurological damage can selectively affect the peripheral components of word processing (e.g., the perception or production of letters) or its central components (e.g., the relationship between the orthographic form of a word and its sound or meaning). Generally speaking, the more peripheral the damage, the more likely the impairment will be specific to either reading or writing. Throughout this article, the reading and writing system will be deconstructed into different components, and the disorders associated with

their impairment will be described. First, the neuropsychological disorders related to the uptake of visual information will be presented. Next, deficits resulting from damage to more central mechanisms will be explained. These central mechanisms relate to orthographic, phonological and semantic knowledge, and often affect both reading and writing simultaneously. Lastly, the deficits that follow damage to orthographic output or, more specifically, to letter production, will be described.

Peripheral Dyslexias

Skilled reading demands accurate and rapid visual access to the symbols displayed on a page or computer screen. The quality of the visual information perceived is in part determined by the capacity to efficiently direct one's gaze and/or attention toward the text on the page (e.g., find the first paragraph). At the same time, in order for reading to be rapid and efficient, one must quickly recognize the letters in each word while maintaining their relative positions (e.g., LISTEN is not the same word as SILENT). In brain-lesioned patients who suffer from reading disorders as a result of damage to peripheral systems, the visual information perceived is inadequate to support accurate or fluent reading. Although these lesions will frequently have major repercussions on reading abilities, they will not affect spelling. Three types of peripheral alexias will be described in this section: pure alexia, attentional dyslexia, and neglect dyslexia. Note that we will use the term 'alexia' for some varieties of reading disorder and 'dyslexia' for others. 'Alexia' has

generally been the term that denotes reading disorders acquired as a result of neurological injury, while 'dyslexia' has more commonly been used to refer to developmental disorders of reading. However, the term 'dyslexia' has also been applied to certain forms of acquired reading disorder (e.g., deep dyslexia, attentional dyslexia, and neglect dyslexia) as has the term 'dysgraphia' to certain acquired writing/spelling disorders. We have varied our labeling, therefore, so as to be consistent with the published nomenclature.

Pure Alexia (Alexia Without Agraphia)

A dramatic example of a reading disorder that occurs without corresponding difficulties in spelling or writing is pure alexia (or alexia without agraphia). Jules Dejerine first described this syndrome over a hundred years ago at the Biological Society in Paris. In this seminal work, Dejerine documented the remarkable case of 'Monsieur C' both behaviorally and anatomically. Monsieur C, a highly educated businessman who had suffered a left hemisphere stroke, showed preserved writing and spoken language skills. He wrote fluently both spontaneously and to dictation but showed severe word blindness; that is, Monsieur C could not even read sentences he himself had written once the memory of the text had faded.

From neuroanatomical and behavioral observations, Dejerine concluded that pure alexia is a deficit caused by a disconnection between vision and language-based areas of the brain, a theory that Geschwind also resurrected in the mid-twentieth century. The disconnection theory Geschwind proposed entails that at least two lesions are necessary to isolate words from visual input, resulting in pure alexia: one in the left occipital lobe and the other in the splenium of the corpus callosum. Although it is a possible explanation for some of the cases reported over the years, current research suggests a more parsimonious neuroanatomical explanation. Most patients with pure alexia show a lesion of a small section of the cortex in the left mid-fusiform gyrus. This region is the only visible damage in at least one documented case of pure alexia. However, the specific role of this brain region and its importance for efficient reading remains a matter of intense debate.

The majority of cases showing alexia without agraphia are not as severely impaired as Monsieur C, who was unable to identify even single letters, treating them as unfamiliar shapes (e.g., he indicated that the letter A looked something like an artist's easel and S like a snake). The majority of pure alexics are able to identify individual letters but are forced to adopt a laborious approach to decipher even short familiar words. As a result, pure alexic readers (or letter-by-letter dyslexics as the syndrome is now often called) show very slow word identification (e.g., more than 2.5 s on average for even short, familiar words). A defining feature of letter-by-letter reading is the so-called word-length effect; that is, a linear relationship between the number of constituent letters and the time taken to read a word. The abnormally large word-length effect in this reading disorder is in striking contrast with the reading profile of normal readers, who show no word-length effect in naming latencies for words of less than seven letters.

The effect of length on performance suggests that patients with this form of reading disorder are limited to deciphering

words by analyzing each letter in sequence, so that the longer the word, the slower the reading speed (hence the term letter-by-letter dyslexia). Interestingly, though, this surface feature of the disorder is misleading. Good evidence indicates that it is generally not the number of constituent letters that impacts the reading of many letter-by-letter dyslexics but the extent to which the word contains letters that are perceptually confusable with other letters of the alphabet. This confusability index tends to be greater for longer words, simply because the longer the word, the more letters there are to be identified that are potentially confusable with other letters. It is possible to vary length while holding constant the summed confusability scores of the letters making up the word. When word-confusability scores are controlled in this way, letter-by-letter readers continue to read slowly, but their performance is generally not slower for longer than for shorter words. Thus, reading in this syndrome, despite the modern label for the disorder, does not seem to be invariably confined to a sequential analysis of letter identities. Rather, simultaneous analysis of multiple letters generates perceptual noise that delays recognition, and the degree of perceptual noise is determined by the overall confusability of the letters in a word.

Pure alexia offers a rich window into the visual mechanisms dedicated to word recognition. How specific is the disorder to reading? There are two alternative views on this question. The first attributes the reading disorder to damage of a specialized system for the visual analysis of alphabetic stimuli (i.e., words and letters). This account is based on the hypothesis that visual experience and expertise with words is sufficient to create area(s) of visual cortex responsive uniquely to visual words. Theories postulating that only alphabetic stimuli are impaired in pure alexia are examples of this specific account. The second account proposes that no brain part is uniquely devoted to visual word recognition per se but that some neural mechanisms that determine efficient perception of words are less crucial for other kinds of objects (e.g., faces, animals, man-made three-dimensional objects, etc.). This last account predicts that pure alexia is not a deficit specific to alphabetic material but rather includes an impairment in any task where the necessary visual resources coincide with those needed for reading. For example, one account proposes that visual word recognition requires simultaneous integration of multiple letters and that this integration mechanism is not specific to reading.

All thoroughly tested patients with pure alexia show some form of visual processing impairment not specific to alphabetic stimuli. Hence, the hypothesis of a general visual deficit is actually plausible. But the nature of the perceptual mechanisms, so important for reading yet of much less significance in other visual tasks, remains to be determined.

Attentional Dyslexia

Attentional dyslexia is a rare form of reading disorder that occurs after a brain lesion to the left parietal cortex. The main behavioral symptom is a failure to correctly perceive one item of a given category (e.g., the letter A) when this item is presented simultaneously with other items of the same category (e.g., BDGAH). A typical patient is able to read isolated words or letters with relative ease but his performance declines when

he is asked to identify those same items in a sentence or a letter string – because many items are visible at the same time. These patients also make many errors when they are asked to identify a single digit flanked by other digits but the error rate decreases significantly when the target is a set of dots to be counted. This behavioral observation implies that naming (in this instance, of numbers) is not accountable for the deficit. The main deficit in attentional dyslexia is a lack of control of a filtering mechanism that suppresses visual processing of unattended items in the visual field. Thus, these patients are unable to direct their attentional spotlight to a specific region of interest. As a result, more input than expected falls within the attentional spotlight and the wrong features are integrated together leading to perceptual errors. Within this framework, error rates are larger when the surrounding stimuli are from the same category.

Neglect Dyslexia

Although it is frequently associated with hemispatial neglect and right hemisphere damage, neglect dyslexia can also be observed in isolation. In fact, at least one patient has been known to have a right-side hemispatial neglect following a left hemisphere lesion in conjunction with left-side neglect dyslexia following right hemisphere damage. This exceptional patient undoubtedly proved the existence of a double dissociation between nonverbal neglect and neglect dyslexia. In this form of peripheral dyslexia, reading is impaired because the patients tend to omit or misread the left side of a page or the first letters of letter strings or words of a sentence. At the word level, visual errors made by left neglect dyslexics can be additions of letters at the beginning of words ('love' read as 'glove'), omissions ('cowboy' read as 'boy') or substitutions ('mother' read as 'bother'). In right neglect dyslexia, these errors occur at the end of the word. By itself, the existence of neglect dyslexia suggests that spatial attention plays an important role in normal reading. However, neglect dyslexia is quite variable between patients and different attentional mechanisms have been proposed to explain this variability.

It has been argued that at least three spatial frames of reference are necessary for understanding visual attention in words. The first frame is retinocentric; spatial information is represented by means of a coordinate system centered on the retina. When this form of spatial attention is impaired in neglect dyslexia, omissions and errors tend to be on the letter strings that appear in one hemifield, generally the left in patients with right hemisphere damage. Indeed, a word written on the left side of a sheet will be ignored or misread while it will be read correctly if it is presented on the right, no matter the word's orientation (right to left, left to right, vertically, etc.).

The next frame of reference is a stimulus-based one. When this frame is impaired for reading, words' spatial representations are altered. The left side of the word as a string of letters is misread, regardless of whether the orientation demands a left-to-right or right-to-left perusal. A word such as 'marble' might be read 'cable' if presented from left to right but as 'march' if demanding a right-to-left analysis of letters (i.e., 'elbram'). In contrast to retinocentric impairment, damage to the second frame of reference leads to the same error rates no matter where the letters string is presented in the visual field.

The third and last frame of reference implicates cognitive, higher-level representations of known words, and the processing is no longer at the visual extraction level. When this reference frame is impaired for reading, a word such as 'bible' could be read as 'cable' even if presented from left-to-right or right-to-left. Interestingly, this kind of patient tends to commit similar errors in writing or spelling, thus suggesting that at this level, attention is applied to more central orthographic representations, akin to the reading and spelling errors in central alexias and agraphias.

Central Dyslexias and Dysgraphias

Central dyslexia and dysgraphia are the result of a disruption to the linguistic mechanisms (i.e., orthographic, semantic, or phonological) that mediate reading and spelling, respectively. Neuropsychological studies of brain-damaged patients have contributed substantially to the development of a model specifying the cognitive processes and their interconnections that determine reading and spelling (see Figure 1). The structure of the model – its cognitive architecture – is founded on the assumption that separate routines from print to sound (or in the case of writing, from sound to print) are recruited for familiar and novel words. A familiar word contacts its stored visual form and meaning, and these representations are then available for reading aloud and writing. If a novel word is encountered (or in a task devised for experimental purposes, a pseudoword), no stored form or meaning is available. Reading aloud or writing to dictation is then based on subword graphemic units assigned to corresponding phonemic segments; for example, the written sequence FENT is pronounced

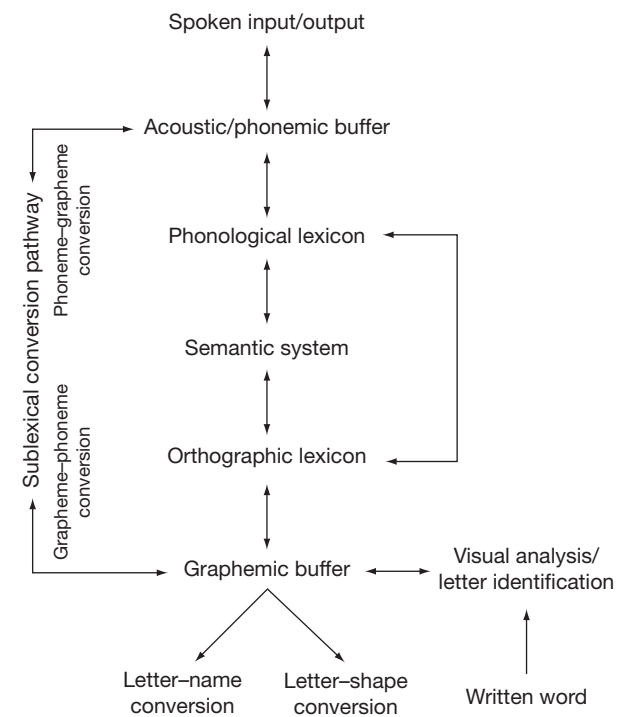


Figure 1 Modular architecture of reading and writing.

by knowing the sound associated with the letter F, and the typical rendering of the segment ENT. The framework offers an account of certain aspects of normal as well as pathological performance but is not without controversy. An alternative connectionist architecture rejects the view of two independent procedures for transcoding familiar and novel words. This rival approach has three sets of simple processing units, and so is referred to as the 'triangle model': grapheme units, representing orthography, phoneme units representing sound, and an array of semantic units for meaning. A spelling pattern generates recurrent activity over the grapheme units which then propagates through the network, resulting in a pronunciation for reading aloud (writing would entail a similar propagation of activity but from phoneme-to-grapheme units).

The triangle model, like its rival, includes two pathways between print and sound; a direct mapping between graphemes and their corresponding pronunciation, and a second pathway from print to sound via semantic units. Nevertheless, there are important differences between connectionist approaches and the more traditional dual-route model depicted in [Figure 1](#), the most basic of which is that the same processing mechanism is applied to the way familiar and unfamiliar words are mapped between spelling and sound. For expository purposes, we will follow the logic of the traditional model to describe central reading and spelling disorders. We will therefore begin our discussion on the central deficits of reading and writing with a short portrayal of the main components of this model.

In order to read, children must learn to assign a pronunciation to spelling units (e.g., the pronunciation of a sequence like INE). For writing, a similar mechanism is required but operating in reverse, to convert a pronunciation into a valid graphemic pattern. Note that the cognitive constraints on spelling-to-sound and sound-to-spelling conversion procedures are rather different. For example, the letter string HAIR has only one possible correct pronunciation but the spoken sequence/hɛər/has at least two corresponding orthographic forms (e.g., HARE, HAIR).

As reading and spelling develop, children learn to access or retrieve familiar words by directly contacting their stored visual forms. The ability to read or spell by using whole words rather than subword units implies three processing components for a word, one for its orthography, the second for meaning, and the last for pronunciation. This lexical-semantic route has some similarity with a dictionary: the orthographic lexicon contains the word's spelling (e.g., A-P-P-L-E), the semantic system containing its definition (e.g., the fleshy usually rounded red, yellow, or green edible fruit) and the phonological lexicon containing its pronunciation (e.g., /'a-pəl/). Theoretically speaking, the orthographic lexicon contains representations of all the words that a normal subject has learned to recognize in a single glance or to spell with high efficiency. The semantic system is responsible for storing the meanings of words. It is shared by other language mechanisms such as oral or sign language. The phonological lexicon is a system involved in the retrieval of spoken words in speech production. It plays an essential role in the spoken component of reading.

We will see that each of these processing routes and sub-systems can be damaged independently and cause different patterns of dyslexia and dysgraphia.

Phonological Dyslexia and Dysgraphia

In phonological dyslexia and dysgraphia, patients have difficulty in reading and spelling unknown words and pseudowords. Their performance, though, is clearly better or even in the normal range for known words, particularly for high-frequency words. Interestingly, most errors made by these patients are real words that are visually similar to the target word (this kind of error is termed a lexicalization; e.g., the nonsense word SIFE read as 'sift').

The cognitive architecture implies a division between the mechanisms responsible for known words and those responsible for unknown words and pseudowords. The fact that a cerebral lesion can affect reading and writing of pseudowords without affecting known words is consistent with the claim that distinct mechanisms are implied for processing these stimuli. In phonological dyslexia and dysgraphia, the lexical route is preserved, enabling the reading and spelling of familiar words, while the nonlexical route is impaired, affecting performance on spelling patterns that have no representation as real words.

Surface Dyslexia and Dysgraphia

At this point in our description of central deficits, the assumption that a distinction exists between a lexical and a sublexical pathway is not the only plausible interpretation of phonological dyslexia and dysgraphia. It is possible that pseudowords are simply harder to read and write than known words and that neurological damage only exacerbates this difference. The fact that normal subjects are slower and less accurate when reading and writing pseudowords versus real words is consistent with this possibility.

The finding of patients with the opposite behavioral profile – that is a deficit for words but no deficit for pseudowords – would eliminate this alternative possibility, however. Marshall and Newcomb were the first to describe such a patient in 1973. They documented what we now call surface dyslexia, that is, an acquired reading deficit in which the reader has difficulty reading 'exception' words (i.e., words with an irregular spelling-to-sound mapping; e.g., colonel) but makes fewer errors when asked to read regular words (e.g., fairy) and pseudowords (e.g., peratine). The initial cases described were less clear than expected given the assumption of a categorical distinction between whole-word and subword procedures for translating spelling to sound. Surface dyslexics often produced errors that indicated impairment of both procedures. This led to some doubt about the validity of the distinction, until a number of unambiguous cases were documented. From the perspective of the model, the reading impairment in surface dyslexia results from damage to the lexical route. Since this processing route is unavailable, surface dyslexic patients attempt to read and spell by the sublexical (i.e., grapheme-to-phoneme and phoneme-to-grapheme conversion) processing systems. Put differently, surface dyslexic patients often treat irregular words as if they were regular words or pseudowords. For example, they will pronounce COLONEL as /'kouləneɪl/ instead of /'kɜːnl/. Such errors are called regularizations and constitute the diagnostic pattern of surface alexia. Importantly,

these errors are more likely to occur for less common exception words (e.g., MOTHER might be read and spelled correctly but not LEOPARD).

Similar symptoms have been described for writing and spelling. In this case, patients make a large quantity of spelling errors for irregular words all the while correctly spelling regular words and pseudowords. The error rate in general is actually higher for this form of dysgraphia than for the corresponding surface dyslexia. In writing, the number of words with unpredictable phoneme-to-grapheme correspondences is quite high (e.g., the pronunciation 'boat' can be spelled in at least two ways, if we simply apply general principles of spelling-to-sound translation, including BOTE). Of course, some words, for example, DOG or CAT, have highly predictable sound-to-spelling correspondences. These words can be correctly spelled using the nonlexical conversion module. But many words have an unpredictable orthography, and the lexical route is needed for these to be correctly spelled.

It seems reasonable that surface dysgraphia should be seen together with surface dyslexia; both reading and writing errors can be attributed to a failure to contact a central representation of the word's orthographic form, and responses are based on more generic procedures that yield regularization errors. In very rare cases, though, surface dysgraphia occurs selectively (i.e., reading via word-specific procedures is demonstrably intact) or in association with another form of central dyslexia (e.g., phonological dyslexia). What do these unusual dissociations imply about the orthographic representations accessed for reading and spelling? One possibility is that different word-specific representations are available for input (reading) and output (spelling). The alternative is that the representations are indeed unitary but that distinct access and retrieval procedures exist that can be separately damaged to yield the dissociations seen in rare cases. The fact that such dissociations are so infrequent, though, indicates that the neuroanatomical substrates underlying any functional distinction between word-specific representations involved in reading and spelling must be so organized that they are mostly affected together.

Surface dyslexic and dysgraphic errors are the result of a failure to retrieve a word's pronunciation based on its stored orthographic form, and an overreliance on more general correspondences between spelling and sound units. We turn now to a very different phenomenon, involving reading or spelling impairment that ensues when the meaning of the word remains the only point of translation between its visual form and pronunciation, because all other routes have been destroyed.

Deep Dyslexia and Dysgraphia

In any cognitive neuropsychological task, the occurrence of semantic errors is probably one of the most spectacular kinds of error. In word reading, semantic errors are the main diagnostic behavior of deep dyslexic patients. For example, the typical patient could produce 'freedom' when confronted with the word 'LIBERTY' or 'knight' in response to 'CASTLE.' The first case of deep dyslexia was described in 1931 but the burgeoning interest in this reading disorder began in the late

1960s with the report of Marshall and Newcombe. In writing, the first case was described by one of us (D.B.) in the early 1980s. The limits on the performance of patients with deep dyslexia or dysgraphia are rather similar to the constraints suffered by patients with a phonological alexia or agraphia. In both types of disorder, performance for nonsense or unfamiliar words is affected while words yield better accuracy. However, deep dyslexic or dysgraphic patients are unable to cope with even a short nonsense word made up of a single syllable, thus suggesting a total destruction of the sublexical pathway. Of course, the syndrome is also associated with semantic errors produced by familiar words.

A comparatively large amount of research has been conducted on deep dyslexia. The reading pattern is probably the most complex and dramatic of all acquired reading impairments. Although semantic errors are the most frequent and diagnostic of errors in deep dyslexia, this kind of mistake is only one of the many characteristics of the syndrome. The most prominent features are (1) semantic errors, (2) visual errors (e.g., SYMPHONY read as 'sympathy'), (3) function-word substitutions (e.g., BUT read as 'and'), (4) derivational errors (e.g., MARRIAGE is read 'married'), (5) a complete failure to read pseudowords, (6) some classes of words found to be harder than others in reading aloud (function words > (i.e., harder than) verbs > adjectives > nouns), (7) strong concreteness (i.e., imageability) effect (TABLE easier than FATE).

To explain deep dyslexia, the dual-route model needs to postulate a number of deficits caused by independent damage to different functional components. Damage to the sublexical print-to-sound translation pathway is needed to explain the striking impairment in pseudoword reading. The presence of semantic errors as well as the concreteness effect suggests impairment to the semantic system itself. Destruction of the direct pathway between the stored visual form of the word and its pronunciation is also necessary since this procedure is clearly not available in deep dyslexia. If it was, the semantic errors would not occur because the pronunciation of the word could be retrieved without requiring that its meaning be contacted. Finally, visual errors suggest damage to the structural analysis of words; a possible source of these errors would be faulty processing within the orthographic lexicon. This unlikely coincidence of deficits observed in most deep dyslexic has led some researchers to argue that deep dyslexia is of no relevance for comprehension of normal reading mechanisms. Indeed, these researchers propose that deep dyslexics' left hemisphere lesion is so extensive that it is no longer available for reading. In this extreme case, reading would be mediated by a weakly literate right hemisphere. The attractiveness of this hypothesis comes from the reading similarities observed between deep dyslexics and patients with an isolated right hemisphere. However, the idea seems less plausible given evidence from a single case demonstrating many deep dyslexic characteristics, but whose reading was abolished after a second left hemisphere stroke.

The question remains, then. Why does the complex of symptoms characteristic of deep dyslexia occur, assuming that the pattern reflects the performance of a partially damaged left hemisphere reading system and not the normal reading capabilities of a linguistically restricted right hemisphere. Some progress on the issue has been made by researchers

constructing and analyzing connectionist models of reading that map the meaning of a visual word to its pronunciation. The relevant architecture consists of a primary layer of grapheme units representing the visual form of words, connected via intermediate units to 'sememe' units. The only function of intermediate units is to learn the pattern of associations that map specific letter patterns to a particular meaning, while sememe units represent the meaning of a word in terms of a limited set of semantic features like 'can be eaten,' or 'made of wood.' Sememe units connect to phoneme units via an additional set of intermediate mapping units.

This type of architecture has trouble learning to associate visually similar words with distinct semantic representations; however, the inclusion of a layer of 'clean-up' units that interacts with the sememe layer dramatically improves the mapping between the orthographic form of words and its meaning, by minimizing the confusion between visually similar words. Of great interest is the fact that damage to a percentage of clean-up units (by randomly altering a subset of weights) yields a number of the symptoms of deep dyslexia: visual errors occur as well as semantic errors, because the clean-up units no longer can differentiate between the patterns of activation generated by visually or semantically similar words. In addition, both deep dyslexic cases and the damaged connectionist model produce more complex errors, involving a semantic error driven by a visual substitution (SYMPATHY read as 'orchestra,' via the visual confusion 'symphony'). A concrete word like BOOK resists damage to the network more than an abstract word like FATE, because the former has many more semantic features than the latter. The clean-up units have greater redundancy to work with and so converge on the right meaning even after significant damage. Finally, because correct recognition of concrete words depends heavily on clean-up units, severe enough damage to this layer reproduces a striking reverse-concreteness effect also observed in one rare case of deep dyslexia; abstract words are read better than concrete words. Despite the undeniable value of these computational accounts, however, this approach has not yet produced a unified, coherent interpretation of the full symptom complex.

Deep dysgraphia is of considerable theoretical interest because the syndrome may sometimes occur in the absence of deep dyslexia, though the writing disturbance is invariably seen in association with some form of reading and language disorder. The dissociation between deep dyslexia and dysgraphia is evidence that procedures affording access to meaning from print may be partially distinct from procedures that operate in reverse to retrieve the spelled form of a word from its meaning. In addition, cases of deep dysgraphia show errors in their written performance indicating a failure to maintain letter identities in an output buffer holding active the graphemic representation of a word for sequential output. We discuss the reason for this surprising association of seemingly disparate effects when we consider writing disorders linked to impairment of the graphemic buffer.

Semantic Dyslexia and Dysgraphia

One possible outcome of severe damage to semantic representations is surface dyslexia, that is, a deficit in reading irregularly

spelled words. It seems reasonable to expect that words will be treated as nonsense words given severe enough damage to semantic representations. If the sublexical conversion pathway remains intact, orthographically irregular words will be regularized. Surprisingly, some patients – despite a severe semantic impairment – retain an ability to read and even spell both regular and irregular words. Semantic dyslexic cases suffer from Alzheimer's dementia or semantic dementia. They are able to read any kind of letter string (i.e., regular and irregular words as well as pseudowords), but they show no understanding of the words they can produce correctly. This kind of patient demonstrates that three processing routines are available to access pronunciation from print: the spelling-to-sound conversion procedure, the lexical-semantic pathway and a lexical nonsemantic pathway directly mapping word-specific orthographic forms to a pronunciation. It is this route that is used in semantic dyslexia to read irregular words correctly. Notably though, semantic impairment often does lead to surface dyslexia rather than semantic dyslexia. Why the different outcome in different cases? An interesting answer is that there are substantial individual differences in the utilization of semantic representations for reading. Some readers may need to rely more on semantic access to read irregular words whereas other readers are less dependent on word meaning.

Graphemic Buffer Impairment

As depicted on [Figure 1](#), the spelled form of words is produced by accessing a graphemic buffer, a component that receives information from both the orthographic lexicon and the phoneme-grapheme conversion mechanism. This component maintains abstract letter information (i.e., case invariant information) while peripheral conversion mechanisms operate sequentially on each grapheme to produce the spelled form (e.g., letter-name conversion for oral spelling, letter-shape conversion for writing, letter-motor scheme for typing).

How should performance be affected if the graphemic buffer were impaired, assuming that the damage is not severe enough to preclude any form of output? The buffer holds the final spelling of both familiar words as well as graphemic sequences generated by spelling-to-sound conversion. Performance should therefore be unaffected by word-specific variables like concreteness, familiarity, and grammatical class. If the capacity of the buffer to maintain letter identities has been reduced, longer words should yield more impairment than shorter words. In addition, if activation in the buffer has been compromised so as to generate interference between letter identities, spelling errors should be more frequent in the middle than the end of words, because terminal letters have fewer adjacent letters to compete with their activation. This profile has been documented in a substantial number of dysgraphic cases. Their errors include doubling applied to the wrong letters (e.g., STREET spelled as STRETT; consistent with the idea that the doubled status of the letters is represented separately from the letters themselves), ordering errors (transpositions), substitutions, and omissions. A successful computational account of this dysgraphic subtype has been implemented (a 'competitive queuing model') based on principles derived from a class of models that deal with the

control of sequential output. The model includes the idea that response elements organized for sequential output are selected by means of an activation gradient; the more active an element the sooner it is produced. In addition, competition occurs between response elements. Random noise added to the sequence generation process yields the key features of a graphemic buffer dysgraphia.

A surprising variant of the syndrome shows many of the cardinal signs indicative of a damaged buffer but in addition, elements of deep dysgraphia, including word class effects (like concreteness) and semantic errors. Nonsense words are spelled very poorly. Like the more typical instances of the syndrome, letter deletions, substitutions, and transpositions occur and spelling is worse for longer than shorter words. However, errors increase monotonically from the beginning to the end of the word (whereas in the more typical case, as we have seen, lower error rates occur at the start and end of words). This variant can be understood if the output of the semantic pathway yields a degraded representation of letters in the graphemic buffer. Subthreshold activation of letter identities results in numerous errors, including premature termination of the word if the very low signal from the last few letters is taken to indicate that the end of the word has been reached.

It was originally assumed that the graphemic buffer's role was restricted to the writing domain. However, the buffer may also be involved in reading, maintaining the level of activation generated by letters in the word. Accordingly, patients with a lesion to the graphemic buffer frequently have difficulty reading items comprising many letters, especially when pseudowords must be read and the orthographic lexicon cannot contribute to the response. Normal readers supply converging evidence for a short-term visual memory needed to derive the pronunciation of unfamiliar words. In this framework, the only strictly peripheral agraphias are those coming from lesions to the letter-shape and letter-name conversion mechanisms.

More Peripheral Agraphias

Impaired writing can occur even though the spelled form of the word has been correctly retrieved. In this type of agraphia, the word TABLE would be spelled aloud as 'tee, ay, bee, ell, eeh,' yet errors occur when the letters are produced in written form. The spelling of the word is clearly available, therefore, at least in a form suitable for naming (but also for other tasks; e.g., constructing the spelled word using block letters), but their shapes are not correctly translated into movements. If the writing impairment is due to a failure in motor processes that govern neuromuscular execution and control, written letters are distorted often to the point of being unrecognizable, and errors include misplaced as well as incorrectly formed strokes of the pen.

More surprisingly, it is possible to observe instances of peripheral agraphia where the dominant error consists of well-formed letter shapes; TABLE would be written as F-A-P-L-E. The question of interest is whether such errors are visually related to the target or whether some other relationship exists, based on the sequence and placement of the movements needed to construct the letter. A question of additional import is whether

the action representation at this level of organization in the writing mechanism concerns movements of the hand or more generally, to any action that is intended to construct letter forms. The answer to the second question is straightforward; the representation affected is sufficiently abstract that impairment is seen even when letters are produced by tracing the shape with a foot. The first question is more difficult. Letters that require similar strokes for their production tend also to be visually similar; how then can we distinguish visually based from action-based errors? A reasonable way of proceeding is to invoke two empirically driven methods to arrive at separate metrics of visual and motor similarity between letters. For example, visual confusability can be assessed by examining the errors of normal readers under restricted viewing conditions; the higher the probability a letter is confused with another, the more they are perceptually similar. Motor similarity can be operationally defined by constructing a reasonable taxonomy involving, say, number of strokes, shape (line vs. curve), direction (up, down, clockwise, counterclockwise), and so on. In this way, it is possible to isolate letter pairs that are more confusable with respect to an underlying metric of motor than visual similarity. An analysis of errors using this methodological approach has disclosed that in some cases of peripheral agraphia, errors are based on stroke similarity between letters rather than visual similarity.

Peripheral agraphias offer the possibility of valuable insights into the processes that govern the production of letters, as the previous example illustrates. Additional evidence from individual cases reveals a degree of categorical organization imposed on the processes that translate letter identities into movement. Impairment can affect the formation of letters while numbers are unaffected; the letter O may be incorrectly written, in other words, but not the number zero! Other forms of peripheral dysgraphia disclose mechanisms that concern the distinction between upper and lower case forms of the same letter (alographs); patients may have severe difficulty in producing uppercase printed letters for example, but not lowercase cursive script. Finally, dysgraphia may involve a disconnection between hemispheres, so that one hand no longer has access to the representations that govern the production of letter shapes.

See also: [Dyslexia](#); [Motor Control](#); [Neuroimaging of Dementia](#); [Psychology of Reading](#); [Reading and Phonological Processing](#); [Semantic Memory](#); [Spatial Perception](#).

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Relevant Websites

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- <http://www.thepadc.com/sdud/index.php> – What is Surface Dyslexia?

Alcohol: Psychosocial Effects

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Glossary

Acute tolerance The phenomenon of alcohol having less effect on the descending limb of the blood alcohol curve (i.e., when blood alcohol levels are falling) than on the ascending limb (i.e., when blood levels are increasing even) at similar blood alcohol levels.

Alcohol myopia A prominent theory of acute alcohol effects that posits that many of the behavioral and emotional effects of alcohol can be explained as a consequence of the narrowing of attention that alcohol produces. Such narrowing results in the drinker attending to only the most salient aspects of the environment which, depending upon the nature of the environment, can result in a range of emotional and behavioral extremes, both 'prized' and 'dangerous.'

Alcohol outcome expectancies Beliefs or associations regarding the effects of alcohol on the drinker. Expectancies can either be positive (e.g., 'drinking alcohol makes me happy') or negative (e.g., 'I get sick when I drink'). Such expectancies can be acquired directly via the personal effects of alcohol or through vicarious learning. Expectancies have been shown to predict drinking behavior both cross-sectionally and prospectively.

Allostasis A chronic adaptation to a substance or activity that is reflected in homeostatic changes (e.g., changes in hedonic set point) associated with tolerance, withdrawal,

and negative affective states. Allostatic changes induced by chronic alcohol consumption are associated with dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis and alcohol dependence.

Balanced-placebo design A type of experimental design used to disentangle the pharmacological effects of alcohol from those attributable to alcohol expectancies. The design, in simplest form, experimentally manipulates both the belief that one has consumed alcohol (i.e., expect alcohol vs. expect no alcohol) and alcohol consumption (i.e., alcoholic beverage vs. a control beverage). This design extends the placebo-controlled design which merely holds expectancy constant and, therefore, doesn't evaluate expectancy effects.

Chronic tolerance The phenomenon of individuals experiencing reduced effects of alcohol with increasing drinking experience and/or needing increasing doses of alcohol in order to achieve a given effect of alcohol.

Pharmacodynamics The study of the physiological effects of drugs on the body.

Pharmacokinetics The study of how the body absorbs, distributes, metabolizes, and eliminates drugs.

Stimulation and sedation Two broad classes of effects on subjective experience. Stimulating effects occur primarily at low doses and early in a drinking episode; sedation occurs primarily at high doses and when blood alcohol levels are falling.

Introduction

From the beginning of recorded history, historians and anthropologists have documented the prominent role of alcohol in the daily life of humans across diverse societies. Thus, when we examine alcohol use and its consequences, we should keep in mind the fact that we are looking at a phenomenon that has been a significant part of human experience for thousands of years.

However, a scientific understanding of alcohol and its effects is only a very recent achievement. Today, epidemiological studies inform us about the widespread use of alcohol in many societies; this makes it a public health concern in those countries where it is used in excess or in hazardous ways. The World Health Organization suggests that as many as 2 billion people consume alcohol in the world, and that about 76.3 million have an alcohol use disorder (AUD); leading it to be considered as one of the most prevalent mental disorders in the world.

This article provides an overview of research on both the acute and the chronic psychosocial effects of alcohol use. Such effects are often highly influenced by moderating factors that are specific to the occasion (i.e., the particular drinking context) or the individual (i.e., some people tend to respond

differently than others); therefore, characterizing the effects of alcohol use requires the consideration of a number of factors, including those beyond the drug effect. Although a comprehensive description of alcohol effects is beyond the scope of this article, we highlight the nature and determinants of some of the most widely known psychosocial effects of alcohol, including increased aggression, sexual disinhibition, injury, stress reduction, and human capital accrual.

Acute and Chronic Effects of Alcohol

Acute Effects

When discussing the effects of alcohol we need to consider both the acute effects associated with having recently consumed alcohol and the chronic effects associated with a pattern of alcohol use over time. Both the acute and the chronic effects of alcohol can be understood in terms of how alcohol acts on the central nervous system (CNS) which is largely responsible for regulating cognition, affect, and behavior. The acute effects of alcohol can be classified into three broad categories: (1) positively reinforcing effects (e.g., euphoria, arousal), (2) negatively reinforcing effects (e.g., anxiety reduction, antidepressant effects), and (3) punishing effects (e.g., depression,

hangover, vomiting). These effects are likely to vary across individuals and contexts, they rely upon different underlying neurobiological processes, and are probably a combination of pharmacological processes as well as individual alcohol expectancies (for further discussion on this topic please see the section 'Beliefs and expectancies'). Controlled experimental studies are better able to disentangle the effects of alcohol and these expectancies compared to real-world environments as the pharmacological and expectancy effects are inextricably confounded in the latter.

Most of the positive reinforcing effects tend to be largely associated with an enhanced activity of the monoaminergic system, that is, neurotransmitters such as dopamine, serotonin, and norepinephrine. The arousing effects of alcohol can be explained by the enhancement of these neurotransmitters, and probably have a lot to do with the resulting increase in talkativeness and excitement that is often seen when someone is under the influence of alcohol. Negative reinforcing effects, however, are most likely the result of increased activity in the GABAergic system through the GABA_A receptor in a way that is not too different from that described for the benzodiazepines. Research has suggested that the anxiolysis (decreased anxiety), and possibly some antidepressant effects, are due to this increase in GABA_A activity, and could explain why some people use alcohol as a means of reducing stress and tension. Lastly, the immediate punishing effects of alcohol (like facial flushing, nausea, and vomiting, for instance, which are mostly pharmacological in nature) represent a heterogeneous set of mechanisms that include ethanol metabolism, direct effects of alcohol on the gastrointestinal system, brain mechanisms, and the behavioral consequences of drunken excess (e.g., unintentional injury).

Regarding the neurocognitive consequences of heavy drinking episodes (i.e., drinking to intoxication), researchers are still investigating for any evidence of significant cognitive impairment. Psychopharmacological studies suggest that, in the case of a single, standard binge episode, once the breath alcohol levels have returned to zero, there is little or no lingering impairment; although there are studies with rodents that suggest that very high ethanol exposures can cause a more persistent impairment. While researchers have yet to fully characterize the relationship between a single drinking episode and a lasting impairment in cognitive function, there are a number of acute effects on cognition. For example, researchers have studied the phenomenon of blackout, which is a period of time (during a single, heavy drinking episode) during which recall is impaired. This memory impairment can either be 'En bloc' (when a large segment of the drinking episode was never encoded and thus impossible to recall), or 'fragmented' (when memories were encoded though not readily recalled unless the person is presented with a cue which serves as a reminder). These acute memory impairments are thought to be due to a disruption in hippocampus activity which can be caused both directly (by interfering with circuitry within the hippocampal CA1 cells) and indirectly (such as inhibiting communication between the hippocampus and the medial septum).

While blackouts may be one of the most dramatic and recognizable acute impairments associated with excessive alcohol consumption, it can also acutely affect a number of cognitive functions, especially those that involve effortful processing

of information, task switching, divided attention, rehearsal, and self-regulation. A slower rate of information processing (e.g., visual encoding) can lead to delayed reaction times, as well as poorer performance on divided attention tasks (such as driving, which requires the ability to engage in multiple tasks, simultaneously). Alcohol consumption remains a major factor in motor vehicle crashes, which are a major source of unintended injury. Indeed, acute alcohol consumption is associated with a range of unintentional injuries; with the risk of injury dramatically increasing with an increase in alcohol levels (for a further discussion on this topic please see the section 'Unintentional and intentional injuries').

Chronic Effects

Those who drink heavily for long periods of time are likely to experience a range of chronic changes in emotional functioning, which are perhaps a result of frequent and reoccurring withdrawal symptoms. When present, withdrawal symptoms are associated with affective disturbance, particularly anxiety, which can lead to the initiation of a vicious cycle of continued drinking motivated by this affective disturbance. More importantly, some mood and anxiety disorders have been found to be induced by alcohol (i.e., substance-induced disorders), and these resolve after a period of abstinence. Additionally, substance-independent mood and anxiety disorders (i.e., they do not resolve with abstinence) often have an onset that follows the occurrence of an AUD at rates that are 'above chance expectation,' thus suggesting protracted affective consequences.

The broad term given to the changes associated with chronic drug or alcohol use is allostasis, which is the result of repeated drug/alcohol challenges to the brain and their resulting counterdirectional (i.e., compensatory, homeostatic) responses that strengthen when such challenges are repeated over time. In addition to providing a basis to the process of chronic tolerance (i.e., the need for increasingly larger doses to obtain a given effect) the allostatic perspective also provides an explanation for chronic mood changes. Specifically, the allostatic burden of adjusting to alcohol-induced homeostatic changes results in a downward drift of the hedonic set point (in the negative direction) via its effects on the hypothalamic-pituitary-adrenal (HPA) axis which result in a chronic negative affective state.

In addition to the chronic emotional effects, prolonged and heavy consumption of alcohol can result in cognitive impairment that ranges from mild to severe. The long-term effects depend on the quantity of alcohol consumed, with greater quantities being associated with a decrease in the chances of recovering lost cognitive functions (for further discussion on this topic please see the subsection 'Chronic effects' within the section 'Individual differences in moderating effects').

In addition to these examples of neurological disease, chronic alcohol use is associated with a broad range of physical health and organ system problems. Even for diseases that are not directly caused by alcohol use, the social and psychological factors associated with AUDs are inextricably linked to one's overall health (e.g., noncompliance with medical treatment). Irrespective of whether the relationship between alcohol and poor health is direct or indirect, statistics indicate that alcohol can be attributed to over 100 000 deaths per year

in the United States alone, making it the third leading cause of death in this country (following tobacco use and poor diet/lack of exercise). Approximately 15–20% of alcohol-related deaths are a direct result of alcohol use (e.g., cirrhosis of the liver or alcohol poisoning), while the remainder are due to disease or injury in which alcohol plays a significant role. Although the overall effect of alcohol on health is negative, moderate alcohol consumption can have a salutary effect on some diseases (e.g., coronary artery disease and ischemic stroke) except perhaps in moderate-drinking, middle-aged men who are at higher risk of heart disease and stroke, where these effects would be expected to be greatest.

Moderators of Alcohol Effects

Drinking Occasion Specific

Dosing and limb effects

The effects of alcohol are highly dose dependent and when discussing what alcohol can do, we need to be specific about the dose under consideration. Very low doses, the kind of dose often taken by moderate drinkers in the context of a meal, may have minimal effects on mood and behavior while binge or heavy drinking can lead to extremes in behavioral disinhibition and an impairment of cognitive and motor performance. Second, there are considerable individual differences in how quickly alcohol is metabolized, so that a specific administered dose (even after taking into account body mass and gender) of alcohol can result in very different blood and brain levels of alcohol in these individuals, depending upon the variability in pharmacokinetics. While most individuals eliminate alcohol from their system at a rate of about $0.015\text{--}0.020\% \text{ h}^{-1}$ (so that it would take, on average, 4.5 h for someone to have his or her blood alcohol concentration (BAC) go from 0.08% to 00%), there is as much as a threefold difference in the rate of metabolism in the general population which results in individual differences in the time taken to clear alcohol from the system.

Moreover, even with comparable blood and brain levels of alcohol, there are considerable individual differences in the magnitude of the physiological and behavioral responses or the pharmacodynamics. Thus, when we seek to explain the effect of alcohol, we must remember to consider the individual differences that occur at the pharmacological and physiological levels.

The effects of alcohol are highly dependent on the amount consumed with higher doses being associated with greater behavioral impairment, behavioral excesses, and a range of acute adverse physical, behavioral, and social consequences (for further discussion on this topic please see section 'Acute and chronic effects of alcohol'). While there is some degree of folklore surrounding the beverage-specific effects of alcoholic drinks, research has demonstrated little evidence for the type of beverage making a difference in the level or the type of intoxication (after controlling for differences in ethanol concentration). The alcohol content of beverages sold in retail outlets in the United States can range from 2% ('near bear') to 95% ethanol (Everclear), and what is considered a standard drink varies from country to country. For example, in the United States, a standard drink (equivalent to ~12 oz. of beer,

1.25 oz of distilled spirits, or 5 oz. of wine) is usually defined as 14 g of pure ethanol. However, there is less standardization of ethanol concentration and drink size than these guidelines imply. Beers tend to have about 5% ethanol and can have concentrations that are more than double this amount. Wine, which is typically around 12% ethanol, can have up to 16% or more. Distilled spirits are typically 40–50% ethanol but can be much higher. This variability, coupled with variability in the size of the drinking vessel and pour size, can make it difficult for individuals to gauge the number of standard drinks they have consumed. Moreover, across the world, what is officially considered a standard drink ranges from 6 g ethanol (Austria) to 19.75 g (Japan), a consideration to be mindful of when comparing drinking statistics and behavior across cultures.

Although a number of adjectives can be used to describe the subjective effects of alcohol, stimulation, and sedation are two 'umbrella' terms for classifying the subjective responses. The term stimulation refers to subjective states such as elation, vigor, loquaciousness, sociability, and euphoria. Sedative refers to subjective states such as sluggishness, difficulty in concentrating, and slowed thinking. Alcohol effects are frequently described as biphasic, a term that is used to refer to the differences associated with the dose administered and, as discussed below, with whether the blood alcohol level is rising (ascending limb; as when someone is initiating drinking) or declining (descending limb; as when someone has recently consumed alcohol but has now ceased and sufficient time has elapsed, and alcohol is actively being eliminated from the system more quickly than it is being absorbed). The limbs of the blood alcohol curve correspond to the biphasic effects of alcohol. On the ascending limb stimulation predominates, while on the descending limb stimulation decreases and sedation begins to predominate. While these are general reports, the magnitude of these subjective effects tends to vary as a function of the individual's typical drinking pattern, with heavier drinkers being more likely to associate alcohol with stimulant effects in general, and lighter drinkers reporting more sedative effects; this partially explains why the heavier drinkers consume more, as stimulation is usually more desirable than sluggishness.

The same BAC can produce different effects depending on the limb of the curve. For example, individuals typically perceive themselves as being more intoxicated and impaired, at the same blood alcohol level, on the ascending limb than on the descending limb. That is, one might feel much more intoxicated at a BAC of 0.08% when his or her blood alcohol level is rising than at the same blood alcohol level when it is falling. However, this acute tolerance (less response on the descending limb than on the ascending limb) to perceived intoxication can diverge from other alcohol effects. Most critically, when blood alcohol is rising, many individuals can perceive that their cognitive or behavioral abilities are impaired (in the ways discussed in section 'Acute and chronic effects of alcohol'). However, as blood alcohol begins to fall these same individuals may subjectively perceive themselves as being no longer impaired. However, objective impairment can show much less acute tolerance (i.e., individuals can still show high levels of objective impairment on cognitive and motor tasks). This combination of perceived low impairment in the presence of objective high impairment is characteristic of the descending

limb and can lead the drinker to misjudge his ability to safely engage in certain tasks (e.g., operating a motor vehicle) and is probably a major factor in hazardous use.

Situational context

In many, if not most societies, alcohol is typically consumed in a social context. Experimental research has shown that the presence of other people strongly influences the effects of alcohol. Research findings are consistent in showing that subjects, in a social drinking condition, report more positive subjective effects of alcohol than those who drink alone. Moreover, the presence of drinking companions can affect the amount and the rate of alcohol being consumed. In fact, research has shown that participants drinking in a social situation might consume almost twice as much as those drinking alone. However, this effect seems to depend on the specific composition of the group, since people in groups drink faster than those in pairs; mixed-gender pairs drink faster than same-sex pairs, and among males, those in all-male groups tend to drink more than those in mixed-gender groups. At least two different mechanisms are likely to be responsible for this pattern of findings. One is the imitative modeling of other drinkers. A number of studies have shown that heavy drinking models (usually the confederate of the experimenter) tend to increase the amount of alcohol being consumed by a companion (the experimental subject). Another potential factor is that alcohol modulates (via effects on the dopamine neurotransmitter system) natural reinforcers, and the presence of others is naturally rewarding for humans (especially in adolescence when alcohol use is typically initiated), as is in a number of animals.

However, there are a number of contextual aspects of drinking, beyond the presence of conspecifics, that can affect both mood and behavior, and these can range from the physical aspects of the drinking environment to specific interpersonal events. A variety of influential cognitive theories have been proposed to explain why there are such large situational determinants of, ostensibly, pharmacological effects of alcohol. Steele and Joseph have stated that alcohol intoxication reduces the ability to attend to and process multiple internal and external cues. Under these circumstances, only those situational cues that are most immediate and salient are likely to be attended to. Such alcohol myopia is predicted to lead to disinhibited behavior (e.g., increased aggression or risky sexual behavior) in situations in which the sober individual would normally experience an inhibition. In other words, in circumstances in which a sober person would perceive strong cues, either provoking or inhibiting a certain behavior, the intoxicated individual will only process the more immediate and salient cues that provoke the behavior. Similarly, salient pleasant stimuli would be more likely to improve mood while salient aversive stimuli would be more likely to worsen mood; both happen to a greater extent in intoxicated individuals compared to sober individuals. Other cognitive theories focus on how alcohol intoxication affects appraisal processes, such as, by diminishing the elaboration and integration of new information that typically takes place when one is confronted with a stressor. There is increasing evidence that the cognitive mediation of alcohol on emotion, through processes related to impaired cognitive processing, is most applicable to situations where low and moderate doses of alcohol are consumed. When intoxicating doses of alcohol are

consumed, it appears that alcohol directly affects the brain circuitry that is associated with reward and behavioral inhibition.

Individual Differences in Moderating Effects

Age

The acute and chronic effects of alcohol are known to vary and have different implications when considered as a function of the life course. Thus, in addition to considering variables such as dosing, limb, and situational context, we need to consider developmental factors that shape the immediate and lasting effects of alcohol.

Acute effects

In most Western countries, self-administration of alcohol does not begin until adolescence with rapidly escalating rates of both any and heavy use occurring across the teen years. Animal research has shown that adolescent rodents are less sensitive than adults to some effects of alcohol such as sedation, hangover, or motor impairment, and exhibit better acute tolerance. Moreover, repeated exposure to alcohol may further reduce their sensitivity to these acute effects. Such diminished sensitivity to some negative consequences of alcohol makes it possible for adolescents to drink relatively large amounts, even if they are still only novice drinkers. However, adolescents are more sensitive to the effects of alcohol on social facilitation and social interaction, a critically important activity at this stage of life. This combination, of diminished punishing alcohol effects with increased reinforcing effects (coupled with relative drinking inexperience and incomplete development of executive cognitive functions), probably represents the key vulnerability to hazardous and excessive alcohol use in adolescence.

The profile of alcohol effects changes over the life course. Studies have also shown that older adults tend to be more sensitive to the negative effects of alcohol than younger adults. For example, older adults have been found to demonstrate an increase in psychomotor impairment than younger adults. This difference most likely explains, in part, the decrease in alcohol use and AUDs that occurs with age. However, older adults develop alcohol problems with lower amounts of alcohol use, and in some situations, they even fail to report the impairment caused by alcohol, which can, alternatively, be observed by objective measures.

Chronic effects

The long-term effects of alcohol consumption on a developing organism can be traced back to the first trimester of prenatal development as prenatal exposure to alcohol can lead to a wide range of behavioral effects that are manifested in childhood, adolescence, and adulthood. Such fetal alcohol spectrum disorders (FASD) can range from attention and impulsivity problems, similar to those seen in attention deficit disorder, to full-blown fetal alcohol syndrome (FAS), which is characterized by distinctive facial dysmorphology (e.g., indistinct groove between the upper lip and nose, small eyes), brain abnormalities, a range of behavioral problems, and (usually) mild retardation.

During adolescence, the brain appears to be especially sensitive to the long-term effects of heavy drinking, presumably

because the brain is undergoing extensive remodeling during this time with dramatic 'pruning' of synaptic connections and the continued development of some brain areas (especially the frontal lobes). Structural and functional neuroimaging studies have shown that adolescents with patterns of excessive consumption show evidence of neurological impairment, and behavioral testing reveals that the impairment is of such a magnitude that it has real-life consequences on learning and self-regulation. At this point in time, neither the levels of exposure that are necessary to induce prolonged changes in brain function in adolescents nor the potential moderating factors such as pre-drinking brain function and other co-occurring substance use are well characterized.

Although it appears that in adults a level of social drinking is not associated with persistent cognitive changes, it is well documented that as drinking increases (e.g., exceeds ~21 drinks/week) various kinds of neurobehavioral deficits, including poor visual-spatial coordination, abstracting performance, verbal associative memory, and verbal fluency, can be observed. Much of this loss in function (e.g., new word learning) can return with the mere passage of time if drinking is reduced or eliminated, but other functions require active retraining (e.g., visuospatial learning, abstraction, problem-solving). In the extreme, well-characterized dementias, such as Korsakoff's psychosis, can occur with prolonged, excessive drinking patterns in vulnerable individuals.

Beliefs and Expectancies

Alcohol expectancies are beliefs that people have about the effects of alcohol. These usually refer to what an individual thinks will be the effects of alcohol on him or herself as well as on others. Expectancies begin to develop in childhood, and grade-school children can differentiate alcoholic beverages from other types of beverages and can express the knowledge that individual behavior can change as a function of drinking. During childhood, most expectancies surrounding drinking are negative but early in the course of adolescence a tipping point is reached where increasing positive expectancies begin to outweigh the negative expectancies. These positive expectancies continue to strengthen during adolescence, but weaken a little in early adulthood. This pattern of change in positive expectancies is consistent with the typical course of drinking in the general population of many cultures; this also peaks during later adolescence and decreases in early and middle adulthood. Although different types of expectancies have been identified across different studies, expectancies about reduction in tension, positive mood enhancement, social and/or sexual facilitation, and enhanced cognitive or motor performance, as well as expectancies for negative effects such as behavioral impairment and adverse physical consequences, have been recurrently found in a number of studies.

The strength with which an individual holds these positive alcohol expectancies has been shown, both cross-sectionally and prospectively, to be strongly correlated with alcohol use (both initiation and level of use) and drinking problems. Such alcohol expectancies have also been found to predict treatment outcome among people in recovery for alcohol dependence.

While most expectancy research, to date, has focused on explicit expectancies (i.e., what someone tells us verbally about

the anticipated outcome of consumption), in the recent years, implicit expectancies, measured unobtrusively and independently of typical explicit expectancies, have also been found to be associated with alcohol use. For example, the Implicit Association Test (IAT) measures the differential associations of alcohol-related words and positive and negative adjectives. Scores in the IAT have been shown to have some incremental predictive power of alcohol use above and beyond the association of explicit measures of expectancies, thus highlighting the fact that these implicit cognitions tap those relevant alcohol-relevant motivations that are not easily captured by what the drinker can tell us explicitly.

Alcohol expectancies change over the course of the lifespan, probably because the experiences that people have when consuming alcohol can modify their beliefs about the consequences of drinking in the future. Some authors have also suggested that expectancies may act as a self-fulfilling prophecy. That is, the beliefs that an individual has about the effects of alcohol can make that individual more susceptible to experience those effects.

In order to understand the nature of alcohol effects, it is important to distinguish between the pharmacological effects of alcohol and the effects attributable to alcohol expectancies. In order to accomplish this, researchers have used the so-called balanced-placebo design (BPD). The BPD is an experimental design in which participants are assigned to four different conditions: (1) subjects in the 'alcohol' condition are told that they will drink alcohol and indeed they are given alcohol to drink; (2) subjects in the 'placebo' condition are told that they will drink alcohol but instead they are given a nonalcoholic beverage to drink; (3) subjects in the antiplacebo condition are told that they will drink a nonalcoholic beverage but are, instead, given alcohol to drink; and (4) subjects in the control condition are told that they will drink a nonalcoholic beverage and indeed that is what they are given. Although it is hard to successfully implement the BPD at high doses of alcohol (i.e., the deceptions in the placebo and antiplacebo are difficult to accomplish), the BPD has shown that, in some cases, the effects that people experience after drinking alcohol are not completely due to its pharmacological effects, but are due to the expectancies that they bring to a drinking occasion. That is, sometimes, subjects in the placebo condition exhibit effects that are at least as strong as those of the subjects in the alcohol condition (for a further discussion on this topic, please see sections on 'Aggression' and 'Sex' below). However, it is also important to point out that the expected and the pharmacological effects of alcohol can be in opposite directions. For example, in one study, men who believed that they had consumed alcohol while watching an erotic film showed an increase in sexual arousal (regardless of whether they actually received alcohol) while those who actually consumed alcohol showed a decrease in sexual arousal, regardless of whether they believed they had received alcohol or not. These experimental findings lend credence to Shakespeare's observation that alcohol "provokes the desire but it takes away the performance. Therefore much drink may be said to be an equivocator with lechery: it makes him and it mars him; it sets him on and it takes him off." Whether or not the placebo effects are iso- or counterdirectional to an alcohol effect appears to be dependent upon a number of factors. When

counterdirectional, it is often viewed as unmasking a preparatory or compensatory adjustment to maintain homeostasis.

Personality Differences

More than 80 years ago, William McDougall conjectured that an extraverted personality was particularly susceptible to the effects of alcohol. Although this is consistent with clinical and anecdotal evidence, research on personality-based differences in alcohol sensitivity has been sparse. However, recent interest in the neuropharmacological basis of personality has provided a further rationale for these ideas by providing a neurobiological foundation to the association between personality type and alcohol sensitivity. That is, if alcohol affects the major neurotransmitter and hormonal systems that are thought to underlie variations in personality, then these individual differences in personality could reflect variation in the baseline functioning of these systems. This baseline functioning could determine, in part, the nature and extent of the effects of alcohol on these systems.

This line of research has shown that some specific personality traits are associated with a higher sensitivity to alcohol. For example, individuals who are high on the trait of impulsivity/disinhibition are more sensitive to the stress-reducing properties of alcohol. With respect to overt behavior, individuals who are high on trait hostility or low on empathy are more likely to exhibit aggression when intoxicated. This means that individual differences in alcohol effects are associated with individual personality differences.

Family History of Alcoholism

Research in the last decades has confirmed the long-standing clinical observation that AUDs tend to run in families, with individuals who report alcoholism in a first-degree relative being at 86% greater risk for alcohol dependence than those without a family history of alcoholism. This phenomenon has led to an increasing interest in the family history of alcoholism as a predictor of alcohol consumption and AUDs, as well as in the mechanisms through which this variable has an impact on alcohol use.

One potential explanatory mechanism for the effect of family history of alcoholism is its impact on the subjective response to alcohol. Specifically, researchers have considered the possibility that the acute effects of alcohol are different among children of alcoholics compared to children of nonalcoholics. The accumulated evidence shows that, on one hand, children of alcoholics are less sensitive to the subjective intoxicating effects of alcohol which may lead them to drink greater amounts of alcohol, while on the other hand, they are more sensitive to some other effects of alcohol, such as stress response dampening and hyperreactivity due to the stimulating properties of alcohol. Newlin and Thomson have hypothesized that differences in alcohol effects between the children of alcoholics and nonalcoholics can be resolved by considering the limb of the blood alcohol curve. Specifically, those with a family history of alcoholism may be more likely to experience an enhanced reinforcement from alcohol early in the course of

intoxication. Later in the drinking episode, when blood alcohol levels are decreasing, children of alcoholics seem to become less sensitive to the effects of alcohol, which in this phase of the blood alcohol curve, tend to be more punishing. This greater sensitivity to the reinforcing effects of alcohol, and decreased sensitivity to the negative effects of alcohol, could lead to greater amounts of consumption with relatively fewer aversive side effects.

Selected Important Acute and Chronic Effects of Alcohol

Aggression

Alcohol is known to reduce inhibitions and alter perceptions of risk. Epidemiological studies have found that alcohol use is associated with episodes of aggression and violence. For example, estimates on the percentage of homicides that have been preceded by alcohol use range from 7 to 85%. Although this range suggests a low reliability of the findings, most studies have found that 60% or more of homicides have been committed by individuals who had consumed alcohol prior to the offense. Also, 40–50% of violent crimes, and 30% of cases of intimate partner violence occur under the influence of alcohol, with greater alcohol use being associated with more severe violence. Moreover, some prospective studies have shown that alcohol problems, or alcohol-related disorders, predict subsequent aggression. However, increased aggression has also been found to predict alcohol problems in the future. With regard to the mechanisms that explain this strong association, studies using the BPD have, generally, found that the effects of alcohol on aggression are primarily due to the pharmacological effects of alcohol.

Although the facilitative effect of alcohol for the expression of aggression is strong, there are some factors that moderate this association. For example, although alcohol increases aggression in both men and women, the effect is much stronger in men and, often, can only be demonstrated if there is direct provocation and sufficient dosage. Other variables, such as personality traits, related to aggressivity and neurocognitive executive functioning appear to moderate the effect. Thus, although there is a clear strong association between alcohol and aggression, some of it is due to aggressive people tending to drink more. When there is a direct alcohol effect, it appears to be limited to certain individuals, drinking heavily, and under certain contexts (e.g., provocation).

Sexual Behavior

Alcohol use has been found to alter sexual behavior in both men and women. Moreover, the consumption of alcohol is associated with impairments in judgment and decision-making. Findings from studies using the BPD indicate that, at least at lower doses, the expectancies regarding the effects of alcohol on sexuality are more powerful than the pharmacological effects of alcohol. However, this effect has been consistently found only in men but not in women. Although these studies provide evidence for expectancy-based theories, there is also research that provides evidence for the alcohol myopia theory in the context of alcohol–sexual behavior association. Research has

shown that impelling (e.g., sexual arousal) or inhibiting (e.g., fear of contracting AIDS) cues can affect the likelihood of risky sexual behavior. That is, whereas sober individuals can weigh both the impelling and the inhibiting cues that are related to risky sexual behavior, the behavior of intoxicated participants reflects the more salient cues in their environment.

Across adolescent and adult samples, both homosexual and heterosexual, cross-sectional data show that those who drink more heavily are more likely to engage in risky sexual practices. Moreover, greater levels of alcohol consumption relate to an increase in the likelihood of contracting a sexually transmitted infection. However, methodological limitations, and the inherent difficulty of conducting research in this area, make causal inferences, regarding the role of alcohol in risky sex, extremely difficult. Furthermore, some event-based studies (i.e., studies focusing on one particular occasion of sex, such as the first or the last intercourse) have not been able to replicate this association and there is good reason to suspect that third variable explanations (e.g., sensation seeking or impulsive personality traits and situational factors) mediate much of this relation between alcohol consumption and high-risk sexual behaviors; although more recent studies have found consistency in the findings from between subjects and the event-based studies.

Recent studies suggest that certain individual and situational characteristics may increase the likelihood of engaging in risky sexual acts following drinking. Variables such as age (the association between alcohol and risky sexual behavior increases with age among men who have sex with men) and gender (rates of unprotected sex increase with number of drinks in men but not in women) or partner's level of alcohol consumption (when partner has also been drinking, the association between alcohol use and unprotected sex becomes stronger among women), and partner type (i.e., casual vs. steady; such that the use of a condom is less likely in women having sex with casual partners after drinking) may provide important information with regard to predicting, under what conditions and for whom there is, an association between risky sexual decisions and the consumption of alcohol on a given occasion.

Unintentional and Intentional Injuries

Alcohol consumption contributes to both intentional and unintentional alcohol-related injuries. Motor vehicle crashes are one of the most common forms of unintentional injury due to alcohol and have resulted in 11 773 deaths in 2008. Blood samples are positive for alcohol in approximately half of the traffic fatalities. Injury deaths account for 45% of all alcohol-related deaths each year, and, in addition to vehicular accidents, can occur as a result of falling, fires, sports activities, being cut, or overdosing. Findings from hospital studies suggest that each episode of alcohol consumption significantly increases one's short-term risk for injury, with a greater increase in risk for violence-related injury. Interestingly, people who typically drink the least have the greatest risk for injury after alcohol consumption.

Intentional injuries from alcohol consumption can be self-inflicted injuries, assaults, or homicides, with self-inflicted injuries being the most common. Alcohol-related homicides

are most likely to occur with the presence of firearms (stabbing and strangling may be just as common but are less likely to result in death). Motivations behind these intentional injuries can be understood through the effect of alcohol on aggression, lowered inhibitions, or low mood. As noted repeatedly, individual differences such as drinking context, peers, drinking pattern, and baseline mood have a large impact on the subsequent effects of alcohol, making the alcohol-injury association highly conditional upon multiple cofactors.

Coping/Stress Reduction

The concept of people drinking to cope with negative emotions is clearly connected to the concept of self-medication. Extensive research on drinking motivations has demonstrated that in addition to enhancement (i.e., drinking to have fun), another common reason to consume alcohol is to reduce or manage dysphoria (i.e., drinking to cope with negative emotions). Many people consume alcohol when they are anxious or overly aroused, with the belief or expectation that the alcohol will reduce their stress levels. Though alcohol is not uniformly stress-reducing across people and situations, people who are strongly motivated to drink, on a regular basis, for coping, have been found to drink larger quantities of alcohol, to drink more frequently, and experience more negative consequences as a result of drinking than those who do not use alcohol to cope; perhaps because they are more likely to drink at inappropriate times or when negative consequences are more likely to result – like before work or during an emotionally vulnerable period. One explanation for people who frequently use alcohol as a means of regulating negative emotions is that they lack other ways of effectively coping with stress.

Human Capital Accrual

Because alcohol can cause role and cognitive impairment and because excessive and problematic alcohol use are most prevalent during adolescence and young adulthood, when schooling is a primary role, the effect of alcohol on human capital accrual is an important issue. That is, to the extent that alcohol interferes with learning and schooling, the effects of alcohol are likely to be long lasting since the human capital that accrues during this period of life plays a large role in determining the economic well being of the individual over his/her life span. When studying the effect of alcohol misuse on educational and occupational attainment, it is important for researchers to look at other potential explanatory variables like general deviance and a family history of alcoholism, as these could clearly be highly related to both the above outcomes (alcohol abuse and poor academic or job performance). Studies that have accounted for these factors have found that, while alcohol abuse in late adolescence does have a modest association with academic and vocational achievement, this association is partly attributable to background variables such as family history, gender, parental education, and previous (early) academic achievement. Also, individuals who have a history of good academic performance (in high school, for example) are most likely to experience negative academic consequences as a result of excessive alcohol abuse (in college). Regarding occupational attainment, research suggests that only those with the most extreme alcohol problems

(early in their career) experience negative impacts in this area. Thus, alcohol misuse can have a negative effect on educational and occupational attainment but the relationship is not particularly strong when other characteristics of the drinker are taken into account. Indeed, there is some evidence that alcohol use, in general, is associated with good educational attainment, probably because it facilitates engagement during college among those who attend, which result in higher rates of degree attainment. Alcohol use appears to be most problematic with respect to educational and vocational achievement when use is early, excessive, and persistent.

Summary

Throughout much of the world, alcohol is a frequently used drug that has been integrated into many aspects of social life but also has a range of effects on health. As a drug, its effects are highly variable, both acutely and chronically, and this variability is due to many factors that relate to the way in which the drug is used, such as individual differences among drinkers, and the context in which it is used.

See also: [Adolescence](#); [Addictions and Adolescence](#); [Aggression](#); [Caffeine](#); [Cognition and Personality](#); [Drugs, the Brain, and Behavior](#); [Risk-Taking Behavior \(Young Male Syndrome\)](#); [Sexual Behavior](#).

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- <http://www.niaaa.nih.gov> – National Institute on Alcohol Abuse and Alcoholism.
- <http://www.rsoa.org/> – Research Society on Alcoholism.
- <http://www.casacolumbia.org/> – The National Center on Addiction and Substance Abuse at Columbia University.

Alexithymia

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Glossary

Alexithymia Inability to describe emotions in a verbal manner.

Construct An abstract collection of ideas that serves as an explanatory concept.

Dysphoria A negative mood state characterized by prolonged bouts of sadness.

Emotion regulation The process through which emotional arousal is redirected, controlled, or modified to facilitate functioning.

Empirical Controlled observation and measurement.

Validity Refers to the extent to which what was observed is the same as what was claimed to be observed.

History

The alexithymia construct has a history that goes back about 40 years. The term alexithymia came from the Greek phrase *a lexis thymos*, which literally means having no words for emotions; the term, however, was initially used in its current form by Sifneos, a psychoanalyst who coined it in 1973. Some of the early insights we have about alexithymia came from observations made by clinicians in the late 1940s, such as Ruesch and MacLean, who described patients struggling to express emotions; these patients seemed to channel their feelings inward rather than outward through expressive behavior.

Following these initial descriptions, additional reports of patients with alexithymia, who were unresponsive to psychoanalysis, became known. Psychoanalysts Horney and Kelman described their patients as having a limited internal emotional activity, including a decreased awareness of feelings, lack of emotional experience, and what seemed like a lack of creativity and openness. *La pensee operateire* (or operational thinking) was the next step in conceptualizing alexithymia. Marty, deM'Uzan, and David described patients with psychosomatic illnesses who, while being treated with psychoanalysis, were less aware of their inner worlds and more preoccupied with their physical experiences.

The information that surfaced over time from these observations became significant once Sifneos and Nemiah's systematic investigations and descriptions of patients with psychosomatic illnesses culminated in alexithymia becoming a formalized construct. Specifically, they described patients with alexithymia as having a 'marked difficulty describing subjective feelings and a communicative style characterized by a preoccupation with minute details of external events and a paucity or absence of drive related fantasies' (p. 28).

Much of the initial evidence for the construct of alexithymia came from observations of patients with psychosomatic illnesses. Continuing this trend, Krystal and Raskin and Brusch reported characteristics similar to those described earlier in patients with other psychiatric illnesses, such as posttraumatic disorders and anorexia nervosa. Ever since, considerable research has been conducted, bringing support for this construct. The operational definition of the alexithymia construct has changed little over the years (e.g., *La pensee operateire* is now maintained under the facet of externally oriented thinking),

although the perspective from which we describe this construct has moved from one of a psychodynamic nature to a view focused on interconnections between alexithymia and both physical and mental health. The development of scales and of studies looking at the relationship between alexithymia and other constructs has afforded a more in-depth understanding of this concept. This has brought about the development of theoretical subtypes of alexithymia, as well as a clearer perspective on its relationship with both physical and psychological health.

Measurement of Alexithymia

The field of alexithymia measurement had been initially concerned with validation of the construct alexithymia itself. In this process, several measures were developed and investigated. Available measures for alexithymia vary widely in their presentation and focus. While historically this area focused on projective techniques, such as TAT, Rorschach, or the Objectively Scored Archetypal Test, such instruments have become obsolete with the development of other scales for measuring alexithymia.

More recently, a new self-report scale, the Toronto Alexithymia Scale (TAS), and its revised version, the 20-item Toronto Alexithymia Scale (TAS-20), have brought support for the alexithymia construct with a more robust psychometric profile. TAS-20 is the latest version of the scale, and it has been shown to have good internal consistency and test-retest reliability. Factor analytic investigations brought up the three factors supporting the alexithymia construct: (1) difficulty in identifying feelings, (2) difficulty in verbalizing emotions, and (3) externally oriented cognitions.

Haviland and colleagues developed the Observer Alexithymia Scale (OAS). The 33-item scale was designed for observers (e.g., family, friends) to report on the alexithymia features of a patient. The items can be divided into five subscales: distant, uninsightful, somatizing, humorless, and rigid. The scale and its subscales have been psychometrically investigated and good reliability and validity were found for clinical and nonclinical populations. The scale was also found to be a useful tool in differentiating between people with clinical and nonclinical levels of alexithymia.

One measure, Levels of Emotional Awareness Scale (LEAS), was proposed as a valid measure of level of emotional awareness. Although not specifically created to measure alexithymia, it was proposed by Lane and colleagues as an alternative conceptualization of alexithymia – a topic developed in more detail below. Unlike the previously presented measures, LEAS uses descriptions of emotion-evoking situations to which subjects are asked to respond by describing emotional reactions from both personal and other perspectives. LEAS has empirical support for good internal consistency and inter-rater reliability.

One of the most recent self-report measures was developed by Vorst and Bermond: the 40-item Bermond–Vorst Alexithymia Questionnaire (BVAQ). In the scale development, alexithymia was conceptualized as having five facets. Using the original TAS scale as a model, the five factors of the BVAQ are emotionalizing, or the incapacity to experience emotions; fantasizing, or having a poor fantasy world; identifying/differentiating emotions; analyzing or showing low levels of emotional analysis; and verbalizing emotions. Validity and reliability were investigated initially through two studies using samples from three different countries. Convergent validity was established by showing correlations between BVAQ and TAS-20.

Related Constructs

Although alexithymia has been conceptualized as a distinct construct, its independence has been questioned. Several other constructs have been proposed as potentially overlapping with alexithymia. This has raised the question of whether alexithymia is a unique construct or whether it can be fully explained by combinations of other existing constructs.

Given alexithymia's conceptualization as a personality trait, its relationship with other personality traits, particularly neuroticism, extraversion, and openness, has been investigated. While positive correlations between alexithymia and neuroticism and a negative correlation with extraversion and openness were indicative of the relationship between all these traits, important differences also surfaced. For example, the ease of emotional expressivity of introverts given their introspective nature is not common to people high in alexithymia. This feature sets introverts and alexithymics apart given the difficulty with which people with alexithymia express emotion. In a similar vein, neuroticism is connected to strong emotionality, which is one of the core deficits in alexithymia; low scores on openness related to externally oriented thinking and low levels of openness to feelings in alexithymia.

Other constructs that have been proposed are repressive coping style, inhibition, and big five personality dimensions. Bonnano and Singer originally proposed that alexithymia may be part of or connected to the repressive coping style identified by defensiveness. Despite defensiveness being in line with the emotional dysregulation found in people with alexithymia, their relationship was not detected by subsequent research. King found that inhibition and alexithymia are positively correlated, although while the former entails control, the latter is primarily conceptualized as a deficiency. Luminet and colleagues also supported the proposition that alexithymia may be

related to other personality traits. However, while alexithymia was related to a certain degree to traits such as proneness to depression and negatively related to other traits such as proneness to positive emotions or openness to feelings, it was not entirely represented by one trait and so, finally, investigators concluded that the construct of alexithymia is distinguishable from these other traits.

Constructs that have raised further questions about alexithymia's independence are somatization, dysphoria, and depression. Somatization and, more specifically, somatosensory amplification – the tendency to focus on bodily responses to emotional stimuli – have been associated with alexithymic individuals. However, somatization does not account for all the clinical facets that create alexithymia. Both somatization and dysphoria have been conceptualized as potential outcomes of emotional dysregulation. High correlations between depression and alexithymia have raised questions about the latter being a part of depression. Although, as noted earlier, while depression may exacerbate alexithymia traits, alexithymia tends to remain stable even once depression subsides. In addition, Parker and colleagues found that by factor analyzing the Beck Depression Inventory (BDI) and TAS together, they loaded on separate orthogonal factors, further supporting the independence of the constructs of depression and alexithymia.

Asperger's and Autism spectrum disorders more recently have gained general interest and have come to alexithymia researchers' attention, given the similarities in the lack of emotional expressivity between these constructs. However, empirical work directly examining the relationship between the two is still sparse. A letter to the editor makes a compelling argument for the importance of investigating these constructs in connection with alexithymia given extensive similarities. The authors talk about similarities in the lack of social interest exhibited by people with either of these disorders. People with alexithymia and Asperger's show a lack of interest and pleasure from interacting with others, and interactions are generally detached. Another central similarity noted by the authors is the poor emotional understanding and functioning, among others. However, research investigating similarities between these constructs has yet to fully develop, although strides are being made in this direction.

Looking at the relationship between alexithymia and other constructs has been an important part in the process of validating alexithymia as a distinct construct. While clinical and empirical evidence points to the similarity and some overlap between alexithymia and other personality traits (i.e., neuroticism) and mental disorders (i.e., depression), the body of work that exists to date has provided the basis to speak of alexithymia as a distinct construct.

Cognitive Aspects

One core characteristic of alexithymia is the difficulty in identifying and describing one's feelings. Lane and Schwartz created a cognitive development model for emotion on the basis of Piaget's theories of cognitive development. They proposed that this ability to identify and describe feelings develops over time just as cognition does. The cognitive development model as applied to emotion has five stages of emotional

experience, starting with physical sensations, action tendencies, single emotions, blends of emotion, and blends of emotional experience. Additionally, the level of emotional development also depends on what and how much people know about emotions.

Research shows that people who score high in alexithymia not only have difficulty in verbal and nonverbal emotion recognition but also show impaired recognition of facial expressions. Cognitive deficits in alexithymia have also been proposed to potentially be adaptive, to the extent that people capable of a complex cognitive understanding of emotions also being more likely to potentially be more impacted by extreme emotional experiences (i.e., traumatic experiences). Given that alexithymia has often been observed in people with mental or physical illnesses that are likely to be associated with increased emotional distress, such a trait can be protective in the short term, although marked deficits in emotional processing most often have been shown to lead to protracted anhedonia and apathy.

Physiological Aspects

As alluded to earlier, the relationship between alexithymia and psychosomatic disorders has a long history with a considerable amount of literature supporting it. An important subsection of this research has focused on aspects of physiology in people who have high alexithymia scores. It has been proposed that alexithymia is related to a higher baseline arousal. This was viewed as a dysregulation of the autonomic nervous system and system linked to pervasive dysphoria in people high in alexithymia and various other mental and physical disorders. Anxiety disorders, such as panic disorder and posttraumatic stress disorder (PTSD), depression and personality disorders, eating and substance abuse disorders, coronary heart disease, diabetes mellitus, and hypertension, all have been seen as related to the deleterious effect of a prolonged state of arousal.

Initially, people high in alexithymia were also thought to experience higher reactivity to emotional stimuli compared to healthy people. Three different theories have been proposed to explain the increased physiological arousal in response to emotional stimuli: Papciak and colleagues' decoupling hypothesis, Martin and Pihl's stress hypothesis, and Cacioppo and colleagues' discharge theory. The decoupling hypothesis proposes that in people high in alexithymia there is a disconnect between emotional experience and physiological automatic response when exposed to stress that results in high somatic response but lack of emotional expression. The stress hypothesis proposes that through the inability of alexithymic people to identify emotion and emotionally charged stimuli, they are also unable to identify stressful situations and, therefore, are not signaled to engage adaptive emotional regulatory tactics, leaving them vulnerable to experience more stressors, or more prolonged stress. Discharge theory views emotional expression as the outward channeling of energy. Alexithymia is characterized by an inward emotional expression through increased activation of the nervous system, given the deficit of individuals high in alexithymia to direct expression of emotion outward through speech or emotional behavior.

More recently, in contrast to previous theories, Linden and colleagues proposed the hypoarousal theory, which suggests that people high in the alexithymia trait will react less to emotional stimuli than other individuals. Evidence for the physiological aspects of alexithymia is still equivocal, although more recent studies have found more considerable support for the theory that people with alexithymia experience low physiological arousal to emotional stimuli. This is perhaps a direct result of decreased awareness of emotions in people high in alexithymia.

Neurological Aspects

Alexithymia is primarily conceptualized as a personality trait, and personality theories emphasize genetic attributes as important contributors to personality development. Research and theory have proposed neural mechanisms as propellers of what constitutes personality. In explaining alexithymia, two main views have crystallized to date, although much is left unknown about this area. One view proposes that alexithymia is a result of poor communication between the left and right hemispheres of the brain. This view is supported by a body of research in split-brain patients. What investigators have found is that such patients exhibit traits similar to those that describe people high in alexithymia: difficulty in recognizing and describing emotions. This view has also been investigated among patients whose brains were intact, by looking at the efficiency or deficit in interhemispheric communication. It was observed that while the transfer of linguistic information was similar among alexithymic and normal individuals, the two differed in the processing of nonlinguistic information, those high in alexithymia showing a deficit in interhemispheric communication. This is meaningful in interpreting the lack of recognition of emotional faces in people high in alexithymia.

Another view proposes that the difficulty in emotional processing experienced by people with alexithymia is due primarily to a dysfunction in the right hemisphere of the brain. This view has been supported by observations of patients with damage to this part of the brain. The right hemisphere has been found to have a role in information processing about emotion of facial expression. This observation has often been documented in people with depression, for example, who have similar difficulties with emotional recognition, which potentially points at one explanation for the relationship between depression and alexithymia. But the role of emotional processing by the right hemisphere goes beyond that of recognition of facial expression, to facilitating information processing of other stimuli with an emotional characteristic. Without a capacity to process different emotional stimuli, a poverty in experience with emotion often occurs.

Two specific areas of the brain that have been theoretically and empirically connected to emotional processing are the amygdala and the hippocampus, both of which have been investigated using diverse methods (i.e., fMRI, PET, EEG). The amygdala has been primarily connected to giving emotional meaning to different sensory information, thus helping individuals integrate experience and memories with an emotional value. The amygdala has also been connected

to emotional behaviors, such as facial expressions. All of these pieces seem to be interconnected in that individuals' experience of an event is determined by the emotional valence attributed to the event, which may depend on the emotional behavioral experience. The hippocampus, on the other hand, has an important role not only in emotional processing, but also in memory, which may be important in creating the emotional schemata that individuals use in expediting information processing. It becomes apparent that a dysfunction in either of these areas can impact the emotional development outlined in Lane and Schwartz's model.

The findings of these different studies attest to the complexity and breadth of alexithymia. The studies looking at the potentially poor interhemispheric communication bring support for the lack of verbal recognition and expression of emotion. Poor emotional experience of people high in alexithymia is mirrored by dysfunction in the right hemisphere and the amygdala corresponds to a low behavioral emotional expressiveness. The hippocampus was connected to emotional memories that may connect further to a poor fantasy world in people with alexithymia.

Alexithymia and Emotional Expression/Regulation

Given that alexithymia has been conceptualized as involving deficits in emotion recognition and expression, one line of research that has looked at emotional expression in alexithymia has been research on crying behavior. Crying, like other emotional behaviors, is sparse among people with alexithymia, possibly due to an unpleasant arousal during crying. Rottenberg and colleagues also found a connection between alexithymia and increased negative affectivity after a crying episode, potentially further supporting the lack of emotional recognition as well as identification of potential roots to the negative affect among people high in alexithymia.

As a consequence of the decreased ability to express and recognize one's emotions, emotion regulation is a major problem in people high in alexithymia. Unable to recognize their emotions, they often mislabel physical symptoms as illness rather than emotional responses to stimuli. Individuals with alexithymia are rarely able to intervene and regulate these emotions. Additionally, people high in alexithymia traits are poor evaluators of others' emotions and so, rarely offer empathic support that would in turn create the social support often employed in adaptive emotion regulation. Alexithymia has also been connected to compulsive behaviors, such as binge eating and drinking, or starvation in anorexia nervosa, all potential indicators of dysfunctional regulatory attempts.

An inability to recognize emotions among people high in alexithymia can potentially interfere with the identification of the source of emotions for adequate problem solving and downregulation of negative emotions. Consequently, people with alexithymia may be prone to experiencing more negative emotion and protracted dysphoria may interfere with the experiencing of positive emotions. Poor emotional processing interferes, not only with personal experience, but also with interpersonal affective exchanges that may lead to poor social experiences.

Alexithymia and Physical Health

A significant body of literature on alexithymia proposes and supports its connections to physical health. Lumley and colleagues wrote a critical review of the literature where they established a model of the connections between physical health and alexithymia. One of the proposed links is that alexithymia is an antecedent to somatic illnesses. Lumley proposes two potential mechanisms by which alexithymia may cause physical illnesses: through physiological changes and unhealthy behaviors. Empirical studies have found thus far that alexithymia is related to a low immune function and, consequently, connected to diseases with an immune component, such as precancerous deficits. There also seems to be a connection between cardiac activity and alexithymia. People with alexithymia have been found to have an increased resting physiological arousal, although high reactivity to stressors has yet to be found. On the contrary, attenuated reactivity as shown by a low RSA fluctuation has been seen in people with alexithymia. A low immune function, high resting arousal, and low reactivity can impact physical health by creating vulnerability for somatic disease. People high in alexithymia have also been found to engage in a variety of unhealthy behaviors, such as unhealthy eating, smoking, drinking, drug abuse, and gambling as well as unhealthy nutrition and lifestyle in general.

According to Lumley and colleagues, 'illness behavior,' which was conceptualized as somatization and health care seeking, is another pathway between alexithymia and physical illness. Research studies have found a relationship between alexithymia and symptom endorsement, without any objective evidence for illness that would warrant the experience of those symptoms. So, in short, alexithymia seems to be connected to the subjective experience of illness-like symptoms, but not to the objective illness. It seems likely that this subjective experience of different symptomatology prompts people with alexithymia to become more engaged in seeking health care services, which is what some empirical studies have shown. Interestingly, however, this finding seemed to be highly dependent on the specific facet of alexithymia for which an individual is elevated. So, Lumley concludes that, at least given what we know now, people with alexithymia who have difficulty in identifying and describing emotions, rather than those highly externally oriented, may have a higher awareness of their bodies and be more likely to identify and seek help on the basis of subjective experiences of illness.

Another proposed pathway between alexithymia and physical illness that Lumley and colleagues identify in their model is physical illness as an antecedent of alexithymia or, as they call it, 'secondary alexithymia.' In support of this possibility, the authors present empirical evidence from literature primarily on stress and trauma that have been shown to result in outcomes similar to qualities of alexithymia. However, the authors recognize that given the strong evidence for alexithymia being a stable trait, it is more plausible that it is an antecedent. Although, given the scarcity of this literature, it is plausible that 'secondary alexithymia' is in the realm of possibilities and this area would benefit from longitudinal studies following healthy people at risk for future trauma or stress (e.g., soldiers).

One last arm proposed by Lumley and colleagues in the model connecting alexithymia and physical illness introduces a third factor as the connecting antecedent of the two. While there is some literature, primarily on depression and other negative affect constructs, the overall status of the evidence currently is that the 'third variable' pathway is not supported. It is possible that with further studies examining genetic and temperamental third variables, they may surface as potential connectors between alexithymia and physical illness.

In conclusion, while there is literature supporting the different proposed pathways, the bottom line is that much of the literature on alexithymia and physical health seems to be mostly based on cross-sectional and correlational studies. While this evidence is an adequate start up point, further investigation using more complex models would be warranted to further the state of this area.

Alexithymia and Mental Health

It is often the case that extreme or chronic stress and trauma result in mental and emotional disorders that are characterized by deficits in affect regulation, and hence have been identified with alexithymia. Two areas relevant to alexithymia that have received extensive attention and empirical support are anxiety and mood disorders. The symptoms associated with these disorders have been conceptualized as potentially adaptive in normative samples in the form of signals of a negative event that is either about to happen (i.e., anxiety-like symptoms) or that has happened (i.e., sadness due to loss). At clinical levels, these symptoms often indicate a dysregulation of affect due to an overwhelming overpowering by emotions resulting from extreme or traumatic events.

Anxiety disorders that have been particularly viewed as portraying a profound deficiency in emotion regulation are panic disorder and PTSD. In people with panic disorder, the focus on bodily sensations and symptoms becomes excessive as they become tuned in with these feelings in an attempt to recognize when the next attack will happen. Because of this high focus on physical arousal and low capability to cognitively regulate these feelings, alexithymia is highly prevalent among people with panic disorder. Similarly, there is considerable overlap between the presentation of PTSD and alexithymia, including rich evidence for a relationship between alexithymia and childhood abuse or adult trauma. Moorman and colleagues developed the Reality Escape Model to explain, among others, the role of alexithymia in victims of childhood sexual abuse: the manifestation of a 'nonfeeling state that is so characteristic of traumatized individuals' (p. 82). In this model, it is thought that alexithymia victims of sexual abuse are able to switch off negative feelings and emotions that are too unbearable to deal with in order to cope with the traumatic events that often are a repeat offense. Unfortunately, as the authors note, the impact of such a manner to 'regulate' emotions is farther reaching, potentially affecting multiple areas and resulting in a generalized state of anhedonia that has been connected back to alexithymia. Abuse in childhood, according to these authors, is particularly deleterious and likely to be connected to alexithymia due to its timing in a period

during development when personality formation may be most vulnerable. Interestingly enough, alexithymia in adults who have experienced childhood sexual abuse seems to be of a certain kind: experientially, they seem to be unharmed, but cognitively they are incapable of recognizing and accepting emotions, making these adults good candidates and potentially rather responsive to cognitive interventions.

The connection between depression and alexithymia is less obvious, given that depression is often conceptualized as a disorder of mood, characterized by intense feelings of sadness, guilt, and excessive ruminative negative cognitions. However, these symptoms are not necessary for a diagnosis of depression. In western cultures, for example, a depression that has marked anhedonia as the primary symptom is clinically recognized. In non-Western cultures, a focus on negative affectivity is not the norm. Somatic symptoms rather form the construct of depression in these cultures and are often mislabeled and missed altogether, especially when somatization is coupled with a culturally encouraged lack of emotional expression. Both anhedonia and somatization have been connected to alexithymia and draw the link between alexithymia and depression.

A substantial body of research has also been developed on the relationship between alexithymia and substance abuse, also characterized by emotional dysregulation. Empirical studies have shown that about 50% of people with clinical levels of substance abuse (primarily alcoholism) score in the clinical range of alexithymia scale. It has been proposed that the primary link between alexithymia and substance abuse disorders is emotional dysregulation. Studies have shown alexithymia to be a stable trait in alcoholics; however, longitudinal studies with younger populations have been proposed to further support this contention. Given that many alcoholics have battled their condition for long periods of time, this may have enabled changes in personality and physiology that are similar to those observed in people with alexithymia.

Another area of psychopathology that has been related to alexithymia is eating disorders, also through a deficit in emotion regulation. An additional aspect that links alexithymia to eating disorders is a difficulty in people with various eating disorders to identify or recognize bodily signals (e.g., those that would signal hunger) and the difficulty to recognize emotions in people with alexithymia. Empirical studies have shown that these two deficiencies correlate closely, and that about 50–60% of people identified as having an eating disorder will also meet the criteria for alexithymia. Similar to other psychopathologies, alexithymia was found to be a stable trait in people with eating disorders, although alternative explanations have been proposed for this finding, such as comorbid psychopathology and continuation of subclinical levels of the eating disorders.

Treatment

Historically, given the initial popularity of psychodynamic therapy, it was the treatment of choice when the first patients with alexithymia were observed and described by clinicians such as Sifneos and Nemiah. However, it was observed that such therapies were not adequate given the reliance on free

verbalization of emotions and internal processes, which go counter to what has been observed in people with alexithymia. Alternative treatment recommendations, in the past, have included therapies focused on support. Other therapies that were considered to be more efficacious were therapies that would focus on teaching *how* to communicate emotions rather than *what* should be communicated.

Many therapies for people with alexithymia are mainly educational in nature, teaching these patients skills such as relaxation techniques to help regulate emotions that are often mislabeled as physical symptoms. Although most therapies for alexithymia target bodily sensations and emotion identification, they also incorporate cognitive behavioral techniques meant to help attend to physiological symptoms and understand them from an emotional and cognitive perspective. Additionally, teaching patients that physical symptoms are time limited has also been successful in helping people with alexithymia. Another psychoeducational technique was developed by Ronald Levant for the treatment of what he called 'normative male alexithymia' to help men express their emotions verbally.

Despite showing a deficit in cognitive and affective understanding of emotions, alexithymia was found to have positive effects on treatment outcomes in cognitive behavioral therapies. The reasoning offered was that people high in alexithymia are more inclined to use specific cognitive styles to manipulate information. Consequently, therapies that target these skills and put less emphasis on affect recognition and expression would better fit these individuals.

Group therapy has been proposed as an option for treating patients with alexithymia, as it affords interaction with other people and direct observation of emotional expression. It is important to note that people with alexithymia are less emotionally responsive and so may provide little emotional support to those in a group therapy. Empirically, group therapy has been evaluated in people suffering from a physical illness (e.g., heart disease) who were also high in alexithymia. Group therapy, in this context, was found to be beneficial in lowering both TAS scores as well as experience of a variety of cardiac events. Given the connection between alexithymia and physical health, it is difficult to disentangle the impact one outcome can have on the other; however, it is hoped that group therapy will be a viable option for people with alexithymia. The group setting affords observation of emotional expression as well as room to practice emotional expression with other peers. It is also important to note that improvements in physical health in conjunction with decreases in TAS scores further reinforce the connection between alexithymia and physical illness.

Despite the use of pharmacotherapy for the treatment of emotion regulation dysfunction in many disorders, psychotropic medications have not been evaluated in patients with alexithymia. However, some studies have looked at the impact of alexithymia on antidepressant treatment of depressed patients showing that alexithymia was related to negative outcomes of treatment. It is, however, possible that people with alexithymia did not experience an increase in adaptive emotional regulatory behaviors with the decrease in low mood, as people without alexithymia may experience with treatment for depression.

Although treatment has not been a focus of research in alexithymia, what has been done so far showed overall encouraging outcomes: CBT and group therapy, in particular, seem to have shown substantial impact in patients with alexithymia, especially in areas that can potentially be life threatening, such as cardiovascular disease. Although the importance of research on treatment for people with alexithymia has been acknowledged and commenced, a long road is still ahead of us in this domain and further attention needs to be directed toward finding empirically supported interventions.

Controversial Issues

Alexithymia Types

There is a limited body of research that has proposed and supported the suggestion that there are two distinct types of alexithymia. Type 1 is considered alexithymia characterized by poor affective and cognitive emotional experience and it presents with distinctive behavioral patterns that set it apart from healthy typologies of behavior. One core aspect of type 1 alexithymia relates to social interaction. People with this type of alexithymia are aversive to what they may perceive as forced social interactions and intrusive social behaviors of others. Some have described this pattern of behaviors as a fear of enmeshment, when one's identity becomes intertwined with that of another, making it indistinct on its own. This becomes particularly meaningful for both treatment and understanding of further ramifications of this trait, as people with this type of alexithymia will not rely on social support as a coping mechanism. Type 1 describes the prototypical person with alexithymia.

Type 2 alexithymia is considered a lower level alexithymia: while it is characterized by a similar deficiency in cognitive emotional awareness as type 1, the emotional experience is present. People with this trait have a low sense of self and, while also retracted from social engagement, it is primarily because of a sense of social inadequacy and insecurity, where feelings of failure are predominant. Although through a different underlying mechanism, just like those with type 1 alexithymia, people with the type 2 trait exhibit similarly poor social coping skills that revolve around abandonment fears and attempts at avoiding it. Type 2 alexithymia has been proposed to primarily identify victims of sexual abuse.

The description of these types of alexithymia affords a look at the full range of characteristics of people high in alexithymia. It becomes clear that social engagement is possibly central in learning emotional coping and emotional understanding, both of which are core aspects that are missing in alexithymia. However, this area is still controversial given that research on the different types has been limited to certain populations. Further research may be needed for the generalization of these traits.

Trait Versus State Alexithymia

Alexithymia has been proposed as a personality dimension, and validation of the construct comes through the work of Taylor and colleagues on the TAS and TAS-20. Both of these scales have been validated by examining their relationships with scales that would tap into deficits observed among people

with alexithymia (e.g., access to one's feelings). Concomitantly, there are studies that support the idea that alexithymia could also be a state reaction to different mental and physical conditions. Longitudinal studies have looked at the stability of alexithymia in the context of different levels of stress. Overall, these studies supported the trait view by demonstrating the long-term stability of alexithymia, thus supporting Taylor's conceptualization of alexithymia as a stable personality trait. In contrast, studies on clinical populations have suggested that when connected to psychopathology, alexithymia is viewed as state dependent, or as an outcome of the experienced vulnerability during stressful situations that subsides with the alleviation of symptoms.

To reconcile these two views, it was proposed that when speaking of personality traits a distinction between relative and absolute stability is warranted. *Absolute stability* is reached if people with alexithymia score the same on an alexithymia scale over time. *Relative stability* refers to temporal stability or people's relative position on levels of alexithymia, even though their absolute score may change. Similar trends are seen in other personality dimensions such as neuroticism and extraversion. Saarijärvi and colleagues offer empirical support for the idea that the two views don't have to be mutually exclusive, but that they can complement each other for a more complex understanding of alexithymia. In their study, while alexithymia scores decreased as depression decreased, overall, subjects remained high in this trait even after reduction of depression. In conclusion, a temporary increase in negative affect may exacerbate alexithymia traits, but this change was not found to explain the entire trait in any given person; hence, those scoring high on alexithymia most likely possess this trait.

Future Directions

Despite the great advancements that have been made in the past three decades in particular, a great deal is still to be investigated and understood about alexithymia. One particular area of research that has not reached a consensus despite great advancements in measurement of alexithymia and research methods in general is emotional reactivity and expressivity in individuals with alexithymia. In spite of the most recent research bringing further support for the hypoarousal theory of alexithymia, the results are still tentative and further research is needed. Emotional expression research has to continue to reach a better understanding of reasons for people high in alexithymia not to experience the benefit of expressing emotional behaviors, like crying. Additional inquiry is needed in the area of treatment for people with alexithymia, as the limited research that has been done indicates that certain types of interventions can be beneficial. Furthermore, while investigators have started posing questions about the overlap or connection between alexithymia and constructs such as Asperger's and Autism spectrum disorders, this area is still in its infancy and considerable work is warranted. Finally, additional empirical inquiry is needed to bring further support to some of the propositions that are still controversial in alexithymia research. For example, longitudinal studies on samples of youth at risk to develop alexithymia could potentially bring further clarification to the state-trait debate.

Summary

Alexithymia as a personality trait has developed rapidly and has attracted interest in areas as diverse as personality and neurobiology, health psychology, and clinical psychology, which have brought support for this construct with diverse, yet specific research agendas. Since the first reports of clinical observations, empirical evidence has added support to this construct. Notable advancements have been made in measurement, with the goal of having a valid and reliable measure of alexithymia having been reached with scales such as the TAS-20 or the BVAQ, among others. Neurobiology has found specific brain structures that are related to alexithymia and that changes in these structures could interfere with this personality trait. Great advancements have been made in understanding connections between alexithymia and both physical and mental health, and consequently how it may impact treatment strides. In spite of all the knowledge that has accumulated about alexithymia over the past 4 decades, areas such as emotional regulation and expression, or types of alexithymia, need further empirical inquiry.

See also: Depression; Dissociative Disorders; Empathy; Facial Expression of Emotion; Moral Emotions; Posttraumatic Stress Disorder.

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Altruism and Helping Behavior

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Glossary

Altruistic helping Helping behavior motivated by concern for the person in distress; selfless helping.

Egoistic helping Helping behavior motivated by concern for the benefits and costs to the helper; selfish helping.

Helping behavior Actions intended to assist another person with a problem or to relieve distress.

Prosocial behavior Positive forms of behavior, including helpfulness; the concept stands in contrast to antisocial behavior.

HELPING BEHAVIORS are activities where people provide assistance in solving the problems of other people. In this article, we review the characteristic forms of helping behaviors, a continuum that begins from spontaneous help which is often given in emergencies, to episodic help such as blood donation, and finally to long-term help which is typically provided by volunteers working for nonprofit organizations. Along the way, we examine the research that has focused on the thoughts, feelings, and behaviors of those involved in helping. We then describe a process model that focuses broadly on the antecedents, experiences, and consequences of helping. Among the many personal and situational influences on helping, we discuss its motivational underpinnings. For example, altruism designates a case where the assistance being provided is motivated by concern for the other person, whereas assistance motivated by concern for self is regarded as egoistic. We maintain a consistent emphasis on the situational and interpersonal contexts that surround any act of helping and contribute to its form and efficacy. Lastly, we examine the consequences of helping with respect to the recipients and the helpers, as well as for the larger community and society.

Forms of Helping

Whereas human beings are clearly capable of extreme cruelty and violence toward others, they are also capable of displaying extraordinary acts of kindness, generosity, and sacrifice on behalf of their fellow human beings. Amidst the horrors of Nazi-dominated Europe were cases of the Gentiles rescuing and hiding the Jewish victims of the Final Solution. In the southern United States, during the 1950s and 1960s, white participants in the civil rights movement were working actively with black participants in political organizing and voter registration. These dramatic acts of helpfulness may well be infrequent occurrences, yet many smaller and more ordinary acts occur with great regularity. During the course of our everyday lives, we can assist others with disabled vehicles or dropped articles, give directions or loose change, to name but a few opportunities. In addition to these brief help-giving encounters, people help on a sustained basis, oftentimes in the form of volunteer work. We find, for example, people providing companionship to young people or the elderly, counseling those who are psychologically distressed, and tutoring illiterate

adults or disadvantaged children. Moreover, national surveys have found that approximately half of all American adults reported having performed some kind of volunteer activity in the previous 12 months.

Clearly, prosocial activities are widespread and include a broad range of actions. One attempt to uncover the differences among this wide assortment of helpful acts applied statistical procedures to helping behaviors, utilized as dependent measures in research, and found helping situations to vary along three dimensions. [Table 1](#) presents helpful actions that are representative of the combination of the three dimensions.

The first dimension looks at whether the helper *directly* provides help or *indirectly* helps the person in need by providing a resource that can be used to alleviate the need. The second dimension is whether the helping situation arises *unexpectedly*, with the helper being surprised by the need for help (e.g., emergencies), or is *planned*, with the helper deliberating before acting and, perhaps, even seeking out the opportunity. Finally, the situation in which the need for help arises may be *serious* or *not serious*.

Researchers have often limited their studies of helping behavior to particular forms of helping. For example, they have studied spontaneous or unplanned helping, episodic helping, and long-term helping; in each case, the situation may have been serious or not serious, and the action direct or indirect. Many studies take just a single type of helping (e.g., blood donation) as their central focus. We now turn to each of these forms of helping and the research that supports them.

Spontaneous Help

For behavioral scientists in the 1970s and 1980s, the central question of interest was whether or not a person would help when he/she was placed in a situation in which a stranger needed help. A major impetus for behavioral scientists' attention to helping behaviors was a dramatic episode of a failure to help. In 1964, Kitty Genovese was murdered by a knife-wielding attacker as she returned to her New York City apartment building in the early hours of the morning. The episode consisted of two separate attacks over an approximately 30 min time period and was witnessed by at least 38 people who were watching from their apartments. None of the observers assisted her. Although recent archival work suggests that some aspects of this 'parable' may be apocryphal, the subsequent

Table 1 Dimensions of helpful actions and representative acts

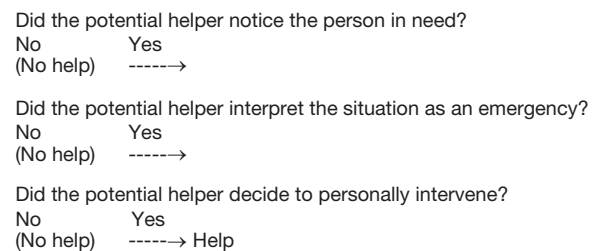
	<i>Planned help</i>		<i>Unplanned help</i>	
	<i>Serious situation</i>	<i>Not serious situation</i>	<i>Serious situation</i>	<i>Not serious situation</i>
Indirect help (giving)	Donate blood	Save cartons for art students	Telephone for a medical emergency	Give money for bus fare
Direct help (doing)	Crisis counseling	Volunteer for experiment	Perform CPR for a heart attack victim	Look for lost contact lens

experimental research did offer important scientific insights into the situational factors that influence whether or not bystanders will intervene in an emergency, using the Genovese story as a model for their studies. College students participating in an experiment, for example, have been exposed to a medical emergency or a theft, and from these studies, one consistent finding has emerged: the presence of other people, and particularly strangers, inhibits intervention during emergencies.

From the attempts which have been made to explain the inhibitory effect of the presence of others has come a framework for the intervention process in emergencies (see **Figure 1**). The first condition that must be met before a potential helper can intervene is attention to the event and, interestingly, several factors can actually lead to a failure in noticing even a dramatic emergency. These include being overwhelmed by stimuli (as might be the case when one lives in a large urban area), distraction from external events (because one is focusing attention on one's own problems), or time pressure. Upon noticing, however, the potential helper must then interpret the episode as a situation that requires help. An interpretation that the episode is an emergency is hindered by any set of conditions that make it ambiguous – for example, is an altercation between a man and woman an attack or a lover's quarrel?

The conditions mentioned up to this point could occur regardless of whether one is facing a possible emergency alone or with others. More directly related to the inhibitory effect of other people is the social process of *evaluation apprehension*. This involves people's desire to present themselves as 'calm, cool, and collected,' and the fear of any embarrassment being caused by acting as if the situation is serious when, in fact, it is not. The unfortunate upshot of this process is that when a group is faced with a potential emergency, individuals present a calm mask while looking around at others' faces to determine if the situation is serious – and if others are acting similarly. The end result is often an interpretation that the event is not an emergency and so no one intervenes; this state of affairs, in which everyone believes that others have confirmed that there is nothing to worry about, is known as *pluralistic ignorance*. When alone, the absence of others removes the audience and gives the individual more latitude in making the interpretation that an emergency has indeed occurred.

Having made an interpretation that the event is an emergency, a person must still decide whether or not he or she will intervene. Again, several factors affect this final step, including an estimation of whether one possesses the skills necessary to assist the person in need. In terms of the inhibiting presence of others, an important aspect of this final decision is the *diffusion of responsibility*. When alone, the responsibility for helping a victim rests solely with the individual. When others are present,

**Figure 1** The bystander intervention process.

however, several individuals psychologically distribute responsibility for the action and each individual's own sense of responsibility is lessened. Thus, while the processes of evaluation apprehension and diffusion of responsibility reduce the probability of helping amongst a collection of individuals, recent research does offer a potential caveat to this dire claim, as findings suggest that when other bystanders are friends or members of the same social group they do not inhibit helping (and may even encourage it), particularly, if the victim is a member of the same social group.

Other situational factors may also influence spontaneous helping. Simple acts of spontaneous helping, such as picking up a dropped pen for someone or making change when asked, may be affected by the immediate environment. In particular, unplanned and nonserious helping may be inhibited in American cities with greater population size or density (perhaps via distraction and sensory overload or diffusion of responsibility). Another inhibition may be the perceived costs that the helper foresees in terms of time, energy, or money. Moreover, some situations which call for serious help are clearly dangerous for the intervener; rescuers of Jewish victims of the Holocaust, for example, faced possible execution if caught. Even in the absence of physical harm, some situations involve victims who are severely injured and suffering, and people can find exposure to these situations psychologically distressing. Even though helping can certainly be costly, there are also costs associated with failing to help (e.g., the disapproval of others).

Yet, spontaneous help is not simply the result of perceiving a lower number of potential losses. People can benefit through helping and the availability of potential rewards increases the likelihood of help. The benefits available to helpers often seem to center on approval in terms of the approval of others for helping, the gratitude of the recipient, or self-approval. With respect to self-approval, helpers can reinforce themselves as having acted in accordance with their values and/or for having 'made a difference.' Moreover, through helping, a helper can experience an increase in self-confidence and, more generally, self-esteem.

A number of other studies have examined why situational features may make spontaneous help more or less likely. Manipulations of a positive mood (e.g., finding a coin in a phone booth or having an experience of success) increase the likelihood of help. Several psychological mechanisms appear to contribute to this relationship, including the tendency for people in a good mood to view things in a more positive light, be reminded of their own good fortune, and the desire to maintain the positive mood state. The relationship of negative moods and helping is more complex, and varies with the specific negative mood. Guilt is generally associated with increased helping, and is especially so when one feels responsible for the potential recipient's state of need, as helping provides a mechanism for reducing that guilt. The relationship of sadness and helping, however, is more variable. Helping becomes more probable if the sadness is directed at the distress of another person, but is less likely if the sadness is directed at oneself. Thus, a potential helper's internal mood state, positive or negative, which is generated by the current situational features or carried into the situation with the helper (as a result of prior events), can clearly influence helpfulness.

Other studies have looked not just at the ways that current affect influences spontaneous helping, but also at how currently accessible cognitions may do so. For example, participants who are running late for another engagement have been found to be less likely to help; thus, competing goals may block spontaneous helping. Researchers have also primed helpfulness in participants; for example, after describing the characteristics of superheroes (a very helpful group), participants were more willing to sign up for volunteer work (and actually follow through with their commitment) compared to a control group. These primes, which often operate at an implicit or unconscious level, may make certain goals that are focused on helping more accessible in thought, and when opportunities arise to act on these goals, primed individuals are more likely to do so.

Besides goals, other cognitions may become active in some situations and can influence spontaneous helping behavior. Here, a great deal of research has examined the role of salient norms in ensuring helpful action. For example, when presented with unexpected opportunities to help, witnessing another person helping increases the incidence of behaving helpfully; a motorist with a flat tire received more offers of assistance when travelers had earlier observed another motorist with a flat tire receiving assistance. In part, witnessing the helpfulness of another person increases the observer's helpfulness by teaching new behaviors and by demonstrating that certain behaviors are appropriate in a situation. Modeling of the helping behavior by others has been shown to have both immediate effects (by making norms salient) and long-term effects (by socializing children to learn social norms or even personal goals). In particular, models may remind those who witness their actions of the *norm of social responsibility*. According to this norm, we should help those who are dependent on us, such as young children, the sick, and people in need.

Whereas research is consistent on the prediction that helping increases as dependency increases, explanations which focus on norms like social responsibility are often criticized on the grounds that they are vague, general, and appear to be present in situations where there is a failure to help (e.g., when

bystanders are present in emergencies). Furthermore, there are social norms that discourage helping, as exemplified by the admonishment 'mind your own business.' Nonetheless, many societies have norms, such as social responsibility, which serve as a backdrop to events in which others are in need and can exert an influence when combined with other factors.

A clearer case of a help-related norm influencing helping behavior concerns the *norm of reciprocity* – we should help those who have helped us. This guideline is not just limited to the realm of helping, but applies more broadly to our relations with others. Reciprocity also appears to represent a universal norm and some societies have very clear-cut guidelines about how and when one returns a gift (e.g., the Kula ring among the Massim peoples found in several small islands near New Guinea). Yet, receiving help does not guarantee that the recipient will later return the help. Recipients of help seem to feel less obligated to reciprocate when the gift represents a small portion of the helper's overall resources or if the original help was given accidentally rather than deliberately. Reciprocal help also seems to be less likely if the helper is judged to have had ulterior motives for acting helpfully. In this case, recipients may experience 'psychological reactance' – a negative motivational state where people wish to reassert their freedom to act, which may result in a refusal to reciprocate.

The conditions under which prior help is more likely to be returned raise a larger question about the potential recipient of help as a situational determinant of helping – when are people in need more likely to receive help? Research suggests there is an increased tendency to help when the need of the victim increases (e.g., in clearly defined emergencies). This tendency, however, is moderated by the potential helpers' judgment about whether or not the victim deserves help. People tend to help more when the victim is viewed as needing help because of circumstances beyond his or her control, compared to when he or she is known to have created his or her own predicament. Subway riders, for example, were more likely to help a fallen rider when his fall appeared to be due to sickness rather than drunkenness. In a related vein, more help is forthcoming when the need seems legitimate and necessary, as in requesting money for purchasing milk, rather than a more unnecessary and trivial need (e.g., requesting money for beer). Finally, there is a tendency to help others more when the person in need appears to be similar to us, as signaled by the person's salient social group memberships.

Thus, a considerable amount of research has been devoted to the social processes that inhibit or enhance spontaneous helping, particularly in emergency settings, and also with less serious behaviors. However, until relatively recently, researchers in behavioral sciences appeared less interested in investigating helping behaviors that occur more frequently or even for long periods of time. We turn next to these, more sustained, forms of helping.

Episodic Helping

When it comes to planned helping behaviors, those who wish to assist others may choose to do so in a limited fashion by engaging in relatively short-term helping behaviors. The most obvious prototype of episodic helping is blood donation, but participation in walkathons or paintathons also falls into this

category. Indeed, a lot of literature has developed which examines the factors that influence charitable giving, and this may sometimes be the helpful choice of those who find themselves time-poor (conversely, those who are resource-poor may choose volunteering time over money).

One approach to examining the giving of time, blood, and money, has focused on the roles that the participants adopt when they choose to engage in these forms of helping and how these roles can become a central part of a person's identity or the sense of self. Research on episodic helping often targets the predictors of this ongoing commitment, rather than only that which led the givers to engage in helping in the first place (which we cover in a later section). Regular ongoing blood donation has been shown to increase as a function of the positive expectations of other people in the donor's social network and as a function of the donor's donation history. Indeed, at a certain point in their donation career, individuals may experience a 'role-person merger' whereby the role of blood donors (or volunteers) becomes a central and important part of who they are, and this is made stronger by the fact that other people in their social network are also likely to acknowledge the importance of this role for these persons; this can help to maintain the role-consistent behavior.

Aside from 'opportunity costs' (e.g., those costs that one must bear if one is to use one's time to engage in helpful behaviors rather than to pursue other goals or leisure activities), other factors may also influence whether or not someone gets involved, episodically. For example, recalling that a parent or another significant role model engaged in the same activity is associated with greater commitment to episodic helping (blood, money, and time); as is the perception that people have a moral obligation to engage in these behaviors. Social marketing research also suggests that episodic helping may also be a function of catching people at the right time and place, or of finding ways to make helping behaviors more convenient and/or a regular part of a person's daily schedule (e.g., blood-mobiles and workplace-sponsored helping). Finally, reducing the costs associated with helping opportunities (such as those involved with driving to the location or giving up time on the weekend) can increase the likelihood of episodic helping.

Long-Term Helping

From the late 1970s onward, behavioral scientists began to turn their attention beyond short-term or emergency helping and the factors that influence it, to the sort of planned and sustained helpful behaviors that are epitomized by volunteerism. In many nations, volunteers provide an enormous resource to communities, free of charge, which can be the equivalent of many billions of dollars per year in labor costs. They get involved in organizations that focus on helping other people (*public-serving* organizations, such as the Red Cross or Habitat for Humanity) or those that focus on bringing like-minded people together or promoting a particular activity (*member-serving* organizations, such as local arts organizations or interest groups). These organizations provide many helping opportunities that range from those focused on improving the health and well-being of adults, youth, or children, to those that focus on specific issues, such as education, the environment, or human rights (including many political organizations), and to

those that help to organize arts, sports, and cultural activities. Within these organizations, volunteers take on many roles, with some requiring few skills and little training (picking up garbage on beaches, delivering meals to housebound elders), and others requiring increasing amounts of training, orientation and existing skills (serving as a mentor to troubled youth, fundraising, coaching a sports team).

Sociologists have examined the ways in which background characteristics may be associated with a greater likelihood of volunteering. First, people with greater stores of 'human capital' resources, such as higher education or higher status jobs, compared to those who have fewer such resources, tend to volunteer at higher rates, perhaps because they are more aware of the social issues that require volunteers' services or because they are more frequently asked to volunteer. Second, volunteering also occurs at higher rates for those who possess greater social resources, or social capital. Having a large social network and belonging to more organizations can create more opportunities for volunteering, as in the type of volunteering that involves people helping the schools or churches that their friends and family attend. That is, through family, friends, and other people they know, people learn about problems and the opportunities to solve them. They get asked to volunteer, but they also develop shared interests and concerns, and become enmeshed in relationships that involve trusting and being trusted, potentially, as part of a community that shares beliefs and norms about the importance of contributing to the public good.

A Process Model of Helping

With volunteerism as a case in point, we now review the antecedents, processes, and consequences of helping behavior and the different theories and findings that have explored this prosocial behavior.

Antecedents

The most distal cause of helping behavior considers the possibility that humans may have evolved to engage in helping behavior, with the discussion centering on the adaptive advantages of helping in the survival of the individual and the species. Evolutionary psychologists have demonstrated that people are more likely to help those with whom they have close biological ties than those with whom they share no genetic similarities (known as kinship selection). Such helping clearly promotes the transmission of one's genes to the next generation if those carrying similar genes are assisted when in need. But humans may also help those who are not blood relatives, to the extent that these strangers are later, more likely, to return the favor. Such reciprocal altruism (as it is known) offers evolutionary advantages, at the group level (by invoking a norm of reciprocity), that may have enabled some early humans (our ancestors) to outlast others who did not develop such a norm of reciprocal altruism with others. Other modern revisions of Darwin's Evolutionary Theory point to other advantages in forming communities, trusting others, and helpfulness; these stand in contrast to earlier suggestions that human selfishness is evolutionarily programmed in ways that discourage the helping of strangers.

A more proximal influence on helpfulness comes from socialization experiences. Parents explicitly teach their children about moral and social rules and principles, and about norms for behavior, using praise and other rewards as well as punishments, to guide and shape children's behavior. For example, people who endorse the values of benevolence (seeing the importance of helpful action toward specific known others) or universalism (seeing the importance of promoting the welfare of all) are more likely to help than those who endorse more hedonistic values. However, parents also provide a more implicit form of learning for children by the example of their own behavior. Social learning theory has demonstrated that children often engage in behaviors, either prosocial or aggressive, that they have seen modeled by adults, particularly when those adults received rewards (and not punishments) for engaging in such behavior. And, indeed, children whose parents have engaged in volunteer work are more likely to volunteer later in life. For example, a group of committed civil rights activists reported that their parents had been activists of an earlier era (i.e., modeled helpfulness), as well as having established warm, positive relationships with their children. This combination appears to be especially important for internalization of such help-related norms and goals: children are more likely to adopt, as their own, those standards that are based on a nurturant model. Research has also shown that preaching helpfulness in the absence of action is ineffective, with children, not surprisingly, imitating this model's (nonhelpful) behavior.

The question has also been asked whether specific personality traits are associated with helping behavior. Relative to nonvolunteers, volunteers have been observed to possess greater degrees of self-efficacy, emotional stability, empathy, an internal locus of control, and intrinsic religiosity. Under conditions of unplanned or unexpected opportunities to help, traits, observed to be related to helpfulness, have included self-esteem, agreeableness, ascription of responsibility, dispositional empathic concern, and a high need for nurturance combined with a low need for succorance. Two important qualifications have been noted regarding the relationship of personality traits and helping behavior, especially in unexpected/unplanned situations. First, a stronger relationship between traits and helping is obtained when one combines several traits into a composite measure, as this composite better captures the more general predisposition to help others and is thus seen as indicating a prosocial (or altruistic) personality. Second, it appears that whether or not a particular trait correlates with helping depends on the fit between the trait and the specific situation. Nurturance, for example, was found to be correlated with willingness to counsel high school students but unrelated to willingness to collate and assemble class materials; this latter activity, however, was related to autonomy.

More broadly, research has shown that personality and other personal factors (such as one's values or beliefs) are more likely to affect helping behavior in certain kinds of situations, rather than in all. Specifically, such situational factors seem to operate as more powerful influences in those situations where the opportunity to help arises unexpectedly and the resulting help is unplanned (e.g., emergencies). Conversely, in situations where the help is planned and may even

involve the helper seeking out the opportunity to help (e.g., volunteer activities), there is a tendency for important personal factors to emerge as predictors of behavior. This variation in the strength of situational and personal factors, as a function of the type of situation, seems to be a general relationship: situations possessing highly salient external cues for behavior reveal situational determinants, whereas situations possessing less salient external cues reveal personal dispositions and desires that guide behavior.

One area of study where both personal and situational influences may be involved is the study of prosocial motivation. Research suggests that there may be individual differences in the ability to see the perspective of another person and, when the other is in need, to feel empathic concern for them. *Empathic concern* is an emotional state marked by feeling 'sympathetic,' 'compassionate,' and 'tender' in response to another's need and represents an orientation toward the other person's distress. Individuals with a disposition to empathize may be more likely to feel prosocial motivation and are therefore, more likely to help; their distinctiveness from other people may be most obvious in those situations when helping may be easily avoided (e.g., when those who can't empathize avoid helping). However, other research has shown that empathic concern may be the result of specific situational factors, particularly the features of the person who needs the help. Perspective-taking and empathic concern are easily achieved by potential helpers who are similar, in some way, to the person needing their help. Moreover, if a potential helper feels dissimilar from the person needing help, they may only feel distress at seeing them in need. *Personal distress*, characterized by such feelings as being 'alarmed,' and 'upset' when in a situation requiring help, may lead a person to try and leave the situation, if it is possible, so as to escape their own negative feelings rather than help. If escape is not possible, they may help but then that help is impelled by an egoistic desire to reduce their own distress rather than to reduce the other person's distress.

Studies in this area have contributed to a major debate in behavioral science which questions if helping is ever truly altruistic and motivated solely by concern for another person's welfare without reference to any personal benefits or costs for the helper, or, whether it is basically egoistic and offering benefits (or avoiding downsides) for the helper. If help to another person is offered, even at a cost to the helper and with no expected benefits, it may be determined to be purely altruistic, especially if the help is given when it would be easy to avoid doing so. On the other side of the debate, researchers continue to point out benefits that helpers can achieve through helping, which include a positive feeling about having done the right thing. Another egoistic possibility available in even the most selfless-appearing help (aside from anticipated social approval and gratitude) is the potential for a feeling of 'oneness' or a merging of self and other, which creates a feeling of shared positive outcome. This is more likely if the person needing help has a close relationship with the helper; this also means that in the most communal relationships, helping the other is essentially self-help.

Research on planned helping has usually eschewed the debate over whether helping is altruistic or egoistic and instead, has focused on the fact that helping behavior may be

motivated by both other-focused and self-focused goals at the same time, and indeed, by many different goals. This principle, and the idea that different people may engage in the same helping action for different reasons, are hallmarks of the functional approach to volunteerism (which investigates the functions that volunteering serves in the lives of those who volunteer). Researchers using this approach have identified a number of reasons for which people get involved in volunteer activities (see Table 2).

Processes

Indeed, researchers have long recognized that merely understanding the antecedents of helping behavior may not be sufficient to fully explain the experience of helping and its consequences. Actual helping is often theorized to be the result of an interplay between background characteristics (e.g., dispositions, motivations) and situational features (e.g., characteristics of the recipient of help, specific affect, and cognition that are aroused by the experience). For example, the functional approach to volunteerism suggests that motivations to volunteer have an impact on positive outcomes such as satisfaction and future intentions to volunteer only to the extent to which the volunteers' actual experiences allow them to achieve these instigating goals.

One important manifestation of the interplay of personal factors and situational features concerns the actual interactions of the helpers and the recipients, especially when helping activities involve people from different social backgrounds or with different group memberships. When a helper and a recipient of the help belong to different social groups, a number of issues may arise which influence how people feel about the experience. Researchers have long suggested that receiving help may be threatening to one's self-esteem, suggesting a weakness or an inability to take care of oneself. That is, helping often involves a relationship that is unequal in power, and may carry a suggestion that the recipient is incompetent, with the result that needing help can be embarrassing and humiliating. Also, helpers vary in the ways in which they give assistance; some are caring and supportive, whereas others may assist in more negative and threatening ways. Certainly, help that is given in a more negative and threatening manner is experienced as being more unpleasant for the recipients.

When help comes from another person who belongs to a higher status social group, the threat involved with receiving

help may take on a new meaning. Findings suggest that low-status participants may be less willing to seek help from high status participants (e.g., studies that have involved Israeli Jews and Israeli Arabs), unless it is clear that the help is designed to enable them to learn the skills that will allow them to help themselves in the future. This type of help, epitomized by the phrase, "Give a man a fish and he will eat tonight, teach a man to fish and he will eat from now on," is called *autonomy-supportive help*. In contrast, *dependency-oriented help* does nothing to help the low-status members of society to change their situation and is more likely to be rejected when such group status differences are seen as illegitimate. Following theoretical traditions that suggest that there are personal benefits to showing favoritism to one's own ingroup (and occasionally derogating outgroups), research also shows that high-status group members are less willing to offer autonomy-supportive help to low-status group members and instead prefer to offer dependency-oriented help. This pattern of behavior can serve to reinforce the existing hierarchical differences between the involved groups. As such, helping experiences may become that much more fraught when they involve bringing together people from unequal backgrounds; however, as we shall see below, the opportunities for greater social benefits may also be higher in such intergroup interactions.

Consequences

The final area to be examined concerns the impact of the help given, and particularly, if the help given was effective. Helpful actions do not necessarily carry a guarantee of success, as attested to by the proverb that 'the road to hell is paved with good intentions.' Moreover, it seems unlikely that there is some basic skill that reliably leads to effective helping. Rather, successful help is most probably related to specific skills being applied to the specific demands of a situation. It is important to point out that research has shown that possessing the relevant skills also affects the decision to help in the first place. In a staged emergency that involved a victim of electrical shock, subjects having experience with electrical equipment were more likely to intervene than those lacking this experience.

At the same time, a relevant skill is not just another variable that influences the decision to help. This was demonstrated in an experiment where subjects, either before or after receiving Red Cross training, were exposed to a mock arterial bleeding emergency. *Whether* subjects intervened or not was influenced by some of the usual bystander intervention variables (e.g., the presence or absence of other people), but *how* these people helped was affected by training – those with training were more likely to provide direct help (the application of direct pressure to the wound) whereas those without training were more likely to engage in indirect help (finding other assistance). Moreover, in the context of the medical emergency used here, failure to apply direct pressure within 4–10 min usually results in death, so indirect help may be of no help. Thus, whether a person will help, or not, is not the same as how one will help.

Research has also examined the attributions of responsibility that helpers and the recipients of their help make about both the causes of the current problem and its solution. In most studies, psychological well-being was *positively* associated with taking responsibility for solutions to problems.

Table 2 Why people volunteer

Motivation	Description
Values function	To act on and to express their prosocial values
Understanding function	To gain a sense of understanding of the world, an issue, themselves, or other people
Enhancement function	To feel more positively about themselves
Protective function	To protect themselves from feeling bad
Social function	To fulfill their social obligations and to fit in with the expectations of others
Career function	To obtain career experience and advantages

Investigations from several areas are generally consistent on this point, with an improvement being more likely when the recipients of help become active participants in solving their own problems. Research on psychotherapy provides one such example in which successful outcomes are associated with the clients' attributing the change to their own efforts.

So, the consequences of helping for recipients of help may vary depending upon the skills and abilities of helpers, the amount of responsibility taken on by recipients (if appropriate), and a number of other factors, including the magnitude of the recipient's need, the difficulty of implementing a solution (e.g., some problems require environmental, political, or social changes for a solution) and the resources that are available to assist in the act of helping. These factors may also influence the consequences of helping for helpers, the communities to which these individuals belong, and to the larger society.

Most research that examines whether helpers also benefit from offering help has examined the goals that helpers may seek to meet in their helping activities. As discussed earlier, numerous egoistic benefits can be achieved from helping and volunteers cite career benefits, social benefits, esteem benefits, and gains in understanding, as desirable personal consequences of their good work. Other research suggests that volunteerism is associated with greater well-being, better mental and physical health, and even longer lives for the elderly (although this latter effect may dissipate if too many hours are committed). However, one recent study suggests that greater well-being is only associated with motivation to help others because of the pleasure that can be derived, and helping motivated by external pressure is less related to well-being. Similarly, those who perceive a requirement to volunteer (often imposed by academic institutions as a condition of graduation) to be too controlling of their actions indicate that they will be less likely to volunteer in the future (as compared to those who are unaffected by such requirements), even if they had already demonstrated a commitment to volunteering freely in the past. These findings are not inconsistent with the notion that there are egoistic benefits to be achieved from helping, but clearly, helpers must be attuned to and value the available benefits. When volunteers find themselves in this situation, research suggests that self-focused motivation may be a greater predictor of continued volunteering than other-focused motivation. That is, those who indicate that they are purely altruistic and selfless may burn out faster than volunteers who possess a mix of self- and other-oriented motives.

Finally, helping behaviors can also have consequences for the organization that is sponsoring the helping activities (if any), the relationship between the helper and the recipient, the community at large, and the greater society. For example, researchers have examined the extent to which volunteers perceive a congruence between their own values and the mission of any organization to which they contribute their time and energy, as a predictor of continued helping (at that organization). Indeed, the respect that an organization shows to its volunteers and the pride that volunteers feel in being part of the organization can contribute to the continued commitment by volunteers, and concomitantly, to the health of the organization and its ability to achieve its mission.

Perhaps even more important for consequences at the macro level is the way in which helping behavior can create positive bonds of trust and reciprocity between helpers and

recipients. Theories focused on the generation of social capital have suggested that such bonds can be created through social participation, either as part of a member-serving organization or a public-serving organization. Although bonds between people from similar backgrounds, dubbed bonding social capital, may be easier to create, bonds between people from different backgrounds, dubbed bridging social capital, may offer more benefits to society and help override social ills that may come about when there is hostility or prejudice between groups in society. However, it is not yet clear if such helping interactions can indeed create bonds of trust across previously established group lines. Most studies of intergroup contact suggest that interactions have more positive outcomes when people meet in circumstances that offer equal status to all participants; however, such is not always the case in helping interactions where helpers and recipients may differ in power. Nevertheless, research does suggest that trust and a sense of community can be realistic outcomes of volunteerism and social participation. As such, societies may need to further promote helping behavior as a way of ensuring that these qualities are in good supply in order to assist with the many problems facing the world.

Conclusions

As with human behavior in general, prosocial action is a complex phenomenon that is affected by a variety of factors and considerations. Whether or not one helps in a situation where another person is in need depends on social forces operating in the situation, the characteristics of the particular needs of the situation, and the motivations and abilities of the potential helper. Having decided to help, the helper must decide how, and in what way, to help, with the specific type of help and approach to helping being influenced by some of the same factors, as well as by others (e.g., the helper's fundamental assumptions about the helping process). An act of helping, then, can be broadly constructed as an interactive function of the characteristics of the helper and characteristics of the helping situation.

In several respects, helping behavior is not as simple an issue as it may appear at first glance. As we have seen, there are different influences on short-term and long-term helping and both distal and proximal influences may guide the course of a helping interaction and its consequences for the recipient, the helper, and the context around them. An array of different theoretical and empirical approaches has been developed to examine helping, both in the abstract and in very specific concrete situations (as with blood donation). However, within this complexity, a generally positive view of human behavior has emerged, with evidence which shows that people are willing to help each other under many different conditions and in many different ways. The scientific endeavor continues to offer data to support new ways of understanding helping behavior and speaks of ways to ensure that it leads to benefits for all.

See also: Crowd Psychology; Empathy; Group Dynamics; Social Values (Influence on Behavior).

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Alzheimer's Disease

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Glossary

Acetylcholine A common neurotransmitter.

Amyloid angiopathy The formation of protein fragments called amyloid inside the walls of cerebral blood vessels.

Amyloid beta The main constituent of plaques in the brains of AD patients.

Amyloid plaques Hard, insoluble plaques made of protein fragments called amyloid accumulated between neurons.

APOE (apolipoprotein) gene A gene that is involved in regulating cholesterol levels. The E4 type of this gene is the major genetic risk factor for late-onset AD.

APP (amyloid precursor protein) A protein from which neurons make amyloid beta.

Autoantibody An antibody that attacks an individual's own proteins.

Blood–brain barrier A separation between the blood and the cerebrospinal fluid restricting molecules from entering the central nervous system.

Cerebrovascular Of or related to blood vessels that supply the brain.

Cholinergic Referring to cells or structures that use the neurotransmitter acetylcholine.

Dementia Loss of cognitive abilities severe enough to interfere with daily functioning.

Diabetes A condition in which normal insulin function is disrupted, resulting in an overaccumulation of glucose in the blood.

Dyslipidemia An abnormality in the lipid content in the blood.

Enzyme Biological catalysts that speed up chemical reactions in the body.

Hippocampus Brain structure important for memory.

Hypertension High blood pressure.

Inflammation The response of the immune system to injury, irritants, or infection.

Inflammatory Of or referring to inflammation.

Neurodegeneration Progressive damage to and loss of neurons.

Neurofibrillary tangles Aggregates of the protein tau found inside neurons of AD patients.

Neuropsychiatric Of or referring to psychiatric disorders attributable to nervous system disease, such as hallucinations, delusions, aggression, and depression.

Neurotransmitter Chemicals used by neurons to communicate with other cells.

Oxidative stress Increased release of unstable oxygen causes damage and possibly death of neurons.

Plaques Abnormal deposits of amyloid cell debris in the brains of AD patients.

Tau The main constituent of neurofibrillary tangles.

Alzheimer's disease (AD) is the most common form of dementia, constituting about 60–80% of all dementia cases. Dementia is defined as loss of cognitive abilities severe enough to interfere with daily functioning. AD is a progressive, degenerative, and terminal disease that currently afflicts more than 25 million people worldwide. The disease is characterized by deterioration of cognition and memory and a gradual loss of the ability to perform activities of daily living. Because the occurrence of AD is strongly associated with increasing age and because life expectancies have been rising across the world, the prevalence (occurrence) of the disease could quadruple by 2050, reaching 107 million people. Lack of effective treatment, high healthcare costs, and increasing numbers of patients make AD one of the most challenging medical conditions of our times.

History

AD was first described in 1906 by Dr. Alois Alzheimer, a German psychiatrist. The report was based on the case of a middle-aged woman with impaired memory, disorientation, a gradual loss of higher mental functions, and brain

abnormalities (plaques and tangles). Dr. Emil Kraepelin, who was Dr. Alzheimer's boss, named the disease after him in a textbook. For many years after Dr. Alzheimer's initial description, AD was not considered a major disease. Cognitive decline and dementia were considered part of normal aging and usually referred to as senility. Not until the 1970s did AD become recognized as a specific disease with well-defined abnormalities of the brain, leading to increased public awareness and research funding. It is now recognized that subtle cognitive changes do occur with aging, but very marked changes are indicative of an underlying disease process.

Symptoms

AD is characterized by a subtle onset and gradual decline. Although each person with AD is different, most individuals advance through a series of stages with progressively more serious symptoms. Because of its subtle onset, AD can progress for many years before being diagnosed. The most prominent early symptom is memory impairment, particularly the ability to remember recent events or names of familiar people or objects.

Other types of memory are initially relatively unimpaired, such as old memories from the person's past, memory for skills, and the ability to benefit from prior experiences in the performance of some task without conscious awareness of these experiences (implicit memory). Early AD is accompanied by other, initially subtle, cognitive deficits, such as impaired verbal, spatial, or problem-solving skills, as well as impaired planning, cognitive flexibility, and abstract thinking. For example, some people may have difficulty working with numbers, following a recipe, driving to a familiar location, following a conversation, or keeping track of bills. Language problems are mainly characterized by a shrinking vocabulary and word-finding difficulties (reduced verbal fluency). Other symptoms may include disorientation, increased irritability, suspicion, mood swings, depression, anxiety, withdrawal from work and social activities, apathy (or loss of motivation), and sleep disturbance.

As the disease progresses, delusions are common, as are behavior problems (e.g., aggression, wandering, disregard for normative social conduct, etc.). Reading and writing skills are progressively lost. Complex motor skills become less coordinated and there is an increased risk of falling. Patients may have trouble recognizing close relatives. In the later stages of the disease, basic activities of daily living, such as eating and dressing, become impaired. Late-stage AD is marked by the loss of recognizable speech and the inability to control bodily functions, leaving patients completely dependent on caregivers. Muscle mass and mobility may deteriorate to the point where patients are completely bed-bound, can no longer feed themselves, and may have difficulty swallowing. AD ultimately leads to death, although the cause of death may not be the disease itself but some external factor, such as infections.

The first symptoms of AD usually appear late in life, although they can occur earlier. Late-onset AD occurs after age 65 and accounts for 90% of all AD cases. Early-onset AD begins around age 30–60 years. There do not appear to be any differences in the symptoms of early- and late-onset AD.

Prevalence and Mortality

Today, the global prevalence of AD in individuals aged 60 and older is estimated to be about 5–7%. This rate doubles approximately every 5 years after age 65 so that up to 40% of individuals over age 85 are afflicted by AD. Overall, the prevalence rate of AD in the United States and Europe is higher than in developing countries. However, as life expectancy is increasing in developing countries, the prevalence of AD is projected to rise in those regions. Cross-cultural studies indicate that lifestyle factors associated with living in developed nations also increase the rates of AD in developed compared to developing nations. For example, Indians from Northern India and Yoruba from Nigeria have a significantly lower rate of occurrence of AD than Indians living in Pennsylvania and African-Americans living in Indiana, respectively. Although women are more likely to have AD than men, this is largely explained by the fact that women live longer than men. AD significantly shortens life expectancy, but survival among those with the disease varies widely. Once diagnosed with the disease, the median survival time ranges from 3 to 12 years. AD is one of the leading causes of death in developed nations.

Both the prevalence of AD and the survival time following diagnosis of AD have been reported to vary across ethnic and racial groups, but it is currently unclear whether those differences are due to genetic heritage, health, or social or cultural differences between groups. For example, compared to Americans of European descent, African and Hispanic Americans are at a greater risk for AD, whereas Asian and Native Americans are at lower risk. At the same time, the life span following a diagnosis of AD has been shown to be shortest among non-Hispanic whites than among Hispanics and African-Americans. When variables such as years of education, literacy, health status, and socioeconomic status are taken into account, these group differences are greatly reduced or disappear, suggesting that they are due to factors other than race.

Causes

The causes of AD have not been well understood, and several competing hypotheses have been proposed to explain the causes of AD.

Cholinergic Hypothesis

According to the cholinergic hypothesis, the degeneration of cholinergic neurons (neurons that use the neurotransmitter acetylcholine) in the basal forebrain of patients with AD leads to a deficiency in the neurotransmitter acetylcholine in the cerebral cortex and hippocampus of these patients. The cerebral cortex and hippocampus are brain structures that are vital for cognition, behavior, and memory. The reduction in acetylcholine transmission is thought to contribute significantly to the progressive decline in cognitive function seen in AD. Consistent with this hypothesis, acetylcholine has been linked to cognition, memory, and attention in both humans and animals. More recently, it has been suggested that non-cognitive symptoms of AD, such as depression, aggressive behavior, psychosis, and overactivity, may also be partially attributable to cholinergic dysfunction.

The cholinergic hypothesis has served as the basis for the first drug treatment approaches for AD. In support of the cholinergic hypothesis, drugs that increase acetylcholine levels are associated with modest improvements in cognition, function, and behavior of AD patients in clinical trials. However, these modest benefits are not sustained in the long term and the disease continues to progress while patients are receiving treatment. This and other findings have led some researchers to conclude that acetylcholine deficits may not be directly causal to AD, but the result of widespread brain damage and loss of neurons.

Amyloid Hypothesis

The most prominent hypothesis about the cause of AD is the amyloid hypothesis, first put forward in 1991. This hypothesis proposes that amyloid beta protein (also written A β or A-beta) deposits are the causative factor of the disease. Amyloid beta deposits are the main constituents of plaques (also called neuritic plaques, senile plaques, or amyloid plaques) that are characteristically found in postmortem brains of AD patients.

According to the amyloid hypothesis, soluble forms of amyloid beta protein may be toxic to the brain, causing programmed cell death, other brain abnormalities, such as tau tangle formation, and the clinical features of AD. Amyloid beta may also disrupt the metabolism of neurons by inhibiting certain enzyme functions and changing how neurons utilize glucose, their main source of energy.

Amyloid beta protein is a fragment of a larger protein called amyloid precursor protein (APP) that is located in the membrane of neurons. The primary function of APP is not known, but it may be important for neuron growth and survival. One mechanism by which amyloid beta accumulates in the brains of AD patients is an increase in the rate at which enzymes cleave APP into smaller fragments, thereby generating increased levels of amyloid beta. Other mechanisms for amyloid beta accumulation are faulty clearance of amyloid beta from the brain and overproduction of amyloid beta caused by genetic mutations that have been linked to early- and late-onset AD. Thus, individuals with early-onset AD typically have genetic mutations in APP or the presenilin proteins, the latter of which form subcomponents of an enzyme that cuts APP into smaller fragments to produce amyloid beta. Both the APP and the presenilin mutations act by increasing the overall production of amyloid beta or by increasing the relative or absolute level of the toxic form of amyloid beta. In addition, elevated amyloid beta deposition has been linked to inheritance of the E4 type of apolipoprotein E (APOE) gene, which is the major genetic risk factor for late-onset AD. Additional support for the amyloid hypothesis comes from the finding that the gene for APP is located on chromosome 21 and that patients with an extra copy of this chromosome, known as trisomy 21 or Down's syndrome, almost invariably develop AD by 40 years of age.

Despite all the evidence consistent with the amyloid hypothesis, a number of findings have raised questions about it. Few studies have been able to demonstrate that amyloid beta is substantially toxic to neurons and induces cell death. Rather, it appears that the toxicity is dependent on the presence of the protein tau, the main constituent of the neurofibrillary tangles. More importantly, drugs that reduce amyloid beta or clear amyloid plaques in the brain seem to have little effect on the symptoms of AD or the progression of the disease. Although there are likely to be a number of reasons for the failure of these drug studies, they strongly suggest that factors other than amyloid beta are important for the development of AD. A possible explanation for why amyloid-reducing drugs may be ineffective in ameliorating the symptoms of AD is that amyloid beta triggers tau tangle formation and other disease-related processes that, once initiated, cause the progression of AD despite reduced levels of amyloid beta.

Also problematic for the amyloid hypothesis are findings from recently developed amyloid imaging studies that are able to measure the amount of amyloid beta deposits in living human subjects. These studies have shown that up to one-third of cognitively normal older individuals show substantial amyloid beta deposits at a level that is similar to that seen in AD patients. This indicates that the presence of amyloid beta alone is not sufficient for cognitive impairment and AD. Moreover, amyloid appears to increase linearly throughout the latter years of life and the rate at which amyloid accumulates in the

brain does not appear to differ between cognitively normal individuals and AD patients. It is now believed that significant amyloid beta deposition occurs prior to the clinical symptoms of AD, which instead are linked to the degree of neurodegeneration (progressive damage to and death of neurons). Recent studies indicate that the cognitive and functional decline seen in AD patients clearly correlates with brain atrophy (shrinkage) that is not linked to the accumulation of amyloid beta in the brain. An updated version of the amyloid hypothesis suggests that a close relative of amyloid beta protein may be the culprit in the disease, whereas amyloid beta plays a complementary role. In this view, an amyloid-related mechanism that is involved in pruning neural connections early in life to eliminate nonproductive neural circuits may be triggered later in life to cause the death of neurons seen in AD.

Tau Hypothesis

The third major hypothesis about the causes of AD is the tau hypothesis. According to this view, abnormalities in the protein tau, the main component of the neurofibrillary tangles, cause the progressive neurodegeneration and clinical symptoms of AD. In this model, tau proteins pair with other threads of tau to form tangles inside neurons. These cause the disintegration of the neurons' internal support structure and transport system (the microtubules), disrupting communication between neurons and later leading neurons to collapse and die. Consistent with the tau hypothesis, the degree of tau tangle aggregation correlates with neuronal loss and appears to agree with clinical indicators of disease severity. In line with the clinical progression of AD, tau tangles first form in brain regions that are important for memory (hippocampus and entorhinal cortex), then spread to other cortical regions involved in cognition and behavior, and only later affect sensory and motor cortex, which control sensation and movement. Also consistent with the tau hypothesis, the APOE4 gene, the main genetic risk factor for late-onset AD, has been associated with increased tangle load through a different mechanism than its effect on amyloid beta. Based on these findings, potential tau-based drug treatments are currently being investigated.

Other Potential Causes

In addition to these three main hypotheses regarding the causes of AD, a number of other mechanisms have been proposed that may cause or contribute to the cause of AD. The mitochondrial cascade hypothesis holds that late-onset AD is caused by alterations in the function of the cell's mitochondria, which are responsible for energy production in cells. Increasing amounts of evidence also indicate that inflammatory processes are involved in the neurotoxicity of AD. Inflammation is the response of the immune system to injury, irritants, or infection. However, it is not clear whether inflammation is a causative agent or a downstream reaction to other events, such as amyloid and tau pathology. AD brains also show evidence of injury mediated by oxidative stress, in which increased release of unstable oxygen, such as free radicals, causes damage and possibly death of neurons. Furthermore, insulin resistance, which is seen in type 2 diabetes, has been linked to AD, although the causal mechanism is unclear. Because most

patients with AD also suffer from small-vessel cerebrovascular disease (narrowing of the small blood vessels in the brain), it has been suggested that there may be a common cause for both AD and small-vessel cerebrovascular diseases or that the two diseases are mechanistically linked. Taken together, current research suggests that multiple factors contribute to the causes of AD and that the balance among these various causes may vary from patient to patient.

Diagnosis

The most definitive diagnostic method is through postmortem examination. The suspected AD brain is tested for amyloid beta plaques, neurofibrillary tangles, and amyloid angiopathy (the formation of amyloid inside the walls of cerebral blood vessels) using antibody stains. According to postmortem diagnosis of AD, 80–90% of the antemortem clinical diagnoses are correct.

Diagnosis of AD in a person with memory complaint is based on criteria specified in the Diagnostic and Statistical Manual IV – Text Revision and from the National Institute of Neurological and Communicative Disorders and Stroke and Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA). The set of criteria states that memory loss should be established and disrupted function occurs in at least one other cognitive domain, such as language or perception, or that executive function is impaired. Some additional common symptoms include confusion, hallucinations, withdrawal, and agitation. To distinguish AD from other cognitive debilitating diseases, the onset of the symptoms must be subtle and the condition deteriorates gradually. Mild cognitive impairment (MCI) describes the category of patients who do not fit into the AD diagnosis but who do display noticeable cognitive deficits such as memory complaints. The symptoms of MCI patients do not interfere with daily life.

Many screening tests have been developed for AD diagnosis. The most commonly used is the mini-mental state exam (MMSE), which assesses competence in language, memory, basic motor skills, and orientation. Despite MMSE's widespread usage, its weaknesses include lengthiness, insensitivity to the extremes of the disease spectrum, and vulnerability to differences in education level, gender, age, and cultural background. The modified version of MMSE includes additional tests for executive function and visuospatial ability to improve the tests' reliability and validity, but the modifications have lengthened the test even further. Some medical practitioners recommend using other more accurate cognitive tests in place of MMSE, such as the Montreal Cognitive Assessment (MOCA), the DemTect, the 7-minute Screen, the General Practitioner Assessment of Cognition, and the Behavioural Neurology Assessment Short Form. The MOCA and the DemTect, in particular, are more sensitive to MCI diagnosis. The MOCA covers a wider array of cognitive abilities than the MMSE, such as clock drawing, executive functions, and abstraction. The DemTect includes word recall, semantic word fluency, backward digit span, and number transcoding.

Screening tests enable quick detection of potential AD occurrence, but a full neuropsychological assessment is necessary to accurately diagnose the disease and to distinguish it

from other dementing diseases. A typical testing battery assesses both verbal and nonverbal memory, language, attention, praxis, problem solving, and activities of daily living. Examples of tests administered to assess these abilities include the Selective Reminding Test (SRT) for verbal memory, the Benton Visual Retention Test (BVRT) for nonverbal memory, the Boston Naming Test (BNT) for language ability, the Digit Span subtest of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) for attention, the Block Design subtest of the WAIS-R for praxis, the Wisconsin Card Sorting Test for problem solving/abstract reasoning, and the Philadelphia Geriatrics center Forms for activities of daily living.

A full neuropsychological battery is crucial to AD diagnosis. Loewenstein et al. (2001) reported that, rather than a single factor, multiple distinct cognitive domains are impaired in AD. To confirm a dementia diagnosis, two or more cognitive functions have to be abnormal as determined by neuropsychological tests. Studies have further shown that different stages of AD have distinct neuropsychological profiles and may help to identify milder forms of AD. For example, Vliet et al. (2003) found that memory and abstract reasoning deficits best differentiated a group of mild AD patients from healthy elders, while scores on memory tests separated MCI patients from healthy elders.

An important diagnostic step is to administer laboratory tests to exclude the possibility of other diseases, such as thyroid diseases and anemia, which may explain the observed symptoms and thus can potentially reverse the memory deficits. Vitamin B12 deficiency contributes to cognitive deficits and has to be ruled out as a possible cause of symptoms as well.

Biomarkers

Another diagnostic step is to test for specific biomarkers found in AD. The biomarkers with the highest specificity and sensitivity are decreased levels of amyloid beta, increased total tau levels, and increased phosphorylated tau in cerebrospinal fluid. However, the necessity of a lumbar puncture, an invasive and uncomfortable procedure, to obtain these biomarkers contributes to these tests being underutilized. A number of AD biomarkers can be obtained with the less invasive method of blood draw, including amyloid beta autoantibodies, APOE, and isoprostanes, but these produce less reliable results.

Brain imaging has traditionally been used as a diagnostic tool for excluding lesions as a cause of symptoms. With recent development in imaging, however, it is becoming a valuable tool for confirming AD diagnosis. Using high-resolution structural magnetic resonance imaging (MRI), the amount of atrophy of the hippocampus, a structure that is vital for forming new long-term memories, provides high sensitivity and specificity for distinguishing AD, MCI, and healthy controls. Calculation of atrophy level is currently most accurately performed manually and takes up to 2 h. Even though programs are being developed to automate the process, which reduces the calculation time to 30 min, there is a lack of a well-validated automated procedure. Other structural imaging modalities being evaluated as a potential AD diagnostic tool include voxel-based volumetry (measures reduction in cortical gray matter), deformation-based morphometry (quantifies the amount of structural deformations in the brain from a standard template), and cortical thickness measures. These methods combined

with multivariate statistics have great potential for clinical diagnosis of AD and MCI.

Research efforts are also underway toward the imaging of brain metabolism for AD diagnosis. Fluorodeoxyglucose positron emission tomography (FDG-PET) measures glucose metabolism in the brain, which shows different patterns of activation in the parietotemporal areas for AD and normal controls with a sensitivity of 90% and a specificity of 70%. Rather than relying on glucose metabolism, a more direct technique uses Pittsburgh Compound B (PiB)-PET, which binds to amyloid plaques and fibrils to image brain regions with amyloid deposition. While studies have found greater PiB binding in AD and to a lesser degree in MCI patients, conflicting results have been reported regarding the relationship between PiB binding and memory abilities. Nevertheless, PiB-PET is under extensive research as a potential diagnostic tool for AD and MCI. Functional magnetic resonance imaging also has potential utility in AD diagnosis. For example, synaptic loss can be located with cerebral blood flow and cerebral blood volume, allowing disease progression to be tracked over time.

A comprehensive AD diagnosis procedure should include a selective combination of the instruments introduced here. For example, the Preclinical AD Scale (PAS), developed to distinguish MCI patients who will convert to AD within 5 years of MCI diagnosis from those who do not, includes six instruments: age, MMSE score, functional impairment, cognitive test performance, hippocampal atrophy, and APOE genotyping. As each of the instruments are developed and validated by further research, a more comprehensive battery of instruments will provide better accuracy in AD diagnosis.

The Brief Smell Identification Test

An interesting diagnostic test that takes advantage of olfactory deficits occurring early in AD and progressing with disease severity is under investigation at Columbia University. Ten items from the lengthier University of Pennsylvania Smell Identification Test (UPSIT) were selected to create the Brief Smell Identification Test (B-SIT) to accommodate the need for short tests in a clinical setting. Study results showed promising diagnostic capability in the B-SIT to distinguish AD, MCI, and normal controls. Furthermore, the test also identified patients who would convert from MCI to AD in follow-up visits. Replication is needed, however, to validate the test by other research groups.

One criticism of using UPSIT items for testing people with cognitive decline is its reliance on memory of odors and verbal ability. As an alternative, the Sniff Magnitude Test (SMT) uses foul smells to test for olfactory deficit and only asks subjects to report the presence or absence of smell in sniff canisters, and thus may be a better diagnostic tool.

Genetics

Genetic contributions to the development of AD differ by disease onset. Early-onset AD, characterized by disease onset before 65 years old, is attributed to mutation in genes that encode APP and the presenilins (PSEN1 and PSEN2), while the risk of having late-onset AD is associated with a gene that

encodes APOE. Hundreds of other genes have been reported to mediate the risk for late-onset AD, but none has been consistently associated with the disease. Familial AD, characterized by two or more family members diagnosed with AD, occurs in 25% of AD cases. Familial AD can be early as well as late onset, with mutations in the APP and presenilin genes accounting for 71% of early-onset familial AD. Mutation in the APP gene is classified as AD1 and occupies 10–15% of early-onset familial AD. Mutations in the PSEN1 and PSEN2 genes are classified as AD3 and AD4, respectively. Whereas AD3 occupies 20–70% of early-onset familial AD, AD4 is rarely observed.

APOE contributes to an increased risk of having late-onset AD via influencing amyloid beta metabolism. APOE has three isoforms (alleles $\epsilon 2$, $\epsilon 3$, and $\epsilon 4$), of which $\epsilon 4$ is associated with the highest risk for AD such that relative to someone without an $\epsilon 4$ allele, having one $\epsilon 4$ allele increases AD risk by 2–3 times and having two $\epsilon 4$ alleles increases the risk by 12 times. The $\epsilon 4$ allele may exert its effect via the onset, location, and amount of amyloid beta accumulation in the brain. Studies have found that in cognitively normal subjects, the amount of amyloid fibers that make up the plaques in AD increases with the occurrence of APOE $\epsilon 4$ allele. Having the $\epsilon 4$ allele does not confirm an AD diagnosis; 42% of AD patients do not have the APOE $\epsilon 4$ allele. The $\epsilon 2$ allele, however, decreases the chance of developing AD, but the incident of individuals with this allele is very rare, making the investigation of allele's protective mechanism difficult to perform.

Individuals with Down syndrome have an extra chromosome 21, which contains the gene for APP, resulting in the overexpression of APP and thus an accumulation of amyloid beta in the brain. AD symptoms are observed by the age of 40 in almost all Down syndrome individuals.

Risk Factors and Prevention

Vascular Diseases and Diabetes

A number of factors have been identified to increase the risk of developing AD, and understanding these factors can help prevent the disease. Among the major risk factors are cardiovascular diseases such as hypertension (high blood pressure), dyslipidemia (an elevation of lipids in the blood), and diabetes. Hypertension in midlife has been shown to increase the risk of AD, but the result is less consistent for hypertension developed in late-life due to the decrease in blood pressure prior to and after dementia onset. Antihypertensive drug trials have shown conflicting results in the effectiveness of reducing hypertension on lowering the risk of AD. Hypertension may increase the likelihood of developing AD by increasing the permeability of the blood–brain barrier to proteins, which results in amyloid beta accumulation in the brain. There is evidence that high cholesterol, similar to hypertension, is most predictive of AD when it is developed in midlife. However, study results have been inconsistent, and further longitudinal studies are needed to clarify its relationship to AD.

While a number of studies have shown that diabetes may increase the risk of developing AD, a few other studies did not find a significant correlation between diabetes and AD. The inconsistency may be due to confounding factors such as APOE genotype. When these effects were adjusted for, diabetes

was found to be a significant risk factor for AD. It can be difficult to isolate the effects of diabetes on AD because of the tendency for diabetes to develop in conjunction with cerebrovascular disease, which is a major risk factor for AD. Hyperglycemia (high blood sugar), which is the defining characteristic of untreated diabetes, causes oxidative stress and damage to brain tissue, which are associated with increased risk of AD. Insulin and insulin-degrading enzyme have also been found to worsen amyloid beta metabolism, further increasing the risk of AD.

Cognitive Reserve

The idea of cognitive reserve originated from the observation that given two different people with similar brain injury, one of them may exhibit obvious cognitive dysfunction, while the other may have no behavioral symptoms. This is best demonstrated by cases in which women were diagnosed with AD at autopsy but had no cognitive abnormality before death. Cognitive reserve enables the brain to maintain cognitive abilities despite brain damage, and thus, having a high level of cognitive reserve can help reduce the risk of AD symptoms.

A number of factors are positively associated with cognitive reserve: education, occupation, physical activities, and social and leisure activities. The majority of studies relating the level of education to the incidence of dementia found that education has a protective role in developing dementia, but a few studies have also reported the effect of lack of education with dementia. Furthermore, even in healthy elders, a higher level of education is associated with slower cognitive decline. Similarly, the degree of cognitive complexity in different occupations and the amount of personnel management have been shown to be associated with a lower risk of dementia. Overall, the risk of dementia is lowered with increased education, more demanding occupation, greater amounts of physical exercise, and more engagement in social and leisure activities.

A possible mechanism through which cognitive reserve decreases the risk of AD is the availability of more neuronal connections and more efficient processing, such that damage in one pathway may be compensated by using another pathway. This way, normal function can be maintained despite damage. Life experiences may increase cognitive reserve by inducing changes in neuronal processes such as greater cerebral activation and increased glucose and oxygen metabolism, and possibly reduced neurodegeneration. Higher education level and career complexity may also be associated with a healthier lifestyle and thus lower exposure to neurotoxins such as heavy drinking. The most likely possibility, however, is a combination of these different causes.

Diet

Studies on the relationship between individual nutritional components, such as antioxidants, vitamins, folic acid, and dietary fats, and risk of AD have not produced consistent results. An exception is moderate alcohol intake in which moderate amounts of alcohol (less than three servings per day) has been shown to lower the risk of AD. There is accumulating evidence, however, suggesting that certain dietary patterns are effective in lowering the risk of AD. One of the most

promising dietary patterns is based on the Mediterranean cuisine (the Mediterranean diet), consisting of vegetables, legumes, fruits, cereals, olive oil, fish, and a moderate amount of alcohol. The Mediterranean diet is associated with a lower risk of AD, and oxidation, inflammation, vascular, and metabolic disease. Furthermore, a reduction of 61–67% in AD risk was reported when the Mediterranean diet was followed along with physical exercise in elderly individuals.

Other Risk Factors

Experimental evidence suggests that traumatic brain injury may contribute to AD development. Studies have found that APP accumulates in injured axons (projections of neurons that transmit information away from the neuron's cell body), which could result in amyloid beta production. In a pig model, amyloid beta and APP were found in neurons after injury to axons. Similarly, amyloid beta accumulation and amyloid plaques were also reported in patients with axonal injury. Nevertheless, consistent evidence is lacking in epidemiological studies relating head trauma to AD.

Cigarette smoking and obesity have also been shown to increase the risk of AD, most likely because of their effect on cardiovascular health. Exposure to metals and solvents has been suggested to increase the risk of developing AD, but these findings could not be confirmed by other studies. The evidence for a link between AD and exposure to electromagnetic fields, such as power lines, electrical wiring, radio waves, X-rays, and microwaves, is also inconclusive. Occupational exposure to heavy metals, such as aluminum or mercury, has also been linked to increased risk of AD, but the evidence is mixed.

Treatment

Currently, there is no cure for AD, or a treatment that slows the neurodegeneration seen in AD. However, some drug treatments are available that can ameliorate or slow down the worsening of the symptoms of AD for a limited time in some individuals. Non-drug-based psychosocial treatments are frequently used in clinical practice, but few studies have examined their effectiveness in controlled double-blind trials.

Drug Therapies

Most currently available drugs to treat AD are based on the cholinergic hypothesis (see section 'Causes'). These drugs, also called cholinesterase inhibitors, act by increasing levels of the neurotransmitter acetylcholine in the brain to counteract the loss of cholinergic neurons. Clinical trials have shown modest improvements in cognition, function, and behavior of AD patients treated with cholinesterase inhibitors, with the greatest benefits being apparent in early stages of the disease. There seems to be little difference in the efficacy of various cholinesterase inhibitors, although some of them tend to be better tolerated by patients and have fewer side effects. Prescribing cholinesterase inhibitors to patients with MCI does not seem to delay the onset of AD. Another type of drug, memantine, reduces the effect of the neurotransmitter glutamate in the

brain. It was developed based on the finding that AD is associated with excessive release of glutamate, which can be toxic to neurons. In the United States, memantine is approved for the treatment of moderate-to-severe AD, while in Europe it is used to treat a variety of neurological disorders. Memantine has shown consistent but small effects in improving cognition and global assessment. It is associated with a few mild adverse side effects.

In general, treatment effect sizes for both cholinesterase inhibitors and memantine tend to be small, though statistically reliable, for measures of cognition and global assessment. Effects on behavior and quality of life seem to be less consistent. Both types of drugs have shown some improvement of neuropsychiatric symptoms associated with AD, such as delusions, hallucinations, apathy, and aggression. The benefits of cholinesterase inhibitors and memantine tend to be lost when the drug is discontinued. The usage of standard antipsychotics, antidepressants, anticonvulsants, and antianxiety drugs for the treatment of AD-related neuropsychiatric and behavioral symptoms is problematic, because their modest effectiveness is offset by the risk of serious adverse side effects and increased risk of mortality.

Several other drug treatments have been proposed, but they are not recommended for routine use at this time because of insufficient efficacy and/or safety in placebo-controlled trials. These include vitamins B, C, and E, folic acid with or without vitamin B12, the herbal extract ginkgo biloba, nonsteroidal anti-inflammatory drugs (such as aspirin or ibuprofen), hormone replacement therapy, the hormone melatonin, cholesterol-reducing statins, and the iron-reducing agent desferrioxamine. Currently, many other products are being tested, such as tau and tangle-reducing drugs and stem cell therapies to replace injured neurons.

Psychosocial Therapies

Much of the published evidence regarding psychosocial treatments is characterized by several limitations, including inadequate sample sizes, short study duration, use of non-standardized evaluation methods, lack of proper controls, and inadequate information on the persistence of treatment effects. In addition, studies are often not specific to AD but focus on dementia in general. Overall, the beneficial effects of psychosocial treatments are small and of a short duration. The effectiveness of particular treatments also seems to vary greatly from patient to patient. Therefore, psychosocial treatments may work best in specific, time-limited situations, tailored to the needs and preferences of an individual. Some interventions may provide pleasure for the patient and/or caregiver and for this reason be valuable despite not being effective in the treatment of the disease. Psychosocial therapies for AD can be classified into four broad groups: behavioral, cognitive, emotion-based, and stimulation-oriented approaches.

The goal of behavioral interventions is to modify specific, maladaptive, or self-destructing behaviors by learning more appropriate behaviors. Overall, behavioral interventions are not effective in treating the overall functioning of patients, but some evidence supports their use in lessening or eliminating specific problem behaviors, such as urinary incontinence.

The benefits of behavioral treatments seem to disappear when treatment is discontinued. The goal of cognitive therapies is to reduce or slow the cognitive decline seen in AD. They include cognitive orientation, cognitive retraining, and skills training. Although modest, short-lived gains in cognition, behavior, and mood have been demonstrated with cognitive therapies, some patients may experience frustration. Stimulation-oriented therapies aim to provide sensory and cognitive stimulation and seem to be modestly effective in improving behavior and mood, and enhancing socialization and the quality of life. They include recreational activities (crafts, games, pets, etc.), music and art therapies, multisensory stimulation, exercise, and aromatherapy. Emotion-oriented treatments focus on improving emotional and social functioning of AD patients and ultimately, the quality of life. They include reminiscence therapy, validation therapy, supportive psychotherapy, sensory integration, and simulated-presence therapy. Currently, there is limited evidence supporting the effectiveness of emotion-oriented therapies.

Societal Impact

Caregiver

Across the world, families are fundamental for the care of patients with dementia. This is particularly true for developing countries, where residential care units are generally unavailable. Individuals with AD need assistance with various aspects of everyday tasks, ranging from legal and financial management to feeding and bathing. AD patients are more likely to need help with everyday tasks than patients with other diseases: 32% of AD patients need help dealing with bladder and bowel incontinence versus only 13% of patients with other diseases. Care is provided by both paid and unpaid individuals, in which unpaid caregivers consist of family members, friends, or neighbors, with ages 50–64 occupying the greatest percentage. Most family caregivers are women, but the number of male caregivers is rising. Due to the slow progression of the disease, providing care for AD and other dementias also lasts for a longer duration than for other types of diseases. The need for care increases as the disease progresses and can be up to 10 h day⁻¹ for patients with severe AD.

The greater demand and longer duration of care leaves the caregiver of an AD patient more susceptible to depression and other illnesses, and can place more strain on the caregiver's finance and career. Studies have found that unpaid caregivers experience greater level of stress and have lower immune function. Some caregivers have to quit their jobs in order to take care of the AD patient, losing financial support and benefits. Caregiver interventions have been effective at increasing caregiver knowledge about AD, improving mood of caregivers, decreasing caregiver stress and depression, decreasing neuropsychiatric symptoms of patients, and delaying nursing home placement of the patient.

Economic Impact

Due to the longer term and extensive care AD patients require, healthcare costs for AD patients can be three times that for individuals of the same age group and will continue to rise as

the number of AD cases increases with the aging population. According to an estimate by the Karolinska Institute, the worldwide cost of dementia amounts to US\$315 billion per year, of which 72% is contributed by high-income countries. Healthcare costs for individuals with AD are not only paid by patients, their families, and government agencies; private businesses also pay indirectly through work missed by employees caring for an AD patient. In the developing world, caregiving is associated with substantial economic disadvantage due to cuts in paid work. A reason for the high healthcare cost for AD patients can be attributed to the tripling of hospital stays relative to the elderly without AD. Besides hospital stays, costs of healthcare for AD patients include greater likelihood of needing to stay in nursing homes and requiring home healthcare.

See also: Aging and Cognition; Aging and the Brain; Brain and Behavior Relationships; The Brain; Hippocampal Formation; Memory, Neural Substrates; Memory; Neuroimaging of Dementia; Neurotechnologies.

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Relevant Websites

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- <http://www.nia.nih.gov/Alzheimers/Publications/adfact.htm> – US National Institute on Aging: Alzheimer's disease fact sheet.
- <http://www.ninds.nih.gov/disorders/alzheimersdisease/alzheimersdisease.htm> – US National Institute of Neurological Disorders and Stroke: Alzheimer's disease information sheet.

Amnesia

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Glossary

Alcoholic blackout Amnesia without loss of consciousness, in which the intoxicated person retains the ability to perform certain 'automatized' behaviors, without any subsequent memory for the episode.

Amnesia A special case of forgetting in which the memory loss is greater than would be expected under ordinary circumstances. Anterograde amnesia affects memory for events occurring after the instigating event; retrograde amnesia affects memory for events occurring before the instigating event.

Amnesic syndrome A profound deficit in learning and memory usually associated with bilateral damage to the diencephalon or the medial portions of the temporal lobe. It always involves an anterograde amnesia, and may involve a retrograde amnesia as well.

Functional amnesia A significant loss of memory attributable to an instigating event, usually stressful, that does not result in insult, injury, or disease affecting brain tissue. Its most common forms are psychogenic amnesia, psychogenic fugue, and multiple personality disorder.

Implicit memory In contrast to explicit memory, which entails conscious recall or recognition of past events, implicit memory refers to any effect of a past experience on subsequent experience, thought, or action – for example, priming effects.

Infantile and childhood amnesia An amnesia observed in adults, affecting memory for personal experiences occurring in the first 5–7 years of life. Infantile amnesia commonly covers the period before language and speech develop.

Posthypnotic amnesia A retrograde amnesia induced by means of hypnotic suggestion; it may be canceled by a prearranged reversibility cue.

Priming A phenomenon where an event facilitates (positive priming) or impairs (negative priming) performance on another, later task.

Source amnesia A phenomenon where a subject retains access to new information acquired during a learning experience, but forgets the learning experience itself; it is commonly reflected in *cryptomnesia*, or unconscious plagiarism.

Transient global amnesia A benign and temporary amnesia characterized by sudden onset, apparently caused by momentary vascular insufficiencies affecting brain tissue.

Trauma-memory argument The notion, rooted in the nineteenth century ideas of Sigmund Freud and Pierre Janet, that psychological trauma causes amnesia by virtue of a process of repression or dissociation.

Traumatic retrograde amnesia A retrograde amnesia resulting from a concussive blow to the head; most of the affected memories are eventually recovered, except for a 'final RA' affecting the accident itself.

Amnesia

Amnesia may be defined as a special case of forgetting, where the loss of memory is greater than would be expected under ordinary circumstances. A head-injured patient is no longer able to learn things that he was once able to master easily; a patient with psychogenic fugue loses her personal identity as well as her fund of autobiographical memories. Amnesia includes frank pathologies encountered in neurological and psychiatric clinics, such as the amnesic syndrome, Alzheimer's disease (AD), traumatic retrograde amnesia (RA), and the interpersonality amnesia characteristic of multiple personality disorder (MPD). But it also includes abnormalities of memory observed ubiquitously, such as infantile and childhood amnesia, the exaggerated forgetfulness associated with normal aging, and the memory failures associated with sleep and general anesthesia. These naturally occurring failures of memory have their counterparts in amnesic states induced in otherwise normal, intact individuals by means of experimental techniques, such as electroconvulsive shock (ECS) in laboratory rats and posthypnotic amnesia in college sophomores.

Experimental research on memory began with the publication of Ebbinghaus' *Über das Gedächtniss* (*On Memory*) in 1885,

but the clinical description of amnesia dates from even earlier. Korsakoff first described the amnesic syndrome that bears his name in 1854. And in 1882, Ribot published *Les Maladies de la memoire* (*Diseases of Memory*), with a detailed description of the consequences for memory of brain insult, injury, and disease, as well as a unified theory of memory and amnesia. On the basis of his observations, and Hughlings Jackson's principle that ontogeny recapitulates phylogeny, Ribot concluded that brain disorder produces a progressive loss of memory that affects memories in the reverse order of their development. Thus, in traumatic RA, memories for events occurring immediately before the accident are most likely to be lost. This principle, now known as *Ribot's law*, does not always hold, but it was an important first step in the journey from clinical description to scientific theory.

For reasons that are not completely clear, clinical and experimental study of amnesia languished for the first half of the twentieth century, but was revived by observations of a patient, H.M. (full name: Henry Molaison), who became amnesic following surgical resection of portions of his medial-temporal lobes, including the hippocampus, in a desperate attempt to relieve intractable epileptic seizures. From the time of his operation in 1953, at the age of 27, until his death in 2009 at the

age of 82, he had no conscious recollection of any episode in his life. In addition, George Talland's 1965 pioneering monograph, *Deranged Memory*, reported an extensive psychometric and experimental study of amnesic patients with Korsakoff syndrome. These studies ushered in a 'golden age' of amnesia research in which clinicians and experimentalists joined forces under the banner of *cognitive neuropsychology* (later, renamed cognitive neuroscience) – a discipline that attempts to integrate evidence obtained from the intensive study of brain-damaged patients with theories of normal cognitive function.

The Amnesic Syndrome

The amnesic syndrome represents a profound deficit in learning and memory; it is by far the most commonly studied pathology of memory. Its most characteristic feature is a gross anterograde amnesia (AA), meaning that the person cannot remember events that have occurred since the time of the brain damage. Short-term memory (as measured by digit span, for example) is unimpaired; but after even a few moments' distraction, these patients cannot remember what they have said or done, or what has been said or done to them, just recently. In the classic case, the patient's cognitive deficits are specific to long-term memory: general intelligence, perception, reasoning, and language functions are spared. But this AA is associated with several different etiologies, and these disparate origins are associated with somewhat different patterns of memory and cognitive deficit. For more details, see 'Amnesia and the Brain' by Race and Verfaellie, following this article.

One form of the amnesic syndrome, now known as *diencephalic amnesia*, was first described by Sergei Korsakoff in association with alcoholism. These patients typically show RA as well as AA, meaning that they also have difficulties in remembering events from their premorbid life, especially those from the years immediately preceding their disease. Remote memory, such as for childhood events, is apparently preserved. Note that such a pattern conforms to Ribot's law. Chronic alcoholics often suffer from a deficiency of vitamin B₁ (thiamine) which results in bilateral damage to structures of the diencephalon, including the upper portion of the brainstem, the mammillary bodies, the dorsomedial nucleus of the thalamus, and the mamillothalamic tract. The acute phase of illness, known as Wernicke's encephalopathy, is characterized by confusion, disorders of visual function, and ataxia; Korsakoff's syndrome emerges as the chronic phase (the entire course of illness is sometimes known as Wernicke–Korsakoff syndrome). Although this disease is now typically prevented by the introduction of vitamin-enriched commercial foods, other etiologies, including vascular insufficiencies, tumors, and frontotemporal brain damage can have similar effects.

Another form of amnesic syndrome, known as *temporal lobe amnesia*, stems from bilateral lesions in the medial portion of the temporal lobe, and especially the hippocampus, entorhinal cortex, and surrounding structures (again, there are also material-specific amnesias resulting from unilateral damage to these structures). The most famous case is patient H.M., but there are many other famous cases. Other cases have been caused by brain tumors, ischemic episodes, head trauma, and herpes encephalitis. Temporal-lobe amnesics show AA by definition.

The occurrence of RA in these patients is somewhat controversial, and may vary if damage extends beyond the hippocampus itself. H.M. showed little RA; another patient, R.B., showed an RA covering only about 1 or 2 years prior to his surgery; yet another, K.C., displayed an RA covering his entire premorbid life.

There is also *frontal-lobe amnesia*, which is qualitatively different from the amnesic syndrome. Frontal-lobe patients are not globally amnesic, but they frequently show deficits on tasks requiring memory for temporal order, as well as memory for the source of newly acquired knowledge. They also lack *metamemory* capabilities – that is, they have little appreciation of the contents stored in their own memories, or in the availability of appropriate memory strategies. Patients who have frontal damage in addition to diencephalic or medial-temporal lobe damage experience their greatest difficulties on memory tasks requiring strategic planning and organization, suggesting that frontal damage may impair executive function, rather than memory per se.

Finally, *transient global amnesia* is a temporary (typically lasting several hours) condition characterized by sudden onset. It closely resembles the permanent diencephalic and medial-temporal lobe amnesias, in that it involves both AA and RA, but – as its name implies – it is brief. The condition, while frightening, is benign: after remission, there are no signs of permanent brain damage (and little risk of another episode in the future). Transient global amnesia appears to be caused by temporary vascular insufficiency affecting brain tissue; interestingly, many cases appear in association with physical exertion or mental stress.

In the absence of permanent brain damage, something akin to the amnesic syndrome may be observed in cases of *alcoholic blackout*. Blackout involves amnesia without loss of consciousness. The intoxicated individual may engage in conversation or perform other actions normally; but after regaining sobriety, he or she will have no memory for the episode. Blackouts are most commonly observed in chronic alcoholics, though they do occur to nonalcoholics who are severely intoxicated. In any case, blackout is most likely to occur when the person ingests large quantities of alcohol rapidly, especially when fatigued or hungry. Alcohol folklore suggests that the amnesia is an instance of state-dependent retrieval – that is, that the memories return when the person resumes drinking. However, laboratory research clearly indicates that the memories covered by blackout are unrecoverable, and thus that the amnesia reflects an encoding deficit. Sedative drugs, such as barbiturates and benzodiazepines, also produce irreversible AA.

The different patterns of task performance offer clues about the nature of the memory deficit in the amnesic syndrome. In principle, any instance of forgetting may be attributed to a failure at one or more of three stages of memory processing: encoding (the creation of a memory trace of a new experience), storage (the retention of trace information over time), and retrieval (the recovery of trace information for use in ongoing experience, thought, and action). Logically, a syndrome that affects memory for postmorbidity but not premorbidity events is most likely due to encoding failure. And, in fact, it has been suggested on the basis of laboratory experiments with lesioned rats and monkeys that the hippocampus and other structures in the medial-temporal lobe mediate the consolidation and storage of new memories. An alternative formulation assumes

that representations of the various elements of an event are distributed widely in the cortex, and that the hippocampus creates a kind of index and binds the elements together. In either case, the occurrence of AA means that the hippocampus is crucial for memory formation, even though the memories themselves are not stored there.

What about the RA? Some degree of RA is usually, but not always, observed in the amnesic syndrome. Logically, damage to a structure that consolidates and organizes new memories should have no effect on old ones. In some cases, RA may reflect the disruption of premorbid memories that were incompletely consolidated at the time of disease onset; this would produce a temporal gradient, but the extent of RA observed would seem to imply that proper consolidation requires weeks, months, or years instead of seconds, minutes, or hours. On the other hand, if the hippocampus serves a binding and indexing function, its destruction will create an RA by effectively preventing the retrieval of memories that remain available in storage; this would produce an amnesia for remote as well as recent memories and would not necessarily produce a temporal gradient. In some cases, what appears as RA may in fact be AA, reflecting the slow onset of an insidious disease process – and producing the appearance of a temporal gradient; this suggestion is particularly plausible in the case of diencephalic amnesia associated with chronic alcohol abuse but cannot account for amnesias of sudden onset. It has also been suggested that the RA may reflect the fact that, once activated and retrieved, premorbid memories are then *re-encoded*: as a result, the same encoding failure that produces the AA for postmorbid events results in a progressive loss of premorbid memories as well, and emergence of RA.

Even conclusions about encoding deficits must be qualified to some extent. At first glance, the AA observed in the amnesic syndrome appears to be a complete inability to acquire new information. However, closer examination indicates that certain aspects of learning and memory are spared even in the densest cases of amnesia. Thus, the patient H.M. learned to solve the Tower of Hanoi puzzle, but he did not recognize the puzzle as familiar. Amnesic patients who study the word *ELATED* do not remember it just minutes later; but when presented the stem *ELA* and asked to complete it with the first word that comes to mind, they are more likely to produce *ELATED* (as opposed to *ELASTIC* or *ELABORATE*) than would be expected by chance. The ability of amnesic patients to acquire cognitive and motor skills, and to show priming effects in word-stem completion and other tasks, shows that they are able to acquire new information through experience – although, somewhat paradoxically, they do not remember these experiences and may not be aware that they possess this knowledge.

The limits of such learning are still being studied, but already they have motivated a distinction between two expressions of episodic memory, *explicit* and *implicit*. Explicit memory (EM) refers to the conscious recollection of a previous episode, as in recall or recognition. By contrast, implicit memory (IM) refers to any change in experience, thought, or action that is attributable to such an episode, such as skill learning or priming. The dissociation between EM and IM in amnesic patients indicates that some forms of learning and memory are preserved. According to one view, amnesics suffer from a specific inability to encode declarative knowledge about

specific events, but retain an ability to acquire procedural knowledge. This would account for their ability to acquire new cognitive and motor skills. Preserved priming has been attributed to the automatic activation of declarative knowledge structures that were stored prior to the brain damage, or to the encoding of new episodic representations in a primitive perceptual memory system that lacks the kinds of information (e.g., about the meaning of an event, or its spatiotemporal context) that would support EM.

Traumatic RA

Another form of amnesia occurs as a consequence of head trauma. A very severe blow to the head can bruise gray matter and shear white matter, producing both cortical and subcortical damage that may result in AA and RA similar to that observed in the amnesic syndrome. Even in the absence of such damage, a blow to the head can result in a concussion, or temporary cessation of electrical activity in the cortex and loss of consciousness. The recovery of consciousness begins with the return of simple reflexes, then the gradual return of purposeful movement, and then speech (another pattern predicted by Ribot's law). After the patient appears fully oriented, he or she will display an AA for some time, as well as an RA for the accident itself and the events leading up to the accident. Typically, the AA is immediate, that is, it will start at the time of the trauma. But if the loss of consciousness is delayed, the onset of the AA will be delayed as well. Such *lucid intervals* suggest that the AA is a result of vascular complications that may take some time to develop.

The RA in traumatic amnesia is characterized by a temporal gradient, meaning that it is densest for events nearest the time of the accident – yet another example of Ribot's law at work. However, the gradient is broken by *islands of memory* consisting of isolated events, not necessarily personally important, that are remembered relatively well. The extent of the RA is correlated with the extent of the AA. Although the memories covered by the AA are permanently lost, apparently reflecting an encoding deficit, the RA gradually remits. It was once thought that this recovery began with the earliest memories and proceeded forward, which again would be predicted by Ribot's law. Although the most recent events are generally recovered last, more careful studies show that the shrinkage of amnesia is accomplished by filling in the gaps that surround the islands of memory, leaving a *final RA* covering the accident itself and the moments or minutes leading up to it, and perhaps a few *islands of amnesia*. The shrinkage of amnesia clearly indicates that traumatic RA is a disorder of retrieval, and that the islands of memory act as anchors to support the recovery process. However, the final RA may reflect either a loss of memory from storage or, more likely, a disruption of consolidation.

A nontraumatic form of RA is observed in psychiatric patients who are administered *electroconvulsive therapy* (ECT) for acute affective disorder. In ECT, electrical stimulation (e.g., 100 V, 500 mA for 500 ms), delivered from surface electrodes applied over the temporal lobe, induces a convulsive, tonic-clonic seizure not unlike those of *grand mal* epilepsy; after a short series of such treatments (e.g., 6–10 sessions over 2–3 weeks), patients often experience a rapid return to their normal mood state (ECT is not a cure, as episodes of

depression or mania may recur). Because they are anesthetized when the treatment is delivered, patients experience no pain or distress from the convulsions themselves; because they receive muscle relaxants, the convulsions do not result in bone trauma. However, the seizure does produce both AA and RA as adventitious consequences (i.e., unrelated to treatment success). The RA shows the same sort of temporal gradient observed following concussive blows to the head. Because there is less memory impairment (though no difference in treatment outcome) with unilateral than with bilateral electrode placement, ECT is usually delivered to the nondominant hemisphere. The RA gradually clears up (except for the moments before ECT is actually delivered), but memories affected by the AA cannot be recovered.

The amnesia induced by ECT shows a dissociation between EM and IM similar to that observed in the amnesic syndrome. In one experiment, patients who studied a list of words within 90 min following administration of ECT showed a deficit in recognition, but no deficit in priming on a word-stem completion test. In another study, patients who read word strings presented in mirror-reversed fashion before delivery of ECT later showed an advantage in reading those words, even though they failed to recognize these words as familiar.

What about the memories covered by the final RA? Although ECS may disrupt encoding processes, it does not appear to remove the memory traces from storage. The relevant evidence comes from studies of the effects on memory of ECS administered to animals. A common research paradigm is called one-trial, step-down, passive avoidance learning. A rat is placed on a shelf above an electrified floor. If the animal steps down, it receives a footshock, and jumps back up on the shelf. Under ordinary circumstances, the animal will not return to the floor: it learns in one trial to avoid the shock by doing nothing. But if the animal received a dose of ECS, after it recovers, it steps down onto the floor after being placed on the shelf. It is as if it has forgotten all about the shock.

ECS-induced amnesia shows a temporal gradient similar to that observed in other forms of traumatic RA. If the ECS is delayed from the time of the original learning experience, there is less amnesia than if it is administered immediately afterward. But the extent of amnesia also depends on how memory is measured. The same time at which the amnesic animal steps down (as if the footshock never happened), it shows a marked increase in heart rate (as if it is afraid). Moreover, if the animal receives *reminder treatments* such as tail shock in another environment or immersion in circulating ice water, it will remain on the shelf and avoid the floor. The *desynchrony* between behavioral and psychophysiological indices of fear is analogous to the dissociation between EM and IM observed in human amnesic patients; and the effectiveness of reminder treatments shows that at least some aspects of the forgotten event have been preserved. Memories covered by the final RA may never be accessible to conscious recollection, but they may nonetheless be expressed as implicit memories.

Functional Amnesia

Clinically significant amnesias are not confined to cases of organic brain syndrome. Psychiatrists and clinical psychologists

sometimes encounter forms of *functional amnesia* in a group of mental illnesses known as the *dissociative disorders*. Functional amnesia may be defined as a loss of memory that is attributable to an instigating event that does not result in insult, injury, or disease to the brain. Because there is no evidence of head injury, such memory failures are also labeled as *psychogenic amnesia*. In the classic formulation, which owes much to Sigmund Freud and Pierre Janet, traumatic stress causes amnesia via a psychological process variously labeled as *repression* or *dissociation*. Several forms of functional amnesia are listed in the *Diagnostic and Statistical Manual of Mental Disorders* under the category of the *dissociative disorders*, all of which entail a disruption of conscious memory and identity.

In the twentieth century, the *trauma-memory argument* became an important fixture of popular culture as well as clinical folklore, but empirical evidence in its favor has been surprisingly lacking. Careful prospective analyses indicate that the vast majority of victims of documented trauma, including childhood sexual abuse, remember their experiences perfectly well. Any forgetting that is observed appears most likely due to infantile and childhood amnesia (see later paragraphs), the mere passage of time, or a failure to appreciate the nature of the experience at the time it occurred (meaning that the 'trauma' was not experienced as such). Moreover, both human and animal studies indicate that high levels of physiological arousal, such as would accompany traumatic stress, enhance rather than impair memory – probably due to the activation of β -adrenergic receptors. The problem with patients suffering from posttraumatic stress disorder is not that they cannot remember their trauma; it is that they cannot forget it.

In *dissociative amnesia*, the patient cannot remember specific events, usually covering a continuous period of time, resembling RA; there is no AA. As in the amnesic syndrome and traumatic RA, the patient's fund of semantic and procedural knowledge remain intact. Compared to traumatic RA, dissociative amnesia appears to be more extensive and longer lasting. Clinical lore holds that dissociative amnesia can be reversed by hypnosis or barbiturate sedation, but evidence for the reliability of recollections produced by these techniques is largely lacking. Because of concerns about the inherently suggestive nature of hypnosis, most American legal jurisdictions forbid witnesses from offering testimony based solely on hypnotically 'refreshed' memories.

Dissociative fugue entails a more extensive loss of autobiographical memory, covering the whole of the person's life, a loss and/or change in identity, and sometimes physical relocation (from which symptom the syndrome derives its name). Such cases often come to the attention of police and health providers when a person cannot identify himself; or when she comes to herself in a strange place and does not know how she got there. Interestingly, fugue patients lose self-knowledge and autobiographical memory, but they do not seem to lose their fund of semantic memory, or their repertoire of procedural knowledge. Upon recovery the patient is left with an amnesia covering the events of the fugue state itself, and retains no knowledge of whatever identity he or she may have adopted in that state. Examination of such cases after they are resolved sometimes reveals an instigating episode of psychological stress.

In *dissociative identity disorder* (DID; formerly known as MPD), two or more personalities appear to inhabit a single body, alternating control over experience and action. One of these personalities is often 'primary,' in that it is the one that has been manifest the longest, and known by most other people. Most important in the present context, the various 'alter egos' appear to be separated by an amnesic barrier that prevents one alter ego from gaining access to the memories of another. In many cases, the amnesia is asymmetrical, in that Personality A may be aware of Personality B, but not the reverse. The amnesia largely affects identity and autobiographical memory; as a rule, the various personalities share semantic memory and procedural knowledge. The most widely accepted theory of DID holds that it develops in defense against abuse, trauma, or deprivation in early childhood – but again, actual evidence for a causal link between trauma and any form of amnesia is very weak.

Reports of DID were relatively common in the clinical literature before 1920, and then virtually disappeared. There was a resurgence of DID, bordering on epidemic, beginning in the 1970s, but it is not clear how many of these cases – and there were hundreds if not thousands of them tabulated in the literature – were iatrogenic in nature, or simply misdiagnosed. Where the alternate personalities were initially elicited through hypnosis or other special techniques, or when an amnesic barrier was absent, the case is especially suspect.

DID is sometimes offered as an insanity defense, claiming that a second personality is actually responsible for crimes of which the first personality is accused. DID does raise interesting issues of criminal law: in principle, the actions of one personality may be outside another personality's ability to control; interpersonality amnesia may prevent the accused from assisting in his or her defense; and techniques intended to elicit testimony from a personality may violate constitutional safeguards against self-incrimination. However, DID has rarely proved successful as a defense against criminal charges.

Several experimental studies confirm the existence of interpersonality amnesia in DID. Thus, for example, one alter ego is often unable to recall or recognize a list of items studied by another. Interestingly, there is some evidence that IM may be spared in these cases. Thus, one alter ego may show savings in relearning, interference, transfer of training, or priming effects involving a list studied exclusively by another one. Although the available research is somewhat ambiguous, in general it seems that the amnesic barrier is permeable in the case of implicit memories.

Just as the amnesic syndrome finds its experimental analog in drug-induced amnesia, and traumatic RA in ECT and ECS, the functional amnesias seen in the dissociative disorders have their laboratory parallel in *posthypnotic amnesia*. Following appropriate suggestions and the termination of hypnosis, many subjects cannot remember the events that transpired while they were hypnotized. After the hypnotist administers a prearranged cue, the critical memories become accessible again; the fact of reversibility marks posthypnotic amnesia as a disruption of memory retrieval. The amnesia does not occur unless it has been suggested (explicitly or implicitly), and memory is not reinstated merely by the reinduction of hypnosis; thus, posthypnotic amnesia is not an instance of state-dependent memory. Response to the amnesia suggestion is highly correlated with individual differences in hypnotizability: while

hypnotic 'virtuosos' typically show a very dense amnesia, their insusceptible counterparts show little or no forgetting.

Like the organic amnesias, posthypnotic amnesia selectively affects episodic as opposed to semantic or procedural memory. The subject may forget which words appeared on a study list, but retains the ability to use these words in speech and writing. Skills acquired in hypnosis transfer to the posthypnotic state, and suggestions for amnesia have no impact on practice effects. Subjects who learn new factual information while being hypnotized may retain it despite suggestions for amnesia, but these same subjects may well forget the circumstances in which this knowledge was acquired – a phenomenon of *source amnesia* that has also been observed in the amnesic syndrome and elsewhere. Finally, there is good evidence that priming effects are preserved in posthypnotic amnesia. That is, subjects who cannot remember words from a study list are more likely to use those words as free associations or category instances than would be expected by chance. Thus, posthypnotic amnesia shows the familiar dissociation between EM and IM.

Because functional amnesia occurs in the absence of brain damage, and because posthypnotic amnesia occurs in response to suggestion, questions inevitably arise about malingering, simulation, and behavioral compliance. Unfortunately, it is difficult to distinguish between genuine and simulated amnesia in either clinical or experimental situations. Claims of amnesia are readily accepted when there is palpable evidence of brain damage. It should be understood, however, that evidence of a significant interpersonal or sociocultural component does not necessarily mean that functional amnesia is faked. Rather, it means that functional amnesia is complex. Hypnosis may be a state of altered consciousness, but it is also a social interaction; thus, it should not be surprising to discover that the subject's response to amnesia suggestions will be influenced by the precise wording of the suggestion, the discourse context in which it is embedded, the subject's interpretation of the hypnotist's words, and perceived social demands. The social context may be important in the organic amnesias, but its role is magnified in their functional counterparts.

Amnesia Through the Life Span

Some forms of amnesia occur naturally in the course of psychological development. For example, adults rarely remember much from early childhood: the earliest memory is typically dated between the third and fourth birthdays, and is limited to a relatively small number of isolated fragments until about 5 or 7 years of age. The appearance of childhood amnesia is not merely an artifact of the long retention interval between childhood encoding and adult retrieval: something special seems to happen to memories for childhood events. *Infantile and childhood amnesia* affects only memories for personal experiences. Children acquire a vast fund of information, and a considerable repertoire of cognitive and motor skills, which they carry into adulthood. Whether this selectivity reflects merely the effects of constant rehearsal, or the dissociation between EM and IM similar to that observed in source amnesia, is not clear.

Infantile amnesia, covering the first year or two of life, may be attributed at least in part to the lack of language and to the

immaturity of the neocortex and other critical brain structures. However, the exact mechanism for childhood amnesia, covering the years after the second birthday, remains uncertain. The classic explanation for childhood amnesia was proposed by Freud. In his view, during the phallic stage of psychosexual development, the child resolves the Oedipus complex by repressing infantile sexual and aggressive impulses, as well as any thoughts, images, and memories that might be related to them. Since (according to the theory) the young child's entire mental life is concerned with these topics, all memories of early childhood are repressed – except a couple of banal *screen memories* that aid repression by giving the person something to remember. Recall that the major goal of psychoanalysis is to lift the repressive barrier, so that patients can acknowledge and cope realistically with their primitive instinctual urges. Other theories emphasize the relationship between cognitive processes employed at encoding and retrieval. For example, Ernst Schachtel proposed that memories encoded by preoedipal, 'primary-process' modes of thought cannot be retrieved by postoeidipal, 'secondary-process' schemata. A similar account can be offered from Piaget's perspective, emphasizing the incompatibility between sensory-motor and preoperational encodings, and the retrieval processes characteristic of concrete and formal operations. Note that all these theories predict that memories of childhood experience should be accessible to young children, who have not undergone the 'five-to-seven shift' (so named because of the major cognitive change occurring between these ages) between preoperational thought and concrete operations. In contrast, some theorists have argued that young children simply do not possess the information-processing capacity – specifically, the ability to pay attention to two things at once, like an event and its episodic context – required to encode retrievable memories. In this case, the prediction is that children will know little more about their childhood histories than adults do.

Although infantile and childhood amnesia are often attributed to autochthonous aspects of cognitive and neural development, it is clear that the child's interactions with other people are extremely important determinants of whether he or she will remember some past event. After all, as Ulric Neisser has pointed out, the 'five-to-seven year shift' is not simply a matter of moving from the preoperational period to concrete operations (or, for that matter, from before to after the acquisition of a theory of mind). It is also when the child first goes to school, and moves into an environment that is more structured with respect to time and place – thus affording the child an opportunity to distinguish one event from another. Even before the child enters school, research by Katherine Nelson, Robyn Fivush, Judith Hudson, and others underscores the important role played by joint reminiscence between child and parent in shaping the child's appreciation of narrative structure, including the causal as well as temporal relations among events, thus strengthening individual memories and connecting them both with each other and with the present.

At the other end of the life cycle, it appears that even the healthy aged have difficulty learning new information and remembering recent events. *Normal aging* has little effect on primary or short-term memory, as reflected in digit span or the recency component of the serial-position curve; but it has

substantial effects on secondary or long-term memory, especially after moderately long retention intervals. Again, the deficit primarily affects episodic memory: the elderly do not lose their fund of semantic information (although they may become slower on such semantic-memory tasks as word-finding); and their repertoire of procedural knowledge remains intact, provided that they have been able to maintain these skills through practice.

At the same time, it should be noted that episodic-semantic comparisons almost inevitably confound the type of memory with retention interval. Memories of recent experiences have, by definition, been encoded recently; most semantic knowledge was acquired while the individual was relatively young. Surprisingly, little is known about the ability of older individuals to learn new vocabulary or acquire new world knowledge. The aged do show impairment in episodic memory for remote events, but it is not clear whether this reflects age differences in retrieval processes, or simply the effects of the retention interval and opportunities for proactive and retroactive interference.

A relatively recent topic in research on aging memory compares EM and IM. Compared to the young, the aged show definite impairments on EM (especially free recall, less so on recognition); but they show less deficit, or none at all, on IM tasks such as stem completion. Part of the reason for their problems with EM may lie in the difficulty that the elderly have in processing contextual information. Spatial context, temporal context, and source are necessary for distinguishing one event from another, and thus crucial to conscious recollection. Whether this difficulty is specific to contextual features of events, or merely a reflection of a more general limitation on cognitive resources, is unclear.

Memory problems are confounded in the *dementing illnesses* often associated with aging – for example, AD. The severe memory problems associated with AD are likely related to the increase of neuritic plaques and neurofibrillary tangles, particularly in medial-temporal regions of the brain. These changes, as well as neuronal loss and depletion of neurotransmitters in other cortical and subcortical areas, especially the hippocampus and other medial-temporal lobe structures, contribute to the extensiveness of the disease process. Both AA and RA emerge early in the course of these diseases, and progressively worsen. In contrast to the amnesic syndrome, however, the memory deficit in dementia affects 'short-term' as well as 'long-term' memory, and forms part of a larger cluster of deficits affecting a broad swath of cognitive and emotional life, including impairments in semantic and procedural memory as well as episodic memory. In the latter stages of their illness, demented patients may show *anosognosia*, or a lack of awareness of their deficits.

Does the abnormal forgetting observed in aging and dementia extend to IM as well as EM? Research on this question is still at a very early stage, but already it seems fairly clear that IM is relatively spared in normal aging. Thus, elderly subjects fail to recognize studied words, but show priming effects on word-fragment completion. With respect to AD and other forms of dementia, however, some controversy remains. There is some evidence of intact motor-skill learning in AD patients, but there is also evidence of impaired performance on priming tasks. The issue is complicated by the fact that AD is

a progressive illness. Although impairments in EM may be observed quite early in the course of the disease, deterioration of IM may wait until later stages.

Amnesias of Everyday Experience

Amnesia is a symptom of neurological or psychiatric disorder, but it is also something that occurs in the ordinary course of everyday living. The most familiar example is *sleep*. A great deal transpires while we are asleep, including events in the external environment and endogenous activity such as dreams, nightmares, and (in some cases) episodes of somnambulism (sleep-walking) and somniloquy (sleeptalking), but virtually none of this is remembered in the morning. In fact, our inability to remember what has been happening is often the phenomenological basis for inferring that we have been asleep. Similarly, attempts at sleep learning have been almost uniformly unsuccessful, leading investigators to conclude that we are able to learn during sleep only to the extent that we stay awake. A paradox here is that a large body of evidence now indicates that sleep plays an important role in the consolidation of *presleep* memories.

Most investigators explain sleep-induced amnesia in terms of an encoding deficit or consolidation failure. According to this view, the low levels of cortical arousal characteristic of sleep effectively impair complex information-processing functions. Thus, events in the environment are not noticed, relevant information in memory is not retrieved, and traces of new experiences are not encoded in retrievable form. Some evidence favoring this view comes from studies of memory for dreams. Sleepers who are awakened during REM sleep almost invariably report a dream, apparently by virtue of retrieval from primary memory; but dreams are rarely reported upon awakening in the morning, which requires access to trace information in secondary memory. However, subjects will remember a dream in the morning if they awaken directly out of REM sleep. And dreams reported during REM awakenings will be accessible in the morning, provided that the dreamer has remained awake long enough to rehearse the dream before returning to sleep.

Most evidence of sleep-induced amnesia comes from studies of EM, leading to speculation that evidence of memory for sleep events, including successful sleep learning, might be obtained with measures of IM. Research on this topic has only just begun, but the available evidence is negative. When care is taken to insure that there is no evidence of cortical arousal indicative of awakening, subjects show neither EM nor IM for events that occurred while they were sleeping. Even if positive evidence for sleep learning were obtained, it would almost certainly not be as efficient as learning in the normal waking state.

Amnesia is also an important component of *general anesthesia* induced in surgical patients. Clinically, the success of general anesthesia is indicated by the patient's lack of response to instructions, suppression of autonomic and skeletal responses to incisions and other surgical stimuli, and absence of retrospective awareness of pain and other events occurring during surgery. Thus, by definition, amnesia is a consequence of adequate general anesthesia. But, as with

sleep, the amnesia is always assessed in terms of EM, leaving open the possibility that even adequately anesthetized patients might show IM for surgical events. Some anecdotal evidence favoring this proposition is provided by occasional cases in which patients awaken from surgery with an inexplicable dislike of their surgeon – an attitudinal change which is plausibly traced to unkind remarks made about the patient by members of the surgical team.

In recent years, this question has been the object of considerable investigation, and in fact research employing paradigms derived from studies of the amnesic syndrome has sometimes, but not always, provided evidence of spared IM. Thus, patients who are presented a list of words during surgery, sometimes show significant priming effects. Such effects are not always obtained, however; and even when they are obtained, they are relatively small. Certainly the scope of information processing during general anesthesia cannot compare to what is possible when the patient is awake and properly oriented; for example, IM after anesthesia may well be limited to the processing of the physical properties of stimuli, but not their meaning. What accounts for the different outcomes across the available research is not clear. Perhaps some anesthetic agents impair EM but spare IM, while others impair both. Such a result might yield interesting insights about the biological foundations of memory.

Theoretical and Practical Implications

Research on amnesia is intrinsically interesting, but it also has theoretical and pragmatic implications. At the theoretical level, amnesia engages our attention because it seems to carve nature at its joints. Amnesia is selective, and the difference between those aspects of memory that are impaired in some form of amnesia, and those that are spared, promises to provide information about the processes underlying memory functioning and the organization of memory into different systems. Such conclusions are based on the *logic of dissociation*. In single dissociations, Variable A affects performance on Task Y but not Task Z; in double dissociations, Variable A affects Y but not Z, while Variable B affects Z but not Y; in reversed associations, changes in A increase Y and decrease Z, while changes in B decrease Y and increase Z; in stochastic independence, performance on Task Y is uncorrelated with performance on Task Z. All other things being equal, differences such as these suggest that the tasks in question differ in qualitative terms. If they were only quantitatively different, they would be correlated with each other, and influenced by the same variables.

Such dissociations are commonly observed in amnesia. For example, the fact that the amnesic syndrome affects the recency portion of the serial-position curve, but not the primacy component, has been cited as evidence that primary (short-term) and secondary (long-term) memory are qualitatively different memory systems, perhaps with different biological substrates (one affected by the brain lesion, the other not). Evidence from amnesia also has been used to support other structural distinctions: between declarative and procedural knowledge and – within the domain of declarative knowledge – between episodic and semantic memory. Thus, amnesic patients have

difficulty learning new factual information, but retain an ability to acquire new cognitive and motor skills; and if they do retain new factual knowledge, they display amnesia for the circumstances in which this information was acquired. Logic and experience tell us that when something breaks, it does so along natural boundaries, which form lines of least resistance. When a disorder of memory separates past memory from new learning, procedural and declarative knowledge, or episodic and semantic memory, it tells us that these distinctions, conjured in the minds of theorists, actually mean something in the real world. The fact that these kinds of dissociations are observed in all sorts of amnesia – not just the amnesic syndrome, but in traumatic RA, psychogenic amnesia, and posthypnotic amnesia as well – strengthens the conclusion that the theoretical distinctions are psychologically and biologically valid.

Of particular interest in recent theory are the various dissociations between explicit and implicit expressions of episodic memory. To date, three broad classes of theories have been proposed to explain these dissociations; each has several exemplars. According to the *activation* view, the activation, by a current event, of preexisting knowledge representations is sufficient for IM; but EM requires elaborative activity, in which individually activated structures are related to each other. According to the *processing* view, IM is an automatic consequence of environmental stimulation, while EM occurs by virtue of controlled processes that are limited by attentional resources. According to the *memory systems* view, IM reflects the activity of a perceptual representation system that holds information about the form and structure of the objects of perception, and EM reflects the activity of an episodic memory system that represents knowledge about the meaning of events and the context in which they occur.

Research on the amnesic syndrome, including studies of both human patients and animal models, indicates that the medial-temporal lobe, including the hippocampus, entorhinal cortex, and perirhinal and parahippocampal cortex, forms the biological substrate of EM. But the diencephalic form of amnesic syndrome seems to indicate that the mammillary bodies and the dorsomedial nucleus of the thalamus are also critical for memory. And, of course, the hippocampus itself is a complex structure, with many elements that may each play a special role in memory processing. As research continues, investigation of amnesia will make a unique and valuable contribution to understanding the relation between EM and IM, and the biological foundations of each.

At the same time, evidence of preserved memory functioning offers new insights concerning amelioration and rehabilitation in cases of amnesia. Loss of EM has debilitating consequences for afflicted individuals in everyday life. Amnesic patients are often unable to keep track of events, remember appointments or schedules, engage in educational or vocational pursuits, or manage home activities. Attempts at rehabilitation have frequently focused on restoration of damaged EM processes either through the use of repetitive drills or by teaching patients mnemonic strategies such as visual imagery or verbal elaboration. These retraining attempts have met with limited success: there is no evidence that exercising damaged neural or cognitive mechanisms leads to positive outcomes; and although patients have sometimes been able to acquire a few pieces of information

by using mnemonic techniques, they do not use the strategies spontaneously in everyday life.

On the other hand, rehabilitation strategies that have focused on providing compensatory devices designed to bypass problems in daily life have been somewhat more promising. External aids such as notebooks, diaries, alarm watches, and environmental labels have enabled some amnesic patients to function somewhat more independently, although use of such devices often requires considerable amounts of training and practice. The hand-held computer, potentially a powerful prosthetic for people with memory impairments, has yet to be extensively used for this purpose probably because of the problems in teaching amnesic individuals how to use such a device.

The finding that IM and procedural knowledge often remain intact even in cases of severe amnesia has recently prompted researchers to begin to explore ways in which these preserved processes might be exploited beneficially for rehabilitation purposes. Cuing techniques, which take advantage of amnesic patients' ability to respond normally to word stem or fragment cues, have been used successfully to teach individuals new factual information such as vocabulary as well as procedural tasks such as data entry and word processing. Continued research in this direction, paralleling more theoretically based research concerning preserved memory functions in amnesia, should enable further progress toward improving the ability of amnesic individuals to function effectively in their everyday lives.

See also: Aging and Cognition; Alzheimer's Disease; Amnesia and the Brain; Dissociative Disorders; Episodic Memory; Hippocampal Formation; Hypnosis; Memory; Memory, Neural Substrates; Posttraumatic Stress Disorder.

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- <http://www.memory-disorders.org/> – Memory Disorders Research Society.
- <http://www.memorylossonline.com/> – Memory Loss and the Brain (Newsletter).
- <http://www.nia.nih.gov/Alzheimers/> – Memory Loss at the Movies.
- <http://www.ninds.nih.gov/disorders/tbi/tbi.htm> – Traumatic Brain Injury Information Page (NINDS).

Amnesia and the Brain

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Glossary

Amnesia Pathological memory loss resulting from brain injury, illness, or psychological disturbance.

Anterograde amnesia Impaired memory for facts or events encountered after the onset of amnesia (postmorbidity memory loss).

Confabulation Falsification of memory without the intent to mislead.

Consolidation Process by which information is assimilated and stabilized into memory. Consolidation includes both fast processes operating at the cellular level and slow processes operating at the systems level.

Declarative memory A form of memory characterized by the ability to consciously bring to mind facts and events. Declarative memory is dependent on the integrity of the limbic system. Episodic memory and semantic memory are both forms of declarative memory.

Episodic memory Memory for personally experienced events or 'episodes' that are specific in time and place.

Limbic system System of brain structures associated with memory function, including the medial temporal lobes, diencephalon, mammillary bodies, and fornix.

Medial temporal lobes Medial region of the temporal lobes associated with memory function. Subregions include the hippocampus, parahippocampal gyrus, entorhinal cortex, and perirhinal cortex.

Nondeclarative memory Memory expressed through behavioral performance without conscious memory content. Includes classical conditioning, skill learning, and repetition priming.

Retrograde amnesia Impaired memory for information acquired prior to the onset of amnesia (premorbid memory loss).

Semantic memory Memory for general knowledge (facts or concepts) that is impersonal and context-free.

The Amnesic Syndrome

Amnesia can be defined as a special case of memory loss that is distinct from ordinary forgetting. The amnesic syndrome is characterized by a profound disorder of memory in the context of preserved general intelligence and other cognitive abilities such as language, perception, and attention. Permanent amnesia can be differentiated from more common forms of memory loss, such as memory loss associated with aging or depression. In particular, amnesia is characterized by anterograde memory loss, in which patients cannot remember events that occur after the onset of amnesia. Retrograde amnesia, in which patients cannot remember experiences or information acquired before the onset of the illness, is also commonly observed, though the extent of retrograde amnesia is more variable. Occasionally patients present with focal retrograde amnesia, but this presentation has been argued to be psychogenic in nature.

The most widely studied clinical case of amnesia is patient H.M. In 1953, H.M. underwent surgery in which his medial temporal lobes (MTLs) were bilaterally resected to relieve medically intractable epileptic seizures. Though the surgery succeeded in alleviating his epileptic symptoms, H.M. immediately showed profound anterograde amnesia that persisted until his death in 2008. In the 55 years following his surgery, H.M. demonstrated a remarkable inability to learn and intentionally retrieve new information. His memory impairment was evident in many types of memory tests (e.g., cued recall, free recall, and recognition) across multiple domains of information (including verbal, visual, auditory, and somatosensory). In everyday

life, H.M. was unable to recall conversations that he had with a visitor 30 min ago, or the fact that he had a visitor at all. He could not acquire new information about salient life events occurring after his surgery, such as the death of his father, and he also had difficulty recalling premorbid memories, with most of his personal memories deriving from the age of 16 or earlier. Interestingly, despite these severe memory problems, H.M.'s IQ was above average (118 on the Wechsler Adult Intelligence Scale) and he performed normally on standard tests of perception, short-term memory, and language comprehension. The specificity of H.M.'s impairment to long-term memory provided strong evidence that the MTL is critical for normal human memory function.

While amnesia can also have a psychogenic origin, the focus of this article is on organic amnesia caused by nonprogressive brain damage to the MTL and related limbic system structures. The laterality of damage to the limbic system results in modality-specific memory impairments, with damage to left-lateralized limbic structures producing primarily impaired verbal memory (such as story recall and list learning) while damage to right-lateralized limbic structures produces impaired visual memory (such as memory for figures or designs) and sometimes, spatial memory. While left-sided lesions seem to produce more functionally significant memory problems in humans, likely due to the importance of verbal memory and language to human behavior, bilateral lesions are required for permanent global amnesia. A range of vascular, infectious, and traumatic processes can cause damage to the limbic system. The following section describes the most common etiologies of permanent amnesia.

Etiologies of Amnesia

Herpes Simplex Encephalitis

Herpes simplex encephalitis (HSE) is a viral infection that causes hemorrhagic lesions in the brain. Neural damage due to HSE typically occurs in MTL regions, including the hippocampus, entorhinal cortex, perirhinal cortex and parahippocampal cortex. Damage can also extend into the insular cortex, basal forebrain, and anterolateral and inferior temporal lobe regions. Anterograde amnesia is a prominent feature of HSE and can be accompanied by aphasia and agnosia when neural damage includes the anterolateral and inferior temporal lobes. In addition, lesions extending into lateral temporal regions can result in extensive retrograde amnesia.

Patient S.S. provides a striking demonstration of the memory impairments following HSE. Patient S.S. became densely amnesic in 1971 after developing HSE that caused bilateral lesions in anterolateral and medial portions of his temporal lobes, as well as lesions in his insula and putamen. S.S. has not been able to form any new declarative memories since the time of his illness. He cannot retain information regarding significant family matters or recent public events, and he cannot acquire new general knowledge such as vocabulary introduced into the English language since the onset of his illness. S.S. also has extensive retrograde amnesia for autobiographical and personal semantic information that includes most of his adult life. Despite these severe memory impairments, S.S. is of superior intelligence and performs well on tasks of short-term memory, language, executive function, and deductive reasoning skills.

Anoxia

Anoxic injury results from a loss of oxygen to the brain and can be caused by a variety of conditions such as cardiac arrest, respiratory distress, or carbon monoxide poisoning. Certain brain regions, such as the hippocampus, are particularly vulnerable to anoxic injury due to their physical location and biochemical makeup. Selective memory impairment following anoxia can vary from mild to severe, depending on the extent of MTL damage, and can include both anterograde and retrograde amnesia. Anoxic brain damage that extends outside the MTL to regions such as the basal ganglia, thalamus, white matter, or other neocortical regions can affect additional cognitive and perceptual abilities. In addition, anoxic injuries occurring shortly after birth can cause bilateral hippocampal atrophy leading to developmental amnesia that presents as impaired learning and retention in the face of preserved attention, reasoning, and visuospatial skills.

Stroke

Stroke can produce amnesia by blocking blood supply to various components of the limbic system, including limbic system white matter. Stroke involving the bilateral posterior cerebral artery (PCA) can cause lesions in the posterior hippocampus, parahippocampal gyrus, and occipitotemporal gyrus and can result in a dense amnesic syndrome. Anterograde amnesia following bilateral PCA stroke can include impairment in verbal recall and recognition as well as in visuospatial memory. Patients can also present with retrograde amnesia. Memory

problems can also occur following left-lateralized PCA lesions, and can affect verbal and visual information either transiently or permanently.

Stroke can also cause amnesia by damaging tissue in the thalamus. Strokes affecting blood supply to the anterior or medial regions of the thalamus most commonly occur due to small vessel occlusive disease or hypertensive hemorrhages and can damage the anterior thalamic nuclei as well as thalamo-frontal connections. Executive dysfunction frequently accompanies memory impairments, and patients often display worse performance on recall than on recognition tests. The extent and persistence of retrograde amnesia is variable.

Several features of stroke make it an important source of information about the nature of memory impairments in amnesia. First, there are usually no pre-illness neurological issues to complicate interpretation of the effects of stroke. Second, the abrupt onset of stroke avoids concerns about adaptive changes in the brain before initial assessment. Finally, stroke generates relatively discrete lesion boundaries without co-occurring diffuse injury, enabling regional effects to be mapped with greater specificity.

Wernicke–Korsakoff Syndrome

Wernicke–Korsakoff syndrome (WKS) is caused by thiamine deficiency and is most commonly observed as an effect of alcohol abuse in populations over 40 years of age. Because thiamine helps to produce energy needed for proper neuronal function, insufficient thiamine can cause neuronal damage or death. The thalamus and mammillary bodies are particularly sensitive to damage due to thiamine deficiency.

Diagnosis of WKS is given when an individual with a history of chronic, heavy drinking or malnutrition presents with anterograde amnesia. This diagnosis can be supported by neuroimaging or autopsy findings showing degeneration of the thalamus and mammillary bodies and loss of brain volume around the fourth ventricle. In the acute phase, patients exhibit a confused state, eye movement disturbances, and ataxia. In the chronic phase, patients exhibit dense anterograde amnesia that is attributed to neural damage in the anterior and dorsomedial nuclei of the thalamus and mammillothalamic tract. Confabulation and source memory errors can also occur in WKS and are thought to reflect additional frontal dysfunction. In addition to anterograde amnesia, many WKS patients also have profound retrograde amnesia that is characterized by a temporal gradient for autobiographical information (i.e., greater impairment for recent compared to remote personal memories). However, interpretation of retrograde amnesia is complicated by premorbid lifestyle characteristics and frontal dysfunction that may interfere with memory encoding and retrieval.

Anterior Communicating Artery Aneurysm

Rupture of an anterior communicating artery (ACoA) aneurysm can cause lesions in the basal forebrain, which are the origin of the cholinergic pathways to the hippocampus, the striatum, and the frontal lobes. Amnesia with ACoA aneurysm is likely due to disruption of hippocampal function, but controversy remains about the specific role of other lesioned regions. Lesions in the basal forebrain are usually bilateral

and if damage includes the basal forebrain, striatum, and frontal lobes, the resultant amnesia is severe and persistent.

Approximately 18% of ACoA aneurysm survivors will have some form of cognitive deficit, of which severe amnesia is the most common. Anterograde amnesia is characterized by delayed recall deficits for verbal and nonverbal material and memory recall is worse than recognition. Severe retrograde amnesia is also common, but is not universally observed. The clinical presentation of patients suffering from ACoA aneurysm can be complicated by significant executive deficits and prominent confabulation. Of all the etiologies of amnesia, patients with ACoA aneurysm are the most likely to be unaware of their memory deficits, which can cause safety and behavioral problems.

Information-Processing Descriptions of Amnesia

Though functional heterogeneity exists amongst the different etiologies of amnesia, comparison across cases with different lesion locations and associated deficits has enabled identification of the core information-processing deficits in amnesia. The following sections describe the core information-processing characteristics of anterograde and retrograde amnesia.

Anterograde Amnesia

Anterograde amnesia includes impaired memory for personally experienced events (episodic memory) as well as impersonal facts and concepts (semantic memory). Together, these forms of memory are categorized as declarative (explicit) memory and can be distinguished from nondeclarative (implicit) forms of memory that are largely preserved in amnesia. To demonstrate the distinction between impaired declarative and preserved nondeclarative memory in amnesia, consider the example of learning to ride a bicycle. While amnesic patients may not be able to recall specific instances when they have ridden a bicycle in the past (impaired declarative memory), they can nonetheless demonstrate the motoric skill of riding a bicycle (preserved nondeclarative memory). This example reflects one form of nondeclarative memory, procedural memory, that is intact in amnesia: amnesic patients are able to retrieve premorbidly learned motor skills and are able to acquire new ones, even if they are unable to retain declarative knowledge of having learned these skills. Other forms of nondeclarative memory that are preserved in amnesia include conditioning (provided that the conditioned stimulus and the unconditioned stimulus are overlapping) and perceptual and conceptual repetition priming. Repetition priming is the behavioral facilitation that occurs when processing a repeated compared to a novel stimulus, even without explicit awareness of the repetition. Perceptual repetition priming refers to facilitated processing of visual information, such as stimulus form, when visual information is repeated after an initial occurrence. Conceptual repetition priming refers to facilitated processing of stimulus meaning, independent from stimulus form, when analysis of stimulus meaning is repeated. The preservation of nondeclarative memory functions in amnesia is thought to reflect intact neural function in regions outside the limbic system, such as the basal ganglia and premotor/motor cortices

(motor learning), cerebellum (conditioning), and inferior and lateral temporal cortex (perceptual and conceptual priming). In the case of perceptual and conceptual priming, neocortical regions in inferior and lateral temporal cortex that store perceptual and conceptual representations are thought to be tuned with repetition such that previously accessed information can be more effectively activated and retrieved.

In contrast to largely preserved nondeclarative memory function, amnesic patients demonstrate profound declarative memory impairments on explicit memory tests requiring conscious retrieval of recent experiences. Explicit memory tests can take the form of recall or recognition. Although both recall and recognition tests require conscious retrieval of mnemonic information, they differ with respect to their processing demands and can be differentially impaired in amnesia.

According to dual-process models, recognition memory relies on two distinct processes: recollection and familiarity. Recollection refers to the effortful and intentional remembering of a prior encounter with its contextual source, whereas familiarity refers to the subjective feeling of knowing that an item was previously encountered without any knowledge of the context in which the item was acquired. Recollection and familiarity can be differentially impaired in amnesia depending on the locus of MTL damage. Amnesic patients with damage limited to the hippocampus have been described as having impaired recollection but preserved familiarity. Consistent with this theory, these patients perform poorly on free recall tasks but demonstrate intact performance on item recognition tasks. Recall deficits with hippocampal damage are thought to reflect impaired binding of contextual information into the memory trace, a process that is normally mediated by the hippocampus and makes recollection possible.

In contrast, when lesions extend into extrahippocampal regions of MTL, such as perirhinal cortex, patients demonstrate more severe declarative memory impairments that include both recollection and familiarity. These impairments are evident in both recall and recognition tests, though impairments in recall may be more severe than impairments in recognition. Extrahippocampal regions of MTL are thought to support memory for individual items without their accompanying episodic context.

While neuroimaging and neurophysiological studies provide convergent evidence for a division of labor in the MTL according to regions that support familiarity and those that support recollection, functional dissociations along these lines have not been consistently observed. An alternative proposal is that the hippocampus supports both recollection and familiarity (supporting both item recognition and recall) and that MTL subregions functionally dissociate according to whether they support stronger memories (hippocampus) or weaker memories (extrahippocampal regions of MTL). While the precise contributions of different MTL lesions to functional impairments in amnesia remain to be specified, episodic memory deficits can be considered to be a core characteristic of amnesia.

In addition to pervasive deficits in acquiring episodic information, new semantic learning can also be impaired in amnesia when MTL lesions are extensive. In such cases, patients demonstrate minimal ability to acquire new facts or concepts, particularly when this new information is difficult to incorporate into existing knowledge structures. For example,

patient H.M. was unable to acquire the meaning of new words that had entered into the vocabulary since the onset of his amnesia in 1953 (e.g., words such as 'granola' or 'jacuzzi').

The magnitude of semantic learning deficits in amnesia has been found to correspond to the amount of MTL damage. Patients with lesions limited to the hippocampus can acquire some degree of new semantic knowledge, including vocabulary words, indicating that new semantic learning can be supported by regions outside the hippocampus proper (e.g., perirhinal, parahippocampal, or lateral temporal cortex). Patients with larger MTL lesions extending into lateral temporal lobe have more severe impairments in semantic learning. Though these patients can acquire small amounts of new semantic knowledge with very extensive repetition, likely reflecting the ability of intact lateral temporal regions to gradually acquire new semantic knowledge after a great number of encoding episodes, such learning is typically very inflexible.

While the extent and location of lesions within the MTL greatly impacts the nature of anterograde memory impairments in amnesia, even more striking are the cognitive symptoms that occur when frontal deficits are superimposed on the core amnesia. Frontal lesions impair executive processes that contribute to memory, such as the ability to mentally manipulate or organize information to be encoded into memory and the ability to initiate and evaluate memory search. Executive deficits can lead to impairments in temporal or contextual aspects of memory and can lead to high levels of intrusions in recall tests or false endorsements in recognition tests. Rather than exhibiting a qualitatively different form of amnesia, patients with additional frontal lesions display a pattern of deficits consistent with a combination of a classic amnesic syndrome and additional problems associated with a frontal dysexecutive syndrome.

Retrograde Amnesia

Though many premorbid memories are preserved in amnesia, some degree of retrograde memory loss is often observed. Retrograde amnesia for events immediately preceding the onset of the brain lesion is particularly pronounced. According to Ribot's law, retrograde amnesia is characterized by a time gradient in which the memory impairment is inversely related to the age of the to-be-recalled event. By this view, memory is worse for more recent compared to more remote memories. While patients with MTL damage reliably demonstrate such a temporal gradient of retrograde memory loss for semantic information, with relative sparing of remote memory compared to recent memory, MTL damage does not spare remote memories in all cases, and patterns of retrograde amnesia appear to depend on the type of memory under investigation. In particular, when personal episodic (autobiographical) memories from different past time periods are probed (e.g., memory for events occurring during childhood, during early adulthood, and within the past 5 years), memory impairments can extend for decades and in some cases can include a patient's entire lifespan.

Temporally graded retrograde amnesia has been interpreted in terms of standard models of consolidation. In these models, memories are thought to depend on the MTL, and particularly the hippocampus, until they can be transferred to more stable cortical storage systems. The hippocampus plays a time-limited

role in memory and is crucial only for the initial consolidation of declarative memories. Thus, while MTL mechanisms are critical for the retrieval of recent memories that have yet to be consolidated, the MTL is no longer needed to retain and recover memories once consolidation is complete.

Observations of extensive temporal gradients of autobiographical memory loss are difficult to incorporate into consolidation theory, as the loss of such memories extends well beyond the time frame during which biological consolidation is likely to operate. An alternative theory, multiple trace theory, suggests that the MTL is always necessary for the retrieval of episodic memories, including both recent and remote autobiographical memories. According to multiple trace theory, older memories become more resistant to disruption because each time a memory is retrieved, a new memory trace is established that is linked to the older memory traces. Thus, older memories are represented by more and stronger traces and are more resistant to partial lesions of the MTL whereas newer memories are represented by fewer and weaker traces and are more vulnerable to damage. By this view, the extent of retrograde amnesia is determined by the amount of MTL damage as well as the number of traces by which a memory is represented. As such, very extensive MTL damage can affect autobiographical memories for all time periods.

Yet another pattern of remote memory loss is seen in patients whose lesions extend beyond the MTL into the anterolateral temporal lobes. In these cases, retrograde amnesia is characterized not only by extensive autobiographical memory loss, but also by severe semantic memory loss. The latter is thought to reflect damage to the neocortical sites where semantic information is stored. Impairments in semantic memory are often more prominent after lesions to the left temporal lobe, likely reflecting the role of the left hemisphere in verbal lexical-semantic processing.

Patients with frontal lobe damage can also present with extensive retrograde amnesia that may encompass both semantic and episodic memory. These retrograde memory impairments are particularly evident under high demands of self-initiated retrieval and likely reflect deficits in frontal executive processing. Confabulatory responses may also be prominent with frontal lobe damage, reflecting impaired monitoring of information retrieved from memory.

Theoretical and Clinical Implications

While memory deficits are the hallmark of amnesia, this article has described the important point that not all forms of memory are similarly impaired in amnesia. Memory impairments can include both retrograde and anterograde components but differ according to episodic and semantic demands and depend on lesion location and extent. Though structurally and functionally heterogeneous, amnesia provides an important window onto the multiple forms of memory supported by the human brain. The patterns of impaired and preserved function in amnesia clearly demonstrate that rather than being a unitary system, long-term memory comprises functionally and structurally distinct memory subsystems.

In addition to expanding our knowledge about long-term memory systems, studies of patients with amnesia have also

influenced our understanding of cognitive functions outside the memory domain. Emerging evidence indicates that amnesic patients have difficulty envisioning the future and are impaired at generating imaginary scenes. These results suggest that the brain regions involved in remembering the past overlap with those involved in thinking about novel future scenarios. It has been proposed that richly envisioning future scenarios requires flexible retrieval and recombination of details from the past, drawing on the same memory processes that are impaired in amnesia. The integrity of long-term memory mechanisms may also impact other related functions in amnesia, such as planning and problem solving.

While the theoretical advances provided by the study of amnesic patients are significant, caution must be taken when inferring strict one-to-one mappings of neural structure to cognitive function. In particular, the behavioral measurements indexed by standard neuropsychological tests may reflect contributions from multiple underlying cognitive processes or neural systems. Indeed, recent evidence raises questions about the independence between memory systems that has been inferred from the performance of amnesic patients on standard neuropsychological tests (such as implicit memory vs. explicit memory and short-term memory vs. long-term memory). For example, while standard neuropsychological measures suggest that memory impairments in amnesia are selective to long-term memory, a growing body of evidence suggests that short-term memory may also be impaired. In particular, recent behavioral studies of amnesic patients with damage to the MTL have demonstrated impairments in retaining relational information over delays as brief as one second. Together with recent functional neuroimaging data in humans that demonstrates delay-period activity in the MTL during short-term memory tasks, these results challenge traditional neuroanatomical dissociations between short-term memory and long-term memory and suggest that the mnemonic role of the MTL may extend beyond the long-term memory domain.

Though the nature of memory impairments in amnesia must be interpreted carefully, research into this topic will continue to enable greater clarification of how memory representations are formed in the human brain and how they contribute to behavior. In turn, such insights may serve as a foundation for improved diagnosis and more targeted treatment of memory disorders. In addition, improved understanding of how the brain supports memory can inform new rehabilitation techniques. Because pharmacological treatments for organic amnesia

are not widely tested or available, behavioral techniques currently offer the most promising method for helping amnesic patients manage and remediate their memory problems. Rehabilitative techniques that take advantage of learning mechanisms that are preserved in amnesia, such as repetitive training and implicit learning, can be effective in teaching amnesic patients new information. With such techniques, patients can be trained to use external memory aids such as personal digital assistants (PDAs) or paging devices. Such memory aids can provide useful reminders about important events, such as the need to take medications, providing functional support in everyday life.

See also: [Amnesia and the Brain](#); [Episodic Memory](#); [Memory](#); [Semantic Memory](#).

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Analogical Reasoning

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Glossary

Analog Situation or domain involved in analogical mapping; either the base (source) or target.

Base (or source) Analog from which inferences and explanatory structure are drawn; typically, the more familiar or concrete domain: for example, in the analogy 'An electric circuit is like a plumbing system,' the base is a *plumbing system*.

Candidate inference Fact posited about the target analog based on completing the common relational structure between base and target: for example, in the above analogy, a possible inference is 'Higher voltage leads to greater current in an electric circuit, just as higher pressure leads to greater water flow in a plumbing system.'

Conceptual metaphor System of words and phrases used conventionally to talk about one domain by analogy with another: for example, 'Love is a journey: The road is sometimes steep; You have to take the rough with the smooth, etc.'

Literal similarity Likeness based on overall similarity; applies when two situations are similar in their objects and entities and also in their relational structure: for example, one dishwasher tends to be literally similar to another (alike in both appearance and causal structure).

Relational similarity Likeness based on relations common to both domains or situations (whether or not the

objects in the two systems resemble each other): for example, an electrical circuit and a plumbing system can be relationally similar if they have a *common causal structure*.

Source (see base) structural alignment Identifying correspondences between two analogs, based on their common relational structure.

Structural consistency The property of having a clear set of matches between the two analogs. In a structurally consistent alignment, the parts of the two analogs are in one-to-one correspondence, and the analogy's inferences are clear.

Structural similarity (see Relational Similarity)

Surface similarity Likeness based only on similar objects and background context between two domains/situations, without a common relational structure: for example, a dishwasher may look like a clothes dryer, but their mechanical and causal relational structures are quite different.

Systematicity Preference for matching deep systems of connected relations, rather than smaller relational sets.

Target Analog one is drawing inferences about; typically the less familiar or more abstract domain: for example, in the analogy 'An electric circuit is like a plumbing system,' the target is *electric circuit*.

Introduction

Analogical reasoning – the ability to perceive and use relational similarity between two situations or events – is a fundamental aspect of human cognition. Indeed, some researchers suggest that it is the crucial cognitive mechanism that most distinguishes human cognition from that of other intelligent species. It is a core process in scientific discovery and problem-solving, as well as in categorization and decision-making.

Reasoning by analogy involves identifying a common relational system between two situations and generating further inferences driven by these commonalities. The commonalities may also include concrete property matches between the situations, but this is not necessary for analogy; what is necessary is overlap in relational structure. Although this may sound like a highly complex process, people routinely use analogy in everyday life. For example, people readily apply proverbs to situations based on purely relational matches. When you hear 'That's locking the barn door after the horse has gone,' you don't look for a barn; rather, you apply the relational pattern – *a precaution taken after the damage is done* – to some current situation. This kind of relational mapping is the essence of analogy.

In the most typical case of analogy, a familiar domain (the *base* or *source*) serves as a model by which one can comprehend

and draw new inferences about a less familiar domain (the *target*). Consider a rather timely example, used by Sterman and his colleagues at MIT to explain the behavior of atmospheric carbon dioxide; they describe the balance of carbon dioxide (CO₂) in the atmosphere by analogy with a bathtub:

The amount of water in a bathtub is determined by the rates of water flowing into the tub and water flowing out through the drain. As long as the inflow of water into the tub exceeds the outflow, the bathtub will continue to fill.

Likewise, the amount of carbon dioxide (CO₂) in the atmosphere is determined by the rates of CO₂ emissions and CO₂ removal.

In this analogy, the bathtub corresponds to the atmosphere. Water inflow corresponds to CO₂ emissions into the atmosphere and water outflow to CO₂ removal. This analogy invites the (correct) inference that as long as CO₂ emissions exceed removal, CO₂ levels in the atmosphere will continue to rise. This illustrates a typical feature of analogy: A process that cannot be seen becomes easier to grasp by virtue of an analogy with a familiar situation. This example also reveals the power of analogy to highlight a common relational pattern. Often, such a common pattern is given a linguistic label – in this case, a *stock-and-flow* system – to facilitate

remembering the abstraction and applying it to other situations. A student who grasps this analogy will find that this abstraction is useful in reasoning about other arenas, such as cash flow. Analogy is often the most effective way for people to learn a new relational abstraction; this makes it highly valuable in education.

Analogy is also frequently used in argumentation, where it allows the speaker to guide his or her audience toward a particular framing and set of inferences. For example, when a US district court judge in December 2002 ordered Microsoft to include Sun Microsystems' version of Java with the Windows operating system, a lively web discussion ensued, often involving analogy. One writer wrote: 'Please explain to me why Microsoft should be forced to include third party software in their OS? Every time I buy a six pack of coke, should a can of Pepsi be included?' and another wrote 'That would be like (my attorney) being forced to refer clients to his competition, since they didn't have as much business as him.' Many of these analogies were picked up and either extended or reversed. Defending the decision, another writer wrote 'If Ford had a monopoly on cars, they certainly would not be allowed to sell their cars with only Ford brand radios and tires ...'

As demonstrated in the above examples, analogies vary widely in their appearance, content, and usage. But they can all be characterized by a set of processes common to analogical reasoning of all types. These processes are:

- **Retrieval:** Given some current topic in working memory, a person may be reminded of a prior analogous situation in long-term memory.
- **Mapping:** Given two cases present in working memory (either through analogical retrieval or simply through encountering two cases together), mapping involves a process of aligning the representations and projecting inferences from one analog to the other.
- **Evaluation:** Once an analogical mapping has been done, the analogy and its inferences are judged.

We begin with mapping, the core process in analogical reasoning, and its subprocesses, reserving retrieval for later. The rationale for this is that, while analogical reasoning invariably involves a mapping process, it does not always require finding a second analog in memory. For example, when analogies are used in argumentation, both analogs are typically presented to the reasoner, who must then carry out a mapping and evaluate the analogy.

Mapping

Mapping is the core process of analogy, and has therefore been the main focus of analogy research. At a first level, the mapping process consists of finding how two situations are similar, and then bringing across further inferences from the better-known situation (the *base*, or *source*) to the less familiar one (the *target*). What distinguishes analogy from other kinds of similarity is that for two situations to be analogical, they must be similar in their relational structure. Analogy research has largely agreed on a set of principles laid out by Dedre Gentner in 1983, in a theory called structure mapping. According to structure-mapping theory, analogical mapping requires *aligning* the two situations based on their commonalities – particularly their common relational structure – and *projecting inferences* from the base to the target, according to this alignment.

Alignment

In an analogy, the two situations being compared can be aligned on the basis of common *relational structure*. For example, consider the simple perceptual analogy in Figure 1. These two scenes are analogous: they can be aligned – that is, the elements can be placed in one-to-one correspondence such that the same relational structure (Circle 1 > Circle 2 > Circle 3, which could be labeled *steadily decreasing size*) holds in both scenes. There is something satisfying about noticing structural alignments like this one. For example, in this case, despite the obvious object similarity between the two circles indicated by black arrows (both circles are the same size), when people are led to compare these two scenes (i.e., to engage in analogical mapping), they will match objects that occupy the same relational role in their respective figures: for example, the smallest, rightmost circles.

This same kind of alignment process occurs with a complex analogy like the bathtub example. Here too, people will align two domains based on their common relations. However, for scientific analogies, the matching relational structure will generally be governed by causal relations rather than spatial relations.

Even though most of us are not aware of how we process analogies, research suggests that there are some implicit principles that people follow during analogical mapping. First, we like our alignments to be structurally consistent. Two things are required for an alignment to be structurally consistent. First, each object in the base should match to one and only one thing in the target; this is known as *one-to-one correspondence*.

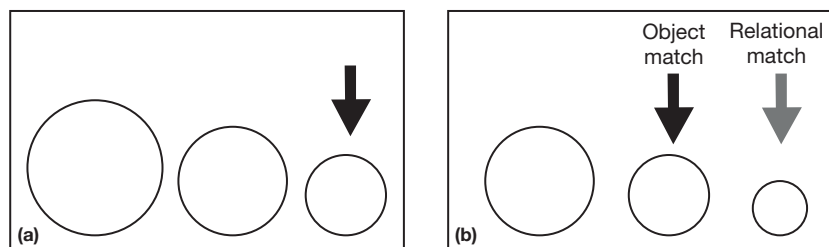


Figure 1 Perceptual analogy depicting *decreasing size*. The smallest circle in (a) could match either with the middle circle in (b) (an object match) or with the rightmost circle (the relational match). Adapted from Markman AB and Gentner D (1993) Structural alignment during similarity comparisons. *Cognitive Psychology* 25: 431–467.

For example, for the pair in Figure 1, people either map the smallest circle in 1A with the smallest circle in 1B (the relational match) or else with the middle circle (the object match) but not both. Second, if two relations are matched with one another, then their arguments must also be matched. We can see the principle of structural consistency at work in scientific analogies just as in simple spatial analogy above. For example, one-to-one correspondence holds in the bathtub analogy: water draining from the tub cannot correspond to both CO₂ emissions and CO₂ removal.

Further, when we align two situations, we do not simply find one pair of matching relations and stop there; rather, we prefer to match large, deep-connected systems. This preference is known as the *systematicity principle*: people prefer to align two domains based on large, connected relational systems, rather than just a single common relation. In the bathtub analogy, people generally prefer to align the entire stock-and-flow system that characterizes water flow and CO₂ flow, rather than simply noting that both involve the single relation of one thing flowing into another. Our desire for systematicity reflects an implicit preference for analogies that are highly informative and have inferential power.

Figure 2(a) provides a schematic depiction of structural alignment. Notice that this depiction shows a one-to-one correspondence between elements of the two domains – each element is mapped to (at most) one element in the other domain. Also, not only are relations matched but their corresponding arguments are matched as well. Finally, a large, inferentially rich relational pattern is matched, illustrating systematicity.

Inference

Analogies permit us to draw new *inferences* about the target. Indeed, one major reason we use analogy is to learn something new about the target domain by recruiting our knowledge of a relationally similar base domain. But this brings up a key question: How do we avoid drawing the many wrong (or even ridiculous) inferences that we might make if we simply mapped across whatever we know about the base to the target? Clearly, analogical reasoning would be useless if we had to spend time rejecting inferences such as *pouring Mr. Bubble into the atmosphere can make for an enjoyable evening*, which could be derived from the bathtub analogy. One key finding in analogy research is that people are highly selective in the inferences they make from analogies – we do not simply bring over everything we know about the base to the target.

According to the structure-mapping view, inference happens as a natural outcome of the structural alignment process. Once the base and target have been aligned and their common relational structure found, if there are additional parts of the relational pattern in the base that are not present in the target, then this missing pattern will be brought over as a candidate inference (Figure 2(b)). Thus, one way to think about inference generation is as a process of *relational pattern completion*. The requirement that candidate inferences be connected to the common relational pattern effectively filters which inferences will be considered. For example, in the bathtub analogy, *pouring in some Mr. Bubble makes for an enjoyable evening* is not connected to the common relational structure (as amplified below), so this inference would not normally be made.

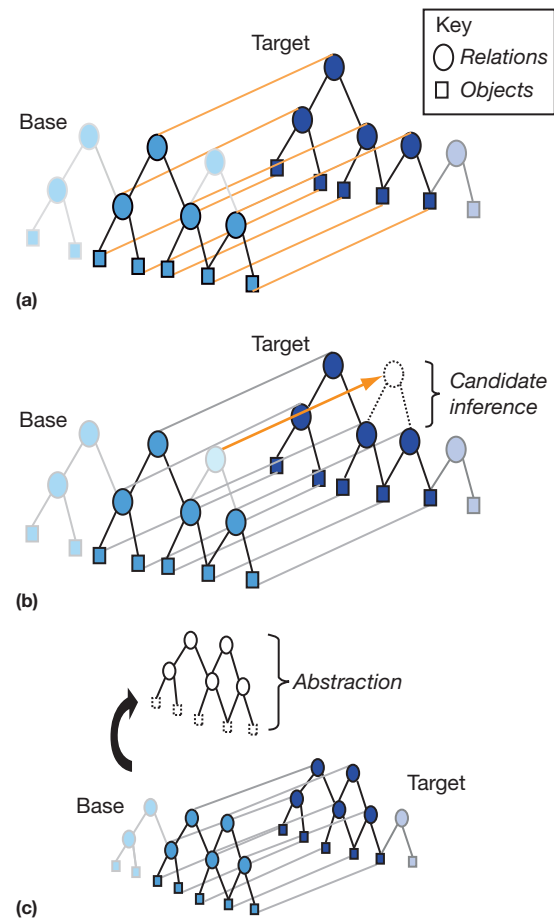


Figure 2 Analogy as structure mapping. (a) Initial alignment of common relational structure. Relations are matched between domains, and their arguments are also matched. (b) A frequent outcome of making an analogy is that candidate inferences are generated by completing the missing relational pattern in the target. (c) A possible outcome of structural alignment is abstraction of the common relational pattern.

Because inference and structural alignment are so tightly linked, perhaps it is not surprising that many of the constraints people impose on alignment they also use in inference. People prefer inferences that are consistent with the rest of the matching structure between the base and target. In addition, people prefer systematicity in inference: that is, people are more likely to project inferences that are connected to large relational patterns, rather than to project isolated parts of the base or inferences involving only a subset of the matching relational pattern. Clement and Gentner in a 1991 study found support for systematicity in inference: people were more likely to import a fact from the base to the target when it was connected to other facts shared with the target. In analogical matching and inference, people are not interested in isolated coincidental matches; rather, there is a tacit preference for deeply interconnected relational patterns.

Here is how you might generate an inference in the bathtub analogy. First, you align the known fact that *the amount of water entering and leaving the tub determines the total amount of water in the tub* with the known fact that *the amount of CO₂ entering and leaving the atmosphere determines the total amount of CO₂ in the*

atmosphere. You can then draw new inferences. For example, let us assume you know that the amount of water in the tub will decrease only if the amount of water draining is greater than the amount of water entering. You can carry this fact over to the target as an analogical inference: 'The amount of CO₂ in the atmosphere will decrease only if CO₂ removal exceeds CO₂ emissions.' This inference is warranted by its connection to the aligned relational structure.

As just discussed, one way in which analogy is useful is that it helps us learn new information about the target by suggesting inferences. Another benefit of analogy is *abstraction*: that is, we may derive a more general understanding based on abstracting the common relational pattern (Figure 2(c)). For example, on the basis of the bathtub analogy, a student might extract an abstract schema of a stock-and-flow system: as long as inflow exceeds outflow, the stock will increase; and as long as outflow exceeds inflow the stock will decrease. Once formed, this abstraction can serve as a general schema for other stock-and-flow systems, such as those that occur in economics or biology.

In addition to highlighting potential abstractions, analogies can also call attention to certain differences between the analogs. For example, a salient difference between the CO₂ system and the bathtub system is that the amount of water in a bathtub can change rather quickly by adjusting the inflow or outflow, whereas if you adjust CO₂ emissions and removal, it takes several decades to see a corresponding change in CO₂ levels in the atmosphere.

Evaluation

Once the common alignment and the inferences have been generated, the analogy and its inferences are evaluated. The criteria for evaluation can be grouped into three classes. The first factor is the *factual correctness* of the inferences generated by the analogy. If the analogy yields inferences that are untrue, the inferences and the analogy will in general be rejected, or at least revised. Of course, in some cases one cannot immediately identify whether an inference is true or not, as when making predictions about a future event, or when predicting a scientific outcome by analogy with another domain. A related factor in evaluating inferences is *adaptability*: how easy it is to modify a fact from the base to fit the target. People accept inferences that are highly adaptable to the target more readily than those that are less adaptable.

A second factor that people use in the evaluation of inferences is *goal relevance*. Goal relevance has been explored as a major factor in analogical reasoning in the theories of Keith Holyoak and colleagues. They emphasize that inferences that are relevant to the current goals of the reasoner are more likely to be projected during analogical inference, and are more important in evaluating the analogy. This constraint is particularly germane in problem-solving situations. During problem-solving, even if an analogy yields a reasonable inference, it is unlikely to be retained if it does not bear on the problem at hand. Spellman and Holyoak showed in a 1996 study that when two possible mappings are available for a given analogy, people will select the mapping whose inferences are relevant to their goals.

A third factor that may influence evaluation is how much new knowledge the analogy and its inferences can potentially

provide. The idea is that inferences that potentially yield a significant gain in new knowledge may be desirable (even if somewhat risky), especially when brainstorming or dealing with unfamiliar domains. The evaluation of inferences and of the whole analogy can mutually influence one another. Evaluation of particular inferences contributes to the larger evaluation of the analogy. If an analogy generates false inferences, we will generally reject or at least revise the analogy.

Analogical Retrieval

So far, we have been discussing a scenario in which two analogs are already present in working memory. However, sometimes only one analog is currently present, and we experience a reminding to something that may be similar or analogous (e.g., a previously solved problem). Thus, understanding the use of analogy in reasoning requires some account of how potential analogs are accessed in long-term memory – what leads people to think of analogies? While relational similarity exerts a strong influence on analogical mapping, it has much weaker effects on retrieval from memory. People often fail to retrieve potentially useful analogs, even if they share relational structure. In a classic 1980 study by Mary Gick and Keith Holyoak, participants were given a very difficult insight problem. When people simply read the problem and tried to solve it, only 10% succeeded. When another group was given a story with an analogous solution (but with different specific content) before receiving the insight problem, about 30% solved it – three times as many as without the analogy. Yet despite this impressive gain, the majority still typically failed to solve the problem. Although one might have suspected that they had simply forgotten or never encoded the analogous story, this was not the case. When people were given a hint to try using the prior story, the proportion solving the problem rose to around 90%. Thus, the solution rate tripled if people had heard an analogous story; and it tripled again if people were reminded of the prior analog. People's failure to access the prior analogous problem resulted not from forgetting it but from failure to be reminded of it by the current problem. This is an example of what Alfred North Whitehead called 'inert knowledge' – knowledge that is not accessed when needed.

Reminders to potential analogs are typically driven by surface similarities, such as similar objects and contexts, rather than by similarities in relational structure. Of course, it is important to bear in mind that in all these studies, some individuals show genuine relational transfer. It is not the case that relational reminders never occur; it's just that they are much rarer than surface reminders and overall similarity reminders. Gentner and colleagues have proposed two inter-related explanations for this. First, people often encode experiences in a content-specific manner, so that later reminders occur only for highly surface-similar experiences. Second, there is evidence that people's representations of relations are more context-specific than those of objects and entities. For example, Brian Ross gave people mathematical word problems to study, and later gave them new word problems. Most of their later reminders were to examples that were similar on the surface (e.g., both problems talked about mechanics), irrespective of whether the underlying mathematical principles matched.

Experts in a domain are more likely than novices to retrieve relationally similar examples, but even experts retrieve some examples that are similar only on the surface. However, as demonstrated by Laura Novick in 1988, experts reject misleading surface reminders more quickly than do novices. Thus, especially for novices, there is an unfortunate dissociation: while accuracy of transfer depends critically on the degree of relational pattern matching, memory retrieval depends largely on surface similarity between domains.

Factors that Influence Mapping

People's fluency in carrying out analogical mappings is influenced by three broad kinds of factors. First are factors internal to the analogical mapping itself, such as systematicity – whether the common relational system possesses a deeply connected structure – and transparency – the degree to which corresponding elements are similar. The second category includes characteristics of the reasoner, such as age and expertise. The third includes task factors such as processing load, time pressure, and context.

We have already discussed the importance of structural consistency and systematicity in analogical mapping, so we turn directly to transparency. *Transparency* depends chiefly on the degree of similarity between corresponding objects. A high-transparency analogy is one in which the objects that play the same roles in the common relational structure are highly similar (or identical), and the objects that play different roles are quite dissimilar. Such an analogy is generally both obvious and easy to align correctly. The most pronounced case of high transparency is *literal similarity*, in which both relations and objects match. As discussed above, literal-similarity matches are more reliably retrieved from memory than are purely relational analogies. To this, we can add that even in online processing, literal-similarity matches are processed faster than purely relational matches (in which the corresponding objects lack similarity). This fits with our intuitions: for example, it is easier to see how one tiger is like another than to see how a tiger is like an eagle (both are carnivores that hunt alone). However, although high-transparency matches are natural and easy to process, many useful explanatory analogies are of relatively low transparency – that is, the corresponding objects are not at all similar. The bathtub analogy discussed earlier is an example of a low-transparency analogy: the corresponding objects are very dissimilar, for example, water looks very different from CO₂ (and in any case, we never directly observe CO₂ molecules). Finally, as noted above, achieving a relational alignment is more difficult when noncorresponding objects are similar. Thus, the worst case of low transparency is *cross-mapped* analogy, in which similar objects play *different* roles within the relational structure, as exemplified below.

Both transparency and systematicity interact with individual characteristics of the reasoner, notably age and experience. For example, Gentner and Toupin gave children a simple story and asked them to reenact the story with new characters. Both 6- and 9-year-olds performed best when the corresponding characters were highly similar between the two stories (the literal-similarity condition – high transparency). They performed less well when corresponding characters were different

(medium transparency), and they performed worst when similar characters played different roles across the two stories (the cross-mapped condition – low transparency). Thus, both age groups were sensitive to the transparency of the correspondences. In addition, older children (but not younger children) benefited strongly from systematicity: when they were given a summary statement that provided the structure for the plot, their performance stayed high regardless of transparency. They were able to use the relational system provided by the plot description to maintain relational correspondences despite the tempting object matches.

Further studies have corroborated this finding that when relational similarity is pitted against object similarity as in the cross-mapped conditions mentioned above, younger children are highly influenced by object matches and less able to attend to relational matches than are older participants. This shift from a focus on objects to a focus on relations has been termed the *relational shift*. Although there is widespread agreement that such a shift occurs, developmental researchers differ on why. Gentner and colleagues have argued that the relational shift is driven primarily by gains in relational knowledge. An alternative view, proposed by Graeme Halford and colleagues, is that the shift results from a developmental increase in processing capacity; according to this view, processing relational matches requires more processing capacity than processing simple object matches. A third view, championed by Lindsey Richland and colleagues, explains the relational shift as stemming from maturational increases in inhibitory control, which permits the child to suppress object matches in favor of relational matches.

The third class of factors affecting analogical processing concerns task variables such as time pressure, processing load, and immediate context. One generalization that emerges from several studies is that making relational matches requires more time and processing resources than making object attribute matches. For example, a study by Robert Goldstone and Doug Medin found that when people are forced to answer quickly, they are strongly influenced by object matches (such as a black wing with a black wing), even in cases where they would choose a relational match (such as both wings same color with each analog) if given sufficient time.

Adult performance in mapping tasks is also influenced by immediately preceding experiences. For example, in the one-shot mapping task of Markman and Gentner, subjects are shown a pair of cross-mapped pictures, such as a truck towing a car and a car towing a boat (Figure 3). The experimenter points to the car in the first picture, and the subject indicates which object in the second picture 'goes with' it. Subjects often choose the object match (e.g., the other car). However, if they have previously rated the similarity of the pair, they are likely to choose the relational match (the boat). These findings suggest that carrying out a similarity comparison encourages structural alignment.

This one-shot mapping task has also been used to test whether processing load influences analogical processing. The experimenter pointed to the cross-mapped object in the first picture (the car), and subjects were instructed to point to the relational correspondence (the boat) in the second picture. Subjects made more object-mapping errors when given an extra processing load, such as having to count backward.

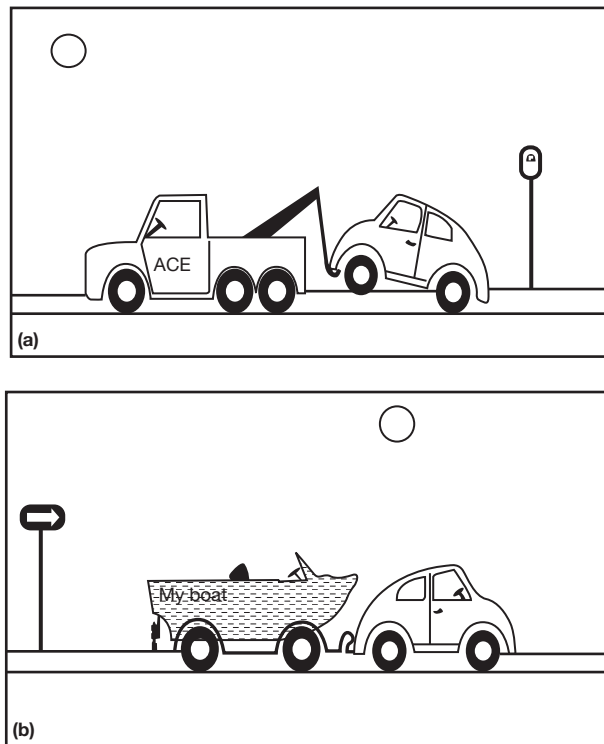


Figure 3 Sample cross-mapped pictures from the Markman and Gentner study. Carrying out a prior comparison increases the likelihood that adults will match the car in (a) with the boat in (b) based on their common relational role (both are the things being towed), rather than simply matching the two cars.

Neuropsychology of Analogical Reasoning

Recent studies have begun investigating the neural correlates of analogical processing. The studies so far converge on areas within the left prefrontal cortex as important in analogical reasoning. Of course, much remains to be discovered. We do not yet know the degree to which these prefrontal areas are specialized for analogy as compared to other higher order reasoning processes. We also do not yet know whether and to what degree other areas of the brain are involved in analogy, and whether this differs according to the type of analogy. Further studies exploring a greater range of analogical tasks and materials should give us a more complete picture.

Analogy in Naturalistic Settings

Analogy researchers note that analogy is a ubiquitous component of human thinking. However, much of the research focuses on analogy use in one very specific setting: the experimental psychology laboratory. Many studies of analogical reasoning in the laboratory have adopted an approach of explicitly providing participants with an analogy and eliciting particular responses from them (e.g., inference preference ratings, identifying correspondences). This method enables psychologists to closely observe phenomena tied to analogical mapping. However, this state of affairs suggests two questions: (1) To what degree do people spontaneously use analogies in

real-world contexts? and (2) Is this analogical reasoning guided by the same preferences (e.g., relational priority, systematicity) identified in the laboratory? For this discussion, we move out of the laboratory to review work on analogy in real-world settings, or analogy ‘in the wild.’

Dunbar and his colleagues have investigated the use of analogy in naturalistic environments in a variety of contexts. In one project, he studied the day-to-day processes of scientists in microbiology laboratories. Dunbar found that analogical thinking was a key component of all aspects of scientific reasoning, ranging from hypothesis generation to experimental design, data interpretation and explanation. Analogy is also a key component of the way scientists reason about unexpected findings. Interestingly, Dunbar observed that many of the analogies scientists made were of high overall similarity, sharing not only causal structure but also many superficial features. For example, a scientist working on a novel type of bacterium might hypothesize that its genetic sequence is like that of a highly similar species. These studies suggest that people frequently make analogies that reveal deep relational similarities, but that superficial similarity between domains aids in the noticing of these analogies, as many theories of analogy would predict.

However, scientists do sometimes use the kind of dramatic analogy that constitutes a true leap in understanding. For example, Robert Boyle likened molecular motion to leaves being swirled around by the wind; and Johannes Kepler likened the course of the planets around the sun to the course of a boat steering in a current (the gravitational attraction). Historical analyses have documented many cases like these, in which scientists have used analogies based on relational patterns that share little or no superficial similarity. These types of analogies often occur in connection with larger discoveries and shifts of paradigms, such as Rutherford’s analogy likening the structure of an atom to that of the solar system, which displaced the then-dominant plum-pudding model.

One interesting case of everyday analogy is the use of conceptual metaphors, as discussed by George Lakoff, Mark Johnson, and colleagues. For example, statements like ‘Their marriage is going over some serious bumps in the road’ or ‘They’re just coasting along without putting in energy’ would be part of the ‘love is a journey’ conceptual metaphor. Often, the same base term can be conventionally used with many different targets; for example, we can liken progress in a career, in college, or even in a specific project to a journey, as in ‘she’s zipping along on her paper, way ahead of the other students.’ Many of these metaphoric systems behave like extended analogies, as illustrated by the journey example. Another frequently used example is the conventional mapping from space to time, as in ‘The holidays will soon be here’ and ‘Exams will come after the holidays this year.’ We also find extended analogical metaphors in the introduction of new technical concepts, such as (*computer*) *virus*, and accompanying ideas such as *antibodies* against such viruses.

Another everyday use of analogy is in humor. For example, Benjamin Franklin stated, “A countryman between two lawyers is like a fish between two cats.” A more elaborate example comes from Louis Menand, writing in the *New Yorker* of February 23, 2009: “Postmodernism is the Swiss Army knife of critical concepts. It’s definitely overloaded, and it can do almost any job you need done.” Research by Jeff Loewenstein and Chip Heath in

2009 has shown that many jokes (as well as many children's stories and advertisements) follow a three-step *repetition-break plot structure*: two closely similar stories are given, followed by the *break* – a sudden change from the parallel plot structure. This kind of structure will be familiar to anyone who has heard a 'three guys walk into a bar' joke; the first two, closely similar, stories set up an aligned structure, and the humor comes from the surprise when the third story 'breaks' that structure.

Analogical Reasoning Without Awareness

Analogical reasoning has typically been considered a high-level reasoning process; for this reason, analogy has traditionally been thought of as a deliberate, conscious activity. Much of the research on analogy accords with this assumption: experimental work tends to focus on the deliberate use of analogy, where learners either discover or are given an analogy, use it to derive new inferences, and accept only those inferences that they consider structurally sound, plausible, and goal-relevant. However, research in the past decade has demonstrated that not all analogical reasoning is deliberate. Isabelle Blanchette and Kevin Dunbar first demonstrated the *analogical insertion effect*, in which analogical inferences are integrated unknowingly into mental representations of the target domain. In their studies, participants read descriptions of a target issue (e.g., legalizing marijuana) and then were given an analogy to another situation (e.g., ending Prohibition). On a subsequent recognition test, these participants often misidentified analogical inferences as facts actually presented about the target: that is, they mistakenly 'recognized' assertions about marijuana repeal as part of the passage, when what they had actually read was the analogous assertions about alcohol and Prohibition.

The studies just described demonstrate that analogical inferences can be drawn without the reasoner's full awareness. However, in both of these studies, the participants were explicitly told about the analogy between the two domains. This invites the question of whether analogical inference can occur without explicit awareness of the analogy. Recent research by Samuel Day and Dedre Gentner shows that the answer is yes. In their study, people read a series of brief passages and then answered questions about one of the later passages. Unbeknownst to the participants, the later passage was analogous to a prior passage, of which there were two versions. The results revealed that participants spontaneously made analogical inferences from whichever version of the early passage they had received, without recognition of having done so. These results show that information from a single analogous instance can influence the way in which another situation is understood or remembered without an individual's awareness. This suggests the intriguing possibility that analogy may be a process by which people implicitly understand and structure everyday experiences, and form abstract schemas over similar experiences.

Conclusion

Analogy is at the core of higher-order cognition. As Douglas Hofstadter puts it, "Analogy is the engine of cognition." Analogical thinking enters into creative discovery, problem-solving, categorization, and learning and transfer. This realization has

led to a surge in research activity over the last three decades, resulting in great gains in our understanding of analogical processing. But there remain many open questions. We need a better understanding of how analogy operates in everyday learning and reasoning. What determines when people will spontaneously compare things, and how much they will profit from the comparison? Are spontaneous, nonaware analogies common, and if so what are their effects? When and how do people filter out bad analogies? Another area that is being actively explored is the neural underpinnings of analogical processing, as discussed above. There has also been recent interest in further specifying the development of analogical ability in children, and also in understanding the role of analogy in children's everyday learning across a variety of domains, from language acquisition to category formation. Finally, we are just beginning to explore analogical processing in other species. Cross-species comparisons will help to delineate the cognitive components of analogical ability.

See also: Creative and Imaginative Thinking; Human Intelligence; Reasoning.

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- http://www.psych.ucla.edu/faculty/faculty_page?id1446&area143 – Keith Holyoak's website.

Anger

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Glossary

Aggression The intentional infliction of harm on others, against their wishes and not for their own good.

Anger An emotional state that involves both an attribution of blame for some perceived wrong and an impulse to correct the wrong or prevent its recurrence.

Category mistake The logical fallacy of assuming that what is true of one category (e.g., aggression) is also true of a related category (e.g., anger); category mistakes are particularly common when the relation between the categories is one of class inclusion, part-whole, or cause-effect.

Catharsis A purgation ('cleansing') or clarification of emotion; used to explain the relief sometimes associated with vicarious emotional experiences, for example, during theatrical performances (Aristotle) and psychotherapy (Freud).

Crime of passion Legal terminology for homicide committed while in an emotional state, typically anger; also termed voluntary manslaughter.

Emotional state A short-term disposition to respond based on an evaluative judgment (e.g., that something is good or bad, challenging or threatening, just or unjust); as traditionally conceived, emotional states differ from other short-term dispositions in that the relevant evaluation is nondeliberate and the ensuing response seems to be beyond personal control (a passion rather than an action).

Hate A long-term disposition to respond with hostility. While anger is typically accompanied by physiological arousal and precipitous action, hate is primarily a way of thinking. Hate can foster anger; conversely, unresolved anger can culminate in hate. But hate can also serve as an antidote to one's own anger for, under normal conditions, those whom we hate cannot hurt us.

Social constructionism The view that most emotions, anger included, are not an intrinsic part of human nature (i.e., genetically determined) but, rather, are constructed from elementary processes in conformance with social norms (beliefs and rules).

Anger and aggression are often discussed under one heading, a fact that has distorted discussions of both. Anger need not be, and typically is not, manifested in aggression; conversely, aggression is frequently manifested for reasons that have little to do with anger. This article focuses on anger as an emotion; the orientation is social-psychological. Psychologically, anger is an accusation of wrongdoing, an attribution of blame, and a determination to correct the perceived wrong; socially, anger functions as a kind of informal judiciary that helps regulate interpersonal relationships.

Generic and Specific Uses of the Concept of Anger

The concept of anger is often used in two distinct ways: first, as a generic term to cover a wide range of related emotional responses, such as envy, jealousy, fury, frustration, annoyance, contempt, and the like; and second, as a specific emotion on a par with other emotions in the same general category (e.g., anger vs. envy). Linguistically, when a single term is used to refer to phenomena at two different levels of generality, the term so used is known as a synecdoche. 'Anger' is often used as a synecdoche, both in everyday speech and psychological theory.

It is important to distinguish the generic and specific uses of the concept of anger, for what is true of a category at one level of generality need not be true at another (higher or lower) level. To conflate levels of generality is to commit a 'category mistake.' Category mistakes are particularly common when

synecdoches are involved, for the use of the same term makes it easy to traverse between levels of generality without recognizing the shift in meaning.

Consider, first, the meaning of anger as a generic category. What do members of the category (e.g., envy, jealousy, and fury, as well as anger as a specific emotion) have in common? On some occasions, at least, all are associated with aggressive behavior. In its generic sense, then, anger may be used to refer to almost any aggressive emotional response. Angry aggression in this sense is typically contrasted with instrumental aggression, that is, aggression deliberately used as a means for achieving some extrinsic reward (as in a robbery).

Now, consider anger as a specific emotion. How does anger in a narrow sense differ from other members of the general category of anger-like emotions, such as envy, jealousy, and fury? As is explained more fully below, anger as a specific emotion involves an attribution of blame for wrongdoing and a desire for reparation. Only rarely is anger in this sense accompanied by aggression, at least by physical aggression. The main objective of anger is not to harm the instigator, but to correct the perceived wrong and prevent recurrence.

Category mistakes can proceed from the top-down (generic to specific categories) or from the bottom-up (specific to generic categories). An example of a top-down mistake is the common assumption that because anger (in the generic sense) connotes aggression, then anger (in the specific sense) must also involve a tendency toward aggression, even if that tendency is repressed, bottled up, disguised, or otherwise made unobservable. An example of a bottom-up mistake is the

inclination on the part of perpetrators to excuse aggression of all sorts, from child abuse to urban riots, with the plea: 'It wasn't my fault; he/she/they made me angry.'

The following discussion focuses on anger as a specific emotion. No attempt is made to review the vast amount of research related to aggression in general. Considerable advances have been made in understanding the biological (evolutionary) and physiological bases of aggressive behavior; as important as that understanding may be, it is only tangentially related to anger as a social-psychological phenomenon. On the other hand, data relevant to anger come from a wide range of sources, including historical (ethical) teachings, legal proceedings, surveys of everyday experience, experimental studies, cross-cultural research, and clinical practice.

Anger in Historical Perspective

Historically, and today, anger appears on nearly every list of 'basic' emotions. Often, this is taken to mean that anger is somehow prior to society, for example, that anger is a relic of biological evolution. Anger, however, does not arise from the depths of some presocial self. It embodies a history of social meanings. From early infancy, we are emotional apprentices, first to our parents, and then to teachers, ministers, artists, entertainers, and other formal agents of cultural transmission. The apprenticeship continues on a less formal basis throughout life as we interact with family, friends, and acquaintances in everyday, face-to-face encounters. In the process, we learn the beliefs and rules that help constitute our emotions, and the skills to enact them properly. Subsequently, we may refine and transform what we have acquired, but we can never completely escape the vestiges of our cultural heritage.

Western culture has been greatly influenced by the confluence of two main streams of thought, Greco-Roman philosophy and Judeo-Christian theology. Each stream has contributed its share to current conceptions of anger. A little later, we will consider briefly the views of three early representatives of these traditions, namely, Aristotle, Seneca, and Lactantius. But first, a bit of etymology may be helpful.

Anger is an emotion. On that, everyone would agree. But what is an emotion? On that, few psychologists agree. For most of Western history, from the time of the ancient Greeks until about the middle of the eighteenth century, what we now call emotions were commonly referred to as passions. As traditionally conceived, a passion is anything a person (or physical object) 'suffers'; this would include, in the case of humans, both emotions and diseases. Hence, from the same root (the Greek, *pathē*, and the Latin, *pati*, *passiones*), we get such emotion-related terms as passion, pathos, and sympathy and such disease-related terms as patient, pathogen, and pathology.

Aristotle considered that the passions formed one of ten fundamental categories of being. Actions – things a person does deliberately and with forethought – formed another distinct category. This distinction between passions and actions is embedded in our ordinary language, as when we say of a person that he was 'gripped,' 'seized,' and 'overcome' by emotion. Anger, in particular, is often depicted as a 'wild beast' that must be 'tamed,' or as an 'inner force' that will 'explode' if not adequately 'vented.' Such conventional ways of speaking

help constitute the way we think and feel. But linguistic conventions can mislead as well as inform.

When addressing the practical concerns of rhetoricians, as opposed to the theoretical concerns of metaphysicians, Aristotle defined anger "as an impulse, accompanied by pain, to a conspicuous revenge for a conspicuous slight directed without justification towards what concerns oneself or towards what concerns one's friends" (*Rhetoric*, 1378a30). Two aspects of this definition are especially noteworthy. First, the 'slight' (by which Aristotle meant any show of contempt, spite, or insolence, especially by a friend or inferior) had to be 'without justification.' A reprove that is deserved is not an adequate provocation to anger, no matter how upsetting it might be. Second, the revenge must be 'conspicuous'; otherwise the offender will not realize that he or she is being punished for the slight. To these two points, we should add a third important feature of Aristotle's analysis, namely, the response must be appropriate to the provocation and the situation, being neither too weak nor too strong.

Aristotle's analysis contains a paradox. If anger is a passion, how can it be so finely tuned to the social context, in both initiation and expression? One way to resolve this paradox is to deny that anger, at least under ordinary circumstances, is beyond personal control: to assert, in effect, that the classification of anger as a passion is based more on metaphor than on fact. More will be said about this possibility later. Another possible resolution is to regard anger as a primitive reaction to painful stimuli, an impulse that is regulated but not constituted by social norms. This is the position of many current psychological theories of anger and aggression. It was also the position taken by Aristotle, who believed that the physiological changes that accompany anger (e.g., a 'boiling of blood about the heart') can impel a person to act in a nondeliberate and irrational manner.

Aristotle's answer, however, hardly seems adequate. The physiological changes that accompany a brisk walk, say, exceed those that accompany most episodes of anger, and yet a brisk walk does not lead a person to act irrationally. Conversely, some of the worst deeds committed in the name of anger are done in a cold and calculated manner, with no more than usual physiological involvement.

The Roman philosopher and statesman Seneca (4 BC–AD 65) wrote the first full work devoted entirely to anger. As a follower of Stoicism, Seneca defined passion as a form of false judgment, the mental analogue of a physical disease. (After all, who would deliberately, 'in his right mind,' make a false judgment?) This definition of passion led Seneca to reject the notion that anger is necessarily tied to one's bodily condition or that it could be anything but a human emotion. A false judgment, no less than a true judgment, is born of reason, no matter how ill-begotten the false judgment might be. Seneca also rejected the Aristotelian notion that anger, properly directed and in moderation, can be considered good. If on occasion a false judgment produces a beneficial outcome, it is a fortunate happenstance. Whatever good is done in anger, according to Seneca, can be done even better and with greater surety, following rational deliberation. In a manner prescient of current cognitive therapies, Seneca offered advice on how to reinterpret events so that they are no longer judged offensive, or, when that is not possible because the offense is too egregious, to correct the wrong in a rational and deliberate manner.

Stoicism was the dominant philosophy of the Roman Empire, and views such as those expressed by Seneca were very influential – in theory, if not in practice. And although it might at first seem like a relatively minor footnote to the history of thought, Seneca's treatment of anger also posed a major challenge to the ascendancy of Christianity. Jehovah of the Old Testament is often depicted as wrathful, vengeful, and punishing. The biblical Christ, too, was not without anger, as when he drove the moneychangers from the temple. How could an all-knowing, all-powerful, and all-loving God be susceptible to anger, if anger is indeed a passion (whether conceived as a form of false judgment or a physiologically based impulse)?

This question was addressed by Lactantius, a Roman convert to Christianity and confidant to the Emperor Constantine (fourth century AD). Lactantius criticized the notion that anger involves a desire for revenge. Rather, anger in the strict sense (i.e., righteous or just anger) is a mental act motivated to restrain offenses. Such anger is proper to God and necessary to humankind, according to Lactantius, for no one who is good and just can fail to be moved at the sight of evil. We therefore rise to punishment, not for the sake of revenge, but in order that morals be preserved and license suppressed. Of course, Lactantius recognized that angry people sometimes do more harm than good. That, however, is a feature of 'unjust' anger, a debasement of true anger that (in a manner similar to Aristotle) he attributed to interference from bodily reactions.

The views of Aristotle, Seneca, and Lactantius, although presented here in the most cursory manner, highlight some of the issues and controversies that still divide contemporary theories of anger.

Is anger a passion or an action? In terms of the language we use to describe anger in everyday discourse, it is clearly a passion. On this point, Aristotle, Seneca, and Lactantius would agree; however, the reasons they give for this classification are very different, a fact that might call into question the nature of the classification itself. Indeed, Lactantius comes close to denying that anger is a passion, at least when he speaks of divine or (in humans) righteous anger. Perhaps the closest modern analog of Lactantius's divine anger (a fully rational, disembodied anger) can be found in the area of Artificial Intelligence. Computers can be programmed to simulate righteous anger, that is, to evaluate 'offenses,' interrupt ongoing activity, and take corrective measures. We need not postulate special circuitry, no less some primitive anger 'instinct' or 'drive' on the part of the computer. All that is required is the programming of appropriate rules.

What is the role of physiological arousal in anger? To the extent that anger leads to vigorous action, it may be accompanied by noticeable bodily changes. There is also evidence that the physiological changes associated with anger are somewhat different from those typically associated, say, with fear. (Anger shows a norepinephrine-like pattern; fear, an epinephrine-like pattern.) Moreover, research suggests that when a person is physiologically aroused, for whatever reason, and regardless of the patterning of the arousal, he or she may be more prone to anger or to any other emotion appropriate to the situation than would otherwise be the case. Thus, the potential importance of physiological arousal during anger should not be underestimated, but neither should it be overestimated.

Physiological arousal is neither a necessary nor a sufficient condition for anger. Fundamentally, anger is to be understood primarily in cognitive rather than physiological terms. This fact was recognized by Aristotle and even more unequivocally by Seneca and Lactantius.

What is the function of anger? When appropriately experienced and expressed, anger serves an important social function, namely, the restraint of offense (Aristotle, Lactantius); indeed, when faced with adequate provocation, anger is not only appropriate, but it is also a God-given duty (Lactantius). Needless to say, anger can be, and too often is, used for selfish and even antisocial ends (Seneca). But a phenomenon must be understood in terms of its normative application, not its misapplication, although the latter may be more dramatic and in need of attention.

To conclude this section, we might ask with regard to historical teachings in general: Does anger exist outside of a particular sociohistorical context, or is it a product of that context? Theorists who adopt the first alternative are sometimes referred to as 'naturalists,' for they believe that anger is an inherent part of human nature. Those who favor the second alternative are known as 'social constructionists,' for they believe that anger is constituted, not just regulated, by social beliefs and rules. For social constructionists, views such as those presented by Aristotle, Seneca, and Lactantius are of more than historical interest; they help form the cultural matrix within which anger is constituted.

Anger in Courts of Law

In contemporary society, the law of homicide both embodies and promotes social norms with respect to anger. In Anglo-American common law, two grades of criminal homicide are generally recognized, murder and manslaughter, and each of these may be divided into two subcategories, first and second degree murder, and voluntary and involuntary manslaughter. Murder is homicide committed with 'malice aforethought,' that is, deliberately and with the intent of gain (cf. instrumental aggression). Second degree murder differs from first degree murder in the presence of mitigating circumstances. Manslaughter is a lesser crime than murder. Voluntary manslaughter is the technical name for a 'crime of passion,' that is, homicide committed during emotion, typically anger. It is 'voluntary' because the angry person wants to attack the victim. Involuntary manslaughter is accidental, but nevertheless culpable homicide, for example, due to negligence.

As just noted, anger serves to mitigate a charge of homicide from murder to voluntary manslaughter. This is no trivial matter. A conviction for murder can mean a life sentence or even the death penalty. By contrast, voluntary manslaughter carries a much lighter sentence – typically little more than a few years in prison, and often probation. Why should this disparity exist? And how does a jury decide whether a defendant was truly angry at the time of the crime?

The law stipulates four major criteria for deciding whether a person was truly angry at the time of a killing: adequacy of provocation, heat of passion, insufficient cooling time, and a causal connection between the provocation and the crime. 'Heat of passion' is a vague reference to the behavior of the

individual at the time of the homicide; and 'causal connection' refers to the fact that the aggression must be a direct response to the provocation. The other two criteria – the adequacy of provocation and insufficient cooling time – are the most interesting from an analytical point of view, for they are judged by the so-called 'reasonable-man test.' This test stipulates that the provocation be sufficient to arouse an ordinary member of the community to anger so intense that it might lead to homicide and, again according to community standards, that there be insufficient time for the anger to dissipate before the homicide is committed.

The reasonable-man test provides ostensibly objective criteria (community standards) against which the feelings and reactions of the defendant can be compared. If there is a match, the defendant may be considered to have been in an angry state; if there is no match, the defendant is not judged to have been angry, regardless of his or her feelings at the time. Put differently, the reasonable-man test objectifies anger; no longer does anger refer simply to a state of mind of the defendant, but to an objectively existing state of affairs to which the individual may or may not have attained. The so-called 'reasonable-man' is, after all, no actually existing person, but is, rather, an idealized embodiment of the norms of the community.

The above considerations suggest that the attribution of anger in courts of law is a kind of social subterfuge. The crime of passion is still a crime, but one that is to some degree excusable. The angry person was, after all, doing his duty by correcting some wrong as defined by community standards. He is therefore given a two-way excuse. First, the victim is, in a sense, put on trial along with the defendant; and if the victim (instigator) was sufficiently guilty (had committed a provocation egregious enough to be judged 'adequate'), then he or she must share the blame for having provoked the incident. Second, as anger is classified as a passion, the defendant cannot be held fully responsible for behavior that was presumably beyond personal control.

Anger in Everyday Affairs

Crimes of passion present a misleading picture of anger in one very important respect – they are crimes. The presumed 'reasonable-man' has proven himself to be unreasonable in his resort to excessive violence. To what extent can we generalize from crimes of passion to anger in everyday affairs?

Anger is a very common emotion. When asked to keep diary records, most people report becoming mildly angry once or twice a day, and seriously angry once or twice a week. The most frequent targets of anger are friends and loved ones; the most common instigations involve some perceived misconduct, for example, an intentional wrongdoing or avoidable accident; and the motivation of the angry person is to correct or prevent recurrence of the 'wrong,' not to hurt the instigator.

Anger may be expressed in a great variety of ways, depending on the person and situation. Common responses include talking the incident over with the instigator, verbal reprimands, withdrawal of privileges, brooding, and so on. At higher levels of intensity, an angry episode may include such behaviors as shouting, slamming doors, and stomping out. Only rarely does anger result in direct physical aggression

against the instigator, at least among adults. In fact, being unusually kind to or solicitous of the instigator – a 'contrary reaction' – is more common than direct physical aggression.

Needless to say, it is easy to think of episodes of anger that do not conform to the above pattern. For example, on occasion we all have become angry at an inanimate object, as when our car stalls in the middle of an intersection; in such instances, however, we typically imbue the object with human qualities (the car had no 'right' to stall). Overwhelmingly, anger is an interpersonal emotion; it is directed at persons or other entities (the self, human institutions) that in some way can be held accountable for their actions.

Few people find pleasure in their own anger; to be the target of another person's anger is even more unpleasant. Nevertheless, surveys indicate that the consequences of most everyday episodes of anger are evaluated positively. Even instigators (the 'wrongdoers') report that, in the majority of cases, they gain from being the target of anger, for example, by coming to realize their own faults or by gaining a better understanding of the angry person's point of view.

An important caveat must be added to this last observation: The more aggressive the response, the less likely it is that anger will have a positive outcome. Rather than being a typical manifestation of anger, aggression reflects a failure of anger to achieve its objective, which is to correct the wrong, not to hurt the target.

Rules of Anger

On the basis of historical teachings, legal procedures, and everyday experience, it is possible to infer the norms that help determine the way anger is experienced and expressed. Some general rules of anger are presented in [Table 1](#).

All theorists recognize the importance of rules for the experience and expression of emotion. There is a crucial difference among theorists, however, in the way the rules are presumed to work. Naturalists assume that anger is an inherent part of human nature and that rules function only to regulate how the emotion is experienced. Social constructionists, by contrast, believe that the rules and associated beliefs not only regulate but also help constitute anger as a distinct emotion. There are other differences among these positions as well. For example, naturalists search for the origins of anger in biological evolution, whereas social constructionists look toward history; naturalists see an essential link between anger and aggression, whereas social constructionists believe that aggression is only one of many ways in which anger may be expressed; and naturalists regard anger as universal, whereas social constructionists consider anger to be culturally specific.

The Utku Eskimos supposedly do not have a name for, nor do they express an emotion equivalent to, anger. Social constructionists take such data as support for their contention that anger is not a biologically based, universal phenomenon; naturalists, on the other hand, argue that the Utku simply suppress their anger, or express it in subtle and indirect ways, in order to preserve harmonious social relationships. There is no easy way to resolve these divergent interpretations, for the issue depends partly on how anger is defined, for example, as a general category or as a specific emotion (cf. the earlier

Table 1 Some rules of anger as inferred from historical teachings, legal procedures, and self-reports of everyday experiences

1. A person has the right (duty) to become angry at intentional wrongdoing or at unintentional misdeeds if those misdeeds are correctable (e.g., due to negligence, carelessness, or oversight)
2. Anger should be directed only at persons and, by extension, other entities (one's self, human institutions) that can be held responsible for their actions
3. Anger should not be displaced on an innocent third party, nor should it be directed at the target for reasons other than the instigation
4. The aim of anger should be to correct the situation, restore equity, and/or prevent recurrence, not to inflict injury or pain on the target, or to achieve selfish ends through intimidation
5. The angry response should be proportional to the instigation; that is, it should not exceed what is necessary to correct the situation, restore equity, or prevent the instigation from happening again
6. Anger should follow closely upon the provocation and not endure longer than is needed to correct the situation (typically a few hours or days, at most)
7. Anger should involve commitment and resolve; that is, a person should not become angry unless appropriate follow-through is intended, circumstances permitting

Source: Averill JR (1993) Illusions of anger. In: Felson RB and Tedeschi JT (eds.) *Aggression and Violence: A Social Interactionist Perspective*. Washington, DC: American Psychological Association, with permission from American Psychological Association.

discussion of anger as a synecdoche). However, this much can be said: as cross-cultural research continues to reveal the great diversity of ways that human societies have developed to deal with potential frustrations and interpersonal conflicts, the case for the universality of anger as a specific emotion becomes increasingly problematic.

Consider *liget*, a fundamental emotion among the Ilongot, a headhunting people indigenous to the Philippines. Like anger, *liget* can be occasioned by insults, slights, and other affronts to the self, and the violation of social customs. Unlike anger, the most dramatic manifestation of *liget* is cutting off the head of another person; the identity of the victim is largely irrelevant – a man, woman, child, anyone will do, but preferably a stranger. The taking of a head helps establish one's place as an equal and honored member of Ilongot society, and hence may be an occasion for celebration. *Liget* also finds expression in a variety of ways other than headhunting. For example, male *liget* is implicated in both courtship and childbirth; 'concentrated' in the sperm, it helps make babies. *Liget* also stimulates work and provides the strength and courage to overcome obstacles. From these few remarks, it is evident that *liget* is constituted by different rules and beliefs than is anger. A crazed American might cut off the head of another, but only a well-socialized Ilongot could experience *liget*. Moreover, if a crazed American did cut off the head of another, we would not attribute the response to anger – neither in a court of law (cf. previous discussion of crimes of passion) nor in everyday affairs.

In short, the rules presented in Table 1 may seem self-evident, but that is not because they are universally held. Rather, they are culturally based norms that, when internalized, become part of our 'second nature.' Other cultures have different norms, different emotions, different 'second natures.'

Anger and the Social Order

We question the sincerity and even the character (or mental health) of a person who claims to be angry but who declines to take action, circumstances permitting (see Rule #7, Table 1). This link between anger and action is not due simply to the fact that anger is a reaction to unpleasant events. Of greater importance is the fact that anger involves a commitment to the shared values that make social life possible. The demand for

action is thus a social as well as a psychological imperative. In traditional moral teachings, the failure to become angry under appropriate circumstances was regarded to be as sinful as excessive or unjustified anger; in the words of the seventeenth century divine, Thomas Fuller, "anger is one of the sinews of the soul; he that wants it hath a maimed mind." A modern extension of this traditional teaching can be found in the popularity of 'assertiveness training.'

In most everyday episodes, the transgressions that provoke anger are relatively minor – breaking a promise, ignoring a responsibility, being inconsiderate and the like. This fact tends to obscure the role that anger plays in maintaining the social order. No matter how trifling our everyday promises, responsibilities, and considerations may seem to be, they are the threads from which the fabric of society is woven. If they are too frequently broken without mend, society unravels. In a very real sense, then, the many small mendings that are the everyday experiences of anger, each minor in its own right, help sustain a way of life.

Anger can be a tool for social change as well as maintenance. There may come a time when we commit ourselves to values other than those embraced by the larger society. In a fight for civil rights and equality, for example, we may turn our anger on people and institutions to whom we previously held fealty. But the new norms we now seek to establish are, typically, old norms applied to new circumstances or extended to new groups (e.g., women, minorities). Even as a tool for radical social change, anger tends to be conservative of the norms it embodies.

Anger in Health and Disease

Anger has implications for the health of the individual as well as society. Evidence for an etiological role of anger is best documented in the case of coronary heart disease and stroke. Chronically experienced anger that goes unexpressed, or that is expressed too vehemently, appears to be especially damaging to the cardiovascular system, increasing the risk of both coronary heart disease and stroke.

Unexpressed or repressed anger has also been postulated as a cause of depression. The concept of repression owes much to Freud and psychoanalysis, although it is not tied to any one theoretical position. The notion of repressed anger has even

passed into the legal system (thus extending the 'insufficient cooling time' criterion for crimes of passion). The basic idea is that, due to situational or personal constraints, anger is too threatening for the individual to even admit experiencing. Banned from consciousness, the anger nevertheless finds outlet in a disguised and maladaptive fashion.

Depression can have many causes, both physiological and psychological. It need not, and typically does not, have anything to do with repressed anger. There are occasions, however, when depressive-like symptoms can take on some of the qualities of an angry response. Consider the case of a woman who is so fatigued that she finds it difficult to get out of bed in the morning, feels despondent through most of the day, and is haunted by frequent thoughts of suicide. Life becomes a burden both to her and to those around her. Now add the following considerations: the woman's husband treats her with neglect; she sincerely believes that she has no right to be angry with her husband, for his neglect of her is somehow deserved; nevertheless, in subtle ways her behavior causes considerable inconvenience to her husband; and, finally, she derives barely concealed satisfaction from her husband's discomfort. In such a case, we might well speak of the woman's depression as being a manifestation of 'repressed' anger. That, however, is a metaphorical way of speaking, for the woman's behavior follows only some, but not all, of the standard norms for anger. A more parsimonious explanation might be that the woman has acquired, in this situation, at least, a set of idiosyncratic beliefs and rules that help constitute an emotion that resembles both anger (retaliation for a perceived wrong) and depression (fatigue, despondency, self-reproach).

Recall the emotion of *liget* described earlier. It bears some semblance to anger within our own culture, but it is constituted by different norms and hence represents a different emotion. Norms of emotion can vary within, as well as between, cultures. There exist subcultures of increasingly smaller scope, down to the level of the family and ultimately the individual. An emotion that is the product of personal (idiosyncratic) norms is particularly subject to misinterpretation because usual forms of consensual validation are lacking. But nothing is gained by way of clarity, and much may be lost, if we label the nonconforming emotion by some common name ('anger,' say, or 'depression') and attribute its idiosyncrasy to repression.

Less often recognized than its pathogenic effects, anger can also have ameliorative effects on the course of disease. For example, patients suffering from serious diseases such as cancer have a better prognosis if they become angry at their condition than if they become merely frightened or depressed. Although the underlying mechanisms are not clear, a possible explanation is that the angry person is more likely to 'fight' the illness, for example, by taking an active role in his or her treatment.

Catharsis

The idea of repression is closely tied to that of catharsis. During psychoanalytic therapy (what Freud originally called the 'cathartic method'), presumably repressed impulses are brought to consciousness and expressed in an adaptive fashion. Using a rather graphic metaphor, Freud compared catharsis to the draining of pus from an infected wound. Continuing

with the example of depression, let us suppose the woman described earlier turns to psychotherapy for help. During treatment, she may come to recognize on a conscious level the unfairness of her treatment, and, blaming her husband rather than herself, she may resolve to do something to change the situation. From a psychoanalytic perspective, it might be said that her depression 'lifts' as her repressed anger is 'released.' An alternative explanation is that one kind of emotional response (an ill-defined anger/depression combination) has been replaced by a more adaptive response (normative anger).

A good deal of experimental research has been devoted to the possible cathartic effects of emotional expression, especially with respect to anger and aggression. On the whole, the results have not been kind to the catharsis hypothesis. More often than not, the expression of anger on one occasion facilitates, and, on subsequent occasions, encourages its expression. This is opposite to the mitigating effect predicted by the catharsis hypothesis. In the case of anger and aggression, as in so many other areas, practice makes perfect or, at least, easier.

When Anger Turns to Hate

In popular conception, anger and hate are closely allied conditions. In actuality, the matter is not so simple. As mentioned earlier, anger is more likely to be directed at friends and loved ones than at strangers and enemies. One reason is opportunity: close contact with friends and loved ones offers frequent occasions for anger. Another reason is that friends and loved ones can hurt us in ways that strangers and enemies cannot; a breach of trust, for example, can only occur where trust exists. Most importantly, if we want a relationship to continue, perceived wrongs must be set right, and anger is one way of achieving that end. It is primarily when anger proves ineffective, or is pursued for selfish ends, that it may turn to hatred on the part of the target as well as the angry person.

Put differently, unresolved anger may cool and solidify into an enduring animosity, which predisposes an individual to a variety of different emotions depending on the fortunes of the hated person; thus, we may feel sorrow at the success of our enemies and joy (*schadenfreude*) at their failures, as well as anger at their presumed transgressions. We may even hate persons or entire groups who have never done us any wrong, as in prejudice. While normative anger is focused on the misdeeds of others, real or imagined, and attempts at repair, hatred has an inner dynamic that is more purely destructive of the self as well as of others. In his novel *Demian*, Hermann Hesse observed: "If you hate a person, you hate something in him that is part of yourself. What isn't part of ourselves doesn't disturb us." That is both an overgeneralization (not all hatreds fit the pattern) and an understatement (something similar could be said of other sentiments; e.g., if you love a person, you love something in him that is part of yourself). Keeping these qualifications in mind, Hesse's observation contains a truth about hatred that is worth remembering.

Gender Differences

A common stereotype is that women are less capable of anger than are men. This stereotype is also sometimes used to explain

the greater frequency of depression diagnosed among women than men (cf. previous discussion of repressed anger). However, surveys of the everyday experience of anger suggest that women become angry as often, as intensely, and as effectively as men. Gender differences in anger, to the extent that they exist, must be sought on a more subtle plane than suggested by the stereotype.

In the conduct of interpersonal relations, men tend to place greater emphasis on competition and individual rights, whereas women tend to place greater emphasis on cooperation and affiliation. Men also tend to be physically more aggressive than women. Such differences in orientation and response style cannot but have reverberations on the way anger is experienced and expressed. Some of the things that a man finds offensive may not offend a woman, and vice versa; and when angry, a man may do and say things that a woman typically would not (e.g., men are more likely than women to engage in physical violence when angry, and women are more likely than men to cry). But as important as such differences may be, they should not be interpreted to mean that anger is less appropriate to women than to men, or that women are less capable of anger than are men. 'Different' does not necessarily imply 'more' or 'less.' Women are as sensitive as men to unfair treatment; and in response to provocations that they deem adequate, women are as likely as men to make their feelings known clearly and effectively.

Wrongful Anger

The rules presented in [Table 1](#) suggest that anger, properly constituted, serves to correct socially recognized wrongs, and that the anger should not exceed what is necessary to achieve that end. And, as described earlier, the majority of episodes fit that description. However, the rules of anger are easily broken, either unintentionally or willfully, with consequences that are harmful to the self and to interpersonal relationships.

When the rules are violated, we may speak of wrongful anger (provided the violation is not so egregious as to preclude the response from being classified as anger altogether). Three types of wrongful anger have already been discussed in passing, namely, anger that goes unexpressed, resulting in continued provocation and unrelieved tension; anger that is expressed indirectly or in accordance with idiosyncratic rules; and anger that is expressed intemperately, resulting in unwarranted violence. To these, we could add anger that is unduly prolonged, is displaced on innocent third parties, is oft-repeated without adequate follow-through, and so forth.

The rules of anger may be violated for many reasons, some of which antedate the angry episode – for example, inadequate socialization, neurological dysfunction, and inordinate stress or fatigue. Extraneous stimuli in the immediate situation can also lead to inappropriate anger. According to Berkowitz's neoassociationistic theory of anger and aggression, aversive stimuli of any kind (which would include aspects of most provocations to anger) tend to automatically elicit aggressive thoughts, feelings, and behavioral inclinations, either innately or through prior experience. These tendencies are especially likely to find expression if other aggressive cues are present (e.g., a weapon) or customary restraints are inhibited (e.g., through the use of alcohol). By contrast, the present article

has focused on higher order sociocognitive mechanisms by which anger may serve as a rationale for aggression, before, during, and after the fact, regardless of what other precipitating factors may be involved. The two types of mechanisms (socio-cognitive and neoassociationistic) are not mutually exclusive; indeed, they tend to complement one another. For a more complete discussion of how anger can go awry, the reader should consult the article on aggression in this Encyclopedia.

Regardless of the precipitating factors, with a better understanding of what constitutes an adequate provocation and with the acquisition of effective coping skills, aggressive tendencies can be typically curbed. But the outcome of anger – whether constructive or destructive – does not depend exclusively on the behavior of the angry person. Anger is more like a dialog than a soliloquy; put differently, there are 'rules of engagement' for the target as well as for the angry person. The most beneficial response for a target (assuming the anger is justified) is an explanation to correct any misunderstanding, an apology if no misunderstanding exists, and a resolve to prevent recurrence. Too often, unfortunately, anger provokes anger, conflict escalates, attitudes harden, and resentments build; eventually, all goodwill may be squeezed from the relationship (see earlier discussion of when anger turns to hate).

When goodwill is absent, the rules of anger may be violated 'wantonly,' so to speak. That is, anger may be used deliberately (if not consciously) to achieve ends that are only tangentially related to the instigation. The concept of anger, it will be recalled, has exculpatory implications, and this could be in two ways: firstly, as anger is commonly interpreted as a passion rather than an action, the angry person presumably cannot control his or her own behavior; secondly, if the anger is accepted as justified, the blame for initiating the incident is shifted from the angry person to the instigator. Not surprisingly, perpetrators and their apologists often seek to excuse vicious behavior – child abuse, spouse battering, mugging and robbery, gang warfare, urban riots, etc. – by attributing it to anger. And in a multitude of more minor ways, we all sometimes resort to anger to intimidate and coerce others in the pursuit of selfish ends.

Wrongful anger is unwittingly fostered by the misguided advice, often found in popular psychology books, that it is healthy to 'let your anger out.' If a response is inappropriate to begin with, letting it out in the name of anger is doubly inappropriate, for a response cannot be labeled as anger without endorsing, no matter how unwittingly, its exculpatory implications. It would be far better to heed the warning of Aristotle: "Anyone can get angry – that is easy; ... but to do this to the right person, to the right extent, at the right time, with the right motive, and in the right way, that is not for everyone nor is it easy; wherefore goodness is both rare and laudable and noble" (*Nicomachean Ethics*, 1109a25).

See also: [Aggression](#); [Depression](#); [Homicide](#).

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Animal Cognition

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Glossary

Associative learning Making the psychological connection between contiguous events in the environment.

Categorization Placing different objects or events into separate classes or categories.

Conceptualization The process of forming an abstract or generic idea from particular instances.

Discrimination Responding differently to two or more stimuli differing in one or more respects.

Generalization Transferring a learned response from one stimulus to another.

Matching-to-sample Experimental procedure for studying memory in which reward is given for responding to a stimulus if it is the same as a prior sample stimulus.

Memory Control of current behavior by past stimulation.

Metacognition Thinking about one's own cognitive states and processes.

Numerical processing Set of abilities related to understanding and manipulating numbers, such as: using symbols to denote quantities; discriminating, ordering, and comparing different quantities; and, combining quantities in order to perform arithmetic operations.

Reinforcer Any consequence of a behavior that increases the probability that the organism will repeat that behavior.

Time-out A brief period of time during which there is no stimulation; time-out is a form of punishment that is used to decrease the probability that the organism will repeat a behavior.

The Science of Animal Cognition

For centuries, it was believed that a clear discontinuity held between the cognitive capabilities of humans and animals. Philosophers and other thinkers tended to be quite skeptical of animals' mental abilities. For example, the great French philosopher René Descartes deemed animals to be mere machines whose actions could be explained without invoking any cognitive processes whatsoever. In his *Letter to the Marquess of Newcastle*, Descartes proposed that "the reason why animals do not speak as we do is not that they lack the organs but that they have no thoughts." Approximately 50 years later, the great British philosopher John Locke, in *An Essay Concerning Human Understanding*, joined Descartes in disparaging the cognitive capacities of animals: "the having of general ideas is that which puts a perfect distinction betwixt man and brutes, and is an excellency which the faculties of brutes do by no means attain to."

All that changed some 200 years later when Charles Darwin advanced his revolutionary ideas about the evolution of species. In *The Descent of Man*, Darwin went beyond suggesting the evolution of physical traits to proposing the evolution of the mind as well. For Darwin, there was "no fundamental difference between man and the higher mammals in their mental faculties" (p. 66). Human and animal intelligence differ only in degree, not in kind, Darwin argued; so, there should be no sharp schism between human and animal mind. The human mind might be the final step in the evolution of intellectual functions, but the roots of human mental processes should be observable in animals as well.

Darwin's unsettling ideas had actually been presaged by other philosophers and psychologists. In his *Principles of Psychology*, Herbert Spencer suggested that the mind could be understood only by examining how it had evolved. According to Spencer, mental capacities could be represented along a continuum with no great gaps: a continuous progression

from simple associative learning to complex forms of abstraction and reasoning.

The ideas of Darwin and Spencer on the evolution of the mind were staunchly defended by Thomas Huxley, who wrote in 1874 that: "the doctrine of continuity is too well established for it to be permissible to suppose that any complex natural phenomenon comes into existence suddenly and without being preceded by simpler modifications; and very strong arguments would be needed to show that such complex phenomena as those of consciousness first made their appearance in man."

These principles of evolutionary biology clearly clashed with Cartesian philosophy. The gradual evolution of cognition was a direct consequence of this new biological vantage point. Critically, within that new paradigm, it was entirely plausible to believe that mental capabilities could be observed in organisms other than humans.

Once the hypothesis of mental continuity was enunciated, evidence to support it was needed. Darwin himself amassed a large collection of supportive anecdotes: stories told by naturalists, zookeepers, and pet owners attesting to how smart animals really were. For example:

Dr. Hayes, in his work on *The Open Polar Sea*, repeatedly remarks that his dogs, instead of continuing to draw the sledges in a compact body, diverged and separated when they came to thin ice, so that their weight might be more evenly distributed. This was often the first warning which the travelers received that the ice was becoming thin and dangerous.

Darwin was alert to the hazards of relying on anecdotal evidence alone; such observations lacked the information needed to pinpoint the mechanisms responsible for the animals' behavior. Relevant to the prior example, Darwin wondered about the origins of the dogs' behavior: "now, did the dogs act thus from the experience of each individual, or from the example of the older and wiser dogs, or from an inherited habit, that is from instinct?"

Any bona fide scientific analysis of animal cognition requires careful recording of the relevant behaviors as well as precise knowledge and control of the variables influencing or determining that behavior. Darwin's disciple, George Romanes, advocated for an objective analysis of the mind in his book *Animal Intelligence*: "We can only infer the existence and the nature of thoughts and feelings from the activities of the organisms which appear to exhibit them." (p. 1). Yet, despite his advocacy for and his interest in documenting mental continuity across species, Romanes' work too was simply a compilation, albeit extensive and thorough, of still more informal observations and anecdotes.

The true transition to the scientific study of animal cognition began with C. Lloyd Morgan. In his *Introduction to Comparative Psychology*, Morgan emphasized the importance of distinguishing between an animal's behavior and the interpretation of that behavior. In order to properly interpret an organism's behavior, high standards of objectivity are needed. As well, systematic experimental studies are required in order to reach incisive conclusions as to the origins of behavior, which he himself undertook with baby chicks whose developmental history could be known and carefully controlled. Finally, circumspection was to be one of Morgan's enduring contributions. Morgan's famous canon urged researchers to be cautious in advocating advanced cognitive interpretations when the behavior in question might be more parsimoniously explained by simpler behavioral processes.

These then were the forebears of the science of comparative cognition. Following the methods of natural science, research in comparative cognition today seeks to discover the extent to which our mental capacities are similar to those of other animals and to answer many longstanding questions. Are animals intelligent? Is human intelligence superior to animal intelligence? What are the cognitive and neurobiological mechanisms of intelligent action?

In this article, we will consider a few particularly prominent and promising areas of research in animal cognition: numerical processing, memory and planning, conceptualization, and metacognition. This sampling of topics, issues, methods, and findings should provide readers with a good taste of the current state of the science of animal cognition. A broader compilation of animal cognition studies can be found in *Comparative Cognition* edited by Wasserman and Zentall.

Numerical Processing

Number is an important property of objects in the external world. Critically, numerical processing can be considered to be mediated by an abstract cognitive process, because behavioral control by number must be made irrespective of the specific physical features of the items to be evaluated; 2, 5, or 8 items are 2, 5, or 8 regardless of whether the items are apples, pebbles, or geckos. Traditionally, it has been believed that linguistic competence is necessary for numerical processing. Although it is the case that a verbal system does mediate several numerical and mathematical operations, considerable evidence has been obtained documenting numerical processing by animals and infants lacking language; this evidence suggests

that common preverbal processes underlie numerical and mathematical competencies in humans and animals.

Basic numerical abilities comprise: learning and using symbols to denote specific quantities; discriminating, ordering, and comparing different quantities; and, combining quantities so that basic arithmetic operations, such as addition and subtraction, can be accomplished.

The Japanese primatologist Tetsuro Matsuzawa taught a 5-year-old chimpanzee, Ai, to use Arabic numerals to denote the number of items in a display. Ai was first presented with either 1 or 2 items in a display window and then required to choose either the '1' or the '2' key on a numeric keyboard. As Ai mastered the lower numbers, higher numbers of items were progressively introduced, up to a maximum of 6. Regardless of the items being colors, objects, or symbols, Ai's accuracy exceeded 90%. Nevertheless, Ai had greater difficulty reporting the numbers when they were close to one another (e.g., it was easier for Ai to distinguish 2 from 5 than to distinguish 2 from 3) and when the numbers were at the higher end of the scale (e.g., Ai was more accurate at identifying 2 and 3 than at identifying 5 and 6, even when the disparity between them was in both cases 1 item). It seems that, as quantities increase, the discrepancies between them become less obvious and, in turn, the discrimination between them becomes more challenging.

Interestingly, Ai's behavior is not an isolated curiosity. Humans too find it easier to distinguish between 2 and 14 items than between 4 and 5 items. This finding is called the numerical distance effect. As well, humans can rapidly distinguish between 2 and 3 items, but we cannot so rapidly say if there are 14 or 15 items, in this case showing what is called the numerical magnitude effect. The numerical magnitude effect has also been found in monkeys, rats, and pigeons.

Recent research has found that rhesus monkeys can learn to choose the smaller of two simultaneously presented sets of items when such nonnumerical factors as area and density are controlled. Monkeys can also choose the larger of two quantities even when the items are sequentially presented, as when the items fall one by one into an opaque container. In addition, Brannon and her colleagues have found that monkeys' accuracy rises as the disparity between the amounts to be evaluated increases. Indeed, the monkeys' performance is affected by the ratio of the values being compared. As predicted by Weber's law, the larger the amounts, the greater the difference between them must be in order to be distinguishable. This relationship was true for human college students as well.

These and other observations have led researchers to propose that humans and animals share a system that calculates inexact, but approximate representations of quantity. For example, when having to choose among different waiting lines, we tend to select the shortest. We rarely do so by precisely counting the people in line, but rather do so by a process of rough estimation; we use an approximate preverbal number system. It is not difficult to imagine that animals in the wild benefit from the ability to distinguish between trees containing 5 and 15 fruits or predators attacking in groups of 2 or 4. Small or large quantities can surely make a difference and numerosity judgments in these situations seem to be similarly performed by verbal and nonverbal organisms.

Estimating and representing numerical values appears to be necessary for the next step in numerical reasoning: interrelating quantities so that operations like adding, subtracting, multiplying, and dividing can be accomplished. Can animals perform these basic arithmetic operations? Studies using a preferential looking paradigm have suggested that preverbal human infants and monkeys can understand simple arithmetical operations, such as adding and subtracting a small number of visually presented objects.

For example, when monkeys watched as two eggplants were placed behind a screen, they looked longer when the screen was removed and only one eggplant was present than when two eggplants were present. Monkeys may have spent more time looking at the incorrect outcome because it surprisingly violated the rules of arithmetic. But, the results of such studies may be explained in terms of the infants' and monkeys' understanding of object permanence: organisms can keep track of occluded objects and when one object unexpectedly appears or disappears, they are surprised; no real arithmetic ability is required in that case.

More compelling evidence of addition in monkeys has been found by Brannon and Cantlon. They presented animals with two sets of dots on two sequential screens. Then, on a third screen, the monkeys had to choose from two sets: one containing the number of dots equal to the sum of the two sets and a second containing a different number of dots (see [Figure 1](#)). Monkeys learned to choose the array that roughly corresponded to the arithmetic sum of the two sets of dots and they readily transferred this behavior to novel combinations. Some problems proved to be more difficult than others. For example, monkeys were faster and more accurate when, after being presented with a set of 2 dots and a second set of 6 dots, they had to choose between 8 and 14 dots compared to when they had to choose between 8 and 10 dots. The closer the two possible answers, the more difficult the task.

When humans were given the same nonverbal task, their pattern of performance was strikingly similar. Although humans were generally more proficient than monkeys, both

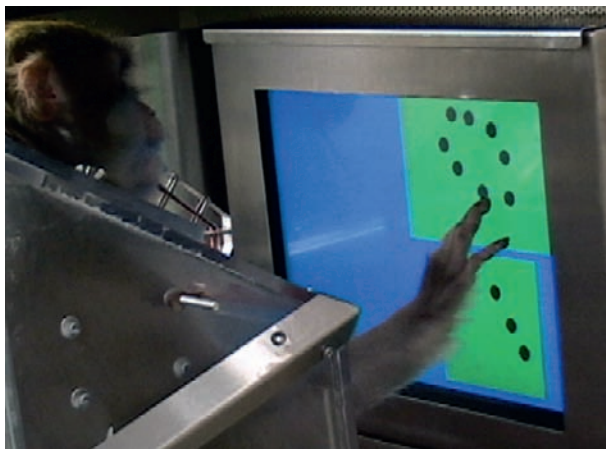


Figure 1 A monkey performing the addition task designed by Brannon and Cantlon. The monkey had to choose from two sets of dots: one set containing the same number of dots as the sum of two previously presented sets and a second set containing a different number of dots. Photograph courtesy of Elizabeth Brannon, Duke University.

species' reaction times and accuracies were affected by the ratio between the numerical values of the choice arrays: the larger the numerical difference between the correct and the incorrect choices, the better the performance. These results further suggest that humans and animals share an approximate calculation system that does not involve verbal processing.

Research in numerical processing thus shows that animals possess the evolutionary precursors to advanced mathematical abilities: animals can identify and name quantities, compare and discriminate different quantities, and even manipulate those quantities to perform simple additive operations.

Memory

There is no question that animals can learn new information. Pavlov's classical conditioning experiments showed that, after presenting dogs with a sound followed by food, the mere presentation of the sound alone would make the dogs salivate, a response that was initially elicited only by food. We can infer that the dogs learned that the sound predicted food. And, if animals can learn, then that implies they remember the events they experienced in the past. So, the fact that the dogs came to salivate to the sound suggests that they remembered the pairing of sounds with food.

Unlike humans, animals cannot verbally express their recollections; but, there are other ways we can study their memory. One popular procedure is delayed matching-to-sample. In the basic task, a sample stimulus (a colored light or a picture) is presented for a few seconds. Then, the sample is removed and a delay ensues. After this delay (which can range from seconds to minutes), the sample is again presented along with one or more comparison stimuli. The animal's task is to pick the choice stimulus that matches the sample. Monkeys and pigeons successfully perform this task. Moreover, their accuracy generally decreases as the delay increases, which is true for humans as well. Further, animals can perform this matching task even when new sample and comparison stimuli are presented to them, showing effective transfer to a novel situation.

Human memory studies have traditionally involved learning and retrieval of lists of items. People are given lists of items and they must later recall as many items as possible. In this situation, the first and the last items in the list tend to be better recalled – primacy and recency, respectively. Animals too show these serial position effects.

The memory of pigeons, monkeys, and humans for lists of visual items has been directly compared after different delays between the last item and the recognition test. All three species show the same pattern: strong recency, but no primacy at the shortest delays; the classic U-shaped serial position function at intermediate delays; and, strong primacy, but no recency at the longest delays. Thus, the same mechanisms may mediate the serial memory performance of all three species.

Although similarities between species abound, there are disparities too. Sometimes, animals can be even more proficient than humans! One noteworthy example comes from Tetsuro Matsuzawa's laboratory in Inuyama, Japan. Chimpanzees were first taught to contact each of the numerals from 1 to 9 in order when they appeared in random locations on a computer touchscreen. Even when the sequence lacked some

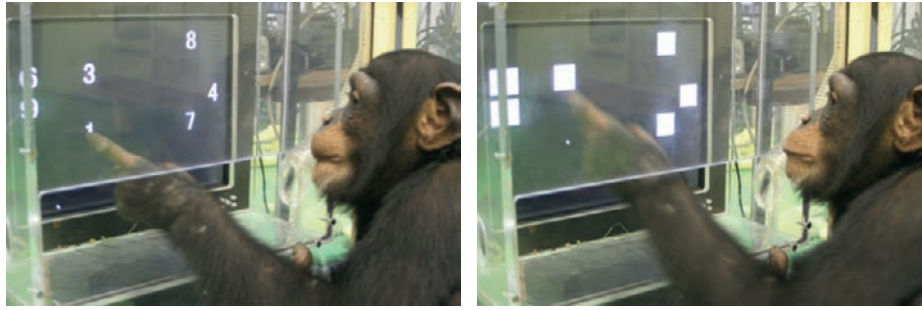


Figure 2 A chimpanzee performing the memory task designed by Matsuzawa and his colleagues. On the left, the chimpanzee is touching in sequential order the numerals from 1 to 9 located randomly on the screen. On the right, after brief presentation, the numerals were covered by white squares; here too, the chimpanzee has to touch each of the squares in the correct sequence. This procedure is detailed in Inoue S and Matsuzawa T (2007) Working memory of numerals in chimpanzees. *Current Biology* 17: R1004–R1005. Photographs courtesy of Tetsuro Matsuzawa, Primate Research Institute, Kyoto University.

of the numbers (e.g., 1-3-4-6-8-9), the chimpanzees could still respond in sequential order from the smallest to the largest. Humans could also do this, of course. But, a critical variation was later introduced. The numerals were presented for a very short duration (from 650 to 210 ms) and then they were replaced by white squares (see Figure 2). Now, subjects had to remember which numeral appeared in which location and then touch each of them in the correct sequence. Humans' performance plummeted, but chimpanzees' performance remained high. The chimpanzees could retain an accurate image of the very brief visual scene, an ability that surpasses our own perceptual memory capacity. This eidetic (or photographic) memory can sometimes be seen in young children, but very rarely in adults. This striking developmental disparity was also seen in chimpanzees; the young animals were the best performers in this task.

Despite these remarkable illustrations of animal memory, some memory capacities have been deemed to be uniquely human. Episodic memory refers to the ability to remember specific events in time and space, thereby involving: the content of an experience (what), its place of occurrence (where), and its time of occurrence (when).

Many mammals and birds are food-hoarding animals; they cache food in specific places for future use. Food hoarding implies that: (1) food has to be stored and concealed and (2) actual consumption is deferred for hours, days, weeks, or months. Successful hoarding appears to require animals to use past spatial and temporal information to retrieve food later.

In a series of experiments with scrub jays, Nicola Clayton and her colleagues allowed animals to store and recover worms and peanuts. Fresh worms are the scrub jays' preferred food. But, the worms do not last very long; after a few days, they degrade and become unpalatable. Peanuts are less appetizing, but they are nonperishable; so, they can be consumed at any time. The jays were trained in the laboratory to cache worms on one side of a distinctive tray and to cache peanuts on the other side (Figure 3 shows a scrub jay caching food from a tray). Critically, the jays were allowed to retrieve their caches either 4 or 124 h later. After 4 h, the birds tended to inspect the side of the tray where the worms should be; but, after 124 h, the birds tended to inspect the side where the peanuts should be. No olfactory or visual food cues were available; the jays had to rely on their memory at the time of cache recovery.



Figure 3 A scrub jay caching worms and nuts in the compartments of a sand-filled ice-cube tray. Photograph courtesy of Nicola S. Clayton, University of Cambridge.

Evidently, the jays can remember: (1) whether peanuts or worms had been cached – what; (2) on which side of the tray each of the food items had been stored – where; and (3), whether a short or a long time had elapsed since the food items had been cached – when. Thus, the cache and retrieval behaviors of the scrub jays meet the criteria for episodic memory.

Many researchers believe that such successful and elaborate food caching suggests that animals plan for the future. However, in order to speak of planning, current behavior must be based on its future consequences and must be independent of the animal's prevailing motivation. Clayton and her colleagues asked if scrub jays could anticipate their future need states and act accordingly. The researchers placed the jays into two different compartments on alternate mornings for 6 days. In one compartment, food was always there in the morning; in the other compartment, the bowl was empty. Following 6 days of exposure to the two compartments, the jays were unexpectedly given a bowl of cacheable pine nuts after the evening meal; they were also given free access to the two different compartments in which the caching trays had been placed. The jays could either eat the pine nuts or store them in one or the other of the two compartments. The birds opted to store the food, but not randomly; they presumably anticipated their future needs and cached more food in the compartment in which food was not going to be available in the morning. Thus, it seems that scrub jays can plan for a future motivational state.

Conceptualization

It is generally admitted that the higher animals possess memory, attention, association, and even some imagination and reason. If these powers are capable of improvement, there seems no great improbability in more complex faculties, such as the higher forms of abstraction, ... having been evolved through the development and combination of the simpler ones.

Darwin's speculation that higher-order cognitive capabilities are the evolutionary outgrowth of more primitive cognitive capacities, has bolstered the search for evidence of abstract concept learning in animals. Over the last quarter century, the extent to which animals, especially those phylogenetically distant from humans, can learn abstract concepts and, particularly, understand the relations of sameness and differentness, has become a focal concern of this work.

Animals must possess at least some primitive sense of sameness and differentness. Animals are comfortable with members of their own species, but they flee from members of alien species. Plus, animals behave consistently in familiar situations, but they change their actions when something unusual transpires. For example, when uninformative stimuli repeatedly occur, a wide range of animals cease responding to them. This phenomenon of habituation requires the animal to perceive a particular stimulus as the *same* as one presented before. By contrast, when a second novel stimulus is introduced along with the habituated stimulus, the organism starts responding again – dishabituation. Now, the organism detects something *different* in the situation and its behavior changes accordingly.

We also know that behaviors which are associated with some stimuli in some contexts generalize to other stimuli in other contexts. Indeed, generalization and its counterpart, discrimination, are the foundations of categorization, another familiar instance of conceptual behavior. When an organism makes the same response 'car' to discriminably different cars, it is generalizing among all cars; when an organism makes the same response 'flower' to discriminably different flowers, it is generalizing among all flowers; at the same time, it is discriminating flowers from cars. Categorization thus involves generalization within a class, but discrimination between classes. If sameness within a category and differentness between categories are not perceived, then each event would have to be treated as entirely unique; animals would need to learn the appropriate response each time that each event is encountered, an excruciatingly demanding and inefficient chore.

Pigeons can learn to respond to photographs that contain a human being and not to respond to similar photographs in which human beings are absent. Even when people in the pictures differ in age, size, race, sex, clothing, and posture, pigeons learn to respond to the photographs when they portray people with a high level of accuracy.

Pigeons can also learn categorization tasks which are even more similar to the real-world situations that confront humans. Wasserman and his colleagues wanted to see if pigeons could report which stimuli belonged to which of four different categories of objects: cats, flowers, cars, and chairs. One image at a time from each category was presented on a viewing screen. Four report keys were also available, each

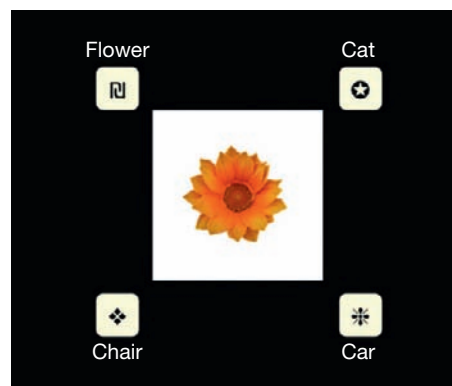


Figure 4 Illustration of one trial of the categorization task designed by Wasserman and his colleagues. In this case, a stimulus from the flower category is presented on the screen. The four report keys correspond to each of the four experimental categories; cats, flowers, cars, and chairs. For each of the categories, the pigeons had to choose the appropriate key. Text labels are included for explanatory purposes; they did not appear on the screen.

corresponding to a different category; these four different keys effectively served as four different 'words' for the pigeons (see Figure 4). Pigeons learned to select the appropriate key for the different categories. After learning, the birds were given novel items from the training categories to see if they would exhibit reliable transfer from the training stimuli, the critical test to document concept learning. The pigeons passed the test; they successfully used the four report keys to classify the novel items from the four trained categories.

It should be noted that items belonging to such categories as cats, flowers, cars, or chairs share a number of physical properties; so, it is generally accepted that perceptual similarity guides classification learning in animals, as it does in humans. A higher level of conceptualization is represented by relational concepts, which do not depend on perceptual similarity, but require learning about the relations between or among two or more stimuli. Here, the absolute properties of the stimuli must be transcended and knowledge of universal applicability must be extracted.

In order to speak of a true same–different concept, relational learning and generalization to novel situations must be demonstrated. Habituation and categorization suggest that abstract conceptualization may be within animals' capabilities, but more explicit evidence is required. Initial efforts to teach pigeons to report whether 2 items – the smallest number that is possible to make a same–different discrimination – are the same as or different from one another were not successful. But, perhaps it would be easier for pigeons to learn same–different discriminations with displays of items containing more than two stimuli.

Therefore, Wasserman and his colleagues trained pigeons to peck one button when a stimulus array comprised 16 identical icons and to peck a second button when a stimulus array comprised 16 nonidentical icons (Figure 5, top). Now, pigeons readily learned the discrimination to high levels of accuracy and, critically, they later transferred the discrimination with little decrement to both identical and nonidentical arrays constructed from novel visual items.

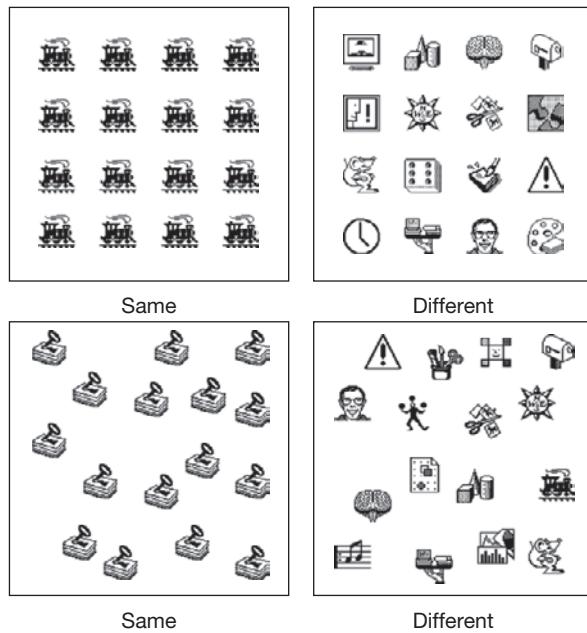


Figure 5 Examples of 16-item same and different arrays used in Wasserman and colleagues' research on same-different discrimination. The top panel shows orderly arrays, whereas the bottom panel shows disorderly arrays. Pigeons are highly adept at discriminating both orderly and disorderly arrays.

One characteristic of the same and different arrays depicted in **Figure 5** is that they differed in their spatial orderliness; the same arrays entailed clear horizontal and vertical regularities that the different arrays lacked. Pigeons could have been performing a perceptual rather than a conceptual discrimination. Remember Morgan's canon of parsimony?

Nonetheless, when pigeons were trained to discriminate 16-icon Same from 16-icon Different arrays in which the items were randomly placed on the screen, the birds readily acquired the discrimination and showed excellent transfer to new arrays (**Figure 5**, bottom). Moreover, randomly rotating the items in an array did not adversely affect pigeons' discrimination behavior. Finally, when pigeons were shown successive lists of same and different items on a one-at-a-time basis – thereby making spatial orderliness an unusable cue for solving the discrimination – the pigeons still exhibited robust discrimination learning and transfer performance. This pattern of results discredits simple perceptual accounts and strongly suggests that pigeons in these studies had acquired a same-different concept. Even Morgan would have been convinced.

To discriminate collections of same and different items involves understanding what are called first-order relations. Can animals go to the next level and learn higher-order relational concepts? Can they understand, not only that several identical apples are the same and that several identical balls are the same, but also that the relation between the apples and the balls is sameness? Judging relations between relations is basic to analogical reasoning; many authors have proposed that analogical competence is the very essence of human intelligence.

In an analogical or relational matching-to-sample task, the animal is given a sample stimulus set (either two or more

identical items on some trials and two or more nonidentical items on other trials), and two choice stimulus sets (one containing two or more identical items and the other containing two or more nonidentical items). Critically, none of the items in the sample is presented in the choice sets; so, if the sample is AA, then the choices can be BB or CD. To be successful, the animal must select the set of choice alternatives that instantiates the same relation as the sample set. Given that there is no overlap between the sample and choice items, only attention to the matching relations (same sample to same choice and different sample to different choice) can yield successful performance.

When baboons were given a relational matching-to-sample task in which the sample and choice arrays contained 16 items, they successfully learned to choose the 16-item choice array instantiating the same relation as sample array. Accuracy was high when sample arrays containing novel items were presented, thereby attesting to the generality of the relational matching concept; but, when the number of items in the sample arrays was reduced from 16 to 12 to 8 to 4 to 2, baboons' accuracy systematically fell to chance level. For the baboons, the task proved too taxing when too little pictorial information was available. Similar results have been reported with pigeons.

In contrast to baboons and pigeons, chimpanzees solve relational matching-to-sample problems even when only 2 items are presented in the sample and the choice arrays. The first chimpanzee to exhibit a variety of analogical behaviors was Sarah, who could evaluate, complete, and even create analogies.

Sarah initially learned to use one plastic token for the concept 'same' and another plastic token for the concept 'different.' In a set of later experiments, Sarah was given four geometric forms on a display board in a 2×2 format. The 2 items on the left represented one relation and the 2 items on the right represented another relation. Sarah had to choose the correct plastic token (one for 'same' and one for 'different') and place it in the middle of the board to indicate whether the relations between the set on the left and the set on the right were same (thus representing an analogy) or different. Sarah chose correctly about 80% of the time.

In other experiments, Sarah was given 2 items on the left side and only 1 item on the right side. The token for 'same' was placed in the middle of the board and Sarah now had to choose, from two alternatives, the item that completed the analogy. Sarah chose the correct option most of the time. She even did so when items representing functional relations were presented. For example, when shown a lock and a key on the left side, and a can on the right side, Sarah would choose the can opener to complete the analogy.

Another set of studies explored whether Sarah could also construct analogies. She was given an empty board and 4 or 5 items that could be used to create a valid analogy. This task was especially challenging because Sarah had to find unspecified relations among the items and arrange them on the board so that they would represent a proper analogical relationship. When only 4 items were available, Sarah created a valid analogy 76% of the times. Her performance dropped when 5 items were available, but it was still above chance level.

Premack and his colleagues have contended that language training and/or prior experience with arbitrary symbols for the

abstract concepts of same and different are needed for animals to exhibit analogical reasoning. Such training may have allowed Sarah to display analogical abilities that had been believed to be uniquely human. Language or symbol systems may facilitate relational and analogical behavior because they provide a way for animals to represent abstract relations so that these relations can be encoded and manipulated.

However, the research described above with baboons and pigeons suggests that language or symbol training may not be necessary for disclosing this cognitive capacity. Perhaps critically, both baboons and pigeons had been trained to discriminate same from different collections of items before training on the relational matching-to-sample task. That prior learning of first-order relations may have provided the scaffolding required to process second-order relations.

We conclude from all of this research that animals either have a rudimentary capacity for analogical reasoning or they at least possess the basic mechanisms that evolved into this capacity. These observations have important evolutionary implications. Higher-level cognition was once believed to be the unique province of human beings; but, we now know that chimpanzees, baboons, and pigeons show similar intellectual abilities, at least in their basic form. The roots of abstract thought may thus lie deep in our animal ancestry.

Metacognition

Demonstrations of numerical and basic mathematical abilities, different types of memory, as well as abstraction and analogical reasoning clearly document that animals possess a broad range of cognitive abilities. But, do animals know what they know? This question is not a tricky word play, but the core matter of research in the growing field of metacognition. Metacognition in humans is said to be associated with conscious awareness of one's own cognitive states. People know whether they can retrieve a specific memory, whether they can ascertain if they have enough information to make a decision, and whether they can assess the amount of knowledge they have about a certain topic; in short, people can think about their own cognitive states and processes.

In the last decade, several researchers have studied metacognition in animals as well. Metacognition in animals is plausible. Imagine this common scene: you are walking through a park and you encounter a woman walking her dog; the dog sees you and then it starts looking back and forth to his owner, as if deciding 'should I stay or should I go?' Or we see a hesitant squirrel at the base of a wall apparently deciding if the wall is low enough for her to jump up and land on it safely. When animals do not know what to do, they might defer their actions and seek help or information. These behaviors may be the result of a metacognitive process; but, do they really require metacognition? Do animals have access to their own cognitive states and can they use those states to control their behavior?

First attempts to address animal metacognition used what has been dubbed the uncertainty paradigm, in which animals must learn to discriminate between categories of stimuli, for example, between high-pitch and low-pitch sounds or between pixel-dense and pixel-sparse visual images by choosing one

of two different responses for each of the categories. Animals receive food reward for a correct response and a time-out period for an incorrect response. When the stimuli are near the extreme values, the task is easy; but, the task becomes increasingly difficult the closer values are to the middle of the continuum.

In addition to the two category responses, animals are also given a third option – the uncertainty response – that avoids the target discrimination altogether and takes the animal to another easier task and a smaller amount of food than if they had chosen the correct response for the training categories. If animals can monitor their knowledge, then they might choose the uncertainty response when the values to be discriminated are highly similar and failure is likely. And, so they do. Dolphins and monkeys choose the two category responses when the task is easy, but they choose the third uncertainty response when the task is more difficult.

Nevertheless, the uncertainty response paradigm has raised several concerns, because alternative explanations based on simple associative learning can explain animals' apparently metacognitive behavior. For example, animals may have learned to select the uncertainty response for a particular range of stimuli (the difficult ones near the middle of the continuum) because of the reinforcement history with those stimuli (animals are consistently rewarded if they choose the uncertainty response, but they are inconsistently rewarded if they choose the category responses), not because of a subjective feeling of uncertainty.

In order to avoid this problem, other paradigms have been devised. As we saw earlier, animals have excellent memories for rich and varied information; but, as in the case of humans, these memories may fade or become difficult to retrieve over time. One interesting possibility is to see if animals can report their having good or poor memory for an event that happened some time ago.

Hampton trained rhesus monkeys on a matching-to-sample task in which a delay was introduced between offset of the sample image and the testing stimuli, with the sample presented along with three distractors. On some trials, an intermediate choice was introduced at the end of the delay interval which allowed the monkeys to either accept the memory test and receive a preferred reward if they were successful or to decline the memory test and receive a guaranteed, but less desirable reward (see method in [Figure 6](#)). On other trials, at the end of the delay interval, only the option to take the test was given, so that the monkeys had to take the memory test. If monkeys have metamemory, then when given the option to accept or to decline the test, they should accept the test if their memory is strong, but they should decline the test if their memory is weak.

As a consequence, the monkeys should be more accurate on those trials in which they are given the choice. They should accept the test on choice-test trials when they know that their memory is good. But, the forced-test trials will also include cases in which the monkeys' memory is poor, thereby, lowering their overall accuracy. Monkeys' performance accorded with this prediction; they were more accurate on trials in which they accepted the test than on trials in which taking test was the only option, suggesting that the monkeys could distinguish between their different memory states. Similar results have been found with rats.

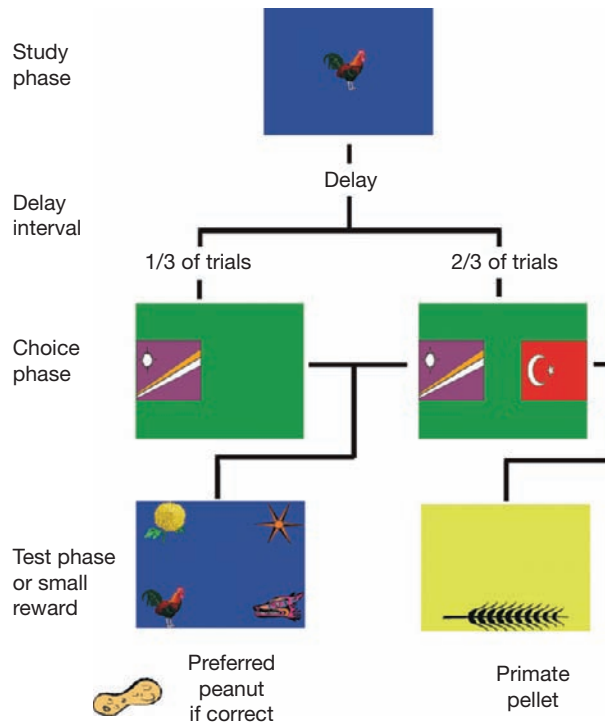


Figure 6 Method for assessing monkeys' metamemory designed by Hampton. Colored panels represent what the monkeys saw on the computer monitor. At the start of each trial, monkeys studied a randomly selected image. After a delay period, on two-thirds of trials, monkeys could choose between taking a memory test (right, left-hand stimulus) or declining the test (right, right-hand stimulus). On the remaining third of the trials, monkeys were forced to take the test (left). From Hampton RR (2001) Rhesus monkeys know when they remember. *Proceedings of the National Academy of Sciences* 98: 5359–5362. Work in the US public domain.

Monkeys' confidence in their memory has also been evaluated by allowing them to gamble. Monkeys viewed a series of six pictures, one by one; after the last picture, nine pictures simultaneously appeared on the screen, only one of which had been presented in the prior series. The monkeys' task was to select this picture. But now, before feedback was provided, the monkeys were given a choice of 2 icons, representing a high-risk option and a low-risk option. A high-risk choice resulted in the gain of three tokens (that could be later exchanged for food) if the monkeys' response in the picture memory test had been correct, but a loss of three tokens if the monkeys' response had been incorrect. A low-risk choice resulted in a sure gain of one token.

The rationale was that a monkey showing metacognitive capabilities should make a high-risk bet when confident about its prior response, but it should make a low-risk bet when unsure about its prior response. In fact, monkeys chose the high-risk button more often on correct trials than on incorrect trials, suggesting that they knew whether they had responded correctly before the presentation of any feedback. Moreover, monkeys generalized the use of the high- and low-risk options to a variety of different perceptual discrimination and memory tasks. This flexibility further helps to discount any specific

associations between the presented stimuli and the alleged metacognitive responses.

Animals can certainly exhibit complex behaviors in these metacognitive tasks; nevertheless, some researchers believe that it is premature to conclude that those behaviors are the result of access to and evaluation of internal cognitive states. Meta-memory tasks, the gambling paradigm, and other studies do suggest that animals can adaptively regulate their behavior under conditions of uncertainty and respond in accord with the knowledge they possess. But, that behavioral regulation may be achieved by means other than metacognitive processes. For example, animals may use their latency to respond as a cue for subsequent behavior (humans also take into account their speed of coming up with an answer to decide whether or not they really know). Although metacognition is a plausible mechanism for the animals' behavioral regulation, it is not yet clear whether it is the only possible mechanism. Again, Morgan's Canon comes into play.

Final Comments

Considerable recent research documents many animals' ability to remember the past, to respond effectively in the present, and to plan for the future. Research also suggests that animals may be able to take into account their current state of knowledge to control their own behavior in an adaptive way. Finally, animals can master numerical and abstract concepts, perform basic arithmetic operations, and even exhibit behaviors which suggest that they possess the roots of analogical reasoning.

Dumb beasts? Hardly! Animals of many different species are sensitive to the rich mosaic of events and relationships that are woven into the causal fabric of the environment. How could it be otherwise? Animals evolved under most of the same constraints and contingencies as the human species. To study animal cognition is to study the mechanisms and functions of cognition without the complexities of language or the biases of anthropomorphism. Doing so not only enriches our understanding of cognition in animals, but it also places human cognition into a more complete evolutionary perspective.

See also: [Analogical Reasoning](#); [Associative Learning](#); [Memory](#); [Primate Cognition](#).

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Antisocial and Narcissistic Personality Disorder

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Glossary

Construct A working concept.

Nosology Branch of medicine dealing with the systematic classification of diseases.

Operationalization The process of defining a variable or variables into measurable factors.

Psychotic Group of psychiatric symptoms that include hallucinations, delusions, and odd behavior that reflect an impaired contact with reality.

Reliability The extent to which a test or criterion repeatedly yields consistent results when assessed by independent raters or in retesting.

Validity The extent to which a test or criterion measures or predicts what it is supposed to.

Introduction

The fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders – Text Revision* (DSM-IV-TR) defines antisocial personality disorder (ASPD) and narcissistic personality disorder (NPD) as persistent maladaptive personality styles that cause distress to a person or interfere with his/her social and/or occupational functioning. ASPD occurs in ~5% of men and 2% of women in the general population and is characterized by a disregard for the rights of others often exemplified by criminal behavior and a lack of remorse. NPD occurs in ~8% of men and 5% of women in the general population and is characterized by a grandiose sense of self and pathological self-centeredness. Antisocial PD and NPD are included in Cluster B in the DSM-IV-TR, which groups PDs according to shared descriptive features. Cluster B is marked by erratic and dramatic behavior and also includes borderline and histrionic PDs. Antisocial and NPD often cooccur with one another reaching 20% and 50% comorbidity in clinical samples and impact not just the individual with these conditions but also the people in their social/occupational circle and the greater society through associated aggressive and criminal behavior.

Conceptualizations of ASPD and NPD

The DSM-IV-TR characterizes ASPD as a ‘pervasive disregard and violation of the rights of others.’ While this current description emphasizes a behavioral disposition toward breaking society’s rules, a discussion of ASPD cannot be complete without addressing psychopathy, a clinical construct that emphasizes not just antisocial behaviors but also interpersonal features such as manipulativeness, glibness, and pathological lying as well as affective features including lack of empathy and callousness, lack of remorse, shallow affect, and failure to accept responsibility. Although not equivalent to DSM-IV’s ASPD definition, the concept of psychopathy has influenced to varying degrees the operationalization of ASPD throughout DSM history. At times, the term psychopathy has been used interchangeably with ASPD, but it has nonetheless been de-emphasized from

the official nosology. As a construct, psychopathy is reemerging in psychopathology research and clinical applications and it is likely to influence future DSM definitions of ASPD.

Descriptions of clinical phenomena that encompass modern conceptualizations of ASPD and psychopathy date from the early nineteenth century when psychiatry pioneers in Europe like Phillipe Pinel and J. C. Pritchard described patients with a conspicuous absence of overt psychotic symptoms, neuroses, or other ‘mental defectiveness’ who habitually violated societal rules displaying *moral insanity* (Pritchard) or *manie sans delire* (insanity without delirium, Pinel). In addition to the consistent antisocial behavior and apparent lack of other psychiatric symptoms, these early descriptions remarked on personality characteristics such as deceitfulness and lack of guilt, which are part of the ASPD construct today. The term *psychopathic inferiority* was first introduced by the German psychiatrist Julius L. A. Koch (1891) to encompass ‘character disorders’ (what we currently would consider PDs) and emphasized their organic etiology. Unfortunately, this broad application of the term ‘psychopathic’ expanded, and it often applied to various conditions ranging from what were considered sexual deviations of various kinds (including homosexuality) to substance abuse. Starting in 1904, Emil Kraepelin refined the concept to include conditions characterized by poor impulse control and severe antisocial behavior (sexual criminals, fire-setters, swindlers). By 1915, Kraepelin had described various ‘psychopathic personalities,’ which included the callous, aggressive, and alienated features of modern conceptualizations of ASPD. Nonetheless, despite refining by Kraepelin, the disorder remained undefined and the term ‘psychopathic’ was used to describe a multitude of unrelated conditions. The issue was further complicated with the introduction of the term ‘sociopathic’ by Karl Birnbaum (1909) to emphasize the view that criminality was mainly the product of social factors.

This confused state of affairs remained when in 1941 Hervey Cleckley published his influential monograph ‘The Mask of Sanity.’ Based on his extensive clinical observations, Cleckley provided a series of illustrative case examples along with 16 diagnostic criteria to operationalize the term ‘psychopathy.’ Cleckley’s criteria described psychopathic

persons in terms of maladaptive behavioral attributes such as unreliability, inadequately motivated antisocial behavior (e.g., robbery committed by someone with significant financial support), as well as affective features including pathological egocentricity, lack of remorse or shame, and untruthfulness. Notably, Cleckley's criteria also included healthy mental and interpersonal characteristics such as superficial charm, average to high intelligence, lack of delusions or signs of irrational thinking, and importantly, 'absence of nervousness or psychoneurotic manifestations.' Cleckley's book became (and remains) a cornerstone for research in the field. Based on it, David Lykken (1957) conducted a seminal psychophysiological investigation supporting the hypothesis that psychopathic behavior may result from impaired affective responses to fear and anxiety. Lykken's findings have been widely replicated and form the basis of his influential 'fearlessness' theory on the etiology of psychopathy.

In 1952, the first edition of the DSM used the term 'sociopathic personality disturbance: antisocial reaction' to refer to persons who habitually violated societal rules, were irresponsible, did not benefit from experience or punishment, were frequently 'callous and hedonistic,' and rationalized their misbehavior. However, under the same diagnostic rubric of 'sociopathic personality disturbance,' the diagnosis of 'dyssocial reaction' was also included to account for people who engaged in antisocial behavior but were able to maintain meaningful relationships with others. As could be expected, the inclusion of two versions of the antisocial personality diagnosis did not help clarify the classification of the syndrome. In response, DSM-II, in 1968, attempted to reduce confusion by discarding the 'dyssocial reaction' category and, in a marked departure from DSM-I, stressed that the diagnosis should not be based solely on a history of offending. Also, other personality characteristics including low frustration to tolerance and selfishness (common to Cleckley's psychopathy criteria) were added in the DSM-II and the name of the disorder was changed to antisocial personality.

As the use of the DSM-II became widespread, it became evident that a narrative description of disorders resulted in poor reliability for some of them, including ASPD. To remedy this, the development of DSM-III included clinical field trials of the proposed diagnostic criteria for each disorder to determine their validity and reliability. The final criteria for ASPD were heavily influenced by the work of Lee Robins (1966), who conducted research on the development of 'sociopathy.' Robins obtained archival clinical data of children and adolescents who had been referred to a clinic for juvenile delinquents from the early 1920s to 1930s and contacted 524 of them 30 years after their original referral. Although Robins initially included some of Cleckley's symptoms (e.g., lack of guilt about crimes), her criteria for the diagnosis of sociopathy heavily favored a behavioral approach to classification (e.g., repeated arrests, large numbers of sexual partners, substance abuse). At around the same time that the DSM-III field trials were being conducted, Robert Hare was developing a structured interview assessment of psychopathy in prison samples based on Cleckley's criteria. The result was the Psychopathy Checklist (1980), which used a clinician rated interview and a review of file information to rate interpersonal, affective, and behavioral indices to arrive at a diagnosis. Since its emergence, the Hare

PCL and its revised version (PCL-R, 1991) have become the gold standard of psychopathy assessment in forensic settings.

Despite its eventual importance, the first version of the PCL was too late to influence the diagnostic criteria for ASPD in the DSM-III, also published in 1980. In the DSM-III, the diagnosis gained its current name (antisocial personality disorder), and it again departed from its predecessor by exclusively relying on behavioral criteria and specifically *including* disregard for social norms and laws as a diagnostic criterion. To meet diagnosis, a person would have to persistently display at least four out of nine symptoms during adulthood and have a history of severe conduct problems before the age of 15. These changes resulted in increased interrater reliability, but many researchers pointed out that it came at the cost of lowered validity. A person could display an inability to sustain consistent work behavior and/or function as a parent, have divorces, and be impulsive, but *not* have any of the personality/affective traits of psychopathy (callousness, lack of guilt), and still receive a diagnosis of ASPD. To address these criticisms, the item 'lacks remorse' was added in the DSM-III-R in 1987. However, criticism continued because the added symptom was not necessary for diagnosis and various researchers suggested that some ASPD symptoms specified on the DSM-III-R (e.g., not maintaining a monogamous relationship for more than a year) were not good indicators of the traits underlying the syndrome.

The current diagnostic criteria for ASPD in the DSM-IV-TR still have not resolved the identity of this disorder as one marked more by behavioral antisocial acts or by personality features reflected in the psychopathy construct. This controversy has continued as the current field trials for the next edition of the DSM are underway and is reportedly one of the reasons that contributed to the recent decision by the American Psychiatric Association to delay the publication of DSM-V until 2013.

In comparison to the development of the ASPD concept, the evolution of the NPD construct has been less controversial. Diagnoses related to pathological narcissism have a relatively long history in psychiatry. In 1898, Havelock Ellis used the term 'narcissism' to describe a sexual perversion in which the self becomes the object of sexual desire. Throughout the twentieth century, the concept evolved with pathological egocentricity at its core and heavy influence from Sigmund Freud's psychoanalytic theory. Various writers including Sigmund Freud (1914), Ernest Jones (1955), and particularly Heinz Kohut and Otto Kernberg through the 1960s and 1970s contributed to the literature that speculated about the disorder's etiology, described its symptomatology, and proscribed its treatment. Although there were some differences between theorists (notably between Kohut and Kernberg) regarding the etiology of the disorder, all conceptions of NPD were remarkably similar in describing it as being characterized by grandiosity that masked underlying feelings of inferiority and fueled by an excessive need for admiration.

Although descriptions of the disorder date back to the late nineteenth and early twentieth centuries, NPD was introduced into the official psychiatric nosology in the DSM-III in 1980. The original description of the disorder was very similar to the current one and included grandiosity, feelings of uniqueness, entitlement, exploitativeness, lack of empathy, and idealization/devaluation of self and others. Since then, the criteria for the diagnosis have undergone only a few changes.

Specifically, a symptom of preoccupation with envy was added in DSM-III-R while the symptom of idealization/devaluation of self and others was removed, and then, in DSM-IV, a symptom tapping arrogance and haughtiness was added while the symptom of feeling rage, shame, or humiliation in response to criticism was removed. Although the symptom of anger in response to criticism was ultimately removed from the diagnostic criteria, the text of the DSM-IV-TR explains that rage and defiant counterattack in response to criticism are often an associated feature of NPD. Importantly, aggression in response to criticism has been well documented in clinical and laboratory settings among NPD patients and nonclinical populations with high narcissistic traits. Therefore, proneness to anger and aggression in response to perceived insult remains an important part of the narcissism construct and it may be a contributor to irritability and aggression, which characterize ASPD.

Although an initial comparison of the DSM-IV-TR's description of the essential features for NPD (grandiosity, need for admiration, and lack of empathy) and ASPD (pervasive disregard and violation of the rights of others) may not readily reveal an obvious overlap, it can be argued that, someone who engages in repeated deceit, assaults, and violations of norms while showing no remorse (characteristic of ASPD) is likely to be entitled, exploitative, unempathic, and arrogant (characteristic of NPD). Support for this view comes from various studies that have found a moderate to strong correlation between ASPD and NPD. In fact, the diagnostic overlap between the disorders was evident during the field trials to develop the current DSM diagnostic criteria for ASPD. Affective symptoms such as 'lacks empathy,' and 'inflated, arrogant self-appraisal' (from a 10-item version of the PCL) provided incremental validity for ASPD, but were not included in the official list of diagnostic criteria due to concerns that it would make the differentiation between ASPD and NPD difficult. These findings suggest that personality aspects that are central to NPD (and psychopathy) are an important aspect of ASPD and will likely influence future diagnostic criteria for the disorder.

Comorbidity

ASPD, Psychopathy, and Overt Criminality

Both ASPD and psychopathy are associated with aspects of criminality, including interpersonal violence, substance abuse (both intake and illegal trade), nonviolent crimes, and recidivism. However, the *type* of criminal behavior displayed by people with ASPD versus those with psychopathy may be an important factor that distinguishes these two syndromes. Studies with prison populations have found that up to 50–70% of people in prison meet ASPD diagnostic criteria, while only 25–30% meet psychopathy diagnostic criteria. However, within 3 years of release from prison, 80% of psychopathic offenders violate the terms of parole compared to only 25% of their nonpsychopathic counterparts. More worrisome are findings that psychopathic offenders are four times more likely than nonpsychopathic offenders to recidivate violently, and according to an FBI report, almost half of persons who kill law enforcement officers are psychopathic. These findings suggest that psychopathic offenders are at higher risk for recidivism, in particular, for violent offenses.

The literature categorizes criminal acts as 'proactive' or 'instrumental' to indicate a level of planning and/or emotional coldness (e.g., planned homicide to steal drugs from dealer) versus 'reactive' to indicate impulsivity and higher affective reactivity (e.g., assaulting a stranger after a perceived insult or argument). Starting in adolescence, a trend emerges for psychopathic individuals to engage in violent, planned criminal behavior whereas persons with ASPD are more likely to engage in unplanned, impulsive criminal behavior. This trend continues throughout adulthood and extends to a variety of crimes ranging from petty crimes to sexual homicide. This is not to imply that persons with ASPD do not engage in proactive criminal behaviors or that psychopaths are not reactively hostile. Rather, psychopathic individuals appear to have a proclivity for violence and are more likely to have planned their actions and/or not be emotionally aroused (e.g., angry) before committing a crime than people with ASPD. Notably, investigators examining the relationship between facets of psychopathy and criminality have found that interpersonal/affective traits of the disorder appear to be uniquely associated with the instrumentality and planning of crime, while the impulsive/social deviance traits are not. On the other hand, the social deviance traits of psychopathy are more strongly related to ASPD and play an important role in the maintenance of antisocial behavior: they predict violent and nonviolent recidivism and, among adults, they predict violent sexual offense recidivism.

Other factors such as intelligence may also play a role in the type of crimes in which people with ASPD or psychopaths engage. Low scores on measures of verbal ability have been associated with ASPD and the social deviance aspect of psychopathy but not with the interpersonal affective traits of psychopathy. Therefore, in the case of people with ASPD, their lower cognitive ability and aggressive and impulsive nature makes them likely to repeatedly engage in opportunistic, unplanned crimes, often 'in the heat of the moment' or under the influence of substances. On the other hand, higher verbal ability, superficial charm, and conning manipulateness of psychopathic individuals allow them to better plan crimes and put them in close contact with victims they may not know. It should be noted that crimes cannot always be clearly divided into planned/instrumental or impulsive/reactive and the majority of crimes have both elements. Research indicates that while psychopaths may be *more likely* to commit proactive/instrumental crimes, *the majority* of the crimes they commit have been categorized as 'impulsively instrumental,' leading some researchers to propose that psychopaths may be able to restrain their violent impulses but are unwilling to do so.

NPD and Antisocial Behavior

As mentioned earlier, ASPD and NPD have features in common and it is therefore not surprising that narcissistic traits and NPD have been associated with antisocial and aggressive behavior. A large part of the evidence supporting a relationship between narcissistic traits and aggression comes from social and personality psychology laboratory studies showing that highly narcissistic individuals (though not necessarily diagnosed with NPD) react aggressively toward people who they think have criticized them. The same relationship between narcissism and aggression has been observed in clinical settings

with NPD patients and persons with 'subclinical' NPD. For example, studies examining domestic violence have reported a strong association between NPD, high narcissistic traits, and sexual coercion (among both genders), child abuse, and violence against women. Importantly, as the levels of narcissism increase, so do the levels of violence. Therefore, the data appear to show a pattern in which narcissistic traits and NPD are clearly related to violence and as narcissistic traits are more elevated (e.g., among psychopaths), the relationship to aggression is more robust and crosses the threshold from reactive to include proactive or predatory aggression.

Comorbidity with Other PDs

Epidemiological data show that nearly two-thirds of people with NPD also meet criteria for another PD at some point in their lifetime. The highest comorbidity is found for other Cluster B PDs, particularly ASPD and borderline PD. Men with NPD are significantly more likely than women with NPD to have ASPD and the converse is true for borderline PD. Histrionic PD occurs in 10% of people with NPD regardless of gender. The next most common lifetime comorbidity for NPD is with Cluster A PDs, which are marked by odd or eccentric behavior. Schizotypal and paranoid are the Cluster A PDs that occur most frequently with NPD and neither of them shows a gender difference in the comorbidity rate. Finally, Cluster C PDs are characterized by anxiety and are found at some point in the lifetime of almost one-quarter of people with NPD regardless of gender. The comorbidity rate with Cluster C PDs is driven primarily by NPD's association with obsessive-compulsive PD. Antisocial PD is fairly similar to NPD in its pattern of comorbidity with other PDs. Like NPD, ASPD has its highest comorbidity with other Cluster B PDs, and ASPD also has substantial comorbidity with paranoid PD from Cluster A and obsessive-compulsive PD from Cluster C.

Comorbidity with Other Disorders

The rate of comorbid PDs among individuals with NPD is rivaled by a similarly high rate of substance use disorders (SUDs). One-half of those with NPD have an alcohol use disorder and one-quarter have a drug use disorder within their lifetime. Men with NPD show double the rate of alcohol and drug use disorders as women with NPD mirroring the gender difference found in the comorbidity of ASPD with NPD. Mood disorders such as major depression and bipolar I and anxiety disorders such as specific phobia and posttraumatic stress disorder are found in 20–25% of those with NPD at some point in their lifetime. Gender differences in the comorbidity rates for these mood and anxiety disorders are similar to those for borderline PD, with women with NPD showing greater rates of all but bipolar I as compared to men with NPD.

An extensive literature documents the high comorbidity between ASPD and SUDs, with some research showing that those with ASPD have an 11-fold increase in risk for an alcohol use disorder and a 14-fold increase in risk for a drug use disorder during their lifetime. There is a large literature on subtypes of alcoholism that consistently identifies two subtypes, one characterized by comorbid ASPD, more severe substance use

history, and higher likelihood of illicit drug use problems. According to research examining the structure of mental disorders, ASPD is part of an externalizing spectrum along with SUDs and behavioral disorders such as attention-deficit hyperactivity disorder. Antisocial PD's significant comorbidity with SUDs and other behavioral disorders stems from their association to a common factor labeled 'externalizing.' This externalizing factor is proving useful in the search for etiological influences (e.g., specific genes) that relate to multiple disorders in the spectrum, including ASPD.

Relationship to Normal Personality Traits

Personality Trait Dimensions Associated with NPD and ASPD

Currently, there is a movement to conceptualize PDs as extreme, aberrant configurations of otherwise normal personality traits. Most personality trait models coalesce around a hierarchical structure of three to five 'broad-band' personality domains comprised of a number of lower-order personality traits. One of the most widely used models is the five-factor model (FFM) of personality. Briefly, the FFM is composed of five broad-band factors: openness (intellectual curiosity vs. conventionality); conscientiousness (orderliness/planning vs. disinhibition); extraversion (outgoing/sociable vs. introverted/quiet); agreeableness (trusting/empathic vs. arrogant/aggressive); and neuroticism (emotionally stable/easy going vs. stress reactive/prone to negative emotions). Various researchers have mapped PDs along these dimensions in an effort to understand the personality traits that contribute to the disorders.

In the case of NPD, studies using dimensional measures of narcissism and the personality profiles of NPD patients have found that the disorder appears to be characterized by low self-reported agreeableness and neuroticism coupled with high extraversion. More detailed examinations of components of the narcissism construct such as leadership, exploitativeness, arrogance, self-absorption, and entitlement are associated with high levels of FFM facets of assertiveness/dominance of others but low gregariousness/affiliation. Therefore, the FFM profile of narcissistic individuals is consistent with the clinical picture of a person who is aggressive and demands attention and/or submission from others but without a desire to establish personal relationships with them. With regard to the relationship between NPD, narcissism, and the broad-band dimension of conscientiousness, findings have been mixed. However, recent studies have found a positive relationship between the motivational dimension of sensitivity to reward and NPD, as well as narcissistic traits. In addition, clinical cases show that persons with NPD endorse high levels of reward driven traits such as achievement striving, but they also score low in deliberation (both facets are subsumed under conscientiousness). This combination of motivational and personality traits contextualizes the clinical picture of persons who might view themselves as capable and diligent but at the same time are careless or impulsive in their approach and indeed aggressive or impatient when frustrated.

Interestingly, studies have shown that the aforementioned FFM features associated with NPD have some parallel relationships to ASPD and psychopathy and could explain their high rates of comorbidity. Specifically, low agreeableness

is common to the three disorders and may be the most relevant factor influencing their characteristic aggressiveness, mistrust of others, arrogance, and lack of empathy. Low agreeableness has also been found to account for much of the covariance between the interpersonal/affective and the social deviance facets of psychopathy. Antisocial PD and the social deviance traits of psychopathy are positively associated with neuroticism from the FFM, particularly the angry hostility, impulsiveness, and vulnerability (to stress) facets. On the other hand, the interpersonal/affective factors of psychopathy have been found to be unrelated or negatively related to neuroticism though positively related to extraversion particularly to the excitement-seeking and assertiveness facets. Finally, various studies have found a strong and negative association between all facets of conscientiousness, ASPD, and the social deviance aspects of psychopathy, completing the clinical picture of people who are unscrupulous, aimless, disorganized, and careless. The interpersonal/affective traits of psychopathy have also been negatively related to conscientiousness; however, the association tends to be lower than the one for psychopathy's social deviance traits and ASPD. This attenuated relationship between conscientiousness and the interpersonal/affective traits of psychopathy may be the result of poor insight conferred by inflated self-esteem. Among the facets subsumed under conscientiousness are competence (self-competence vs. ineptness) and dutifulness (ethical/scrupulous vs. lax/casual). Therefore, psychopaths' arrogance may lead them to report being competent while at the same time endorsing a nonchalant attitude toward responsibilities and ethics.

NPD Subtypes, ASPD, and Psychopathy

The above description of NPD presents a paradoxical picture of persons who may demand attention and recognition yet dislike being with others they deem inferior. Also, although some aspects of narcissism (e.g., vanity, arrogance) are negatively related to omnibus measures of emotional reactivity (neuroticism), the entitled and exploitative aspects of the disorder are positively related to it. In addition, as mentioned above, persons with NPD may have high conscientious traits such as achievement striving and competence but low deliberation and therefore poor control of impulses including their well-documented aggressive reactions. This 'narcissistic paradox' has been widely noted in the clinical literature and has led some writers to propose that there may be subtypes of narcissism: grandiose (or overt) and vulnerable (or covert). Both subtypes of narcissism have been related to undercontrol of aggressive and erotic impulses, insistence on self-expression even at the expense of others, and unrealistic and entitled expectations. However, grandiose narcissism is positively related to personality traits measuring social poise, self-assurance, and well-being, whereas, vulnerable narcissism is negatively related to these traits. Vulnerable narcissism has also been related to hypersensitivity and fear of social scrutiny, whereas grandiose narcissism is related to exhibitionism and attention seeking.

The duality of the narcissistic paradox is similar to the one observed with psychopathy and ASPD. Psychopathy, particularly its interpersonal/affective traits, is associated with high levels of assertiveness and excitement-seeking but low levels of stress reactivity (similar to grandiose narcissists),

whereas ASPD and the social deviance factor of psychopathy are associated with high levels of both excitement-seeking and stress reactivity (similar to vulnerable narcissists). Given the similarities in personality factors associated with NPD, ASPD, and psychopathy, recent theoretical proposals have posited that grandiose narcissism may be related to the interpersonal aspects of psychopathy while vulnerable narcissism may be related to the social deviance/ASPD aspects of the disorder. These proposals would be in line with earlier theories (e.g., Kernberg) suggesting that there is a pathological egocentric core to psychopathy and ASPD. Though provocative, these proposals require further exploration.

Etiological Influences: Genes and Environment

Twin studies are a primary methodology for estimating the extent to which genetic and environmental factors are associated with individual differences in a behavior or trait. The comparison of monozygotic (MZ) twins who share all of their genes to dizygotic (DZ) or fraternal twins who share, on average, half of their segregating genes allows for estimates of the amount of variability in a behavior or trait that is associated with genetic factors, shared environmental factors (things that are common to individuals who live together and serve to make them more alike), and nonshared environmental factors (experiences that are not shared among relatives which serve to make them different from one another). Research on the etiology of NPD is lacking relative to the voluminous literature on the etiology of ASPD. This is apparent when examining research on genetic and environmental influence.

Only a handful of twin studies have examined NPD or its dimensional representations. These studies based on a Norwegian twin sample suggest that 60–80% of the individual differences in NPD diagnoses or symptom counts are associated with genetic factors. The remaining variance is accounted for by nonshared environmental factors. Studies examining a dimensional representation of narcissism using the Dimensional Assessment of Personality Pathology in a large Canadian twin sample have found a similar pattern as found for NPD but with a more equal distribution of variance across genetic and nonshared environmental factors. Like NPD, ASPD is influenced by genetic and nonshared environmental factors, but many twin studies also indicate a small influence of shared environment on ASPD. Juvenile forms of antisocial behavior such as conduct disorder and delinquency show larger estimates of shared environmental influence that decreases in magnitude as people age.

A natural question given the comorbidity between ASPD and NPD is whether comorbidity arises from common genetic and/or environmental factors. This question has been addressed in two reports on a large Norwegian twin sample and the results suggest that a common set of genetic factors contributes to the association between NPD and ASPD (and histrionic and borderline PD). The data are inconsistent on whether a common set of nonshared environmental factors contribute to the disorders. Other research has shown ASPD to be part of an externalizing spectrum of disorders that also includes SUDs, attention-deficit hyperactivity disorder, and constraint (a personality dimension reflecting risk taking, adherence to

traditional values, and behavioral control). The externalizing spectrum has a common genetic etiology contributing to the various disorders as well as some disorder-specific genetic factors. Future research will need to assess the extent to which NPD fits within the externalizing spectrum.

Twin studies are useful in providing information on how much of the variability in a behavior or trait is associated with genetic or environmental factors, but they have not typically provided information on the specific genes and environmental factors involved. Recent developments in data analytic techniques are beginning to spur research on the interplay between genes and environment, but NPD has not been the focus of that research. Nor has NPD received attention in molecular genetic studies aimed at identifying specific genetic variants associated with the disorder. A growing body of work is beginning to show that there are gene \times environment interactions at work for antisocial behavior and ASPD. Adoption data, which provide a direct test of shared environment, show that conduct disorder symptoms are more frequent among adoptees whose biological parent had ASPD *and* whose adoptive environment was disadvantaged (e.g., presence of mental illness in adoptive parent). Research has also identified peer group as an important environmental factor in the development of persistent antisocial behavior. Finally, numerous studies have examined associations of genetic variants with ASPD and have found some support for genes related to the dopamine neurotransmitter system and to monoamine oxidase.

Treatment

The treatment of NPD has received much attention in the psychoanalytic literature with case studies of difficult to treat patients and outlines of psychoanalytic treatments for the disorder. Studies of clinical samples have shown that NPD is associated with impairments in interpersonal relationships and epidemiological studies have shown that impairments appear to be worse for men than for women. In addition, the presence of NPD can hinder treatment of other disorders such as SUDs and depression. Despite the evidence that NPD is a real phenomenon that impairs relationships and can negatively impact clinical practices, there are very few published studies of effective cognitive/behavioral treatments for NPD. Given this lack of attention, it is not surprising that there are no published reports on the empirical effectiveness of treatments for NPD using well-controlled clinical trials.

Psychopathy and ASPD have long been considered difficult to treat conditions. In fact, many PDs are difficult to treat because the conditions are ego syntonic, which means the person lacks insight into the fact that their personality is the root of their distress or functional impairment. The research on ASPD suggests that it might be more amenable to treatment than was first thought, but that the type of treatment makes a difference. Randomized control trials suggest that behavior-based treatments can be effective for reducing related problems such as substance use, whereas treatments that depend on the formation of a strong therapeutic alliance are less effective for people with ASPD. In the case of psychopathy, some researchers have presented evidence that treatment may actually make the disorder worse. Other researchers are less

pessimistic and claim that, like ASPD, some of their behaviors may be moderated while other researchers suggest that persons with psychopathy may only be managed or 'contained' (i.e., imprisoned and/or closely supervised). There is agreement, however, that the main reason for inconclusive or even contradictory findings in the area is the dearth of rigorous studies. In short, it is not clear that the symptoms of ASPD or psychopathy themselves are highly amenable to treatment of any kind once the disorder is present, and this has led some to advocate for early identification of severely antisocial youth as targets for intervention.

Summary

Narcissistic and antisocial PDs are persistent, maladaptive personality styles that interfere with a person's functioning. The DSM-IV-TR defines NPD as characterized by a grandiose sense of self and pathological self-centeredness. Antisocial PD is characterized by a disregard for the rights of others often exemplified by criminal behavior and a lack of remorse. Narcissistic PD occurs in ~8% of men and 5% of women while ASPD occurs in ~5% of men and 2% of women in the general population. Narcissistic PD and ASPD are included in Cluster B in the DSM-IV-TR which groups PDs marked by erratic and dramatic behavior. Narcissistic PD and ASPD are related to psychopathy, a disorder that embodies a particularly virulent combination of traits from both NPD and ASPD. Research has shown that NPD and ASPD have similar relationships to many normal range personality dimensions, which might help explain the high comorbidity among the disorders. Both NPD and ASPD are also comorbid with other disorders such as depression and SUDs. The effects of NPD and ASPD extend beyond the individuals with the diagnoses to people in their social/occupational circle and the greater society through associated aggressive and criminal behavior. The causes of NPD and ASPD include both genetic and environmental influences, and some evidence suggests that the disorders may be underlied by common sets of genes and environment. Like many PDs, both ASPD and NPD are often difficult to treat because individuals with the disorders often lack insight into their personality dysfunction.

See also: Behavior Genetics of Personality; Big Five Model and Personality Disorders; Borderline Personality Disorder; Histrionic Personality Disorder; Personality Disorders.

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Relevant Websites

- www.hare.org – Robert Hare's website devoted to the study of Psychopathy.
- <http://www.nlm.nih.gov/medlineplus/personalitydisorders.html> – National Institutes of Health website on Personality Disorders.

Anxiety and Fear

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Glossary

Anxiety An emotional state characterized by verbal reports of distress (e.g., apprehension, worry), physiological arousal (e.g., increased heart rate), behavioral activation (e.g., avoidance), and/or disruption of cognitive processing (e.g., hyperawareness). Anxiety is associated with more cognitive symptoms and less visceral activation, and cues for its manifestation are more diffuse and changeable, relative to fear, as the focus of anxiety is on objects/events that are more physically removed in space and/or time.

Fear An emotional state involving verbal reports, physiological arousal, overt behavior, and/or cognitive disruption similar to that of anxiety. Fear, however, involves greater mobilization for physical action, as the threat typically is related to specific objects or situations that are immediately present.

Panic Sudden onset of a discrete period of intense fear, typically involving feelings of terror and often accompanied by a sense of imminent doom. Physiological (e.g., hyperventilation) and/or cognitive (e.g., feelings of unreality) symptoms are involved. Panic attacks can either be associated with specific situations or are manifested with no known situational trigger; they can be either expected or unexpected, or situationally predisposed.

Phobia Extreme and persistent fear and/or anxiety of specific object(s) or a situation(s) that is out of proportion to any actual danger involved, typically provokes an immediate response, is recognized by the person affected as excessive, involves avoidance or considerable discomfort, and results in interference with life activities or great suffering.

What Is Anxiety and What Is Fear?

Use and Origins of the Words *Fear* and *Anxiety*

The importance of anxiety and fear in the human experience is reflected by the rich vocabulary that describes these emotions. A few of the many words used in everyday language to describe fear and anxiety include agitation, apprehension, concern, dread, edginess, fright, horror, jitters, nervousness, restlessness, scare, tension, terror, uneasiness, wariness, and worry. Historically, the word *fear* evolved from the Old English word *faer*, which meant peril or calamity but later came to mean a feeling of uneasiness caused by possible danger. The word *anxiety* originated from the Latin word *anxius*, which means troubled in mind, solicitous, or uneasy.

While the terms *anxiety* and *fear* are used interchangeably in much of the literature, recent theorizing suggests important differences between them. Fear, being an evolved basic emotion, typically is in response to a more immediate threat, and so is more highly associated with psychophysiological activation. Anxiety, on the other hand, primarily is a fear reaction to distal or non-present threat, and so is more cognitive in nature.

Fear and Anxiety in Discrete and Dimensional Models of Emotion

Discrete models of emotion propose the existence of a finite number of basic, fundamentally different emotions. Izard, for example, proposes ten fundamental emotions including anger, fear, sadness/distress, contempt, disgust, guilt, shame/shyness, joy, interest/excitement, and surprise. These basic emotions are considered innate and are thought to motivate adaptive action. For example, in fear, the corresponding 'flight' or 'fight' action

tendencies help motivate the organism to avoid or escape or fight to survive a dangerous situation. Individual emotions may combine with one another to produce a large variety of affective states. Fear typically is regarded as a basic emotion while anxiety is viewed as a blend of emotions.

Dimensional models generally assert that all emotions can be classified in terms of their relationship to two or three major orthogonal, bipolar dimensions of affect. The two dimensions proposed by Watson and Tellegen are positive affect (feeling active, elated, vs. dull, sleepy) and negative affect (feeling distressed, nervous vs. calm, relaxed). These dimensions are usually depicted visually as two axes intersecting at a 90° angle within a circumplex. In Watson and Tellegen's model, anxiety is associated with heightened negative affect.

Lang's bioinformational model proposes three rather than two orthogonal, bipolar dimensions: (1) a valence dimension, pleasantness-unpleasantness (feeling happy, content vs. afraid, sad), (2) an activity dimension, arousal-calm (feeling excited, tense vs. relaxed, sleepy), and (3) a control dimension, dominance-submissiveness (feeling in control, dominant vs. submissive, guided). These dimensions are visualized as three axes intersecting at 90° angles in three-dimensional space. According to this model, anxiety involves the experience of unpleasantness, arousal, and lack of control.

Components of Anxiety and Fear

Some psychological perspectives have regarded fear and anxiety as amorphous entities *inside* an individual. Critics have labeled these as *lump* theories. The lump perspectives have been criticized as being unscientific and nonconducive to empirical verification. More recently, fear and anxiety have been regarded as

comprised of verbal reports of distress (with underlying cognitive activity), physiological arousal, and overt behaviors. These three systems are fear and anxiety themselves and comprise their structure.

In many cases, verbal report is the most salient of anxiety/fear responses. The verbal report component is quite complicated in that people can not only describe private, internal states, such as feelings and thoughts, but can also report on their overt behaviors and physiological responses. Accuracy and reliability of reporting are an issue, due to the effects of social desirability and acquiescence, reactive effects of measurement, bias, and faking.

Behaviors associated with fear and anxiety are often motoric and observable. In fact, actual avoidance of an object or situation has long been a hallmark of phobia. Escape is a related behavior, but instead of avoiding the object or situation altogether, the individual confronts it, but leaves prematurely. While avoidance and escape behaviors are the most classic overt behaviors relevant to fear and anxiety, Marks has identified a total of four types of overt behaviors associated with fear and anxiety:

1. withdrawal (avoidance, escape),
2. immobility (freezing, unresponsiveness),
3. submission (vulnerable posturing, appeasement),
4. aggression (verbal attack, threats).

Immobility often is seen in the animal kingdom as an adaptive response to threatening situations, such as when predators are nearby and neither escape nor aggression would be prudent. Immobility can either be attentive, in which an animal freezes, or tonic, in which an organism is unresponsive, perhaps appearing dead. Immobility may be less common in human beings, but can be seen in extreme reactions to major stressors. For example, victims of brutal attacks have reported reacting by being paralyzed and unable to respond during the event. Individuals with height anxiety typically report feeling 'frozen' in place, which is adaptive to their fear as they are less likely to fall.

In submission, organisms attempt to deflect attacks on themselves (or their young) or try to appease a threatening organism. In human beings, appeasement can be observed in a variety of social encounters, such as in situations in which individuals with less status attempt to placate higher status persons by avoiding eye contact or making self-deprecating remarks.

Aggression is less commonly associated with fear or anxiety. Nevertheless, *fight* is one option in the fight or flight reaction. Sometimes, colorful aggressive displays, like the threatening rustling of plumage in some peacocks are involved in such reactions. Responding to threat with fear- or anxiety-associated aggression can be adaptive, discouraging attack by others.

Anxiety and fear are associated with changes in various bodily organs and systems. Of greatest interest in this area has been the nervous system, particularly the autonomic nervous system. The parasympathetic and sympathetic nervous systems (divisions of the autonomic nervous system) are associated with changes in physiological function related to anxiety and fear.

In fear/anxiety responses, cardiovascular and other systems are activated. The heart rate is increased. Blood flow to the

extremities is decreased because of the constriction of peripheral blood vessels. In order to aid in defense, blood pressure increases to allow blood to be directed to the large skeletal muscles. Blood is stored in the torso so that it is readily available for vital organs. Skeletal muscles prepare to contract and so generate electrical activity. Muscles of the face change, which may be evident in facial expression. Sweat gland activity increases to prepare the organism to cool itself after exertion. The skin surface becomes cooler because of decreased blood flow to the skin. Breathing becomes more rapid to supply the blood with increased oxygen. An increase in the release of glucose into the bloodstream prepares the muscles and organs for response. Pupils dilate and hearing becomes more acute.

This mobilization of the organism for action is not the only aspect of fear. A unique diphasic response, specific to blood, injury, and/or illness stimuli, ultimately decreases heart rate and blood pressure, sometimes causing the organism to faint. This response is usually triggered by the sight of injections, blood, or injury. Blood flow is reduced, presumably to lessen the danger of shock if an injury were actually to occur, thereby rendering an organism more likely to survive.

Relationship of Anxiety and Fear to Courage

Courage is persistence in the face of fear and anxiety. To carry on with behavior despite both responding physiologically and acknowledging fear or anxiety verbally is to act courageously. For example, rescuing a child from a burning building would constitute courageous behavior for a passerby. It is also courageous behavior, however, for someone with an intense fear of public speaking to give a speech to an audience. Repeated and successful practice of courageous behavior leads to a decrease in verbal reports of fear and psychophysiological responsivity, which can lead to a state of fearlessness.

Individuals 'deficient' in fear and anxiety are not necessarily seeking treatment, but can suffer negative consequences. Marks and Nesse describe this phenomenon as 'hypophobia,' and explain that it is more beneficial to be appropriately cautious than to take risks. When a potentially harmful situation is encountered, anxiety can be beneficial and used in a way to warn and prepare for the possible threat. Hypophobic individuals may not experience as much fear and anxiety as the average person, which means they are at a higher risk of engaging in risky and possibly injurious behavior.

Measuring Fear and Anxiety

Assessing fear and anxiety can follow the three systems model, in which the focus of measurement is what a person says (e.g., expressing oneself in speech or writing by saying 'I'm afraid'), what a person does (e.g., avoiding a feared situation), and how their body responds (e.g., muscle tension). Interestingly, these systems appear to operate somewhat independently of one another. This phenomenon is known as *desynchrony* or *discordance*; anxiety or fear is present in one or more systems, but to a lesser or greater degree in others. For example, some people appear outwardly calm while making a speech and do not avoid or escape, but their hearts pound and they later report having been terrified. People who are highly fearful, however, typically show consistency in fear across the three systems.

Anxiety can be measured in response to a specific situation at a discrete time, or can be assessed as a more general response tendency. Spielberger has characterized anxiety as being either state or trait in nature. State anxiety is a transitory emotional condition characterized by feelings of tension and apprehension which fluctuate over time as a function of environmental stressors and the individual's coping response to them. Trait anxiety is a relatively stable personality attribute that is an individual difference in proneness to experience stressors as distressing.

In assessment, the question arises as to which of the three response systems is the 'gold standard.' No one system has precedence over the others, nor is any one considered the most important, although self-reporting is the most commonly used approach, as a matter of convenience. Nevertheless, ideally the use of methods to assess each of the categories of self-report, psychophysiological response, and overt behavior is applied for the most comprehensive approach.

Self-reports are what people indicate through spoken, written, or other symbolic communication. Methodologies such as questionnaires and interviews are commonly used self-report assessment strategies. Questionnaires that directly prompt the individual to indicate the presence and intensity of anxiety/fear typically use numerical ratings. Some nonverbal assessment methods involve presentation of symbolic stimuli and require an individual to select stimuli that match internal feeling states. For example, the Self-Assessment Mannikin prompts individuals to rate dimensions using an abstract stick figure, changing characteristics of the mouth (for smiling or frowning), bodily activity (to indicate arousal), and body size (to report on feelings of dominance).

Another self-report methodology, interviews, can be used to collect information about anxiety and fear and can have the advantage of allowing a trained interviewer to use judgment in assigning ratings to compensate for interviewee biases such as over-reporting or minimizing. The interview format can be unstructured and general, such as open-ended interviews conducted by most mental health professionals in purely clinical settings. Structured interview protocols can be utilized to assess broadly (e.g., Anxiety Disorders Interview Schedule) or in highly specific areas (e.g., Dental Fear Interview).

Overt motoric behaviors are typically evaluated by observation. Observation of behavior can take place in the clinic, laboratory, or natural environment. Self-monitoring is often used with clinical patients, asking them to record event frequency, context, and associated thoughts and feelings (e.g., recording when panic attacks occur and in what situations). Monitoring can also be done by parents, partners, and others. In clinical settings, role plays can be used to emulate actual situations so that behavioral responses of patients can be observed.

It is possible to utilize trained personnel for standardized observations, such as monitoring of facial expressions or assessment of social skills. A standardized strategy for observing behavior in clinical and research settings is the behavioral assessment test (BAT). In this method, the individual being assessed is asked to confront a fear/anxiety-eliciting stimulus in a standardized format (e.g., how long a person can carry on a speech). It is also possible to observe more subtle behaviors (e.g., stammering during a speech), which can be quantified.

Typically, measures involve approach (e.g., how close a person can get to a snake in a BAT for snake phobia) or endurance (e.g., how long an individual can stay seated in a dental chair in a BAT for dental phobia).

Psychophysiological data most often are collected in the laboratory or clinic, but can be acquired in the natural environment using ambulatory monitoring equipment. Typically, psychophysiological levels are measured at resting baselines and then compared to precisely timed events that provoke fear and/or anxiety. The most frequently utilized measures of physiological arousal in fear and anxiety research are cardiovascular. Of these, heart rate has been the most often selected index. Another commonly used physiological measure is electromyography, the assessment of skeletal muscle activity. By measuring electrical activity from a muscle, it is possible to infer muscular tension. Assessment of electrodermal activity is yet another type of psychophysiological measurement; it focuses on sweat gland activity in the skin, using measures of skin conductance and resistance. An increase in perspiration will be reflected in a decrease in resistance and an increase in conductance. Other ways of measuring psychophysiological fear and anxiety reactions include endocrinological measures. Research has examined changes in catecholamine levels before, during, and after stress in both normal and anxious subjects. Endocrinological studies have also investigated changes in epinephrine, norepinephrine, and adrenocortical functioning.

Across the three systems, specialized instruments allow evaluation of aspects of anxiety and fear that would ordinarily be impossible to measure accurately or at all. Instruments are commonly used to measure psychophysiological responses as well as to record speed and accuracy of cognitive processing. Moreover, brain imaging techniques that allow measurement of very basic physiological processes are available now. Novel assessment methods have been introduced to accurately record cognitive processes. These techniques can be used to assess responses to stimuli that are within the consciousness (supraliminal) or outside the awareness (subliminal). Assessing cognitive processes in fear/anxiety research has focused on attention and memory, assessing reaction time, processing time for complex tasks, accuracy of recall and recognition, comprehension of ambiguous stimuli, and effects of interfering probe stimuli, among others.

What Makes Human Beings Anxious and/or Fearful?

Anxiety and Fear as Normal, Adaptive Emotional States

Fear and anxiety are normal responses in everyday life that are an important part of being human. Fear and anxiety can be adaptive reactions to realistic threats or to the possibility of some negative event(s). In dangerous situations, fear can mobilize people to respond rapidly and efficiently. Without this capacity, human beings would not have been able to survive when faced by the dangers present in the natural environment. Cannon's emergency action tendencies of 'fight' or 'flight' represent the organism's alarm reaction to life-threatening emergencies. With regard to anxiety, the ability to anticipate possible negative futures and to prepare to deal with them is adaptive as well.

Fear and anxiety continue to have adaptive value in everyday life. Without some minimal amount of fear and anxiety,

people might become careless and lack the motivation to accomplish things that need to be done. People might drive recklessly on the highway, approach dangerous animals, neglect work, or not plan for the future. According to the Yerkes–Dodson law, human and animal performance generally improves with increases in arousal until some optimal level is reached, at which point further increases in arousal hinder performance. With too little arousal, a pilot may become inattentive and make a critical mistake; with too much activation, the pilot may become paralyzed with fear and unable to respond effectively to danger.

People do not always avoid situations which provoke fear and anxiety and at times may actively seek out dangerous activities. Many sky divers, mountain climbers, and race car drivers enjoy the challenge of mastering danger. Most people enjoy some sort of danger vicariously such as by viewing horror movies, or reading suspense novels. Some individuals also enjoy the fear involved in riding roller coasters and going to Halloween ‘haunted houses.’

Pathological Fears and Anxieties

While a bit of fear and anxiety can keep people alert and ready for action, excessive amounts are disruptive and even paralyzing. It is important to clarify the relationship of normal fears and anxieties to pathological states, diagnostically known as anxiety disorders. The immediate context is particularly important with fear, as when there is danger present, even high levels of fear may be appropriately activating, to remove the individual from threat. Without such danger, however, higher degrees of fear likely interfere with functioning. Similarly, some lower levels of transient anxiety may be a cue for individuals to plan ahead and overcome procrastination, while excess worrying probably interferes with performance.

As illustrated in [Figure 1](#), fears and anxieties exist along a continuum of severity, ranging from fearlessness at one end to typical levels of anxiety and fear to their pathological manifestations in anxiety disorders at the other end. Inherent in this model is the idea that normal anxieties and fears are continuous with psychopathological states. The anxiety disorders are not disease states completely unlike that found in ‘normal’ individuals. They are, however, quite extreme and persistent versions of emotional states experienced by almost all people.

Anxiety and fear are considered pathological when they are out of proportion to the actual threat present, interfere with one’s daily activities, involve maladaptive behavior such as avoidance or escape, and are recognized by the individual as excessive or unreasonable. The prevalence of anxiety disorders

surpasses that of any other category of mental health problems in the general population. Additionally, substance abuse, especially alcohol abuse, is common among individuals suffering from anxiety disorders and sometimes reflects an attempt at self-medication.

Situations Eliciting Anxiety and Fear

A considerable amount of research has been directed at identifying the objects and situations that evoke fear in human beings. New fears and anxieties emerge or are lessened periodically. Only in the last several decades have there been concerns about terror attacks and AIDS; concerns about contracting certain diseases which were common prior to and early in the 20th century are considerably less now due to availability of certain medications. The specific focus of fear and anxiety are, in part, culturally and otherwise environmentally determined. It may be more common to fear violence, for example, in high-crime areas in certain cities and in war-torn lands, given the greater vulnerability and probability associated with attack. Nevertheless, work by Arrindell and others has made it possible to categorize anxieties and fears of adults into the following five basic dimensions:

1. social situations,
2. environmental and/or agoraphobic situations,
3. blood, bodily injury, illness, and death,
4. sexual and aggressive scenes,
5. small animals.

Fear and Anxiety Across the Lifespan

While fears and anxieties can develop at any time of life, some have greater incidence in particular developmental stages. Fears identified as being common in infancy typically include fear of heights, loss of physical support, loud noises, and other sudden, intense, unexpected stimuli from the environment. A fear of strangers typically develops between 6 and 12 months. Stranger fear appears to be different from distress associated with separation from parents. Fear of strangers can emerge as early as 4 months and peaks between 13 and 18 months. A program of research by Kagan and colleagues on temperament evident in infancy suggests that some human beings are constitutionally predisposed to being anxious and/or fearful, inhibited, and physiologically reactive, which may have long-lasting implications.

Common fears of children 1–3 years old include fear of toilet training activities, injury, loud noises, animals, dark rooms, masks, and novel stimuli. During preschool, kindergarten, and

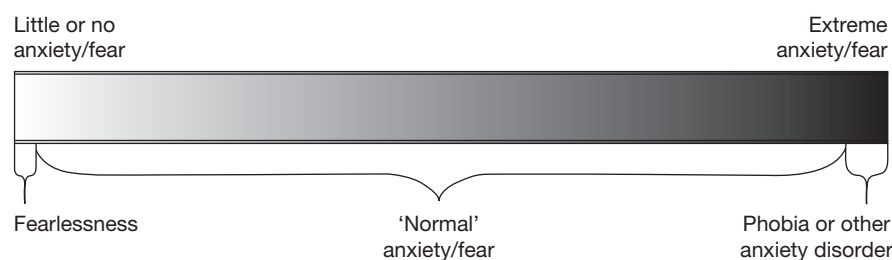


Figure 1 Continuum of severity for anxiety/fear.

first grade, prominent fears include fear of separation from parents, animals, darkness, bodily harm, thunder, lightning, sleeping or staying alone, and supernatural beings. Older elementary school children frequently experience fears and anxieties related to test taking, grades, physical appearance, injury, illness, death, and natural phenomena such as thunder and tornadoes. Most fears and anxieties of adolescents are focused on personal adequacy, school events, physical health, sexual matters, and political and economic concerns. In general, over the course of childhood, fears and anxieties change from having a formless and imaginary quality to being specific and reality-based.

Many fears and anxieties are common in the general population. The five most common fears among adults, in developed Western societies, in order of prevalence, are:

1. snakes (most common),
2. heights,
3. storms,
4. flying in an airplane,
5. dental treatment.

What human beings fear and find anxiety-provoking changes across the lifespan. During the course of development, virtually all children display a large number of fears (e.g., of injections, doctors, darkness, strangers), most of which are transitory or short-lived. Fears of snakes, animals, heights, storms, enclosures, and social situations are frequently acquired during childhood and adolescence, but appear to be more long lasting, as their prevalence remains relatively high throughout adulthood and into old age. Fears which reach their peak of prevalence at the upper end of the lifespan include fear of crowds, death, injury, illness, and separation. Fears and anxieties in older adults are complicated by frequent coexistence with other disorders such as depression and dementia. Symptoms of anxiety, including worry, are similar in younger and older adults, although there may be some unique considerations in the elderly, such as the greater likelihood of medical illnesses. While some anxiety disorders decrease in prevalence in older adults, phobic disorders and generalized anxiety disorder are relatively frequently manifested.

Sex and Gender Differences

Studies consistently have shown that, in most domains (with social fears a notable exception), men generally report less fear and anxiety, while women report more such distress. This sex difference appears during childhood, and is seen throughout life. What males and females fear and find anxiety-provoking also seem to differ. Women express more environmental and agoraphobic fears, distress about small animals, and concern about sexual and aggressive scenes than men. Fear of social situations, as well as fear of bodily injury, death, and illness appears to be more equivalent. During childhood, girls report more fears and anxieties related to animals and physical injury and illness, while boys report more fears and anxieties related to economic and academic failure.

Variables other than biological sex may account for many of the differences observed between females and males regarding the prevalence of fears, anxieties, and anxiety disorders. While

there is more generalized anxious response in women relative to men, with females reporting higher and males reporting lower levels of anxiety, the response of females may be healthier for them, consistent with the literature on the benefits of emotional expression. Craske suggests sex differences in anxiety may be related to four main issues: gender role expectations (females allowed greater social latitude to report fear), life events (females have more negative events than males), physiology (males more physically reactive to acute stress, females more reactive to contextual cues), and cognition (females more likely to worry). Wilson and Daly contest that males are socio-biologically developed to be competitive risk takers, especially when there is a good chance of success. This predisposition to risk taking may result in either less fear and anxiety, or perhaps less *reporting* of fear and anxiety.

Cultural Considerations

Fear and anxiety are emotional states that are experienced by people across the world, although their environmental content, context, and manifestation vary widely. Traditional Aboriginals in Australia, for example, prefer open areas that are not closed in, and some may react quite negatively to being shut in a room. This reaction may be related to thousands of years of nomadic existence, in which closed in shelters were uncommon. As another example, Chinese males in Southeast Asia may suffer from *koro*, the fear of the penis retracting into the abdomen and death occurring as a result. This phenomenon results in acute panic and various devices may be employed to prevent retraction of the penis. Occasionally this disorder is seen among women as well; they fear retraction of the nipples, the breasts, or the labia. In this culture, male genitals are considered to be vital for life and excessive sexual activity is believed to be unhealthy. Therefore, it is not surprising to find that patients who experience *koro* may relate the cause to past sexual transgression.

Fright-related disorders are interesting phenomena that have been observed in many different cultures. In Iranian society, a variety of problems ranging from physical illness to psychotic episodes may be explained as being caused by a prior startle or fright experienced by the individual. Similarly, in some Hispanic cultures, *susto* is a condition that is caused by a sudden fright, the *evil eye*, or the casting of a spell and is characterized by a state of anxiety, fearfulness, or illness. The result of these beliefs may lead to what is termed *Voodoo Death*. The victim of the *curse* or *evil eye* can be in a state of autonomic hyperarousal for an extended period of time, which presumably may lead to damage of the internal organs and eventually death.

While these culture-specific conditions differ across the globe, the prevalence rates of many classic anxiety disorders are relatively similar. Nevertheless, there are differences between ethnic and racial groups within nations and geographic areas. For example, there is a higher rate of phobic disorders among African Americans than Caucasians in the United States. This distinction may be due to the stress of being in a minority group that has experienced prejudice and which has higher proportions of low socioeconomic status relative to the general population, placing them at higher risk for stress and negative life events.

Comparisons Across Species

Fear and anxiety responses have been instrumental in the survival of both human beings and other species throughout the course of evolution. Humans and animals have often experienced similar hazards to their existence and, through natural selection, have come to share many similar, adaptive fears. For example, human infants, like the young of other land-dwelling species such as cats, goats, and monkeys, display an adaptive fear of heights and withdraw from a visual cliff. Aquatic species such as ducks show no such fear. Similarly, novel objects, foods, and situations elicit adaptive approach-avoidance behaviors in humans and other species such as birds and primates; such behaviors are beneficial to organisms in that the unfamiliar carries with it the possibility of both danger and opportunity. Other fears common to both humans and many other species include fear of too much or too little light or space, fear of sudden touch, seizure, proximity, or movement, and fear elicited by visual and auditory alarm cues from members of the same species.

Theories of the Development and Maintenance of Anxiety and Fear

Origins of Angst

For centuries, philosophers and clinicians have pondered the cause(s) of diffuse and objectless anxiety. Kierkegaard used the German word *angst* to describe this experience. For Kierkegaard, *angst* results from the distinctively human, self-conscious capacity to discern the *possibility of freedom* and the ultimate threat of nonbeing. Kierkegaard thought that the achievement of selfhood was possible only if one was able to recognize and confront anxiety and to move ahead and actualize one's possibilities despite it.

Psychodynamic Models

Early theories of anxiety and fear arose from psychodynamic traditions. Freud used the word *angst* (anxiety) to refer to vague, objectless anxiety and the word *furcht* (fear) to label such distress when it was focused on an object. Freud viewed anxiety as the reaction to and signal of unconscious memories of real or imagined threats to the child. Anxiety is related to fantasized situations that were perceived as real and dangerous to the child, who felt helpless in the face of them. The generation of anxiety acts as a signal to elicit the psychological defense mechanisms, which, if adequate, reduce anxiety and allow for a high level of functioning. If the defenses are not adequate, phobic or compulsive symptoms symbolically related to the unconscious source of anxiety may arise.

Learning Theories

Although the capacity to experience fear is innate, most fears and anxieties are learned through association. Fear and anxiety may develop through classical conditioning. In this type of learning, an unconditioned stimulus (UCS), such as pain, is the original source of fear (unconditioned response). After pairing the UCS with a new, previously neutral stimulus, this

second stimulus becomes the conditioned stimulus (CS). The CS then can elicit a fear response (conditioned response) without the UCS being present. Watson and Raynor demonstrated this process in their case of little Albert. Albert, a young child, initially showed no fear of rats. He was, however, frightened by loud noises (UCS). Watson and Raynor repeatedly exposed little Albert to a loud noise (UCS) while viewing a rat (CS). Little Albert soon developed a conditioned fear to rats. This fear generalized to other objects that resembled rats, such as rabbits and other soft, furry animals.

An early adaptation to classical fear conditioning theory was the avoidance learning model, which hypothesized that fears fail to decrease or remit completely if the individual learns to avoid the stimulus. Mowrer stated that the learned fear of the CS was acquired according to classical conditioning principles, and that the motor response of avoidance was learned by instrumental conditioning. As it involves both classical conditioning and instrumental conditioning, it is known as the 'two-factor theory.' It purported to explain why phobias do not resolve even with repeated exposure. Mowrer reasoned that the motor response was first made to escape a negative situation, but on subsequent trials, the behavior was an avoidance response motivated by fear, and maintained by fear reduction. Despite the fact that the two-factor theory has not fared well when subjected to rigorous empirical investigation, it has made significant contributions toward the understanding of the maintenance of fear and anxiety.

Other mechanisms have been introduced to resolve the limitations of conditioning theories to account for the development and maintenance of anxieties and fears.

Vicarious Learning Through Observation and Direct Instruction

Vicarious learning has been extensively studied, and undoubtedly can play a major role in the acquisition of anxiety and fear. Such learning through observation, hearing accounts of fearful situations, or someone telling another person that an event (e.g., dental care) is *scary* can be linked to learned sensitivity of bodily sensations (e.g., suffocation cues related to panic attacks) and social phobias (e.g., socially anxious parents fearing and avoiding social situations, thereby serving as a model for their children's social behaviors). Although vicarious learning certainly does not always lead to phobic responses, or even anxiety or fear, it may serve as a specific type of psychological vulnerability for the development of anxiety disorders.

Cognitive-Behavioral and Cognitive Theories

Cognitive-behavioral and cognitive formulations of fear and anxiety have grown in influence within the scientific literature. Barlow regards panic as a critical component to anxiety disorders, with biological diathesis and psychological vulnerability potentially predisposing individuals to develop problems with anxiety. Barlow's work suggests anxiety, fear, and panic may be described as cued or uncued, expected or unexpected. Panic is considered cued when the individual is able to identify an external or internal event that precipitates it; panic is considered uncued when the individual is not able to identify a trigger. If a panic attack is anticipated, then it is expected; otherwise, it is unexpected. Thus, panic attacks fall into one

of four categories: cued and expected, cued and unexpected, uncued and expected, uncued and unexpected. For example, a panic attack is both cued and expected when a person with a snake phobia encounters a snake. Spontaneous panic that comes 'out of the blue' is uncued and unexpected. In this conceptualization, fear is largely cued, while anxiety is uncued.

Research suggests there are three particular categories of anxiety/fear-linked cognitive bias. Specifically, individuals experiencing anxiety (1) attend selectively to threat-related information, (2) show facilitated memory for threat-related information, and (3) demonstrate an interpretive bias favoring more threatening meanings of ambiguous information. In terms of the content of thinking, anxiety has been found to include negative self-talk, low self-efficacy, and self-abnegation.

Beck's cognitive theory depicts a three stage approach in responding to anxiety and fear: (1) registration of the threat, (2) activation of an automatic response to the threat, and (3) the subsequent evocation of secondary, elaborative checking. Further, this theory emphasizes that beliefs and cognitive processing of errors play an important role in producing and sustaining negative emotional states. For example, an anxious individual may believe that 'others are critical' and subsequently feel anxious when meeting new people. This individual will be quick to attend to threatening information in a social situation (e.g., frowns), will likely remember and ruminate about the most negative aspects of the situation (e.g., mispronouncing someone's name), and interpret ambiguous information negatively (e.g., someone ending a conversation is an indication of dislike rather than some more neutral explanation).

Metacognitive theory is a branch of cognitive psychology which emphasizes thinking about the manner in which individuals' process cognition, or 'thinking about thinking.' Instead of focusing on maladaptive beliefs, this theory places importance on awareness and control over cognitive (and emotional) processes, as well as overarching beliefs and appraisals of specific situations. Therefore, as described by Wells, an individual with generalized anxiety disorder may utilize various types of worrying as a means of appraising a situation and coping with it.

Network Models

As discussed earlier, Lang has forwarded a bioinformational model of emotion, differentiating the dimensions of valence, arousal, and control. In this theory, anxiety and other emotions are represented in memory via stimulus characteristics (e.g., hearing a dental drill sound), response propositions (e.g., gripping the arms of a dental chair), and meaning elements (e.g., being in a dental office for root canal therapy versus attending for routine care). Lang's theory may best be considered in the context of a defensive motivational system, in which the behavioral reactions of anxiety and fear are reflected in defensive immobility (freezing, hypervigilance response) and defensive action (flight-or-fight response). In Lang's recent research, there has been a focus on these responses, specifically the phenomenon of a startle potential. A noticeably stronger startle response is the result of the activation of the defensive motivational system, resulting from high arousal and a high level of unpleasantness.

Evolutionary Significance and Biologically Prepared Stimuli

Encounters with environmental stressors that cause fear and anxiety have been present throughout the history of humankind. Early encounters included contact with feared beasts that have shaped humans' reactionary responses. It has been proposed that animal fear originates in a predatory defense system that allows animals, including humans, to avoid or escape potentially dangerous animals such as poisonous snakes.

The evolutionary significance of fear and anxiety is directly linked to the biological idea of survival of the species. Fear and anxiety serve a protective function for all members of the animal kingdom who are capable of experiencing this biological warning. Some theorists believe that the ability to plan for the future is also dependent on anxiety and fear.

Seligman, Öhman, and others posit that humans, and some lower animals, are *prepared* or predisposed to fear certain animals and other stimuli. Human beings more frequently fear stimuli that can potentially cause harm (e.g., rodents). This theory of evolutionary *preparedness* implies that some aspects of what humans learn to fear, along with the fear response, may be innate. For example, investigators have suggested that humans may have an innate fear of small stimuli that move rapidly or abruptly (e.g., snakes, spiders). It is somewhat less frequent for people to fear things that have little or no apparent danger, although quite unusual fears are observed clinically (e.g., distress about opening large dictionaries).

This fear of evolutionarily relevant creatures (e.g., poisonous snakes and spiders) is observed even in individuals living in geographic regions in which no such threat exists. Therefore, even without the risk of encountering a dangerous animal, the fear persists. In contrast, the likely harmful aspects of modern life (e.g., overconsumption of alcohol, tobacco use, excess dietary fat, obesity, casual unprotected sex), are typically not feared, even though they are encountered more often and are more of an actual threat to individual well being.

Genetic and Familial Transmission

A variety of studies have asked, 'Are fear and anxiety inherited?' and 'Are fear and anxiety acquired through learning?' These questions are an example of the 'nature versus nurture' debate that permeates much of psychology. Researchers have looked at family histories, parenting characteristics, and prevalence rates of anxiety disorders within families to answer these questions. Comparative psychologists have demonstrated that it is possible to breed anxiety/fear in rats and dogs and have observed severe social anxiety to be naturally occurring in a subset of certain nonhuman primates. When exploring the heritability of the global category of *anxiety neurosis*, one study noted that as many as 50% of the children with parents with an anxiety neurosis also carried that diagnosis. Studies with twins suggest a genetic component in transmission of anxiety disorders. Studying the connection between phobias and the stress-diathesis model, Kendler, Myers, and Prescott suggested the importance of nonassociative models of fear acquisition, proposing vulnerability that primarily is biologically determined and innate. Most studies with humans support the idea that in some individuals, tendencies to develop fear and anxiety are inherited, but learning through familial

transmission has been demonstrated to be extremely influential as well. These interacting influences are represented in the diathesis-stress model, which integrates genetic or other biological vulnerability (diathesis) with environmental influences, particularly early learning. Further development of this model in the stress-vulnerability-protective factors approach also introduces the idea that there can be genetic and other biological hardiness as well, and certain earlier learning can 'inoculate' an individual from otherwise negative environmental events.

The contribution of heritability has ignited another question: *What is it that is inherited?* The most widely accepted answer is that one inherits a vulnerability to fear and anxiety generally, which may or may not develop in pathological proportions based on an individual's environment. Chronic stress is an example of an environmental influence that may induce problem fear and/or anxiety in a vulnerable person. Without that stress, the individual might never have developed an anxiety disorder.

Conclusions

The knowledge base about anxiety and fear continues to evolve. There are scientific journals devoted to anxiety and anxiety disorders as their exclusive subject matter. In the last several decades, national organizations (e.g., Anxiety Disorders Association of America) have come into being, with memberships including lay people afflicted with problem fear and/or anxiety, and professionals who provide treatment and/or research in the area.

In the anxiety and fear literature, theories of emotion and emotion regulation have gained prominence in recent decades. Learning, cognitive, and particularly cognitive-behavioral models continue to be important, but, theorists increasingly try to understand fear and anxiety in the context of the theoretical work and basic research emerging from the field of emotion.

Anxiety and fear are important emotional states, but are in truth like the proverbial double-edged sword. On the one hand, they are motivating emotions, prompting people to behave in healthy and safe ways. Conversely, in extreme forms, they are associated with misery and distress, causing chronic and lifelong problems that can disrupt an individual's life entirely and indefinitely if left untreated. While anxiety and fear are scientifically fascinating, and reveal much about the human condition, the associated distress can be

overwhelming. Anxiety disorders are also often associated with other emotional problems, particularly depression, as well as problems with alcohol and other drug abuse. While there is an extensive knowledge base on anxiety and fear, further conceptual work and more research is needed to better understand and more fully understand these emotions and the treatment of their pathological manifestations in anxiety disorders.

See also: Aggression; Anxiety Disorders; Behavioral Genetics; Classical Conditioning; Motivation; Phobias; Sex Differences; Sex Roles; Social Anxiety Disorder; Stress and Illness; Subjective Culture; Work Efficiency and Motivation.

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Anxiety Disorders

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Glossary

Agoraphobia Fear and avoidance of situations associated with panic, or from which escape might be difficult, due to the fear of having a panic attack or not being able to obtain help.

Diagnostic and statistical manual of mental disorders The reference manual used by mental health professionals to diagnose psychological disorders. The DSM is published by the American Psychiatric Association and contains information on the diagnostic

criteria, associated features, prevalence, and course for each disorder.

Exposure A treatment technique that involves facing a feared stimulus (including images, thoughts, objects, events, or situations), and remaining with that stimulus until anxiety has decreased.

Panic attack A rush of intense fear or discomfort accompanied by physical sensations.

Phobia Excessive and/or unreasonable fear of an object or situation.

What Is Anxiety?

In general, anxiety is good and is an adaptive survival mechanism. It helps in keeping us from danger and in remaining motivated. Without anxiety, we would not jump out of the way from a car about to hit us, or study for a test, or be alert to signs of potential danger. Anxiety can be described in terms of behavior, thoughts, and physiological sensations. For example, behavior related to anxiety involves moving out of the way of the car that is about to hit us or paying attention to our surroundings in potentially dangerous situations. An anxiety-related thought might be, 'If I don't study, I may fail my test.' Physiological sensations of anxiety might include palpitations, sweating, or trembling. Thus, anxiety can be very adaptive, such as when it leads us to take precautions to protect ourselves from real dangers or to take action to run from or fight off real dangers (e.g., the fight-or-flight response). Even in safe situations, mild anxiety typically leads to better performance than does none at all.

When anxiety is excessive for a situation, however, it may become harmful rather than helpful. Maladaptive anxiety may include the same behaviors as adaptive anxiety, but in different circumstances. For example, the level of hypervigilance for potential danger that makes sense while one is walking alone in the street at night would likely be excessive while one is walking in a hallway in an office building during the workday. Another example of maladaptive anxiety is avoidance, such as refusing to participate in class due to fear of evaluation. The Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition, Text Revision (DSM-IV-TR) describes 11 disorders related to anxiety, and as a whole, anxiety disorders are among the most prevalent of all psychological problems.

It is important to recognize that anxiety falls along a continuum. So while everyone experiences anxiety and many people experience common symptoms of an anxiety disorder, this does not in itself mean they have an anxiety disorder; diagnosable anxiety disorders require that the anxiety leads to distress and/or functional impairment. For example, it is very common for individuals to fear public speaking due to fear of evaluation by others, a symptom of social phobia. Yet, many

people with this common fear will not meet the criteria for social phobia because it does not bother them to have this fear, nor does the fear or fear-related avoidance affect their lives. On the other hand, if the same individuals, with the same fear level, were to receive a job promotion that required them to give presentations, the same fear of public speaking might now be problematic for them, and might then be considered a diagnosable social phobia. Alternatively, the same individuals might find themselves developing stronger fears of the same situation, and becoming more distressed by their fear, which would also lead to their reaching the threshold of a diagnosable social phobia. Thus, distress or interference with functioning may be prompted by symptoms becoming more intense or more frequent, or by the same symptoms becoming problematic in a way that they had not been before (e.g., having a new job requirement to give presentations). Without distress or interference, however, even excessive or irrational anxiety would constitute nonclinical features of a disorder rather than a clinical disorder itself.

The Anxiety Disorders

Panic Disorder and Agoraphobia

Panic disorder is a common mental health condition that affects between 1% and 3.5% of the population in their lifetime. This disorder requires unexpected panic attacks, at least initially (often people with panic disorder then begin expecting to panic in specific situations, and thus may experience cued attacks as well as uncued ones). Panic attacks are periods of intense fear or discomfort that peak within 10 min and are accompanied by at least four of the following symptoms: palpitations; pounding or racing heart; trembling or shaking; feelings of choking; chest pain or discomfort; dizziness, unsteadiness, lightheadedness, or faintness; fear of losing control or going crazy; fear of dying; chills or hot flushes; numbness or tingling sensations; sweating; nausea or abdominal distress; sensations of shortness of breath or smothering; and derealization. Panic attacks can occur in all anxiety disorders, but in panic disorder, the attack is unexpected, rather than caused by a specific stimulus. Further, panic disorder requires at least 1 month of one or

more of the following symptoms: persistent concern about additional attacks, worry about the implications of an attack, or a significant change in behavior linked to the attacks. Finally, the attacks must not be due to a medical condition or substance use.

The change in behavior noted above can take many forms. It might include always having one's cell phone charged to be able to call for help if necessary. Using distraction, such as playing the radio loudly while driving, is another form of behavior change. One of the most common forms of behavior change is agoraphobia, or fear/avoidance of being in places where escape might be difficult or where help might not be available if the individual were to have a panic attack. One-third to one-half of all individuals with panic disorder also have agoraphobia, and are thus diagnosed with panic disorder with agoraphobia. (Those who do not develop agoraphobia are diagnosed with panic disorder without agoraphobia.) Common situations avoided in agoraphobia include bridges and tunnels, highways, and crowds. Such individuals avoid these types of situations entirely or in part (e.g., they will enter such situations with another person, but not alone) or endure them with marked distress.

More infrequently, agoraphobia may exist in the absence of panic disorder. This is most common in individuals who experience limited symptom attacks, which include panic symptoms fewer in number than are required for a panic attack. It may also occur in the presence of other nonpanic symptoms, such as someone with irritable bowel syndrome avoiding situations for fear of not having immediate access to a bathroom, in those who have never experienced the symptoms they fear but who avoid situations because 'it could still happen,' or for a small number of people, without the individuals being able to specify exactly what the fear is.

Specific Phobia

Specific phobia is characterized by excessive or unreasonable fear that is induced by the anticipation or presence of a specific object or situation, such as flying, animals, the sight of blood, or heights. The five specific phobia subtypes classified within the DSM-IV-TR are animal, natural environment (e.g., storms), blood-injection-injury (BII), situational (e.g., flying), and other (e.g., vomiting); however, there has been some discussion about these subtypes in the preparation of DSM-V. The person must recognize that the fear is unreasonable and the phobic stimulus must be avoided or endured with significant distress.

As noted earlier, it is important to keep in mind that many people have very strong fears that would not be considered phobias, due to a lack of distress or functional impairment. For example, a person may be very fearful of air travel; however, if the person does not need or want to fly anywhere, and does not mind having that fear, it would not rise to the level of a diagnosable phobia. If that person is offered a job that regularly requires air travel, however, the same fear may now become a phobia (e.g., if having to fly now leads to significant distress, refusing to fly would lead to poor job performance reviews, or the person must turn down the job despite otherwise wanting to accept it). Approximately 7–11% of people meet criteria for a specific phobia within their lifetimes.

Social Phobia (Social Anxiety Disorder)

Social phobia, also referred to as social anxiety disorder (with this term being considered as the official diagnostic term for DSM-V) is characterized by fear of negative evaluation or of embarrassing or humiliating oneself. Social phobia can be very specific, limited to just one or two situations such as public speaking, or it can extend to almost all social interactive situations. As with specific phobias, some social evaluative fears (such as public speaking) are quite common, and do not necessarily rise to the level of a diagnosable social phobia due to a lack of distress regarding the fear or impairment (such as avoidance of social evaluative situations) caused by the fear. In addition to the distress/impairment requirement, a diagnosis of social phobia requires that the individual should recognize that the fear is unreasonable, that anticipation of and/or exposure to such social situations induces anxiety, and that these situations are either avoided or endured with significant distress.

Social phobia is one of the most commonly diagnosed anxiety disorders, affecting between 3% and 13% of the population in their lifetime. Most commonly, people fear public speaking and performance. Typically, people fear more than one social situation; for those who fear most social situations due to fear of evaluation, the specifier 'generalized' is given. In some severe forms of social phobia, even situations not usually thought of as socially evaluative might be avoided, such as driving during the daytime when other drivers might be encountered at stop lights, for example.

Obsessive–Compulsive Disorder

Obsessive–compulsive disorder (OCD) is characterized by obsessions and compulsions. Obsessions are defined by the DSM-IV-TR as "persistent ideas, thoughts, impulses, or images that are experienced as intrusive and inappropriate and that cause marked anxiety or distress." Typically, individuals with OCD feel that the obsessions are not under their control and often feel alien to them, in that they are not the kind of thoughts the individuals wish to have, or that make sense to them. Similarly, compulsions are defined as "repetitive behaviors or mental acts the goal of which is to prevent or reduce anxiety or distress, not to provide pleasure or gratification," and thus are engaged in to neutralize the obsessions or otherwise prevent feared thoughts or impulses from happening. Thus, many behaviors often referred to as 'compulsive,' such as gambling or shopping, would not be considered symptoms of OCD, as these behaviors are both enjoyed and engaged in for pleasure, albeit sometimes regretted later.

Common obsessions include contamination (e.g., being contaminated by touching a door handle), a need to have things in a certain order (e.g., feelings of distress when objects are asymmetrical), aggressive or horrific impulses (e.g., to yell out profanity in public or assault someone), repeated doubts (e.g., wondering whether one has turned off the stove), and sexual imagery (e.g., obscene thoughts or images); common compulsions include washing and cleaning, checking, repeating actions, ordering, requesting or demanding assurances, and counting. Often the compulsions are readily linked to the obsession, although far in excess of what would realistically make sense, as in the case of washing compulsions to neutralize

contamination fears. In other cases, the compulsions are not realistically connected to the obsession the individual is attempting to neutralize or prevent; for example, someone with an obsession of hurting another person intentionally may attempt to neutralize the thought by counting to ten backwards and forwards 10 times. Compulsions may include both overt (e.g., hand washing) or covert (e.g., bringing up positive images mentally to counteract horrifying images) behaviors.

For a diagnosis of OCD, individuals may experience obsessions only, compulsions only, or both, and these symptoms must cause significant distress or functional impairment, and/or take up at least one hour per day. Thus, as with the other disorders reviewed, it is important to note that many individuals engage in some forms of compulsive behaviors at levels that would not be considered clinically significant, such as occasionally feeling as if one needs to check the locks again, or even doing so again despite having done so already; without causing distress or interference or being time consuming, such symptoms would not be considered OCD.

There is also increasing attention being paid to problems sometimes referred to as 'obsessive-compulsive spectrum disorders,' such as skin picking, trichotillomania, and body dysmorphic disorder, and there is some discussion about consolidating these disorders, currently classified elsewhere in the DSM, into an obsessive-compulsive spectrum disorders group in the DSM-V or a later edition. Further, compulsive hoarding, currently classified as a form of OCD, has been the subject of increased attention in both the popular and research literature, and there is some discussion of classifying hoarding as a separate disorder rather than as one form of OCD. At the time of this writing, however, no such decisions have yet been made for the DSM-V.

OCD is somewhat less common than other anxiety disorders, affecting between 0.5% and 2.1% of the population in their lifetime. It typically begins in adolescence and is as common among women as it is in men (as opposed to other anxiety disorders, which are more common in women); however, childhood-onset OCD is more common in boys than in girls.

Posttraumatic Stress Disorder

Posttraumatic stress disorder (PTSD) is one of only two anxiety disorders that specify a cause for the onset of the disorder: extreme trauma. The traumatic event must involve serious injury or actual or threatened death, a threat to one's physical integrity, or the witnessing or learning of such events. The individual's response at the time of the trauma must be one of fear, helplessness, or horror. Additional required symptoms include reexperiencing of the trauma, avoidance of stimuli associated with the event and general numbing of responsiveness, and increased arousal. Reexperience can range from flashbacks to intense distress when exposed to reminders of the trauma. In children, reexperiencing symptoms may take the form of distressing dreams or repetitive play related to the trauma. Avoidance can be effortful (avoiding thoughts, feelings, or situations related to the trauma) and could also include symptoms of emotional numbing, such as diminished interest in significant activities, and feelings of detachment. Increased arousal can take the form of difficulty in sleeping, outbursts of anger, trouble in concentrating, and hypervigilance. These

symptoms must be present for over a month, must represent a change since the trauma, and must cause distress or impairment in the individual's functioning.

While PTSD does have a specific cause identified, it should be noted that not all people with exposure to an extreme trauma go on to develop PTSD. The severity of, proximity to, and duration of the trauma affect the likelihood of an individual's developing PTSD. Estimates of lifetime prevalence of exposure to trauma range from 40 to 60% in the general population, yet only about 8% of the population actually develops PTSD. Clearly, exposure to an extreme trauma is necessary but not sufficient for the development of PTSD.

Acute Stress Disorder

Acute stress disorder (ASD) is similar to PTSD in the requirement of a precipitating traumatic event; however, the time frame needed for a diagnosis differs as do some of the prominent symptoms. For ASD, the individual must exhibit symptoms within 4 weeks of exposure to the traumatic event and these symptoms must last a minimum of 2 days and a maximum of 4 weeks. If symptoms last longer than 1 month, a diagnosis of ASD is no longer applicable, and a diagnosis of PTSD or another disorder should be considered.

Like PTSD, ASD requires exposure to an extreme trauma; response of fear, helplessness, or horror; symptoms of reexperiencing of the trauma, avoidance, and increased arousal and significant distress or interference from these symptoms. In addition, the individual must experience at least three dissociative symptoms such as a subjective sense of numbing, reduction in awareness of surroundings, derealization, depersonalization, or an inability to recall important events of the trauma; and at least one symptom of reexperiencing the trauma; these symptoms must also interfere in the individual's daily functioning.

Less information is available on the prevalence of ASD than other anxiety disorders, but the lifetime prevalence rate is estimated to be between 14% and 33% for individuals exposed to severe trauma. Individuals with ASD also have an increased risk of developing PTSD.

Generalized Anxiety Disorder

Generalized anxiety disorder (GAD) is characterized by excessive and persistent worries that the individual feels are uncontrollable. The worry must be experienced more days than not for at least 6 months, and focus on multiple topics. The diagnosis of GAD also requires at least three of the following: restlessness, fatigue, difficulty in concentrating, irritability, muscle tension, or sleep disturbance. Finally, the individual must experience marked distress or impairment in functioning due to these symptoms.

Those with GAD worry about common concerns, such as work, health, and finances, but the degree of worry is excessive, given the actual likelihood or impact of the event. Further, those with GAD feel as if they cannot stop worrying even if they want to. Often, the worries interfere with other tasks because the person is unable to focus on other tasks due to worrying, or engages in reassurance-seeking behaviors such as calling home to make sure everyone is okay.

The lifetime prevalence rate for GAD is ~5%, and the disorder is more common in women than in men. Often, people with GAD report worries as far back as they can remember, and describe their worry as a personality trait.

Anxiety Disorder due to a General Medical Condition

Anxiety disorder due to a general medical condition is characterized by symptoms of anxiety that are deemed the direct consequence of the medical condition, with the anxiety symptoms causing distress or functional impairment. The relationship of anxiety to the general medical condition is usually determined by examining the history, laboratory findings, or physical examination of the individual. Some medical conditions that have been known to cause anxiety symptoms include hyperthyroidism, cardiac arrhythmia, pneumonia, vitamin B12 deficiency, and encephalitis.

Substance-Induced Anxiety Disorder

Anxiety symptoms that cause marked distress or an impairment in functioning and are the direct effect of substance use are categorized as substance-induced anxiety disorder. Here again, the relationship of the anxiety to the substance must be determined by examining the history, laboratory findings, or physical examination of the individual. The anxiety symptoms must occur during intoxication or within 1 month of use and should be in excess of typical anxiety symptoms incurred during use or withdrawal from the substance.

Anxiety Disorder Not Otherwise Specified

Anxiety disorder not otherwise specified (NOS) is diagnosed when someone experiences a clinically significant level of anxiety but does not meet criteria for a specific anxiety or adjustment disorder. For example, a person who reports excessive worry that interferes with functioning but without enough accompanying physical symptoms (e.g., fatigue, muscle tension) to warrant a diagnosis of GAD could be diagnosed with anxiety disorder NOS.

Etiology

As with the majority of mental disorders, it is difficult to identify a single cause for the development of anxiety disorders. Anxiety disorders are thought to develop due to a combination of factors. While no single gene has been found that passes on an anxiety disorder to an individual, we know that children who have parents with anxiety disorders are more likely to have anxiety disorders. Some researchers believe that rather than a deficient gene that is passed from one generation to another, it is a general vulnerability or sensitivity to anxiety that is transmitted. This hypothesis may be supported by the fact that it is not uncommon for children to have a different anxiety disorder than that of their parents.

Environmental factors also play a role in the development of anxiety disorders. Parents may model anxious behavior for their children, or may transmit messages suggesting that various objects, situations, or feelings are dangerous and should be

avoided. Excessive levels of stress may trigger biological and psychological vulnerabilities that can manifest in an anxiety disorder.

Many clinicians focus less on causal than on maintaining factors in anxiety disorders, with the idea that one cannot change the past, but can change the present. Specifically, behavioral, cognitive, and physiological factors are thought to maintain anxiety. Generally speaking, individuals with anxiety disorders tend to avoid anxiety-provoking stimuli or to distract themselves so that they do not feel as anxious. While these behaviors can be helpful in temporarily reducing anxiety, they are harmful in the long term because the individual does not learn that the anxiety will decrease eventually on its own, even without such avoidance. Cognitive factors also play a role in the maintenance of anxiety disorders, with negative and unrealistic thoughts often perpetuating anxiety. For example, someone with social phobia may believe that everyone around her thinks she is stupid for dropping her books when in reality most people did not notice, and those who did notice did not think about the event or pay any further attention to it. Finally, physiological factors, such as higher autonomic lability, leading to frequent fluctuations in bodily sensations such as heart rate, can also maintain anxiety. Often, these maintaining factors interact to perpetuate a cycle of anxiety.

Treatment

Cognitive Behavioral Treatments

Currently, the psychosocial treatment with the most empirical evidence to support its use in the treatment of anxiety disorders is cognitive-behavioral therapy (CBT). CBT may include a variety of treatment components, such as psychoeducation, relaxation, exposure, and cognitive challenging; exposure is by far the method most implicated in the successful treatment of anxiety disorders. Psychoeducation refers to providing information about the nature of anxiety, such as the interaction of different components described in the previous section. Relaxation training, often in the form of breathing retraining, is taught as a coping strategy. Breathing retraining involves breathing more slowly, and diaphragmatically rather than from the chest, to dampen physiological sensations. When using such physical relaxation methods, however, especially in conjunction with exposure treatment, therapists generally emphasize that the idea is not that one *must* use these methods to decrease anxiety, or that experiencing anxiety is a dangerous thing that must be avoided by using such methods. Rather, such methods are presented as ways for individuals to decrease anxious responding at times when it is inconvenient (e.g., during an exam), and the anxiety should then be revisited at a later time.

The cognitive component of CBT typically involves recognizing and challenging maladaptive and/or unrealistic thoughts. Once the thoughts have been recognized, clients engage in an examination of the evidence for and against such thoughts and of the consequences of these thoughts, leading to the development of a rational response that best fits the evidence and the individual's desired outcome. Common unrealistic thoughts include overestimating the likelihood of a particular outcome (such as thinking that a panic attack will lead to a heart attack)

and catastrophizing, or thinking things are much worse than they are, or that they cannot be coped with (such as fearing embarrassment as something one cannot live with). Generally, consequences that are likely are also the least serious, while those that are the most serious also tend to be the least likely, and so countering the two thinking errors described above is generally sufficient for most anxiety-related thoughts. Another component in cognitive challenging is to continue drawing out one's fears to the fullest; this generally allows the individual to recognize that most of these fears are in fact quite irrational, something that had not been noticed due to the refusal to consider the next steps in a chain of anxious thoughts. For example, those with social phobia often fear being laughed at or being embarrassed in front of others, but may not continue drawing out those scenarios. When the scenarios are drawn out further, they may realize that their fears include having to run out of the room, that everyone will continue talking about their performance, that it will be printed in the paper for others to laugh at, etc. Using this method, it becomes much clear that these further consequences are truly unlikely, and that without those additional consequences, temporary embarrassment is not that big a deal.

Exposure, a key component in most CBT programs and the component with by far the most research to support its use, requires individuals to confront anxiety-provoking stimuli and to remain with those stimuli until their anxiety decreases. Exposure can be conducted in a gradual manner, beginning with easier situations and moving on to harder ones, or all at once, referred to as flooding. With flooding, the individual confronts the most anxiety-provoking stimuli from the start. While flooding has been found to be as effective as exposure conducted in a gradual manner, most clinicians use gradual exposure over flooding due to the decreased perceived distress related to working up to the most feared anxiety-provoking stimulus. Flooding may be preferred by some individuals, however, such as those who wish to overcome their problems in the quickest manner possible.

There are many different forms of exposure used to target different kinds of stimuli. In *in vivo* exposure, or real-life exposure, the individual physically confronts the feared stimuli. For example, a person with a specific phobia of snakes would remain in a room with a snake, touch a snake, or hold a snake. A person with a fear of public speaking would give a speech in front of others. Imaginal exposure is often used when *in vivo* exposure is not feasible or the individual is reluctant to begin with *in vivo* exposure, or when the anxiety-provoking stimulus is an image or memory. In the previous example, if the snake-phobic individual refused to get anywhere near a real snake, imaginal exposure might be used first, having the person imagine touching a snake, with the goal of then moving on to the *in vivo* exposure. Imaginal exposure is often used in the treatment of PTSD, wherein the memory of the trauma itself is anxiety-provoking. Interoceptive exposure, generally used for panic disorder, involves exposure to bodily sensations such as fast breathing or increased heart rate. Exercises such as running in place or spinning in a chair are used to induce feared sensations and continued until anxiety diminishes. Phobias are particularly helped by exposure treatment, as the focus of fear in these disorders is so specific. As noted above, these phobias are typically treated with *in vivo* exposure, with imaginal

exposure sometimes being used to start off, and sometimes with the use of modeling as well, wherein clients first observe the therapist confront the feared object before confronting it themselves. In general, exposure treatments are conducted similarly across the anxiety disorders, as only the focus of the exposure needs to vary. One exception to this is in the treatment of BII phobia, in which the phobic response is often a bit different from that in other phobias. Specifically, while most anxiety responses include increased physiological arousal, BII phobics often respond with decreased blood pressure, lightheadedness, and even fainting, an opposite physiological response. Thus, for BII phobia, applied muscle tension is generally added (generally by clenching one's fists), to prevent the fainting response by boosting blood pressure during the exposure.

Another addition to exposure treatment is response prevention, which is used for individuals with OCD. Individuals are first exposed to the thought, image, or impulse that triggers the obsession, but then they must also refrain from engaging in any behaviors or mental rituals aimed at neutralizing that obsession. For example, an individual with contamination obsessions would touch objects felt to be contaminated, and then refrain from washing. In complete response prevention, sometimes used in the treatment of more severe cases of OCD, the neutralizing behaviors are completely avoided; for example, contamination-fearful individuals would not touch any water at all for a period of several days, and would immediately 'recontaminate' upon the completion of the allowed shower at that time. Of course, in any exposure treatment it is important that clients do not engage in safety behaviors, whether they are ritualizing, distraction, or other behaviors, that detract from the idea of fully confronting one's fears.

Finally, exposure treatment may be augmented by the addition of D-cycloserine, an antibiotic that has been shown in some recent studies to enhance the learning process that occurs during exposure. This medication is not used as a treatment in itself for anxiety, but rather, is taken prior to the exposure session, to facilitate the exposure treatment.

Medication

Two different classes of drugs have been extensively studied for the treatment of anxiety disorders: anxiolytics and antidepressants. The anxiolytic drugs, benzodiazepines, are often used to treat anxiety disorders, but it is typically recommended that they be used as a short-term rather than long-term treatment due to the increased likelihood of dependency with long-term use. Further, both low-potency benzodiazepines (such as diazepam) and high-potency benzodiazepines (such as alprazolam) tend to decrease anxiety only temporarily. In addition to the dependency issue and the related withdrawal symptoms, benzodiazepines tend to have fairly high relapse rates once the medication is discontinued, and alprazolam for panic disorder may also lead to rebound panic attacks, where the panic attacks are more frequent and/or severe, following discontinuation, than they had been before treatment.

Antidepressants, such as selective serotonin reuptake inhibitors (SSRIs), tricyclic antidepressants (TCAs), and monoamine oxidase inhibitors (MAOIs), have been shown to be helpful in treating a number of anxiety disorders. SSRIs (e.g., fluvoxamine, fluoxetine, sertraline) are often the first-line pharmacological

treatment for anxiety disorders due to their tolerability and their effectiveness in many anxiety disorders. The TCA most commonly used in the treatment of anxiety is imipramine, which is most indicated in the anxiety realm as a treatment for panic disorder; another TCA, clomipramine, is indicated for the treatment of OCD. MAOIs have also been shown to be effective in some anxiety disorders, especially social phobia and panic disorder; however, they carry a greater risk. Specifically, those on MAOIs must adhere to a strict diet, avoiding foods (such as red wine and aged cheese) with tyramines and related substances in order to avoid a steep rise in blood pressure, which can be fatal.

It should be noted that while pharmacological treatments have been shown to have a positive effect in terms of symptom remission for many with anxiety, they are often found to be no more effective, and sometimes less effective, than cognitive-behavioral treatments. Further, cognitive-behavioral treatments tend to be more effective in the long term, have a lower likelihood of relapse, involve lower overall cost, and have fewer adverse effects.

Other Psychosocial Treatments

While cognitive-behavior therapies and medication treatments enjoy considerable empirical support for their use, they are not the only treatments used for anxiety disorders. Another common intervention for anxiety disorders is psychodynamic therapy. In this form of therapy, the anxiety is not seen as the problem in itself, but rather as the symptom of an underlying problem that needs to be recognized and resolved. Thus, the focus of psychodynamic treatment is not on reducing anxiety symptoms directly. While this treatment does not have the extensive research to support its use in decreasing anxiety that CBT or medication treatments do, some individuals prefer to focus on the possible causes of their problems rather than on the alleviation of their anxiety symptoms, and thus may prefer this more insight-oriented approach to treatment. Similarly, there are numerous self-help approaches for the treatment of anxiety, as well as other therapist-led treatments such as group therapy, that individuals sometimes find more helpful and/or prefer, compared to the CBT or medication approaches.

Issues in Diagnosis

Among the anxiety disorders, there is significant overlap in symptoms, which is reasonable given that this group of disorders requires the presence of anxiety that causes the person marked distress or impairment in functioning. While the reason for symptom overlap is expected, sometimes differentiating between different anxiety disorders can be difficult. For example, people with social phobia as well as those with agoraphobia may fear going to a store. They may both experience significant physiological sensations while in this situation, such as increased heart rate, sweating, and trembling. They may both attempt to leave the situation or distract themselves to feel less anxious, and both may exhibit impairment in their social functioning due to their anxiety. They may even fear evaluation by others in this situation. However, what

differentiates these two disorders is the specific focus of their fear. For individuals with social anxiety, their fear centers on others negatively evaluating them, such as the belief that others will think they are stupid. Individuals with agoraphobia fear having symptoms of a panic attack or not being able to escape a situation if they experience these panic symptoms. While they may also fear the evaluation by others, this fear would be focused on others noticing their panic symptoms, not the social phobia focus of tripping, saying something stupid, or other such foci separate from the anxiety symptoms themselves; further, the person with social phobia is likely to feel anxious only in the presence of others, whereas the person with panic disorder will likely be anxious even when others are not around.

As treatment often stems from the specific diagnosis (e.g., applied tension for blood phobia) and certainly on the specific focus of the anxiety, it is important to make an accurate diagnosis. For example, treating all panic attacks with interoceptive exposure ignores the reality that only in panic disorder is the panic attack itself the focus of anxiety, and thus an appropriate target for interoceptive exposure; an individual who experiences panic attacks when near a dog would not be expected to benefit from interoceptive exposure, and should instead receive in vivo exposure to dogs, if properly diagnosed with a specific phobia of dogs.

Special Populations

Children

It is not uncommon for children to experience excessive anxiety or worry that warrants an anxiety disorder diagnosis; in fact, some anxiety disorders, such as GAD, often have an onset in childhood. Separation anxiety disorder, excessive anxiety related to separation from parents or other caregivers, is relatively common in childhood, yet rarely diagnosed in adulthood. Children with separation anxiety disorder often experience significant distress at the idea of separation from caregivers, and may be reluctant, or outright refuse, to attend school, go on sleepovers or to camp, or even be in a different room from their parents while at home. This fear is generally focused on the possibility of caregivers being harmed while away from the child, their not coming back for the child, or harm befalling the child while away from the caregivers; the fear is often expressed in nightmares and/or physical symptoms, such as stomach aches instead of, or in addition to, words. Symptoms must persist for at least 4 weeks for such a diagnosis to be warranted; ~4% of children meet criteria for separation anxiety disorder in their lifetime.

In general, children are more likely to express their anxiety through somatic symptoms such as headaches, vomiting, and stomachaches, than are adults. This may be due to their developmental stage and their lack of insight into their symptoms. For example, children with a phobia may demonstrate freezing, tantrums, or crying when presented with their particular feared stimulus. Often, children with an anxiety disorder do not report distress related to the fear, especially if a parent accommodates the child and his or her fears, such as by allowing a child with separation anxiety to stay with the parent throughout the day.

Elderly Adults

As is true of children, elderly adults may also experience the same anxiety disorders as other adults. Differential diagnosis may become even more important in this population, however, when one recognizes that medical conditions and neurological difficulties, more common among geriatric patients, can cloud the diagnostic picture. For example, it is not uncommon for those with dementia to exhibit symptoms of anxiety, especially in the early stages of the disorder when the dementia has not been clearly recognized. While both dementia and anxiety disorders can coexist, for a specific anxiety disorder diagnosis to be warranted, the anxiety symptoms must be in excess of those typically found in dementia.

It is also fairly common for older adults to experience worries and anxieties related, in full or in part, to aging. For example, while some worries tend to decrease as people age, other specific worries, such as those about one's health, personal safety, finances, and independence may increase with age, due to changing life and personal circumstances, which make these issues more salient.

Dually Diagnosed/Severely Mentally Ill Patients

It is not uncommon for individuals with an anxiety disorder to also have another diagnosis. Anxiety disorders tend to co-occur with one another. For example, as many as half of the individuals with GAD may also have another anxiety disorder, especially social phobia. Anxiety disorders also commonly co-occur with depressive disorders and substance use disorders. Some individuals with anxiety disorders self-medicate with alcohol or recreational drugs, using these substances to cope with anxiety-provoking situations or to mask their symptoms of anxiety.

Due to this high comorbidity, careful assessment is needed not only of anxiety, but also of related problems. Additional treatment may be needed to target these other problems, although treating the primary anxiety problem may also generalize to other anxiety disorders, or alleviate the co-occurring depression or substance use.

Individuals who suffer from severe mental illness, such as psychotic disorders, along with an anxiety disorder may also benefit from anxiety treatment. For example, a person with schizophrenia who also suffers from panic disorder with agoraphobia may avoid leaving home for fear of having a panic attack. This could interfere with the person's obtaining treatment for schizophrenia. With treatment for agoraphobia, the individual may be more likely to properly manage the schizophrenia. Further, even anxiety that is not separate, but instead is better considered part of the psychotic (or other) disorder, may be alleviated by targeted intervention; this symptom reduction, while not 'fixing' the primary problem, may certainly improve the individual's life by removing at least some source of distress.

Non-Western Cultures

Anxiety disorders can be seen across the world; they are not simply a Western phenomenon. A number of culture-bound syndromes, or disorders specific to a particular region, resemble

DSM-IV-TR diagnoses, but often with a focus that more reflects culturally specific fears. *Ataque de nervios*, seen in Latin American and Latin Mediterranean cultures, is associated with a sense of being out of control, uncontrollable shouting, trembling, crying, heat in the chest rising to the head, and fainting or seizure-like episodes, and somewhat resembles panic disorder. *Koro*, found in south and east Asia, refers to extreme anxiety and panic regarding the penis (in men) or vulva and nipples (in women) retracting into the body and causing death. In Korea, *shin-byung* is characterized by excessive anxiety, dissociation, and somatic complaints (e.g., weakness, dizziness, insomnia, gastrointestinal problems) that are attributed to possession by ancestral spirits. Numerous other culture-bound syndromes exist as well.

Medically Ill Patients

Anxiety disorder symptoms may also overlap with a range of medical conditions; for this reason, physical exams are generally recommended before anxiety treatment begins, to rule out a medical explanation for the anxiety and/or to ensure that anxiety treatment is safe medically. For example, hyperthyroidism can result in palpitations, nervousness, insomnia, fatigue, trembling, and sweating, and can resemble a panic attack. While the symptoms may be similar for both issues, the treatments differ greatly.

Medical conditions can also lead to diagnosable anxiety disorders, when the initial symptoms caused by the medical problem become exacerbated by the attention to those symptoms or what they may lead to. For example, a person with hyperthyroidism may become quite frightened of the increased heart rate, and fear that it is leading to a heart attack and death. This fear may prompt increased monitoring of heart rate and heart rate changes, leading to more frequent fears of heart attack, well beyond what the hyperthyroidism itself would involve. In such cases, where the anxiety is beyond that expected from the medical condition alone, an anxiety disorder may also be diagnosed.

Treatment for anxiety may also need to take medical conditions into account. For example, while interoceptive exposure may be among the best treatments for panic disorder, it may be contraindicated for an individual who also has a heart condition and must avoid the increased heart rate that such exposure often entails. In such cases, exposure may still be used, perhaps with modifications such as monitoring heart rate to ensure it does not exceed the medically advised level, or an alternative treatment may be used instead.

Conclusion

Anxiety disorders are common across gender, age, and culture. Accurate diagnosis of an anxiety disorder rests on determining the specific feared stimuli and the presence of functional impairment or distress related to this fear. Generally speaking, CBT is the psychosocial treatment of choice for all anxiety disorders, and it has also been shown to be effective when treating clients with severe mental illness, dual diagnoses, and medical illnesses. Medication is frequently used to treat anxiety disorders and is often preferred by many for its initial lower cost in terms of money, time, and effort; however,

medication tends to be less cost effective in the long term and involves higher relapse rates when discontinued than does CBT.

See also: Agoraphobia and Panic Disorder; Anxiety and Fear; Childhood Mental Disorders; Clinical Assessment; Cognitive Behavior Therapy; Evidence-Based Practice; Generalized Anxiety Disorder; Hypochondriasis or Health Anxiety; Obsessive–Compulsive Disorder; Obsessive–Compulsive Personality Disorder; Phobias; Posttraumatic Stress Disorder; Psychotherapy; Separation Anxiety; Social Anxiety Disorder.

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- <http://www.nimh.nih.gov/health/topics/anxiety-disorders/index.shtml> – National Institute of Mental Health Anxiety Disorders Page.
- <http://www.abct.org> – The Association for Behavioral and Cognitive Therapies.
- <http://www.therapyadvisor.com> – Therapy Advisor Website.
- www.trich.org – Trichotillomania Learning Center.

Aphasia

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Glossary

Agraphia An acquired inability to write.

Alexia An acquired disorder of reading.

Aphasia An acquired disorder of language caused by brain disease.

Frontotemporal dementia or frontotemporal lobar degeneration A neurodegenerative condition in which frontal lobe behavioral syndromes or aphasia are the presenting features.

Language A system of symbols used to convey thoughts, or internal, nonverbal images and representations, from one individual to another.

Lexical Of or pertaining to a word.

Literal (phonemic) paraphasic error An incorrect utterance based on substitution of an erroneous sound.

Morpheme A word ending which may vary depending on the use of a word, for example, in singular or plural, masculine or feminine, present or past tense.

Phoneme The smallest unit of speech which can alter the meaning of a word.

Semantics The meaning of words.

Syntax A system of grammatical rules used in language.

Verbal (semantic) paraphasic error An incorrect utterance based on substitution of an erroneous word.

Aphasias are disorders of language, or symbolic communication, acquired as a result of brain disease. Aphasia strikes at that most human of capabilities, symbolic language, and deprives the subject of communication with others.

By this definition, aphasia can be distinguished from several related conditions. First, aphasia is a disorder of language, and not a motor speech disorder. Motor speech disorders are abnormalities of speech articulation brought about by weakness or incoordination of the muscles of the speech apparatus. Neurological motor speech disorders include dysarthrias, abnormalities of speech articulation; dysphonias, disorders of voice; and speech apraxias, impairments of the ability to sequence a series of phonemes. In motor speech disorders, language comprehension and production are normal; in a patient with abnormal sounding speech output, language production can be ascertained by examining the patient's writing or by transcribing speech output into type. Second, aphasia is an acquired language disorder, not a congenital or developmental disorder. In North America, developmental language disorders are often called 'dysphasias,' just as developmental reading disorders are 'dyslexias,' and developmental writing disorders are 'dysgraphias.' It should be noted that in the UK, and in Europe, these terms are sometimes used in the sense of partial and not total language disorders. Third, the language disorder of aphasia must relate to brain disease, and not to psychiatric disorders. Psychotic disorders such as schizophrenia and bipolar affective disorder typically derange thought, or the content of language, rather than language itself. This last distinction is the most problematic, for two reasons. First, language is difficult to separate from thought. Even severely aphasic patients, however, seem capable of nonverbal thought, and their behavior, outside of language function, usually seems normal. On the other hand, patients with psychoses such as schizophrenia usually express their disturbed thoughts in normal articulation and syntax. Second, these psychotic disorders, though they remain in the domain of psychiatry rather than neurology, are likely brain diseases as well.

Introduction

History of Aphasia

Historically, language was the first of the higher cortical functions to be correlated with focal lesions of the brain. The French physician Paul Broca, in 1861, provided a clear description of nonfluent speech associated with lesions of the dominant hemisphere, especially the left frontal lobe. The principal syndrome of nonfluent aphasia is still called 'Broca's aphasia.' Similarly other nineteenth century physicians correlated areas of brain damage, usually resulting from stroke, with specific syndromes of abnormal language. Carl Wernicke, in Germany, described the fluent aphasia syndrome which now bears his name, as well as conduction aphasia; Lichtheim outlined the 'transcortical aphasias'; and Dejerine designated the syndromes of pure alexia with and without agraphia. The late nineteenth and early twentieth centuries saw slow progress in the understanding of aphasia, largely because physicians had to outlive their patients to correlate an aphasic syndrome with a brain lesion at autopsy. In addition, the early twentieth century witnessed a decline in interest in behavioral syndromes, in favor of the 'hard' neurological deficits of paralysis, sensory loss, and incoordination. The higher cognitive functions were either accorded little interest or assumed to have a diffuse distribution throughout the brain.

Modern Techniques in Aphasia Research

In the late twentieth and early twenty-first centuries, aphasia has undergone a revolutionary expansion of knowledge. First, brain imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) have permitted the study of brain lesions in living patients, simultaneously with behavioral studies. Functional brain imaging modalities such as positron emission tomography (PET), single photon emission computed tomography (SPECT), and functional MRI (fMRI) allow the mapping of brain regions which are

metabolically active or show increased blood flow during specific behavioral tasks in normal subjects or in patients with aphasia. In addition, the language tasks themselves have been refined. Speech/language pathologists administer standardized test batteries to compare performance between subjects, or in the same subject over time. Neuropsychologists, cognitive neurobiologists, and linguists have constructed language tasks to test specific steps in language processing at which deficits occur, thereby creating models of the language process. Finally, knowledge about language and the brain has been acquired not only from the study of patients with strokes, head injury, and brain tumors, but also in normal subjects, with the use of functional brain imaging. In addition, in the evaluation of patients with epilepsy, to prepare for surgical resection of epileptogenic foci, techniques of electrical stimulation of brain loci have permitted mapping of areas of the language cortex. These areas can then be correlated with the results of surgery to ablate epileptogenic foci. These additional sources of information about language and the brain have modified our maps of language function in the brain. Stimulation of the cortex in epileptic patients, for example, has confirmed the general concepts of the localization of language functions derived from stroke patients, but electrical stimulation has identified new language areas and has suggested that the traditional areas may be smaller and more variable than previously thought.

Handedness and Cerebral Dominance

As Broca observed, the vast majority of right-handed patients with aphasia have left hemisphere lesions, suggesting that the left hemisphere is dominant for language function. In general, at least 95% of right-handed patients and a majority of left-handed patients have relative left hemisphere dominance for language. Cerebral dominance can be determined definitively by Wada testing, in which sodium pentobarbital is injected into the internal carotid artery, thus temporarily 'putting to sleep' the frontal, temporal, and parietal cortical areas of one hemisphere. Wada testing is carried out to determine whether an area of the brain can be surgically removed without producing aphasia. Newer methods of determining language dominance include mapping of language activity during language tasks by PET or fMRI, magnetoencephalography, and other techniques. The Wada test, however, remains the gold standard for determination of language dominance. The dominance of language in the left hemisphere appears genetically programmed, since it is present even in illiterate people. Geschwind and Levitsky pointed out that, in most human brains, the superior temporal plane ('planum temporale') is larger in the left hemisphere than in the right. Subsequent measurements using CT and MRI scans have shown similar asymmetries in living patients. The most reliable measurement is the occipital length, which is longer in the left than the right hemisphere in most right-handed people. This asymmetry is present at birth, again indicating that the enlargement of the left language cortex is genetically programmed, rather than acquired through use in language function. Studies have suggested that patients with atypical cortical asymmetries on brain imaging may have abnormal language dominance and atypical recovery patterns after injury to the language cortex.

Occasionally, a right-handed patient with an acquired right hemisphere lesion develops aphasia, a phenomenon termed

'crossed aphasia,' or 'crossed aphasia in dextrals.' These patients presumably have atypical cerebral dominance, and some have atypical hemispherical asymmetries on CT scan. The specific 'crossed aphasia' syndromes are frequently atypical, milder than would be expected with a lesion of similar size in the left hemisphere. Patients may also have expressive language in the left hemisphere, and receptive language in the right, or vice versa, leading to partial syndromes in which deficits are more specific to expressive or receptive functions than in the typical, expected aphasia syndrome.

Aphasia in left-handed patients also differs from the typical syndromes of right-handed patients with aphasia secondary to left hemisphere lesions. More left-handed patients than right-handed patients develop aphasia after a stroke, regardless of the side of the stroke, suggesting that left-handed patients have some language representation in both cerebral hemispheres. Though aphasia is more common in left-handers, recovery may be better. Taken together, these findings imply that the language dominance of left-handed patients is less rigid than that of right-handers, and either hemisphere can subserve recovery of language function. Most left-handed aphasic patients in a large series had typical aphasia syndromes, but two patients had large right hemisphere infarctions, with nonfluent aphasia but preserved comprehension. These patients appeared to have language expression arising from the right hemisphere, but language comprehension from the left. Most left-handers, like right-handers, have left hemisphere dominance for speech and language, but there may be separate loci of dominance for handedness, motor speech, and auditory comprehension. There is some evidence that women have less rigorously defined language dominance than men, and recovery may be better in women.

Epidemiology and Etiologies of Aphasia

Aphasia has classically been described in association with focal brain lesions. The most common such lesion is stroke, long the leading etiology of aphasia in research studies. Stroke can be thought of as an 'experiment of nature,' in which one area of the brain is damaged, while the rest remains intact. Both major types of stroke, cerebral infarctions, in which the brain is damaged by reduced blood flow, and hemorrhages, or bleeds into the brain, cause aphasia. Approximately 750 000 strokes occur annually in the United States. About 20% of stroke patients, or over 100 000 persons each year, develop aphasia following a stroke. The total prevalence of aphasic stroke victims in the United States approaches 1 million.

Traumatic brain injury frequently disrupts discourse and produces other language impairments, which are often part of a syndrome of general cognitive dysfunction. Penetrating brain injuries cause focal areas of damage which resemble strokes, except that the lesion locations are different, and the 'remote effects' of swelling, increased intracranial pressure, and contrecoup injuries are greater with traumatic brain injuries than with stroke.

Brain tumors, abscesses, and other mass lesions may also disrupt language. These syndromes typically develop gradually, over weeks or months, unlike the abrupt onset of aphasia secondary to stroke or head injury. As in head injuries, there are remote effects related to mass effect and edema, in addition

to the focal damage. For this reason, these disorders have been less useful than stroke in aphasia research. Focal brain damage from encephalitis and other infections also causes aphasia. The Herpes simplex virus causes encephalitis, with a predilection for the orbital frontal lobes and temporal lobes. Patients may present with fluent aphasia, as well as confusion, memory loss, seizures, and fever. Patients undergoing epilepsy surgery have also provided new knowledge of the language areas of the brain, as discussed earlier.

In addition to the language disorders associated with focal brain lesions, generalized brain diseases produce language disorders. Aphasia accompanies such diffuse syndromes as encephalopathies, acute confusional states, dementias, and chronic syndromes of memory and cognitive loss. These syndromes will be discussed after the focal aphasias.

Evaluation of Aphasia

Bedside Evaluation

Language functions are tested informally at the bedside to arrive at a preliminary syndrome diagnosis of aphasia. Deliberate testing is carried out for spontaneous and automatic speech, naming, repetition, comprehension, reading, and writing. Physicians correlate these language tests with other findings of the neurological examination such as motor paralysis, visual field defects, and sensory loss to arrive at a localization of the responsible brain lesion. Brain imaging studies are then performed to confirm the diagnosis.

Standard Aphasia Batteries

In addition to the bedside language evaluations carried out by neurologists and other physicians, a number of standardized aphasia tests are available. Most are used by speech/language pathologists or neuropsychologists for documentation of the type and severity of aphasic deficits and of progress during recovery. Among the widely used batteries are the Boston Diagnostic Aphasia Examination (BDAE), its Canadian adaptation the Western Aphasia Battery (WAB), and the Porch Index of Communicative Ability (PICA). More specific language tests have also been developed by cognitive psychologists, linguists, and speech pathologists for research studies.

Classification of Aphasias

Aphasia experts have used a variety of terminologies and classification systems. This article utilizes the 'Boston' aphasia

classification, developed from classical neurology, as reflected both in the bedside examination and in the BDAE and WAB. **Table 1** summarizes the language characteristics of the major aphasia syndromes.

Broca's Aphasia

Broca's aphasia was the first aphasia syndrome described, and the first correlated with a specific brain region. The syndrome involves reduced speech output, sometimes with complete mutism or hesitant, struggling efforts to produce single words or short phrases. Subjects utter the most important, meaningful words of a sentence, leaving out the small grammatical words. This speech pattern is called 'telegraphic speech' or 'agrammatism.' Patients struggle to recall names, often stuttering on the initial phoneme ('tip-of-the-tongue' phenomenon). Repetition is hesitant, like spontaneous speech. Auditory comprehension is intact for simple conversations, but detailed testing reveals deficits, especially for complex grammatical relationships, which also cause difficulty in expressive speech. Reading is often less preserved than auditory comprehension. Writing is influenced by the usual association with right-sided paralysis, or hemiparesis, but patients with Broca's aphasia usually cannot write well even with the nonparalyzed left hand, indicating the presence of an expressive language disorder. Interestingly, studies have found that patients write better with the paralyzed right arm, aided by a mechanical device resembling a skate. This technique removes the necessity of transmission of language information to right hemisphere motor centers.

The lesions of Broca's aphasia traditionally involve the inferior frontal gyrus, just anterior to the face area of the motor cortex (**Figure 1**). Small lesions in this area are associated with excellent recovery of language function. Larger lesions, involving the frontoparietal cortices, produce an early global aphasia, or loss of all language function, followed by gradual evolution toward Broca's aphasia, or 'mixed nonfluent aphasia.' Studies by the Boston VA group of CT scans in patients with nonfluent aphasia have established three lesion patterns: (1) lesions restricted to the lower motor cortex of the precentral gyrus produce only dysarthria and mild expressive disturbance; (2) those involving the more anterior frontal operculum (Brodmann areas 44 and 45) result in difficulty initiating speech without true language difficulty (see discussion of 'aphemia,' below); and (3) lesions combining these two lesion sites, plus the subcortical white matter and periventricular white matter cause deficits of Broca's aphasia. These additional aphasic disturbances may result from interruption

Table 1 Characteristics of aphasic syndromes

Syndrome	Fluency	Naming	Repetition	Comprehension	Reading	Writing
Broca	—	—	—	+	!:	—
Wernicke	+	—	—	—	—	+
Global	—	—	—	—	—	—
Conduction	+	±	—	+	!:	+
Anomic	+	—	+	+	+	+
TCM	—	+	+	.+.,	+	±
TCS	+	—	+	—	—	—
Isolation	—	—	+	—	—	—

of pathways from the posterior language areas. Damage to two subcortical areas, the rostral subcallosal fasciculus deep to Broca's area and the periventricular white matter adjacent to the body of the lateral ventricle, appears necessary for the permanent loss of functional expressive speech (Figure 2).

Aphemia

The term 'aphemia' was Broca's original choice for the name of his nonfluent aphasia syndrome, but the term 'aphasia,' promoted by Trousseau, was adopted instead. Aphemia was then

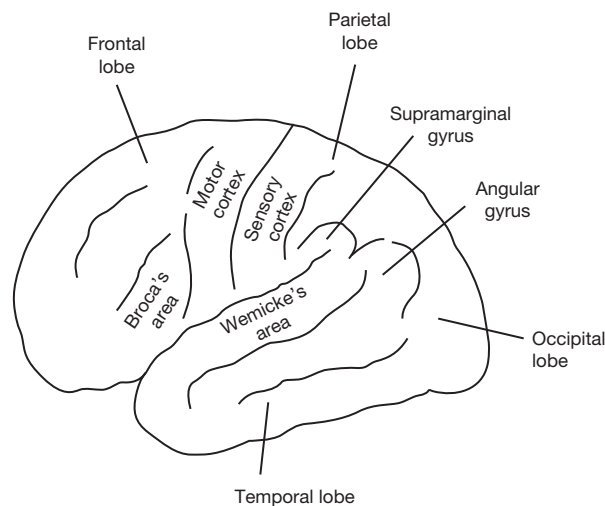


Figure 1 A drawing of the lateral surface of the left hemisphere of the brain. The approximate locations are given for Broca's area in the left inferior frontal convolution, Wernicke's area in the left superior temporal convolution, and the angular and supramarginal gyri of the inferior parietal lobule.

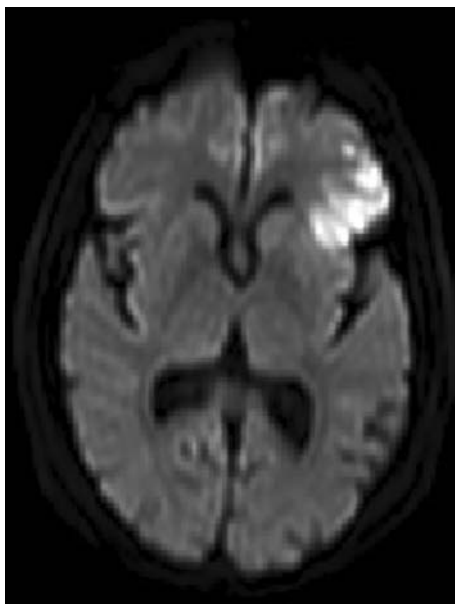


Figure 2 MRI scan from a patient with Broca's aphasia immediately after stroke. MRI images are displayed in the standard orientation used in radiology, with the left side of the brain on the right side of the image. This is a diffusion-weighted image, showing an acute, left frontal infarction.

applied to a more restricted, often transitory syndrome of muteness or nonfluent speech with difficulty of initiation of speech, dysarthria, and phoneme substitutions. Repetition is impaired in a similar manner, and to a similar degree, as spontaneous speech. Both auditory and reading comprehension are preserved, and writing is usually much superior to speech. Most patients have right facial weakness, and some have an associated right hemiparesis. Aphemia is more closely related to the motor speech disorders, apraxia of speech and dysarthria, than to aphasia. Some authorities have even equated it to apraxia of speech, a disorder in which hesitancy of initiation and inconsistent substitutions of phonemes, are also characteristic. Aphemia is associated with lesions of the lower motor cortex for the face in the precentral gyrus, with extension in some cases into the inferior frontal gyrus and underlying white matter.

Wernicke's Aphasia

In contrast to the nonfluent speech of the patient with Broca's aphasia, the Wernicke's aphasic speaks fluently, with abnormal language content. Spontaneous speech contains empty phrases, circumlocutions, neologisms (new or nonexistent words), and errors reflecting sound substitutions (literal or phonemic paraphasic errors, e.g., 'poon' for 'spoon') and word substitutions (verbal or semantic paraphasic errors, e.g., 'fork' for 'spoon'). Sometimes no meaning at all is conveyed, amounting to 'jargon speech.' To a nonnative speaker of English, however, the fluent speech productions sound normal. Naming often produces paraphasic utterances that have no obvious relationship to the target word, and repetition is also disturbed. Comprehension of spoken language is severely impaired. Reading is typically affected in the same way as auditory comprehension, but occasional cases show interesting dissociations between comprehension of auditory versus printed language. Spared reading comprehension may be important in providing a means of communication with the patient. Writing is often well-formed, since patients with Wernicke's aphasia usually have no hemiparesis, but the written productions share the same lack of meaningful words as the speech output. Written language productions also contain misspellings; patients with mild Wernicke's aphasia may be detected most easily by analysis of writing.

Patients with Wernicke's aphasia typically have no motor or sensory deficits; some have a partial or complete loss of vision in the right visual field. As Wernicke originally demonstrated in 1874, the lesions of patients with Wernicke's aphasia typically involve the posterior portion of the left superior temporal gyrus, the traditional 'Wernicke's area.' Studies by Naeser and colleagues have suggested that damage to a major part of Wernicke's area is necessary for lasting loss of comprehension, while more temporary loss of comprehension can be seen with lesions elsewhere in the temporal lobe or in the inferior parietal lobule. Some patients with lesions restricted to the temporal lobe may have spared reading ability in the presence of severe auditory comprehension deficits, whereas those with lesions primarily affecting the inferior parietal lobule may have disproportionate reading difficulty (Figure 3).

Pure word deafness

Pure word deafness is a rare syndrome involving the inability to understand or repeat spoken language, in the absence of

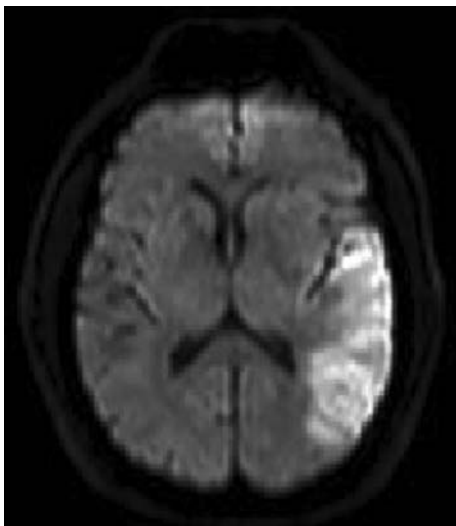


Figure 3 MRI scan, diffusion weighted image, showing an acute stroke in the left temporal lobe, resulting in Wernicke's aphasia.

other language difficulty. The patient is not deaf to pure tones or to meaningful nonverbal noises such as animal cries or the ringing of a bell. Classically, the deficit occurs with bilateral temporal lesions. By the 'disconnection' theory, these lesions disconnect the left hemisphere Wernicke's area from both primary auditory cortices (Heschl's gyrus in the superior temporal gyrus of each hemisphere), such that sounds can be heard but not analyzed by the receptive language cortex in Wernicke's area. Destruction of the auditory cortices themselves causes cortical deafness, or complex auditory disorders referred to as 'auditory agnosia.' Patients with cortical lesions are usually not completely deaf; some cannot recognize either words or nonverbal sounds. Cases of unilateral, left temporal stroke have also been reported to develop pure word deafness. As mentioned earlier, some patients with Wernicke's aphasia and damage predominantly affecting the temporal lobe may have disproportionate involvement of auditory comprehension, as compared to reading comprehension, thus resembling the deficit of pure word deafness. In fact, pure word deafness is often not entirely 'pure,' in that mild paraphasic speech dysfunction is usually associated.

Global Aphasia

Global aphasia may be thought of as the sum of Broca's and Wernicke's aphasia. It is a loss of all six of the commonly tested language functions: spontaneous speech is mute or severely nonfluent, naming is reduced, repetition and comprehension are severely impaired, and the patient cannot read or write. Most such patients have large areas of damage in the left hemisphere and profound associated neurological deficits such as right hemiplegia, right-sided sensory loss, and right hemianopsia. Occasionally, strokes can damage both Broca's and Wernicke's areas, without massive involvement of the motor system, and global aphasia without hemiparesis can result. When lesser degrees of deficit are seen across all language functions, the syndrome is called 'mixed aphasia.'

Conduction Aphasia

Conduction aphasia is an unusual but interesting language syndrome, in which repetition is affected, out of proportion to all other aphasic deficits. Patients speak relatively fluently, though some make frequent literal paraphasic errors and pause frequently for self-correction, giving the speech output a hesitant, choppy pattern. Naming is often impaired, but auditory comprehension is intact. Reading aloud and copying may be affected in a way similar to repetition.

Wernicke originally postulated that conduction aphasia might be caused by a lesion that did not damage either Wernicke's or Broca's area, but disrupted the connections between the two areas, namely the arcuate fasciculus. Geschwind rediscovered this explanation of conduction aphasia as a 'disconnection syndrome,' in which the language impairment is caused by disconnection between cortical language centers, in the absence of damage to the centers themselves. In fact, most cases of conduction aphasia are related to stroke and do have evidence of cortical damage, either in the left temporal lobe, without complete destruction of Wernicke's area, or in the left inferior parietal lobule. Recent research has indicated that the arcuate fasciculus, originating in Wernicke's area, terminates not in Broca's area, but in the precentral gyrus, or motor cortex, shedding doubt on the importance of arcuate fasciculus damage to the syndrome of conduction aphasia. While the disconnection theory of conduction aphasia has remained popular, some investigators have favored a disorder of auditory processing, with some evidence favoring the supramarginal gyrus as a site where auditory inputs are processed for transmission to Broca's area, thus enabling repetition. Others have analyzed the deficit as a disorder of immediate memory for word sequences, such that phrases cannot be maintained in the immediate memory store long enough to allow repetition. These theories sound very different, but they are difficult to separate, in terms of practical details of language deficits.

Anomic Aphasia

As its name implies, anomic aphasia involves the selective loss of naming ability, out of proportion to other language deficits. Patients speak fluently, though with word-finding pauses and circumlocutions. Repetition, auditory comprehension, reading, and writing are intact. This syndrome is less well correlated with focal pathology than the other classical aphasia syndromes, though anomic aphasia can occur with focal lesions of the left temporal or inferior parietal region. Anomic aphasia may also be the last stage in the recovery process from other aphasia types, including both Broca's and Wernicke's aphasia. Anomic aphasia is also common in the early stages of dementing conditions such as Alzheimer's disease.

Transcortical Aphasias

The transcortical aphasias were named to describe the sparing of the perisylvian language circuit, and thereby of repetition. The word 'transcortical,' as used by Lichtheim, implies that the damage is not to the language cortex itself, but to other areas of the brain which project onto the language cortex. Lichtheim referred to these other cortical areas as the 'area of concepts.'

Current neuroanatomy texts do not list an area of concepts, but this would be part of the association cortex of the frontal, temporal, and parietal lobes. The three transcortical aphasia syndromes share the sparing of repetition, despite marked aphasic deficits.

Transcortical motor aphasia is similar to Broca's aphasia, in that the patients speak nonfluently, often with long pauses before utterances and single word or whispered replies to questions. Patients may remain mute when asked questions requiring sentence length responses, but if a single word will suffice, the patient may answer accurately. Auditory comprehension is usually quite good. These patients, unlike Broca's aphasics, can repeat long sentences, even with complex grammatical constructions. The lesions of transcortical motor aphasia spare Broca's area itself but involve adjacent portions of the left frontal cortex, including medial frontal areas such as the supplemental motor cortex, or the frontal subcortical white matter. These lesions all fall within the distribution of the anterior cerebral artery, a relatively uncommon locus of stroke, as compared to the middle cerebral artery, parts of whose territory are affected in Broca's, Wernicke's, global, and conduction aphasias.

Transcortical sensory aphasia resembles Wernicke's aphasia, in terms of fluent, paraphasic speech and poor auditory comprehension, but these patients can repeat normally. The lesions are located posteriorly, in the left temporo-occipital confluence. This syndrome is seen uncommonly in stroke patients, but it occurs in patients with Alzheimer's disease, in later stages of the disease. In one electrical stimulation study in normal subjects, stimulation of adjacent groups of neurons in the temporal lobe could produce either Wernicke's or transcortical sensory aphasia.

Mixed transcortical aphasia, also called the 'syndrome of the isolation of the speech area,' is a syndrome resembling global aphasia, except for the sparing of repetition, which may even be excessive or palilalic. These patients cannot speak spontaneously or comprehend spoken or written language, but they can repeat fluently. Some patients have a tendency to complete partial utterances, as in poetry lines or common idioms (if the examiner says 'roses are red,' the patient may repeat 'roses are red, violets are blue'). Geschwind and colleagues reported the case of a young woman who had extensive, bihemispherical damage from carbon monoxide poisoning, sparing the perisylvian language circuit. This patient could not speak in any meaningful way, could not comprehend conversation, but she could repeat long sentences and could even memorize lyrics to songs which became popular after her illness implying that the medial temporal lobe memory circuit was also spared. Mixed transcortical aphasia has also been reported in patients with severe dementia.

Subcortical Aphasias

Unlike all of the aphasia syndromes described up to this point, subcortical aphasias are defined more by the location of the responsible brain lesion than by the language characteristics of the aphasia. While aphasia is usually thought of as a cortical phenomenon, several patterns of aphasia with subcortical lesions have been described, all within recent decades since brain imaging became widely available. First, lesions of the left

thalamus have been associated with fluent aphasia, usually with better comprehension and repetition as compared to Wernicke's aphasia. A 'dichotomous state' has been described, in which the patient may speak clearly while awake, but drift into incomprehensible, paraphasic speech when sleepy. The thalamus has a role in activating the language cortex; Luria referred to thalamic aphasia as a 'quasiaphasic disturbance of vigilance.' 'Thalamic aphasia,' as it is called, was first described in patients with thalamic hemorrhage, but many cases have also been reported with ischemic strokes involving the thalamus.

Ischemic lesions of the basal ganglia and subcortical white matter also cause aphasia. Lesions of the head of the caudate, anterior limb of the internal capsule, and anterior putamen produce a nonfluent aphasia with dysarthria, termed the 'anterior subcortical aphasia syndrome.' The syndrome bears some resemblance to Broca's aphasia, but these patients usually have longer phrase length and better comprehension and repetition than patients with Broca's aphasia from cortical lesions. More extensive damage in the subcortical structures can produce other aphasic syndromes; lesions which extend posteriorly in the basal ganglia and laterally into the deep temporal lobe white matter can cause syndromes resembling global and Wernicke's aphasia. Similar aphasias are seen with hemorrhages into the basal ganglia, but deficits tend to be more severe because of pressure effects on surrounding structures and on the overlying language cortex.

Alexias

Alexia is an acquired disorder of reading secondary to brain disease. Since reading is a language function, alexia falls under the definition of aphasia as an acquired disorder of language. The alexias can be either largely restricted to reading, or they may be part of an aphasic syndrome.

Pure alexia with agraphia is an acquired illiteracy, a syndrome in which patients cannot read or write, but they can speak, repeat, name, and comprehend spoken language. In fact, most patients with alexia with agraphia do not have such a 'pure' syndrome; they often have a mild fluent aphasia, and the syndrome overlaps with Wernicke's aphasia. The lesion involves the inferior parietal region, particularly the angular gyrus. This type of alexia is also referred to as 'central alexia.'

Pure alexia without agraphia is, in effect, a linguistic blindfolding. Patients cannot read, but they speak normally and can understand spoken language, even when words are dictated in spelled form. These patients can write, but they cannot read their own written productions, a striking feature of the disorder. Naming for objects is usually preserved, but patients may be unable to name colors. They have not lost the concept of color names, as shown by their ability to name the usual colors of common objects such as bananas or apples, but they cannot name a perceived color. In addition, they usually have short-term memory loss and a right visual field defect. Pure alexia is associated with a lesion of the left occipital cortex, within the territory of the left posterior cerebral artery, usually also involving the splenium of the corpus callosum, and sometimes the medial temporal cortex as well. Pure alexia without agraphia is a classical disconnection syndrome, as originally postulated by

the French physician Dejerine in 1891, and later rediscovered by Norman Geschwind. By the disconnection theory, the non-damaged right occipital cortex can subserve vision in the left visual field, but visual language and color information cannot be transmitted properly to the left hemisphere language cortex. Like the disconnection theory of conduction aphasia, this model does not account for all of the complexity of the pure alexia syndrome. Some investigators have pointed to a disturbance of visual immediate memory as a factor in pure alexia; if the patient cannot keep a string of letters in mind, then the letters cannot be processed into a word. In fact, patients with pure alexia often can read letters one by one, but they cannot read a word at a glance. The ability to recognize words (or 'word forms') at a glance is likely a left occipital lobe function. Alternate names for the syndrome are 'letter-by-letter' alexia and posterior or occipital alexia.

Many patients with aphasia have associated reading disturbance, termed 'aphasic alexia.' Benson called the alexia of Broca's aphasia the 'third alexia' following the syndromes of alexia with and without agraphia. It is also called 'frontal alexia.' This type of alexia can vary from a mild alexia related to difficult syntactic material to a severe alexia, in which patients can read only by recognition of a few familiar words. Wernicke's aphasics often have deficits in reading and writing similar to the syndrome of alexia with agraphia, though patients have been described with more partial, selective deficits.

In recent years, neurolinguists and cognitive psychologists such as Marshall, Newcombe, and Coltheart have divided alexias according to the specific stages in the reading process which go awry (Figure 4). Four patterns of alexia (or 'dyslexia,' as these investigators often call it) have been recognized: letter-by-letter, deep, phonological, and surface dyslexia (Table 2).

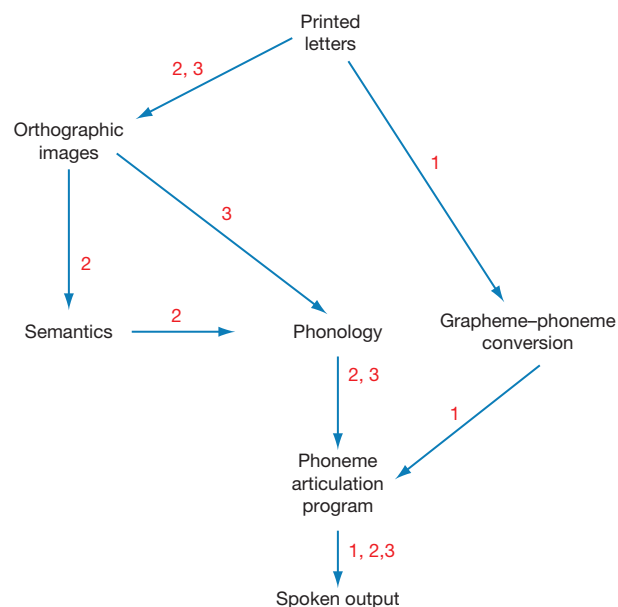


Figure 4 Three separate routes to reading. (1) The grapheme–phoneme conversion system used in learning reading. This is the only route available in surface dyslexia. (2) Reading only from recognizing the meaning of familiar words, the only route available in deep dyslexia. (3) A direct conversion of words to sounds, available along with route 2 in phonological dyslexia.

Letter-by-letter dyslexia is equivalent to pure alexia without agraphia, while the other three patterns are usually seen with aphasia.

Deep dyslexia involves several distinctive features: intact reading of familiar words, inability to read nonsense syllables or nonwords, semantic and visual errors in reading aloud, and pronounced effects of word frequency, word imageability, and word class. Imageable words, those which denote an object or animal that can be seen by the mind's eye, are read more accurately than abstract words, while nouns and verbs are read better than adjectives, adverbs, and prepositions. Word reading is not much affected by word length or by regularity of spelling; for example, patients have been described who can read 'be' but not 'B,' or 'ambulance' but not 'am.' Examples of semantic errors are 'jail' for 'prison' and 'soccer' for 'football'; examples of visual errors are 'perform' for 'perfume' and 'banish' for 'blush.' Deep dyslexia involves the loss of reading by the 'phonological,' or grapheme-to-phoneme conversion route, with residual reading involving only recognition of familiar words (route 2 in Figure 4). Most cases have severe aphasia, with extensive left frontal and parietal damage. The residual reading of patients with deep dyslexia may involve the right hemisphere.

Phonological dyslexia is similar to deep dyslexia, except that single content words are read in a nearly normal fashion, and semantic errors are rare. As in deep dyslexia, reading of nonwords is poor. Patients sometimes read words without access to meaning. The syndrome of phonological dyslexia, like deep dyslexia, involves the loss of grapheme-to-phoneme conversion. In deep dyslexia, only words whose meaning is recognized can be read aloud; only a semantics-to-phonology reading route can operate. In phonological dyslexia, words can also be read via a lexical-phonological route (route 3 in Figure 4), in which printed words can be recognized and transferred into their sounds, without access to semantics, or meaning. Only the nonlexical-phonological route, by which nonwords must be read, is inoperative. Most patients with phonological alexia have severe, nonfluent aphasia.

In surface dyslexia, subjects can read laboriously by grapheme–phoneme conversion, but they cannot recognize words at a glance. They can read nonsense syllables, but not words of irregular spelling, such as 'yacht' or 'colonel.' Their errors tend to be phonological rather than semantic or visual; an example would be to pronounce 'pint' as if it rhymed with 'lint.' Reading in these patients is accomplished without access to semantics until the word is pronounced. Individual graphemes are sounded out by the most common way they are

Table 2 Characteristics of alexic syndromes

Characteristic	Deep dyslexia	Phonological dyslexia	Letter-by-letter dyslexia	Surface dyslexia
Nonwords	–	–	–	+
Word class effect	+	+	–	–
Imageability	+	–	–	–
Word length	–	–	+	+
Regular spelling	–	–	–	+

Source: Patterson KE (1981) Neuropsychological approaches to the study of reading. *The British Journal of Psychiatry* 72: 151–174.

pronounced in the language, producing errors for both irregularly spelled words and regular words which have atypical pronunciations. For example, a surface dyslexic might pronounce 'rough' and 'though' alike. Surface dyslexia represents a syndrome in which only one route of reading, the grapheme-phoneme route, is operative (route 1 in [Figure 4](#)). Patients cannot read words without pronouncing their component graphemes. This syndrome is also seen in patients with aphasia, and also in patients with primary progressive aphasia (PPA), or the frontotemporal dementia (FTD) syndrome (see below).

Graphias

Like reading, writing may be affected either in isolation ('pure agraphia') or in association with aphasia ('aphasic agraphia'). In addition, writing can be deranged by motor disorders, by visuospatial or constructional impairments, and by apraxia, a disorder of learned motor activities. Isolated agraphia has been described with left frontal and occasionally left parietal lesions. In the past, a cortical writing center called 'Exner's area' was postulated, just above Broca's area. The existence of a specific writing area has not been supported, however, either by stroke cases or by electrical stimulation studies; stimulation of Broca's area interferes with writing, while excitation of other frontal regions does not produce agraphia without disturbing speech.

Agraphias have also been analyzed in ways similar to the alexias. A syndrome of 'phonological agraphia' has been described, in which patients cannot convert speech sounds (phonemes) into letters (graphemes). These patients cannot write pronounceable nonsense words but can write familiar words, even when irregular in spelling. Reported cases have been relatively few, with limited neuroanatomic data, but some cases have had lesions of the supramarginal gyrus. Most patients have had associated aphasia, but of varied types. 'Deep' dysgraphia is similar to phonological agraphia, but as in deep alexia, mainly familiar nouns and verbs can be produced, with a marked word class effect.

A 'lexical agraphia' syndrome, also called 'surface agraphia,' has also been described. Patients can write regularly spelled words and pronounceable nonsense words, but not irregularly spelled words. These patients have intact phoneme-grapheme conversion but cannot write using a whole word, or 'lexical' strategy. Lesions have been reported in the posterior angular gyrus and occipitotemporal gyrus, but other cases have had more anterior localizations.

Recovery of Aphasia

Patients with aphasia from acute disorders such as stroke generally show spontaneous improvement over the first several months. The traditional opinion in rehabilitation is that this improvement is maximal during the first 3 months, but, as Sarno has pointed out, patients with severe, global aphasia may actually improve more in the second 6 months than the first. The aphasia type often changes during this improvement; global aphasia often evolves into Broca's aphasia, and Wernicke's aphasia may evolve into conduction or anomia aphasia. The neuroanatomical correlates of language recovery appear to involve the taking over of language functions by

adjacent cortical areas of the left hemisphere, and the right hemisphere may also participate. Studies of activation of language areas by PET, SPECT, and fMRI techniques promise to advance our understanding of the neuroanatomy of language recovery. To summarize a growing and not always congruent literature, if left hemisphere language cortex can resume language functioning, recovery is excellent, but if centers in the right hemisphere take over, the recovery is incomplete. Recovery using the contralateral hemisphere to assume lost functions may be a 'second best' strategy.

Speech therapy, carried out by trained speech/language pathologists, seeks to facilitate improvement in language function by a variety of techniques. Repetitive exercises are carried out to promote better articulation, and matching vocabulary tasks are designed to improve receptive language. Other techniques in speech therapy include melodic intonation therapy, which attempts to involve the right hemisphere in speech production through the use of melody, and computer techniques originally developed for primate communication. Patients who cannot speak can learn to produce major nouns and verbs and associate them into simple phrases or sentences. A variety of augmentative devices are also available to help make language outputs available to others via printers or voice simulators. Therapy techniques are now chosen based on the patient's aphasia test results, and some investigators are using brain imaging studies to predict which techniques are likely to succeed. While many speech therapy techniques have been developed empirically, large, randomized trials have clearly indicated that patients who undergo formal speech therapy recover more communicative function than untreated patients.

New techniques in aphasia therapy include drugs, such as amphetamines or beta blockers, both of which have been shown to improve fluency and naming, and dopaminergic agents such as bromocriptine, which may improve speech output in nonfluent aphasias. All the evidence of the benefit from these drugs has come from small studies and series, and there is a lack of strong evidence of clinical effectiveness. Another avenue for aphasia therapy involves brain stimulation techniques. Transcranial magnetic stimulation is a noninvasive way of stimulating the language cortex, and some preliminary studies have indicated benefit. Again, large clinical trials are lacking. Direct, transcranial electrical stimulation, or surgical placement of electrodes in the brain or subdural space has also been attempted, but these procedures are more invasive and will require much better evidence of benefit to justify the risks. Transplantation of stem cells has also been attempted in patients with poststroke aphasia, though this research, too, is at an early stage of development. These new techniques carry new promise for patients with aphasia secondary to strokes and other causes of brain damage.

Miscellaneous Topics in Aphasia

Aphasia in Polyglots

Aphasia in patients who speak more than one language ('polyglots') has been the subject of considerable interest. In 1895, Pitres postulated that the language used most before the onset of aphasia would be the first to be recovered. In contemporary

terms, the language in which the patient works every day, and in which hospital personnel and therapists speak, is likely to be recovered faster and better than another language the patient has learned, or even grew up speaking. Ribot, in 1906, predicted that the first-learned or native language would be the most resistant to later brain injury. These two rules are now known as Pitres' and Ribot's laws. Other investigators have considered both the time of acquisition and the relative skill level in each language. Thus, Canadians who acquired French and English simultaneously in growing up ('compound bilinguals') have more congruent language involvement than those who learned one language later than the other ('coordinate bilinguals'). In recent studies, coordinate bilinguals have even developed different aphasia syndromes in two languages; for example an Israeli patient was globally aphasic in Hebrew but had only a mild anomic aphasia in Russian. In general, the language used more extensively before the brain injury, as Pitres originally postulated, appears to be less disturbed than the less used language, regardless of which was learned first.

Aphasia in Acute Confusional States and Dementias

Patients who develop acute delirium or confusion frequently utter meaningless or nonsensical phrases. In most cases this involves abnormal thought, or language content, rather than abnormal language, resembling a psychosis. In some cases, however, delirious patients produce fluent, paraphasic speech and even neologisms. Naming is frequently disturbed in acute confusional states. Comprehension is at least partially preserved, if the patient's attention and memory can be entrained to the task. Many delirious patients have abnormal writing. The diagnosis of delirium rests on a general confusional state, with impaired attention, reasoning, and often hallucinations and delusional thinking as well as agitation or drowsiness and autonomic signs such as tremor, sweating, tachycardia, hypertension, and fever. All of these 'positive' cognitive symptoms such as agitation, delusional thinking, and hallucinations, and also the autonomic signs, are much less prominent in dementing illnesses, except in advanced cases.

Patients with dementing diseases such as Alzheimer's disease frequently demonstrate abnormal language functions. The dementia of Alzheimer's disease usually begins with memory loss, and among the earliest symptoms is a loss of memory for names. Recollection of proper names and rapid generation of a series of names are very sensitive to aging and dementia. For example, patients with early dementia have marked difficulty with the 'animal naming' subtest of the BDAE, which requires the subject to name as many animals as possible in one minute. Articulation, repetition, and auditory comprehension tend to remain intact into later stages of dementia. At an early stage, an Alzheimer's disease patient often shows the profile of anomic aphasia. As the disease advances, reading and writing deteriorate, and auditory comprehension begins to decline. Repetition and articulatory fluency remain preserved, and the patient may then show the language profile of transcortical sensory aphasia. The content of expressive speech is also severely impoverished, devoid of abstract content. Ultimately, language expression becomes limited almost to statements of biological need. Some patients

become mute in late stages, resembling global aphasia, while others repeat fluently.

Alzheimer's disease is a 'diffuse' degeneration of the cerebral cortex, but pathological studies indicate early involvement of the association cortex, particularly of the parietal and later the frontal lobes. Medial temporal structures such as the hippocampus, which are important to memory function, and medial forebrain structures such as the nucleus basalis, also show neuronal loss and senile plaques.

Other dementing diseases also produce language disorders. After Alzheimer's disease, the most common cause of dementia is multiinfarct or vascular dementia. The specific features depend on the size and location of the cerebral infarcts, but many patients manifest aphasia.

Pick's disease was described in the nineteenth century as a lobar atrophy involving predominantly the frontal and temporal cortices, with microscopic stains showing intraneuronal, silver-staining inclusions called 'Pick bodies.' Many cases with similar clinical and neuroradiological features lack Pick bodies, and the newer term for this family of focal neurodegenerative disorders is 'FTD' or 'frontotemporal lobar degeneration.' Some cases begin with 'frontal' syndromes of behavioral abnormality, others have isolated aphasia at onset. What was described in North America as 'PPA' is now thought to be a variant of the syndrome of FTD, described in Europe. Some cases of PPA have been followed for several years, with steadily worsening language function, usually with nonfluent, or Broca-like aphasia, but no significant memory loss or generalized dementia. Brain imaging studies show only a lobar atrophy. PET studies have consistently shown left frontal and/or temporal hypometabolism, with more advanced cases showing more widespread metabolic changes. The pathology is usually of lobar atrophy, without the typical changes of Alzheimer's disease, but with neuronal loss and glial scarring. A variant of the syndrome is 'semantic dementia,' in which patients speak fluently but lose their ability to name or even to comprehend the meaning of names given to them. This syndrome can be seen in either FTD or Alzheimer's disease. A great deal of research has been published recently on this family of conditions. Two different gene mutations have been found in familial cases of FTD and PPA, both entirely separate from the genes associated with Alzheimer's disease. Another disease that can present with progressive aphasia is corticobasal degeneration, a variant of Parkinson's disease also associated with mutations in the tau protein, one of the two gene mutations associated with FTD.

Creutzfeldt-Jakob disease is a more rapidly progressive dementia, often with myoclonus and seizures, and often a fatal course within several months. Numerous variants of the syndrome have been described. Aphasia has been documented as a presenting symptom of Creutzfeldt-Jakob disease, but the development of a rapidly progressive dementia with myoclonus and seizures usually makes the diagnosis clear.

Language and the Right Hemisphere

While the right hemisphere has traditionally been called the 'minor' hemisphere because of its lack of language dominance, research has shown that patients with right hemisphere disease have significant problems with verbal communication. While

they can produce and understand appropriate words and sentences, patients with right hemisphere lesions speak monotonously, lacking the emotional tone or 'prosody' which makes normal language colorful. These patients lose the ability to understand emotional tone, connotation, irony, sarcasm, satire, and humor, responding only to the literal meaning of the words; they understand what is said, but not how it is said. The right hemisphere may have a similar organization to the left in terms of speech prosody, the emotional intonation, and emphasis present in spoken language; frontal lesions disturb production of prosodic speech, while temporal lesions disturb comprehension of emotional tone. Right hemisphere stroke patients have difficulty even with nonemotional aspects of prosody, such as placement of emphasis within sentences or inflections, as in the difference between a statement and a question. Despite their intact language skills, these patients are at a great disadvantage in normal human communication.

Aside from these effects of right hemisphere disease, the right hemisphere appears to have considerable linguistic ability. Patients with surgical commissurotomy, or section of the corpus callosum, are able to recognize words flashed in the left visual field, or presented in tactile fashion to the left hand. They can perform simple matching tests between words or short phrases which are semantically related. The mystery about these abilities is the failure of patients with left hemisphere lesions and global aphasia to perform similar tasks, despite the presence of an intact right hemisphere. It is possible that the corpus callosum contains fiber tracts which inhibit the right hemisphere from expressing its full language capability. If such systems could be therapeutically disrupted, the recovery of aphasia might be significantly enhanced.

Conclusion

The subject of aphasia is a rich field. Language was the first of the higher brain functions to be analyzed in terms of specific localization of brain lesions, and it remains the best studied and understood of all of the cognitive functions. Increased understanding of both normal language and aphasia is likely to emerge from new studies combining specific language testing measures with precise neuroanatomic techniques such as MRI and functional activation methodologies such as PET and fMRI. The result should be not only a better knowledge of language and the brain, but also improved therapies for patients afflicted with aphasia.

See also: [Agraphia and Alexia](#); [Alzheimer's Disease](#); [Handedness](#); [Language Development](#); [Neuroimaging of Dementia](#); [Sign Languages](#); [Syntax](#).

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Appetite

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Glossary

Anorexia Decreased appetite and eating caused by illness, aversion, or abnormal interference with the normal physiological controls of eating.

Appetite The subjective experiences and behaviors associated with the urge to eat including food seeking and meal initiation and with eating, including flavor hedonics and satiation.

Body mass index A measure of normal or abnormal adiposity equal to weight divided by height squared (BMI, kg m^{-2}); normal BMI is 18.5–25, overweight is 25–30, and obese is >30 .

Flavor hedonics The component of food reward referring to the pleasure or displeasure accompanying eating a particular food and the associated increase or decrease in selection and ingestion of that food; hedonic reactions are responses of the brain, not intrinsic properties of foods.

Homeostasis The maintenance of crucial physiological variables within relatively narrow ranges by active physiological mechanisms.

Hunger A synonym for appetite; formerly often limited to urges to eat elicited by physiological consequences of nutrient depletion.

Meal An organized bout of eating which is the functional unit of eating upon which physiological controls act.

Obesity A degree of excess adiposity associated with markedly increased health risks, often defined as BMI > 30 .

Palatability A synonym for flavor hedonics.

Postprandial satiety The subjective experiences and behaviors associated with the lack of eating during intermeal intervals.

Satiation The subjective experiences and behaviors produced during a meal by the ingestion of food that cause the termination of the meal; the physiological mechanisms of satiation and postprandial satiety are thought to be partially independent.

Introduction

Scope

The physiology of eating is a crucially important problem because of the epidemic proportions of obesity and the immense societal costs of obesity-related health disorders. Thus, why so many of us eat more than we need to and how this might be controlled are pressing scientific questions. Psychiatric eating disorders, although far less prevalent than obesity, are significant causes of morbidity and mortality, and therefore are also important basic research medical challenges. Unfortunately, the physiology of eating is very poorly understood. A reflection of this situation is that at present no truly effective physiologically based medications for disordered eating are available. Such medications are urgently needed to aid obese persons to diet or to aid persons with eating disorders to overcome their afflictions.

My aim in this article is to introduce the physiology of eating to students of physiology, neuroscience, and behavioral science. Fundamental physiological knowledge is emphasized, with some current areas of intense research interest highlighted. Social and cognitive aspects are not included. Disordered eating, as occurs in obesity and psychiatric eating disorders (anorexia nervosa, bulimia nervosa, etc.) are very briefly introduced.

Some background in neuroscience and physiology, such as could be easily obtained in basic texts, is assumed. **Table 1** lists hormones involved in the control of eating (except those discussed in connection with sodium appetite) together with their abbreviations; **Table 2** lists neurochemicals involved in the control of eating, only some of which are discussed, with their abbreviations. Because space requires that the review be incomplete, many mechanisms and mediators are not covered; this includes several of the molecules listed in **Tables 1** and **2**.

The role of *learning* in the physiological control of eating can hardly be overestimated. Although I cover this topic in a separate section, several examples of how learning shapes physiological controls are included. Finally, my discussion is organized around a few concepts that, although in wide use, are not universal or have varying definitions in the physiological literature. Therefore, I begin by describing my use of these concepts.

Concepts and Categories

The basic behavioral and subjective concepts used in various scientific approaches to eating – for example, appetite, hunger, palatability, satiety, and satiation – have no standard definitions. These days, as physiological and psychological methodologies are growing ever closer, as exemplified by functional brain imaging work, the semantic opportunities for miscommunication and confusion abound. The student of eating must keep in mind what actually is measured, rather than the names used to describe the measures.

The physiology of eating comprises: (1) the behaviors and subjective phenomena of eating; (2) the types of exteroceptive and interoceptive information that affect eating; (3) the peripheral neural and endocrine sensory mechanisms relaying this information to the brain; and (4) the brain neural networks that process and integrate this, and other, information to control acts and subjective phenomena associated with it. An important aspect of this processing is the plasticity of the brain's eating-control systems – that is, experience shapes every aspect of the physiology of eating.

Eating in humans and other mammals is organized into discrete meals, which, in turn, are thought to result from four functional processes: (1) *hunger* processes related to the

Table 1 Peripheral within- and across-meal feedback signals in the control of eating

<i>Control</i>	<i>Species</i>	<i>Within-meal</i>	<i>Across-meal</i>	<i>Physiological role</i>
Flavor hedonics	R-M, H	✓		◆◆
Gastric mechanoreception	R-M, H	✓		◆
Cholecystokinin (CCK)	R-M, H	✓		◆◆
Glucagon-like peptide-1 (GLP-1)	R-M	✓	✓	◆
GLP-1	H	✓		◆
Peptide YY (PYY)	R-M, H		✓	◆
Amylin	R-M	✓		◆◆
Amylin	H	✓		◆
Amylin	R-M	✓		◆
Ghrelin	R-M, H		✓	◆
Metabolic signals	R-M	✓	✓	◆
Insulin in overweight	R-M		✓	–
Insulin in underweight	R-M		✓	–
Leptin in overweight	R-M		✓	–
Leptin in underweight	R-M, H		✓	◆

Summary of within- and across-meal controls discussed in the text. Several other candidate mechanisms are not included. Species refers to laboratory rats or mice (R-M; for simplicity, the sometimes-important species differences between rats and mice are ignored) or to humans (H). Physiological role means the likelihood that the control produces a graded, dose-related effect on normal eating, rated as unlikely (–), somewhat likely with very incomplete evidence (◆), probable due to promising but incomplete evidence (◆), or well established (◆◆).

Table 2 Brain neurotransmitters and neuromodulators involved in the control of eating

<i>Neurotransmitter</i>	<i>Typical abbreviation</i>
Agouti-related peptide	AgRP
Cholecystokinin	CCK
Cocaine- and amphetamine-related transcript	CART
Corticotropin-releasing hormone	CRH
Dopamine	DA
Dynorphin	Dyn
Enkephalin	Enk
Galanin	GAL
γ-aminobutyric acid	GABA
Gastrin-releasing peptide	GRP
Glutamate	Glut
α-Melanocyte-stimulating hormone	α-MSH
Neuropeptide Y	NPY
Norepinephrine	NE
Orexin-A and orexin-B	Or-A, Or-B
Oxytocin	OT
Melanin-concentrating hormone	MCH
Serotonin (5-hydroxytryptamine)	5-HT
Thyrotropin-releasing hormone	TRH

This list is not exhaustive. Many neurotransmitters are named for their initially discovered endocrine roles. This is an example of how signaling molecules often have different roles in different parts of the body. There are variants for several of the abbreviations listed.

initiation of meals; (2) *flavor hedonics* processes related to the evaluation of the food that stimulate or inhibit eating during the meal; this is one aspect of food reward; (3) *satiety* processes related to inhibitory feedbacks from postingestive food stimuli that act to terminate eating at the end of the meal; and (4) *postprandial satiety* processes inhibiting eating during the intermeal interval. These four processes appear to have at least partially independent underlying neural mechanisms. Although each process includes both behavioral and subjective phenomena, for simplicity, I use single names for both aspects.

We make the decision to select this food or that food, or to have a little more of a particular food during a meal, many times a day, usually with little conscious effort or thought. Nevertheless, these are important decisions that can be subject to many influences, some physiological, some not. Furthermore, these various influences may push us in opposite directions at the same time – for example, feedbacks from the stomach and intestines may signal us to stop eating at the same time that sensory feedbacks related to food flavor tell us to keep on. For example, the influence of flavor hedonics is often in opposition to the influence of another category of controls, *homeostatic* or *regulatory* controls of eating. Both hedonic (section ‘Flavor Hedonics’) and homeostatic (section ‘Eating and Homeostasis’) controls of eating are discussed in more detail below.

Finally, my review of the physiology of eating is organized around *within-* and *across-meal* controls of eating. Within-meal controls refer to mechanisms in which a signal (e.g., changed peripheral sensory neural signals or changed plasma hormone concentrations) and a change in eating occur during the same meal; across-meal controls are those in which the signal and the eating response are not linked to the same meal. The major peripheral within- and between-meal signals are presented in the sections ‘Within-Meal Controls of Eating’ and ‘Across-Meal Controls of Eating,’ respectively. As it becomes clear, however, within- and between-meal controls function along a continuum, so that the distinction is mainly heuristic.

Eating and Homeostasis

Because eating is our only source of metabolic fuel and of essential nutrients, it is an integral part of homeostatic regulation, that is, the maintenance of crucial physiological variables within relatively narrow ranges. The concentrations of glucose, O₂ and CO₂ in the blood, blood pressure, body temperature, and a number of other variables are maintained within ranges that are much smaller than would occur if there were no

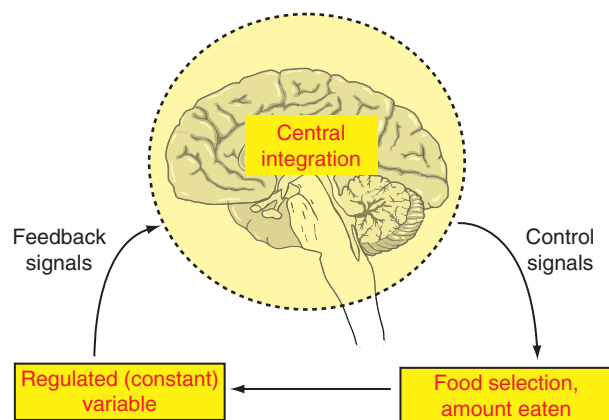


Figure 1 Schematic diagram of the organization of a negative-feedback control system, such as is thought to regulate micronutrient homeostasis and energy homeostasis. An afferent feedback signal related to the regulated variable is compared by the brain to the desired level of the signal and to other inputs. This integrated signal then causes the brain to initiate or adjust effector signals that affect control of the selection of food, amount eaten, energy expenditure, etc., in ways that bring the regulated variable back to the appropriate level, that is, reestablishes homeostasis.

regulation. Similarly, physiological regulations providing for appropriate supplies of metabolic energy, of protein, and of micronutrients can powerfully influence how much is eaten and what is eaten. As a consequence, homeostasis is a major conceptual scheme used to understand eating. **Figure 1** shows the basic organization of a negative-feedback regulatory system. Interestingly, many regulatory controls of eating seem to be organized asymmetrically, in that they protect from deficits but not from surfeits.

Specific Appetites for Micronutrients

Sodium appetite is an excellent example of the contribution of eating to micronutrient homeostasis. The concentration of sodium ions, Na^+ , in the extracellular fluid and blood plasma, is maintained near 150 mOsm. Loss of Na^+ , for example, when little or none is ingested for several days, leads to a number of homeostatic responses. These include secretion of the mineralocorticoid hormone aldosterone from the adrenal cortex, activation of the peptide hormone angiotensin II from its circulating precursor, and stimulation of neural baroreceptors in the vasculature. The synergistic action of these three sensory feedback signals in the brain produces a specific appetite for sodium, that is, a marked increase in the palatability of any sodium-containing food or fluid and an increase in its intake. This appetite is innate: it occurs during the first occurrence of sodium depletion, and the taste of salt is recognized without prior experience. Only a few other similar molecules, such as potassium, are partially confused with sodium. The occurrence of sodium appetite sensitizes the system in a way that increases 'need-free' salt ingestion. Although sodium appetite is generally considered in the context of body fluid homeostasis, salt preference increases food palatability, which may lead to chronic increases in the intake of salty foods.

In contrast to the sodium appetite, most specific appetites are learned. Vitamin B appetite is a good example. When rats

are fed a diet containing no vitamin B, deficiency signs begin to appear in about a week. If the rats are then offered a choice of a few new and differently flavored diets, they consume significant amounts of all of them. If just one of the new diets contains vitamin B, they learn in the course of a few days to eat mostly that diet. They do not recognize the flavor of vitamin B; rather, the enriched diet must have a salient flavor. If the experimenter switches the vitamin B to a different diet after the rats have learned to choose the first vitamin B-containing diet, the rats continue to eat the originally enriched diet until deficiency signs reappear. Learning capacity is also limited. If deficient rats are offered about ten diets, with only one enriched with vitamin B, they cannot learn to select it. Most micronutrient appetites appear to function like vitamin B appetite. Such specific appetites, however, do not exist for all micronutrients. Finally, in the cases of sodium appetite, vitamin B appetite, and most other micronutrient regulations, only deficits and not surfeits lead to regulatory behavior.

Energy Homeostasis

Food is the only source of metabolizable energy. Both the supply of readily available energy metabolites and the amount of stored energy are physiologically regulated. These regulations together are referred to as 'energy homeostasis.'

Energy balance refers to the relation between the metabolizable energy content of the food eaten and the energy expended (as physical work, heat, or in excretions) over a specific time. During positive energy balance, excess energy is stored as chemical energy in the body, and during negative energy balance, stored energy is utilized. Body weight is a relatively accurate indicator of an individual's history of energy balance. Young, growing individuals are normally chronically in positive energy balance, as energy is transformed into increased lean body mass. In adulthood, however, increases in body weight usually reflect increases in adiposity, that is, energy stored as fat, that is, triacylglycerols. These relationships are described by the energy balance equation:

$$\text{Energy stored} = \text{Energy ingested} - \text{Energy expended.}$$

Fat is stored in the adipose tissue. There is also ectopic storage of triacylglycerol in liver, muscle, and other tissues in overweight people. Although ectopic fat has important health consequences, the amount is much less than the amount of fat in the adipose tissue. Similarly, the few thousand calories of energy stored in the form of carbohydrate, that is, glycogen, is quantitatively negligible in comparison to fat stores.

The gold standard for measuring adipose tissue mass is computed tomography. In humans, much handier methods are waist circumference and body mass index (BMI):

$$\text{BMI} = \text{weight (kg)} / \text{height}^2 (\text{m}^2).$$

BMI correlates well with body adiposity for most people, although the relation breaks down in more muscular and taller people, especially women, and in children. BMI scores predict different percent body adiposity in males and females, in accordance with the higher normal fat content of females after puberty. The standard threshold BMI for overweight and obesity are 25 and 30. These days, about two-thirds of adult

US American adults are overweight or obese. Waist circumference is increasingly used because it correlates better than BMI with abdominal adiposity (i.e., the sum of abdominal subcutaneous and intra-abdominal adipose tissues) and has a better predictive value for risk factors of metabolic disease. The threshold waist circumferences for increased risk are 102 cm in men and 88 cm in women.

Despite the high prevalence of overweight and obesity, three lines of evidence indicate that the brain senses energy stored and, depending on its level, appropriately adjusts eating and energy expended. (1) The relative stability of body weight over longer periods. Although people gain several kilograms from young adulthood to middle age, the cumulative error in energy balance is small – if there were only a 1% constant error in energy balance over 25 years, weight gain would be over 1000 kg. (2) Dynamic compensatory responses that experimentally induced overweight (or underweight) elicit. For example, after experimentally induced obesity, animals usually decrease eating and increase energy expenditure and return to near the initial levels of body weight and adiposity. Why the compensation is often incomplete is not understood. (3) Our increasing understanding of the extensive neuronal networks in the brain that contribute to the regulation of adiposity, is introduced below. Why does this system not function better? It seems that the increased availability of highly palatable foods and the decreased amount of physical activity in our society overwhelm the regulatory system and cause many people to take in more energy than they need and become overweight or obese.

Finally, it is generally agreed that starvation, rather than obesity, was the more important challenge during the mammalian evolution. Accordingly, it should not come as a surprise that the physiological adaptations and compensatory responses elicited by starvation, including the drive to eat more, are more powerful than the responses elicited by overweight.

Within-Meal Controls of Eating

Flavor Hedonics

The effects of food hedonics on eating are often considered the antithesis of homeostatic influences. In fact, this is not entirely true, as shown by the example of increased sodium palatability in sodium-deficient animals or people. Indeed, in many ways we seem to be physiologically programmed to like what we need. Unfortunately, in the environments in which most of us live, energy-dense foods are available in abundance, so that flavor hedonics opposes the regulation of adiposity.

The flavor of preferred foods is a biological pleasure, as basic as the pleasure of sexual behavior. In fact, eating and sex activate extensively overlapping neural networks in the brain, as, unfortunately, do drugs of abuse. The neural evaluation of the pleasantness of flavor stimuli can either stimulate (for preferred flavors) or inhibit (for nonpreferred flavors) eating during a meal. Thus, flavor hedonics is an important within-meal control of eating.

The perception of flavor arises from olfactory, gustatory, tactile, and thermal food stimuli affecting receptors in the nasal and oropharyngeal cavities. Flavor has two roles in eating. (1) Flavor stimuli provide information guiding food selection, that is, identification of the type (e.g., *it's sweet*) and

intensity (*it's as sweet as candy*) of food stimuli, independent of the stimulus' hedonic qualities. (2) Flavor stimuli produce hedonic (used especially when conscious experience is measured) or palatability (used for behavioral as well as subjective measures) judgments, that is, the pleasant (or unpleasant) subjective experiences of food stimuli (e.g., *I like sweet*) that stimulate or inhibit eating. Although some preferences (e.g., sweet in any intensity, salt in moderate intensities) and aversions (e.g., bitter, sour) seem to be innate, the vast majority of preferences and aversions are learned. Some such learning is linked to the physiological consequences of eating – for example, hungry rats learn to prefer food with higher energy contents. But much learning occurs independent of nutritional or physiological consequences. Emotional, cognitive, and cultural associations, and even just repeated exposure, produce learned flavor preferences. Repeated exposure is a recommended method to induce children to eat usually nonpreferred vegetables or other foods the parents may be interested in, such as hot chili (capsaicin). Most people learn to like certain specific foods, for example, chocolate or pizza, very much, and their eating is markedly influenced by stable, strong 'cravings' for such foods. Because flavor preferences dramatically affect patients' success in adhering to therapeutic dietary regimens, the origins and plasticity of flavor preferences are important areas for behavioral and physiological research.

One mechanism for learned preferences seems to be associations between flavors and the postingestive consequences of the food. A dramatic example of the ability of such learning to overshadow the strong innate hedonic response to sweet was described by Anthony Sclafani of the City University of New York, Brooklyn, NY, USA. Hungry rats were offered either a noncaloric bitter solution or a noncaloric sweet solution (0.2% saccharin) to drink on alternate training days. Food, but not water, was available. On training days with the bitter solution, glucose was intragastrically infused in proportion to the amount drunk, and on training days with the sweet solution, water was intragastrically infused. After 4 days training with each solution, the rats were offered the bitter and the sweet fluid simultaneously, and no intragastric infusions were done. Rats selected 80% bitter solution and only 20% sweet solution, the opposite of the normal preferences.

It is important to note that, as the data just described indicate, hedonic judgments are responses of the brain, not properties of food. A flavor that is judged pleasant in one situation (e.g., garlic added to salad dressing) might be judged unpleasant in another (e.g., garlic added to chocolate cake). The neural processes producing flavor hedonics are thought to be mainly in the telencephalon (cerebral hemispheres). They include both subcortical areas (e.g., parts of the striatum, including the anterior caudate, ventral pallidum, and nucleus accumbens (NAc), and parts of the *amygdala* (central nucleus and basolateral)) and, at least in primates, several cortical areas (e.g., cingulate cortex, insular cortex, and orbitofrontal cortex (OFC)). The OFC is especially interesting. It receives relatively direct inputs from both olfactory and gustatory receptors, and, as increasing numbers of functional imaging studies indicate, it is involved in the evaluation of the pleasantness of flavor and other stimuli. For example, as shown in [Figure 2](#), it has been reported that the sight or flavor of chocolate produce greater activation of the OFC in people who describe themselves as

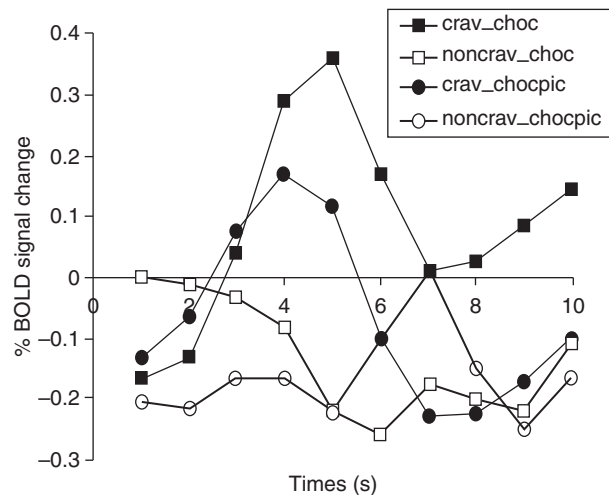


Figure 2 Demonstration that persons who are chocolate cravers (crav) increase activation of the OFC to the sight (chocpic) or flavor of chocolate (choc) more than persons who are not chocolate cravers (noncrav). Data are percent changes in blood oxygenation level (BOLD) measured for 10 s after presentation of the chocolate or picture of chocolate. Reprinted with permission from Rolls ET and McCabe C (2007) Enhanced affective brain representations of chocolate in cravers vs. non-cravers. *European Journal of Neuroscience* 26: 1067–1076.

chocolate cravers than in people who do not. Finally, the neurochemicals most strongly implicated in hedonics include dopamine (especially dopamine acting on D2 dopamine receptors in the NAc), endogenous opiates, and serotonin.

Finally, hedonic judgments are conscious perceptual states, and eating is a behavior. What, then, is the relationship between subjective states and behavior? Since acceptance of the principle of evolution by natural selection, the most parsimonious view is that subjective states evolved as causal agents, that is, conscious experience can cause behavior. This has been especially forcefully argued by the philosopher John Searle. Part of his view is that the belief that the (subjective) mind and the (physical) brain are fundamentally different kinds of things is illusory. How neural activity produces consciousness, and how consciousness affects neural activity, however, remain beyond the scope of today's technologies. Nevertheless, functional brain imaging methods are yielding more and more information about the relationships among neural processes in the brain, conscious states, and eating.

Gastric Mechanoreceptors

The stomach is richly innervated with mechanoreceptors, that is, sensory nerve endings that respond to stretching the smooth muscle of the stomach wall. These sensory nerves project to the brain via both vagal and spinal visceral (splanchnic) afferents. Studies in animals and humans indicate that the increase in gastric volume that occurs during large meals is an adequate stimulus for these mechanoreceptors and that the resulting neural signals contribute to satiation. The chemical nature of the gastric contents, in contrast, is not sensed. (More nutrient-dense gastric loads empty into the intestines more slowly than less nutrient-dense loads, however, to produce longer-lasting volume signals.)

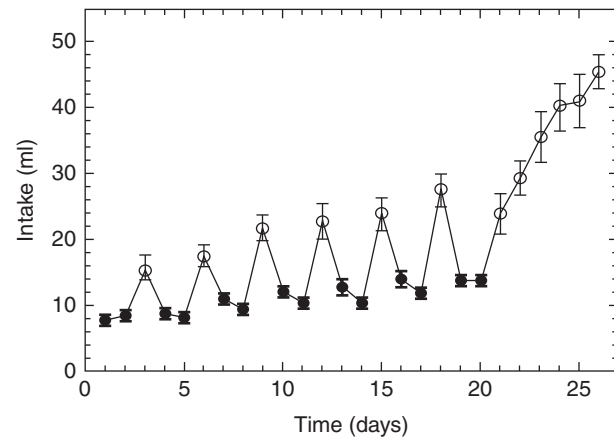


Figure 3 Demonstration that learned associations between flavor stimuli and gastric and postgastric signals control meal size. Rats consumed daily test meals of a sucrose solution during which pyloric cuffs were closed, so that ingested food could not pass from the stomach to the duodenum, in two conditions: first, with the gastric drainage cannulas closed (closed symbols), and second, with the gastric drainage cannulas open, so that the stomach remained empty (open symbols). Three phenomena are visible. First, meal size increased about twofold on the first test with the gastric cannulas open (day 3). This reflects the absence of normally operating *unlearned* controls of eating. Second, meal sizes in both conditions increased progressively during days 4–20, when two tests with the gastric cannulas closed were done between each test with the cannulas open. These progressive increases reflect the gradual weakening of learned associations between the flavor of sucrose and the absent gastric or postgastric food stimuli. Third, meal size increased even more rapidly in tests after day 20, when the gastric cannulas were open in every test. Because the only difference between the two conditions was that gastric filling occurred when the gastric cannulas were closed (recall that the pyloric cuffs were closed in all tests), this indicates that learned flavor-gastric volume signals are potent controls of meal size. Reprinted with permission from Davis JC, Smith GP, and Meissner J (1993) Postpyloric stimuli are necessary for the normal control of meal size in real feeding and sham feeding rats. *American Journal of Physiology* 265: R888–R895.

Neural recording studies in animals indicate that some of the vagal afferents respond synergistically to gastric volume and other meal-control signals, such as cholecystokinin (CCK). In humans, the volume of the antrum, that part of the stomach nearest the pyloric sphincter, which separates the stomach from the small intestine, seems most important for the feeling of fullness. Functional brain imaging studies suggest that fullness perceptions arising from increased gastric volume involve neural networks in the amygdala and the insular cortex, two areas also implicated in flavor hedonics.

The normal influence of gastric volume on eating is in large part learned. This has been elegantly demonstrated in rats that were surgically prepared so as to break the normal association between the flavor of the food eaten and gastric volume during test meals. As shown in **Figure 3**, this disconnection caused a progressive increase in meal size over test days, indicating the gradual deterioration of learned satiation signals.

Cholecystokinin

The gut peptide hormone CCK is an important mediator of the satiating effects of nutrients in the small intestine. CCK is

secreted from glandular cells dispersed in the epithelial cell layer of the small intestine, especially its initial part, the duodenum. As is the case for many other endocrine cells of the gastrointestinal tract, one side of the cell is exposed to the gastrointestinal tract lumen and expresses receptors that stimulate secretion from the opposite side of cells. CCK is secreted from the other side of the cell into the extracellular space of the lamina propria, from which it diffuses into the blood. The digestion of fats and proteins stimulate CCK secretion within minutes of meal onset. CCK satiating was first described in a series of classic studies starting in the 1970s by Gerard P. Smith, James Gibbs, and their colleagues at Cornell University Medical College. By now, tests of a number of stringent endocrine criteria indicate that one of the normal effects of CCK is to elicit satiation both in rats and humans. Some of the most important results are (1) infusion of CCK in amounts that reproduce levels reached during meals are sufficient to inhibit eating in humans; (2) infusion of selective CCK-1 receptor antagonists just before meals blocks the satiating effect of intraduodenal infusions of fat; and (3) CCK-1 receptor antagonist infusion during meals increases meal size (and the perception of hunger in humans). **Figure 4** shows some of these data. The amount of evidence implicating CCK in normal satiation is greater than for any other meal-control signal. Whether long-term treatment with CCK or CCK agonists can be used effectively to control eating therapeutically, however, remains unclear.

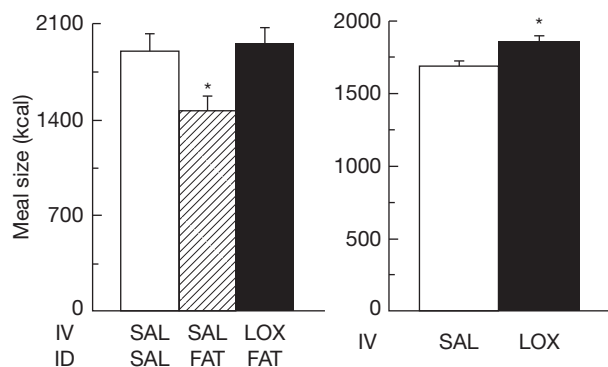


Figure 4 Demonstration of the satiating action of CCK in human subjects. Left: Intravenous (IV) infusions of the CCK-1 receptor antagonist loxiglumide (LOX) or a control saline solution (SAL) and intraduodenal (ID) infusions of a fat emulsion (FAT) or SAL were done while normal-weight male volunteers ate a lunch of orange juice, ham sandwiches, chocolate mousse, and coffee. ID fat infusions reduced meal size, and this satiating effect of fat was blocked by CCK-1 receptor antagonism, indicating that endogenous CCK was necessary of it. Right: Under similar conditions, except without ID infusions and a banana shake preload before the IV infusion, IV infusion of a larger loxiglumide dose increased meal size, indicating that endogenous CCK was involved in normal satiation under these conditions. Meal sizes are expressed in calorie equivalents because of the different foods eaten. *Statistically significant effect. Reprinted with permission from (left) Matzinger D, Gutzwiller J-P, Drewe J, et al. (1999) Inhibition of food intake in response to intestinal lipid is mediated by cholecystokinin in humans. *American Journal of Physiology* 277: R1718–R1724; (right) Beglinger C, Degen L, Matzinger D, D'Amato M, and Drewe J (2001) Loxiglumide, a CCK-A receptor antagonist, stimulates calorie intake and hunger feelings in humans. *American Journal of Physiology* 280: R1149–R1154.

CCK's satiating action may be in part endocrine (i.e., reach receptors via the circulation) and, at least in rats, in part paracrine mode (i.e., locally, in the lamina propria of the small intestine, before entering the blood). In rats, the CCK-1 receptors that mediate the paracrine action appear to be located on gastrointestinal smooth muscle in the pyloric area and on sensory fibers of the vagus nerve that innervate the same region, and those that mediate the endocrine action appear to be in the hepatic–portal vein or liver. The signals generated by all these CCK-1 receptors elicit afferent signals in the vagus nerve, which projects from the gut directly to the brain, to a region known as the nucleus of the solitary tract (NTS) in the hindbrain. A wealth of data, some reviewed below, indicate that the NTS is an important processing station in the control of eating.

Glucagon-Like Peptide 1 and Peptide YY

Glucagon-like peptide 1 (GLP-1) and peptide YY (PYY) are also gut peptide hormones. They are cosecreted by a single endocrine cell type, located mainly in the ileum, during and after meals. Glucose produced during the digestion of carbohydrates is the most potent stimulus for GLP-1 and PYY secretion. These peptides may contribute to both satiation and postprandial satiety. In rats, GLP-1 may act locally, on receptors on vagal neurons in the lamina propria of the small intestine, to produce a vagal signal to the brain. Whether its across-meal action is also vagally mediated or is the result of stimulation of GLP-1 receptors in the brain is unknown. The brain also contains neurons that use GLP-1 as a neurotransmitter. These neurons have been implicated in inhibition of appetite during visceral illness. The site of action of PYY is not yet clear; the NPY-Y2 receptors that mediate its actions of are expressed in the hypothalamus, the hindbrain, and abdominal vagal afferents.

As for CCK, infusion of GLP-1 in amounts that produce levels reached during meals are sufficient to inhibit eating in humans. In contrast, pharmacological amounts of PYY, which often elicit illness, seem to be required to inhibit eating. Note, however, that intravenous administration may not mimic the potentially paracrine effect of PYY on vagal afferents. The effects of GLP-1 or PYY antagonism have not been tested in humans as yet. GLP-1 agonists are in use to facilitate insulin secretion in patients with type-2 diabetes mellitus (T2DM), who are generally obese, and may also be useful for appetite control.

Amylin

The peptide hormone amylin (or islet amyloid polypeptide, IAPP) is synthesized mainly by pancreatic β -cells and cosecreted with insulin beginning in the first minutes of meals. Meal-related amylin secretion may function as a within-meal satiation signal, and basal amylin levels may function as an across-meal control of meal size (basal levels). Thus, in rats, acute injection of an amylin receptor antagonist, just prior to a meal, increased the size of that meal, and continuous infusion of the antagonist over 2 weeks chronically increased meal size and body weight. Amylin acts on receptors in the area postrema, a part of the brain with little or no blood–brain barrier that is adjacent to and heavily interconnected with the NTS. Amylin's satiating effect has not yet been investigated in detail

in humans, although pharmacological use of amylin agonists is attracting interest both as an aid to weight loss and for the control of diabetes.

Ghrelin

Ghrelin is a peptide hormone synthesized and secreted mainly by endocrine cells in the gastric wall. Ghrelin has attracted great interest as a potential hunger signal because it is the only gut peptide whose secretion is stimulated during fasting and inhibited by eating and because it is the only gut peptide whose administration stimulates eating, which has been shown in animals and humans. This appears to be an endocrine effect of ghrelin acting on receptors in the arcuate nucleus (Arc) of the hypothalamus. The physiological status of ghrelin is not yet well established.

Across-Meal Controls of Eating

Metabolic Signals

Neural sensitivity to metabolic processes in three organs, the intestines, the liver, and the brain, appears to contribute to the control of eating. Systemic administration of metabolic fuels often reduces eating, and pharmacological inhibition of glucose or fatty-acid utilization often increases it. These appear to be across-meal signals, that is, the changes seem to develop over durations that are longer than individual meals. Changes in glucose, however, may lead to within-meal as well as across-meal effects. Finally, whether metabolic processes are normally involved in the control of eating or contribute only in metabolic emergencies, such as severe hypoglycemia or starvation, remains unknown.

Glucose

Glucose is the most important metabolic fuel and has been much studied. Several demonstrations that intravenous glucose infusions inhibit eating and that coinfusion of insulin increases the effect suggest that the metabolic utilization of glucose contributes to the control of eating. Mice with a transgenic, relatively brain-specific deficiency in the glucose transporter-2 (GLUT-2) eat more than wild-type mice and show abnormal patterns of hypothalamic neuropeptide expression during the fasted-to-fed transition, suggesting the absence of GLUT-2 compromised the function of glucose sensors that contribute to the hypothalamic control of eating (see next section).

The liver also expresses GLUT-2, and meal-related increases in hepatic-portal vein glucose concentration may contribute to satiation. For example, intrameal hepatic-portal vein infusions of small amounts of glucose or of glucose plus insulin selectively reduced the sizes of spontaneous meals in rats. Electrophysiological and anatomical data indicate that the glucose receptors stimulated are likely to be on vagal afferents terminating in the wall of the hepatic-portal vein.

Glucose-sensing neurons, that is, neurons that change electrophysiological activity depending on changes in glucose level or utilization within the normal range, are present in several brain areas, from the hindbrain to the hypothalamus. Many of these neurons express GLUT-2, sulfonylurea receptor-1 (whose activation stimulates insulin secretion), and glucokinase

(the rate limiting enzyme in glycolysis), thus making them excellent candidates as glucose-utilization sensors. There is evidence that brain glucose-sensing neurons contribute both to the homeostatic regulation of blood glucose level and to the control of eating.

Finally, a small, transient decrease in blood glucose level occurs prior to spontaneous meals in rats and humans under some conditions. This decrease may be a pattern whose recognition contributes to meal initiation. The decrease seems not to reflect a decrease in glucose utilization because it is very small and because glucose level usually returns to normal before the meal is initiated. One possibility is that the brain periodically initiates a pulse of insulin secretion via vagal afferents in order to test the body's ability to compensate and initiates eating if the compensation is not rapid enough.

Fatty acids

Fatty-acid utilization has also been implicated in eating. Acute pharmacologic inhibition of fatty-acid oxidation (FAO) has been shown to stimulate eating in animals and humans. Although the liver is a primary site of FAO, several results suggest that it is not the site where FAO sensing contributes to the control of eating. Rather, recent evidence suggests that the intestinal wall may be the site. That is, depending on nutritional status, intestinal epithelial cells may absorb fatty acids either from the blood or (when medium or short chain fatty acids are ingested) from the intestinal lumen and oxidize them to cover their own energy needs, and the level of oxidation may be sensed by vagal afferents. Fatty-acid levels or metabolism can also be sensed centrally, in the hypothalamus, and this also appears to affect eating, at least during pharmacological manipulations.

Intracellular energy flow sensors

The intracellular signaling mechanisms linking metabolism and eating have also been investigated. Reduction of cellular-energy availability, whether due to decreases in fatty-acid or glucose utilization, increases the AMP/ATP ratio and activates (via phosphorylation) the intracellular-energy sensor AMP kinase (AMPK), which exists in the periphery and the brain. Local pharmacological activation of AMPK in the hypothalamus increases eating, suggesting that changes in cellular-energy status are sensed. Similarly, pharmacological manipulation of another cellular-energy status sensor, the molecule mammalian target of rapamycin (mTOR), also affects eating. mTOR appears to be expressed by neuropeptide Y (NPY)/agouti-related peptide (AgRP) neurons in the Arc of the hypothalamus, which, as explained in the next section, are supposed to play a crucial role in homeostatic eating. mTOR activity is decreased by metabolic-fuel deficiency and is increased by fuel repletion, that is, the opposite pattern as AMPK activity. In addition, activation of AMPK inhibits mTOR activity in the some brain areas. These data suggest that activation of the two fuel-sensing molecules should have opposite effects on neural activity, but this has not yet been shown.

Insulin

Insulin, besides its many metabolic actions in the periphery, seems to have a direct inhibitory action on eating. This action is

the result of active transport of insulin from the blood into the brain, where it acts on receptors in the Arc of the hypothalamus. It has been suggested that insulin may function as an 'adiposity signal,' that is, a signal providing the brain with information about body fat that enables it to mount compensatory responses when body fat is increased or decreased. A variety of indirect evidence supports this view. Insulin administration into the brain reduces eating and increases energy expenditure, and insulin antagonist infusion has opposite effects. In addition, cross-sectional studies indicate that in humans or animals who are maintaining a steady weight, whether normal or elevated, basal (i.e., fasting) plasma insulin levels are correlated with weight or adiposity. Finally, specific transgenic knockout of brain insulin receptors rendered mice obese. Although these data indicate that insulin is necessary for normal energy homeostasis, they do not provide direct evidence that insulin signals change in adiposity to the brain. In fact, basal plasma insulin is not correlated with either body fat or the magnitude of compensatory eating or energy expenditure responses in rats that were dynamically regulating their weight following experimentally induced obesity or underweight. Thus, insulin's role in the control of eating remains in doubt.

Leptin

Leptin is a peptide hormone secreted by the adipocytes themselves. Its position in the physiology of eating is similar to insulin's. Cross-sectional studies indicate that basal plasma leptin levels are correlated with weight or adiposity in humans or animals who are maintaining a steady weight. Administration of leptin or leptin antagonism decrease and increase eating, respectively, and genetic defects in the leptin signaling pathway produce dramatic obesity phenotypes. But direct support for a role as an adiposity signal is lacking. For example, basal plasma leptin was not correlated with either body fat or the magnitude of compensatory eating and energy expenditure responses in rats that were dynamically regulating their weight following experimentally induced obesity.

Several data suggest that leptin's physiological role may be in starvation or weight loss rather than in obesity. For example, underweight animals become progressively more sensitive to leptin administration, whereas overweight animals become less sensitive. Rudolph Leibel, Michael Rosenbaum, and their colleagues at Columbia University, New York, NY, USA, have performed several fascinating studies of human subjects recovering from a ~10% loss in body weight, which leads to decreased plasma leptin levels, decreased energy expenditure, and, presumably, increased hunger. In one study, these investigators showed that leptin infusions that reinstated normal-weight leptin levels normalized energy expenditure. In a follow-up study, brain responses to the sight of food items or nonfood items were measured with functional magnetic resonance imaging (fMRI) at normal weight and after weight loss. Weight loss caused selective changes in the neural responses to the sight of food items in several brain areas thought to be involved in the control of eating, and normalization of leptin levels reversed many of these. Such data suggest leptin is a necessary part of the brain's complex response to the homeostatic challenge of weight loss.

Brain Mechanisms

Eating is mediated by a complex, anatomically diffuse neural network that is organized hierarchically, redundantly, and recurrently. Three somewhat autonomous subnetworks have been identified: a telencephalic network for hedonic processing, a hypothalamic network especially involved in homeostatic mechanisms, and a hindbrain network. Some of the principal structures in each of these networks are depicted in [Figure 5](#). The telencephalic network was introduced in the section 'Flavor Hedonics.' The others are briefly sketched here.

Hypothalamus

Several subareas, or nuclei, of the hypothalamus have been implicated in the control of eating, and an intrahypothalamic neural network is thought to orchestrate the eating, neuroendocrine and autonomic responses contributing to energy homeostasis. The Arc appears to be an important sensory node in this network ([Figure 6](#)). As mentioned already, Arc neurons are sensitive to hormones including leptin, insulin, and to metabolites. One population of these neurons synthesizes and uses the neurotransmitter NPY and the neuro-modulator AgRP, and another population synthesizes and uses the neurotransmitters α -melanocyte-stimulating hormone (α -MSH; these neurons are often called POMC neurons after the precursor of α -MSH, proopiomelanocortin) and cocaine- and amphetamine-related transcript (CART). NPY and AgRP stimulate eating when injected into the hypothalami of animals and are therefore called orexigenic peptides, whereas α -MSH and CART injections inhibit eating, so they are called anorexigenic peptides. Three main targets of projections of these two classes of Arc neurons are the nearby paraventricular nucleus (PVN), lateral hypothalamic area (LHA), and perifornical area (PFA). Arc NPY/AgRP neurons inhibit PVN neurons that express neurotransmitters including oxytocin (OT) and corticotropin-releasing hormone (CRH), and other anorexigenic peptides, and stimulate LHA neurons that express melanin-concentrating hormone (MCH) and PFA neurons that express orexin-A and -B (Or-A, Or-B), which are orexigenic. In contrast, Arc α -MSH neurons inhibit PVN OT and CRH neurons and stimulate LHA/PFA MCH, Or-A, and Or-B neurons. Additional neural elements of this network include inputs from serotonin (or 5-hydroxytryptamine, 5-HT) neurons projecting from the raphe nuclei in the midbrain and electrophysiologically inhibitory interconnections mediated by γ -aminobutyric acid (GABA) neurons, both local interneurons and projection neurons from the NAc. The latter represents one likely connection between the hypothalamus and telencephalic networks processing flavor hedonics.

This summary is based on a huge number of experiments. Nevertheless, because available methodologies do not permit truly crucial physiological experiments, the extent to which this neural network, or parts of it, controls normal eating is uncertain. Whether or not particular neurochemical signaling systems operate in most conditions, however, does not preclude the development of pharmacotherapies based on them (or on the gut signaling molecules discussed above). Because of the many health problems related to the obesity epidemic, pharmaceutical companies have mounted huge efforts in this direction.

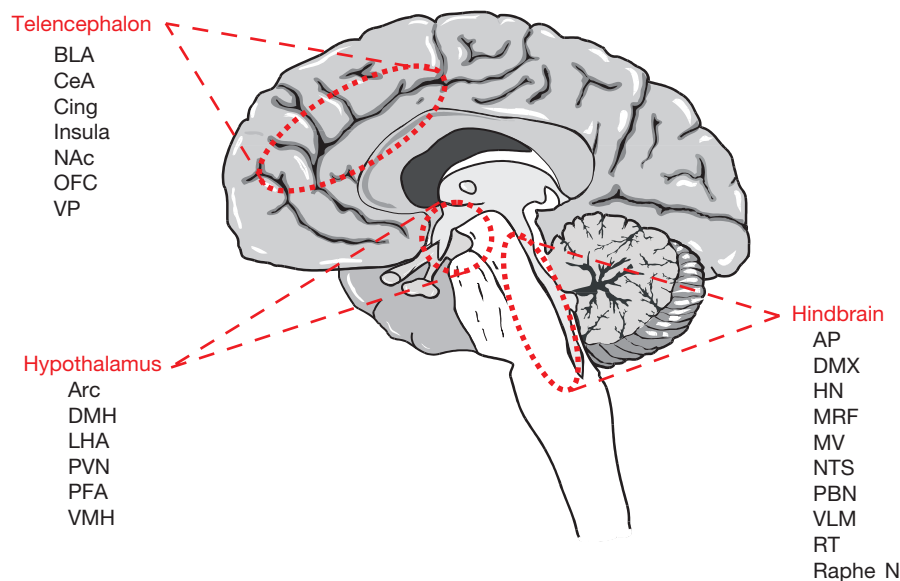


Figure 5 Schematic diagram of the roughly localizing three partially independent subnetworks controlling eating in the telencephalon (cerebral hemispheres), hypothalamus, and hindbrain. Several important brain areas in each region are listed. The view of the brain is the medial aspect of the right side of the brain after a midsagittal section, as can be done by cutting tissue with a knife or by computed tomographic imaging. The front is to the left. AP, area postrema; Arc, arcuate nucleus; BLA, basolateral amygdala; CeA, central nucleus of the amygdala; Cing, cingulate cortex; DMH, dorsomedial hypothalamus; DMV, dorsal motor nucleus of the vagus; HN, hypoglossal nucleus; LHA, lateral hypothalamic area; MRT, medullary reticular formation; MV, motor nucleus of the trigeminal nerve; NAc, nucleus accumbens; NTS, nucleus of the solitary tract; OFC, orbitofrontal cortex; PBN, parabrachial nucleus; PFA, perifornical area; PVN, paraventricular nucleus; Raphe N, midbrain raphe nuclei (dorsal and magnus); VLM, ventromedial medulla; VMH, ventromedial hypothalamus; VP, ventral pallidum.

Hindbrain

The hindbrain (midbrain, pons, and medulla) is the target of both neural and endocrine signals involved in the control of eating. In addition, it contains the interneuronal networks that function as 'central-pattern generators' coordinating the acts of eating and the cell bodies of the motor neurons that project to the muscles involved. The results of neural processing in the telencephalon and hypothalamus must be conveyed to these hindbrain motor networks to have any influence on eating. These descending projections do not appear to target the motor networks directly, but to project to interneuronal networks that process peripheral inputs to the hindbrain, such as vagally mediated meal-control signals. The final integrated output is then directed to the motor networks. The PVN is the source of a number of projections from the hypothalamus to the hindbrain. For example, PVN OT and CRH neurons project to the NTS and nearby sensory and motor areas.

Hindbrain neurons that express the amine neurotransmitters serotonin, dopamine, and the catecholamines norepinephrine and epinephrine are another source of projections to the forebrain involved in the control of eating. Serotonin and dopamine have been implicated in both flavor hedonics and satiation. The catecholamines, which are also expressed by neurons in the forebrain, have been implicated in normal satiation and in anorexia.

A series of elegant studies by Harvey Grill and his colleagues at the University of Pennsylvania, Philadelphia, PA, USA, revealed several unsuspected aspects of the hindbrain's contribution to eating. Much of this work used chronic decerebrate rats, which are rats with transections of the neuroaxis that

separate the hindbrain and forebrain (i.e., telencephalon, thalamus, and hypothalamus). This work indicates that the hindbrain is sufficient for nearly normal effects of gustatory and gastrointestinal feedback signals on meal size. Although these rats do not initiate meals unless food is placed into the mouth, when this is done by intraoral infusion, they take well-defined meals terminated by passive refusal of more food, ingest more of sweeter solutions, ingest less after CCK injections, etc. These investigators have also shown that leptin and a number of other endocrine signals can act directly in the hindbrain to control eating. How these capacities of the hindbrain are integrated with forebrain neural processing is a focus of current research.

Intercellular Signaling

Multiple neurotransmitters and neurotransmitter receptor subtypes in addition to those already mentioned have been implicated in the control of eating. These are listed in Table 2. The assessment of their physiological roles in eating is much more difficult than the assessment of peripheral endocrine signals discussed previously, so that progress in this area is slow. Again, however, it is important to realize that pharmacological treatments for eating can be based on neurotransmitter systems even if they are normally only rarely involved in the control of eating.

Intracellular Signaling

Some intracellular signaling molecules involved in the brain neural networks controlling eating have been identified. These

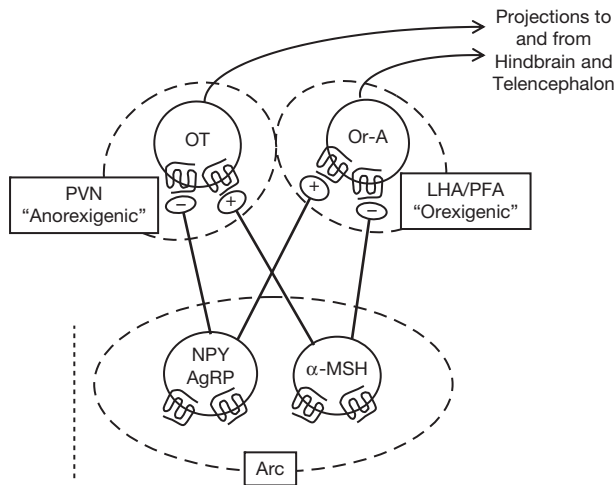


Figure 6 Schematic diagram of the core 'anorexigenic' and 'orexigenic' neural networks in the hypothalamus, as described in the text. Dashed lines indicate the Arc, PVN, and LHA/PFA. Within these areas, neural cell bodies are represented by circles, neurotransmitter or endocrine receptors by squiggles, axons by straight solid lines, and axon terminals by ovals. Excitatory synapses are denoted by a plus sign in the axon terminal, and inhibitory synapses by a negative sign. Arc neurons are receptive to a variety of metabolites, hormones, and neurotransmitters. A medially located population of neurons expresses the signaling molecules NPY and AgRP and has excitatory projections to neurons in the LHA/PFA that express Or-A and other orexigenic molecules; the NPY/AgRP neurons also have inhibitory connections with neurons in the PVN that express OT and other anorexigenic molecules. A more laterally situated population of Arc neurons that express α -MSH has a reciprocal connectivity: it excites PVN neurons and inhibits LHA/PFA neurons. Finally, the PVN and LHA/PFA send and receive projections from a variety of hindbrain and telencephalic areas. The diagram shows only one side of the brain; the dotted line on the left represents the midline.

include adenosine 44/42 mitogen-activated protein kinase (MAPK or ERK1/2), cAMP response element-binding protein (CREB), signal transducer and activator of transcription 3 (STAT3), and suppressor of cytokine signaling 3 (SOCS3). In addition, the immediate early gene products c-Fos and c-Jun, which are activated by neural activity, are useful markers of brain areas activated in particular functional states. The roles of these various molecules are not yet well established. Activation (i.e., phosphorylation) of MAPK is especially interesting because it has been reported that pharmacological inhibition of MAPK affects eating, indicating that it has a necessary role under some circumstances.

Sex Differences

In addition to their functions in reproductive physiology, gonadal steroid hormones, especially the estrogens and androgens, act in the brain to affect eating. The clearest phenomenon, which occurs in women as well as in many animal species, is that eating decreases during the periovulatory phase of the ovarian cycle. In rats and mice, this has been shown to be due to an inhibitory effect of endogenous estrogens on eating leading to reduced meal size. An important

mechanism underlying this is that estrogens increase the satiating potency of CCK. This increase is due to the activation of estrogen receptors on neurons in the NTS about a day before ovulation, as has been shown with local administration of estradiol (the major estrogen) or estrogen antagonists. Three other effects of estrogens have been identified in rats and mice that may also contribute: first, estrogens decrease the eating-stimulatory effect of ghrelin; second, estrogens increase the satiating potency of pancreatic glucagon; and, third, at least under some test conditions, estrogens decrease the eating-stimulatory effect of sweet taste.

In rats and mice, interruption of ovarian cycling increases meal size and leads to increased food intake and adiposity. This phenomenon has also been linked to the effect of estrogens to increase CCK satiation. On average, women increase adiposity during the menopausal transition, but whether this is due to increased eating is unknown (there is also a shift in regional adipose tissue deposition, which may be due to the decrease in circulating leptin levels after menopause).

The estrogenic inhibition of eating is mediated by a particular estrogen receptor, estrogen receptor-alpha (ER- α). Girls with variants of the ER- α gene that lead to partial loss of function have been found to develop an increased risk to become overweight or obese beginning at puberty. This strongly suggests that estrogens control eating similarly in women as in rats and mice. It has been reported that estrogens increase the eating-inhibitory effect of exogenous leptin and decrease the eating-inhibitory effect of exogenous insulin, but whether these are endogenous physiological mechanisms is not yet clear.

There are also sex differences in flavor hedonics. In rats, females prefer sweet solutions less than males, and in humans, women designate less sweet foods maximally pleasant than men. Estrogens appear to reduce the hedonic evaluation of sweets both in female rats and women. Estrogen-independent mechanisms may also contribute. In humans, there is a sex difference in the numbers of sweet- and bitter-sensitive taste receptors which is associated with differences in flavor hedonics. Men and women also tend to have very different sorts of food cravings, although the extent to which this reflects biological sex differences rather than cultural influences is unknown.

Finally, how sex differences in the physiology of eating are related to women's increased vulnerability to psychiatric eating disorders are important, but little understood, issues.

Anorexia

Anorexia is decreased appetite or decreased eating caused by illness, aversion, or abnormal interference with the normal physiological controls of eating.

Illness Anorexia

Anorexia is a common element of systemic infections and other immune challenges. Anorexia during the 'acute-phase response' of the innate immune system, like fever, is unpleasant, but can facilitate recovery. More chronic illness anorexia, such as that which accompanies cancer, however, is a maladaptive response that can increase illness severity.

A number of proinflammatory cytokines (interleukin-1, interleukin-6, tumor necrosis factor- α , etc.), prostaglandin- E_2 , and other immune signaling molecules are involved in acute illness anorexia. These appear to converge on the same neural networks that mediate normal eating. For example, serotonergic neurons in the dorsal raphe nuclei, which project into the hypothalamus and telencephalon, have been implicated in both the normal control of eating and in illness anorexia.

Acute illness leads to a unique form of learning, the conditioned taste aversion. If an unfamiliar food item is eaten in the hours before an acute illness occurs, especially upper intestinal malaise, animals and humans develop a very strong aversion to the flavor. This is an unusual form of Pavlovian conditioning in that it occurs with only one association between the flavor stimulus and illness, it occurs with very long intervals between these stimuli, and it is unusually resistant to forgetting.

Stress Anorexia

The classical hypothalamic–pituitary–adrenal axis stress response involves a three-step endocrine cascade: secretion of CRH from the hypothalamus into the hypophyseal portal circulation, secretion of adrenocorticotrophic hormone (ACTH) from the anterior pituitary into the systemic circulation, and secretion of glucocorticoid hormones, especially cortisol in humans and corticosterone in rats, from the adrenal cortex. Stress also stimulates secretion of arginine vasopressin and OT from the posterior pituitary and activates the sympathetic nervous system, leading to the secretion of epinephrine and norepinephrine from the adrenal medulla. All of these hormones appear to contribute to stress-induced anorexia, although their specific roles in the many types of stressors that are associated with anorexia are not fully clear.

CRH is secreted into the hypophyseal circulation by neurons in the parvocellular part of the PVN. CRH neurons also project to other brain sites, where CRH is released as a neurotransmitter, as mentioned above. These neurons can be activated in the absence of HPA axis activation, suggesting that CRH has a role in normal eating as well as anorexia. Similarly, as OT also acts as a neurotransmitter, and oxytocinergic projections from the PVN to the NTS also appear to be involved in the control of normal eating.

Glucocorticoid hormones play a crucial role in obesity – most experimental obesity syndromes are reversed by adrenalectomy and reinstated by glucocorticoid treatment. Pathological increases in CRH or ACTH lead to Cushing's syndrome, which includes abdominal obesity. Both overeating and direct metabolic effects of glucocorticoids appear to contribute to the obesity of Cushing's syndrome.

Psychiatric Eating Disorders

Anorexia Nervosa

Anorexia nervosa is a grave disorder characterized by dangerously low body weight (often defined as BMI < 17), an intense fear of weight gain, refusal to eat and, in women, amenorrhea. A substantial number of people who develop anorexia nervosa die from it. The name, however, is a misnomer. That is,

although people with anorexia refuse to eat, it is because of suppression of appetite, not lack of appetite. This is evidenced, for example, by findings that people with anorexia nervosa often consume huge amounts of noncaloric sweetener. The prevalence of anorexia nervosa is approximately threefold higher in women than in men. Furthermore, the incidence of anorexia nervosa is highest around puberty, when the estrogenic inhibition of eating appears. Unfortunately, therapeutic manipulation of the physiological controls of eating to alleviate anorexia nervosa remains a distant goal.

Bulimia Nervosa and Binge-Eating Disorder

Bulimia nervosa and binge-eating disorder are characterized by binge eating (i.e., ingestion of abnormally large amounts of food associated with a perceived loss of control of eating); in bulimia nervosa, binges are followed by inappropriate compensatory behaviors, such as self-induced vomiting or laxative abuse, with maintenance of normal weight. In binge-eating disorder, there is not compensation, so obesity develops. There is considerable evidence that some satiation signals are less potent in patients with bulimia nervosa. For example, food preloads decrease meal size less in patients with bulimia nervosa than in controls, patients with bulimia must eat larger amounts of food to produce equivalent self-reports of fullness, and food-stimulated CCK release is less in patients with bulimia nervosa than controls. There is also evidence that serotonergic processing of satiation signals in the brain is altered in patients with bulimia nervosa. All these abnormalities appear to resolve as bingeing decreases, however, suggesting that they are not the initial cause of bulimia. It is likely that they facilitate the maintenance of bulimia nervosa once it has begun and impede recovery from it. Thus, these are attractive candidates for development of physiologically or pharmacologically based treatments. The risk of both disorders is substantially higher in women (approximately threefold for bulimia nervosa and approximately twofold for binge-eating disorder). Binge-eating disorder, which was recognized more recently, urgently requires investigation as it has a strong statistical association with morbid obesity (i.e., BMI > 40).

Animal Models of Psychiatric Eating Disorders

A number of animal models have been developed in the attempt to understand normal genetic, neurochemical, physiological, and behavioral factors that are involved in the cause or maintenance of psychiatric eating disorders. Activity-based anorexia (ABA) is the most interesting animal model of anorexia nervosa. ABA is produced by limiting food access to 1–2 h day⁻¹ and providing free access to a running wheel. When this is done, rats become progressively anorectic until death. The neurochemical changes produced by ABA have been extensively investigated and have provided several clues as to potential pharmacological treatments for anorexia nervosa. Animal models of binge eating, of which there are several, also seem to hold great promise. These models are based on increased intake of palatable foods stimulated by restricted access, stress, and other factors thought to be involved in the development of the human syndrome.

Genetics of Eating

Heritability of Obesity

Body weight is a highly heritable trait. The heritability (h^2 , the percent of variation in a population phenotype that is due to genetic variation) of body weight or BMI is generally $\sim 75\%$, which is similar to that of height. A recent large ($>90\,000$ subjects) genome-wide association study revealed eight genes that contribute to this high heritability. Some of these are related to eating, such as the gene for the α -MSH receptor, the melanocortin-4 receptor (*MC4R*). About 100 *MC4R* variants have been associated with obesity. People bearing such gene variants report constant hunger and apparently lack a normal sense of satiation. *MC4R* variants are quite common, occurring in about 2–6% of obese people, depending on the population studied, and one variant had a minor allele frequency of about 25% in a cross-sectional study of US American women of all weights.

A common question is, how can the recent increase in the prevalence of obesity, which clearly occurred without any change in the human genome, be reconciled with the high heritability of body weight? The problem evaporates when one recalls that h^2 measures heritability in a single environment. If the environment changes, so will h^2 . Thus, individual estimates of h^2 in the present high obesity-risk environment and in the former low obesity-risk environment might each be $\sim 75\%$, but this would be markedly reduced if h^2 were estimated in both environments simultaneously. Second, although the genome has not changed much in recent times, the particular genes that are expressed and their degree of expression probably have. That is, different genes are likely to contribute effectively to our phenotypes in the present environment more than in former environments. Genes whose expression is related to sugar and fat intake, for example, would certainly be expressed more now than in former days, when sugar and fat intakes were lower.

Genes and Eating

Fascinating links between genetic variation and eating have begun to emerge. These new findings suggest, among other things, that, at least in some individuals, overeating and obesity may be caused by inborn genetic differences, no more under the person's control than common inherited variations in color vision. Here I describe two interesting examples in addition to *MC4R*, described above, that support this conclusion.

First, Mariken de Krom, Roger Adan, and their colleagues at the University Medical Center, Utrecht, NL, identified women who were obese and who overate, as estimated using photos of food portions, and then searched for the presence of known variants in the *ckk*, *lep*, and *lepr* genes. Women with one particular *lep* variant had markedly increased risk for extremely frequent meals, whereas those with a particular *ckk* variant had increased risk for extremely large meals. These data indicate that specific high-risk eating traits can have genetic bases. Furthermore, the variants identified were surprisingly common.

Second, Eric Stice and his colleagues at the Oregon Research Institute, Eugene, OR, USA, combined genetic and functional imaging approaches to link dopamine neurotransmission with

food hedonics, eating, and body weight. Subjects were people with or without a variant of a gene (rs1800497) that reduces dopamine D2 receptor function. Activation of the striatum, a telencephalic area in which dopamine neurotransmission contributes to the processing of food hedonics, was measured with fMRI while subjects ate a chocolate drink or a tasteless solution. They found that eating chocolate activated the striatum less in subjects with the gene variant in comparison to subjects with other forms of the gene and that the degree of activation of the striatum was significantly associated with BMI. Their interpretation was that the gene variant reduced the hedonic impact of foods, leading people to eat more in order to get the desired or normal hedonic experience (a similar phenomenon is well known in drug-reward studies).

See also: Behavioral Medicine; Bulimia Nervosa; Homeostasis; Hormones and Behavior.

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Asperger's Syndrome and Nonverbal Learning Disorder

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Glossary

Adaptive skills Living skills needed to live, work, and play in the community.

Crossmodal integration Synthesizing information from different sensory modalities (tactile, gustatory, visual, auditory, and olfactory).

Pragmatics The social use of language; both verbal and nonverbal.

Semantics The knowledge and usage of words; one's lexicon of vocabulary.

Social reciprocity The back and forth of interactions such as playing, gesturing, attention, and conversations.

Introduction

Asperger's syndrome (AS; sometimes referred to as Asperger's disorder) and nonverbal learning disorder (NLD; sometimes referred to as nonverbal learning disability or nonverbal learning disability syndrome) are first identified in childhood and are considered neurological disorders, meaning that the way the brain processes information is affected. These conditions share a substantial number of symptoms and characteristics; however, there are certain features that distinguish these conditions from one another. Understanding the overlapping and distinctive genetic, neurological, cognitive, and behavioral characteristics of AS and NLD is the focus of current researchers across multiple scientific disciplines. There is conflict as to whether these are two separate disorders; that is, whether they are similar enough such that they belong to the same diagnostic continuum. There are no clear definitions of NLD, as compared to AS, which results in relatively more familiarity with and information available on AS compared to NLD.

The diagnostic classification systems commonly used by practitioners (such as psychologists, medical doctors, etc.) to diagnose psychological and psychiatric disorders include the Diagnostic and Statistical Manual of Mental Disorders, 4th edition, Text Revision (DSM-IV TR) and the International Classification of Diseases, 10th edition (ICD-10). AS was first introduced into these classification systems in 1993 (ICD-9) and 1994 (DSM-IV). Despite NLD's absence in these two diagnostic systems, children continue to be diagnosed with NLD, especially within school settings, and there is increasing research on NLD. Practitioners and researchers currently conceptualize these two conditions as belonging to different diagnostic categories; AS is considered a pervasive developmental disorder, whereas NLD is classified as a learning disability. This is due in part to the available research on these disorders. Examination of the diagnostic criteria can be helpful in understanding the overlap and distinguishing characteristics of each condition.

Diagnosis of Asperger's Syndrome

AS was first described by Hans Asperger, an Austrian psychologist, in 1944. Asperger's early descriptions of AS continue to correspond with current definitions of the disorder. According to Asperger, children with AS display a pattern of social,

communicative, and behavioral difficulties, including a lack of empathy, difficulty forming friendships, a tendency to engage in one-sided conversations, intense and limited interests, and poor motor coordination skills. To date, there is substantial overlap between the diagnostic descriptions of AS in both the DSM-IV TR and ICD-10.

Within the DSM-IV TR, AS is subsumed under the category of pervasive developmental disorders (PDD), which also includes autistic disorder (more commonly known as Autism), Rett's syndrome, child disintegrative disorder, and pervasive developmental disorder, not otherwise specified (PDD-NOS). Broadly, the criteria for a diagnosis of AS identified by the DSM-IV TR and ICD-10 include impairments in social interaction (often including social communication impairments) as well as the presence of restricted, repetitive, or stereotyped interests, activities, or behaviors. AS is distinguished from Autism in the area of language development. Specifically, individuals with AS do not present with a delay in or absence of language development before the age of 3, which is a requirement for the diagnosis of Autism. There is ongoing research to increase knowledge about important similarities and differences between AS, autistic disorder, and PDD-NOS. For example, it is often difficult to differentiate persons with AS from individuals with Autism who demonstrate average to high average intellectual abilities. As such, there is significant debate among researchers and practitioners as to whether HFA and AS are distinct psychological disorders or manifestations of the same disorder across a spectrum of severity.

As part of the established research literature and the process of updating diagnostic classification systems, proposed revisions for new DSM-V (to be released in 2013) suggest removing the diagnosis of AS and subsuming three of the pervasive developmental disorders (i.e., autistic disorder, Asperger's disorder, and pervasive developmental disorder-not otherwise specified) under the broader category of autism spectrum disorder. Under these revisions, the level of severity of an autism spectrum disorder would be indicated based on the extent of social deficits, the presence of a language delay, and the level of intellectual functioning. Despite issues related to the diagnosis of AS and whether or not it will be recognized as a separate disorder in the future release of DSM-V, inclusion of AS in the DSM-IV TR and ICD-10 has led to exponential growth in research and knowledge related to the disorder and enhanced our understanding of autism spectrum disorders

more generally. Interestingly, this is one reason why awareness and research on NLD may be more limited at the present time.

Diagnosis of NLD

In contrast with AS, NLD are not represented in the DSM-IV or ICD-10, which can lead to confusion regarding how NLD is defined in research and clinical or school settings. Learning disability is a broad diagnostic category in the DSM-IV TR and only encompasses disorders that describe learning difficulties in the areas of reading, math, and writing (not NLD). The term NLD was first used by Helmer Myklebust in 1975 and is often described as a subtype of learning disabilities within the field of neuropsychology. NLD is used to refer to a profile of neuropsychological strengths and weaknesses, and these neuropsychological impairments are similar to AS in that they are associated with poor understanding of social situations. In the mid-1990s, Dr. Byron Rourke developed a model that includes the primary strengths and deficits associated with NLD. The major strengths that many individuals with NLD possess include strong auditory perception skills, verbal skills, and memory skills related to verbal information. The three primary deficits of NLD include tactile perception, motor coordination, and visual perception. According to Rourke's model, these deficits lead to marked impairments in social perception and awareness (similar to those seen in AS, but often to a lesser degree of severity). For example, due to difficulties in organizing and interpreting visual information, individuals with NLD are often unable to interpret nonverbal cues in their environment, and thus may have difficulty interpreting social gestures and facial expressions. Children with NLD are often incorrectly diagnosed with attention deficit hyperactivity disorder due to their difficulty focusing on tasks and hyperactivity; however, as individuals with NLD age, they often become much less physically active (hypoactive).

Common Characteristics of AS and NLD

NLD and AS are described as neurological disorders, meaning that specific brain processes are impaired or dysfunctional and that these processes in turn affect one's behavior and how one interacts with the world. Even though there are characteristics that distinguish AS from NLD, these conditions do share a significant number of common features, which impact academic performance, executive function, tactile and visual perception, motor function, as well as social skills.

Academic Performance

Because individuals with AS and NLD present with relatively strong verbal skills, they may appear to be more competent in academics even though there is not commensurate performance in the classroom. High expectations can be placed on both groups; however, due to some of the characteristics of these disorders, academic problems can arise. For example, due to difficulty with fine motor skills, handwriting is problematic in AS and NLD. Additionally, sometimes math is identified as a weakness since mathematical concepts are more abstract,

nonverbal, and spatial in nature. At a younger age, children with NLD or AS may be able to memorize formulas and complete simple calculations; however, their performance deteriorates when reasoning skills and word problems are introduced.

Individuals with AS and NLD also demonstrate several academic strengths. For one, strengths in recalling factual information are common due to well-developed rote memory skills. Additionally, word recognition and basic reading skills (i.e., decoding words, phonemic awareness) are well developed. Individuals with NLD and some with AS are also known to have strong spelling, short-term memory, and auditory-perceptual skills. However, comprehension of abstract and inferentially based information is usually impaired in both groups (i.e., reading comprehension, word problems, idioms, analogies, and metaphors). As more abstract understanding is required of students, and the value of memorizing factual information decreases, the academic success of individuals often declines.

Executive Functioning

Many skills associated with executive functioning (i.e., the ability to plan, organize, shift attention, and set goals) are found to be impaired in AS and NLD, and may result in academic difficulties. Difficulty in organizing information can make planning, carrying out work, and breaking down tasks into components challenging. Executive functioning deficits also make cause and effect relationships difficult to understand. Furthermore, poor problem solving is common in NLD and AS; tasks are approached with inflexibility, inhibiting the ability to generate alternative options. Additionally, individuals with AS and NLD have problems generalizing newly learned techniques and behaviors to different tasks and settings.

Some have suggested that individuals with AS have difficulty discerning relevant from irrelevant stimuli. This is known as the weak central coherence theory. Central coherence can be thought as the ability to process different levels of information together to generate overall meaning and understanding in an immediate context. Thus, this theory suggests, individuals with AS tend to attend to detail rather than the 'big picture.' Despite the ability of individuals with NLD to also recall specific details of verbal information rather than drawing inferences (e.g., seeing the forest through the trees), more research related to weak central coherence is needed to better understand this phenomenon in NLD.

Tactile and Visual Perception

Individuals with NLD are known to have deficits in tactile and visual perception, discrimination, and attention. Visual-spatial organization impairments are a hallmark of this disorder. Although individuals with NLD may be able to perform simple tasks requiring these skills (i.e., matching items of a similar shape), they may have more difficulty as tasks become more complex (i.e., finding a figure embedded in a picture or putting blocks in a form board while blindfolded). Due to tactile and visual perception deficits, individuals with NLD are less likely to physically explore their environment. Additional neuropsychological characteristics of NLD include problems with time perception; individuals with NLD often have difficulty placing themselves in space and orientation. Tactile

and sensory disturbances are also well noted in AS. Individuals with AS are known to be hypo- or hypersensitive to visual, auditory, gustatory, olfactory, and tactile stimuli. Thus, they often experience sensory information at a higher or lower degree than typically developing individuals. For example, difficulty in modulating sensory information can lead to individuals with AS avoiding situations where the stimuli may be encountered (e.g., avoiding crowded rooms in an attempt to escape loud noises). Although hypersensitive individuals may attempt to avoid certain types of sensory information, hypo-sensitive individuals with AS may engage in repetitive behavior (e.g., humming, hand flapping), in order to experience sensory stimulation.

Motor Functioning

Motor problems are characteristic of both AS and NLD. Deficits in fine motor (small muscle movements) and gross motor (large muscle movements) skills can cause individuals with AS and NLD to appear 'clumsy' and 'awkward.' Additionally, problems with coordination and balance are known to occur. Simple motor tasks can be performed; however, more complex tasks are challenging. As noted earlier, motor problems can make handwriting difficult. Complex motor tasks are also difficult for individuals with AS and NLD, such as playing sports. Visual-motor coordination or synthesizing visual information with motor output is known to be impaired in NLD and some individuals with AS. This deficit in crossmodal integration (synthesizing the information from different senses) can make tasks such as completing a puzzle challenging.

Social Skills

Individuals with AS and NLD often demonstrate poor social competence due to their inability to perceive and interpret the social interactions, social communication, and behavior of others. Individuals with AS and NLD may appear 'socially awkward,' 'socially inappropriate,' or 'odd' to those around them due to the combination of deficient social skills, impaired social perception, and poor social communication skills. As a result, many individuals with NLD and AS experience difficulty in forming close friendships or relationships, even when having these relationships are important to them.

Conversations can be characterized by a lack of social reciprocity, commonly known as the back and forth of social interactions. Attempts by another person to respond or change topics may be unsuccessful due to problems with turn taking (i.e., people are often interrupted). When conversations are one sided, the individual with AS or NLD often dominates the dialog in a pedantic manner (which can appear as if he/she is showing off). Thus, it can appear that they are 'talking at you' rather than 'talking to you.' Likewise, language can be overly formal and full of jargon. In addition, language impairments are observed both in AS and in NLD that interfere with social interactions. Notably, problems with semantics (the knowledge and use of different words) and pragmatics (the social use of language) are present. This can lead to difficulties interpreting the subtleties of communication, such as humor, sarcasm, and metaphors. Additionally, individuals with AS and NLD demonstrate impairments with prosody,

the patterns of stress and intonation, which cause them to sound monotonous or make it difficult for others to understand their emotional state based on the tone of their voice. In AS, speech may be at a rapid rate or higher volume. Since it is difficult for individuals to use language in a social context, often learned and rote, or memorized, responses are provided even when individuals realize that their repertoire of responses are not appropriate in a number of social situations. Children with AS and NLD may be more successful interacting with adults or even younger peers, as these social situations are generally more structured, predictable, and forgiving.

Individuals with AS and NLD also have difficulty with the nonverbal aspects of the social environment (e.g., reading facial expressions, body language, and gestures). In NLD and AS, these problems can be attributed to the visual-perceptual deficits that are characteristic of the disorder. Another explanation of these deficits is an impairment in theory of mind (the ability to recognize and understand the thoughts, desires, beliefs, and intentions of others); however, the research is mixed and this remains to be clarified. An inability to read the intentions of others might lead individuals with AS and NLD to inappropriately plan their own behaviors in social situations. For both populations, problems with social judgment, inferring intentions of others, and reading nonverbal communication lead to an increased vulnerability to peer rejection and bullying. Although social skills may improve over time from childhood, they often continue to remain problematic into adulthood.

Difficulty in navigating the social world and repeated unsuccessful attempts to form peer relationships can cause low feelings of self-worth and self-esteem in individuals with AS and NLD. Among the most common comorbid (i.e., co-occurring) psychiatric conditions for individuals with AS and NLD are internalizing problems (e.g., depression and anxiety). In AS, increased self-awareness of differences between themselves and their peers contributes to the development and maintenance of internalizing problems.

Individuals with AS and NLD have difficulty adjusting to novel situations and environments. In NLD, these issues may arise due to deficits in nonverbal problem solving, flexibility, and the ability to learn from environmental feedback. They may approach novel situations with a reliance on rote behaviors, which in many cases may be inappropriate. Conversely, problems recognizing familiar situations can lead to approaching the same situation with different responses. Some researchers hypothesize that behavior problems emerge as a result of perceiving the world as unpredictable or 'fast-paced.' Thus, due to deficits in social perception, individuals may feel constantly bombarded by unpredictable and confusing information. Additionally, a lack of emotional regulation, the ability to maintain and control emotional states, can contribute to behavior problems. Since individuals commonly have preference for routine, they often exhibit problem behaviors when these routines are altered or broken. Moreover, impairments in identifying and interpreting emotions can lead to frequent distressing events. For example, 'tantrums,' 'meltdowns,' and withdrawal from situations can often occur when children become upset.

Other behavior characteristics of AS and NLD include difficulty with adaptive skills, which are skills required to live, work, and play in the community. Examples of adaptive skills

that may be deficient in AS and NLD include dressing, diet, hygiene, household chores, managing money, and shopping. Deficits in adaptive skills may continue into adulthood if not taught properly in childhood and adolescence. Furthermore, in NLD, individuals may show hyperactivity in childhood; however, this behavior decreases with age.

Distinguishing Characteristics of AS and NLD

The characteristics that distinguish AS from NLD are debated by researchers and practitioners due to different theoretical orientations, limited research, and conceptualizations or definitions of the disorders. Given the relatively recent research on both disorders, there is not yet a definitive answer. However, some differences that have yielded more support include cognitive profile of nonverbal compared to verbal intelligence, severity of social impairment, and circumscribed interests.

One of the most significant features of NLD is the disparity between verbal intelligence (language-based abilities) and nonverbal intelligence (visual-spatial abilities), with verbal intelligence being relatively stronger. This is not surprising given the visual-spatial deficits characteristic of NLD. Even though there is conflicting evidence and opinions, it appears that not all individuals with AS present with a similar cognitive profile (a higher verbal intelligence score relative to nonverbal intelligence); however, when individuals with AS demonstrate a similar cognitive profile as NLD, the individual is sometimes given a diagnosis of NLD in addition to AS.

Social impairment is a defining characteristic of both AS and NLD. In general, individuals with AS and NLD have deficits in social behaviors and interactions, as well as poor social communication skills. What distinguishes the two disorders is level of severity: individuals with NLD show similar social difficulties as AS, but to a much lesser degree. A social communication difficulty often observed in AS occurs when circumscribed interests are discussed to a long and inappropriate extent (and at times in a pedantic manner). A circumscribed interest is a topic that is of intense focus. Often, a large amount of information on this topic has been acquired by the individual with AS, regardless of age, meaning that young children in addition to adults with AS exhibit circumscribed interests that might interfere with social interactions. These interests can range considerably from a well-known topic such as a popular television show to a more obscure topic such as locations corresponding to zip codes around the world. The research is mixed on whether circumscribed interests are characteristic of NLD.

Etiology

At present, the exact cause or etiology of AS and NLD is unknown. There is ongoing research examining the role of genetics in both, but no consistent findings have yet emerged. There has been and continues to be extensive efforts to determine the neurological characteristics of AS and NLD. Disturbances in the development of, or damage to, white matter in the right hemisphere of the brain have been found to be the main neurologic characteristic that may be responsible for the

manifestation of NLD. The right hemisphere of the brain houses the ability to process information simultaneously and the ability to synthesize novel information and has important neural connections to different areas of the brain. It has been suggested that the perceptual and motor deficits characteristic of NLD are more marked on the left side of the body because of this right hemispheric dysfunction (information to and from the brain travel contralaterally to the other side of the body). It has been reported that some conditions that have deleterious effects on the brain's white matter have led to NLD symptoms (e.g., callosal agenesis, hydrocephalus, multiple sclerosis, seizures, head injuries, tumors, etc.). Conversely, there is not yet a clear understanding of the brain structure in AS despite the efforts of researchers. Abnormalities in the prefrontal cortex, temporal, striatal, and cerebellar regions of the brain and gray matter have all been identified by researchers as related to a potential cause of AS; however, there is not yet a consensus due to a lack of consistent findings. Thus, disruption to several areas of the brain, rather than a focal lesion, is thought to contribute to the development of AS. Even with the use of advanced brain imaging technology, many studies have resulted in inconsistent results, and different areas of the brain have been implicated. Nevertheless, strong evidence exists to suggest AS is at least partially genetically determined and caused by disruption to brain regions important for social and emotional functioning.

Prevalence

Prevalence is a term used to refer to the proportion of the population diagnosed with a certain disease at a specific time. Prevalence estimates can vary dramatically across studies due to differences in how the studies were conducted or the year in which they were conducted. This is especially true for AS since the prevalence of AS appears to be rising over the years. The prevalence of AS has ranged from 0.3 per 10 000 children to 8.4 per 10 000 children. AS is now reported as occurring in 20 per 10 000 children. This is equal to 1 in 500 children in the United States. As NLD is not an official diagnostic category within the DSM-IV or ICD-10, the prevalence of NLD has been difficult to estimate. Approximately 3% of the total United States' population is diagnosed with a learning disability, and of those diagnosed with a learning disability, ~5–10% are diagnosed with NLD. Some estimates suggest that about 2.7 million people have NLD in the United States (or 1% of the population). With regard to differences in prevalence between genders, AS is much more common in males than females: For every nine males diagnosed with AS, one female is diagnosed with the disorder. Currently, it is suggested that NLD occurs in males and females at similar rates (i.e., no gender differences are reported).

Treatment Considerations

Although NLD is not currently part of the DSM-IV or ICD-10, practitioners do diagnose NLD and individuals with NLD are often eligible to receive special education services as are individuals with AS. Currently, there is no biological or pharmacological intervention that improves either disorder in its

entirety. Rather, medication is sometimes prescribed to manage specific symptoms (e.g., hyperactivity, concentration difficulties, anxiety, etc.) experienced by individuals with AS or NLD. Although there is no cure available for AS or NLD, there are several interventions that can help individuals with AS or NLD learn new skills, overcome challenges of their disorder, and adapt to different environments in order to successfully engage in these environments using educational, behavioral, or cognitive-behavioral approaches. Given that the consequences of having AS or NLD surround academic and social functioning, the focus of treatment within the school setting might include addressing poor organizational skills, information processing deficits, difficulty in integrating and adjusting to new information or routines, stress/anxiety in social situations, poor social competence, deficits in comprehension and abstract reasoning, attention and/or concentration difficulties, and time management.

See also: Nonverbal Communication; Reading and Phonological Processing; Word Retrieval.

Further Reading

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Relevant Websites

- <http://www.nld-bprourke.ca/> – Byron Rourke, PhD, on NLD.
- http://www.ninds.nih.gov/disorders/asperger/detail_asperger.htm – Information page for Asperger's Disorder on the website of the National Institute of Neurological Disorders.
- <http://www.nlda.org> – Nonverbal Learning Disorders Association.
- <http://childstudycenter.yale.edu/index.aspx> – Yale University Child Study Center.

Associative Learning

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Glossary

Autoshaping The tendency for an organism to make contact with a stimulus (CS) that reliably predicts food (US), as when a pigeon begins to peck a lighted key that appears shortly before food is presented.

Classical conditioning The process by which a conditioned response – for example, salivation – comes to be elicited by a previously neutral conditioned stimulus (CS) – for example, a tone – through the association of the CS with an unconditioned stimulus – for example, food.

Conditioned suppression When a previously neutral stimulus (CS) is paired with an aversive stimulus (US), presentation of the CS will disrupt ongoing operant behavior.

Eliciting stimuli Events that invariably produce reflex actions (or respondent behavior). For example, a puff of air in the eye produces an eyeblink.

Extinction In classical conditioning, when the conditioned stimulus (CS) is presented several times without the

unconditioned stimulus, the conditioned response ceases to occur when the CS is presented.

Habituation A decline in the magnitude of an unconditioned response after it has been repeatedly elicited by an unconditioned stimulus.

Observing responses Responses that produce stimuli correlated with schedules of reinforcement, but that have no effect on the occurrence of reinforcement.

Rescorla–Wagner model A theory that clarifies the specific conditions under which a conditioned stimulus (CS) acquires control over a conditioned response through pairing of the CS with an unconditioned stimulus.

Respondent behavior Behavior that is automatically produced by a specific eliciting stimulus.

Spontaneous recovery In classical conditioning, the return of a conditioned response after a delay following an extinction period; in habituation, the resumption of responding to a habituated stimulus following a rest period.

Basic Concepts

Innate, automatic reactions that occur in all organisms are called reflex actions or respondent behavior, and the events that unvaryingly produce them are known as eliciting stimuli. The experimental procedure known as Pavlovian conditioning was developed from a study of reflexes carried out by the Russian physiologist, Ivan Pavlov (1849–1936). Pavlov had developed a technique to study digestion whereby he could measure the fluids secreted in a dog's mouth and stomach. His aim was to study the precise relationship between a stimulus (food) and a response (salivation). But as his research on digestion progressed, Pavlov encountered the unexpected: his dogs were salivating prematurely, before they even saw the food. In fact they would salivate as soon as Pavlov entered the room. Pavlov then began to study this phenomenon which he called 'conditioning.' Since Pavlov's time, the conditioning process has been intensively investigated and applied experimentally to behavior in addition to reflex actions. The subject of Pavlov's initial research, however, is viewed as a distinctive form of conditioning dealing mainly with reflexive behavior. Thus, it is sometimes called classical conditioning. It is a fundamental form of associative learning – that is, the learning of a relationship between stimuli. We turn first to the basic concepts of classical conditioning.

Paradigm

The central principle of conditioning is the modification of an organism's response by environmental events. Pavlov found that after pairing a formerly neutral stimulus with a positive

stimulus such as food, the organism would come to react to the previously neutral stimulus. Pavlov grasped the significance of this observation and redirected his research effort to its study. Perhaps a great deal of learned behavior might be based on modification of innate reflexes, much as the learned behavior of salivating to the sight of the experimenter developed from the initial food-salivation reflex. Thus, Pavlov developed procedures for studying classical conditioning that remain in use today. Pavlov's discovery also opened up a new way of studying behavior. Pavlov described his dogs' reflexes to experimental stimuli without speculating about the dog's thoughts and feelings. Thus he helped usher in the idea that some behavior may be described and understood in terms of observable and measurable reflexes, helping to lay the foundation for modern behaviorism.

Figure 1 depicts the sequence of events in the experiments conducted by Pavlov. A hungry dog was restrained in an apparatus designed to isolate the dog insofar as possible from distracting stimuli. A tube leading from the dog's mouth carried saliva directly from the salivary gland to a receptacle where it could be measured. When food powder, the eliciting stimulus or unconditioned stimulus (US) was placed in the animal's mouth, the dog salivated reflexively. Salivation was the unconditioned response (UR) to food in the mouth. Pavlov then struck a tuning fork one-half second before each presentation of the food. After several pairings of tone and food, he would occasionally sound the tuning fork without presenting food. On these food-omission trials, the tone alone was sufficient to elicit salivation to almost the same degree as when food was actually placed in the dog's mouth. Thus, the originally neutral stimulus, the tone, had become a conditioned stimulus (CS),

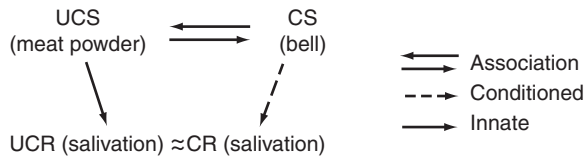


Figure 1 Pavlov's classical conditioning paradigm. See text for details. Reproduced from Fantino E and Logan CA (1979) *The Experimental Analysis of Behavior: A Biological Perspective*. San Francisco: W.H. Freeman.

capable of eliciting a conditioned response (CR), salivation, which it had not previously elicited.

It should be noted that research since Pavlov's era has shown that the CR is not identical to the UR: classical conditioning is not a simple process of substitution in which one stimulus (the CS) merely replaces another stimulus (the US). Even when the CR and UR appear to be the same (as in the salivation example), they differ in detectable ways (e.g., in terms of latency, duration, or magnitude of the response). In other situations, there is no obvious relationship between the CR and UR. For example, in one type of experiment, a rat is periodically subjected to the occurrence of a light for 5 s (the CS), followed by a moderately intense electric shock (the US) delivered to the rats' feet for 2 s. The rat's normal response (the UR) to electric shock is to jump and/or run around the cage. But after a few pairings of the light and shock the rat begins to develop a CR to the light that is the antithesis of running or jumping: it demonstrates rigid immobility ('freezing') at the onset of the light. Freezing (the CR) actually precludes simultaneous expression of the jumping or running (the UR).

Parameters of conditioning

A crucial variable in classical conditioning is the time interval between the CS and US. Conditioning works best when the CS precedes the US by a ½ s or more whether or not the CS remains on until US onset (delayed conditioning) or whether it turns off some time before US onset (trace conditioning). Conditioning works less well, or typically not at all, when the CS and US are contemporaneous (simultaneous conditioning) or when the US precedes the CS (backward conditioning). As with operant conditioning if the CS is presented several times without the US, *extinction* (EXT) occurs, that is the CR ceases to occur upon CS presentation. But as with operant conditioning, if sufficient time passes the CS will again elicit the CR (spontaneous recovery).

Relation of classical to operant conditioning

Whereas the principal relation in classical conditioning is that between the CS and US (a stimulus–stimulus association), the central relation in operant conditioning is that between the response and the reinforcer contingent upon the response (a response–stimulus association). The critical difference is in the *contingency*: in classical conditioning, the US occurs whether or not the CS elicits the CR; in operant conditioning, the reinforcing stimulus occurs if and only if the response has been emitted. That is, the reinforcer is contingent upon the response in operant conditioning but the US is not contingent upon the CR in classical conditioning.

Theory of associative learning

Elegant theories of the processes underlying classical conditioning have been proposed. The most influential is that of Robert Rescorla and Alan Wagner, developed while both were at Yale University. Their theory clarifies the specific conditions under which associative strength accrues to a stimulus when CS–US pairings have occurred. Specifically, under what conditions does contiguity of CS and US result in formation of an association? The model rests on the assumption that the effect of a reinforcer (US) depends not only on that reinforcer itself but also upon the relationship between that reinforcement and the reinforcement *anticipated* by the organism. In other words, the organism's existing expectations form a context that modulates the effectiveness of the US. The following are the essential assumptions of the Rescorla–Wagner model:

1. Any given US can support only a given amount of conditioning. After this point further US presentations will produce no additional behavior change. This parameter, the asymptote of learning, differs for each distinct US, effectively placing a ceiling on the magnitude of changes in associative strength.
2. The rate of learning supported by different USs also differs with qualitative changes in the US.
3. When conditional stimuli (CSs) occur in compound, the total associative strength of the compound is equal to the sum of the associative strengths of each element of the compound.
4. Changes in associative strength occurring with additional experience are determined by the difference between the current strength of the compound and the asymptote of learning (first assumption above) defined by a particular US. Only a certain amount of change can occur. Thus, increments in associative strength with each successive CS–US pairing will become progressively smaller, since each additional change insures that less change is potentially possible. This final assumption most succinctly describes how the associative strength of a CS will be altered during the course of conditioning.

While this contemporary account of classical conditioning is in accord with Pavlov's assignment of an informational, or signaling, function to the CS, agreement on the means whereby that function develops has changed dramatically. Mere contiguity of CS and US should no longer be thought of as necessary or sufficient for conditioning. Instead, conditioning must be considered in a larger, correlational context: only when a CS and US are positively correlated will the CS acquire associative strength. Thus, a CS in close temporal contiguity with a US (say 2 s) may not acquire associative strength if the US is as likely or more likely to follow the absence of the CS within an equivalent (2 s) period. At the same time, a CS that is less contiguous with the US (say 5 s) may acquire associative strength if its occurrence increases the likelihood that the US will follow. This correlational view of conditioning, inspired by the research and theory of Rescorla and Wagner, has a parallel development in operant conditioning, particularly in the area of conditioned reinforcement. We will see further evidence for this contextual and correlational view of associative strength throughout this article.

Habituation

Many behaviors are modified simply as a result of repeated exposure to a stimulus. When these repeated stimulations result in a decrease in responsiveness, habituation has occurred. Habituation is an important behavioral adjustment. An interesting example of habituation occurs in relation to an organism's ability to pay attention to new or unexpected stimuli in its environment. Known as the orienting reaction, this behavior is significant in that it helps the organism detect and prepare for new and potentially dangerous events. It would be inefficient, however, if the organism made an orienting reaction to every occurrence of a previously novel stimulus. Instead, habituation tends to occur; repetition of the once-novel stimulus without any consequence results in a decline (even disappearance) of the organism's responsiveness to that stimulus. It is a form of learning in that the organism has, with repeated exposure to the stimulus, learned not to respond to it. The decline in response is temporary, however; after an interval during which the habituating stimulus does not occur (from several minutes to several days, depending on the particular situation), the response to the stimulus returns. Habituation is an adaptive phenomenon that occurs among a wide range of organisms from those as relatively simple as primitive worms to more complex organisms such as primates. Habituation can occur in organisms without central nervous systems, for example sea anemones. Sea anemones close and retract their tentacles when water strikes them from above, a protective response that prevents intense stimuli from harming the anemone. But sea anemones also employ their tentacles to gather food in the form of organisms residing in the ocean. Were anemones living in tide pools to contract each time that they were struck by a wave or each time a strong current of water passed over them, they would lose the food gathering advantage of having their tentacles ready to capture organisms that might be passing overhead. Thus, it is adaptive for the sea anemone to cease responding (habituate) to repeated presentations of water striking them from above. That they in fact do so has been demonstrated in the laboratory; after a number of repeated stimulations from a stream of water presented from above, the sea anemones stop contracting. The recovery from habituation, noted above, has also been demonstrated with these sea anemones: when water is not presented for 24 h, the next water stimulation produces a response almost as intense as that elicited initially.

In addition to reinstating the original strength of a habituated response by allowing time to pass, an alternative technique is that of dishabituation, in which a novel stimulus is presented. For example, if the habituated sea anemone is stimulated with a glass rod instead of a water stream, there is an immediate loss of habituation to the water stream: the next several presentations of the water stream stimulation produce contraction. This renewed responsiveness is short-lived, however; after a few water streams, the anemone again habituates.

Habituation occurs more rapidly on a second series of stimulus presentations than on the first such series and occurs still more rapidly on a third. This progressively more rapid habituation suggests that habituation may not only represent the simplest form of learning but also a primitive form of memory.

Habituation is a form of simple nonassociative learning: the organism learns that the repeatedly presented stimulus has no significant consequence. This is distinct from associative learning phenomena in which the association between stimuli (classical conditioning) or response and reinforcement (operant conditioning) is centrally important. Habituation can be considered as learning when not to respond. This can be vital to the organism. For example, some insectivorous birds spend 90% of each winter day eating insects (catching them at a rate of one every 2.5 s!) in order to sustain themselves. For these birds, too much time responding to unimportant stimuli may result in starvation. Research with human infants and adolescents suggests that the ability to habituate to unimportant, repetitive stimuli early in life may be a predictor of later mental ability and health.

Complex Phenomena

There are a plethora of phenomena based on associative learning that have important implications for understanding the behavior of organisms. In this section, we discuss research involving biological constraints, taste-aversion learning, and conclude with autoshaping. At this point, we will be ready to address the important theoretical question: What are the necessary and sufficient conditions for the occurrence of associative learning? We will do this by drawing on critical research in the areas of autoshaping, conditioned suppression, and on the determinants of observing and information seeking.

Biological Constraints

For decades, an implicit assumption of researchers in conditioning was that a principle of equipotentiality held, at least to an approximation. According to this principle, learning represents a general process in which the elements of the learning situation, for example, the CS, the US, and the CR (or, in operant conditioning, the stimulus, response, and reinforcer or punisher) can be arbitrarily chosen for conditioning. The specific quality of the elements was deemed unimportant. According to this view, these elements are arbitrary and completely interchangeable. They do not bear an innate fixed connection to one another. Thus, two potent aversive stimuli such as nausea-producing irradiation and electric shock should be equally effective in supporting associative strength regardless of the stimulus with which they are associated (e.g., a gustatory or auditory stimulus). We shall see in the next section (on taste-aversion learning) the inadequacy of this prediction. We will illustrate the limitations of the equipotentiality principle here with an example from the extensive literature on avoidance learning. Then we will summarize the contemporary view of the biological constraints position.

Avoidance learning

Avoidance is a type of negative reinforcement in which behavior is strengthened because it avoids an aversive event such as electric shock. In a typical avoidance acquisition procedure, a CS (say a light) is followed a few seconds later by a US (say an electric shock). After a few CS-US pairings, the previously neutral CS acquires associative strength and the onset of the CS becomes

aversive. In avoidance learning, the organism (most commonly a rat) is given the opportunity to make a response that will simultaneously turn off the CS and avoid the US. Hence this response is termed 'the avoidance response.' When the response is not made, the US occurs and the same response can terminate (escape) the US. Now according to the equipotentiality principle, the nature of the response should not matter. But it turns out that the selection of the response has a profound effect on the ability of the organism to acquire the avoidance response and therefore avoid the shocks. If the response involves jumping up to a platform, a rat will acquire the response in a handful of trials (sometimes as few as one or two). If the response involves running to another part of the apparatus, the rat's acquisition is also fairly rapid. But if the response is a simple lever press, the rat may not acquire the response for several hundred trials, enduring painful shocks along the way. Thus, with respect to the acquisition of the avoidance response, the critical relation is between the required response and the reinforcer. How might we best understand why this is so? One answer is that provided by those who stress that there are biological constraints on the acquisition process.

Consider the rat's normal response to an aversive, say painful, stimulus. Likely responses include freezing, running away, and jumping. These are known as species-specific defense reactions (SSDR). Thus running and jumping, being natural responses to electric shock, are readily associated with avoidance and are acquired swiftly. A more measured response such as a chain pull is not a natural response to shock and is therefore acquired more slowly. But by selecting a lever-press response, researchers were unwittingly selecting a response that was almost designed to fail. First of all, lever pressing is not a natural response to shock. Second, the fact that the rat can escape the shock once it begins, lever pressing keeps the rat in the vicinity of the lever (actually crouching over it) when the CS turns on. Freezing, a natural response to shock, predominates and freezing is incompatible with lever pressing. In fact, rats show good acquisition of the lever-press response when they are required to make the ostensibly more complex response of running to another part of the chamber to press the lever. Running, a natural response to shock, disrupts freezing. At the end of the run, the rat presses the lever, avoiding shock.

Interestingly, the same lever-press response that is resistant to acquisition when the reinforcer is avoidance of shock is acquired rapidly when it produces food, another example of how the nature of the response–reinforcer association is critical in determining the extent and speed of acquisition of associative strength.

Challenge and limitations of the biological constraints position

The focus on biological constraints on associative learning has leveled two classes of criticism against traditional theories of reinforcement and of associative learning. The first criticism is that laboratory research on learning is artificial. Thus, the principles of the acquisition and maintenance of behavior that results from such research lacks generality for any natural settings. Technically principles derived from such studies are said to lack external validity. The second challenge is the claim that traditional theories incorrectly assume that any emitted

response and any contingent reinforcer may be associated with equal effectiveness (technically, the principle of equipotentiality, introduced above).

The first challenge does not negate the value of laboratory research on the principles of associative strength and behavior change. The natural environment imposes temporal constraints on accessibility to vital resources. The study of schedules of reinforcement under rigorously defined laboratory conditions may help determine how natural restrictions result in changes in associative strength and in behavior change. The focus on biological constraints is important in that it correctly suggests that different patterns of responding may emerge depending upon the nature of the species being studied and on the particular selection of stimuli, responses, and reinforcers. But if we are to comprehend how the effects of response and temporal partitioning are altered by biological constraints on learning, we must also understand how they operate when constraints are absent. Because the biological factors are demonstrably potent, an arbitrary laboratory situation in which the effects of these factors are minimized becomes a definitive way to analyze the effects of temporal factors in isolation. The emerging principles must, at some point, be integrated with the constraints presumed to operate in the wild. To summarize, laboratory studies have value for both because they reveal fundamental ways by which behavior change is effected by limiting access to vital resources and because these effects can be assessed most clearly under conditions in which the intrusion of biological constraints are minimized.

The second challenge argues against the equipotentiality position. This challenge is well taken in the sense that most experimenters in the area appeared to harbor the belief that the particular selection of stimulus, response, reinforcing event, and species was relatively unimportant. However this assumption was never made explicit by any of the great learning theorists: in fact Edward Thorndike, B. F. Skinner, and others explicitly stated that the principle was invalid. Indeed, well before the issue of biological constraints on learning became popular, Skinner acknowledged that a thorough appreciation of the determinants of behavior change could not be accomplished simply from the study of representative stimuli, responses, and reinforcers. Recognition of this fact led Skinner to select stimuli, responses, and reinforcers that would likely minimize intrusion by complicating biological factors. He hoped that the resultant behavior would be orderly and that its form would also describe the behavior maintained by other stimuli, responses, reinforcing events, and species. As Barry Schwartz has argued, the central problem centers around appreciating which features of a phenomenon are attributable to general associative principles and which are attributable to situation-specific variables.

We conclude by noting that both the complexity and diversity of behavior require that both phylogenetic and ontogenetic principles are part of any complete explanation of behavior. Whereas phylogenetic factors may predominate where insect behavior is concerned, ontogenetic (learned) factors may assume a more central role in the explanation of the more generally flexible behavior of humans. The real challenge is to achieve the correct mix of phylogenetic and ontogenetic factors that best accounts for the behavior of individual members of a particular species in a given circumstance.

Taste-Aversion Learning

When discussing avoidance learning we showed that the ease or difficulty of associative learning in avoidance depends critically on the interaction between the selected response and the reinforcer. Research on taste-aversion learning instead emphasizes stimulus–reinforcer or stimulus–punisher interactions.

The bulk of the pioneering research on this topic, conducted by John Garcia and his colleagues, was concerned with an analysis of the conditions under which rats would learn to avoid ingestible foods. In one classic experiment, Garcia and Sam Revusky studied the differential suppression of drinking as a function of the type of CS and US used. Four groups of rats were served. For two groups, the CS was ‘bright-noisy (bubbly) water’: when the rats drank from the water tube gurgling sounds and flashing lights were presented. For the other two groups, the water was flavored with sweet-tasting but nonnutritive saccharin. For one group of the bright-noisy rats and one group of saccharin rats drinking was followed immediately with electric shock. Rats in the other two groups received the sensation of nausea (produced by X-ray irradiation). The results are shown in [Figure 2](#): suppression of drinking occurred only for rats that had the taste–nausea association or the visual/auditory–shock association. Shocks following the saccharin-flavored water and nausea following the bright-noisy water were ineffective in suppressing drinking. Thus, the same punisher (whether it was toxicosis or electric shock) was either extremely effective or ineffective in suppressing drinking depending on the stimulus modality with which it was associated. This general finding has been replicated dozens of times with various species. Other studies have shown that rats are capable of associating novel exteroceptive stimuli with illness. Thus, it may not be necessary to interpret the taste-aversion findings in terms of natural predispositions to associate certain stimuli with sickness. From the ecological perspective, it also makes sense that the organism has a flexible response to novelty.

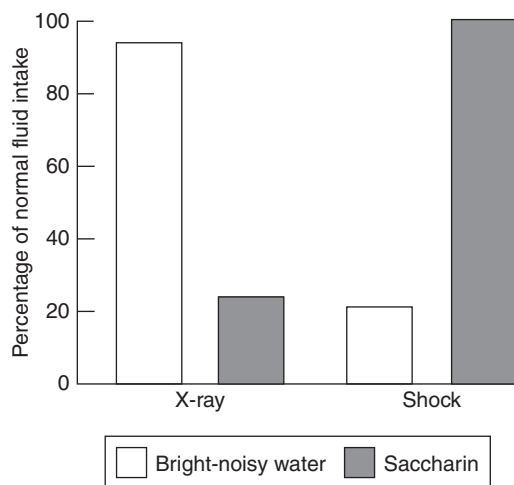


Figure 2 Differential suppression of drinking as a function of the type of cue and consequence used. See text for details. Reproduced from Revusky S and Garcia J (1970) Learned associations over long delays. In: Bower GH (ed.) *The Psychology of Learning and Motivation*, vol. 4, pp. 1–84. New York: Academic Press.

Autoshaping

A hungry pigeon is placed in a standard pigeon chamber for the first time. A circular key on the wall of this box is repeatedly illuminated once every minute for a period of 6 s. When the light turns off, the pigeon is presented with food. In this procedure, food is delivered independently of the pigeon’s behavior vis-a-vis the circular key. That is, the food appears even if the pigeon never approaches the key. Nonetheless, after very few light–food pairings, the pigeon is likely to begin pecking the key as soon as it is illuminated. This procedure is called autoshaping, since the pigeon’s key pecking is acquired without the conventional shaping by differential reinforcement and successive approximations commonly used in animal training. All that appears necessary is the simple association between the light and the food.

The mechanism for autoshaping is well understood. Once the pigeon pecks the lit key, it produces immediate reinforcement of the key pecking. As for the first peck, that too is unsurprising: the lit key is a highly salient stimulus and the pecking response is a high probability one for the pigeon. Moreover, after repeated pairings with food, stimuli become likely to promote food-related behaviors such as pecking, a phenomenon that is the basis for instinctive drift, in which natural, prepotent responses appear spontaneously in a food-related behavioral sequence. For example, in 1937, the legendary American behaviorist B. F. Skinner found that a hungry rat that had been trained to pick up a marble and deposit it down a chute in order to obtain food began holding on to the marble instead. More darkly, a porpoise at Marineland in Florida died playing a game of ‘catch,’ when it swallowed a baseball that had been associated with food. In the case of autoshaping, however, the key peck is actually reinforced and is neither puzzling nor maladaptive.

But a more intriguing finding illustrates the robustness of autoshaping, the power of the association between the stimulus and food and a case where the key pecking is highly maladaptive. David Williams, Alan Silberberg, and their colleagues largely reported these findings at the University of Pennsylvania. The phenomenon has been called automaintenance, negative automaintenance, and food avoidance by different investigators. This procedure differs from basic autoshaping in that pecks at the lighted key actually prevent the next scheduled presentation of food. In other words, when the key light is pecked instead of producing immediate food (autoshaping), the light turns off but no food is presented. The only way to obtain food is by not pecking at the lit key. This proves extremely difficult for most pigeons and rats. Some pigeons acquire the pecking response to such a degree that they rarely obtain food (hence food avoidance). What is the mechanism for this highly maladaptive behavior? Automaintenance appears to depend in part on basic associative learning (fueled by light–food pairings) and instinctive drift, both processes promoting pecking to the light, as well as to conditioned reinforcement associated with the offset of the key light. As in autoshaping, pecking the key does have an effect: it turns off the key light (although unlike autoshaping, food is not presented). On trials when the organism does not peck for 6 s, the key light is turned off and food is simultaneously provided. Thus, the food is always preceded by the termination of the light. Steven Hursh and his colleagues at the University of

California, San Diego showed that light termination developed into a conditioned reinforcer after repeated pairings of light termination and food. Together these sources of strength (classical conditioning, instinctive drift, and conditioned reinforcement) appear to account for the puzzle of automaintenance.

Necessary and Sufficient Conditions for Learning

An important study by Elkan Gamzu and Barry Schwartz at the University of Pennsylvania addresses the necessary and sufficient conditions for the generation of autoshaped responses. This study also makes a central point about the necessary and sufficient conditions for the occurrence of conditioning (in this case autoshaping). In one condition of their study, pigeons were exposed to two alternating schedules of reinforcement, each associated with a different stimulus (technically, a multiple schedule). On one schedule, food was never provided. On the other alternating schedule, food occurred on the average every 33 s and occurred whether or not the pigeon had responded. In other words, these food presentations were response-independent. This schedule is technically a variable-time 33-s schedule (VT 33 s). From our discussion of autoshaping, we would expect that the pigeon might begin responding to the stimulus associated with the VT 33-s schedule even though such responding was superfluous and that no responding would occur in the presence of the EXT stimulus. This is indeed what was found. In another condition, however, the EXT component was replaced with another VT 33-s schedule. Thus, in this condition, two VT 33-s schedules alternated, identical except for the different key colors illuminated during their operation. Would autoshaped responding occur to these two stimuli? The answer was 'no,' suggesting that a differential correlation with reinforcement is necessary for the generation of autoshaped responding. Rephrasing in simple terms, when both stimuli were equally good, neither elicited autoshaping. Recall that in the basic autoshaping procedure, the stimulus follows a period of darkness in which no reinforcement is provided; thus the light onset is correlated with reinforcement and elicits autoshaped responding.

Finally, consider a condition in which the VT 33-s schedule alternated with a VT 100-s schedule (in which food is provided, on the average, once every 100 s). We can guess (correctly as it turns out) that the VT 33-s schedule generates autoshaped responding in this condition since it is differentially correlated with (a higher rate of) food presentations. The interesting question is whether or not the VT 100-s schedule generates autoshaped responding. From what we have suggested above, the VT 100-s schedule should behave more like EXT than a positive stimulus since it is *not* differentially correlated with a higher rate of food presentation. The results supported this view.

Based on these results, we may reach the tentative conclusion that in order to promote associative learning a stimulus must be differentially correlated (or be 'predictive of') reinforcement. The next two sets of studies confirm this conclusion in areas other than autoshaping.

Conditioned Suppression

Conditioned suppression is a quantitative measure of anxiety that has been used extensively in nonhuman laboratories, and,

in modified form, with humans as well. In this procedure, a hungry organism that is emitting a standard operant response such as a lever press, reinforced by food presentations on an intermittent basis, is presented at specific intervals with an originally neutral stimulus (such as a light or tone) and immediately afterward is administered electric shock independent of its behavior. The effect of pairing a neutral stimulus with shock and superimposing the two on a schedule of food reinforcement is to lower the rate of responding in the presence of the stimulus (the light or tone is a CS; the electric shock the US) when compared with the rate of responding in the absence of the stimulus (i.e., the rate when the stimulus is not present). This suppression of response is called conditioned suppression, or a conditioned emotional response. This paradigm has proven effective in the study of anxiety and conditioned suppression with many species of animals including rats, pigeons, monkeys, and humans in order to assess the conditions under which a stimulus paired with an aversive event will suppress or disrupt ongoing behavior.

An additional reason for introducing conditioned suppression is that it was utilized in another critical study evaluating the necessary and sufficient conditions for associative learning. Traditional accounts of conditioning had generally assumed that simple contiguity is the central factor in the reinforcement process. Today we are aware of the central role of the signaling or informative (or predictive) value of the CS. We have already encountered this when discussing research from the autoshaping domain. Mere temporal contiguity between the CS and US is not enough for conditioning to occur. An obvious example is the fact that simultaneous conditioning is ineffective, though in that case it might be argued that the salient US overshadows the simultaneously presented CS. As the autoshaping results suggest, contiguity is effective for conditioning only if a correlation exists between the CS and US. A correlation exists if the CS reliably predicts occurrence of the US, for example, when the occurrence of the US is contingent upon (depends on) the prior occurrence of the CS. Robert Rescorla used the conditioned suppression paradigm to demonstrate this. His rats, responding on an intermittent schedule for food, were also exposed to superimposed CS and US pairings. Unlike the usual conditioned suppression procedure, the US also occurred at times in the absence of a prior CS, and the US sometimes failed to occur following a CS. Thus, Rescorla could independently manipulate the probability of the US following a CS as well as the probability of the US in the absence of the CS. Across conditions, he could observe how the degree of conditioning was affected by manipulating the probability of the US in the absence of the CS while holding constant the probability of the US following the CS. No conditioning was found when the probability of the US was equal following the presence or absence of the CS, that is, when the US was equally likely to occur with or without the CS. The CS no longer predicted (was not correlated with) the US and no longer gained associative strength (here, no longer suppressed ongoing response for food). The conclusion: pairing without correlation is insufficient for conditioning.

Observing

Research on observing explores the question of what types of information reinforces (strengthens) behavior. The procedures

and results are presented at length when discussing conditioned reinforcement (operant conditioning). Thus, here we need only to summarize the rationale and the implications of the results for the issue of the necessary and sufficient conditions for associative learning. Observing responses are those which produce stimuli correlated with schedules of reinforcement, but that have no effect on the occurrence of reinforcement. For example, two equally probable schedules of reinforcement differing only in frequency of reinforcement – say, variable time (VT) and EXT – may alternate unpredictably. Effective observing responses would produce stimuli identifying the schedule in effect. Will organisms respond to produce these stimuli even though they have no influence on the course of reinforcement? Many studies with a wide array of species (including humans) have answered this question in the affirmative. What is the mechanism at play here since it is not an enhanced rate of primary reinforcement? Does a stimulus maintain observing responses because it is correlated with the occurrence of primary reinforcement (the conditioned-reinforcement hypothesis)? For example, according to the delay-reduction theory, a stimulus will be a conditioned reinforcer when its onset is correlated with a reduction in time to primary reinforcement. This prediction is also consistent with other major theories of conditioned reinforcement. Alternatively, does a stimulus reinforce observing responses because it predicts or informs about the availability of reinforcement (the information or uncertainty-reduction hypothesis)? The critical test for distinguishing between these views is whether or not an S-, or bad news, is reinforcing, since bad news is not a conditioned reinforcer but is highly informative. The overwhelming preponderance of evidence shows that bad news does not reinforce (maintain) an observing response. Only good news reinforces observing. Additional research has refined this position: a stimulus maintains observing (shows associative strength) only when it is differentially correlated with positive reinforcement (good news). Thus, an FI 5-min schedule will maintain observing when it alternates with EXT but will not maintain observing when it alternates with a richer schedule (say FI 1-min).

Summary

The results from all three of these areas of research (autoshaping, conditioned suppression, and observing) support the

following conclusion: a stimulus typically acquires associative strength if and only if it is differentially correlated with reinforcement. The role of *contextual variables* is central: depending on the context, the same stimulus–reinforcer relation (whether in classical or operant conditioning) may be sufficient to generate powerful conditioning (or associative strength) or none at all.

See also: [Associative Learning](#); [Operant Conditioning](#).

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Attention

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Glossary

Alerting A short-lasting increase in neural activation that is often hard to distinguish from attention. However, while alerting, just like attention, is typically characterized by a speeding-up of participants' behavioral responses, it often leads to more error-prone performance (thus contrasting with attention).

Attention Refers to those (neural) mechanisms giving rise to a temporary enhancement (or prioritization) of the processing of certain stimuli relative to others.

Attentional bottleneck The hypothetical point in information processing at which the selection of certain information, over other information, takes place. For many years, researchers have argued over whether the bottleneck (i.e., selection) takes place 'early' or 'late' in human information processing.

Divided attention The ability to process multiple streams of information, or to perform multiple tasks, at the same time. Typically, those conditions that make dividing one's attention easier will make it harder to focus one's attention, and vice versa.

Focused attention The ability to process a particular subset of the available incoming sensory information while simultaneously ignoring other distracting (or currently task-irrelevant) information.

Perceptual/attentional load According to the theory of perceptual load, our attentional resources are always fully engaged with the processing of any incoming sensory

information. Thus, when a person's primary task is not overly demanding, any spare attentional resources will be available for the processing of other stimuli.

Prior entry Refers to Titchener's (1907) claim that attended stimuli are perceived earlier than unattended stimuli.

Spatial cuing The name given to a popular behavioral paradigm introduced by Mike Posner in the 1970s to study spatial attention. In a typical study, a cue stimulus is presented from one or other side of central fixation, followed a short time later by a target stimulus on either the same or opposite side. Participants normally respond more rapidly and/or accurately to targets presented on the cued side. The claim is that this facilitation of performance reflects the beneficial effects of spatial attention on information processing.

Sustained attention Otherwise known as 'vigilance' – the ability to maintain one's attentional focus on a given task or source of information, often over prolonged periods of time. Vigilance tasks are often repetitive and/or boring, and perhaps for this reason are less popular than they once were.

Working memory The cognitive system thought to contain storage buffers and a central executive that actively maintains goal-relevant information in the service of complex cognition. The central executive, the least well-understood part of the working memory system, is typically conceptualized as controlling attention and the flow of information to/from the buffers.

Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought.

(William James, *The Principles of Psychology*, vol. 1, pp. 403–404)

Introduction

Research on the topic of selective attention really developed in the years after the end of the Second World War, when scientists began to attempt to understand why it was that fighter pilots sometimes missed perfectly audible signals that had been presented over their headsets. Perhaps unsurprisingly, such applied problems led to the development of the selective (or dichotic) listening task, in which psychologists attempted to simulate the kinds of multispeaker environments faced by the pilots. In a typical study, participants would be required to shadow the speech stream presented to one ear, and then they would be tested for their recall of the information presented to the other 'unattended' ear (or channel). The majority of research efforts in the intervening years have, however, tended to focus on

understanding the mechanism underlying selective attention in the visual modality. That said, the role of selective attention in the other senses as well, such as touch, is now being studied.

Everyone agrees that the human brain has only a limited capacity to process incoming sensory information, and hence selection must occur in order to prevent overload. The key question motivating much of the early research on attention was where exactly selection (or the bottleneck) occurred and just how much processing there was of the information that was not currently task relevant. Some researchers, such as Donald Broadbent, argued that the bottleneck in human information processing occurred early in the process, whereas others, such as Deutsch and Deutsch, argued that all incoming stimuli were processed to a fairly high (possibly semantic) level, just short of awareness. If one were to try and summarize this large body of research, one would have to say that different researchers using different experimental paradigms were able to provide evidence consistent with both early and late selection. Part of the problem in this area was that different researchers also used different measures of awareness (everything from verbal report through to galvanic skin responses and implicit behavioral measures). By the early 1990s, the field had stagnated. However,

two changes occurred that revitalized research in this area. First, the development of neuroimaging meant that for the very first time researchers were able to peer inside the heads of their experimental participants in order to see where exactly attentional selection was occurring in the human brain. Second, Lavie and Tsal put forward the perceptual load theory, which provided a means of explaining the apparently inconsistent pattern of selection sometimes occurring early and at other times appearing to occur much later in information processing.

The Theory of Perceptual Load

According to the theory of perceptual load, our attentional resources are always fully engaged with the processing of any incoming sensory information (i.e., we cannot store them up for use at a later point in time). Thus, under those conditions in which a person's primary task is not overly demanding, any spare attentional resources they have will be available for the processing of other stimuli (e.g., the irrelevant stream of speech presented in the 'unattended' ear in a dichotic listening study). Lavie has argued that under such 'low-load' conditions, late selection can be observed. However, under those conditions in which the load of a participant's primary task is increased (such as when the complexity, or rate of presentation, of the to-be-shadowed message increases, or when the number of stimuli presented simultaneously in a visual display goes up), a participant will need to devote more resources to processing it. Hence, there will be fewer resources left for the processing of any other incoming information. Lavie argues that under such 'high-load' conditions, attentional selection will, on the contrary, likely occur relatively early in information processing.

Perceptual load theory has provided a popular explanation for why attentional selection sometimes occurs early in information processing, whereas at other times (and/or in other studies) it occurs much later. As such, this intuitive theory appears to offer a means of resolving the long-standing (and, for many years, seemingly intractable) debate amongst researchers over early and late attentional selection. In the years since Lavie and Tsal first proposed their theory, a large and ever-growing number of studies have been published in support of the theory's main tenets. Empirical support has come from a number of sources, including both behavioral and neuroimaging research. What is more, relatively few results have been reported that cannot be accounted for by the theory. That said, one limitation of the theory is that no objective measure of 'load' has yet been provided.

Thus far, the majority of studies of perceptual load have tended to restrict themselves to investigating those conditions in which participants are presented with (and hence have to select between) the information presented in just one sensory modality. Most researchers have focused on conditions of unimodal visual selection, though studies demonstrating the applicability of the theory to those conditions requiring unimodal auditory selection have now started to appear in the literature. As yet, there has been relatively little research investigating the validity of perceptual load theory in accounting for participants' behavior under conditions requiring unimodal tactile selection. However, that said, there is no obvious reason to believe that selective attention should operate any differently within the

tactile modality than it does within either of the other spatial modalities (i.e., vision or audition).

Having demonstrated attentional selection under a variety of different unimodal conditions, the next question to be addressed by researchers was whether the attentional resources that lie at the heart of perceptual load theory are unitary, or whether there are instead separate resources for the processing of stimuli in each sensory modality (as originally suggested by Christopher Wickens' 'multiple resource theory,' back in the early 1980s). While the results of the early crossmodal perceptual load studies came to the conclusion that resources were indeed modality-specific, the story has, in recent years, become much less clear. While some researchers have demonstrated that varying the perceptual load in one sensory modality (e.g., vision) affects the level of processing of stimuli presented simultaneously in another sensory modality (e.g., audition), other researchers have failed to observe any such crossmodal effect.

Working Memory and Selective Attention

What has emerged very clearly though in recent years is the close link that exists between selective attention and working memory (WM). It appears that whenever a participant's WM is compromised, his or her ability to selectively attend to one source (or stream) of sensory information and to ignore another (task-irrelevant) source (or stream) of information will be impaired. In laboratory studies, WM is typically loaded by giving a participant a list of stimuli to remember (such as a random list of digits) while he or she simultaneously performs a selective attention task. Many studies have now demonstrated that loading WM effectively impairs a participant's ability to selectively attend to a particular source of information. Intriguingly, it would appear that individual differences in WM capacity can also help to explain the existence of striking differences in people's selective attention abilities. So, for example, it has been known for more than 50 years now that only around one-third of participants will report hearing their own name if it happens to be presented in the 'unattended' ear in a dichotic listening experiment. Counterintuitively, it turns out that those individuals who have a lower WM capacity are significantly more likely to hear their name. One suggestion here is that these individuals are simply more likely to forget which ear it is that they are supposed to be shadowing, and hence will be more likely to inappropriately shift their attention to the other ear (the one containing their name).

Neuroimaging studies have now started to highlight the neural underpinnings of this interaction between selective attention and WM. For example, in one recent study, loading participants' WM (by giving them a digit string to remember) resulted in the suppression of neural activity in the right temporoparietal junction, a brain region that constitutes a core structure in the ventrofrontoparietal attention network.

Inattentional Blindness, Change Blindness, and Change Detection

One intriguing visual analog of auditory shadowing experiments has come from a spate of studies over the last decade

or so that have revealed the existence of severe limitations in our awareness of multiple simultaneously presented visual stimuli. In what is perhaps the most famous example (of what has come to be known as *inattention blindness*), researchers found that participants would often fail to notice a person dressed up in a gorilla suit thumping his chest in the middle of a monitor, if their attention happened to be focused on a group of people dressed in white passing a basketball. It turns out that the more demanding the participant's task – such as, for example, having to keep separate running totals of the number of times that the white team throw the ball and the number of occasions on which they bounce the ball – the more likely it is that participants will miss the gorilla, consistent with the predictions of perceptual load theory. Surprisingly, the results of many such studies now demonstrate that we frequently miss (i.e., fail to notice) even highly salient visual stimuli, if our attention happens to be directed elsewhere (i.e., to another object or stimulus). Such findings show that our subjectively strong belief that we see everything before our eyes is nothing more than an illusion.

A related phenomenon, known as *change blindness*, occurs when a scene and the same scene with a major (i.e., otherwise clearly noticeable) change in it are presented for brief periods of time separated by a blank interval. It turns out that until attention alights on the changed element it will not be reportable. The argument here is that the blank display inserted between the two scenes acts as a global visual transient that obscures the localized spatial transients in the scene that would normally capture our visual attention (as when an item suddenly appears, disappears, or moves). Even when these transients are visible (i.e., when one scene directly transitions to the other), people may not perceive the scene change if mudsplashes (i.e., localized changes in a visual display, such as a bunch of gray circles projected at random points on the screen) happen to be presented at the same time.

Following the original research conducted in the visual modality, it was demonstrated by subsequent studies that a similar phenomenon, known as 'change deafness,' also affects auditory perception. For example, in one study, participants were presented with an auditory scene containing between four and eight auditory stimuli (including sounds such as those of a trumpet, a piano, a female voice, and a clucking hen) for 5 s. Each sound occupied a different position in the virtual auditory display presented over headphones. Next, white noise was presented for 500 ms, followed by a second auditory display for a further 5 s. The two auditory displays were identical except that, on half of the trials, one of the auditory stimuli was removed from the second display (sometimes it was replaced by another item). On each trial, the participants simply had to decide whether one of the auditory stimuli had been removed (or replaced) in the second display. Performance dropped from near perfect when the first display contained four auditory objects, down to chance-level performance when it contained eight. By contrast, in the control condition, in which participants were informed which of the stimuli might change, performance was virtually perfect regardless of the set size, thus demonstrating the attentional nature of the effect (and ruling out an account of the poor performance observed in terms of masking).

Studies of change numbness have revealed even more severe limitations in the perception of tactile stimuli presented

over the body surface or fingertips. So, for example, in a typical study of the tactile analog of change blindness, participants are presented with patterns consisting of vibrotactile stimuli being delivered to two or three locations across the body surface. The mask typically consists of the brief stimulation of a number (e.g., seven) of widely distributed vibrators. A second pattern of two or three vibrotactile stimuli is then presented, and participants have to decide whether there had been a change (which occurs on half of the trials), either in the total number of stimuli presented or in the location of the stimuli on the body surface. The results of several such studies have shown surprisingly poor change detection performance when the two vibrotactile patterns are separated by a mask. By contrast, the performance deficit was far less severe when the interval between the two patterns was empty (i.e., when no mask was presented). Interestingly, researchers have even shown that the presentation of visual mudsplashes can crossmodally give rise to tactile change blindness as well.

Taken together, studies of inattention blindness, change blindness, change deafness, and change numbness support the conclusion that people may actually be unaware of much of the sensory information present in complex multisensory scenes. It would seem that we are only aware of the stimuli that we happen to be attending to voluntarily, or which capture our attention automatically. The results of the many studies published in this area therefore highlight the critical role that attention plays in awareness.

Spatial Attention

Researchers studying attention distinguish between two types of selection – exogenous and endogenous: *Exogenous* (or involuntary) attentional orienting occurs whenever attention is reflexively shifted to the location of a sudden and unexpected peripheral event, such as when a person calls your name at a cocktail party, or when a fly suddenly, and unexpectedly, lands on your arm. By contrast, *endogenous* attention is typically involved in the voluntary orienting of a person's attention to a particular event or spatial location, such as when you choose to attend to a particular person at the noisy party, or when you decide to concentrate on the feel of the MP3 player that you are holding in your hand. Orthogonal to this distinction between endogenous and exogenous (or voluntary and automatic) spatial attention, is the distinction between overt and covert attentional orienting: *Overt* orienting refers to any shift of the sensory receptors (as in eye, head, or hand movements) that helps to bring a stimulus onto the most sensitive parts of the receptor sheet (think, the fovea or the fingertips). *Covert* orienting, which is of most interest to cognitive psychologists studying the topic of selective attention, refers to an internal shift of attention, as when what we attend to visually changes in the absence of any overt movement of the eyes. Many researchers believe that there is a close link between these two forms of spatial orienting, as, for example, captured by the premotor theory of attention. According to the premotor theory, the same frontal-parietal brain circuits control both action – that is, motor behavior toward specific spatial locations – and attention, when those circuits happen to be activated less strongly. Although the premotor theory of attention has

perhaps not received the credit it is due, it is certainly true that the superior colliculus, a subcortical structure implicated in the control of overt eye and head movements, plays an important role in the covert shifting of spatial attention.

Exogenous Spatial Attention

While it is certainly true that attention can be directed, either exogenously or endogenously, to a sensory modality, or to any one of a range of other stimulus features (such as color), by far the most popular topic in attention research in recent decades has been the spatial distribution (or orienting) of attention. The majority of studies in this area have adopted the spatial cuing paradigm first popularized by Mike Posner back in the 1970s. In a typical exogenous cuing study, a cue stimulus is presented in one modality shortly before a target stimulus, presented on either the same or opposite side (and in either the same or different sensory modality). Participants normally have to make either a speeded detection or discrimination response to the target (on occasion, they may be asked to try and detect a near-threshold masked target). The key feature of such studies is that the cue is nonpredictive with regards to the likely location of the subsequently presented target. Often, participants are explicitly instructed to try and ignore the cue as much as possible. However, the results of many such studies conducted over the last 30 years or so have demonstrated that often people simply cannot ignore such cues. Instead, they respond more rapidly, and sometimes more accurately, to targets presented at the cued location as compared to the uncued one. These short-lasting exogenous spatial cuing effects typically last for only a few 100 ms after the presentation of the cue. Often, especially in detection tasks, facilitation is replaced by a longer lasting inhibitory effect, known as 'inhibition of return' (IOR). The idea here is that an inhibitory tag is attached to any location where attention has been directed (either overtly or covertly), but where no target has been found. Such inhibitory tagging is thought to help prevent us from perseverating on uninformative, or irrelevant, locations (e.g., as in visual search tasks; see below).

The presentation of spatially nonpredictive auditory, visual, and tactile cues has been shown to elicit exogenous spatial cuing effects that affect the subsequent processing of auditory, visual, and tactile targets presented from more or less the same location. Researchers using signal detection analysis have demonstrated a genuine enhancement of perceptual sensitivity for stimuli presented at the cued (or attended) location. What is more, the same stimuli reach consciousness sooner when attended than when attention happens to be directed elsewhere, a phenomenon known as 'prior entry.'

Whether peripheral cues always capture our attention automatically, or whether we have to be 'set' appropriately in order for them to elicit a shift of attention has been a topic of heated debate in the attention literature in recent years. The evidence generated by this debate has led many researchers to suggest that even the putative involuntary spatial orienting of our attention may, in fact, be subject to at least some degree of top-down (or strategic) control – that is, it depends on our having the right 'attentional set.' In fact, the interplay between the bottom-up and top-down control of our attention is one that has pervaded the literature on attention over the last three decades or so.

Endogenous Spatial Attention

Turning now to the deployment of endogenous spatial attention, it has been demonstrated that if people deliberately direct their attention to a particular spatial location, performance will normally be enhanced for targets subsequently presented at that location, as compared to targets presented elsewhere. Just as for the case of exogenous orienting, endogenous (or voluntary) attention facilitates the processing of auditory, visual, and tactile stimuli presented at the attended location. Several different methods have been used to direct a participant's spatial attention endogenously to one side or the other. In early studies, peripheral spatial cues were often made informative with regard to the likely location of the target, as when the target appears on the cued side on 75% of the trials, and on the uncued side on the remaining 25% of trials. However, under such conditions, both exogenous and endogenous spatial attention are likely directed to the cued side. In many subsequent studies, therefore, a central cue (such as an arrow pointing to the left or right) has been used to direct attention to one or other side on a trial-by-trial basis instead. That said, it has been argued that even central arrow cues may direct attention exogenously (in a manner similar to centrally presented faces where gaze is deviated to one or the other side). Hence, currently, one of the best means of directing a participant's attention in a purely endogenous manner is by means of blocked cuing, where, for example, the majority of targets appear on the left, say, and only a small number of unexpected targets appear on the other side. The latter approach ensures that any performance facilitation that happens to be observed can unequivocally be attributed to the consequences of endogenous attentional orienting.

Endogenous Versus Exogenous Spatial Orienting: One Mechanism or Two?

There has been a great deal of debate over the years as to whether exogenous and endogenous orienting simply reflect different means of engaging the same attentional resources, or whether instead they have fundamentally different properties/consequences for human perception/performance. Recently, Prinzmetal and his colleagues have reported on a very large number of studies demonstrating that while endogenous spatial attentional orienting typically enhances perceptual sensitivity, exogenous orienting primarily influences which spatial location information is sampled from first. As a consequence, exogenous orienting primarily affects the speed (but not necessarily the sensitivity) or a participant's performance.

Spatial attention has been conceptualized as taking a variety of forms: Early on, researchers typically envisioned spatial attention as a spotlight (the assumption being that it had a fixed size). Subsequently, the analogy of a zoom lens was proposed as an alternative – the idea being that the size of the attentional spotlight was variable, and that there was a trade-off between the size of the spotlight and the 'density' of attentional resources directed toward a particular region of space. When researchers discovered that attention could be directed to objects, as well as spatial locations, a debate started concerning the relation (or interplay) between space- and

object-based attention. While the majority of this research has, once again, focused on the visual modality, researchers have, more recently, highlighted the existence of object-based attention in the auditory modality as well.

Crossmodal Spatial Attention

The question of how attention might be configured crossmodally has been a topic of intense scrutiny over the last decade or so. It now appears that there are extensive crossmodal links in spatial attention, such that visually attending to a particular location will lead to a shift of auditory and tactile attention to the same spatial location (or at the very least in the same direction). Similarly, the exogenous capture of spatial attention by a sudden auditory, visual, or tactile event leads to a shift of attention that will facilitate participants' ability to respond to any target subsequently presented at the cued location (regardless of the modality in which the target happens to be presented). What is more, these crossmodal links in spatial attention update following posture change, such as when the eyes move with respect to the head, or when the arms are moved (often crossed) with respect to the body. This means that attention is always directed in such a way that the processing of all sensory stimuli originating from a given environmental location will be facilitated, regardless of how our various sensors (e.g., the eyes, ears, and skin) happen to be configured spatially.

The Attentive Brain

Neuropsychological studies of patients suffering from spatial neglect/extinction following brain damage have been particularly informative in terms of furthering our understanding the neural substrates of attention. Neglect and extinction typically occur following right hemisphere damage to the parietal cortex. Neglect patients tend to be unaware of stimuli presented in the contralesional field (i.e., the left side of space following right parietal damage). Extinction patients can perceive contralesional stimuli when presented in isolation, but the simultaneous occurrence of an ipsilesional stimulus will typically extinguish the contralesional stimulus from the patient's awareness. Research on such patients has, for example, further helped to highlight the importance of the distinction between space- and object-based attention.

The last few years have seen an explosion of cognitive neuroscience research investigating the neural mechanisms underlying attentional selection. Researchers have used a variety of brain imaging techniques, from PET and fMRI through to electrophysiology and single-cell neurophysiological recordings, in order to better understand how, and where, attention is operationalized in the brain. While a detailed discussion of this literature is beyond the scope of this article, it is worth noting that the spatial distribution of attention in neurologically normal individuals appears to be controlled by a large-scale frontoparietal neural network. Perhaps unsurprisingly, the exogenous and endogenous orienting of attention appears to rely on somewhat different neural circuitry. Consistent with the behavioral data, the neuroimaging and transcranial

magnetic stimulation (TMS: a means of temporarily lesioning a normal participant's brain) data support the view that exogenous spatial attention (and IOR) may be controlled by a supramodal orienting system, while endogenous spatial attention is controlled by a system that approximates to the separable-but-linked account originally proposed by Spence and Driver in 1996.

Feature Integration Theory

Around 1980, Anne Treisman published what has subsequently turned out to be a very influential model of selective attention, known as feature integration theory (FIT). The model helps to account for why visual search through cluttered displays is sometimes difficult (as when we search for our misplaced car keys in our untidy office), while at other times it appears easy (as when a single hand is raised in a crowded auditorium). According to Treisman, attention is required to bind the different features of an object (such as its color, shape, orientation, and motion) into a coherent whole. By contrast, unique features (such as a pink circle in a sea of green circles) '*pop-out*,' thus automatically capturing our attention. Across a series of now classic experiments, Treisman demonstrated that the search for a visual target defined by a unique feature was equally fast regardless of the number of stimuli that happened to be presented in the display. By contrast, search for a conjunction of features (such as for a red square presented in amongst green squares and red and green circles) tended to be slow and effortful (or attention-demanding). Hence, search latencies would increase linearly as a function of the set size. One prediction of FIT is that when attention is overloaded, either because attention has been spread over too wide an area, or because the stimuli are presented for too brief a time (and are, anyway, quite possibly masked), then illusory conjunctions may occur (whereby, e.g., the color of one object may be bound together with the shape of another). Whether such errors reflect perceptual mis-combinations rather than just errors in memory recall remains a contentious issue. Researchers have demonstrated that brain-damage, or repetitive TMS (rTMS) applied to right parietal sites, can impair a person's ability to conjoin features correctly.

Over the intervening years, FIT has generated a huge amount of interest from the psychological research community. Perhaps unsurprisingly, then, a number of findings that are apparently inconsistent with the theory, at least as originally stated, have now been published. In particular, the evidence that is currently available shows that attention is sometimes required to detect (or at the very least, to respond to) targets defined by a unique feature. What is more, many targets that are defined by a conjunction of features appear to pop-out, when, according to Treisman, they should not. However, that said, the general approach still lives through various other models – that can be seen as an extension of Treisman's FIT – such as, for example, Wolfe's '*guided search*' model. It is, though, important to bear in mind that the attentional spotlight thought to be directed to the location of an unexpected peripheral stimulus in the Posnerian cuing task appears to have somewhat different properties than the feature-integrating spotlight made famous by Treisman's FIT. While FIT

was originally formulated to account solely for participants' *visual* search performance, the last few years have seen researchers extending the approach to account for the binding of auditory, tactile, and even multisensory object features.

Temporal Attention

While the majority of studies related to attention have tended to focus on the *spatial* aspects of selection, a growing body of research has, in recent years, started to look at the *temporal* limits on information processing instead, as when participants are offered rapidly presented sequences of visual, auditory, or tactile stimuli. So, for example, using such an approach, researchers have highlighted the existence of a temporal attentional deficit known as the 'attentional blink' (AB). This robust performance impairment is typically observed under those conditions in which two targets, each requiring a behavioral response (often unspeeded), are presented in close succession within a rapidly presented sequence of distractor stimuli. The rate of stimulus presentation in such studies is often very high (~8–10 items per second). If the second target is presented a couple of stream positions after the first target, a participant's ability to identify it will often be severely impaired. (Curiously, if the second target is presented directly after the first target then discrimination performance is often preserved – a phenomenon known as Lag-1 sparing.) As the interval between the first and second target increases, performance typically recovers back to baseline level. It is almost as if there is an attentional gate that is closed after the arrival of the first target in order to prevent it from being overwritten by subsequent items in the stream. Interestingly, certain patients suffering from clinical extinction have been shown to exhibit a significantly larger AB than neurologically normal individuals.

Although originally discovered in the visual modality, the AB has now been demonstrated to occur in the auditory and tactile modalities as well. There is even evidence to suggest the existence of a crossmodal visual–tactile AB. That said, the evidence concerning the existence of an audiovisual AB is, despite the continued efforts of researchers, much more mixed. Researchers have also identified a number of other temporal limitations to our ability to process rapidly presented stimuli. For example, Hal Pashler has conducted very many experiments documenting what appears to be a response selection bottleneck that limits our ability to make speeded responses to different stimuli when two targets are presented in rapid succession. Many neuroscientists have spent the last decade looking for the neural correlates of this psychological refractory period (PRP) bottleneck in the human brain.

Over the last decade or so, researchers have also started to study the temporal orienting of attention to a specific 'point in time.' Many of the studies in this area have simply adapted the spatial cuing paradigm (originally developed to study spatial orienting) in order to study the consequences of temporal expectations on the efficiency of human information processing. So, for example, temporal expectations may be generated in the mind of an observer by making it highly likely that the target will appear a short time after a cue stimulus has been presented (and much less likely that it appears at a later point in time). Target performance in such trials (or blocks) is then compared

to that seen when the probabilities are reversed (such that the target is now much more likely to appear in the later interval than in the earlier one). The results of many such studies now show that stimuli presented at an expected point in time are processed preferentially as compared to when the same stimuli are presented unexpectedly at another point in time.

Attention: The Future

As will have become clear from this brief review, the last few years have seen tremendous advances in our understanding of attention at both the behavioral and neural levels. The field has certainly moved a long way forward since the late Stuart Sutherland uttered the following put-down in a commentary in the science magazine *Nature* in 1998: "after many thousands of experiments, we know only marginally more about attention than about the interior of a black hole." The old box-and-arrow diagrams, once popular in cognitive psychology textbooks (approximately the 1960s), are now increasingly being replaced by neurophysiologically plausible models of the manner in which, and the location where, attention operates in the human (and animal) brain. These models are also increasingly able to explain the deficits in attention (such as neglect and extinction) sometimes observed in patients following brain-damage. One of the other trends in attention research that has been noticeable in recent years is the increasing shift from the traditional approach of considering selection among sensory inputs from just a single modality (most often vision) to a rapid growth of interest in the nature of the *crossmodal* constraints on human information processing.

In the years to come, it is hoped that our growing understanding of attention, fine-tuned by sophisticated behavioral experiments paired with the latest cognitive neuroscience research, will allow researchers to better understand the real-world limitations on human information processing: everything from the problems associated with trying to divide one's attention between eye and ear talking on the mobile phone while driving, through to the difficulties associated with trying to detect infrequent targets (be it a weapon in the luggage at the baggage-scanning machine or the precancerous growths on a radiological image) while engaged in a repetitive visual search task.

See also: [Spatial Perception](#); [Touch](#); [Visual Neglect](#); [Visual Perception](#).

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Attention Deficit Hyperactivity Disorder

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Glossary

Dopamine and norepinephrine Catecholamine neurotransmitters that regulate brain activity.

Executive functions Executive functions represent an umbrella construct that includes a collection of interrelated functions responsible for problem-solving behavior. Executive functions include the ability to formulate goals, to focus and sustain attention, to inhibit impulsive responses, to generate effective and efficient problem solving, organizational, and learning strategies, and to

monitor and correct one's performance when necessary (e.g., self-regulation).

Off label use Legal use of an available medication in a manner or for a condition not approved by the Food and Drug Administration.

Prefrontal cortex The most highly developed part of the human brain, which is responsible for executive functions and higher levels of thinking.

Psychiatric comorbidity The presence of one or more psychiatric disorders in addition to ADHD.

Historical Overview

One of the earliest descriptions of a clinical phenotype that we now associate with attention deficit/hyperactivity disorder (ADHD) can be found as early as 1902 in the works of Sir George Frederick Still, a British pediatrician. In a series of lectures, he presented a number of cases with 'a quite abnormal incapacity for sustained attention,' deficits in 'volitional inhibition,' and a 'defect in the moral control over their own behavior.' Over the decades, this clinical constellation has been labeled 'minimal brain dysfunction,' 'hyperkinetic impulse disorder,' attention deficit disorder (ADD) with or without hyperactivity, and finally, in 1987, attention deficit/hyperactivity disorder (ADHD).

Introduction

The operational definition of ADHD is straightforward: the presence of significant and developmentally inappropriate symptoms of inattention, impulsivity and/or hyperactivity in more than one setting, for more than 6 months and with an onset before age 7. These symptoms must be worse than expected for the patient's age. Children with these symptoms are at increased risk of academic underachievement and a variety of interpersonal difficulties, most notably disruptive behaviors. In addition to their core symptoms of inattention and hyperactivity/impulsivity, individuals with ADHD tend to (a) have problem-solving and social skill deficits, which can lead to social marginalization, (b) have more accidents and visits to local emergency rooms, (c) be more likely to smoke and use alcohol and illicit drugs, (d) be less likely to finish high school and college, (e) have children earlier, have more partners, and spend less time in relationships, (f) have a harder time maintaining a job, and (g) have a higher rate of motor vehicle accidents. Although not all those with ADHD show all of these features, a defining feature of ADHD is that it causes serious problems in the patient's life. In fact, the presence of serious problems is essential to make an ADHD diagnosis.

Epidemiology

The prevalence of ADHD in children and adolescents is around 5–10% with most results being between 4.2% and 6.3%, although a recent epidemiological study suggests that the prevalence may be as high as 9.5%. Boys are diagnosed more frequently with ADHD than girls although this gender difference is less extreme in community samples. The most significant risk factor for ADHD in a child is presence of parental ADHD (up to eightfold) followed by low birth weight, and in utero exposure to neurotoxic substances such as alcohol, pesticides, and tobacco.

Etiology

ADHD is a complex trait that likely involves an interplay of numerous genetic and environmental effects. ADHD is one of the most heritable psychiatric conditions, as heritable as schizophrenia or bipolar disorder. Certain environments (gestational nicotine exposure, consumption of food additives, etc.) appear to contribute to ADHD risk in the presence of some but not other gene variants. In addition to genetics and environmental risks, the neurotransmitters, dopamine, and norepinephrine have received attention as being relevant to understanding ADHD possibly because medications which alter the transmission of these chemicals in the brain are effective for treating ADHD.

Neurologically, the prefrontal cortex appears relevant to understanding ADHD. The functioning of prefrontal cortex requires dopamine and norepinephrine and plays a role in cognitive functions such as executive functions. Executive functions are an umbrella term which refers to goal-oriented problem-solving. Included in the definition of executive functions are abilities such as self-regulation of attention, behavior, and emotion. Low levels of dopamine in the prefrontal cortex can cause the prefrontal cortex to have difficulties maintaining effective problem-solving behaviors.

The prefrontal cortex has many reciprocal connections with other brain regions including the striatum (caudate nucleus,

putamen), cerebellum, and parietal cortex. Research has indicated that some of these brain regions are slightly smaller or have decreased activation in ADHD.

Assessment Issues

The symptoms of ADHD are currently defined by the American Psychiatric Association's (APA) *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, text revision (DSM-IV-TR). To be diagnosed with ADHD, an individual must have persistent and impairing symptoms of inattention, impulsivity, and/or hyperactivity. ADHD is diagnosed when six or more of the nine symptoms of inattention or hyperactivity-impulsivity occur for at least 6 months, occur in two or more settings, and impair the individuals' functioning (see [Table 1](#) for DSM-IV-TR symptoms).

The DSM-IV-TR is currently being revised to update the diagnosis based on recent research findings. For example, the DSM-IV-TR requires that some impairing ADHD symptoms be present before age 7. The age of onset criterion (before age 7) is highly controversial and is likely to be dropped from the next iteration of the DSM. In its place is likely an age of onset before early adolescence (~ age 12). The decision to change the age of onset criterion is based primarily on a lack of evidence differentiating children with onset before and after age 7. This and other changes are anticipated for the fifth edition of *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5).

Diagnosing ADHD in adolescents and adults is often more challenging than diagnosing ADHD in children. For

example, children are often more carefully supervised by parents and teachers (usually only one) who are able to observe much of the child's functioning. However, in adolescence, many more teachers are involved and outside of school, adolescents have less contact with parents. For instance, parents may be able to provide information regarding homework completion and school grades but may not have as much information on peer interactions and social relationships. In adults, most are not involved in school and thus, obtaining information from others who know the adult (e.g., spouse, parent, employer) is important yet can be difficult to obtain. This may be even more important as significant discrepancies may be present between self report of symptoms and the reports from others. Many times, the self-report will underestimate the level of symptoms and the amount of impairment.

Three subtypes of ADHD now exist in the DSM-IV-TR: Predominantly inattentive subtype (only has threshold levels of impairing inattentive symptoms; occurs in 30–40% of all ADHD), predominantly hyperactive/impulsive subtype (only has threshold levels of impairing hyperactive/impulsive symptoms; occurs in <5% of all ADHD, nearly always in preschool children), and the combined subtype (has threshold levels of impairing inattentive and hyperactive/impulsive symptoms; occurs in 50–60% of all ADHD).

For some patients, these ADHD impairing symptoms may occur in most situations, including high-interest activities. However, for most, these attention and inhibition difficulties are manifested primarily in settings requiring self-restraint, persistence, and a high level of concentration to relatively uninteresting activities. In children with ADHD, these difficulties negatively affect classroom or social functioning and may result in limited learning, disruption of class activities, poor work completion, impaired peer interactions, and increased conflict with teachers/parents.

It is also possible that an adolescent or adult may be present for an ADHD evaluation having never been formally diagnosed with ADHD. The age of referral and recognition of the problem is older for those with the inattentive type, compared with the combined type. Intelligence, family support, and academic placement can be protective and in some cases appear to delay the onset of evident symptoms or impairment to much later than specified in the DSM. For example, sometimes highly intelligent individuals show no academic impairments relative to peers until they complete high school, college, or even later.

Careful attention to potential comorbidities is critical in ADHD, particularly learning disabilities as well as mood, anxiety, and substance use disorders. While psychological testing can be helpful in determining strengths/weaknesses and assessing for the presence of learning disabilities, psychological testing is not necessary to either rule in or rule out the presence of ADHD. Rather, an ADHD diagnosis is based on the careful integration of clinical information from as wide a variety of sources that are available. Rating scales and other clinical instruments have been devised to assist with this. An ADHD diagnosis is not based on brain scans or any other biological test. Despite this lack of biologically sensitive and specific tests, ADHD is a well-validated and highly reliable clinical diagnosis.

Table 1 DSM-IV-TR criterion A symptoms

Inattention

1. Often does not pay close attention to details or makes careless mistakes in schoolwork, work, or other activities
2. Often has trouble keeping attention on tasks or play activities
3. Often does not seem to listen when spoken to directly
4. Often does not follow instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)
5. Often has trouble organizing activities
6. Often avoids, dislikes, or does not want to perform tasks that take a lot of mental effort for a long period of time (such as schoolwork or homework)
7. Often loses items needed for tasks and activities (e.g., toys, school assignments, pencils, books, or tools)
8. Is often easily distracted
9. Is often forgetful in daily activities

Hyperactivity/impulsivity

1. Often fidgets with hands or feet or squirms in seat
2. Often gets up from seat when remaining in seat is expected
3. Often runs about or climbs when and where it is not appropriate (adolescents or adults may feel very restless)
4. Often has trouble playing or enjoying leisure activities quietly
5. Is often 'on the go' or often acts as if 'driven by a motor'
6. Often talks excessively
7. Often blurts out answers before questions have been finished
8. Often has trouble waiting for one's turn
9. Often interrupts or intrudes on others (e.g., butts into conversations or games)

Developmental Course

Most often, ADHD symptoms and associated problems occur as early as age 3 or 4 and the first manifestations tend to reflect problems of hyperactivity and impulsivity (disinhibition). Issues pertaining to inattention tend to be more easily noticed later around age 5–7 when the child starts attending school.

In children with ADHD, difficulties exerting physical self-control are central. Children with ADHD fidget, leave their seat when seating is expected, have a hard time waiting for their turn, are often on the go, and run, climb, or touch objects inappropriately. Children with ADHD also have difficulties exerting verbal self-control. Children with ADHD talk excessively, even when restraint is expected, blurt out answers even before the question was completed, and tend to interrupt others or intrude in other's conversations. In adolescents and adults with ADHD, these physical and verbal self-control difficulties appear more as restlessness.

During school years, the problems of inattention and school productivity tend to be almost universal. As the child is progressing into adolescence, often the symptoms of hyperactivity are less obvious but impairment related to impulsive behaviors tends to stay significant. Academic problems that might have been less noticeable or were treated effectively during elementary school may become much more of a problem. This is possibly a function of the increased demands for functional independence that are inherent in the middle- and high-school curriculum. In middle and high school, adolescents are expected to become more independent of adult supervision. Adolescents also change classes and are exposed to multiple teachers, teaching styles, and homework demands. Procrastination, forgetfulness, and poor persistence often become the most academically impairing symptoms.

In adolescents, peer relationships rise in importance. Adolescents with ADHD often struggle in peer relationships, typically as a function of their impulsivity. Emotional impulsiveness manifested as low frustration tolerance, quickness to anger, being impatient, and being easily excitable or annoyed is most predictive of social relationship problems for adolescents and adults with ADHD.

In children, adolescents, and adults with ADHD, the core ADHD symptoms can lead to a wide variety of other associated features. Individuals with ADHD tend to have a hard time regulating arousal levels to meet contextual demands, tend to seek more immediate reinforcements, tend to discount more steeply the value of future rewards, and have a poor sense of time. In addition to the core symptoms, these associated features contribute to functional impairments. In fact, the overall relationship between symptoms and impairment in ADHD seems to be such that as an individual ages, the core symptoms of ADHD, especially hyperactive and impulsive symptoms, decline while functional impairment persists or worsens through adolescence and into adulthood. Due to the decline of ADHD symptoms throughout adolescence, by adulthood, many grown-up ADHD children will no longer show a high level of ADHD symptoms. However, despite this decline of symptoms, about two-thirds of children with ADHD continue to have some impairing symptoms of ADHD as they enter adult life. These impairing symptoms can cause serious problems if not treated.

Treatment Issues

The treatment of ADHD typically includes the following types of interventions: (a) medication(s), (b) behavioral interventions (also known as psychosocial treatments), and (c) a combination of medication and behavioral interventions.

Stimulant Medications

In 1937, Dr. Charles Bradley from East Providence, RI, reported in the *American Journal of Psychiatry* his findings about behavioral changes in children when using an amphetamine drug called benzedrine. From his description of these children, it is likely that most would have been diagnosed as ADHD using modern criteria. His initial thought was that Benzedrine would alleviate the headaches these youth experienced after an experimental procedure. The headaches persisted, but the children's teachers reported "a spectacular improvement in school performance in half of the children." Dr. Bradley also found that "a large proportion of the patients became emotionally subdued without, however, losing interest in their surroundings." These results represent historically one of the first examples of using pharmacology to address behavioral disorders.

Over the last 70 years, the use of amphetamine and other stimulant medications for treating ADHD has grown considerably. Stimulants are now used for treating symptoms of ADHD across the life span from preschoolers to school-age children to adolescents and later adults. The two stimulant medications most often used in the treatment of ADHD are methylphenidate and amphetamine.

Methylphenidate, which has been used since the early 1960s, blocks reuptake of the neurotransmitters norepinephrine and dopamine by blocking the activity of their respective transporters in the brain. As a result, the synaptic availability of norepinephrine and dopamine is increased. Methylphenidate is available in multiple formulations including immediate and extended release. Methylphenidate has a short elimination half-life (1.5–5 h) and this creates significant problems in practical treatment. Therefore, extended release formulations are more often prescribed because one daily dose is often sufficient for treating symptoms throughout the day. Amphetamine was discovered at the end of the nineteenth century and is also used in the treatment of ADHD. Amphetamine is also available as immediate or extended release formulations.

Over 70% of individuals respond to initial trials of either methylphenidate or amphetamine; of those who fail the initial trial, an additional 70% generally responds to the other class. Both medications usually require adjustments in doses (including when doses are taken) in order to maximize effectiveness.

Both amphetamine and methylphenidate are associated with small but generally insignificant changes in pulse and blood pressure. The more common side effects of stimulants include delayed sleep, reduced appetite, headaches, and mild abdominal pain growth delay. There is a good deal of individual variability in these side effects. While significant adverse events may occur, when prescribed correctly, stimulants are generally well tolerated.

Both amphetamine and methylphenidate also have potential for misuse, abuse, and dependence. Misuse refers to situations in which the medication is used for reasons other than treating ADHD. For example, some college students obtain stimulant medication illegally and use it to stay up late to study. Abuse and dependence refer to situations in which the medication is used to get high, which could lead to addiction. Although these are concerns, there is no convincing evidence that the therapeutic use of stimulants causes abuse or dependence. In fact, long-term follow-up studies of stimulant-treated children with ADHD suggest the opposite effect. Treatment with stimulant medication generally decreases the risk for later drug abuse and dependence.

The rate of failure to adhere to treatment with stimulants may be as high as 20–65%. There are multiple factors contributing to poor adherence including perceived stigma, denial, externalization of the problem, unwanted side effects (headaches, emotional blunting etc.), the cost of the medication, as well as the fact that ADHD symptoms (e.g., forgetfulness) may directly contribute to poor adherence.

Nonstimulant Medications

Stimulant medications are usually the first line of treatment for ADHD due to their high efficacy and relatively long history of use. However, there are alternatives, including three food and drug administration (FDA)-approved nonstimulants: atomoxetine, extended release guanfacine, and extended release clonidine. Other medications such as bupropion, desipramine, venlafaxine, and modafinil are sometimes used ‘off label’ in the treatment of ADHD, especially in the adult population. ‘Off label’ means that the use of the medication for ADHD has not been approved by the FDA.

Atomoxetine is a selective norepinephrine reuptake inhibitor (SNRI) that increases the availability of synaptic norepinephrine, especially in the prefrontal cortex. One of the advantages of atomoxetine (and other nonstimulants) is the absence of a potential for abuse, which makes it a preferred agent in many situations where this can be a concern, especially in adults. Atomoxetine tends to be well tolerated; headaches, nausea, and loss of appetite are the most common side effects. Some of the rare events in treatment include increased suicidal thinking and behavior, unusual changes in behavior, and liver problems, potentially severe. While numerous studies found superiority of atomoxetine relative to placebo, atomoxetine is less effective than stimulant medications for most patients.

Guanfacine is an α -2 agonist with some selectivity for the 2A postsynaptic receptors. Guanfacine and other α -2 agonists increase noradrenergic brain activity; yet actually serve to regulate glutaminergic transmissions. A similar agent, clonidine, is also frequently used; yet clonidine is less selective at the level of 2A receptors. Both guanfacine and clonidine have similar side effects including somnolence, dry mouth, hypotension, and constipation. Both of these medications will likely increase in use in coming years because long-acting versions of both were recently approved by the FDA.

While the medication treatments for ADHD are effective, ‘normalization’ of functioning with medication treatments only occurs in a minority of those with ADHD. For this

reason, most in the field recommend that after medication treatment has been instituted, if any significant problems remain, these should be addressed with behavioral (psychosocial) interventions.

Psychosocial Interventions for Children

Behavioral parent training (BPT) programs are effective for children with disruptive behaviors whether or not they have co-occurring attentional/hyperactive difficulties. BPT techniques generally consist of training parents in the use of reward and punishment following appropriate and inappropriate behaviors. Reward procedures have typically relied on praise, privileges, or tokens while punishment methods have usually been loss of positive attention, privileges, or tokens or formal time out from reinforcement.

BPT programs generally consist of weekly training sessions, either in groups of parents or with individuals, each focusing on a discrete method. These methods can be grouped into three basic types of procedures: (1) those that manipulate the setting events that may precede or surround a child’s tasks or activities so as to increase positive or negative behavior (i.e., parental commands, task demands, teacher instructions, etc.); (2) those which may restructure the tasks to be done (reduce work quotas, insert more interesting task materials, etc.); (3) and those that manipulate the nature of the consequences for child behavior in that setting (i.e., attention, praise, token reinforcement, punishment, etc.).

Teachers often receive explicit training in classroom behavioral management during their training and education. Proper classroom placement, adequate attention to concomitant learning disabilities, and reasonable accommodations that might include classroom seating, extended time on tests, and modified work assignments are also commonly employed in school settings. Accommodations (including extended time) on standardized tests are also relatively common. Curriculum modifications, strategy training, and other cognitive behavioral approaches are less reliably associated with classroom behavioral improvements in children.

In general, medication management along with individually tailored psychosocial treatments are the most commonly employed interventions for managing children and adolescents with ADHD.

Adult Psychosocial Interventions

As noted above, behavioral treatments for ADHD children involve direct contact with parents and teachers and less direct intervention with the child. Cognitive behavioral therapy (CBT) is a more individual-delivered therapy which involves less direct contact with parents and teachers and more contact with patients. Unlike behavior therapy which focuses exclusively on changing behaviors, CBT also focuses on changing a person’s cognitions or thoughts and how they can use their thoughts to overcome real-world problems associated with their ADHD. CBT for ADHD children historically included many different treatment components such as self-instruction training, problem solving training, and social skills training; as psychosocial interventions. Research studies suggest that CBT is not useful for treating children with ADHD. In fact, due to its

limited efficacy in children, CBT was not included in the MTA treatment protocols. In adults, however, CBT holds some promise as a psychosocial component to an integrated treatment plan.

There are several CBT protocols for managing adult ADHD. Most protocols address the following topics: (1) education about ADHD; (2) organizational/planning training usually including teaching adults with ADHD how to use a calendar/daily planner, how to use 'to-do' lists, and how to break down a large task into more manageable chunks; (3) reducing distractibility through a variety of means, including managing environmental distractions, reducing large tasks into smaller chunks that correspond to the length of the adult's attention span, and the use of alarms/timers to encourage sustained focus; (4) reducing procrastination; (5) improving communication/social skills; (6) reducing anger and frustration through managing maladaptive thoughts and dysfunctional beliefs.

Although there is relatively little research on the use of CBT for treating adult ADHD, initial studies show that ADHD adults treated with CBT and medication have better outcomes than ADHD adults who are treated with medication alone.

Complementary and Alternative Treatments

The pharmacological treatment of ADHD is effective and safe for the large majority of patients. Nevertheless, because many parents object, in principle, to the idea of using psychiatric medication with their children, they seek help from complementary and alternative medical therapies.

Many alternative approaches for treating ADHD have been attempted. These use nutritional interventions; natural health products such as essential fatty acids, vitamins, and minerals; and other health supplements. Currently, there is no evidence to support recommending such interventions systematically, although anecdotal reports of improvement are numerous. When alternative treatments have been studied systematically, results are typically negative. For example, studies of zinc and omega-3 fatty acid supplementation show they are not effective for treating ADHD. Because most alternative treatments for ADHD have not been adequately studied, parents and patients should use them with extreme caution, keeping in mind that any concerns about the side effects of medications should be balanced by the risks associated with not treating ADHD as effectively as possible.

One alternative treatment that has gained some traction is use of electroencephalogram (EEG) neurofeedback. The EEG measures the electrical activity of the brain and is known in the popular language as 'brain waves.' Attempts to describe patterns of EEG activity in children with ADHD go back many decades. These studies suggest that ADHD children show increased theta and decreased beta and alpha activity. Neurofeedback has the child performing an activity that requires sustained attention. The child will receive negative feedback when the EEG reflects an increased theta/beta ratio and positive feedback otherwise. Initial studies suggest that this method is useful for some ADHD children. However, large randomized, well-controlled studies will likely clarify this issue. In scientific circles suspicion persists as we lack currently a convincing model correlating the EEG findings and the putative correction of the theta/beta ratio with executive functions and attentional processes.

Challenges and Perspectives

Over the past several decades, scientists have made important strides in understanding the causes of ADHD, refining its diagnosis, and developing new and more effective treatments. However, much more work remains to be done. One important challenge, which is faced by nearly all psychiatric disorders, is the lack of a biological test for the disorder. Although we know that ADHD and non-ADHD patients differ on measures of brain structure and functioning and that some genetic variants predispose to ADHD, these measures are not sufficiently accurate to use as a diagnostic test.

Scientists also need to provide a richer description of the causes of ADHD and the effects that these causes have on the brains of ADHD patients. Our hope is that future discoveries along these lines will lead to newer and more effective treatments for ADHD. New treatments are needed for several reasons. Current treatments for ADHD reduce symptoms and the risk for impairing behaviors, but in most cases they do not eliminate ADHD or 'cure' the disorder. Further studies of the brains and genes of ADHD patients may lead us to such improved treatments.

Current medication treatments for ADHD do a good job of reducing the symptoms of inattention, hyperactivity, and impulsivity. They are, however, less effective in treating other features of ADHD such as executive dysfunction or problems with the self-regulation of emotions. More work is needed to develop new medicines for such problems or to combine medicine and psychosocial treatments in a manner that addresses the full range of symptoms and impairments caused by ADHD.

Conclusion

In concluding, it is important to recognize the social context for ADHD in the United States and many other countries. It is not unusual to read on the internet or in newspapers, stories that question the validity of ADHD as a true disorder or describe current treatments as remarkably dangerous. Many of these stories are simply wrong or, at best, exaggerations. Parents and patients should rest assured that the disorder we call ADHD has received substantial scientific scrutiny and can be considered as valid as any other medical disorder that might be diagnosed in their child. They should also rest assured that medical treatments approved by the FDA have been sufficiently studied for safety and effectiveness.

People with ADHD should also understand that, although this article has focused on the clinical features and impairments associated with ADHD, having this disorder does not define the patient as hopelessly impaired or 'abnormal.' All people have strengths and weaknesses. ADHD is a weakness that leads to problems, but ADHD people often have many other strengths that help them lead productive and satisfying lives.

See also: Academic Achievement; Anxiety Disorders; Attention; Cognitive Behavior Therapy; Depression; Developmental Psychopathology; Neuroexecutive Function.

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Relevant Websites

- <http://www.aacap.org> – American Academy of Child & Adolescent Psychiatry.
- <http://www.aap.org> – American Academy of Pediatrics.
- <http://www.chadd.org> – CHADD Organization.
- <http://www.ldanatl.org> – Learning Disabilities Association of America (LDA).
- <http://www.nichcy.org> – National Information Center for Children and Youth with Disabilities.

Attitude Change

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Glossary

Attitude A global evaluation of a person, object, or issue indicating the extent to which it is liked or disliked.

Attitude change Modifying one's evaluation to become different from what it was.

Attitude strength The extent to which an attitude is persistent, resistant, and influences thinking and behavior.

Central route Persuasion through effortful thought and extensive elaboration that involves generating issue-relevant thoughts.

Dissonance An attitude change technique that involves having a person engage in inconsistent thought or action.

Inoculation Providing arguments against one's attitude in an attempt to strengthen it from future attacks.

Peripheral route Persuasion through less effortful mechanisms including mental shortcuts, simple associations, and the impact of contextual cues.

Resistance The extent to which attitudes remain firm when confronted with an attempt to persuade.

Attitudes refer to people's global and relatively enduring (i.e., stored in long-term memory) *evaluations* of objects, issues, or persons (e.g., I oppose capital punishment; I like the President). Numerous procedures have been developed to modify these evaluations with some change techniques involving considerable thinking about the attitude object and some requiring little. Attitudes are one of the most studied and important constructs in psychology because of the critical role of attitudes in guiding everyday choices and behavior.

Overview of Attitudes and Attitude Change

Attitudes are based on some combination of cognitive, behavioral, and affective (emotional) influences and are typically measured by self-report scales such as the *semantic differential*, where a person rates the target on bipolar evaluative dimensions such as how good/bad or favorable/unfavorable it is. Increasingly, in addition to assessing people's explicit or deliberative attitudes, assessments are made of the evaluations that come to mind automatically without much reflection (i.e., quick evaluative associations) using *implicit measures*. Measures such as Greenwald's Implicit Association Test (IAT) and Fazio's evaluative priming measure are popular in this regard. Often, implicit and explicit measures yield the same outcome, but sometimes there are discrepancies which might suggest that people are unwilling to report their attitudes due to social desirability concerns or might be unable to report them due to limited access.

Furthermore, in addition to assessing attitudes on a positive to negative continuum, scholars have also found it useful to assess attitudes on dimensions other than their valence such as their accessibility (how quickly the attitude comes to mind), ambivalence (how consistent the basis of the attitude is), and certainty (how confident people are in the validity of their attitudes). These indicators of attitude 'strength' are useful in determining which attitudes are consequential and which are not. Strong attitudes are those that persist over time, are resistant to change, and predict other judgments and actions. At any given moment, one's expressed evaluation can be influenced by a variety of contextual factors, but a common assumption is

that one's core 'attitude' is the underlying evaluation that is capable of guiding behavior (one's actions), cognition (one's thoughts and memories), and affect (emotional reactions).

Attitude change occurs when one's core evaluation shifts from one meaningful value to another, and is typically inferred from a change in either an implicit (automatic) or explicit (deliberative) measure of evaluation. Often, an attitude change induction produces change on both kinds of measures but sometimes change is more likely on one type of measure than another. Most studies of attitude change involve exposing individuals to a persuasive communication of some sort, but as explained shortly, some attitude change techniques do not involve exposure to any message. The earliest work on attitude change attempted to examine which variables and procedures increased and which decreased the likelihood of change.

Two Routes to Attitude Change

After numerous studies, the accumulated evidence suggested that even the simplest variables (e.g., being in a positive vs. negative mood; using a high vs. low credible source) sometimes increased, sometimes decreased, and sometimes had no impact on the likelihood that a person's attitude would change. Numerous theories and psychological processes were proposed to account for these divergent results. Even though the many theories of attitude change that were developed have different names, postulates, and particular effects and variables that they explain, the many different theories of attitude change can be thought of as emphasizing just two relatively distinct *routes to persuasion*: the *central route* and the *peripheral route*.

Central Route Approaches to Attitude Change

The first attitude change technique, persuasion via the central route, focuses on the information that a person has about the central merits of the object under consideration. Some of the theories and techniques that utilize the central route assume that comprehending and learning the information presented is

critical for attitude change, whereas others focus more on the evaluation, elaboration, and integration of this information.

Message Learning Approach

One of the most influential programs of research on attitude change was that undertaken by Carl Hovland and his colleagues at Yale University in the years following World War II. The Yale group studied how source, message, recipient, and channel factors affected the comprehension, acceptance, and retention of the arguments in a persuasive communication. Although no formal theory tied together the many experiments conducted by this group, they often attempted to explain the results obtained in terms of general learning principles, such as the more message content you learned, the more your attitudes should change. Contemporary research shows that people can be persuaded without learning or remembering any of the message content. That is, people are sometimes persuaded solely by the 'cues' associated with the message (e.g., the source is expert). Or, the message might elicit a favorable thought that persists in the absence of memory for the information that provoked it. Message learning appears to be most important when people are not engaged in an online evaluation of the information presented to them such as when they do not think they have to form an opinion at the time of information exposure. In such cases, subsequent attitudes may be dependent on the valence of information they have learned and can recall.

Self-Persuasion Approach

Self-persuasion theories hold that people's attitudes can change in the absence of any new external information. This is because people can self-generate reasons to favor or disfavor any position. The powerful and persisting effects of completely self-generated messages were shown in early research on 'role-playing' where people were asked to generate messages on certain topics (e.g., the dangers of smoking). The subsequent attitudes of these people were compared to those who had either passively listened to the communication or who had received no message. A consistent result was that active generation of a message was a successful strategy for producing attitude change, and these changes persisted longer than changes based on passive exposure to a communication. Finally, merely asking someone to think about an issue, object, or person can lead to attitude change as a result of the evaluative thoughts generated. *Cognitive response* theorists hold that just as one's own thoughts can produce change in the absence of a message, so too are one's own thoughts responsible for attitude change even when a persuasive message is presented. That is, to the extent that a person's thoughts in response to the message are favorable, persuasion should result, but to the extent that they are unfavorable (e.g., counterarguments), resistance or even boomerang is more likely. These theorists hold that persistence of persuasion depends upon the decay function for cognitive responses rather than message arguments per se.

Expectancy-Value Approach

The message learning and self-persuasion approaches focus on the information (either externally or internally generated) that

is responsible for persuasion. Neither approach has much to say about the particular features of the information that are critical for influencing attitudes. In contrast, expectancy-value theorists analyze attitudes by focusing on the extent to which people expect the attitude issue to be related to important values or produce positive and negative consequences. In one influential expectancy-value model, Fishbein and Ajzen's *theory of reasoned action* holds that the attributes (or consequences) associated with an attitude object are evaluated along two dimensions – the *likelihood* that an attribute or consequence is associated with the object and the *desirability* of that attribute or consequence. If a persuasive message says that raising taxes will lead to reduced crime, the effectiveness of this argument should depend on how likely people think it is that crime will be reduced if taxes are increased (likelihood), and how favorably they view the outcome of reducing crime (desirability). Although some questions have been raised about the necessity of one or the other of these components, a large body of research supports the idea that attitudes are more favorable the more that likely-desirable consequences (or attributes) and unlikely-undesirable consequences are associated with them. The major implication of this theory for persuasion is that a message will produce attitude change to the extent that it introduces new attributes of an object, or produces a change in the likelihood and/or the desirability components of an already accepted attribute. Another proposition of this theory is that the items of information constituting an attitude are combined in an additive fashion. Other theorists, however, have contended that an averaging mechanism is more appropriate.

Self-Validation Approach

Not all of the thoughts that people have with respect to an attitude object will necessarily be used to form an overall evaluative judgment. According to the self-validation approach, people are more likely to rely on thoughts in which they have confidence (i.e., see as valid) than thoughts about which they have doubt. For example, if two people have equal numbers of favorable thoughts about a proposal and each assesses the likelihoods and desirabilities of the consequences as equivalent, the person who has high confidence in the thoughts generated will show more attitude change than the person who has doubts about these thoughts. Numerous studies have identified a wide variety of variables that can affect thought confidence. One well-studied factor is the ease with which thoughts come to mind. For example, it is easier to generate two reasons to stop smoking rather than 12. Because things that come to mind easily are seen as more valid, people who generate two reasons could show more attitude change than those who generate 12, reversing the typical effect of number of thoughts on persuasion. This is because when people generate only two reasons, they have confidence in these reasons, but when they generate 12, there is less confidence in their validity. Other variables have been shown to affect thought confidence and thus reliance on one's thoughts. These variables include whether people are nodding (up and down) rather than shaking (side to side) their heads during the persuasion attempt, and whether they are made to feel powerful or happy right after thought generation. If people have generated mostly favorable thoughts during the message,

increasing thought confidence will lead to more persuasion, but if people have generated mostly unfavorable thoughts during the message, increasing thought confidence will result in reduced persuasion. Finally, it is important to note that people assess their thought confidence primarily when they are motivated and able to think carefully about the message, such as when they are high in their need for cognition or the personal relevance of the topic is high. When motivation and ability are low, meta-cognitive activity (i.e., thinking about one's thoughts) is also low.

Functional Approach

In their expectancy-value theory, Fishbein and Ajzen speculate that five to seven attributes or consequences are critical in determining a person's overall attitude. It is not clear, however, which particular attributes will be the most important (i.e., how the attributes are weighted). Functional theories of persuasion focus on the specific needs or functions that attitudes serve for a person and are therefore relevant for understanding the underlying dimensions of the attitude that are most important to influence. For example, some attitudes are postulated to protect people from threatening truths about themselves or to enhance their own self-image ('ego-defensive function'), others give expression to important values ('value-expressive function'), or help people to understand the world around them ('knowledge function') or facilitate achieving rewards and avoiding punishments ('utilitarian function'). According to these theories, change depends on challenging the underlying functional basis of the attitude. Thus, if a person dislikes lowering taxes because of concern about social inequality (value expressive function), an argument about the amount of money the taxpayer will save (utilitarian function) will be ineffective.

Consistency Approach

Just as functional theories hold that attitudes serve important needs for individuals, dissonance and related theories hold that attitudes are often in the service of maintaining a need for consistency among the elements in a cognitive system; in Leon Festinger's original formulation of *dissonance theory*, two elements in a cognitive system (e.g., a belief and an attitude; an attitude and a behavior) were said to be consonant if one followed from the other, and dissonant if one implied the opposite of the other. Two elements could also be irrelevant to each other. One of the more interesting dissonance situations occurs when a person's behavior is in conflict with his or her attitudes or beliefs because behavior is usually difficult to undo. According to the theory, dissonance, experienced as an aversive tension, can be reduced by changing beliefs and attitudes to bring them into line with the behavior. Thus, if you were opposed to the election of Candidate Smith, it would be inconsistent to sign a petition in favor of this candidate. According to dissonance theory, signing such a petition would produce discomfort that could result in a more favorable evaluation of the candidate in an effort to restore consistency.

Although early dissonance research was generally supportive of the theory, several competing formulations were proposed. Although it is now clear that many of the behaviors described by Festinger induce in people an 'unpleasant

tension,' just as the theory predicts, current research has begun to focus more on understanding the precise cause of that tension. For example, some have questioned Festinger's view that inconsistency per se produces tension in many people. Rather, some argue that people must believe that by their behavior they have freely chosen to bring about some foreseeable negative consequence, or that the inconsistency involves a critical aspect of oneself or a threat to one's positive self-concept.

Peripheral Route Approaches

Each of the central route approaches described above assumes that attitude change results from people actively considering the merits of some position either in a fairly objective manner or in a biased way (such as when seeking to restore consistency). The next group of theories does not share this assumption. Instead, these theories suggest that people often prefer to conserve their limited cognitive resources and form or change attitudes with relatively little cognitive effort. The peripheral route focuses on eliciting attitude change without much thinking about information central to the merits of the attitude issue. Thus, the peripheral approaches deal with changes resulting from rewards, punishments, and affective experiences that are associated directly with the attitude object, or simple inferences that people draw about the appropriate attitude to adopt based on their own behavior or other simple cues in the persuasion environment.

Inference Approaches

Rather than effortfully examining and thinking about all of the issue-relevant information available, people can make an evaluative inference based on some meaningful subset of information. One popular inference approach is based on 'attribution theory' and holds that people come to infer underlying characteristics about themselves and others from the behaviors that they observe and the situational constraints imposed on these behaviors. Bem suggested that people sometimes have no special knowledge of their own internal states and simply infer their attitudes in a manner similar to that by which they infer the attitudes of others. In his *self-perception theory*, Bem reasoned that just as people assume that the behavior of others and the context in which it occurs provides information about the presumed attitudes of these people, so too would a person's own behavior provide information about the person's own attitude. Thus, a person might reason, 'since I signed Candidate Smith's petition, I must be in favor of her election.'

The attribution approach has also been useful in understanding the persuasion consequences of making inferences about relatively simple cues. For example, when external incentives (e.g., money) provide a salient explanation for a speaker's advocacy ('he was paid to say it'), the message is less effective than when a discounting external attribution is not possible. Research indicates that these simple attribution processes are most likely to influence attitudes when people are relatively unmotivated or unable to think carefully about the issue, such as when they have relatively little knowledge on the topic and the issue has few anticipated personal consequences.

Like the attributional framework, the *heuristic-systematic model* of persuasion postulates that, when people are not motivated or able to process all of the relevant information available, attitude change can result from the use of certain heuristics or rules of thumb that people have learned on the basis of past experience and observation. To the extent that various persuasion heuristics are available in memory, they may be invoked to evaluate persuasive communications. For example, either because of prior personal experience or explicit training, people can evaluate a message with many arguments by invoking the heuristic 'the more arguments, the more valid it is.' If so, no effortful learning or evaluation of the actual arguments presented is necessary for influence to occur.

Approaches Emphasizing Affect

The attribution and heuristic models focus on simple cognitive inferences that can modify attitudes. Other peripheral route theories emphasize the role of affective processes in attitude change. One of the most direct means of associating 'affect' with objects, issues, or people is through *classical conditioning*. In brief, conditioning occurs when an initially neutral stimulus (the conditioned stimulus, CS) is associated with another stimulus (the unconditioned stimulus, UCS) that is connected directly or through prior conditioning to some response (the unconditioned response, UCR). By pairing the UCS with the CS, the CS becomes able to elicit a conditioned response (CR) that is similar to the UCR. So, in Pavlov's initial conditioning studies, when food was paired over and over again with a bell, eventually the bell elicited salivation in the absence of food.

Considerable research has shown that attitudes can be influenced by pairing initially neutral objects with stimuli about which people already feel positively or negatively. For example, peoples' evaluations of words, other people, political slogans, consumer products, and persuasive communications have been modified by pairing them with such affect-producing stimuli as unpleasant odors and temperatures, the onset and offset of electric shock, harsh sounds, and elating and depressing films. People are especially susceptible to the simple transfer of affect from one stimulus to another when the likelihood of object-relevant thinking is rather low. Some recent research by Jones, Fazio, and Olson suggests that conditioning in the domain of attitudes (*evaluative conditioning*) occurs by means of a simple misattribution process. That is, although people are actually feeling unpleasant because of the UCS (e.g., an pleasant odor), they misattribute (confuse) this feeling as originating from the CS (e.g., the persuasive message).

Another procedure for modifying attitudes through simple affective means was identified by Robert Zajonc in his work on *mere exposure*. In this research, Zajonc and his colleagues have shown consistently that when objects are presented to an individual on repeated occasions, the mere exposure is capable of making the individuals' attitudes toward these objects more positive. Recent work on this phenomenon indicates that simple repetition of objects can lead to more positive evaluations even when people do not recognize that the objects are familiar. Mere exposure effects have been shown in a number of studies using a variety of stimuli such as polygons, tones, nonsense syllables, Chinese ideograms, photographs of faces, and foreign words. Interestingly, what these stimuli have in

common is that they tend to be meaningless and are relatively unlikely to elicit spontaneous thought. In fact, the simple affective process induced by mere exposure appears to be more successful in influencing attitudes when processing of the repeated stimuli is minimal. When more meaningful stimuli have been repeated such as words or sentences, mere exposure effects have been less common. Instead, when processing occurs with repetition, the increased exposures enhance the dominant cognitive response to the stimulus. Thus, repeating strong arguments tends to lead to more persuasion (at least to the point of tedium), and repeating weak arguments tends to lead to less persuasion.

A Dual Process Approach to Understanding Attitude Change

Although the theories just described continue to be useful in accounting for a variety of persuasion phenomena, much of the contemporary literature on attitude change is guided by one of the available 'dual process' models of judgment. For example, one of the earliest approaches of this type, the *Elaboration Likelihood Model* (ELM), was introduced by Petty and Cacioppo and represented an attempt to integrate the many seemingly conflicting findings in the persuasion literature under one conceptual umbrella by specifying a finite number of ways in which source, message, recipient, and contextual variables have an impact on attitude change (for reviews of the ELM, the related heuristic/systematic model, and other dual process approaches). The ELM is based on the notion that people want to form correct attitudes (i.e., those that will prove useful in functioning in the environment) as a result of exposure to a persuasive communication, but there are a variety of ways in which a reasonable position can be adopted.

The most effortful procedure for evaluating an advocacy involves drawing upon prior experience and knowledge to carefully scrutinize and think about all of the issue-relevant information available in the current environment along the dimensions that are perceived central to the merits of the attitude object. According to the ELM, attitudes formed or changed by this *central route* are postulated to be relatively persistent, predictive of behavior, and resistant to change until they are challenged by cogent contrary information along the dimension or dimensions perceived central to the merits of the object. However, it is neither adaptive nor possible for people to exert considerable mental effort in processing *all* of the persuasive information to which they are exposed. This does not mean that people never form attitudes when motivation and/or ability to think are low; in contrast, they may change via a peripheral route, wherein relatively simple associations, online inferences, and well-learned heuristics are utilized. For example, a person might be more persuaded by a message containing nine rather than three arguments because each of the arguments is evaluated and determined to be compelling (central route), or because the person simply counts the arguments and reasons and assumes 'the more the better' (peripheral route). Attitudes formed or changed by the central route processes are postulated to be relatively more persistent, resistant, and predictive of long-term behavior than those based on peripheral route processes. Thus, the ELM

holds that both central and peripheral processes are important for understanding attitude change, but their influence varies depending on the likelihood of thinking.

The ELM holds that there are many variables capable of affecting elaboration and influencing the route to persuasion. Some variables affect a person's motivation to process issue-relevant information (e.g., the personal relevance of the issue; personal accountability for a decision; whether the person is relatively high or low in need for cognition), whereas others affect their ability or opportunity to think about a message (e.g., the presence of distraction; the number of times the information is repeated; the amount of issue-relevant knowledge available). Some variables affect processing in a relatively objective manner (e.g., distraction disrupts whatever thoughts a person is having whether favorable or unfavorable to the proposal), whereas others influence elaboration in a biased fashion (e.g., a positive mood makes positive thoughts more likely than negative thoughts when people are motivated and able to think). Biases can stem from ability factors (e.g., a biased knowledge store) and motivational factors (e.g., when a desire to maintain one's current attitude is more salient than one's desire to objectively consider new information).

Research on the ELM has shown that when the elaboration likelihood is high (e.g., high personal relevance, high knowledge of topic, simple message in print, no distractions, etc.), people typically know that they want and are able to evaluate the merits of the information presented, and they do so. When thinking is high, the number, valence, and confidence people have in their thoughts determine the extent of influence. The extensive thinking that people do can be relatively objective or biased. On the other hand, when the elaboration likelihood is low, people know that they do not want and/or are not able to carefully evaluate the merits of the information presented (or they do not even consider exerting effort). Thus, if any evaluation is formed, it is likely to be the result of relatively simple associations or inferences (e.g., agreement with an expert source; counting the number of arguments presented). When the elaboration likelihood is moderate (e.g., uncertain personal relevance, moderate knowledge, moderate complexity, etc.), however, people may be unsure as to whether the message warrants or needs scrutiny, and whether or not they are capable of providing this analysis. In these situations, they may examine the persuasion context for indications (e.g., is the source credible?) as to whether or not they should attempt to process the message.

There are at least two important implications of the ELM. First, the model holds that any one variable can produce persuasion by different processes in different situations. For example, putting people in a positive mood can influence attitudes because of a simple inference process when the likelihood of thinking is low (e.g., 'I feel good so I must like it'), bias thinking when the likelihood of thinking is high (i.e., making positive interpretations more likely than negative ones), and influence the extent of thinking when it is not already constrained to be high or low (e.g., thinking about an unpleasant message less when happy than when sad). In addition to considering the extent of thinking, it is also important to consider the timing of key persuasion variables such as whether they are salient before or after message processing. For example, if a person is motivated and able to think about

a message, inducing happiness prior to the message will likely lead to biased thinking about the message. However, when happiness is induced right after message exposure, it is likely to affect the confidence people have in the thoughts that they have already generated. Thus, by considering the likelihood of thinking and the timing of persuasion variables, the mechanism by which the variable affects attitudes can be understood. Second, as explained next, the ELM holds that the mechanism of persuasion has implications for the strength of the changed attitude. The ELM holds that not all attitude changes of the same magnitude are equal. Specifically, thoughtful attitude changes (central route) tend to be more consequential than nonthoughtful changes (peripheral route).

Consequences of Attitude Changes Produced by Different Processes

It is now clear that there are a variety of processes by which attitudes can be changed, and that the different processes dominate in different situations. That is, some attitude change processes dominate when motivation and ability to think are high, but other change processes dominate when motivation and ability to think are low. Research suggests that attitudes formed by different processes often have different characteristics. For example, *persistence* of persuasion refers to the extent to which attitude changes endure over time. When attitude change is based on extensive issue-relevant thinking, it tends to persist longer than when it is not. However, multiple exposures to positive cues can also produce relatively persistent attitudes.

Resistance refers to the extent to which attitude change is capable of surviving an attack from contrary information. Attitudes are more resistant the stronger the attack they can withstand. Although attitude persistence and resistance tend to co-occur, their potential independence is shown conclusively in William McGuire's work on cultural truisms. Truisms such as 'you should brush your teeth after every meal' tend to be highly persistent in a vacuum, but very susceptible to influence when challenged. People have very little practice in defending truisms because they have never been attacked. These beliefs were likely formed with little issue-relevant thinking at a time during childhood when extensive thinking was relatively unlikely. Instead, the truisms were probably presented repeatedly by powerful, likable, and expert sources. As noted above, the continual pairing of an attitude with positive cues may produce a relatively persistent opinion, but it may not prove resistant when attacked. The resistance of cultural truisms and other attitudes can be improved by motivating and enabling people to defend their positions in advance of a challenging communication. One such *inoculation treatment* involves exposing people to a few pieces of counterattitudinal information prior to the threatening communication and showing them how to refute it. The inoculation procedure does not change the valence of a person's initial attitude, but it makes it stronger. Other persuasion treatments that seem ineffective in changing the valence of attitudes might nonetheless be effective in modifying the strength of the attitude, making it more or less enduring, resistant, or predictive of behavior than it was initially.

Perhaps the most important consequence of attitudes changed by high rather than low thought processes is that these attitudes are more likely to predict and guide behavior. There are several reasons for this. First, as noted above, high thought attitudes are more likely to be stable over time so that they will be available to guide behavior when the opportunity arises. Second, however, attitudes based on high amounts of thought are also held with greater confidence, making people more willing to act on these attitudes. Interestingly, recent research by Barden and Petty shows that if attitude confidence is increased even in the absence of enhanced thinking, people are more willing to act on these attitudes, providing a relatively low thought way to increase attitude strength.

Summary

In sum, contemporary persuasion theories hold that changes in attitudes can come about through a variety of processes which imbue them with a multiplicity of characteristics and render them capable of inducing a diversity of consequences. According to the popular dual process logic, the processes emphasized by the central route theories should be largely responsible for attitude change when a person's motivation and ability to scrutinize issue-relevant information is high. In contrast, the peripheral route processes should become more dominant as either motivation or ability to think is attenuated. This framework allows understanding and prediction of what variables affect attitudes and in what general situations. It also permits understanding and prediction of the consequences of attitude change. It is now accepted that all attitudes can be based on cognitive, affective, and behavioral information, and that any one variable can have an impact on persuasion by invoking different processes in different situations. Finally, attitudes that appear identical when measured can be quite different in their underlying basis or structure and thus can be quite different in their temporal persistence, resistance, or in their ability to predict behavior. Work on attitude change to the present has focused on the intrapsychic processes responsible for change in adult populations mostly in Western cultures. Future research is needed on the interpersonal processes responsible

for attitude change, and the potentially different mechanisms that produce change in different population groups (e.g., children vs. elderly individuals, those in individualistic vs. collectivist cultures). In addition, as the field matures, current theories are ripe for exportation to important applied domains such as health promotion (e.g., AIDS education), political participation (e.g., determinants of voter choice), and others.

See also: [Persuasion](#).

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Attitude Formation

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Glossary

Attitude Positive and negative evaluations of things, people, and concepts.

Implicit cognition Cognitive processes that operate efficiently and involuntarily, and often without the awareness of the perceiver.

Priming Happens when exposure to a stimulus influences responses to another stimulus, often in the absence of awareness.

Tripartite model A method of categorizing different attitude formation processes into affect (emotions), cognitions (beliefs), and information about attitude-related behavior.

Introduction and Relevant Distinctions

Attitudes are positive and negative evaluations of things, people, and concepts. A person might, for example, feel positively toward his or her mother, value his or her car for its reliability, be suspicious of foreigners, and constantly crave chocolate. All of these are attitudes in that they imply positive/approach tendencies or negative/avoidance tendencies and involve summaries of the value of the object. Such precomputed summary judgments of attitude objects are functional in that they help prepare the individual for action so that one does not need to deliberately make important decisions from scratch every time a behavioral opportunity arises. In other words, because people know what they like and dislike, they can spend less time pondering what to buy and consume, for whom to vote, how to behave, and with whom to affiliate. They need only consult their attitudes toward the relevant object and act in accordance with it. Indeed, attitudes have been considered 'ready aids' for sizing up the world and how to live in it, and it is difficult to imagine how people could function without having a grasp of the things that benefit and sustain them and things that could potentially hinder or harm them.

The attitudes people hold toward the objects in their world have immense personal and social consequences. Attitudes have been implicated in health behavior (e.g., attitudes toward regular physicals or safe sex practices), politics (e.g., attitudes toward general political ideologies or more specific political figures), consumer behavior (e.g., attitudes toward various brands and products), and social conflict (e.g., attitudes toward various religious groups and ethnicities), among many other domains. Because attitudes are so relevant to such an array of life domains, and because they are thought to be important determinants of behaviors and judgments (at least under certain conditions), the attitude concept is one of the most well-studied concepts in the field of psychology. Hence, an understanding of the basic origins of attitudes is critical to understanding human psychology in a more general sense.

For most people, attitudes' origins are often understood on a per-case basis, whereby one simply attempts to identify the source of each attitude individually (e.g., 'I learned to like blue cheese from my mother,' or 'I like Volvo cars because of their safety record'), without considering broader themes. Social scientists consider such broader themes and, in so

doing, have provided some ways to organize attitude formation processes. The first and most prevalent is referred to as the tripartite approach, whereby attitudes' origins are considered in terms of affect (based on affect or emotion), cognition (based on belief or cognition), behavior (based on information derived from one's own behavior), or some combination of the three. More recently, researchers have distinguished between explicit origins, where attitudes are derived consciously through some sort of thoughtful and effortful process, and implicit origins, where attitudes form without conscious intent or awareness on the part of the person. In this article, attitude formation processes are discussed in terms of their tripartite and implicit versus explicit origins, with each being discussed in turn.

A final distinction is whether a given attitude is learned (either socially or through direct experience) or biologically derived (either genetically or through evolutionary processes). Although most attitudes of interest to social scientists are typically assumed to be learned, there is evidence that some attitudes are meaningfully influenced by biological processes relating to genetics and evolution. This article describes the main sources of attitudes as they have been studied by social scientists and considers some additional issues when pondering about the origins of attitudes.

Origins

Cognitive Origins

One way an individual may come to evaluate a particular object is through acquiring positive or negative beliefs about the object. One may read information outlining the significant, harmful health effects of smoking and consequently develop beliefs that cigarettes lead to negative outcomes such as lung cancer and emphysema. Attitudes can develop through this often thoughtful, 'rational' route as individuals acquire cognitions that inform them whether an attitude object leads to good or bad outcomes or possesses wanted or unwanted qualities.

The most prominent framework within which to understand the cognitive origins of attitudes is the expectancy-value model. The model claims that an attitude is a function of the expectancy that the object has certain attributes and the value attached to each of the perceived attributes of the attitude object. The *expectancy* is one's belief about whether the

attribute will occur, and the *value* represents one's evaluation of the attribute. For example, in forming an attitude toward smoking, one might think of various attributes of smoking cigarettes (that they cause cancer, make one appear cool), determine how (un)favorable they find each attribute, and then assess the likelihood that each will occur. I might believe that smoking cigarettes will make me look cool and that this outcome is quite good (high positive value) but is only marginally likely to occur (low expectancy). Additionally, I am keenly aware of adverts stating that smoking cigarettes leads to an increased risk of lung cancer, and I conclude that this is clearly a negative outcome (high negative value) that according to published statistics is likely to occur (high expectancy). These values and expectancies are then combined, yielding an overall attitude toward the object. In the aforementioned example, I really want to look cool but I do not want to get lung cancer. Since looking cool is quite positive yet not likely, and getting cancer is quite negative as well as likely, the net sum of my attitude should be negative. As one might imagine, this model represents a conscious, *explicit* process, requiring a certain degree of attention and deliberate effort.

Similar to the expectancy-value model is information integration theory. This model states that as new object-relevant information is learned, it gets added to existing thoughts and beliefs about the object, and the result of this integration produces an attitude. At first, each piece of new information is added in a way similar to the expectancy-value model. However, in this process, the potential (un)favorability of each new attribute is evaluated, and this evaluation is combined with a judgment about the importance of the attribute in forming the attitude. Once we determine how we think about the attributes of an attitude object and how important each attribute is in determining the attitude, they can then be integrated with current attitudes and beliefs to form new attitudes. For example, I may learn that smoking leads to a risk of developing emphysema, an unfavorable outcome, which I deem as unimportant (perhaps because this consequence occurs in the distant future). However, if I already possess thoughts that smoking will make me feel relaxed – a likeable outcome that I place more value on because it is so immediate – then it will comprise a larger portion of my complete attitude toward smoking. This last point touches on an important distinction between the value-expectancy model and the information integration model. Information integration theory acknowledges that when forming attitudes toward objects, not all pieces of information are entered into the equation equally. Rather, some beliefs are learned earlier, or may be seen as more important, and therefore have more influence on information learned later.

Among other explicit, belief-based approaches to attitude formation are the reception-yielding model and the cognitive-response model. Both of these models are less concerned with calculations in their descriptions of how attitudes form and focus rather on the explicit reactions to people's thoughts about what they learn about attitude objects. The reception-yielding model describes a two-stage process where one initially receives object-relevant information and then chooses to either yield to it (i.e., change one's evaluation of the object in light of the new information) or reject it (i.e., maintain one's evaluation of the object despite the new information). Considering the previous smoking example, when deciding how I feel

about smoking, I might read the surgeon general's warning about birth defects caused by smoking while pregnant (reception) and then adjust my attitude toward smoking due to this potential health risk (yield). Although this model has been primarily applied to attitude change, it can be used to describe how people perceive information and form attitudes from scratch based on their own thoughts about what they learn. Thus, this approach helps us understand the origins of attitudes based not simply on what people learn about an object but how they respond to what they learn.

The cognitive-response model presents another process by which attitudes form in an active, deliberate, and explicit manner. When we encounter an attitude object, we tend to actively relate qualities and information about the object to existing thoughts. The process of relating new bits of information to those already held results in cognitive responses concerning the attitude object, and the extent to which these responses are (un)favorable determines our overall evaluation of the object. When I learn that cigarettes are expensive, for example, I relate this new, negatively evaluated thought to my preexisting thought that cigarettes also make one smell bad. Taken together, I conclude that there are more negative aspects of smoking (cost and interpersonal consequences) than there are positive qualities (it feels pleasurable), and I form an overall negative attitude toward smoking.

A more recent development in the literature on the cognitive origins of attitudes is the metacognitive model (MCM). According to the MCM, one considers the various qualities of the object, but also considers the truth value of each of his or her beliefs about the object. One might, for example, consider some beliefs about the object to be more certain than others. Therefore, it is possible to have contradictory cognitions about an object, with some cognitions labeled as valid (presumably allowing these attributes to exert greater influence) and others labeled invalid (presumably not influencing one's overall attitude). Interestingly, the application of these so-called validity tags requires some amount of effort, and in the absence of such effort (as when one has little time or energy to think), all cognitions are available to influence one's attitude, even those that one might not believe to be true. I may possess the negative cognition that cigarettes cause cancer, but I supplement this belief with an invalidity tag (i.e., 'this is not applicable because it only applies to long-term smokers and I have only been smoking recently and plan to quit'), so when asked, I might claim to have a positive attitude toward smoking, even though I still harbor some negative beliefs about it.

The aforementioned descriptions of cognitive routes to attitude formation all share a relative reliance on thoughtful conscious processes. It is worth noting that cognitive origins are called so because they have at their core cognition or beliefs about the attitude object. This fact, while implying that some minimum of explicit, deliberate effort be present during the formation process, still leaves open the possibility that attitudes can form through implicit, less-conscious forms of learning. Unconscious thought theory, for example, argues that one can process large amounts of information outside of conscious awareness, compared with the relatively small amount of information that can be consciously processed at one time. Unconscious thought has been shown to give individuals the ability to process large amounts of information, perhaps allowing for

attitudes to form by consolidating cognitions even in the absence of any deliberate or conscious intentions. When bombarded with complex information about an object, it often becomes difficult to weigh the pros and cons using the more explicit manners discussed previously. Unconscious thought provides the possibility of taking large amounts of object-relevant information and, in essence, letting the powerful, unconscious parts of the brain do the work, yielding an overall evaluation of the attitude object that is presented to consciousness later as a gut feeling.

Lastly, the value-account model outlines another cognitive yet implicit process by which attitudes have been shown to arise. Overall evaluation of objects attitudes can be characterized as value accounts comprising the positive or negative values associated with the various attributes of the object. When new information is obtained, it gets incorporated into the account, and the value, or evaluation, of the account linked to the object changes the overall value or attitude toward the object. This process has been shown to function even outside of deliberate control, such that individuals who are engaged in another task designed to deprive them of cognitive resources are still able to detect valence information concerning an attitude object, and this information has been shown to influence overall evaluations of the attitude objects. Applied practically, if I have an overall positive attitude toward cigarette smoking (a positive value) and am exposed repeatedly to antismoking billboards describing the number of deaths caused every year by smoking, my attitude should become more negative due to the incorporation of negative-valued information, even though the bulk of my attention is fixed on the task of driving and not on deliberately processing public health bulletins.

Affective Origins

In addition to thoughts, attitudes can also form from the emotional responses that we experience when we encounter an attitude object. For example, I may experience a pleasurable feeling while smoking a cigarette, and this affect could lead me to have a positive attitude toward smoking. Or, I might think about the negative health effects of long-term smoking such as lung cancer or death, and I experience a distinctly negative attitude instead. These examples highlight several ways that affect can be used to form attitudes toward objects. It is worth noting that the aforementioned first example derives solely from an emotional response, but the second example is based on an emotional experience felt in response to a cognition concerning the attitude object. This highlights the fact that affective origins can be directly experienced or derived secondarily from an object quality. In this section, we focus on affect, independent of whether it is in response to a thought about the object. Later, we address how affective responses lead to attitude formation and then we consider three processes that lead to affectively derived attitudes: operant conditioning, evaluative (a form of classical) conditioning, and mere exposure. Operant conditioning, a process by which the frequency of a response is increased following a positive outcome and decreased following a negative outcome, can provide one mechanism for the formation of affectively based attitudes. If interaction with the attitude object causes a positive emotional response, then the evaluation of the attitude object will

become more positive and this connection will strengthen, resulting in a positive general attitude. Research has shown that individuals who were reinforced when recalling favorable responses toward an object (via hearing 'good' in response to these recollections) later demonstrated more positive attitudes toward the object, compared to unreinforced participants. If every time I smoke a cigarette and I am reinforced with a positive feeling from nicotine, the act of smoking will be reinforced, resulting in a stronger positive attitude toward smoking. Conversely, if every time I light a cigarette everyone leaves the room, the likelihood of my smoking will decrease and I will develop a negative attitude toward it. Thus, attitudes can be formed by experiencing positive or negative outcomes based on our attitudinal responses, and the more often one's responses are reinforced, the more likely that attitude will manifest itself in the future.

Operant conditioning tends to occur in an explicit fashion with one consciously perceiving the reinforcing outcomes of relevant behavior. Classical conditioning, while similar to operant conditioning, does not require that the person respond to an attitude object. Instead, the connection between an object and an affective evaluation develops by simply observing the pairings between an attitude object and a positively or negatively evaluated stimulus. Observing these pairings creates an association between the previously neutral object and the valence of the object with which it is paired. For example, researchers created positive and negative attitudes toward two names ('Ed' and 'George') by visually presenting these names to participants on index cards while having them repeat aloud positive or negative adjectives that were paired consistently with either name. Importantly, this occurred even though there was no meaningful relationship between the names and the adjectives. When considering our smoking example, repeatedly noticing advertisements containing attractive models engaged in smoking behavior can lead to a change in one's attitude toward smoking due to the transfer of the positive affect associated with the attractive model to the cigarette brand. This can occur in an explicit fashion where one is consciously aware of the pairings of the attitude object (cigarettes) and the valences stimuli (attractive model).

Research on a variant of classical conditioning – evaluative conditioning – has shown that attitudes can form via affective connections between an object and another, valenced object, without conscious awareness of this relationship. Like classical conditioning, evaluative conditioning happens when a previously neutral object takes on the valence of stimuli that co-occur with the previously neutral object. Studies have shown that participants who view a novel object repeatedly paired with positive stimuli will later evaluate the novel object more positively, whereas novel objects repeatedly paired with negative stimuli will come to be viewed more negatively. There has been some debate concerning whether this process of attitude formation occurs in an explicit fashion where awareness of the connection between attitude objects and valenced associates is necessary, or whether it can occur implicitly, in the absence of such awareness. Recent work seems to indicate that it depends. Explicit awareness of the repeated pairings of neutral objects with strongly positive or negative stimuli leads an individual to form consciously held beliefs concerning the relationship between the two. However, if one remains unaware of the

repeated contingencies between a neutral object and a valenced stimuli, then the affect from the valenced stimuli can be implicitly misattributed to the previously neutral object, resulting in an attitude, the origins of which remain obscured to the attitude holder. If every time I sit next to an ashtray, my sense of smell is insulted by the foul stench of old cigarette smoke, I am likely to associate smoking with the negative feelings elicited by the smell of smoke, and whether I become conscious of the association between the negative affect and smoking will determine whether this attitude stems from a propositional, explicit process or an implicit, misattributional process. Research on the 'mere exposure' effect has also shown that simply increasing the familiarity of an attitude object can create more positive attitudes toward the object. In a study that presented Turkish words or Chinese symbols to participants in increasing frequency, those who observed more repetitions of the words or symbols showed a more favorable attitude toward them compared to others who saw the stimuli infrequently. This is due to a phenomenon known as 'perceptual fluency,' that is, greater ease at perceiving an object upon subsequent encounters, which is interpreted as liking for the object. Thus, the more familiar one is with the attitude object, the more likely one is to have a positive evaluation of it. So, if I choose to smoke, in the absence of other considerations, I am likely to prefer a brand of cigarettes that I have been exposed to in the past more than a brand I have never before encountered, even if I am unable to consciously recall which brand I have seen more often in adverts. Similar to the conditioning research described previously, mere exposure research outlines a way attitudes can form due to affect alone, without reliance on cognitions regarding an object's attributes, and often in the absence of explicit awareness of the underlying process.

Behavioral Origins

In situations where we lack either a cognitive or affective basis for an attitude, we can infer an attitude by observing our past behavior toward the object in a process of self-perception. When the internal cues that might otherwise normally lead to an attitude are weak, we instead make inferences regarding our behavior much like an outside observer would make. Consider our earlier example. I may not have any solid beliefs about the benefits or hazards of smoking, nor does the idea of smoking elicit any salient emotion. However, I may recall that I have smoked in the past, and I therefore conclude that I must have a positive attitude toward smoking – why else would I have behaved so? This scenario exemplifies how attitudes can have a behavioral genesis whereby our attitudes fall in line with our self-perceived actions.

Research on cognitive dissonance provides a framework to understand how attitudes can stem from past behaviors toward an attitude object when one has preexisting evaluative knowledge of the object. Cognitive dissonance occurs when an individual experiences an inconsistency between thoughts and behaviors concerning a target object. This state of dissonance is characterized by a negative state of arousal, which the individual seeks to correct by restoring consonance between the attitude and the behavior. If my behaviors include smoking cigarettes and I possess cognitions that cigarettes can lead to cancer, I would be susceptible to the negative affect created by

the conflict between my thoughts and behavior. To restore consistency, I can either quit smoking, thus realigning my thoughts and behaviors, or change my cognitions concerning the health risks of smoking (e.g., arguing that only heavy smokers will develop cancer) so that the cognitive component of my attitude toward smoking is no longer in conflict with my actions related to smoking. Thus, the behavior informs the attitude.

Similar research has shown that we are often nonconsciously tuned into subtle bodily gestures that inform us as to how we feel about an object. In a seminal study on the behavioral antecedents of attitude formation, participants held pencils in their mouths while viewing cartoons and were asked to rate how funny they felt the cartoons were. Some participants held the pencil with their lips, simulating a frown, while others held it with their teeth, simulating a smile. Participants who exhibited a smile while viewing the cartoons rated them as funnier than those who frowned. In a related research, participants induced to nod their heads while perceiving social stimuli rated those stimuli more positively than stimuli perceived while they were made to shake their head from side to side. Thus, in the absence of an obvious external reason for behavior, we infer an internal one, and this attribution can result in a new attitude that is consistent with our actions.

Self-perception, and its effects on attitude formation from our overt behavior, can have the opposite effect if it is applied when one already possesses an attitude. Researchers led preschoolers to engage in an enjoyable activity (drawing with magic markers) and promised some children a reward for participating in the activity while providing no reward for other children. When later given the chance to engage in the activity, children given the reward spent only half as much time coloring with the markers as did children who had not been given a reward. The explanation rests on an overjustification effect, where children who had played while anticipating a reward must have perceived that they did so because of the reward, whereas the others perceived that they engaged in the behavior simply because they liked it.

Biological Origins

Many social attitudes (e.g., racial, political, and interpersonal attitudes) probably are learned, as shown by the wide and easily observed varieties of attitudes in such areas. However, universal attitudes that show little cultural variation (e.g., xenophobia or a preference for sweet foods) can also be observed, suggesting biological origins. Moreover, cultural variation in a given attitude does not itself rule out a role for biological origins, as biological processes must interact with experience to produce a given attitude or behavior. Interest in the biological origins of attitudes has waxed and waned in the social sciences, and those advocating an evolutionary perspective have been attacked by critics for a variety of reasons, not the least of which is the notion that evidence for biological origins of attitudes might be taken as evidence of 'fixedness' (the impossibility of change). Others have voiced concern that evidence of biological origins might be misconstrued as justification for the existence of a given attitude or trait (the 'what is natural must be good' argument, also known as the adaptationist fallacy).

Evolutionary supporters tend to focus on mate preferences as examples of evolved attitudes. For example, owing to their greater costs to produce offspring, women are thought to be 'choosier' in selecting a mate and prefer a mate who shows evidence of both willingness and ability to invest in the health of the woman and her offspring. Men, however, are more likely to prefer a greater number of mates and be less careful about their mate choices, because their investment in offspring production is less. Moreover, men prefer potential mates with outward indicators of fertility, such as a waist-hip ratio of about 0.80, which has been shown to lead to more successful offspring production. Cross-cultural data on attitudes toward potential marriage partners consistently support this reasoning.

Flexibility in mate preferences is in line with an evolutionary perspective as well, as women will tend to show an increased preference for mates of high genetic value (e.g., more attractive men), as well as more aggressive and competitive mates, during the most fertile points of the menstrual cycle. Preferences for a mate who is willing and able to provide resources do not vary as a function of the menstrual cycle.

Little progress has been made in addressing more social scientific-oriented attitudes (e.g., racial and political attitudes) from an evolutionary perspective. There are some exceptions, however, including some research suggesting that racial prejudice may be a natural extension of an evolved preference for people who appear more similar to oneself. Another simple extension of evolutionary approaches to attitude research involves food preferences. Mammals, which acquire immediate energy from the ingestion of sugars and starches and long-term storable energy from fats, have likely evolved a taste for both. Hence, positive evaluations of foods high in sugars and fats are likely to have evolved components.

Other biological approaches to the study of attitude formation come from behavioral genetics research. Here, studies of identical twins who were either reared in similar or different environments have come to show that some attitudes are linked to genetics. For example, attitudes toward jazz, the death penalty, and some political ideologies have been shown to have genetic components, whereas attitudes toward coeducation have not. Attitudes may have heritable components because of their links to other traits with clear evidence for heritability (e.g., intelligence, openness). For example, because intelligence is somewhat genetically determined, attitudes related to intelligence may be at least partially determined by genes. Because a preference for jazz music is associated with intelligence, and intelligence has genetic components, a preference for jazz is indirectly linked to genetics. Similar arguments can be made about other biologically determined traits such as physique and preferences for various physical activities. Indeed, recent twin research suggests that one of the more studied social attitudes – prejudice – may have genetic components.

Regarding their implicit versus explicit origins, a preexisting biologically based tendency toward a given set of attitudes may suggest a more implicit basis. Indeed, people are seldom able to explain why they prefer sweet and fatty foods, or members of their own group, without referring back to their attitude in a circular fashion. However, people are certainly aware of their food preferences, and most social scientists would agree that they are also aware of their prejudices, whether they wish to admit them publicly or not. Thus, we must consider what

we mean by 'implicit.' Here, researchers typically refer to an attitude as implicit if one is unaware of its origins, its influence on judgments and behavior, or both. Attitudes partially determined by biology probably meet these criteria, as people have a difficult time generating the underlying reason – the foundation – for their food preferences, preferences for their own groups, etc. Similarly, it was mentioned that men tend to prefer a certain waist-hip ratio in women, but most would be unable to explain the evolutionary origins of their preference for more shapely feminine forms. Hence, biologically determined attitudes are liable to have implicit origins, although many of them are certainly further molded by culture and personal experience.

Additional Considerations

The question of how attitudes form has been thoroughly investigated for several decades by social scientists, but it is difficult to isolate this origins question from several other relevant issues. Thus, the final section discusses additional concepts related to attitude formation in the hopes of providing a broader context.

First, we have covered the different attitude formation processes individually, but we must also point out that such processes are likely to combine and interact in real-world attitude formation situations, and some research has investigated these more complex situations. It is also likely that the different formation processes are mutually reinforcing in natural environments, such as when one uses one's affective reactions to an object as cause to seek positive cognitively oriented information about it. Similarly, one's biological predispositions to prefer sweet foods are often reinforced by cultural information that encourages the consumption of sugary foods. However, interesting situations arise when two or more formation processes conflict. We have already mentioned the case of cognitive dissonance, where knowledge of one's behavior contradicts either other beliefs or other affective reactions regarding an object. Conflict also arises when affective and cognitive reactions disagree, such as when one feels warmly toward an object he or she believes has negative effects (e.g., smoking or an unhealthy relationship partner). Such situations are usually unstable and prompt discomfort in the perceiver that he or she is motivated to reduce.

Attitudes are also related to other social constructs studied by social scientists, including morals, values, impression formation, and social judgment. Morals and values have been considered classes of attitudes that relate to interpersonal conduct. Impression formation is a bit broader than attitude in that it involves not only the question of whether we come to like someone, but also whether we think of the individual as having specific traits (e.g., introversion, extroversion, etc.). Social judgments are made at a specific point in time, whereas attitudes, potentially among other information, are brought to bear on a specific case, such as when someone judges a particular politician as qualified to hold public office. Judgments are single cognitive acts, whereas attitudes are thought to have some longevity in the person's mind. Thus, answers to questions about the origins of attitudes can also be found in these literatures.

Although this article is about attitude formation, another article in this volume is directly relevant. Although the concepts differ in that the former addresses how attitudes come about without the existence of a prior attitude and the latter addresses how one's attitudinal position can change over time, in reality, the research paradigms and theories used to describe these processes differ only trivially. Indeed, most persuasion research involves cases where no attitude existed prior to exposure to a persuasive message. Hence, most persuasion research directly informs attitude formation research.

Attitudes also vary in important ways, and attitude formation processes have implications for these other attitudinal qualities. For example, attitudes vary in strength, that is, their persistence over time, their ability to predict behavior, and their resistance to counter-persuasion attempts. Stronger attitudes are more likely to form from direct experience with the attitude object as opposed to hearsay or indirect experience. Affectively based attitudes also tend to be better predictors of behavior in many domains, particularly regarding political attitudes and voting behavior. However, evidence from persuasion research indicates that attitudes formed through more thoughtful processes are often stronger. There is also some evidence that attitudes of a biological origin are less malleable.

An attitude's ability to predict behavior is part of its appeal to psychologists, but one should not assume that attitudes should always predict behavior. Specific theories describe when attitudes are likely to predict behavior, and some argue that an attitude's origin must be taken into account when considering whether it might predict behavior. For example, because people are less able to articulate the bases of implicitly formed attitudes, they are less likely to notice their influence. Implicit attitudes are then likely to leak out into one's behavior without one's awareness. For example, racial prejudice, if formed gradually through socialization processes that one rarely acknowledges, is likely to appear in one's less-controllable behavior. For example, in one study, Black participants were able to detect racial prejudice in Whites' nonverbal behavior. Controllable behavior is less likely to be influenced by implicitly formed attitudes and is instead more influenced by explicitly held attitudes.

In conclusion, fundamental goals of the science of psychology include the ability to explain and predict human behavior.

Because attitudes are so central to achieving these goals, attitudes hold a central place in psychology. Further, an understanding of an attitude's origins is useful in understanding its later influences on behavior. This article has addressed several formation processes – affective, cognitive, behavioral, and biological, as well as implicit and explicit. Although the power of each of these formation processes is appreciated by social scientists generally, there is still considerable debate about the role of each (e.g., whether implicit or explicit formation processes are more pervasive). The further reading section provides examples of such debates, as well as more thorough treatments of attitude formation processes in general.

See also: Impression Formation; Persuasion; Prejudice, Discrimination, and Stereotypes (Racial Bias).

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Attribution

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Glossary

Actor–observer effect Attributing other people's behavior to dispositions, but one's own similar behavior to the situation.

Attributional complexity Highly developed attributional knowledge structures.

Causal attribution An inference about why an event or behavior occurred.

Causal uncertainty Doubt about one's abilities in the area of attribution.

Correspondence bias Attributing an event that can be explained by the situation to dispositions.

Dispositional attribution Something about the person caused the behavior.

Implicit theories Beliefs about the fixed or malleable nature of attributes.

Self-handicapping Creating an obstacle that makes it difficult to attribute failure to low ability.

Self-serving attributions Attributing one's successes to dispositions and failures to situational factors.

Situational attribution Something about the person's environment caused the behavior.

Introduction

Causal attribution involves identifying one or more factors as being responsible for bringing about a particular behavior or outcome. In short, it is the answer to the question 'why?' Research has found that this type of thinking can occur spontaneously when we observe another person's behavior. When we overhear a person shouting at a coworker, we may wonder why the person is shouting: Is it because he or she is just a rude person or was the person provoked somehow? Attributions are especially common when we are confronted with an unexpected or negative event. If a spouse suddenly announced that he or she wanted a divorce, the partner would want to know why. If a student failed a test, he or she would want to know why.

Note that there is no single, overarching theory of attribution. Rather, the literature about attribution consists of complementary theories that approach different aspects of the attribution process. The classical theories identify different types of attributions and specify the conditions under which each type should be drawn. Researchers then discovered that people often exhibit various attributional biases. They began to devote their attention to explaining why these biases occur. Contemporary theories focus on the cognitive processes that underlie the attribution process, differentiating the steps that occur automatically from those that take more effort. Increasing attention to individual and cultural differences in attribution has shed light on how basic beliefs about people and various motivations can influence the attributions people make. And lastly, a final set of theories illustrates the implications that different types of attributions have for motivation, well-being, academic performance, and marital satisfaction.

Classical Theories

Heider (1958)

Heider argued that we can learn a lot by examining lay people's understanding of the causes of action. It is their understanding,

right or wrong, that will influence their thoughts, feelings, and behavior. He also argued that causal understanding plays an important role in life. When people attribute transient events to stable underlying factors, they feel that they can predict and control their outcomes.

Heider distinguished between two sets of causes: person and environment. One type of person factor is power, which includes ability, self-confidence, mood, and fatigue. Another person factor is trying, which includes intentions and exertion. Environmental factors include task difficulty, luck, and opportunity. Of primary importance, according to Heider, is understanding the causes of intentional behavior. Intentional behavior occurs when a person consciously or unconsciously tries to bring about a particular consequence. When we can attribute such intentional behavior to stable underlying factors, such as ability or task difficulty, we gain a sense of prediction and control over future outcomes.

How do we know when it is appropriate to attribute an outcome to ability? The level of exertion can be used as a cue. Greater exertion is necessary when power is low or difficulty is high. To keep up with a professional marathon runner, for example, the average person would have to exert a great deal of effort. Thus, when perceivers observe a person successfully perform a difficult task with great ease, they might infer that the person has a high level of ability.

Heider's analysis of attribution sparked a great deal of interest. The task for subsequent researchers was to translate Heider's ideas into hypotheses that could be tested in the laboratory.

Jones and Davis (1965)

Jones and Davis focused on how perceivers infer intentions, and corresponding dispositions, from a person's choices. They argued that perceivers consider the effects of an action and try to figure out which effects were intended (rather than simply incidental or accidental). Perceivers also consider whether the actor was capable of bringing about the effects.

If they conclude that one or more effect was intentionally produced, they then try to figure out what it tells them about the person. They compare the chosen action with other possible unchosen actions. Perceivers attend to non-common effects, or the unique attributes of a chosen alternative. For example, imagine a person choosing from a set of computers or job candidates. If all computers in the set are of the same brand, or if all of the job candidates have expertise in the same area, these factors cannot help a perceiver understand why a person chose one over another. But if the chosen computer is the only one of a particular brand (e.g., the only Mac), or if the chosen candidate is the only one with a particular type of expertise (e.g., the only health psychologist), this factor can potentially tell perceivers something about the person who made the selection.

The social desirability of the effects, or how desirable a particular feature is, also matters. If a choice has several unique attributes, people typically assume that the factor attracting the person to that option was the more desirable one. For example, if the computer chosen was the only Mac and the most expensive, people would assume that the person chose the computer because it was a Mac, not because it was the most expensive. In terms of what one learns about the target, however, more unusual choices and behaviors are more diagnostic. If a person does what anyone else would have done, perceivers do not learn much. But if a target's behavior diverges from that of the average person, perceivers are more likely to draw an inference about the correspondent's disposition.

Kelley (1967)

Kelley's model describes how perceivers analyze behavioral information; typically about a person interacting with a social or nonsocial stimulus. Perceivers consider whether the person's reaction is similar when compared to different people (consensus), stimuli (distinctiveness), and occasions (consistency). Depending upon the information they gather or infer, perceivers may then attribute the reaction to something stable about the person or the entity.

As an example, perceivers may learn that Jennifer likes her English professor. They would then analyze whether the effect (liking) covaries with the person (Jennifer), the stimulus (the English professor), or the particular occasion. Do other people like the English professor? Does Jennifer like her other professors? Has Jennifer always liked this professor? When the cause is present, the effect should be present; when the cause is absent, the effect should be absent. If we find that other people do not like the English professor (low consensus), Jennifer likes her other professors (low distinctiveness), and Jennifer has always liked the English professor (high consistency), we would draw a dispositional inference: something about Jennifer is causing her to like the English professor. However, if we find that other people like the English professor (high consensus), Jennifer does not like her other professors (high distinctiveness), and Jennifer has always liked the English professor (high consistency), we would draw an external attribution: something about the English professor is causing Jennifer to like him or her. Other potential outcomes would lead to attributions of some combination of the person, the stimulus, and/or the particular circumstances.

Abnormal conditions focus model

An alternative way of understanding the role of consensus, distinctiveness, and consistency information in attribution comes from the abnormal conditions focus model. It posits that perceivers contrast a target event with other events, identify any abnormal feature(s) of the target event, and use the abnormal feature(s) to explain the target event's occurrence. When few other people react the same way to a stimulus (low consensus), the target person seems abnormal. For instance, if someone loves a relatively unpopular activity such as filling out a tax return or doing laundry, we may conclude it is due to something peculiar about the person. When a target person responds differently to other stimuli (high distinctiveness), the target stimulus seems abnormal. If a person likes everyone except for one particular coworker, for example, we would wonder about the coworker. When the target person responds differently to the target stimulus over time (low consistency), the present circumstances seem abnormal. If a person does not usually enjoy opera but enjoys it on a specific occasion, we would look to the occasion for an explanation. Perceivers also bring real world knowledge to the table. If an event is an ordinary occurrence (a scripted event that is high consensus, low distinctiveness, high consistency), nothing seems abnormal, and thus, the event does not need to be explained. If we learned that someone ordered food when they were at a restaurant, for example, we would not experience a pressing need to figure out why.

Summary

The classical attribution theories reviewed above established an interest in determining when perceivers attribute intentional behavior to something stable about the person (e.g., abilities or dispositions) or something stable about the situation (e.g., task difficulty or the nature of the stimulus). Each theorist focused on different potential determinants: Heider on the relationships between ability, task difficulty, and exertion, Jones and Davis on the outcomes of various choice options, and Kelley on other potential reactions as a function of differing actors, stimuli, and occasions. Common to all theories, however, is the assumption that it is not always appropriate to conclude that a person's behavior is due to some stable, inner disposition. However, as the next section reveals, people sometimes draw such conclusions even when a person's behavior can be completely explained by the situation.

Biases

Perceivers do not always follow logical rules or use all of the available information when making attributions. This section will review three widely studied biases in the attribution process: the correspondence bias, the actor-observer effect, and self-serving attributions. All of these biases involve a tendency to favor either dispositional or situational attributions for certain types of events.

Correspondence Bias

Logically speaking, people should not attribute a behavior to a corresponding disposition when the situation can explain

the behavior. For example, if a person writes arguments in favor of Fidel Castro after being instructed to do so by his or her debate advisor, a perceiver should not conclude that the author truly likes Fidel Castro. If a person is nervous while discussing anxiety-inducing topics, a perceiver should not conclude that the person is dispositionally anxious. However, studies have found that perceivers continue to draw dispositional inferences in such cases. This tendency is referred to as the correspondence bias, or the fundamental attribution error.

One reason for the bias is that perceivers are sometimes unaware of situational factors or the target's perception of them. If they are unaware that the topics are anxiety-inducing or that the author felt compelled to comply with the debate advisor's request, they cannot be expected to take these factors into account. Additionally, even if perceivers are aware of the situation, they may underestimate its power. They may mistakenly think, for instance, that most people would refuse to write arguments that conflicted with their beliefs. However, even if they were to recognize the full strength of the situation, that knowledge could bias their perceptions of behavior. Knowing that the person is discussing anxiety-inducing topics could make the person's behavior seem more anxious than it would otherwise seem. This type of influence is more likely to occur when the behavior is somewhat ambiguous. Lastly, as I will explain later, it can require greater effort on the part of the perceiver to factor in situational information. Thus, if perceivers are either unmotivated or unable to think carefully, they would not be expected to adjust their attributions in light of situational information.

Another factor that can encourage people to draw dispositional inferences is the motivation to maintain a belief in a just world. When another person experiences a negative outcome (e.g., homelessness, assault), blaming the person allows the perceiver to keep believing that the world is just and fair. It also can create a false sense of security; perceivers may believe that as long as they take the right precautions, they will be able to prevent negative outcomes.

Actor–Observer Effect

Although perceivers are likely to underweight situational information when explaining someone else's behavior, they are better at taking it into account when explaining their own behavior. For example, one study found that when interacting with another person, people attributed their own behavior to the situation, but their partner's behavior to his or her personal characteristics. This is known as the actor–observer effect. Researchers have discussed several reasons for this effect. First, actors are more aware of their feelings, intentions, prior situational factors, and past behavior than are observers. Second, situational factors are more salient to actors whereas behavior is more salient to observers. When engaged in an interpersonal interaction, we may further be cognitively occupied, unable to estimate the effect that we are having on the other person. We may also focus on how the other person differs from us since the environment is shared. Lastly, our tendency to see others primarily in dispositional terms may be sustained when we have limited opportunities to observe them across a variety of situations.

Self-Serving Attributions

Some researchers have argued that the motivation to feel good about oneself can affect the extent to which actors attribute their behavior and outcomes to situational factors. This motivation can lead people to make internal attributions for their positive outcomes and behaviors, and external attributions for their negative outcomes and behaviors. For example, one study found that participants who lost a game attributed their negative outcome less to skill and more to luck than did their opponents. Conversely, participants who won the game attributed their positive outcome more to skill and less to luck, compared to their opponents. Other researchers have argued that results like this can be explained without drawing on motivation. For instance, actors may perceive that their behaviors are connected to a greater extent with their positive outcomes than with their negative outcomes. Additionally, given that people typically intend to succeed and expect success, negative outcomes may be unexpected, and thus attributed to situational factors such as bad luck.

Automatic and Controlled Components

The classical attribution models reviewed in the first part of the article were primarily descriptive. Contemporary models delve into the underlying cognitive processes. Specifically, they break the attribution process into different stages or systems. They distinguish between relatively automatic processes and more controlled processes. Automatic processes are those that are efficient, unintentional, involuntary, or occur outside of awareness. Controlled processes are just the opposite: effortful, intentional, voluntary, and aware. These dual process models shed additional light on attributional biases, especially the correspondence bias. I will first describe three prominent dual process models, and then discuss two lines of research that illustrate specific issues relevant to the automatic and controlled ends of the processing spectrum.

Gilbert's Model

Gilbert's model of person perception focuses on the efficiency of different stages of the attribution process. According to his model, people first categorize behavior (e.g., she is being rude) and then characterize the person in dispositional terms (e.g., she is a rude person). These two stages are relatively automatic (efficient). The third stage involves factoring in the situation (e.g., she was just insulted), and it requires greater cognitive effort. Thus, if perceivers are unmotivated or unable to think carefully, they will not make it to the third stage. This model helps us predict when the correspondence bias is especially likely to occur: whenever perceivers lack the motivation or ability to engage in the final stage of processing.

A common methodology used to test Gilbert's model places some perceivers under cognitive load by having them rehearse a series of digits while learning about and rating a target person. Their judgments will be the product of only automatic stages (categorization and characterization), as they do not have the cognitive resources available to engage in the controlled stage (factoring in the situation). Researchers then

compare their judgments to judgments made by undistracted perceivers. Such studies typically find that cognitive load prevents perceivers from factoring in situational information.

However, other researchers have noted that situational information is not inherently more difficult to consider. If it is particularly salient, even distracted perceivers can use it to explain behavior. Additionally, if a perceiver's initial goal is to figure out the situation, he or she can automatically categorize the behavior (e.g., she is being rude) and characterize the situation (e.g., this is an aggravating situation). In the latter case, factoring in dispositional factors requires greater effort.

Trope's Model

Trope's model of person perception can easily accommodate the finding that people sometimes make relatively automatic situational attributions. In his model, perceivers automatically identify behavior and then engage in either diagnostic or pseudodiagnostic attributional reasoning. Diagnostic reasoning involves thinking about multiple potential causes (dispositions and situations), and it requires motivation and ability. Pseudodiagnostic reasoning is easier, but it focuses on a single cause (disposition or situation). So when situational information is made especially salient, it can be the focus of pseudodiagnostic reasoning, which can take place even under cognitive load.

Trope's model also goes into more detail about how salient information about the person and the situation can bias the early, relatively automatic stage of behavior identification. For instance, studies have found that perceivers will judge an ambiguous expression as sadder if they think a person was at a funeral when the picture was taken. This is an example of an assimilation effect, where perceivers see the behavior in line with the context (sad situation, sad expression). However, contrast effects can also occur, where judgments move away from the context. Several studies have found that exposure to a highly successful performance can make a subsequent performance seem less successful. This effect happens when perceivers are under cognitive load, indicating that it is automatic. Indeed, when perceivers are not under cognitive load, they correct for the influence. The latter finding also indicates that perceivers may correct for a number of factors (e.g., exposure to other targets) and not just situational factors when they are motivated and able.

Social Neuroscience Approach

Building on their interest in the automatic and controlled components of attribution, researchers have recently turned their attention to the neural substrates of attribution. They have proposed an X-system that carries out automatic, reflexive operations, and a C-system that carries out reflective, controlled operations. According to this model, the lateral temporal cortex, amygdala, and basal ganglia are involved in the X-system. Current experience is processed in a stream of consciousness fashion, interpreted through the lens of relevant past experience and current goals. The C-system comes online when the anterior cingulate sounds an alarm, indicating that further processing is needed. The prefrontal cortex and hippocampus then help perceivers use symbolic logic to make sense

of existing events. The social neuroscience approach opens up a new realm of possibilities for understanding and studying attribution.

Spontaneous Trait Inferences

Research on spontaneous trait inferences bears on the automatic side of the processing continuum, but focuses more on intentionality and awareness rather than efficiency. This research examines whether people spontaneously infer corresponding traits as causes of behavior. For example, if I read that Bob gave Sarah half of his sandwich, I may spontaneously infer the trait 'generosity.' Participants in these studies are typically asked to read sentences that describe behaviors, and then are prompted to recall the sentences with one of a number of prompts: the corresponding trait term (generous), the gist of the behavior (shared), or words that are semantically related to parts of the sentence (bread). Numerous studies have found that the trait terms help participants recall the sentences, suggesting that participants spontaneously inferred the traits when reading the behavior. This occurred even though participants had not been instructed to form impressions and even when the sentences were presented as a distracter task, indicating that the inferences were unintentional. Furthermore, participants tended to be unaware that they were drawing trait inferences. Thus, this research supports the idea that parts of the attribution process can occur automatically.

Trait-Behavior Relations

Research on trait-behavior relations allows us to better understand the corrections that may occur at the controlled end of the processing continuum. That is, to fully understand correction, we need to think about different kinds of traits and how they map onto behavior. When dealing with capacities or abilities, like intelligence or athletic ability, highly skilled people may perform well or poorly (e.g., if they are not trying), but unskilled people will typically perform poorly (assuming the task is at least moderately difficult). A poor performance, then, could be due to lack of capacity, or to situational factors such as direct instruction from others to perform poorly or the motivation to save an opponent from embarrassment. However, because an unskilled person is not capable of executing a highly skilled performance, a highly successful performance is diagnostic of high ability. Thus, even if perceivers are motivated to correct their dispositional inferences for any relevant situational factors, a consultation of their trait-behavior theories would tell them it is logical to assume that a highly successful performance is due to high ability, even if situational factors also encouraged success (e.g., trying to impress an audience or wanting to win a cash prize).

A similar asymmetry occurs with morality-related traits such as honesty. In this case, however, it is the immoral person who exhibits a greater range of behaviors. This type of person may behave morally some of the time and immorally at other times. However, a moral person should behave morally at all times. We learn more about a person, then, when we observe an immoral behavior. Even if a situational factor encouraged immoral behavior (e.g., another person suggested that the target person lie or steal), perceivers may not adjust their

dispositional inferences. Instead, they may maintain that a person who commits immoral acts is immoral. Moral behavior is more ambiguous, though, so perceivers would be more likely to correct their dispositional inferences in light of relevant situational pressures.

Perceiver Differences

Thus far, perceivers have been treated as interchangeable. Given certain information and certain processing constraints, perceivers will follow similar processes and arrive at similar conclusions. Indeed, that is the social psychological approach – to look for commonalities in people’s responses to social stimuli. However, we gain a deeper understanding of the attribution process by examining how perceivers differ from one another in experience and motivation. This section will examine individual and cultural differences in attribution.

Individual Differences

Researchers have identified a number of individual differences that are directly relevant to attribution. I will focus here on three: attributional complexity, causal uncertainty, and implicit theories about attributes. These constructs have been found to moderate classic attribution effects, such as the correspondence bias.

Attributional complexity

Attributional complexity includes a high level of interest in causal explanations, a preference for more complex, abstract, and temporally distal explanations, greater thought about the attribution process, and greater awareness of the influence that people have on each other. Psychology majors are higher in attributional complexity than natural science majors. There is also some evidence that women are higher in attributional complexity than men. People who are high in attributional complexity generate more causes when describing a friend’s personality, and when making attributions for hypothetical events, they prefer explanations that address more than one potential cause. Additionally, one study found that people who are high in attributional complexity are less susceptible to the correspondence bias. Their more intricate causal schemas make them more sensitive to situational constraints when judging others.

Causal uncertainty

Causal uncertainty refers to doubts about one’s ability to understand the causes of events in the social world. Such doubts can be triggered by a loss of perceived control over events in one’s life, and once in place, causal uncertainty can further undermine a person’s sense of control. Men and women do not differ in their levels of causal uncertainty, but causal uncertainty is associated with depression, anxiety, and low self-esteem. Because it threatens control and causes one to feel bad, people are highly motivated to resolve causal uncertainty. As long as they think there is some chance that their efforts will pay off, causally uncertain perceivers should attempt to improve their understanding of events. They may start with relatively automatic strategies for understanding and

progress to more effort-intensive strategies if needed. Automatic strategies could include accessing stored schemas and heuristics. Controlled strategies could include gathering and carefully processing causally relevant information. Consistent with the idea that they use controlled processing to improve their understanding, studies have revealed that individuals who are high in causal uncertainty are less susceptible to the correspondence bias. As long as their cognitive load does not prevent them from doing so, they carefully consider situational constraints when judging others.

Implicit theories

Implicit theories refer to people’s beliefs about the nature of attributes such as personality, intelligence, and morality. Entity theorists think that such attributes are fixed, whereas incremental theorists think that they are malleable. These beliefs have implications for the attribution process. Entity theorists place a high value on dispositional inferences and readily draw them based on small samples of behavior. Furthermore, they tend to generalize to broader attributes and assume those attributes will remain relatively stable over time. To entity theorists, dispositional inferences provide an explanation for why a particular behavior or outcome occurred. Incremental theorists draw dispositional inferences as well, but they are more responsive to new contradictory information, they generalize less, and assume less stability. They focus more on the situational context and a person’s strategy, effort, goals, and intentions. To incremental theorists, dispositional inferences simply summarize a person’s behavior in a particular situation.

Researchers have examined how these differing beliefs affect judgments about the self and others. Implicit theories predict responses to setbacks. When people receive news that they performed poorly on a test, entity theorists draw negative, global inferences about their abilities, while incremental theorists focus more on strategy and effort. When judging another person’s negative behaviors, entity theorists draw more global and stable negative dispositional inferences and recommend greater punishment. More troubling, they more readily draw inferences about morality from a person’s appearance, and base their verdicts upon these inferences rather than the strength of evidence presented in a criminal case. Thus, implicit theories about the malleability of attributes, which differ across individuals and domains, help us predict the extent to which perceivers will draw correspondent dispositional inferences from behavioral information.

Cultural Differences

Just as individuals differ from one another in attributionally relevant beliefs, so do cultures. Different thinking styles prevail in western (European American) and eastern (East Asian) cultures. People in western cultures tend to think analytically, focusing on objects and individuals. People in eastern cultures tend to think holistically, focusing on the context in which objects and individuals are located. These styles affect the ways in which people in the two types of cultures view themselves and others. Westerners use more abstract traits to describe themselves and others, whereas Easterners refer more to specific contexts and social identities. Furthermore, a number of studies have revealed that Easterners are less susceptible

to the correspondence bias than are Westerners when situational constraints are made salient (e.g., they just experienced the same situational constraint themselves). However, when situational constraint information is available but not salient, both groups show the correspondence bias.

In some respects, Easterners and Westerners share similar views of dispositions. They have similar conceptualizations of personality and predict that people engaging in a certain type of behavior once will engage in similar types of behavior in the future. Furthermore, when dispositional and contextual explanations are assessed separately, Easterners and Westerners typically differ in the amount of contextual explanation, but not always in the amount of dispositional explanation. However, there are subtle differences in their views of dispositions. Easterners are more like incremental theorists, while Westerners are like entity theorists. Thus, Easterners see dispositions as malleable, and they also acknowledge the role of the context in shaping dispositions. Lastly, Easterners are more likely than Westerners to attribute causality to a group, rather than to an individual.

In sum, while basic social psychological research provides a good starting point for common biases in the attribution process, research on individual and cultural differences sheds light on moderating factors. Individuals who are high in attributional complexity or causal uncertainty, or who subscribe to an incremental theory or Eastern culture are more likely to consider situational constraints on behavior.

Implications

Motivation and Psychological Well-Being

Up until now, I have focused primarily on the degree to which perceivers see the cause of a behavior or outcome as internal or external. However, there are meaningful differences within these two general categories. Some factors (ability, task difficulty) are more stable than others (effort, luck). In addition, some factors (effort) can be controlled more easily than others (luck). Lastly, some factors (social skills) affect a broader range of events than others (ability to remember names).

These dimensions affect a person's motivation level as well as their overall psychological well-being. The attributions people make for an unsuccessful performance (e.g., a low test score or negative job evaluation) can greatly affect their motivation. If people attribute the failure to insufficient effort (an internal, unstable, and controllable factor), improvement will seem possible and motivation can be maintained. However, if they attribute the failure to a lack of intelligence (an internal, stable, uncontrollable factor), improvement will seem unlikely and motivation may decline. Research has revealed that people who are depressed tend to make the latter type of attribution, and furthermore think the cause will affect many other outcomes. This stands in contrast to the self-serving attributions mentioned earlier, where people attribute failures to external factors.

Self-Handicapping

People sometimes try to manipulate plausible attributions in order to prevent people from attributing their failure to a lack

of ability. Specifically, when individuals doubt their ability to succeed, they sometimes withdraw effort or engage in an activity that interferes with their performance. Because any one of these factors can explain a failure, it becomes more difficult to attribute the failure to a lack of ability. This type of behavior is known as self-handicapping. As one might imagine, it can have negative implications for performance in the classroom and beyond.

Marital Satisfaction

Attributions can also affect how we feel about the important people in our lives. Research has revealed that the type of attributions married people make about their spouses' behaviors are associated with their levels of marital satisfaction, emotions, and behavior. Relationship researchers have distinguished between *causal* attributions, or judgments about who or what brought about an event, and attributions of *responsibility* and *blame*, or judgments about who is accountable and at fault for an event, respectively. These attributions tend to build on each other, with internal attributions potentially leading to responsibility attributions, and responsibility attributions potentially leading to blame attributions. However, in marriage, responsibility and blame tend to co-occur. To measure causal attributions, researchers have presented individuals with hypothetical negative partner behaviors and asked them to rate the extent to which something about the partner caused the behavior (locus), as well as whether the reason will change (stability) and affect other parts of their marriage (globality). Unsatisfied individuals tend to attribute negative partner behaviors to causes that are internal (something about the partner), stable (not likely to change), and global (will affect many other areas). Responsibility/blame attributions are assessed by having individuals rate whether the negative partner behaviors were intentional, selfishly motivated, and blameworthy. Greater responsibility/blame attributions are associated with less marital satisfaction, and during an interaction, greater anger (wives only) and whining (husbands and wives).

Findings from longitudinal studies have supported the idea that a negative attributional style predicts decreases in marital satisfaction over time. There is also some evidence for the opposite path as well: low satisfaction sometimes predicts the development of a more negative attributional style over time. Importantly, these relationships held up when related variables such as depression were controlled.

Conclusion

Over 50 years of attribution research has shed much light on the processes people use to understand the causes of events, the biases they exhibit along the way, the beliefs that impact people's attributions, and the implications of particular attributions for important domains. We see that people can spontaneously and efficiently draw dispositional inferences about others. Sometimes they stop here, and if they have neglected relevant situational information, they would be said to have shown the correspondence bias. Perceivers are more likely to factor in situational constraints if they are motivated and able (due to accuracy motivation, attributional complexity, causal

uncertainty, lack of cognitive load), if the situational information is salient, and if their beliefs encourage such a consideration (incremental theories, Eastern cultures, trait-behavior relations). Furthermore, we see that certain types of attributions can enhance functioning. Specifically, attributing a negative performance to a lack of effort, rather than ability leaves room for improvement. Attributing negative partner behavior to external, unstable, and specific factors helps people maintain positive views of their relationships. Finally, we see the difficulties that people face when they lack confidence in their ability to understand the causes of events. This relatively new research on causal uncertainty supports assertions that Heider and others have made that understanding why events occur is critical for a sense of prediction and control over one's environment.

See also: [Cognitive Bias](#); [Marital Dysfunction](#); [Perceptual Development](#).

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Autism and Pervasive Developmental Disorders

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Glossary

Diagnostic criteria The established guidelines for a specific diagnosis that include the specific behaviors, the course of symptom development, and characteristics an individual must exhibit.

fMRI Functional magnetic resonance imaging, used to observe brain functioning.

Prevalence The number of people in the population who have a particular characteristic or diagnosis. Often expressed as the observed number per 10 000 people.

Stereotyped A rigid repetition of a specific behavior or activity that is often nonfunctional.

Stress A negative physical or emotional reaction to events or series of events in the environment that may or not produce similar effects in other individuals.

Stressor An event or series of events or interactions that can precipitate a negative emotional or physical reaction.

Perspective

Leo Kanner first described the syndrome of autism in the early 1940s. There are long historical roots to the conceptualization of severe early childhood disturbance, primarily referring to dementia and intellectual limitations. A few detailed accounts of individual cases, such as Itard's classic description of the wild boy of Aveyron, provide clear examples of the confusion that existed as to how to best conceptualize severe pathology in children. Descriptions of educational programs in the mid-1800s have fascinating detail of treatment programs and individuals who today would most likely be diagnosed as having autism. The term autistic was first used by Eugene Bleuler in the early 1900s to describe a specific thought process characterized by poor logic and a detachment from reality, but was not in reference to a specific disorder.

These historical accounts were at times very systematic descriptions and provide interesting continuity to the present. What was lacking was effective formal differentiation or diagnostic criteria. Kanner is credited for identifying the syndrome and asserting its distinguishing characteristics that set it apart from other severe disorder categories of the time. He provided clear description of an initial group of eight boys and three girls, drawn from the very large pool of his clinical experience as a psychiatrist at John Hopkins. He chose the term 'autism' to describe his observations, a term also associated with the description of social withdrawal in schizophrenia. However, Kanner's perspective was quite different. Unfortunately, there still persists a popular but simplistic image of individuals with autism solely as being withdrawn and retreating from social interaction. Kanner used the description 'aloof' to describe the type of social interactions, and lack thereof, that he observed. 'Aloof' better describes the feeling of detachment often observed in social interactions of individuals with autism, connoting more of a detachment than withdrawal in the emotional sense.

Kanner identified almost a dozen specific characteristics that he associated with the syndrome he termed early infantile autism. Some of these were: aloofness, excellent rote memory, echolalia, pronoun reversal, an intense desire to maintain sameness, alert

expression, poor eye contact, appearance of being deaf, no anticipatory reaching out from infancy, lack of social and communication initiation, normal intelligence (as assessed by the Seguin Form Board), and normal motor coordination.

In his description of the 11 children that he presented, he noted considerable variation in the number and severity of behaviors observed, but he conceptualized the syndrome as primarily an 'autistic disturbance of affective contact' and later he utilized the term 'early infantile autism.' Importantly, however, he saw the primary feature as the inability to relate to other people and situations from infancy. He specifically contrasted his syndrome with others such as Heller's dementia infantilis and DeSanctis' dementia praecocissima in that these are characterized by a period of normal development prior to symptom onset. In contrast, Kanner stressed the presence of symptoms from infancy: hence the use of the term 'early infantile autism.' This emphasis on the presence of autism from birth was maintained by Kanner when he stated almost 30 years later that the primary characteristics for autism were '(a) the children's inability from the beginning of life to relate themselves to people and situations in the ordinary way and (b) an anxiously obsessive desire for the preservation of sameness.' However, as various researchers have pointed out, by focusing on just the social isolation and preservation of sameness, this reduced the number of symptoms thought to be part of the syndrome, and may have inadvertently led to overly broad diagnostic criteria.

Diagnosis

Terminology

As listed in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) of the American Psychiatric Association, the current standard for diagnosis, the pervasive development disorders (PDDs) include: autistic disorder, Asperger's disorder, Pervasive developmental disorder-not otherwise specified (PDD-NOS), Rett's disorder, and childhood disintegrative disorder. With a very rapid rise in the diagnosis of autistic disorder over the past two

decades, the attention directed at the PDDs has increased. However, the terms used to describe the disorders within the PDDs have grown imprecise. Terms such as 'autism spectrum disorders' and 'ASD,' which do not appear in the DSM-IV-TR, are often used as if they were a diagnosis, are frequently used interchangeably with PDD and autistic disorder. The lack of clarity when using such terms creates confusion, particularly among consumers. The inconsistent use of such terms is not limited to just the popular media, but is also observed in professional writings. Websites and publications often use the term ASD to describe individuals without specifying which DSM diagnostic categories individuals actually fall into, and in what proportion, for the research article or description presented. In addition, national organizations such as the National Institute of Mental Health (NIMH) and the American Academy of Pediatrics differ in their use of the term ASD. The NIMH includes all of the disorders within the PDDs as part of their definition of ASD whereas the American Academy of Pediatrics includes only autistic disorder, Asperger's disorder, and PDD-NOS under their use of the term ASD. **Figure 1** illustrates the DSM-IV-TR PDD categories and the partial overlap of the term ASD by the two organizations.

A related problem is the use of descriptive labels for presumed subcategories of autistic disorder that also have yet to be adequately defined. For example, the terms high-functioning autism and low-functioning autism are widely used, often in the context of presumed severity and prognosis; yet they have no reference in the DSM-IV TR. The term high-functioning autism typically is used to refer to individuals with a diagnosis of autistic disorder who have adequate verbal language abilities and an average or above-average level of cognitive ability. Individuals described as having high-functioning autism present with symptoms that are clinically similar in a number of ways to that of individuals with Asperger's disorder. However, there is strong debate in the field as to whether there are meaningful clinical and prognostic differences between individuals diagnosed with Asperger's disorder and those described as having high-functioning autism. This is an important area of research that has begun to receive more attention, as it might have implications for the study of etiology, response to treatment, type of treatment recommended, and prognosis. Currently the term high-functioning as a qualifier for autism is not consistently defined and creates potential diagnostic overlap. This can lead to problems when interpreting research and clinical descriptions.

Related to this concern, proposals for subtyping within autistic disorder, which could be essential for both clinical and etiological research, have come primarily from clinical observation. Perhaps the most cited proposed subtyping comes from Lorna Wing and her colleagues who describe three subtypes: aloof, passive, and active-but-odd, to explain observations as to the variation in types of social deficits. Recent research questions the validity of these specific categories, but does support the presence of subtypes, with replication of research findings required for more precise specification.

Symptomatology

The three most prevalent PDDs are autistic disorder, Asperger's disorder, and PDD-NOS, which from here forward will be referred to as ASD. While they each have separate diagnostic criteria, the DSM-IV-TR outlines three core characteristics of interest that are associated with these three disorders. These include:

- Impairment in social interaction
- Impairment in communication (specifically as used in social situations)
- Stereotypic, repetitive behaviors, and restricted interests

Diagnostically, the difference between the disorders lies in the severity and nature of each of these core characteristics and their pattern. **Table 1** provides a comparison of the three disorders across the three core characteristics. A description of the specific behaviors associated with each of the core characteristics of interest follows.

Impairment in social interaction

Kanner's initial description of autism highlighted the deficits in social interaction as central to the disorder. Currently, these deficits are still considered to be the most important of the core deficits. Some have argued that these social interaction deficits, because of their specific manner of expression and pervasive nature, are what differentiate ASD from other clinical populations who also show social interaction problems.

As listed in the DSM-IV-TR, impairments in social interaction include: (1) deficits in nonverbal behaviors such as eye-to-eye gaze, facial expression, and gestures to regulate social interaction; (2) failure to develop peer relationships

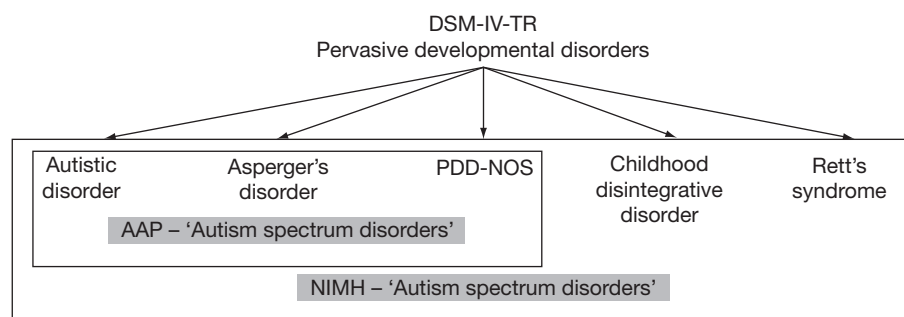


Figure 1 A comparison of definitions of autism spectrum disorders.

Table 1 A comparison of core diagnostic characteristics for autistic disorder, Asperger's disorder, and PDD-NOS

	<i>Autistic disorder</i>	<i>Asperger's disorder</i>	<i>PDD-NOS</i>
Age considerations	Delay in at least one area is present prior to the age of 3.	After 36 months	None specified
Marked impairment in social skills	At least two of the following must be present: <ul style="list-style-type: none"> – Marked impairment in the use of multiple nonverbal behaviors (eye-to-eye gaze, facial expression, body postures, and gestures) to regulate social interaction – Failure to develop peer relationships appropriate to developmental level – Lack of spontaneous seeking to share enjoyment, interests, or achievements with others – Lack of social or emotional reciprocity 	Same criteria as autistic disorder	Severe and pervasive impairment in development of social interaction
Marked impairment in communication	At least one of the following must be present: <ul style="list-style-type: none"> – Delay in, or total lack of, the development of spoken language (without attempts compensate through alternative means) – Marked impairment in the ability to initiate or sustain conversation with others – Stereotyped and repetitive use of language or idiosyncratic language – Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level 	No clinically significant delay in language development present	Impairment in either verbal and/or nonverbal communication skills and/or presence of stereotyped behavior, interests, and activities
Restricted, repetitive, and stereotyped patterns of behavior, interests, and activities	At least two of the following must be present: <ul style="list-style-type: none"> – Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus – Apparently inflexible adherence to specific, nonfunctional routines or rituals – Stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements) – Persistent preoccupation with parts of objects 	Same criteria as autistic disorder	Presence of stereotyped behavior, interests, and activities and/or impairment in either verbal and/or nonverbal communication skills
Other considerations	Behavior not better accounted for by Rett's disorder or childhood disintegrative disorder	<ul style="list-style-type: none"> – Behavior causes clinically significant impairment in social, occupational, or other important areas of functioning – No clinically significant delay in cognitive development or in the development of age-appropriate self-help skills, adaptive behavior, and curiosity about the environment in childhood – Criteria not met for another specific PDD or schizophrenia 	Criteria not met for a specific PDD, schizophrenia, schizotypal personality disorder or avoidant personality disorder

appropriate to developmental level; (3) lack of spontaneous seeking to share enjoyment and interests (e.g., by a lack of showing, bringing, or pointing out objects of interest); and (4) lack of social or emotional reciprocity.

Social deficits observed in children with ASD include difficulties understanding the facial expressions of others, initiating social interactions, responding to the social bids of others, and responding to the emotions of others. Research has also

identified specific social behaviors that differentiate children with ASD from typically developing children at 2 years of age. These behaviors include:

- decreased attention to the voices of others (e.g., failing to respond to their name when called);
- the use of another's body as a tool (e.g., taking another's hand and putting it on a toy in an attempt to have the person turn it on);
- little to no interest in other children (e.g., preferring to engage in isolated play when with other children, failure to initiate social interactions with peers, indifference to the activities of other children);
- limited use of pointing to communicate with others;
- deficits with understanding gestures;
- lack of seeking to share enjoyment with others (e.g., not showing items of interest to an adult or peer or directing the attention of others to events in their environment).

Joint attention behaviors have been an area of particular interest for researchers and clinicians studying social deficits in ASD as it has been proposed that this specific deficit of joint attention is specific to ASD and not observed typically in other clinical populations. Joint attention has been described as using gestures and mutual eye gaze to share interest, enjoyment, and attention. Examples of these joint attention behaviors include: a child shifting his or her gaze between an interesting object and a familiar person, combining gaze shift and pointing to direct another individual's attention to an object of interest in the environment, or showing a toy to someone as part of initiating a social interaction. Whereas typically developing children begin to exhibit joint attention behaviors around 15 months of age, joint attention deficits tend to be a characteristic of individuals with ASD throughout their lives. Other behaviors observed early in the social development of typical children that are problematic in individuals with ASD include, but are not limited to: imitation, social play, friendship-seeking behavior, comfort seeking, responding to the facial expressions of others, and cooperative play.

Striking in some, the social deficits in others with ASD are more subtle. For example, individuals with Asperger's disorder display many of the social difficulties described above, but in particular have a difficulty identifying and interpreting the social cues of others. Some research has shown that some individuals with Asperger's can learn skills, such as how to correctly identify emotions and other social cues. However, they often have difficulty using those skills in their everyday environment, making the development of friendships and maintenance of social relationships difficult. Complicating the picture further, individuals with Asperger's possess typical cognitive and verbal abilities. They are often aware of the fact that they are socially different from others, and it is not uncommon for them to express frustration with these issues, placing them at risk for a number of other issues including lower academic achievement, depression, and anxiety. Further, the changing nature and often emotional intensity of adult social and sexual relationships present great difficulty for individuals with Asperger's disorder.

Impairment in communication

The communication deficits observed in individuals with ASD can vary. A delay in the development in expressive language is

observed in some, others may never develop meaningful speech, and some may have no delay in the development of speech but have difficulty with the more pragmatic aspects of conversation. It is often estimated that up to 50% of individuals with autistic disorder do not develop spoken language, whereas to receive a diagnosis of Asperger's disorder, individuals must not have had any delays in the development of spoken language.

It is estimated that a majority of individuals with ASD fail to develop spoken language. Whereas children with speech delays typically compensate for their difficulties through the use of nonverbal communication (e.g., physical gestures, pointing, eye contact), individuals with ASD do not. For individuals with autistic disorder, these areas of nonverbal communication are either absent or noticeably impaired throughout their development. A large body of research has been devoted to assessing and developing methodologies to teach individuals with ASD, who do not have spoken language, alternative methods (e.g., sign language, pictures) of communication. A number of different strategies have been successful for teaching individuals with ASD to communicate their wants and needs. However, even when these individuals acquire an alternative means of communication, the use of communication to initiate social interactions and conversations tends to remain deficient.

The language of individuals who develop expressive speech is often rote, repetitive and can be lacking in communicative meaning. Echolalia is a characteristic of speech patterns in the majority of individuals with autistic disorder. Echolalia is the repetition of the speech of another person or oneself and it can be immediate (i.e., repeating a word, phrase, or sentence immediately after it is spoken by someone else) or delayed (i.e., repeating speech heard in the past). Although echolalia often appears to be unrelated to an individual's environment, there is some question in the field as to whether there is a communicative function of echolalia for individuals with ASD.

When functional language does develop, pragmatic deficits often persist. Such deficits include: difficulties with 'turn-taking' in conversation, and preoccupation with one conversational topic. For example, individuals with Asperger's disorder have the verbal abilities to carry on a conversation but typically choose to keep the conversation focused on a specific topic of interest, be indifferent to requests to change topics, and have difficulty taking turns in the conversation.

The prosody and intonation of speech are also impaired in individuals with ASD. Prosody, the rhythm of spoken language, helps a speaker add specific meaning to a phrase or sentence. For example, when asking a question, most individuals raise their voice slightly at the end of the sentence, helping a conversational partner understand the intent of a sentence or phrase. Individuals with ASD typically have abnormal intonation and use of rhythm and stress in speech production. Other characteristic speech abnormalities include pronoun reversals, articulation difficulties, and idiosyncratic use of speech, including the development and use of neologisms.

Stereotyped and repetitive behavior

The broad category of restricted and repetitive behaviors in individuals with ASD includes self-stimulatory behavior (e.g., repetitive finger movements, gazing at lights, rocking,

toe walking), stereotypical motor behavior (e.g., posturing), preoccupation with objects and activities, insistency with sameness or inflexibility in routines, and restrictive interest in objects or activities. Parents of young children with ASD may notice that their children play with toys in an odd manner. Rather than using cars or blocks for pretend play, children with ASD may prefer to line up toys according to attributes such as shape, size, or color. Children with ASD may also become preoccupied with one part of a toy and their toy play may become restricted (e.g., spinning the wheel of a toy truck over and over). In addition, individuals may develop interests in specific types of toys or collections, which are greater in intensity than seen with typically developing individuals.

When compared, the toy play of individuals with ASD shows clear differences from the play of typically developing children. Children with autism exhibit limited functional and symbolic play, atypical play preferences, lack of creativity and flexibility in their play, and limited capacity for imitation. Children with ASD also use less appropriate, less varied, and more repetitive play. Changes in routines can also be difficult for individuals with ASD. Children with ASD often exhibit a desire for sameness in their environment. Disruptions in daily routines, or changes in their environment (e.g., rearranging furniture in a common room) can precipitate behavior problems (e.g., crying, tantrum throwing) in children with ASD.

Repetitive behavior in individuals with ASD may also manifest itself as a persistent, focused, and intense preoccupation. For example, an individual may become fixated on learning everything there is to know about train schedules. For others, it may be clocks, maps, radios, or a particular sports team. These focused interests differ from hobbies or more typical interests of others, by their exclusive focus. For example, many typically developing individuals are passionate about a particular sports team. They enjoy watching their team play, talking to others about the team, wearing the team colors, and reading about them. An individual with ASD who is fixated on that same team may know all of the numbers for every player who has been on that team and their home towns, but does not necessarily enjoy watching the team play, and cannot carry on a conversation about that team beyond what numbers the players wore or from where they came. Individuals with ASD might talk at length about a specific area of interest, even after the conversational partner has displayed disinterest in the topic or attempted to change the topic of conversation. Further, the typical fan, no matter how devoted, is able to carry on social conversations on other topics, whereas the individual with ASD often has great difficulty in exhibiting this type of flexibility.

Prevalence

For decades after Kanner's publication, autism was thought to be extremely rare. In the 1960s, it was estimated to affect less than 1% of the population. Research conducted in the 1980s and 1990s presented a different picture with prevalence rates almost 10 times what were reported previously. Most recent figures released from the Center for Disease Control report the prevalence rates of ASD between 45/10 000 and 67/10 000. While the prevalence statistics have changed over time, the ratio of diagnosis between boys and girls has remained fairly

consistent. It is estimated that the rate of ASD is 3–4 times higher in boys than in girls. The increase in prevalence statistics has led some to conclude that we are experiencing an epidemic while others make arguments that the explosive increase in the prevalence of ASD does not reflect a single cause epidemic in the typical sense, but rather may be the result of changing diagnostic criteria, diagnostic substitution, early identification programs, increased services specific for individuals with ASD, and increased awareness.

Changes in Diagnostic Criteria

In the 1950s Kanner and Eisenberg published a list of criteria for early infantile autism. Their criteria included aloofness and indifference to others, and an intense resistance to change in the child's own repetitive routines. They also specified that these behaviors needed to be present before 24 months of age.

Michael Rutter, a researcher working primarily in Great Britain, suggested in 1978 modifications for the definition of childhood autism. He presented four criteria: (1) Impaired social development, which has a number of special characteristics out of keeping with the child's intellectual level; (2) Delayed and deviant language development that also has certain defined features and is out of keeping with the child's intellectual level; (3) Insistence on sameness as shown by stereotyped play patterns, abnormal preoccupations, or resistance to change; and (4) Onset before 30 months. Rutter further gave examples of the behaviors based on his own research and clinical experience, as well as on Kanner's descriptions.

Autism was formally recognized in the DSM, in 1980, with the publication of the Diagnostic and Statistical Manual Third Edition (DSM-III). Referred to as Infantile Autism, it was included under a new class of disorders – the PDDs. To receive a diagnosis, individuals had to meet six mandatory diagnostic criteria. The criteria included onset before 30 months of age; a pervasive lack of responsiveness to other people; gross deficits in language development; when speech is present, peculiar speech patterns such as immediate and delayed echolalia, metaphorical language, and pronoun reversal; bizarre responses to various aspects of the environment (e.g., resistance to change, peculiar interest in or attachments to objects); and the absence of delusions, hallucinations, loosening of associations, and incoherence as observed in individuals diagnosed with schizophrenia.

Seven years later, the diagnostic criteria were modified with the publication of the revised edition of the DSM-III (DSM-III-R). Now referred to as autistic disorder, the diagnostic criteria were divided into three main categories (impairment in reciprocal social interaction, impairment in verbal and non-verbal communication, and restrictive repertoire of activities and interests) with specific behaviors (16 total) listed under each one. To receive a diagnosis of autistic disorder, individuals had to exhibit at least 8 of the 16 behaviors listed, with two from the reciprocal social interaction category and at least one from each of the other categories. Onset also needed to occur in infancy or early childhood. Described earlier, the criteria were further modified with both the publication of the DSM-IV and the DSM-IV-TR.

Studies comparing DSM-III to DSM-IV have found that the DSM-IV broadened the diagnostic criteria of autistic disorder.

To examine the effect that changes in the diagnostic criteria could have on prevalence, research has been conducted in which the DSM-III and DSM-IV criteria are applied to a sample population. Research comparing the diagnostic criteria of the two versions has revealed that the application of the DSM-IV criteria resulted in significant increases in diagnosed cases of autistic disorder over the DSM-III criteria.

If one examines the prevalence rates for autism over the last two decades, one can see a direct relationship between the date of publication of DSM-IV, in 1994, and DSM-IV-TR, in 2000, and a corresponding significant increase in prevalence rates in the United States. In addition, studies have found that when case definitions and identification methods are held constant, no significant increase in diagnosis is observed. While it appears a relationship may exist between changes in diagnostic criteria and prevalence of autism, it is not likely the sole cause of the observed increase.

Diagnostic Substitution

In addition to changes in diagnostic criteria, researchers have examined the possible influence of diagnostic substitution and the increase in the prevalence of autism. The premise of 'diagnostic substitution' is that an individual who would typically receive a specific diagnosis would now receive a different diagnosis because of changes in social acceptability, consumer preference and selection of diagnostician, differential availability of services based upon diagnostic classification, and lessening concern about the need for specific differential diagnosis.

If in fact diagnostic substitution is influencing the prevalence rate of autism, the observed increase in the prevalence of autism would coincide with a similar decrease in the prevalence of some other disability (or disabilities). This, in fact, has been reported by numerous researchers, indicating that substitution may be occurring for the diagnosis of mental retardation.

Public Awareness of Autism and Early Identification

Awareness and publicity of autism has increased dramatically during the last two decades. A review of the archives of Time Magazine revealed a considerable increase in the number of stories published about autism. Between 1980 and 1989, three articles were published about autism. Between 1990 and 1999, the number of articles increased to 11 including 2 cover stories. Between 2000 and 2009, Time Magazine has published 73 articles about autism including 6 cover stories.

Earlier identification and detection of autism has also been suggested to be a factor in the observed increase in the prevalence of autism. Improved diagnostic assessments and increased awareness have been suggested to play a role in the early detection and diagnosis of the disorder. In the last two decades, the number of assessment measures and procedures has increased dramatically with regard to both the diagnostic process and screening. As would be expected, research has indicated that the mean age of diagnosis of autism and start of service delivery has declined over this period.

There is no denying that there has been an increase in the prevalence of ASD over time. Whether the increase is due to factors such as changing diagnostic criteria or better

identification, or multiple other factors is unclear. Continued research in this area as well as the etiological roots of ASD will help develop a better understanding of its prevalence.

Etiology

To date, the specific causes of ASD remain unknown. Hypotheses about the etiology of ASD have ranged from psychological, to environmental, to biological. However, research focused on genetic and neurobiological factors has been most promising. More than 15 genes have been implicated in the etiology of ASD. Information obtained from twin studies provides further support for the role of genetic factors in the development of ASD. In studies with monozygotic twins, the median concordance rate for autistic disorder is reported to be as high as 90%. The prevalence of ASD among nontwin siblings of children with ASD is also significantly higher than that of the general population, with estimates ranging from 4% to 8%. In addition, phenotypic studies have revealed that characteristics such as rigidity, social anxiety, and communication difficulties are seen more frequently in relatives of individuals with ASD compared to controls.

While the current research supports a biological link in the development of ASD, the data on the specifics of the link is less clear. Multiple genes have been implicated in the development of ASD including chromosomes 2, 7, 13, 15, 16, and 17 and the X chromosome. Neuroanatomical features that have been hypothesized to be linked to ASD include abnormal functioning of the brain stem, cortex, cerebellum, hippocampus, and amygdala. There is also evidence suggesting that the brain is enlarged in children with autism. However, the implications of brain enlargement have yet to be determined. Lastly, some research has implicated neurotransmitter abnormalities in individuals with ASD. Specifically, abnormalities in serotonin and GABA levels have been found in some individuals with ASD.

A major difficulty in drawing conclusions from the current research evidence from the neurobiology and neuroimaging fields is that the sample size is still small and is typically biased towards the individuals with ASD who are considered 'higher functioning.' This is understandable given that the behavioral issues that many individuals with ASD exhibit prevent them from participating in intensive assessments such as functional magnetic resonance imaging (fMRI). However, the absence of data from individuals with more challenging behaviors makes generalizing the results of such studies difficult. Advancement in the research methods used to collect this type of data is needed to help researchers collect information from a broader population and develop a better understanding of the etiological roots of ASD. It cannot be underscored enough that the ASD represent a heterogeneous population and that there are likely multiple pathways in its development.

Treatment Challenges

Individuals with ASD present with three core characteristics: (1) impairment in social interactions, (2) impairment in communication, and (3) stereotyped or repetitive behavior. Thus, a comprehensive treatment program needs to address these core

areas and the individual differences in the expression of related problems. Elements that must be included as components of a comprehensive treatment program include child-focused instruction, family focused support, addressing the multiple skill domains, and intensive educational instruction (e.g., lasting throughout a school day, and occurring across multiple settings), and the program typically continues over a period of months or years. Often, a distinction is made between treatment and education for individuals with ASD. This is a false dichotomy. School, work, home, and community, should all be seen as the various settings in which comprehensive treatment must be applied. The focus of this section is not to describe all of the many hundreds of interventions promoted for individuals with ASD but to discuss the challenges parents and practitioners face in developing comprehensive treatment programs. In particular, the myriad of treatment options, parental stress, and accessibility to services are discussed. Lastly, because of the extreme heterogeneity in ASD, it is important to state explicitly that not all individuals with ASD require, nor desire, treatment intervention.

Treatment Options

When a simple Internet search is performed with 'autism spectrum disorders' and 'intervention' or 'treatment' as the search terms, over two million results are found. Search results run the gamut from intensive behavior therapy to restrictive diets and horse back riding. The number of different approaches and options available for treating individuals with ASD can be overwhelming for parents and practitioners trying to do the best they can for their children. Researchers are recognizing this concern and have begun publishing scientific reviews of the benefits of different treatment options. Between the research that has been conducted and the methodology-based systematic literature reviews, there is convergence and agreement that interventions based on the principles of the extensive research in basic learning and the applied research in behavioral approaches to comprehensive intervention (behavior therapy, applied behavior analysis, cognitive-behavior therapy) are the most effective. Such reviews have also found that the majority of treatment approaches promoted for ASD lack empirical evidence of effectiveness, and some have been identified as potentially harmful. Further, while not all treatment approaches identified as 'ineffective' are harmful, they can come at a significant cost with respect to time commitment that then reduces a family's ability to devote time to other important activities and also typically have a significant monetary cost.

Parental Stress

Parents of all children experience varying levels of stress. However, having a child with special needs has been associated with increased levels of stress among parents. Further, it has been reported that parents of children with ASD experience significantly higher levels of stress than parents of children with other disorders. In particular, primary caregivers (e.g., mothers) typically experience more stress than other family members (e.g., fathers, grandparents).

Factors that have been associated with parental stress in children with ASD range from child-specific characteristics

(e.g., communication difficulties, social impairments, disruptive behaviors) to making decisions about treatment options for their child. Increased attention has been directed at developing interventions to reduce parental stress as well as address the source of the stressors. Interventions to address parental stress reactions (e.g., cognitive and behavioral programs for coping and relaxation) and interventions to address source of stressors (e.g., parent education programs in behavioral management techniques, provision of information about and help attaining community resources such as respite care) have been reported to be effective in reducing overall levels of stress in parents of children with ASD. Reducing parent stress is an important, but often neglected, element of treatment for children with ASD, and research has suggested that helping parents alleviate stress can improve treatment outcomes through greater effective parent participation in intervention programs.

Access to Services

Access to appropriate treatment is often problematic for parents as well as those professionals assisting in implementing comprehensive intervention. A number of factors may interfere with access to quality treatment including monetary cost, geographic location, and availability of qualified providers. The standards of care and practice, particularly with respect to educational services, vary significantly across states and within states.

Families trying to obtain services are faced with the problem of availability of service providers. With the increase in the number of individuals needing services, families are often faced with extensive waiting lists to receive appropriate services or with the choice of accepting services that are inadequate with respect to intensity and/or the evidence base for the intervention offered. Research on treatment for individuals with ASD has indicated that early and intensive treatment is associated with better long-term outcomes. However, individuals and families can be left waiting for months and, in some cases, even years to receive appropriate treatment.

The most effective interventions for individuals with ASD are often quite time and resource intensive. Interventions based on the principles of behavioral approaches have received the most consistent and extensive research support in addressing the needs of individuals with ASD. However, comprehensive intervention involving this approach for individuals with severe needs can involve between 25 and 40 h a week of direct services. Research has demonstrated that such comprehensive behavioral services are associated with significantly better outcomes and are more cost-effective in the long term. Currently, there are no universal standards or regulations in place to determine who is responsible for the costs associated with ASD (e.g., insurance company vs. school district vs. family).

See also: [Asperger's Syndrome and Nonverbal Learning Disorder.](#)

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- <http://www.nimh.nih.gov/health/publications/autism/complete-index.shtml> – National Institutes of Mental Health.
- <http://www.nationalautismcenter.org> – The National Autism Center.
- <http://www.researchautism.org> – Organization for Autism Research.

Autobiographical Remembering and the Self

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Glossary

A positivity bias in recall The tendency to remember positive autobiographical events better than negative autobiographical events, or to generate false memories for positive autobiographical events; sometimes reversed in the service of current self-positivity.

Autobiographical memory A memory system consisting of episodes recollected from an individual's life, based on a combination of episodic (personal experiences and specific objects, people and events experienced at a particular time and place) and semantic (general knowledge and facts about the world) memory.

Episodic memory The element of the memory system that includes specifics about when and where an event occurred, thought to be accompanied by the sense that an event is relived or reexperienced.

Infantile amnesia A fairly universal observation is that many individuals fail to recall much from the time of their early childhood; it used to be believed that such failure reflected failures in the structural or processing capabilities of children, but more recent research suggests that the failure lies in retrieval failure, not in a failure of storage.

Meaning-making People sometimes try to make the world meaningful; to do so, they often construct a narrative that places events into a story-like context. Such narratives have implications for autobiographical memory: negative events that are part of narratives that have the theme of overcoming

or redemption may be well recalled because the negative event is critical to the theme of the story.

Procedural memory The memory that reflects the acquisition of skills, often thought to be represented in nonsymbolic forms and to reflect implicit knowledge (e.g., knowledge that it not cognitively accessible).

Self-enhancement motivation The motivation that the self has to view itself in a positive light; can cause negativity biases in recall when the current self benefits from recalling autobiographical events in an especially negative light.

Semantic memory The knowledge that is remembered in a fashion such that it is known, but not reexperienced.

Typically, such knowledge refers to general knowledge about the world, but it can also refer to knowledge about the self.

Symbolic self The self's capacity to consider itself as a concept or as an object of consideration.

The reminiscence bump The tendency to recall autobiographical events from the adolescent and young adult years; one reason may be that these years are crucial to the development of the self.

The self A collection of mental structures that comprise an individual's identity. These structures can be quite diverse and multidimensional, so that different aspects of the self can become activated in different contexts or by different goals. Current views of the self in psychology position the self as playing an integral part in human motivation, cognition, and affect.

An issue that has often been the focus of interest about the self (an ability that reflects humans' possession of a *symbolic self*) concerns the nature of the relation between one's personal identity and memory of one's own personal past. This interest is evident in the speculations offered by many philosophers. For example, John Locke directly linked the self to memories of the personal past (*Essay Concerning Human Understanding*; 1975/1689, Book II, Chapter 27). Locke argued that selfhood existed entirely in such memories: That a person found identity in the extension of consciousness backward in time, and that the person's identity reflected those parts of the past that could be remembered. An extension of this idea is that a person who remembers nothing of his or her past has no identity.

Interest in the extent to which selfhood is linked to autobiographical memory has extended into modern-day psychological theory and research, and it has led to the development of a huge and diverse literature. One exciting element of this literature is that it is truly a reflection of cross-disciplinary efforts in psychology, with major contributions coming from researchers in many of psychology's major subfields. This literature obviously cannot be adequately reviewed in this modestly sized article. Instead, our goal in this article is to selectively

highlight findings and ideas that illustrate some of the themes that have emerged from theory and research into the relation between autobiographical memory and the self.

One of these modern themes pursues the Locke thesis: Is autobiographical memory necessary for the presence of a sense of self? However, this is not the only line of research that pursues links between the self and autobiographical memory. Considerable work has addressed the extent to which the current self directs and affects autobiographical memories to serve the purposes of the current self, causing them to be remembered, forgotten, distorted, or to even be entirely fabricated. Yet, other scholarship has focused on the mechanisms underlying such effects. For example, one line of work focuses how an individual's attempts at meaning-making might affect recall of events from the personal past and how the self-concept might direct those attempts at meaning-making. Another line considers the role that social processes might play in the interplay between the self and autobiographical memory. The remainder of this article attempts to provide an entrée into the area of autobiographical memory and the self by describing just some of the research that has been conducted in each of these subareas.

Is Autobiographical Memory Necessary for Individuals to Experience a Sense of Personal Identity?

We begin by discussing the issue that was raised by Locke: Is the sense of self, or the sense of personal identity, dependent on the ability to recall one's personal past? Modern psychological scholarship (which is reviewed in more detail by others) suggests that the answer to this question is 'no.'

Understanding this answer requires a brief overview of how psychologists currently think about memory. One widely held view is that long-term memory reflects the action of multiple systems. For example, one system is thought to contain procedural memories and another is thought to contain declarative memories. Procedural memory involves learning and retention in the body's action systems, reflecting the acquisition and retention of motor, perceptual, and cognitive skills (e.g., knowing how to swim). Such knowledge is often represented in a nonconscious, nonsemantic form. Certainly, while one can listen to and acquire a description of how to engage in a given activity, acquisition of such descriptions clearly are not sufficient to learn how to engage in the actions themselves. To learn how to perform the activity, one has to engage in, and practice the activity. That ability to *do* stuff reflects the learning that has occurred in the procedural memory system.

In comparison, it is thought that the declarative memory system is the repository of symbolic and semantic knowledge about the world. Tulving, among others, argues that the declarative memory system contains two subtypes of information (perhaps residing in separate subsystems): semantic memories and episodic memories. Semantic memories reflect relatively generic knowledge about the world (e.g., DeKalb is a city in Illinois). Such memories typically are not accompanied by recall of when or where the memory was acquired; rather, they are retrieved without such information.

In contrast, episodic memories contain such specifics. Examples of episodic memories (e.g., from one of the chapter authors) are a memory of hitting a walk-off home run in a little league baseball game and a memory of throwing a hanging curveball in a college baseball game that was hit by an opposing batter for a walk-off home run.

The key to these memories being classified as episodic is that they have a 're-living' quality that includes the notion that the events were experienced by the self at a particular point in space and time. Certainly, a rememberer can 'know' things about themselves in a way that reflects semantic memory. However, that same knowledge can also be recalled in a way that, at least to some extent, provides a sense of reexperiencing the event. Such a memory is exemplified by Proust when he writes about an encounter with a Petit Madeline given to him by his mother. Proust indicates that when his mother offered him the little cake, he retrieved 'a feeling of inexplicable happiness' and a childhood memory of Saturday mornings in Combray where his Aunt Leone used to give him a Madeleine after first dipping it in her own cup of tea. Proust describes such a memory by saying that "It is a complete fragment of the past, with its original 'perfume,' that is for a moment given back to us." By definition, episodic memories have this 'reliving' quality.

In modern terminology, Locke's assertion about the necessary link between memory for the personal past and a sense of identity can be framed in terms of episodic memory: Is the

ability to retrieve such memories crucial to an individual's sense of identity or a sense of self? The answer appears to be 'no.' A moment's reflection should reveal why this should be the case. The semantic memory system can contain a lot of self-relevant information that is important to the sense of self. While some of this information might reflect the symbolic system's encoding of self-events (I know that I hit a home run), other information may reflect higher-order conceptual knowledge (e.g., I believe that I am lazy; other people think I am driven; I am a golfer). Hence, it seems reasonable that disruption of the ability to 're-live' the specific events contained in episodic memory should have no effect on those components of self-knowledge that reflect semantic memory.

Indeed, this proposition is now supported by considerable research. Even people who exhibit total amnesia for events from their personal past can describe their own personal characteristics both reliably and accurately. For instance, Clive Wearing, an accomplished musician who suffered viral encephalitis-induced episodic memory loss in 1985, has retained both his musical ability and his personality, including a profound and often-professed love for his wife. Such observations would seem to at least partially refute Locke's notion that one cannot have a sense of self without access to autobiographical memories (or, at least, to the episodic variety).

However, the fact that episodic memories are not necessary for the possession of a sense of self does not mean that such memories are unimportant to the sense of self. For example, as illustrated by their observations of the patient D.B. Klein, et al. note that episodic memory seems to be required for a sense of continuity in personal identity across time.

Another way in which the autobiographical memory is important to the self lies in the extent to which the self uses memory to maintain and promote the current self. For example, the Self-Memory System outlined by Conway proposes that the self-system works to maintain the self's 'status quo,' as well as working to maintain the extent to which the self perceives goal coherence. Conway speculates that control processes of the working self may act on the stored corpus of autobiographical event knowledge in the service of such maintenance, doing so by means of editing memory content and by generating false memories. Such ideas imply that the self plays an important role in the ability to recall events from one's personal past. It is to this idea that we turn our attention in the next section.

Does the Self Direct, Affect, or Alter the Content of the Autobiographical Memories That Can Be Recalled?

Event Valence and Memory for the Personal Past

One example of this notion of selectivity lies in the potential relation between event valence and recall, sometimes expressed in the widespread belief that people remember the past through 'rose-colored glasses.' In more precise terms, this idea suggests that there may be a *positivity bias* in the content of memory such that when trying to remember the events of their lives, people's memories tend to retain the positive and eliminate the negative.

The hypothesis that such a positivity bias may emerge in autobiographical memory can be generated from modern

thinking about the self. The argument is that the powerful motivations of self-enhancement and self-protection, as well as both cognitive tendencies and motivational tendencies toward self-consistency for those who think positively about themselves, should generally work to promote recall of positive autobiographical memories and to diminish recall of negative autobiographical memories. Moreover, psychologists have detailed a large set of mental mechanisms that can work to produce such positivity biases in recall. Indeed, the results of many studies have evinced some form of a positivity bias. Such results induced Walker, Skowronski, and Thompson to confidently declare that "Life is pleasant – and memory helps keep it that way."

These biases can be manifest in different ways. One manifestation of the positivity bias is that people tend to *selectively remember* the positive and *selectively forget* the negative. For example, D'Argembeau and Van der Linden asked participants to recall positive and negative events that involved self-evaluations (i.e., pride and shame) and positive and negative events that involved evaluations about others (i.e., admiration and contempt). The results showed that for events that involve self-evaluations, people reported a subjective remembrance of positive events with more details than they did negative events; this outcome did not occur for events that involved evaluations of others. A study by Skowronski, Betz, Thompson, and Shannon similarly found that people exhibited positivity biases in self-reported self-memory that were not evident in memories about others (in fact, the memories about others evinced a *negativity bias*).

A second way in which the positivity bias in memories of the personal past can be manifest relies on *distortions* in memory. In one type of distortion, events are misrecalled to be more positive (or less negative) than warranted when compared to the objective historical record. One example comes from Bahrick, Hall, and Berger, who reported that college students remembered more As than were present on their high school transcripts. A second example comes from a study conducted by Croyle, Loftus, Barger, Sun, Hart, and Gettig, the results of which suggested that people misrecalled (minimized) both their cholesterol scores and the cardiovascular risk categories into which they were placed; those who received the most undesirable test results were most likely to evince evidence of this distortion (for results with similar implications, see Christensen, Wood, & Barrett).

These memory tendencies seem to be present at an early age. For example, Wilson, Smith, H.S. Ross, and M. Ross interviewed pairs of siblings to assess memories for their sibling disputes. Although describing the same episodes, both older (M age = 7.0) and younger (M age = 4.4) siblings ascribed more serious transgressions to the other than to themselves.

However, a thorough review suggests that the autobiographical memory data are not always entirely congruent with the presence of a hedonic valence effect in recall. Such inconsistency emerged in an early review of the literature conducted by Meltzer and again in a later review reported by Matlin and Stang. Indeed, modern studies that look for evidence of a positivity bias in memory sometimes continue to fail to find evidence of the effect.

Additional pessimism about consistency of the positivity effect in memory comes from results provided by researchers who have studied the relation between trauma and memory.

One of these researchers suggests that the available evidence shows that traumatic events are essentially unforgettable. However, results from such studies are not definitive: They cannot rule out the possibility that, despite their negativity, such events are well recalled because of their extremity. Indeed, studies consistently show that event extremity is much more strongly predictive of recall than event valence. Nonetheless, such results do pose a challenge to the idea that self-related processing of autobiographical events will tend to promote positivity in recall.

Skowronski notes that such inconsistencies can be at least partially resolved by a focus on the mental structures, processes, and mechanisms that are involved in processing autobiographical memories. Such an idea is wonderfully exemplified by the work of Wilson, M. Ross, and their colleagues. The work produced by these researchers suggests that the self-enhancement and self-protective motives that often serve to maintain the positivity of the *current self* can sometimes produce a negativity bias in memory for past events. The Wilson and M. Ross team suggests that this can occur as a consequence of the meaning-making activities in which people engage as events are retrospectively considered and rehearsed.

For example, one way in which one might glorify one's current ability to play golf is to remember how bad one was at the activity when one started to play the game. A parable can be constructed from such events, one that says: "Look at how far I've come – I never broke 120 when I started, but now I break 90 almost every time." This exact effect has been observed in the research conducted by the Wilson and M. Ross team: People reconstruct their memories of their early performance levels, and such reconstructions often reflect performance that is worse than is objectively suggested by the historical record. Similar results were reported by Dewhurst and Marlborough, who reported that students who surpassed their target grade sometimes exaggerated how anxious they had been prior to the exam. Echoing the conclusion of the Wilson and M. Ross team, Dewhurst and Marlborough attributed these findings to the action of the motives of self-enhancement and self-protection that bias the recall of preexam anxiety in the direction that maximizes current self-esteem.

The implication of such research is that the self-enhancing or self-protective goals of accentuating the positive do not always eliminate memory for the negative – in the right circumstances, when it benefits the current self, these goals can actually maintain, enhance, or distort memory for negative life events. However, given the way that memory becomes framed over time, remembering the negative actually has at least one positive effect – it makes the current self feel good. More important to the current article, though, is the idea that regardless of whether they are positive or negative, these memory biases occur *because of the influence of the self*. The consistency, protection, and enhancement motives that are activated by the current self in a given situation cause differential cognitive treatment of memories of an individual's personal past. It is this differential treatment that is responsible for biased recall of autobiographical information.

The Reminiscence Bump

Other data link the self to recall by showing that the extent to which an event is important to the self is related to memory for

the event. A fine example of this effect comes from research examining the reminiscence bump. The reminiscence bump effect shows that when recalling events from their personal past, people tend to produce a disproportionately high proportion of memories for events that occur roughly between the ages of 10 and 30. Presumably, this is a time that is crucial to the emergence of an individual's self-concept, and the events that are remembered during such periods may bear special significance to the self.

Consistent with this view, one study has shown that bump memories were found to be more novel, more important for identity development, more distinct, and more likely to involve developmental transitions than memories from other age periods. The content of the memories in the bump period is more likely to be positive than negative, an outcome that arguably is also consistent with the action of the self on memory. Other studies have shown that reminiscence bumps are not always restricted to their typical age range, but can emerge during any period of substantial life transition that is likely to cause significant changes to an individual's self-conception. Thus, as with the valence biases in memory, these studies document the fact that memory of the personal past is strongly related to an individual's identity.

Mechanisms that May be Related to the Recall of Events from the Personal Past

Meaning-Making

What are some of the mechanisms that might be responsible for the relations between the self and memory of the personal past? Clearly, there are a host of cognitive mechanisms that may be relevant. However, one mechanism that has received considerable recent empirical attention reflects the cognitive efforts that one undertakes to make sense of one's life. Such meaning-making seems to be a routine activity, and as such, has the potential to affect memory for many negative autobiographical events that might become incorporated into the life story.

Such processing is exemplified by the results of a recent study by Ritchie, Skowronski, Hartnett, Wells, and Walker. This paper examined events that changed their affective tenor over time, moving from negative to positive, or vice versa. The authors argue that such changes might occur because of the way in which events become reinterpreted in the light of subsequent life events. For example, consider the plight of a person who had been denied her tenure in her first academic job. Such an event might have been crushing when it happened, but later, as the person's life progressed, the event might be viewed in a different light. For example, the person might have obtained a second job that was a perfect fit for them. As the person reflects on and tries to understand her own life, the tenure denial (I was crushed) may come to be viewed positively (in the end, it was the best thing that could have happened to me).

In such a case, one would likely not expect memory for the original event to be diminished. In fact, one might expect that because of the high relevance of the entire event sequence, memory for the tenure denial event might actually be quite good and might strongly persist over time. Indeed, the story

becomes even more important to the self, (e.g., illustrating self-resilience) if the crushing nature of the tenure denial is emphasized.

Certainly, then, mental activity such as meaning-making and event reprocessing might be responsible for the fact that not all negative events are poorly recalled. When such negative events are essential to a life story that helps to ascribe meaning to events, those negative events may be recalled quite well. These considerations suggest that, more generally, a full understanding of how the self affects autobiographical memory necessitates an understanding of how an event fits into the personal narratives that people use to make sense of their lives (an idea anticipated by Singer).

Social Mechanisms

However, it is also the case that these meaning-making activities may not solely be for private consumption. People also need to explain themselves to others, and the need to concoct such public explanations may affect the meaning-making process.

Consistent with this proposition, data indicate that people often relate autobiographical event descriptions to one another in the course of those conversations. Moreover, some data suggest that social rehearsals occur at least as often as, and perhaps more often than, other rehearsal types. For example, in each of the two studies reported by Walker et al., participants listed autobiographical events that occurred within the last 6 months. After listing the events, participants were asked to estimate the number of times that they had rehearsed each event for one of the several different reasons (e.g., to remember the details of the events, to reexperience the emotions associated with the events, to better understand the events, to talk about the events to others, or the events were thought of involuntarily). In both studies, the most frequent reason that people rehearsed events was for the purpose of talking to others, and its reported frequency was significantly greater than any other reason.

Consideration of the social underpinnings of autobiographical event rehearsal adds additional complexity to the study of autobiographical memory, for different motives may drive the public presentation of different kinds of memories. Certainly, one might expect the need for others to view the self positively to motivate the selective self-presentation of positive events over negative events, a process that might be expected to push autobiographical memory toward positivity. However, sometimes in social circumstances, one needs to tell an interesting story, and stories can be especially entertaining when they involve themes such as overcoming obstacles (a theme that often appears from studies of meaning-making). Moreover, sometimes one can ultimately gain benefit by presenting one's foibles to others (e.g., self-deprecating humor might serve the purpose of ingratiation), which suggests that, at least under some circumstances, one might be motivated to relate one's negative life experiences to others. Thus, as in the M. Ross research, it may be that enhanced recall of negative personal life events may be a consequence of the need to enhance the current positivity of the self; that need sometimes induces rehearsal of negative events for the purpose of relating those events to others.

However, the effects of public event disclosures may go beyond the moderation of positivity effects in recall. For example, Skowronski and Walker suggest that other elements of social interactions that might affect autobiographical public self-presentations are the Grice conversational norms to be *relevant*, to be *informative*, and to be *brief*. These norms should not only work toward selectivity in the rehearsal of autobiographical memories, but they might also work toward distorting their content. This can happen in two ways. The norm to be brief may cause people to omit many details from their event descriptions; such omissions might cause those details to be permanently inaccessible when the memory is retrieved. Moreover, people may sometimes add event details, or fabricate events entirely, in the service of telling a good story. When the story is told often enough, a storyteller may experience a false memory because of a failure to accurately engage in reality monitoring: The storyteller may ultimately lose track of the fact that an event element was self-fabricated, coming to believe that the fabricated element was true (though this may not always occur).

The social nature of remembering has also been explored from a developmental perspective. In fact, the themes of social interaction and narrative construction have been remarkably combined in a program of research that has examined the emergence of the self as it related to the emergence of the capacity to produce early autobiographical memories. Until the middle 1980s, it was widely believed that autobiographical memory emerged relatively late in development. One example of this came from the literature on literature detailing *infantile amnesia*. Observations suggested that this amnesia was widespread. These observations led scholars to believe that such children did not report such memories simply because they lacked the cognitive mechanisms to do so. This apple cart was upset by research that began to emerge in the late 1970s. Researchers in these studies began to ask 3- and 4-year-old children to report what happens in the course of everyday events and routines. The children could do so, and readily provided rich reports of their experiences. As it has evolved, this research has now demonstrated conclusively that young children do have considerable memory for significant life events.

There have been a number of intriguing lines of research that have emerged from these examinations of early autobiographical memory. One of these lines of research links frequent social discourse with parents to both the emergence of autobiographical memory reporting capabilities and to the emergence of a personal identity. The scholars in this area argue that through participating in joint reminiscing with parents, young children develop a sense of subjective perspective on their personal past. These scholars argue that, even more importantly, through participating in adult-guided conversations about their past that are replete with information about their inner mental life, children come to develop a subjective sense of self.

Part of this thesis revolves around the idea that reminiscing is not just about what happened, but what happened *to the actor* (the 'me'). This necessitates distinguishing what happened to the self from what happens in the world at large. It is thought that a child's interaction with parents about the child's own life events aids the development of this self-perspective, especially to the extent that such activity promotes the inclusion of the child's thoughts, feelings, and evaluations of the past in their autobiographical memories.

In a rather ironic sense, these scholars have moved back, at least a bit, toward Locke's idea that autobiographical memory is essential to the sense of self. While we have argued that considerable data suggest that autobiographical memory (at least in its episodic form) does not appear to be necessary for adults to maintain a sense of identity, those data do not preclude the possibility that the recall of the personal past as is reflected in child discussions with parents is important to the development of a personal identity. It should be emphasized that it seems to be the social nature of these interactions, not the emergence of language itself, that is the driving force behind these findings. Indeed, developmental psychology scholars have provided impressive evidence that links such interactions to personal identity. For example, considerable data now show that maternal style early in development has a substantial effect on children's emerging ability to recall their own past, and that this effect emerges over a relatively long developmental period. For example, data provided by Reese, Haden, and Fivush, showed that the ways in which mothers reminisce with their young preschool children continued to affect children's memory skills more than 2 years later.

One important idea outlined by these scholars is the notion that it is discourse with caregivers that contributes to the development of a sense of time in autobiographical memory. That is, it is thought that talking about experienced events with parents whose narrative styles induce a child to incorporate memory fragments into coherent narratives of the past provides not only a way for the child to organize memory for future recall, but also a scaffold for understanding the order and specific locations of personal time, an element that is essential to autobiographical memory.

This temporal element is also essential to the sense of self. As noted earlier in this article, one contribution that autobiographical memory does make to the self is that it helps to provide information about both stability and change in the self. Thus, the content of the self is closely connected to the sense of a personal past, and discourse with caregivers can help children to develop the understanding that it was the same self that exists in the present that experienced an event in the past. Moreover, the ability to report autobiographical events is closely tied to evidence that a child has acquired a sense of self. For example, Harley and Reese measured children's self-recognition with the mirror test at age 1½ years and used it as a predictor of children's memory reports with mothers and experimenters at ages 2 and 2½ years. Children's memory reports with mothers and experimenters varied as a function of their earlier self-recognition skill, with early recognizers engaging in more interactions with mothers and with experimenters over time. Additional analyses showed that the initial importance of self-recognition was mediated by maternal reminiscing style when children were 2 years old: Children who recognized themselves earlier in the mirror test had mothers who responded with increased elaborations in past event conversations with children at age 2 years, and maternal reminiscing style directly predicted children's later memory reports.

In summarizing the 2002 'state of the art,' Reese argued that the data collected up to that point showed that social factors, such as parental reminiscing style, interacted with children's self-understanding to produce autobiographical memory. She also argued that such effects occurred for at least two reasons.

First, parents' talk about personally relevant past events may be an important source of information for children's self-understanding. Second, children may not be able to benefit from increased self-understanding in their retention of autobiographical memories unless they have the added elaborative and evaluative support from their parents in understanding past events. Such ideas clearly support the contention that one must incorporate social variables when attempting to understand the relations between the self and autobiographical memory.

Coda

Scholars who are interested in the relation between the self and autobiographical memory have a daunting task. This task begins with gaining an appropriate understanding and appreciation of the philosophical issues relevant to the topic, represented in this article by the works of Locke and Grice. This task continues by keeping abreast of developments in the area, which means monitoring literatures across many of psychology's subareas, especially social psychology, developmental psychology, cognitive psychology, personality psychology, clinical psychology, and neuroscience. Finally, to contribute empirical scholarship in this area, one needs to be open to multiple methodologies and analytic techniques. The information presented in this article merely samples the field and is obviously substantially influenced by the research programs, interests, and explanatory stories preferred by the article's authors. While the task is daunting, it is likely that their payoff is substantial. For one, assimilating the scholarship in this area will contribute to a broad view of psychology and will perhaps allow one to better appreciate the methods, areas, and approaches that might characterize the subareas that differ from one's own specialty. Moreover, we believe that the interdisciplinary nature of the area continues to make it a fertile ground for scholars who want to pursue new avenues of research into this relation. We hope that this article may serve to stimulate interest in such research, and we look forward to examining the products of such research in the years to come.

See also: Agnosia (including Prosopagnosia and Anosognosia); Amnesia; Confabulation and Reality Filtering; Episodic and Semantic Systems of Autobiographical Memory; Episodic Memory; Eyewitness Identification; Implicit Memory; Memory; Self-Efficacy; Self-Esteem; Semantic Memory.

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Avoidant Personality Disorder

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Glossary

Anhedonia A mental health symptom, commonly seen in mood disorders and schizophrenia-related disorders, involving the inability to experience pleasure from enjoyable activities.

Comorbidity The presence of two or more psychiatric diagnoses found simultaneously in the same individual. Comorbidity may reflect the presence of two distinct pathologies, but may also reflect imperfect diagnostic categories.

Distress disorders A higher order classification of the broad range of anxiety and depressive disorders.

DSM The *Diagnostic and Statistical Manual of Mental Disorders* (current version: *Diagnostic and Statistical Manual of Mental Disorders*, 4th revision, text revision, or DSM-IV-TR) is published by the American Psychiatric Association and provides a multiaxial classification system for mental disorders, with personality disorders such as APD listed under Axis II disorders.

FFM The Five Factor Model of personality describes five broad personality domains: openness, conscientiousness,

extraversion, agreeableness, and neuroticism. Each domain has six facets descriptive of lower-order personality traits.

Generalized social phobia A subtype of social phobia marked by a fear of social situations across all aspects of the social world. GSP is very closely linked to APD.

ICD The *International Statistical Classification of Diseases and Related Health Problems* (current version: *International Classification of Diseases*, 10th Revision, Clinical Modification, or ICD-10-CM) is published by the World Health Organization and provides a classification system for a broad range of medical symptoms and conditions, including mental health diagnoses. It is widely used internationally but is less common within the United States.

SASB Structural Analysis of Social Behavior, a model of personality based on interpersonal theory that describes patterns of behavior, suggests origins of maladaptive interpersonal behavior, and guides psychotherapy process.

Social anxiety disorder The term introduced in the DSM-IV as an alternative name for social phobia.

Social phobia A disorder marked by an enduring fear of social situations and the embarrassment that may result from participation in social interactions.

Introduction

When does anxiety in interpersonal situations become pathological, and what makes it so? Clearly, functional impairment is an important element. For personality disorders in general, there is the assumption that there are clinically significant deficits in both the self and interpersonal relationships. For avoidant personality disorder (APD) self-definition encompasses a desire for affiliation hobbled by a sense of personal inadequacy, and intense fears of interpersonal rejection stemming from a heightened sensitivity to criticism from others is another key feature, leading to social detachment that is perhaps the most obvious clinical feature of APD. In broader terms, the feelings of the person suffering APD have been described as anxiety, and the behaviors as shyness, suggesting overlap with other forms of psychopathology. Historically, one thing that differentiates APD from other forms of psychopathology, however, is that APD is characterized by isolative interpersonal behaviors combined with a desire to be close to others that is stilted by fears of rejection.

Diagnosis

APD affects about 1–2% of the general population, and is frequently present among patients in outpatient psychiatric clinics, often ranging between 10% and 20% of the cases. Personality pathology corresponding to APD is included in

the two major diagnostic manuals for psychiatric diagnosis of mental disorders: the tenth edition of the *International Statistical Classification of Diseases*, or the 'ICD-10,' which is published by the World Health Organization, and the fourth edition of *Diagnostic and Statistical Manual of Mental Disorders*, or the 'DSM-IV-TR,' which is published by the American Psychiatric Association. Both diagnostic manuals specify avoidant personality pathology as chronic and enduring. The actual diagnosis 'APD' is listed among DSM-IV-TR personality disorders, whereas the corresponding diagnosis in ICD-10 is 'Anxious (Avoidant) Personality.' The DSM-IV-TR diagnostic criteria are shown in [Table 1](#), and criteria from the ICD-10 in [Table 2](#). (The 'TR' in DSM-IV-TR stands for 'Text Revision.' The fourth edition of the DSM, published in 1994, was updated in 2000 by revisions to the 'text' describing some diagnoses; however, none of the diagnostic criteria were altered).

DSM Definition and Criteria

In the DSM-IV-TR, APD (code number 301.82) is characterized by a "...pervasive pattern of social inhibition, feelings of inadequacy, and hypersensitivity to negative evaluation..." (p. 718). The diagnostic title 'Avoidant Personality Disorder' was first introduced into official diagnostic nomenclature with the DSM-III, which was published in 1980. Within the DSM (DSM-III through DSM-IV-TR) Axis II, APD resides in 'Cluster C' of the Personality Disorders, along with Dependent and

Table 1 DSM-IV-TR diagnostic criteria for avoidant personality disorder

A pervasive pattern of social inhibition, feelings of inadequacy, and hypersensitivity to negative evaluation, beginning by early adulthood and present in a variety of contexts, as indicated by four (or more) of the following:

- (1) avoids occupational activities that involve significant interpersonal contact, because of fears of criticism, disapproval, or rejection
- (2) is unwilling to get involved with people unless certain of being liked
- (3) shows restraint within intimate relationships because of the fear of being shamed or ridiculed
- (4) is preoccupied with being criticized or rejected in social situations
- (5) is inhibited in new interpersonal situations because of feelings of inadequacy
- (6) views self as socially inept, personally unappealing, or inferior to others
- (7) is unusually reluctant to take personal risks or to engage in any new activities because they may prove embarrassing

Source: American Psychiatric Association (2000) *Diagnostic and Statistical Manual for Mental Disorders*, 4th edn., text revision, p. 721. Washington, DC: American Psychiatric Association.

Table 2 ICD-10 diagnostic criteria for anxious (avoidant) personality disorder

Anxious (avoidant) personality disorder is characterized by at least four of the following:

- (1) Persistent and pervasive feelings of tension and apprehension
- (2) Belief that oneself is socially inept, personally unappealing, or inferior to others
- (3) Excessive preoccupation about being criticized or rejected in social situations
- (4) Unwillingness to get involved with people unless certain of being liked
- (5) Restrictions in lifestyle because of need of security
- (6) Avoidance of social or occupational activities that involve significant interpersonal contact, because of fear of criticism, disapproval, or rejection

Source: World Health Organization (1992) *The International Statistical Classification of Disease (ICD)*, 10th edn., pp. 155–156. Geneva: World Health Organization.

Obsessive–Compulsive Personality Disorders. Personality disorders in this cluster share features of internalizing distress including anxiousness and fearfulness. As is the case with all personality disorders in the DSM-IV-TR, there is for APD the general requirement of “. . . an enduring pattern of inner experience and behavior that deviates markedly from the expectations of the individual’s culture and is manifest in at least two of the following areas: cognition, affectivity, interpersonal functioning, or impulse control. . .” (p. 686).

Of the seven criteria for the DSM-IV-TR APD shown in **Table 1**, at least four are required for a patient to meet the diagnostic threshold. The first criterion, ‘avoids occupational activities that involve significant interpersonal contact, because of fears of criticism, disapproval, or rejection,’ may apply to work or school. Often a person suffering from APD will limit their educational opportunities, and they are likely to choose an occupation where interpersonal contact is minimal. They

will also avoid working in teams, preferring to do things themselves. This is to be distinguished from the perfectionism aspect in obsessive–compulsive personality disorder, in which people prefer to work alone because their standards are so high they believe that others would bring the work down.

The second criterion, ‘is unwilling to get involved with people unless certain of being liked,’ is based on a preoccupation with feelings of inadequacy. This preoccupation essentially creates a cognitive disturbance that interferes with interpersonal interactions in novel social situations. An avoidant person will deal with this by being reticent and reluctant to ‘make the first move.’ This is unlike the case of dependent personality disorder (DPD) where a person is reticent based on fears that differentiating their opinions from another will destroy or otherwise damage the relationship. For avoidants, the fear is the confirmation of their own perceptions of inadequacy.

The third criterion, ‘shows restraint within intimate relationships because of the fear of being shamed or ridiculed,’ is also driven by the fear of being criticized. Being avoidant means always being petrified about what is to them, ‘deep, dark, secrets’ that, if revealed, would almost certainly invite ridicule. Even a slight teasing might be perceived as humiliating. For these reasons, APD is often associated with a great deal of secretive behavior that is, for the most part, irrational, except for the fact that it brings a needed security even in the ‘closest’ relationships. In contrast, such restraint observed at the clinical surface with DSM-IV-TR ‘Cluster A’ (odd, eccentric) personality disorders such as schizoid, schizotypal, or paranoid, is better attributed to an indifference to intimacy (schizoid) or paranoid fears underlying secretive behavior (schizotypal and paranoid).

The fourth criterion, ‘is preoccupied with being criticized or rejected in social situations,’ at the first blush may appear similar to the DSM-IV-TR Axis I clinical syndrome of social phobia. Clearly, anxiety in a social situation is the hallmark of this criterion. For avoidants, any aspect of their being is fair game, from their hairstyle and clothing to their ideas and intellect. In contrast to social phobia, anxiety associated with avoidant personality disorder is not situation specific, but wide-ranging across all areas of the social world. It is not, for example, limited to situations where they might be called on to speak in front of others. A variant of social phobia, generalized social phobia, interestingly appears to diagnostically cooccur with greater frequency than the simple type, and will be considered in greater detail in a later portion of this article.

The fifth criterion, ‘is inhibited in new interpersonal situations because of feelings of inadequacy,’ represents more than mere cautiousness. Often it involves social comparisons that may have no basis in reality, for instance, the feeling that others whom the avoidant person is with are smarter, more successful, have better relationships, better family life, a better job, etc. Again, rooted in this criterion is the idea of being ‘less of a person’ across multiple domains. Here again, with APD, the person will unfortunately hold back information about himself or herself, information that might actually lead to the experience of being liked or respected by others if it weren’t for this inhibition or competing cognitive process of evaluation of self and others.

The sixth criterion, 'views self as socially inept, personally unappealing, or inferior to others,' is a pervasive inferiority complex that includes the beliefs that one is not at all likeable and possesses no social skills. The insecurity that accompanies these feelings of awkwardness is paired with the belief that others will always judge or otherwise evaluate them negatively. Here, it is important to distinguish this criterion from cognitive features of depressive disorders. For depressive disorders, whether they are shorter in duration but intense, such as the case of major depression, or longer in duration but less intense, such as dysthymic disorder, the key distinction is that in APD, these feelings of ineptness and being unlikeable are independent of depressive mood states. In other words, the depressed mood may come and go or otherwise vacillate, but with APD, the inferiority remains constant.

The seventh criterion, 'is unusually reluctant to take personal risks or to engage in any new activities because they may prove embarrassing,' translates to 'never be the first to express deeper feelings.' Thus, the risk is not about 'risk-taking behavior' as might be found in people with antisocial tendencies or thrill seekers. For APD, the risk is much more pedestrian and mundane. The person will be loath to reveal feelings that may expose him or her, whether positive or negative. Even if someone has a positive feeling, the typical approach would be to wait for the other to share the feeling or observation and then to agree with that observation rather than risk the certain humiliation that would come with a 'stupid' disclosure that was 'off the mark.'

ICD Definition and Criteria

The ICD-10 diagnosis, anxious (avoidant) personality disorder (code number F60.6) is very similar to that of DSM-IV-TR, despite the slight variation in the title. As with the DSM-IV-TR, anxious PD features must meet the accepted general criteria for personality disorder including characteristic and enduring disturbances in a person's inner experience and behavior that is outside the accepted norm. Disturbances in specific processes that impede functioning may include cognition, affect, impulse control, and interpersonal relatedness. In the ICD-10, the behaviors must also be seen as maladaptive and inflexible, evidence personal distress or otherwise have an adverse impact, and be of long duration and not attributable to other mental or organic disorders.

Comparing the APD criteria from the ICD-10 to the DSM-IV-TR reveals many similarities and a few differences. On the whole, the criteria appear to be tapping an isomorphic construct. Both require four criteria for a diagnosis, though the ICD-10 has total of six possible criteria compared to seven in the DSM-IV-TR. Comparing [Tables 1](#) and [2](#), reveals an almost direct correspondence of ICD-10 to DSM-IV-TR criteria (ICD-10 #2 to DSM-IV-TR #5, ICD-10 #3 to DSM-IV-TR #4, ICD-10 #4 to DSM-IV-TR #2, and ICD-10 #6 to DSM-IV-TR #1). Of the two remaining ICD-10 criteria (#s 1 and 6), criterion #6, 'Restrictions in lifestyle because of need of security,' roughly approximates DSM-IV-TR criterion #7, 'is unusually reluctant to take personal risks or engage in new activities because they may prove embarrassing,' and may also partially capture DSM-IV-TR criterion #6, 'is inhibited in new interpersonal situations

because of feelings of inadequacy.' A subtle difference is that the ICD-10 focuses on 'security' which is in contrast to the DSM-IV-TR focus on 'embarrassment' or 'feelings of inadequacy.' Finally, the first ICD-10 criterion #1, 'Persistent and pervasive feelings of tension and apprehension,' appears to tap a more general construct of anxiety. In contrast, DSM-IV-TR attempts to focus more specifically on anxiety related to a negative concept of self.

In the version of the ICD-10 updated in the year 2007, there is a general description of anxious [avoidant] personality disorder that reads as follows:

Personality disorder characterized by feelings of tension and apprehension, insecurity, and inferiority. There is a continuous yearning to be liked and accepted, a hypersensitivity to rejection and criticism with restricted personal attachments, and a tendency to avoid certain activities by habitual exaggeration of the potential dangers or risks in everyday situations. (Chapter V of Version 2007 published on the Web)

In Version 2007 of the Web-based ICD-10, there are no specific criteria lists for any of the personality disorders, hinting at a shift to more prototypic representations or descriptions of personality pathology. This is consistent with future plans for the APD diagnosis in the next edition of the DSM.

ICD-11, DSM-5, and the Future of APD

Both the ICD-11 and the DSM-5 are under revision at the time this article is going to press, and so there are many uncertainties about the future diagnostic conceptualizations of APD. Though still subject to further revisions, a general model of personality disorders for the DSM-5 has been developed and informs the likely diagnostic future of APD in this manual. While the DSM-IV had conceptualized personality disorders in terms of essential features, the committee developing DSM-5 is considering a prototypic model in which specific domains or facets may be characteristics of multiple disorders.

The DSM-IV opens the discussion of APD in terms of its key feature, namely, a "pervasive pattern of special inhibition, feelings of inadequacy, and hypersensitivity to negative evaluation." This idea of a disorder having one 'essential feature' is different from the DSM-5, which opens with the phrase "Individuals who match this personality disorder type" and also later uses the phrase "individuals resembling this type," both of which illustrate prototypic description rather than one derived from a polythetic collection of an essential number of criteria.

One proposal is to change the diagnostic system from a categorical system to a hybrid prototype-dimensional system based on a prototype rating and ratings on six-domain trait dimensions. The first component is an assessment of where an individual fits in the five severity levels of personality functioning using the Self and Interpersonal Functioning Continuum. This assessment of level of personality functioning was not a part of the DSM-IV, as historically the diagnosis of a functional impairment was seen as sufficient evidence of a personality disorder without a quantitative rating of disturbance. The second component is the prototype rating system. Each personality disorder has a prototypic description that emphasizes typical deficits and features of the disorder. Patients are

compared to the prototype in terms of how well they match the description, and a rating from 1 (no match) to 5 (very good match) is made. The description of the APD prototype is shown in [Table 3](#).

The second component of the proposed personality disorder diagnosis for DSM-5 has roots in trait theories of personality, including the Five Factor Model developed by Thomas Widiger, Paul Costa, and many others. The resulting DSM-5 model is a 'hybrid' system that combines specific personality disorder 'types' along with ratings for traits and functioning. Traits relevant to APD in the DSM-5 rating system include the tendency to feel responsible for bad things that happen, anhedonia, having difficulty allowing oneself to acknowledge or express wishes and emotions, and a desire to be recognized as unique. As shown in [Table 3](#), the traits are rated 0 (very little or not at all descriptive) to 3 (extremely descriptive). The American Psychiatric Association maintains a web site illustrating the diagnoses and keeping the field abreast of updates to the proposed revisions.

The future of APD, or anxious personality disorder, in the ICD-11 is less certain at this point in time. Mental disorders in general are among a handful of disorders that are a focal point for substantial revision. In contrast to the DSM, which focuses solely on mental disorders, the ICD covers all disease-related classification and the 'Mental and Behavioral Disorders' is but one component of the manual. Empirical studies on the structure of mental disorders are being presented to the work group for ICD Mental and Behavioral Disorders led by Dr. Steven Hyman, and there exists the possibility for substantial revision, including folding the symptoms of personality disorders into clinical syndromes. These considerations stem from questions raised by overlapping features of psychopathology and personality disorders in the current form of diagnoses, which call for new ways to examine and parse clinical symptoms to better address the problem of diagnostic comorbidity, a problem for many disorders including APD to which we now turn.

Comorbidity

Like APD, fear or avoidance of social situations and fear of possible scrutiny characterize social phobia, an Axis I disorder, in the DSM-IV-TR. However, the social situations tend to be more circumscribed for social phobia than for APD. Still, there is considerable diagnostic overlap between APD and social phobia, especially the generalized subtype of social phobia where a number of social settings are associated with an anxious state. In light of this overlap, and as the DSM moves more toward a dimensional approach, a key question reemerges: Does APD exist as part of a continuum, representing the more chronic, wide-ranging, and severe point on a spectrum of anxiety disturbance? In general, empirical results have supported the idea of a continuum model where APD is a more severe and pervasive form of 'social phobia' that is so longstanding that it has become integral to personality and interpersonal functioning. Perhaps it is an anchor point toward the more extreme end, with social phobia falling somewhere in the middle, and anxious behavior colloquially described as 'shyness' falling in the more mild, clinically insignificant end

of the continuum. In considering the continuum model, it is important to determine if it is merely quantitative differences that distinguish the two disorders.

Are APD and Social Phobia Separate Disorders?

The question of whether or not social phobia and APD are separate and distinct forms of psychopathology is a question that has plagued the field since the diagnosis was introduced in the 1980 DSM-III. Many studies have found overlap between APD and social phobia; this overlap may reflect shared or similar facets of the pathology, or it could be due to similarities in the descriptive criteria for the diagnoses. In the revisions from the DSM-III to DSM-IV-TR, there have been several adjustments to the criteria to reduce the diagnostic overlap and increase specificity. As previously described, the proposed revisions for the DSM-5 include reformulating APD as avoidant type; characterized by a 'negative sense of self, associated with a profound sense of inadequacy, and inhibition in establishing intimate interpersonal relationships,' specifying that, for APD, the social anxiety stems from the personal feeling of inadequacy.

Despite modifications and changes in wording and emphasis of criteria in DSM-III through DSM-IV, a trend for the cooccurrence of these two disorders has persisted. An apparent lack of qualitative differences leads researchers to hypothesize that the difference between the two is quantitative. Given similarities in criteria sets, this finding is somewhat intuitive and unsurprising as similar relations are also found between other Axis I and personality disorders. For APD, various research groups including the collaborative longitudinal personality study (CLPS) have reported significant associations with Axis I disorders, including social phobia, that have anxiety/inhibition as criteria. Several personality disorders also show this same association with related Axis I disorders with which they share criteria. A potential limitation in many of these studies is that data is derived from clinical samples that are comorbid for multiple Axis I and II disorders. However, other researchers, such as Chambless and colleagues have assessed impairment and distress among participants with the generalized type of social phobia, with and without APD, using self-report and observation and found no significant differences between the groups when they controlled for social phobia, thus supporting the continuum hypothesis.

To argue against the continuum model, it has been noted that higher levels of social avoidance, depressive symptoms, neuroticism, introversion, and social and occupational impairment were found for participants with generalized social phobia in combination with APD than for those participants with generalized social phobia alone. Thus it may be that APD differs from social phobia because it manifests itself in more severe cases of depression, introversion, and social and occupational impairment. Rettew has argued for a qualitative distinction between APD and social anxiety disorders, suggesting that widening the assessment scope to include nonsocial domains (introversion, passivity, fear of novelty, for example) would increase the likelihood of clarifying the distinction between APD and social phobia. Regardless of the outcome of this debate, two things seem clear. First, those with APD are

Table 3 Prototype description for avoidant personality disorder DSM-5 presently under consideration by the DSM task force

Prototype description

Individuals who match this personality disorder type have a negative sense of self, associated with a profound sense of inadequacy, and inhibition in establishing intimate interpersonal relationships. More specifically, they feel anxious, inadequate, inferior, socially inept, and personally unappealing; are easily ashamed or embarrassed; and are self-critical, often setting unrealistically high standards for themselves. At the same time, they may have a desire to be recognized by others as special and unique. Avoidant individuals are shy or reserved in social situations, avoid social and occupational situations because of fear of embarrassment or humiliation, and seek out situations that do not include other people. They are preoccupied with and very sensitive to being criticized or rejected by others and are reluctant to disclose personal information for fear of disapproval or rejection. They appear to lack basic interpersonal skills, resulting in few close friendships. Intimate relationships are avoided because of a general fear of attachments and intimacy, including sexual intimacy.

Individuals resembling this type tend to blame themselves or feel responsible for bad things that happen, and to find little or no pleasure, satisfaction, or enjoyment in life's activities. They also tend to be emotionally inhibited or constricted and have difficulty allowing themselves to acknowledge or express their wishes, emotions – both positive and negative – and impulses. Despite high standards, affected individuals may be passive and unassertive about pursuing personal goals or achieving successes, sometimes leading to aspirations or achievements below their potential. They are often risk-averse in new situations.

Traits

Domain	Facet	Description
Negative emotionality	Anxiousness	Having frequent, persistent, and intense feelings of nervousness/tenseness/ being on edge; worry and nervousness about the negative effects of past unpleasant experiences and future negative possibilities; feeling fearful and threatened by uncertainty
	Separation anxiety	Having fears of rejection by, and/or separation from, significant others; feeling distress when significant others are not present or readily available; active avoidance of separation from significant others, even at a cost to other areas of life
	Pessimism	Having a negative outlook on life; focusing on and accentuating the worst aspects of current and past experiences or circumstances; expecting the worst outcome
	Low self-esteem	Having a poor opinion of one's self and abilities; believing that one is worthless or useless; disliking or being dissatisfied with one's self; believing that one cannot do things or do them well
	Guilt/Shame	Having frequent and persistent feelings of guilt/ shame/ blameworthiness, even over minor matters; believing one deserves punishment for wrongdoing
Introversion	Intimacy avoidance	Disinterest in and avoidance of close relationships, interpersonal attachments, and intimate sexual relationships
	Social withdrawal	Preference for being alone to being with others; reticence in social situations; avoidance of social contacts and activity; lack of initiation of social contact
	Restricted affectivity	Lack of emotional experience and display; emotional reactions, when evident, are shallow and transitory; unemotional, even in normally emotionally arousing situations
	Anhedonia	Lack of enjoyment from, engagement in, or energy for life's experiences; deficit in the capacity to feel pleasure or take interest in things
	Social detachment	Indifference to or disinterest in local and worldly affairs; disinterest in social contacts and activity; interpersonal distance; having only impersonal relations and being taciturn with others (e.g., solely goal- or task-oriented interactions)
Compulsivity	Risk aversion	Complete lack of risk-taking; unwillingness even to consider taking even minimal risks; avoidance of activities that have even a small potential to cause injury or harm to oneself; strict adherence to behaviors to minimize health and other risks

Source: Accessed from <http://www.dsm5.org/> on 30 December 2010.

Ratings are made on the prototype (1 = no match to 5 = very good match) and on the traits (0 = very little or not at all descriptive to 3 = extremely descriptive).

more severely impaired; whether or not the distinction is qualitative or quantitative is secondary. Second, it may be helpful to understand APD as a dysfunctional developmental adaptation to chronic social anxiety that, along with low self-worth, becomes folded into an individual's personhood.

In sum, the evolution of the criteria for APD from DSM-III to DSM-IV-TR, and beyond to those under consideration for DSM-5, places greater emphasis on the characteristics or traits of fear of novelty, passivity, and introversion, along with a poor sense of self and the expectation to draw the criticism from others. The proposed changes for APD emphasize introversion and avoidance of activities, including social situations, while criteria for social phobia emphasize the anxiety limited to what is felt in the midst of social situations.

There are several aspects among the APD criteria that highlight nonsocial factors, such as low self-esteem and guilt/shame. There is also an emphasis on behavior in intimate relationships in the criteria for APD that is not present in the social phobia. Additionally, criteria for social phobia highlight the reaction to social situations; fear and anxiety out of proportion to the danger presented by the situation, which is not discussed in APD definitions. These distinctions may eventually clarify qualitative differences, or may suggest personality traits that make individuals more vulnerable to anxiety. It is worth noting that differences in the criteria sets for APD and social phobia are not wholly mutually exclusive, and the rates of cooccurrence still merit investigation and raise questions about the Axis I and Axis II division in the DSM. This suggests

the possibility that there are core pathological elements that may be the same if diagnosis were based on a different level than the clinical reports and observation, for instance, neural, cognitive, or more basic temperamental features.

APD and Other Personality Disorders

Prior to the introduction of APD in the 1980 DSM-III, 'avoidant' personality was captured by the diagnosis of schizoid personality and the psychoanalytic construct of 'phobic character.' In 1969, Millon first argued for a distinct diagnostic construct for 'avoidant personality disorder' but it was not until the DSM-III that APD was officially cleaved from the old DSM I/II diagnosis of schizoid personality. Thus, among the personality disorders, APD and schizoid personality disorder share a close relationship based on their diagnostic lineage, though there have been efforts to distinguish the two. Both personality types tend to engage primarily in solitary as opposed to social activities, and appear aloof or inhibited in social situations. Although similar on this clinical symptom, the distinction between avoidant and schizoid personality disorders resides in motivation or desire for intimacy for APD, something that is said to be lacking in schizoid. In addition, there is a capacity, albeit an often unfulfilled capacity, for social attachment in APD that does not seem to be present for schizoid personality disorder. Unlike individuals with avoidant personality disorder, who intensely desire relationships and avoid them because of exaggerated fears of rejection, persons with schizoid personality disorder have little or no apparent interest in developing interpersonal relationships. In 1982, Millon clarified this distinction in motivation for attachment, and his distinction has been included in the criteria and the text description of APD in the DSM ever since. For schizoid, the motivation was passive, whereas for avoidant, it was active. Millon's distinction between active and passive detachment was central to the official introduction of avoidant personality disorder in DSM-III.

Like schizoid, those with schizotypal or paranoid personality disorder may also react negatively to the idea of interpersonal relationships. However, in both of these cases, the wariness in interpersonal relatedness is more apt to stem from paranoia rather than the hypervigilance for criticism common to APD or the indifference of schizoid. Schizoid, schizotypal, and paranoid personality disorders all reside in the DSM Cluster A 'odd-eccentric.' Though paranoid features connote a certain sense of fear, that type of reaction is based more on disordered thinking rather than anxious fear based on the anticipation of criticism, as is the case with APD.

Another personality disorder that may share some similarity on the clinical surface with APD is dependent personality disorder. Like APD, dependent personality disorder rests in the anxious or fearful 'Cluster C' of DSM Axis II personality disorders. Characteristic of both disorders are low self-esteem, rejection sensitivity, and an excessive need for reassurance. Both may be defined in terms of attachment anxiety. However, a key distinction of APD is that the anxiety is driven by a fear of rejection, whereas in the case of dependent personality the anxiety stems from fear of separation and/or rejection once a relationship has been established. Thus, with dependent

personality disorder, distress is clear in the midst of a close relationship or after a close relationship ends. Often, those with dependent personality disorder scurry to find a new relationship after one has ended. People suffering from APD, on the other hand, are slow to enter into new relationships.

Stability and Course

A primary distinction between Axis I and Axis II personality disorders in the DSM system is the chronic and enduring course of personality disorders relative to clinical syndromes on Axis I. This long-held assumption is part of the definition of personality disorders as chronic and enduring, which has been challenged with recent empirical studies that have examined the prospective course of personality disorders, such as the CLPS and the McLean Study for Adult Development. The general finding from both of these longitudinal, naturalistic studies is that personality disorders remit diagnostically much more often than was originally assumed. This pattern has been demonstrated specifically with APD in report from the CLPS led by Grilo (at the symptomatic level) and by Sanislow (at the construct level). However, other CLPS reports led by Skodol have shown that functional impairment, including social and occupational deficits, persist for APD and other personality disorders even though the symptom counts may drop below diagnostic threshold (true for other personality disorders, too). Thus, clinically significant impairments that impede the social relationships and occupational potential of those with APD remain evident over the long run.

DSM-IV-TR personality disorder criteria are a mixture of traits, symptoms, and behaviors, and it is reasonable to query if certain APD symptoms tend to persist more than others. In another CLPS report led by McGlashan, it was evident that certain APD criteria were more enduring than others. In assessments conducted 2 years later by clinical interviewers blind to the baseline diagnoses, the criteria 'feels inadequate' and 'socially inept' were the most persistent. 'Preoccupation with rejection,' 'need to be liked first,' and 'void risks for fear of embarrassment' continued to a moderate degree, while 'fears ridicule and shame' and 'avoids jobs with interpersonal contact' were the most likely to remit. Thus, the top two most persistent criteria include both a deficit in self and an interpersonal deficit. At the other end, the least persistent are tied to behavior in a specific situation (jobs with interpersonal contact) and fear-based anxiety (fear ridicule and shame). The more persistent are more global, representing general personality constructs, whereas the least persistent are based on behaviors (interpersonal jobs) and symptom based (fear). Like APD's Axis I counterpart, social phobia, these latter two criteria may be easier to overcome than one's sense of self or more global deficits in social skills.

Interpersonal Experiences, Development, and Risk for APD

Like other personality disorders, interpersonal problems are a critical feature of avoidant personality disorder. In fact, almost all DSM criteria for APD describe aspects of the interpersonal

problems generated and encountered by an individual with APD. The most articulate description of the interpersonal features of the APD symptoms are derived from Lorna Smith Benjamin's *structural analysis of social behavior* (SASB). The SASB codes patterns of interpersonal behavior of both the self and the other, and also codes for the patterns of interpersonal behavior that one has repeatedly experienced as they relate to how a person perceives or thinks about him or herself. Benjamin has applied this model to the DSM personality disorders, including APD, and has linked characteristic interpersonal patterns to APD criteria. From there, it is possible to trace back characteristic interpersonal experiences of the person suffering APD and to infer how they 'talk to' or otherwise treat themselves.

Interpersonal Origins of APD

According to Benjamin's interpersonal theory, the people with APD live in a state expecting degrading, humiliating attack. Their self-protective response to this possibility, which for them looms with certainty, is social withdrawal. This promotes a perception of others that borders on paranoid and a reliance on safety at home that can sap the resources of the few individuals with whom the person with APD does have a relationship. Benjamin describes these patterns in her book, *The Interpersonal Diagnosis of DSM-IV Personality Disorders*. The origins of this pattern of behavior require that the person had enough love and nurturance to form a good sense of self, and the difficult interpersonal transactions came during later stages of psychological development. For instance, "exhortations combined with degrading mockery" (p. 292) put a premium on the need to occlude any personal failings, thus leading to intense self-scrutiny along with vulnerability to criticism. For Benjamin, the *sine qua non* for APD is a "...defensive withdrawal out of fear of humiliation, attack, and rejection, and the wish for acceptance" (p. 298). Clearly, for professionals treating the persons with APD, it is important provide uncritical support while not pushing them too far, too fast.

Treatment

Individual therapy has historically been used as a treatment for APD. This type of therapy can be difficult for an avoidant, because the maladaptive behaviors and thought processes characteristic of APD interpersonal relationships also extend to the relationship with the therapist. Those with APD often fear being rejected by the therapist, tend to doubt the authenticity of the therapist's concern, and are likely to reject help. Therapists should take extreme care to avoid behavior that may be interpreted as judgmental, as the person with APD is generally sensitive to even mild criticism, and should be prepared for the patient to perceive the therapist as critical even if there is no real basis for this perception. Benjamin stresses that therapists should aim to provide 'accurate empathy' and 'warm support' in order to build trust. Once trust has been successfully established, the therapeutic relationship may serve as a testing ground for new coping skills. In the context of a 'safe' relationship, dysfunctional beliefs about the therapy relationship can be frankly examined, serving as a model for the patients to evaluate other relationships in their life.

Cognitive behavioral therapy (CBT) techniques, which encourage patients to identify the fears of rejection and criticism that underlie APD and then modify these distorted thought processes, have proven particularly helpful in the treatment of APD. Cognitive restructuring, for example, involves examining the patient's thoughts about the feared situations and challenging them. This technique is predicated on the theory that social anxiety arises from misconceptions about dangers that social situations pose and other false and overly negative cognitions. The process of cognitive restructuring includes identifying these negative beliefs, evaluating their accuracy, and recognizing possible alternatives to help address the overwhelming anxiety characteristic of patients with APD.

Behavioral therapy strategies to treat APD generally fall under two categories: graduated exposure and skills training. Exposure therapy rests on the idea that graduated exposure to the fear-provoking situation (in this case, social interaction) will help the individual overcome their fear and bring about behavioral change. For those suffering APD, exposure therapy typically involves learning relaxation techniques and then applying them to gradually higher-risk social situations both in and outside of therapy. This treatment is most effective when the patient is fully engaged in the threatening situation and is open to becoming fully immersed in the experience despite the negative emotions destined to arise. For the person with APD, this is difficult because it runs counter to instinctive avoidance of engaging in frightening social situations. The response by someone suffering from APD is not always obvious avoidance, and a patient may surreptitiously or unwittingly utilize maladaptive cognitive processing strategies to reduce their anxiety such as not fully attending to the stimuli meant to induce negative emotion. Thus, in the case where social anxiety has become bound with self-definition and esteem, exposure therapy may prove ineffective.

Social skills training is intended to directly address any interpersonal deficits the avoidant may exhibit. This strategy is predicated on the assumption that people with APD exhibit poor social skills, and that teaching them positive social skills will increase positive reactions from others and thus reduce anxiety. Much of this work has focused more specifically on shyness and related social deficits, and clinical researchers who have targeted the symptomatic aspects have demonstrated good results that are applicable to treatments aimed at APD. For instance, basic skills training in social behaviors such as assertiveness, eye contact, self-disclosure, nonverbal social cues, and listening skills are likely to invite positive, warm, and uncritical responses from others and thus help the person suffering from APD build confidence.

Both social skills training and graduated exposure therapy can be performed in a group or individualized setting, though there are obvious advantages for those patients who can tolerate group treatment as the results may more effectively generalize to other areas of the patients' lives. As with any therapeutic treatment, a personalized approach matched to the patient's needs is desirable, though much more research is needed on how to effectively identify needs and match those needs with different interventions.

Treatment Outcome Studies

Alden and colleagues conducted a rare study that specifically focused on group treatment for APD. They performed a

randomized controlled clinical trial investigating the efficacy of graduated exposure therapy alone versus graduated exposure with interpersonal skills training, and found that the APD patients who received both types of treatment had improved in reports of social reticence, social anxiety, and a wide variety of other measures, and that the gains had been maintained 3 months after treatment had ended. However, the treatment groups did not significantly differ from one another in terms of the amount of improvement, suggesting that the addition of social skills training did not increase the benefits of graduated exposure alone. Alden and colleagues later reexamined the data from their study and concluded that variations in the symptom patterns of APD may differentiate treatment response. The reanalysis showed that patients who exhibited more distrust and anger benefitted most from graduated exposure, while patients with problems asserting themselves were shown to benefit from both treatments, especially an intimacy-focused social skills training. Unfortunately, despite the gains made by the APD patients during treatment, the patients still functioned significantly below normal levels of social behavior at the conclusion of the 10 week treatment. The authors suggest that a longer period of treatment may be necessary to further increase progress. Research is also needed to compare the efficacy of group and individual therapy for APD, as Alden studied all treatments in a group setting.

Insights from Treatment of Social Anxiety

Scientific research on the clinical outcomes for treatment of the APD diagnosis per se is very limited. Other, related forms of anxiety, such as social phobia, have been more frequently studied and this more general work offers insights about techniques that may be effective for APD. Like APD, treatment for social anxiety often consists of CBT techniques such as cognitive restructuring, graduated exposure, relaxation techniques, and social skills training. Heimberg reviewed the efficacy of treatment for social anxiety looking at the efficacy of types of CBT as treatment for social anxiety. He reported that all types of CBT produce better effect sizes than no treatment control groups, and exposure alone and exposure plus cognitive restructuring produce similar, significant effect sizes, while social skills training, cognitive restructuring, and relaxation training all produce slightly less change than exposure-based interventions. No differences were found between individual and group treatments, and these gains were maintained at follow-up assessments. Another group of researchers, Alden and colleagues, looked at exposure alone versus exposure plus social skills training versus a waitlist control group for adults who reported impairment in various areas of social functioning, including experiencing extreme shyness. The group given the combination of exposure plus social skills training reported significantly improved functioning compared to other groups.

Pharmacotherapy

A number of studies have looked at the effectiveness of pharmacotherapy for social anxiety disorders, although results are inconclusive as to whether the benefits of medication are clinically significant over CBT and other psychotherapy

approaches. Antidepressants, particularly the SSRI's are the most studied and appear to be the most effective medication treatment, although antianxiety medications may provide short-term relief. Beta blockers are also often helpful. In comparative studies, most work demonstrates that medication groups and CBT groups improve about the same, and curiously, placebo groups also show significant improvement, though usually to a lesser degree. A combination of medication plus CBT is common in practice, but the efficacy of adding medication to CBT, relative to CBT alone, is not well studied enough to draw firm conclusions. Most important, studies examining longer-term outcomes of medication versus psychotherapy are needed.

Limits to Understanding APD Treatment from Other Disorders

Treatment for social anxiety appears to address some, but not all types of impairment in APD. It addresses the social impairment, and can thus be somewhat helpful in treating APD. In his review, Heimberg showed that one of the factors predicting outcomes of treatment is the severity of symptoms at pretreatment. Patients with both social anxiety disorder and APD tend to begin treatment more impaired than those with social anxiety alone, and while they showed improvement, they were still more impaired than patients with just social anxiety at posttreatment. Patients with the generalized type of social anxiety (the diagnosis of social anxiety most similar to APD) also tended to be more impaired, and CBT was less effective for this type than for those with the nongeneralized types of social anxiety. This result is not too surprising as treatment for social anxiety typically does not address nonsocial characteristics that typify APD, such as guilt/shame, avoidance of (nonsocial) activities, fear of novelty, and passivity.

Conclusion

Most diagnosticians and taxonomists of psychopathology and personality are well aware that these diagnoses are constructs that help us to organize patterns in myriad traits, symptoms, and behaviors and to recognize those features that coalesce and thus suggest some coherence. As such, diagnostic constructs such as APD provide a useful explanatory tool to help understand and communicate among professionals, and to develop, implement, and guide treatments. The APD diagnosis provides valuable clinical utility, but diagnostic systems are not perfect, in part because the diagnostic constructs themselves are not 'real' or natural kinds. Rather, diagnostic constructs are approximations of a hypothetical construct; one that itself is not directly observable or otherwise tangible. In the absence of an etiological understanding and the identification of a specific pathology (rather than a syndrome), problems such as diagnostic overlap are part of the course. Thus, it is important to bear in mind that the comorbidity with APD and Axis I disorders such as social phobia may be a matter of intensity, or that criteria overlap and comorbidity with other Axis II disorders such as schizoid personality disorder may reflect shared pathological mechanisms or more simply may be an artifact of our diagnostic architecture.

APD is a useful diagnostic construct that tells us about a person chronically suffering extreme levels of anxiety that stems

from a negative view of the self, as evident in social avoidance. While APD has manifest interpersonal 'symptoms,' it is equally a problem of one's own inner experience. Core to the disorder is the fear of being perceived as a failure, and this fear is so intense that it drives the person suffering from APD to isolation. The relief experienced from this self-imposed isolation can further reinforce the problem, and thus perpetuate a long-standing personality pattern from which it is difficult to break free.

The anticipated DSM-5 and ICD-11, along with a host of issues that the field is presently tackling, present challenges beyond human prescience when describing a diagnosis that may change or disappear altogether as knowledge advances. For instance, although the prototype description helps make clear the definition of APD, a trait approach to diagnosis may be favored in the DSM-5. Nonetheless, there are exciting possibilities of changes ahead, including whether dimensional approaches offer advantages over categorical approaches, or if an optimal number of factors or criteria better captures a form of personality-related pathology than does the DSM nomenclature that has persisted for the last three decades. Last, questions about the boundary between Axis I and II disorders have also been raised, for APD with social phobia. Future developments in personality pathology and psychiatric diagnosis are sure to be exciting, and whatever viewpoint one holds of the DSM system, it has in the last three decades yielded a wealth of empirical information to scaffold for future diagnostic efforts.

See also: Anxiety Disorders; Self-Esteem; Separation Anxiety; Social Anxiety Disorder.

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Relevant Websites

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<http://apps.who.int/classifications/apps/icd/icd10online/> – ICD-10/11 Website.

http://www.mentalhelp.net/poc/view_doc.php?type=doc&id=29133&cn=8 – Interview with Professor Lorna Benjamin on SASB and the Structure and Treatment of Personality Disorders.

Behavior Analysis

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Glossary

Applied behavior analysis The application of principles of operant conditioning to the behavior of individuals in socially significant contexts.

Extinction Withholding reinforcement of a previously reinforced response, which results in a decrease of that response.

Operant behavior Behavior that is influenced by stimulus changes that follow its occurrence.

Punishment A process of behavior change by which a change in a stimulus event or condition that immediately

follows a response decreases the future frequency of that response.

Reinforcement A process of behavior change by which a change in a stimulus event or condition that immediately follows a response increases the future frequency of that response.

Selection by consequences Behaviors that produce favorable outcomes are more likely to be repeated and those that produce aversive outcomes are less likely to be repeated.

Three-term contingency The relation between an antecedent event, a target behavior, and a consequent event.

Introduction

Behavior analysis is a discipline with three primary branches: (a) behaviorism, which focuses on the world view or philosophy of behavior analysis; (b) the experimental analysis of behavior (EAB), which focuses on identifying and analyzing the basic principles and processes that explain behavior; and (c) applied behavior analysis (ABA), which focuses on solving problems of social importance using the principles and procedures of behavior analysis. Behavior analysis can be better understood by examining the history and philosophy of how behaviorism came to be.

Behavior analysis began as a school or subfield within the discipline of psychology. While the majority of psychologists in the early 1900s studied mental processes such as consciousness, John B. Watson argued that the proper subject matter was not states of mind or mental processes, but rather observable behavior. Thus, Watson created a new direction in the field of psychology by objectively studying behavior as a natural science consisting of direct observation of the relationship between environmental stimuli (S) and responses (R) which came to be known as S-R psychology.

One component of S-R psychology is respondent behavior, which is defined as behavior that is elicited by antecedent stimuli. In 1927, Ivan Pavlov, published a collection of experiments demonstrating that new stimuli can acquire the ability to elicit respondents. At the time of this experimentation, Pavlov was studying digestion using dogs as experimental subjects. In a well-documented paradigm, a tone signaled the availability of food. Although unintentional, Pavlov found that the dogs began to salivate when the tone occurred (i.e., before the food was presented) presumably because the dog had learned to 'expect' the forthcoming food. This line of research led to the development of a type of learning typically referred to as respondent (Pavlovian) conditioning. In Pavlov's basic respondent conditioning arrangement, the presence of food was termed an unconditioned stimulus (US), which elicited a reflexive response (in this case,

salivation) which was termed the unconditioned response (UR). Initially, the tone exerted no differential effect on the dog's behavior and was therefore referred to as a neutral stimulus (NS). However, after several trials in which the tone was presented just before the presentation of the food, the dogs began to salivate at the presence of the tone. Thus, through this pairing, the previous NS acquired characteristics of the US; thereby becoming a conditioned stimulus (CS). The salivation which followed the CS was referred to as the conditioned response (CR) to differentiate that this response (although topographically similar) was under the influence of a different stimulus (a tone as opposed to the presentation of the food).

The work of Pavlov was influential to many scholars. Among them was a young Harvard graduate student named B. F. Skinner. Skinner was interested in replicating much of Pavlov's work and began his doctoral work in the joint areas of psychology and physiology. After a great deal of work based upon Pavlov's findings, Skinner came to the conclusion that although respondent conditioning could explain why several behaviors occurred, it could not explain the majority of behaviors; especially those with no apparent antecedent causes in the environment. This conclusion drove Skinner to study other types of behavior (such as a rat's movement down a runway) and a near-continuous modification of his experimental methods (e.g., modifying devices so they recorded the rats' behavior). These modifications, in turn, led to the discovery of patterns of behavior among the rats such as how quickly a rat ate food after running or what occurred if the device failed to deliver food to the rat following running. Skinner observed that these patterns were predictable across organisms. Moreover, he observed that the organisms' behavior was not influenced by the prior stimuli that elicited a reflexive response; instead behavior seemed to be influenced by consequent stimuli (changes in the environment that occurred following behavior).

In 1938, Skinner published *The Behavior of Organisms* which summarized his laboratory research attempting to account for behavior that did not appear to be respondent. Skinner was

interested in the scientific account of all behavior, including those behaviors that appear to follow antecedent stimuli, not just those that appeared to be involuntary or reflexive. They are influenced by stimulus changes that have occurred after a behavior (i.e., a consequent stimulus) and are called operant behaviors. In other words, Skinner identified behavior that operated on the organism's environment to produce differential effects. He surmised that an organism's behavior was governed by a process of selection by consequences in which behaviors that produce desirable outcomes are repeated (or strengthened), whereas those that produce aversive outcomes are decreased (or weakened). In examining the effects of consequences on behavior, Skinner interpreted responding within the context of the operant three-term contingency (antecedent-behavior-consequence).

Skinner's laboratory findings led to the development of a new field of study which was referred to as the *experimental analysis of behavior*. This field produced its own set of experimental methods and (eventually) therapeutic practice as well as a fundamentally distinct conceptualization of behavior. Nevertheless, behavior analysis is often considered a subfield of psychology. Many would argue, however, that the field of behavior analysis differs considerably from the broad field of psychology. To illustrate, the basic tenets that distinguish behavior analysis from other areas of psychology include its emphasis on (a) behavior as the basic datum for the field rather than the psyche, the self, or other internal mental or metaphysical structures or phenomena; (b) continuity between publicly observable behavior and private events (e.g., thinking, feeling); (c) prediction and modification of the behavior of individuals (rather than groups); (d) environmental explanations of behavior; and (e) the study of behavior as a natural science. These basic principles of behavior analysis continue to define the work of behavior analysts and the separate domains of the EAB and ABA. Before considering these respective domains, a brief discussion of the underlying principles and concepts of behavior analysis will be reviewed.

Basic Principles of Behavior

Reinforcement may be considered the most important principle of behavior and is the key to behavior change. Reinforcement occurs when there is a change in a stimulus event or condition that immediately follows a response, which increases the future frequency of that response under similar conditions. The changes in stimuli that function as reinforcers can be described as either presenting a new stimulus into the environment or removing an already present stimulus from the environment.

Positive reinforcement occurs when a behavior is immediately followed by the *presentation* of a stimulus which, as a result, increases the future frequency of that behavior. For example, a rat pushes a lever in an operant chamber and receives a pellet of food. If the frequency of lever pressing increases, one can conclude that the presentation of the food pellet positively reinforced the lever-pressing behavior. A similar effect might be observed for the child who throws a tantrum in the department store. If the parent 'gives in' to the child's behavior by purchasing a toy, the future occurrence of

throwing a tantrum is strengthened such that the child may be more likely to throw a tantrum in the future to produce a desired outcome. (It should be noted that positive reinforcement is a technical term used to describe the effect of a contingency on the occurrence of a response. This is in contrast to the term 'reward' which is used to describe an item or activity presented to someone in an attempt to change behavior. That is, reinforcement is an effect demonstrated by an increase in behavior, whereas a reward is simply something presented to a person that may or may not affect their behavior).

When the frequency of a behavior increases because a stimulus in the environment has been removed, the process is referred to as negative reinforcement. Negative reinforcement is characterized by *escape* or *avoidance* contingencies in which the organism emits a response that either removes or avoids the presentation of an aversive stimulus. The concept of negative reinforcement can be demonstrated by revisiting the rat and operant chamber. For example, a low dose of electricity is sent through the floor of the operant chamber which gives a mild shock to the rat and when the rat pushes the lever the shock is terminated. If the frequency of lever presses in the presence of the shock increases, the lever press response has been negatively reinforced. In a more applied example, loosening one's belt following a large meal often results in the temporary attenuation of discomfort associated with eating too much. In this example, the response of loosening the belt is reinforced by the cessation of aversive stimulation (physical discomfort) which increases the future likelihood of this response in similar situations.

It is important to note that once a behavior has been established and strengthened with reinforcement, it is not necessary to reinforce that behavior on each occurrence. Many behaviors are maintained by intermittently reinforcing its occurrence. An intermittent schedule of reinforcement is a contingency of reinforcement in which some, but not all, occurrences of the behavior produce reinforcement. However, if reinforcement for a behavior that was previously reinforced is withheld for all occurrences, the frequency of that behavior will decrease to similar levels demonstrated prior to reinforcement or will cease altogether. This behavioral procedure is referred to as extinction.

Punishment is another principle of behavior that is defined based on its function. Punishment occurs when a change in a stimulus, event, or condition immediately follows a behavior and decreases the future frequency of that behavior. Like the process of reinforcement, punishment affects behavior through either the presentation or the removal of a stimulus. If an aversive stimulus is presented contingent on a particular behavior which results in a decrease in that behavior, positive punishment has occurred. For example, when a child runs into the street unsupervised, his mother reprimands him. Therefore, the frequency of child running into the street decreases. In contrast, negative punishment occurs when a stimulus (or access to forms of stimulation) is removed from the environment contingent upon a response, and decreases the future frequency of that response. An example of a negative punishment contingency can be demonstrated by a situation in which a child throws a toy. The mother then takes the toy away so he cannot play with it. In this example a preferred stimulus, the toy, is removed following inappropriate

behavior. Timeout is another example of a negative punishment contingency in that, while in timeout the individual cannot access sources of reinforcement. If a punishment contingency is removed, the behavior will ultimately reverse (increase) to levels near those seen prior to punishment. This process is called recovery from punishment.

Although punishment has been shown to be an effective procedure to decrease behavior, it can be argued that there are potential side effects and problems that occur when implementing punishment procedures. First, punishment can produce emotional and aggressive reactions. This is especially seen when positive punishment procedures are used when an aversive stimulus is presented as a consequence for a response. Second, inappropriate escape and avoidance behaviors may arise when a behavior is being punished. For example, a child may begin to lie or hide behaviors to avoid contacting the punishment contingency. Third, punishment may involve undesirable modeling of the punishing behavior. Finally, the decrease in the undesirable behavior of the person being punished may negatively reinforce the behavior of the punisher. In other words, the person implementing the punishment contingency may continue to implement punishment procedures more frequently in the future.

Critical variables for the use of both punishment and reinforcement are consistency and contiguity. A consequence should be implemented consistently to obtain the desired effect on behavior. If reinforcement is applied sporadically, the response will be more resistant to strengthening and less resistant to extinction. Likewise, if punishment is applied on a variable basis, the behavior will not decrease as quickly. Contiguity also plays a role in the efficacy of reinforcement and punishment procedures. Generally speaking, delayed consequences are less effective at changing behavior than are more immediate consequences.

Some behavior analysts argue that, from a functional perspective, reinforcement and punishment are the only principles needed to explain the basic effects of behavioral consequences. However, a number of factors may influence a response within behavioral contingencies. One such factor is the antecedent stimulus that signals the availability of reinforcement to occur. Such a stimulus is called a discriminative stimulus (S^D). For example, a friend asking 'How are you' acts as a S^D for you to say, 'I'm fine,' which is then reinforced by social approval. One would not say, 'I'm fine,' in the absence of another person asking how you are feeling. Likewise, stopping at a traffic signal is an example of behavior under the influence of a S^D . There is not physiological response governing this behavior; rather, our learning history dictates the relation between stopping or moving in the presence of red, yellow, or green lights. When a response comes under the control of some stimuli and not others, it is said to be under stimulus control (as in the case of stopping instead of driving in the presence of a red light).

Another factor that may potentially influence a response within a behavioral contingency is the reinforcing value of the consequence. A motivating operation (MO) refers to an environmental variable that alters the reinforcing effectiveness of a stimulus, event, or condition and alters the current frequency of all behavior that has been reinforced by that stimulus event or condition. A common example of an MO is food deprivation. Food deprivation acts as an MO that

increases the reinforcing effectiveness and value of food. Therefore, food deprivation evokes behavior that, in the past, has been reinforced with food. For example, the response of food ingestion (e.g., eating a sandwich) is more likely to occur when one has not eaten for several hours. It is unlikely that the sandwich will be highly reinforcing immediately after eating a large lunch.

Throughout the past 70 years, literally thousands of studies have supported the fundamental principles of behavior analysis through extensive empirical research carried out in both basic laboratory and applied settings. In the following sections, the focus of research and practice will be outlined for both EAB and ABA.

The Experimental Analysis of Behavior

As mentioned previously, the EAB began in 1938 with Skinner's, *The Behavior of Organisms*. The book summarized Skinner's laboratory research conducted from 1930 to 1937. In the early studies, Skinner primarily used animals (rats and pigeons) as subjects to demonstrate reliable functional relations between behavior and various environmental stimuli. He did this by systematically manipulating the arrangement and schedules of stimuli that precede and follow behaviors while recording the rate at which a single subject emits a given behavior in a controlled setting.

Because behavior analysts working in EAB are focused on basic laboratory research, studies are typically conducted in a well-controlled setting in which the researcher can control the conditions and environment under which the research occurs. When working with animals, operant chambers are used that typically consist of at least one operandum for the subject to manipulate (typically a lever or response key), and a device for reinforcement delivery. During a typical session in an operant chamber, the subject emits a specified response (e.g., lever press) which results in the delivery of a reinforcer (e.g., a food pellet). Skinner developed the operant chamber during the early years of his experimentation to measure the rate of responding and to study various schedules of reinforcement. Since Skinner began his work with operant chambers, thousands of studies examining the effects of changes in environmental stimuli prior to and preceding behavior have been conducted by behavior analysts. Such studies have examined differing schedules of reinforcement, novel or variable responding, allocation of responding or choice (commonly known as the matching law), the effects of different drugs on responding, and stimulus and discriminative control of responding, along with several other areas.

Since the development of the operant chamber, some behavior analysts have moved to conducting basic laboratory research with human participants as well. In recent years, research has focused on studying complex human behavior such as stimulus equivalence, choice, self-control, and the effects of drugs on the behavior of humans.

Applied Behavior Analysis

The general principles under which ABA was founded were developed (and continue to be refined) from the results of laboratory experiments conducted in EAB. Thus, many of the

principles that are applied to human behavior are the result of translational research in which laboratory findings have informed the development of novel applications. This translational link serves as the bridge between EAB and ABA.

ABA differs from EAB in that it is generally interpreted as a clinical discipline in which the general principles of learning and behavior are used to solve or improve problems of social relevance. Behavior analysts who work in ABA conduct research that assist in developing and evaluating practices directed toward the remedy of problems associated with socially significant behavior. Applied behavior analysts then use the results of the applied research to create and implement effective evidence-based procedures in more natural settings such as schools, home, and the community. Such work often focuses on behavioral problems that occur in particular settings and are associated with particular populations (e.g., autism or other developmental disabilities) as well as those that are within a large social context such as organizational behavior management. ABA also has been used to treat clinical behavioral problems such as anxiety, phobias, and depression.

Dimensions of ABA

Early in its development, applied behavior analysts worked primarily in the field of psychology and education. As described by Baer, Wolf, and Risley, there are seven dimensions of ABA that must be implemented in order to assure that effective interventions are developed and implemented. The seven dimensions are (1) applied, (2) behavioral, (3) analytic, (4) technological, (5) conceptually systematic, (6) effective, and (7) generalizable.

Applied behavior analysts select behaviors that are *applied*, meaning that they are socially meaningful and are currently of importance to the individual whose behavior is being modified. For example, if a child with a diagnosis of autism does not have verbal language in his repertoire, it would be more socially acceptable and appropriate to teach the child to request items (e.g., snacks, drinks, and toys) as compared to teaching the child to ride a bicycle. At any given time, a behavior analyst could modify numerous behaviors an individual emits. It is important to prioritize which behaviors are most important to modify. In addition to identifying target behaviors for individuals, behavior analysts must modify behaviors which will affect how behavior analysis is communicated to the media, the general public, and legislatures who fund services.

As described previously as one of the tenets of behaviorism, applied behavior analysts directly observe and manipulate *behavior*. They typically do not use indirect measures of behavior like self-report, interviews, or checklists. In addition, they do not attribute behavior as characteristics of inner qualities such as personality traits. Instead, they attempt to identify a function of the behavior by manipulating environmental variables and observing interactions between behavior and those variables.

Even when working in an applied setting in which the goal is to develop an intervention that will effectively increase or decrease a behavior, it is important to demonstrate experimental control via a systematic *analysis* of behavior. Experimental control is achieved when an experimenter demonstrates a functional (i.e., causal) relationship between environmental variables and a behavior. In ABA, experimental control is

demonstrated using various single-case experimental designs including the reversal, the multielement, and the multiple baseline design. These basic designs share three commonalities: (a) prediction – the anticipated outcome of future measurement, (b) verification – demonstration that the previous expectation of behavior would remain unchanged in the absence of an intervention, and (c) replication – repeating the previous changes in behavior via the introduction and removal of the intervention.

In addition to the analysis of an intervention through the use of a controlled research design, behavior analysts often track one or more dimensions of behavior to determine if an intervention is producing significant behavior changes. Measures such as the frequency (the number of times a behavior occurs), duration (the amount of time in which a behavior occurs), and latency (the measure of time from the onset of a stimulus to the start of a response) are used to track the behavioral progress of an individual. By repeatedly measuring and evaluating different dimensions of behavior, the behavior analyst can determine if changes are needed to the specified intervention.

An example of the *analysis* component of ABA can be demonstrated by the single-subject treatment analysis conducted within a reversal (ABAB) design that is depicted in [Figure 1](#). Each data point represents a 5-min session and sessions are presented along the x-axis in the order in which they were conducted. The y-axis depicts the percentage of each 5-min session in which inappropriate behavior was observed. An initial baseline was conducted to measure the occurrence of inappropriate behavior in the absence of an intervention. High levels of inappropriate behavior were observed ($M = 65.9\%$). On the basis of these data, one would predict that similar levels of responding would continue in the absence of an intervention (which was verified by the collection of each subsequent baseline data point). Conversely, one would predict that the introduction of an intervention would result in a change in behavior, which it did ($M = 6.9\%$). To ensure that the observed change in behavior was due to the intervention presented (as opposed to an extraneous influence), the treatment was withdrawn and the initial baseline pattern of responding was replicated ($M = 88.0\%$ during the second set of baseline data). Finally, the treatment effect was replicated when the intervention was reintroduced ($M = 14.6\%$ during the second set of treatment data).

In addition to selecting an appropriate design for evaluating a functional relation, it is important that behavior analysts are *technological*, meaning that they thoroughly and accurately describe the procedures they use when conducting experiments and implementing behavioral interventions. This information, which includes written procedures, operational definitions of target behaviors, and procedural integrity data, must be documented in a way that allows another individual to replicate the study after reading these documents.

The assessments and interventions that behavior analysts implement are applied in nature. However, these interventions, and the approaches used to develop the interventions, must be *conceptually systematic*. This means that they are based on the basic behavior principles that have been empirically validated over many years by scientists who conduct basic research on the behavioral theories of EAB. Examples of conceptually systematic intervention components are reinforcement, extinction, and schedules of reinforcement (described above).

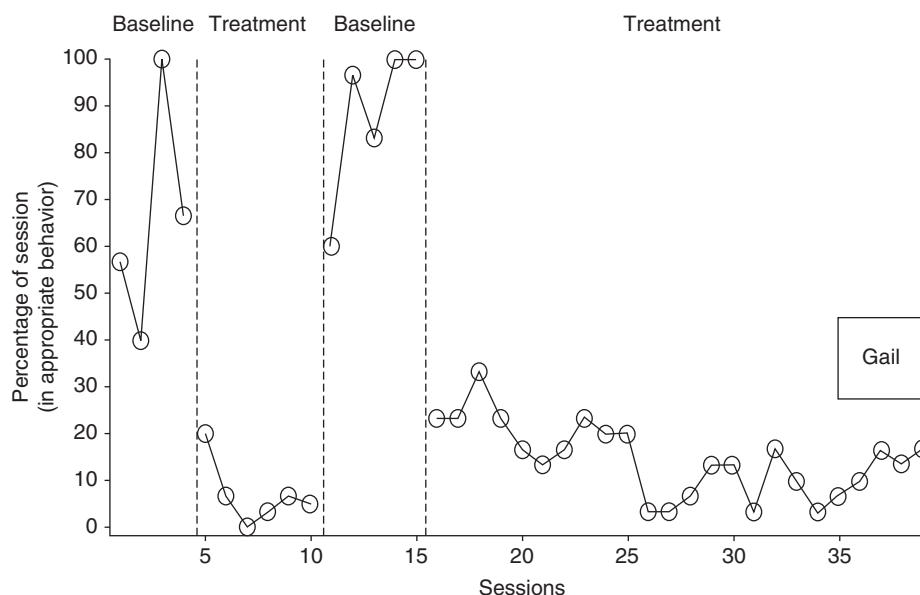


Figure 1 Percentage of session during which inappropriate behavior occurred during the baseline and treatment conditions for Gail. Adapted with permission from Roane HS and Kelley ME (2008) Decreasing problem behavior associated with a walking program for an individual with developmental and physical disabilities. *Journal of Applied Behavior Analysis* 41: 423–428.

Many experiments that utilize group designs use statistics to determine if there are statistically significant differences between groups. Applied behavior analysts rarely use statistics to determine if behavior change is significant (although there are several statistical procedures for use with single-case research designs). Instead, behavior analysts determine the *effectiveness* of their procedures by evaluating their data, often through visual inspection, that is, whether the individual whose behavior was changed and the family, caregivers, and friends of the individual find the behavior change significant. Just because a behavior change is statistically significant does not mean that the change is socially significant. For example, a reduction of head banging from a rate of 12 per minute to 6 per minute may be statistically significant. However, the individual is still hitting her head ~360 times an hour. Consequently, this is not a socially acceptable level of reduction of head banging. A more significant reduction needs to occur in order to classify the intervention as effective. Typically, behavior analysts examine data visually to assess changes in the stability (relative degree of variability in the data), trend (direction of the behavior; either no trend, a therapeutic trend, or a countertherapeutic trend), and level of behavior across different experimental manipulations or interventions.

The last principle of ABA is that the findings must be *generalizable* to other settings, caregivers, or behaviors. If a child is treated at a clinic and the child's aggressive and disruptive behaviors are decreased to near-zero levels at the clinic, but at school and at home the child is still engaging in the problem behavior, then the behavior reduction has not generalized. Generalization is important because it is not beneficial to decrease a child's behavior in the clinic if he only spends a few hours of his week in that setting. The behavioral intervention is only beneficial if the intervention decreases the child's behavior across different settings when different caregivers implement it. The most effective way of ensuring that generalization occurs is to program it into the intervention.

Researchers and clinicians have been implementing the seven dimensions of ABA across several settings for years. Most notably, ABA has been implemented in educational and clinical settings with individuals with disabilities. However, interventions based on the principles of ABA have been implemented successfully in educational, clinical, sports, and business settings to address a wide range of behavioral issues. The following sections briefly describe the application of ABA in these areas.

Assessment and Treatment of Destructive Behavior

Destructive behavior (e.g., physical aggression, property destruction, self-injurious behavior, pica) is fairly common among individuals with developmental disabilities. Although the principles of ABA have been applied therapeutically to many types of behavior, one of the most notable utilizations of these methods has been within the context of the assessment and treatment of destructive behavior displayed by individuals with developmental disabilities. The following text describes the general course of assessment and treatment of these behaviors using principles of ABA.

Conducting a functional behavior assessment (FBA) is one of the most crucial components of behavioral interventions in educational and clinical settings. It allows a hypothesis to be made about the relationship between the environmental events and behavior. More specifically, it obtains information about the functions a behavior serves (i.e., the causal effects these behaviors have on altering the individual's environment). FBAs allow the behavior analyst to hypothesize what consequences an individual is obtaining for engaging in the problem behavior. There are three common FBA methods: (1) experimental functional analysis, (2) descriptive assessments, and (3) indirect assessments.

An experimental functional analysis is the most structured form of FBA. During a functional analysis, the antecedents

and consequences similar to those in the person's natural environment are experimentally arranged so that the effects on destructive behavior can be separately observed and measured. An experimental functional analysis is often referred to as an 'analog assessment' because, although the antecedents and consequences are similar to those in the natural environment, the assessment itself is not conducted in the natural environment. This allows the behavior analyst to control the environmental variables to better assess the conditions under which the destructive behavior occurs.

Typically, an experimental functional analysis comprises four separate conditions: contingent attention, contingent escape from demand, an alone condition, and a control condition. During the control condition, it is expected that destructive behavior will be low because reinforcement is freely available and no demands are placed on the individual. The four conditions are presented one at a time in a random sequence to determine which conditions result in highest levels of destructive behavior.

Although functional analyses result in clear demonstrations of variables that influence the occurrence of destructive behavior, there are some limitations as well. First, there is a risk of temporarily strengthening or increasing the destructive behavior because the individual is contacting reinforcing stimuli contingent on that behavior. It is also possible that the individual's destructive behavior may acquire new functions during the assessment. Second, it may not be optimal to assess some behaviors using a functional analysis (e.g., those behaviors that, although very serious, occur infrequently or those behaviors that are too dangerous to briefly reinforce). Third, although variables are contrived to simulate the natural setting during a functional analysis, the contrived setting may not detect the variables in the natural setting that are maintaining the destructive behavior.

If conducting an experimental functional analysis is either not feasible or optimal, a behavior analyst may choose to conduct either a descriptive FBA or indirect FBA. Similar to an experimental functional analysis, a descriptive FBA requires direct observation and measurement of the problem behavior; however, during a descriptive assessment, the observation of the behavior is in the natural environment. Hence, descriptive assessments involve observation of destructive behavior under naturally occurring variables that are not systematically arranged. If direct observation is not possible, an indirect FBA can be conducted. An indirect FBA encompasses methods that result in information about the behavior without directly observing that behavior. Such assessments include behavioral interviews with caregivers or teachers, behavioral checklists, rating scales, or questionnaires. Although indirect FBAs are helpful when the behavior cannot be observed, the information gathered must be taken with caution. Often, those being interviewed may have a personal relationship with the individual exhibiting the problem behavior. This may make it difficult to obtain an unbiased and accurate description of the problem behavior.

It is often important to develop an intervention that incorporates an individual's preferences for different activities, foods, etc. For many individuals, identifying preferred items and activities which can be incorporated into behavioral interventions as reinforcers is as easy as asking the individual or

significant others (i.e., caregivers, teachers, etc.) what kinds of things they like. However, identifying effective reinforcers for those individuals with severe disabilities may be more challenging. Fortunately, there are a variety of procedures supported by research that can be used to determine the stimuli an individual prefers as well as the conditions under which reinforcing values of the preferred stimuli change. Although a number of methods have been presented in the literature, most preference assessments involve measuring relative interaction with each stimulus and ordering the stimuli hierarchically in terms of relative level of interaction. In general, stimuli that are associated with higher levels of interaction (i.e., more preferred) function as more effective positive reinforcers.

Once an FBA and a stimulus preference assessment are conducted, a behavioral intervention is typically implemented. Behavioral interventions typically include extinguishing the problem behavior by stopping the delivery of the maintaining consequence identified by the FBA. As noted above, withholding a reinforcer that has previously been shown to maintain a response is a process referred to as extinction. In the context of destructive behavior, extinction would involve no longer delivering the reinforcer (identified in the FBA) following the target behavior. For example, if a child's physical aggression occurred because it resulted in others allowing him out of school work, extinction would be arranged such that the child would no longer be given a break from his work following instances of aggression (i.e., the response no longer produces the reinforcer). An FBA is useful because it indicates what variables to withhold during extinction. However, extinction as a solitary form of intervention is typically not recommended due to the possibility of negative side effects (i.e., an extinction 'burst' or an immediate worsening of behavior before it decreases). Thus, most FBA-based behavioral interventions involve the combined use of extinction and a process called differential reinforcement (DR). In a typical DR procedure, the reinforcer that has been found to maintain destructive behavior is delivered following some alternative response (or the omission of destructive behavior) and destructive behavior is placed on extinction. A commonly used DR approach is called functional communication training in which the individual is taught an alternative, appropriate form of communication which is reinforced while no longer providing reinforcement for the target destructive behavior. Using the above example, the child might be taught that in order to receive a brief break from working he must complete a problem first. Finally, once a treatment is developed to reduce the occurrence of destructive behavior, the treatment must be modified slightly such that it can be implemented in the individual's natural environment (a process referred to as treatment generalization). Again using the above example, the treatment might be gradually modified such that the child is required to complete one problem, then five problems, ten problems, etc. before a break is given (all the while destructive behavior is placed on extinction).

ABA and Autism

In recent years, the term 'applied behavior analysis' has become synonymous with a therapeutic approach targeting autism. Autism is a neurological disorder associated with

ritualistic and restricted engagement in activities and behaviors as well as impairments or abnormalities in a child's development in the areas of communication and social interaction. Although a number of procedures have been presented as potential treatments for autism, procedures based on the principles of ABA have received the most empirical support.

When used to refer to the treatment of autism, 'applied behavior analysis' is most often associated with a specific method of instruction (called discrete trial instruction, DTI) that was pioneered by Ivar Lovaas and colleagues at UCLA. The procedures involved in DTI are firmly grounded in the principles of ABA; however, it is incorrect to use the terms DTI and ABA as synonyms. That is, ABA as a field incorporates many different procedures beyond those utilized in DTI for individuals with autism. Moreover, there are additional behavioral procedures, also based upon principles of ABA, which are effective for teaching autistic individuals. The basic components of these procedures are described below.

In general, the strongest empirical support for the treatment of autism favors the use of early and intensive behavioral intervention (EIBI). In an EIBI program, the procedures from the field of ABA are used (a) to reduce the occurrence of problem behaviors associated with autism and (b) to replace those behaviors with appropriate communication, social skills, play skills, academic skills, and independent living skills. The basic procedures employed in an EIBI program involve rearranging the antecedent and consequent events in the environment such that appropriate behavior reoccurs and problem behavior is extinguished (i.e., the 'selection by consequences' paradigm presented by Skinner). Such treatment is developed by a practitioner with specialized training in ABA and is typically implemented at a 1:1 therapist to child ratio for ~20–40 h per week.

A number of empirical studies have found that ABA-based programs are consistently more effective than eclectic or play-based therapies and the use of ABA programs has been endorsed by a number of professional organizations. A critical review of the features and demonstrated efficacy of ABA-based treatment approaches for autism is beyond the scope of the current chapter; however, common procedures that are based on principles of ABA include: (a) DTI, (b) incidental teaching, (c) pivotal response training, (d) verbal behavior training, (e) natural language paradigm, (f) peer-mediated interventions, (g) precision teaching, and (h) errorless learning.

ABA in Other Areas of Focus

Although the principles of ABA are typically used in educational and clinical settings for individuals with developmental disabilities, these are not the only settings in which ABA has been implemented. Applied behavior analysts have shown that the same principles hold true and are effective in changing individuals' behaviors in organizational settings such as factories, restaurants, and retail. In addition, ABA has been shown to be effective with different populations such as adults with dementia, children with attention deficit/hyperactivity disorder, and athletes.

Conclusion

There are three branches of behavior analysis: behaviorism, experimental behavior analysis, and ABA. Behaviorism is the study of the philosophy and theories of behavior. The major tenants of behaviorism which collectively make it unique are that (a) behavior analysts view behavior as its own subject matter; (b) that private events are the function of the same environmental variables as public events; (c) that individuals, not groups, behave; (d) behavior is a function of variables in the environment; and (e) the study of behavior is a natural science. The purpose of the branch of the EAB is to further develop the basic principles of behavior analysis. The third branch of behavior analysis is ABA and its purpose is to implement the basic principles of behavior analysis in ways that result in socially significant changes for individuals in communities. There are seven dimensions of ABA, including: applied, behavioral, analytic, technological, conceptually systematic, effective, and generalizable. ABA is commonly implemented in educational and clinical settings with individuals with disabilities and this term is sometimes utilized (albeit inaccurately) as a label for a specific treatment for autism. However, the principles of ABA extend beyond individuals with developmental disabilities. ABA is an effective method of changing the behavior of many populations across many settings.

See also: Autism and Pervasive Developmental Disorders; Behavior Measurement in Psychobiological Research; Intellectual Disabilities; Operant Conditioning.

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Behavior Genetics of Personality

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Glossary

Behavior genetics A scientific field that uses both quantitative genetics and molecular genetics to understand both the genetic and environmental contributions to individual variation in human behavior.

Gene The basic unit of inheritance, a section of DNA that codes for a particular product.

Gene–environment correlation When the genetic influences on a phenotype are correlated with the genetic influences on an environmental variable.

Gene–environment interaction When the effect of genes on a phenotype depends on exposure to a certain environment, and vice versa.

Heritability The proportion of total variance in a behavior or trait that varies among individuals in the population that can be attributed to genetic influences.

Nonshared environment Environmental experiences/influences on a phenotype that differ between family members.

Phenotype An observed characteristic of an individual, resulting from a combination of genetic and environmental influences.

Shared environment Environmental influences on a phenotype that are shared between family members and result in making them more similar.

Introduction

The characteristic ways that people think, feel, and behave constitute personality, and personality varies among people. Some people are more introverted, some more extroverted; some enjoy trying new experiences, while others are cautious, restrained, and stick to old habits. Psychologists have long been interested in understanding the reasons for this variation. One obvious place to look is the person's rearing environment, particularly the family. If an individual is more introverted, we might reasonably expect them to have, for instance, a mother who is also more introverted. However, when mother and child are biologically related, it becomes difficult to determine whether the child is introverted because of the genetic similarity to the mother, or if the learning processes and environments that the mother exposed her child to over the course of the child's younger years are the relevant causal factors.

Methods in behavior genetics for modeling genetic and environmental influences on human behavior are a fundamental tool for parsing out these possibilities. The field of behavior genetics, with its focus on twin and adoption studies and 'biometrical modeling' of these kinds of family data, was vitally important in demonstrating genetic influences on most behavioral traits long before the genome was sequenced. We can now say with reasonable certainty that individual differences in personality are influenced by genetic and environmental factors. Some may ask whether, in the era of molecular genetics, these biometric approaches are still necessary. In fact, biometric modeling of personality still has much to contribute, particularly as the field of molecular genetics struggles to find replicable results linking measured genes to personality traits.

Recently, the field of behavior genetics has extended earlier work that estimated the heritability (the magnitude of genetic influence) of personality. New focus on forms of gene–environment interplay – that is, how genetic and environmental factors interact and correlate – may have important implications

for understanding the etiology of personality. In this article, we provide a brief overview of biometric approaches, particularly using twin sample methodology, and how this work informs our understanding of the etiology of personality. We then present extensions of twin modeling that have implications for the structure of personality, links between personality and psychopathology, and connections between personality and environmental risk factors. Our goal is to provide the reader with a broad overview of conceptual and statistical issues related to the modeling of personality data in behavior genetics. Space limitations prevent us from providing a more in-depth treatment of the issues, but we refer interested parties to several excellent texts on behavior genetics.

Genetic and Environmental Influences on Personality Traits

Twin Studies

The most common method for examining genetic and environmental influences on personality variation involves the use of the twin study, thus we focus much of our discussion on this method and the findings from twin studies. Twins are nature's way of providing a natural experimental design to disentangle the relative influence of genes and the environment. Twins come in two varieties: identical (monozygotic, MZ) twins result from the splitting of one fertilized egg, and thus MZ twins share the same DNA/genes. Fraternal (dizygotic, DZ) twins result from two eggs being fertilized at the same time, and share on an average, half of their segregating genes. Biometric modeling takes advantage of the known degrees of genetic and environmental similarity between MZ and DZ twins, using the concordance between twin pairs to decompose the variance in a phenotype into percentages as explained by genes relative to environmental influence. Any phenotype in the human population that differs among individuals (e.g., a personality trait)

can be said to display 'phenotypic variance,' which is attributed to both genetic and environmental influences.

The basic goal of a univariate ('one variable') twin study is to estimate the relative influence of genes and environment. Biometric models separate the variation in a phenotype into three sources that, taken together, can be summed to account for the total variance of the phenotype. The first source of influence is genetic variance, or the amount that a phenotype differs among people because of genetic differences in the population. This source of influence is typically indexed with the heritability statistic, h^2 , or the proportion of total variance in the phenotype that is due to genetic influences. It is important to note that heritability, like the commensurate estimates for environmental influences, is a population-based statistic; thus, if we say that the heritability of a personality trait is 50%, we are saying that 50% of the variance in that trait in the population from which we sampled is due to genetic differences among people in that population; not that 50% of any one individual's personality is due to genes. If genetic influences completely explained all of the variation in a personality trait, we would expect that the correlation between MZ pairs would be 1.0, because MZ twins share all of their genes, while the correlation between DZ pairs would be 0.5 because DZ twins share ~50% of their genes.

The second source of influence is the shared or common environment, abbreviated c^2 . The shared environment indexes the extent to which growing up in the same household makes twins more similar to each other. Shared environment includes things like socioeconomic status, traditions, customs, habits, personality traits of rearing parents, and neighborhood characteristics. If the shared environment completely explained the variance in a personality trait, we would expect that both MZ and DZ twins reared together would correlate 1.0 because all twin pairs share the experience of having been reared together, regardless of their zygosity. The nonshared environment indexes the extent to which twins are different despite sharing the same household and genes. It is abbreviated e^2 and is also referred to as unique environment. Examples of nonshared environment include having friends, life experiences, and traumas that are different from one's siblings. The estimate of nonshared environment also contains any error or imprecision of measurement, and will thus be inflated to the extent that people are measured with less than perfect fidelity. Expectations resulting from nonshared environment completely explaining the variation in a personality trait would be MZ and DZ twin correlations of 0.0, consistent with the idea that the nonshared environment represents the uniqueness of a specific person.

Both shared and nonshared environmental effects are also commonly discussed as proportions of variance, like the heritability statistic. It is important to note that the distinction between nonshared and shared environmental influences can be subtle. Parenting practices could be conceived of as shared between all siblings in the family, to the extent that the same parenting style might make siblings more similar to each other (shared environment), but perceptions of parenting may be unique to each individual child and thus work to make children growing up with the same parent less similar to each other (nonshared environment).

Evidence from decades of work consistently shows that almost any psychologically interesting phenotype has a genetic

component, a finding so ubiquitous that it has been called the 'First Law' of behavior genetics. This includes almost every major personality trait or domain. Across varying samples, cultures, population cohorts, and personality measures, the heritability of any typical personality trait is around 50%, with the rest of the variance coming mostly from nonshared environmental influences. Very little personality variation can be accounted for by the effects of the rearing family environment, beyond the contribution of shared genetics. Much of this work has been conducted on traits from the Big Five personality domains (extraversion, openness, agreeableness, conscientiousness, and neuroticism). In their review of the literature on twin studies of the Big Five traits, Bouchard and Loehlin found that the heritability of all five domains was around 40–50%. The consistency of this finding across the traits, which differ widely in the aspects of human behavior that they capture, is compelling evidence of the ubiquity of genetic influences on human individual differences.

Several points related to these findings are worth considering. First, moderate to sizeable estimates of genetic influence have also been found for dimensional measures of pathological personality and categorical personality disorder diagnoses. Second, with only a few exceptions, (e.g., altruism), estimates of shared environment tend to hover close to 0, suggesting that influences from the family, beyond genetic inheritance, have little or no impact on personality. However, we cannot rule out the possibility that shared environmental influences act in an interactive manner on personality, as opposed to having a main effect. If interactional or transactional processes are at work, such that some family-level factors enhance and some suppress genetic effects on personality, the influence of such factors could appear in either heritability or nonshared environmental estimates.

Third, most heritability estimates are based on the assumption of additive genetic effects, the idea that individual genetic contributions are fungible and 'add up' in their influence on phenotypic variation. More complex genetic effects (such as genetic contributions interacting with each other, a phenomenon known as epistasis) are possible and may also be important in understanding the underlying molecular architecture of personality. Fourth, even though a substantial portion of the etiology of personality is estimated as nonshared environmental effects, research has been relatively unsuccessful in linking personality variation to specific environmental effects or risk factors, a topic we return to below.

Finally, much of the work to date on personality and behavior genetics has concentrated on adult twin samples using self-report methods. More recently, research has extended downward to child and adolescent samples, using both self- and observer report of personality. One study, using a sample of 9–10-year-old twins, found substantial heritability estimates for only two (Self-directedness and Harm Avoidance) of the scales from the Junior Character and Temperament Inventory. Notably, they found substantial shared environmental effects for Novelty Seeking and Cooperativeness. A different study used a sample of toddlers and found that the variation in inhibitory control (IC), a dimension of temperament, was 38% genetic and 62% nonshared environment using observer ratings, but 58% genetic, 26% shared environment, and 16%

nonshared environment using parent ratings, suggesting both developmental and rater effects may be important in understanding the etiology of personality.

Adoption Studies

Most behavior genetic research on personality has utilized the twin study design, but adoption studies also provide a genetically informative perspective on the etiology of personality. Families in which there is an adopted child, like the twin design, provide a natural experiment for understanding genetic and environmental influences on personality variation. Consider, for example, a family in which there are both biological children of the parents and adopted, nonbiologically related children (thus, not a kinship adoption). The adopted child or children will share 100% of their family environment with their adoptive parents and nonbiological adopted siblings, but 0% of their genes.

Adoption studies, like twin studies, find substantial nonshared environmental effects and little influence of the shared environment; however, they tend to produce smaller heritability estimates than do twin studies. There are two major possibilities for the discrepancy in findings between twin and adoption studies. One possibility is that identical twins reared together are highly correlated on phenotypes like personality because they are raised in environments that encourage imitation (e.g., being dressed alike by their parents). Twin studies operate under the equal environments assumption (EEA), which posits that the environments of MZ twins are no more alike than DZ twins; if this assumption were violated, MZ twin correlations could be inflated, thus increasing heritability estimates. A powerful research design, focusing on twins reared apart, has proved valuable in supporting the likelihood of the EEA. Any resemblance between twins who are reared apart cannot be traced to the shared environment. Studies of twins reared apart conducted in Minnesota and Sweden find estimates of heritability in line with what has been found in studies of twins reared together.

Another possibility for the discrepancy in heritability estimates between adoption studies and twin studies involves the role of nonadditive genetic effects on personality. As noted above, most twin studies assume that genetic effects are additive, and few find evidence of dominant or nonadditive genetic effects. It is possible that adoption studies are better at identifying nonadditive genetic effects, that is, effects due to interactions among specific genes. The Nonshared Environment in Adolescent Development (NEAD) study was important in furthering our understanding of the role of nonadditive effects in the variation in personality. This study combined information from MZ and DZ twins, full siblings, half siblings, and genetically unrelated children in the same family resulting from remarriage. Results indicated high heritability estimates, significant shared environmental estimates, and little effect of nonshared environment on broad domains of adjustment. In a follow-up study, the authors found slightly lower heritabilities than in the original study, and confirmed the presence of significant nonadditive genetic effects.

While, in general, adoption studies are commensurate with twin studies in showing little evidence of the shared environment, recent findings suggest that the adoption design may be

important in elucidating influences of the family environment on personality variation. A recent study used a large sample of both biologically related and adoptive families to examine genetic and environmental influences on a range of phenotypes, including personality traits of disinhibition and negative emotionality (NE). Both types of families consisted of parents and two adolescent siblings, either biologically related or, in the adoptive families, two adopted siblings or one adopted sibling and one biological sibling. While variation in NE was largely due to nonshared environment and genetic effects, there was evidence of significant shared environmental influences (20%) on disinhibition. The findings support the use of large samples of adoptive families to detect the presence of systematic family influences on the etiology of personality.

Multivariate Modeling of Personality

In the following sections, we argue that the approaches in behavior genetics, particularly advanced biometric models applied to data from twins, adoptions, or other informative behavior genetic designs (e.g., twin family), can help us in better understanding the etiology of personality. We begin by elucidating how biometric models can improve our understanding of the structure and development of personality, before turning to exploration of overlap with psychopathology.

Structure of Personality

Extending beyond the basic univariate twin modeling of personality, research has examined the overlap between genetic and environmental influences on several personality traits considered together. Multivariate biometric modeling of personality variables allows a researcher to decompose not only the variance within phenotypes, but also the covariance between phenotypes, into genetic and environmental influences. These multivariate biometric models have important implications for understanding the structure and organization of personality. For example, we know that at the phenotypic level, the facets of the five factor model (FFM) domain of neuroticism (e.g., angry hostility, anxiety) are correlated, thus supporting their use as indicators of a higher-order factor; biometric modeling can be used to determine if the genetic and environmental influences on these facets mirror the phenotypic factor structure. Biometric modeling of multiple phenotypes (i.e., two or more personality traits) works much like the analysis of single traits, estimating heritability and environmental proportions of variance unique to each, in addition to the amounts shared in common between the two phenotypes. Further, this type of model estimates the genetic and environmental correlations between different traits. A genetic correlation, for example, indexes the amount of overlap between the genetic influences on two different traits, ranging from 0 to 1.0. These genetic and environmental correlations can then be subject to factor analyses, much like phenotypic correlations between traits.

Findings from this work provide a complex picture of how genetic influences on specific domains of personality operate. For example, the genetic structure of personality traits from the FFM domains parallel the phenotypic structure; yet, in addition to genetic influences on the higher-order factors,

there are also genetic influences on more specific personality traits subsumed under the broad domains that are not accounted for by the higher-order genetic factors. Jang and colleagues examined the genetic and environmental structure of the FFM traits using data from a combined German and Canadian twin sample. They found that each of the five domains consisted of two genetic and two nonshared environmental factors, and concluded that the FFM higher-order personality traits may not represent coherent psychological entities. A subsequent study applied the same biometric multivariate models to data consisting of adjectives representing the FFM domains in a nationwide sample of American twins. One etiologically coherent common factor explained the variation in Extraversion and Neuroticism, suggesting that these domains came closest to being unitary personality constructs.

Personality over Time

Genetic and environmental influences can also be studied longitudinally. For example, one study examined the contribution of genetic and environmental influences to the stability and change in 'withdrawn' behavior from age 3 to 12. Substantial genetic influences were found at all ages, particularly at age 3 and 7, and high genetic correlations over time indicated that generally the same genetic influences were operating at all ages. Only modest shared environmental effects were found at any age, although they were slightly higher for girls than for boys and explained more of the stability of withdrawn behavior over time in girls (14% for girls vs. 4% for boys). Nonshared environmental effects increased over time, but smaller nonshared environmental correlations indicated that these effects were different at different ages. The general point is, given longitudinal data on twins, developmental processes can also be parsed into genetic and environmental aspects.

Links to Psychopathology

Approaches in behavior genetics have also been used to examine the shared etiology of personality and psychopathology. Considerable evidence points to the phenotypic associations between personality traits and different psychopathological syndromes. Behavior genetics provides useful tools for examining whether these associations are due to genetic overlap between personality and psychopathology. Extensions of the multivariate biometric model (described above) have also been used to estimate genetic and environmental influence shared in common between personality traits and symptoms of mental illness. Numerous studies have shown shared genetic influences between personality and different forms of psychopathology, including neuroticism and mood disorders and disinhibition and externalizing disorders.

Major theories of the links between personality and psychopathology have been reviewed extensively elsewhere. In brief, the model that has received perhaps the greatest support in both the child and adult literatures suggests that personality traits and different syndromes of psychopathology are lower-order components of a higher-order spectrum. For example, the internalizing–externalizing model of psychopathology indicates that mood and anxiety disorders are indicators of a higher-order spectrum of internalizing, while behavior

disorders of substance use and antisocial behavior and conduct disorders form indicators of a higher-order externalizing factor. The personality trait of neuroticism seems to fit well within the internalizing factor, while the personality trait of conscientiousness (reversed) fits well within the externalizing spectrum.

Two types of biometric models are particularly appropriate for examining the spectrum model of personality and psychopathology. The *common pathways* model posits that the covariation in a set of variables form a single latent phenotype (e.g., personality and psychopathology variables as in the internalizing factor), and this latent phenotype is influenced by one set of additive genetic, shared environmental, and nonshared environmental effects. In contrast, the *independent pathways* model specifies direct links to the personality and psychopathology variables from genetic, shared and nonshared environmental influences common to all the variables and unique to each individual variable. Researchers have recently begun to directly test these competing models. In a twin sample of more than 600 adolescents, Krueger and colleagues found that a common pathway model best explained the covariation between adolescent antisocial behavior, conduct disorder, alcohol dependence, drug dependence, and the personality trait of constraint (reverse scored). This finding is supported by parallel results finding a common factor model of externalizing behavior. More recently, Singh and Waldman compared the common pathway and independent pathway models to explain the covariation among NE and childhood externalizing disorders in a sample of 4–17-year-old twins. Unlike Krueger and colleagues, they found that the independent pathways model provided the best fit to the data, positing that the genetic influences common to both NE and externalizing disorders may support the role of NE as an endophenotype that lies between measured genes on the chromosome and syndromes of mental illness.

Biometric modeling has also been applied to the internalizing spectrum. Kendler and colleagues concluded that the genetic factor structure of the internalizing spectrum disorders, not including any personality traits, closely paralleled the phenotypic structure. A later analysis added neuroticism, and found two overlapping genetic factors; one factor was shared between neuroticism, major depression, generalized anxiety, panic disorder, and the phobias, while the other factor explained the covariation between major depression, generalized anxiety, and panic disorder, independent of neuroticism. Finally, South and Krueger found support for a one-factor model of internalizing with indicators of depression, generalized anxiety, panic attacks, and neuroticism; biometric modeling found estimates of moderate genetic influences and large nonshared environmental influences, with smaller estimates of the shared environment.

Environmental Influences

Having firmly established the importance of genetic influences on personality variation, the field of behavior genetics moved forward with the goal of identifying and explicating the role of environmental risk factors that impact the etiology of personality. One important line of research was initiated by David Rowe, showing genetic influences on putatively

'environmental' measures. Genetic influences have now been found across a variety of environmental measures and assessment approaches. This seminal finding was valuable in showing how people, to some extent, 'make' their own environments; thus, the quality of parent-child, sibling, and marital relationships, for instance, is due, in part, to the genetically influenced traits of the individuals in those relationships. This is known as *gene-environment correlation*, or the degree to which a genotype influences the likelihood of exposure to a specific environment. To directly examine this hypothesis, researchers have modeled the genetic and environmental overlap between personality and measures of the environment. As with the multivariate personality research described above, a Cholesky decomposition can be conducted with personality traits and environmental variables to estimate any shared genetic influences.

Research has shown that there are shared genetic influences between personality traits and aspects of the environment. In a sample of twins reared apart, Krueger and colleagues showed that there was genetic overlap between personality traits and aspects of the childhood rearing environment as recalled in adulthood; further, these genetic influences on personality accounted entirely for the genetic influences on the environment. Kandler and colleagues later replicated these results in a sample of twins reared together. Again, they found genetic overlap between aspects of the rearing environment (i.e., support) and personality traits, using both self- and peer-reports of a different personality measure than the prior study. South and colleagues, in a sample of adolescent twins, found genetic correlations between self-reported personality factors of positive emotionality, NE, and constraint from the Multidimensional Personality Questionnaire (MPQ) and aspects of the adolescent's relationship with his or her parent relationship. Together, these findings support the role of personality in shaping the nature of environment. Not only do genetically influenced personality traits impact the perception of the rearing environment, it appears that aspects of the environment (e.g., the quality of the parent-child relationship) are reactive to those same genetically influenced personality traits.

Another possible form of interplay between personality and the environment, beyond gene-environment correlation, is called gene-environment interaction, and refers to the fact that different environments might moderate the genetic and environmental influences on personality. In other words, whether or not genetic influences on personality traits are expressed may depend on the context or experience of certain environmental influences. Typically, when heritability is estimated in a biometric model using twin samples, it is estimated across the entire sample-specific population. Thus, the heritability estimate averages over any differences that might occur within certain subsamples in the population. Biometric moderation models have been developed that allow for different estimates of heritability depending on a person's standing on an identified environmental moderator variable. Consider that univariate and multivariate twin studies have, for many years, utilized biometric models that examine whether there are gender differences in heritability estimates. Biometric moderation models extend this idea, but instead of using gender they estimate whether heritability may differ depending on

environmental contexts like socioeconomic status, marital quality, or the parent-child relationship. A recent study used these biometric moderation models to examine gene X environment interactions between personality traits and the parent-child relationship in a sample of adolescent twins. They found that the heritability of broad personality factors (positive emotionality and NE) varied as a function of the quality of the parent-adolescent relationship, suggesting that how much genes influence the variation in personality may depend on the family context. This work is still in the early stages and much more still needs to be done before we can say with any great certainty whether gene-environment interplay will be a major step forward in understanding the developmental, causal pathways to personality.

Summary

In this article, we reviewed the decades of research in behavioral genetics that has consistently found moderately strong estimates of genetic and nonshared environmental influences on personality. Family influences, beyond genetic effects, have been more difficult to find, although recent studies using younger samples, different personality assessment methods, and adoption studies provide some tentative evidence that shared environment may be more important, particularly in childhood, than previously thought. While nonshared environmental effects have historically been substantial, researchers have struggled to identify the specific environmental contexts or risk factors involved in the etiology of personality. Biometric moderation models that estimate gene X environment interaction in the presence of gene-environment correlation may provide one way of finally elucidating important environmental contexts. This has particularly strong implications for finding measured genes (from a molecular genetic approach) involved in personality variation. As the field of behavior genetics of personality moves forward, there appears to be ripe opportunities for collaboration with molecular genetics, with methodologies from both fields helping to inform the other, linking more refined personality inventories with measured genes and the particular environmental contexts which modify their expression.

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Relevant Websites

- <http://www.personality-arp.org/> – Association for Research in Personality.
- <http://www.bga.org/> – Behavior Genetics Association.
- <http://www.ists.qimr.edu.au/> – International Society for Twin Studies.
- <http://www.vcu.edu/mx/> – Mx Webpage.

Behavior Measurement in Psychobiological Research

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Glossary

Cardiothoracic impedance A noninvasive technique for the measurement of cardiothoracic blood flow by passing an electrical current through thorax and recording and analyzing changes in impedance (impediment to electric current flow). This information can be used to derive measures of cardiac contractility, which reflects alterations in sympathetic nervous system activity as well as cardiac output, which indexes cardiovascular status.

Cortisol A steroid hormone typically associated with the stress response that has broad effects on metabolic, cardiovascular, and immunological processes.

Galvanic skin response A method for measuring the electrical resistance of the skin which can serve as an index to sympathetic responses.

Heart rate variability The rhythmical fluctuation in heart rate that serves as a measure of autonomic cardiac control. Variations within particular band widths can then be used to parse out parasympathetic cardiac control through the quantification of the component of heart rate variability in the respiratory frequency band (respiratory sinus arrhythmia).

Oxytocin A hypothalamic neuropeptide that plays an important role in various social behaviors in animals and humans.

Introduction

Human behavior is an emergent phenomenon that results from complex neural and environmental determinants occurring across multiple levels of organization. Psychologists have long appreciated this fact, and the application of psychophysiological measures to psychological research has expanded in recent years. Multilevel analyses, such as those commonly used in psychophysiological research, represent a subset of interdisciplinary approaches where the measures, constructs, and theories cover multiple levels of organization. The growth of multilevel analysis has provided important insights into the reciprocal interactions between psychological and neurophysiological processes.

Multilevel analyses involve more than manipulating or measuring variables at different levels of organization. If multilevel analyses are to provide more extensive models of human behavior, they also require an explication of the mechanisms connecting these variables. This, in turn, requires an appreciation for the nature of the potential mappings between levels of organization. The unique scientific dialects used by the social and biological sciences can increase the prevalence of category errors, where seemingly parallel concepts from different levels of analysis reflect only partially overlapping domains, rather than representing a one-to-one isomorphism. Although the inherent complexity of psychophysical relations can present unique scientific challenges, multilevel analysis capitalizes on such complexity through a mutual calibration process whereby knowledge at one level of analysis can refine and inform another and reduce the incidence of category errors.

In this article, we highlight some features of contemporary neurobehavioral measurement within the context of multilevel analysis and provide a framework for applying such analyses to the study of human behavior.

Some Principles of Multilevel Measurement of Behavior

In this section we highlight some of the conceptual foundations of the multilevel measurement of phenomena relevant to human behavior and provide the rationale, and the potential limitations, for conducting such broad-based research.

The principle of *Multiple Determinism* postulates that processes occurring at one level of organization (e.g., psychological) will have multiple antecedents within and across levels of analysis. For example, individual differences in the psychological and behavioral manifestations of perceived stress are dependent on both genetic and environmental factors. Consequently, isolated analysis of behavioral output may provide information on psychological processes, but the precise determinants of such responses are not necessarily inherent in this behavior. Because of the multiple determinants across even proximal levels, the mappings across more divergent levels of analysis become increasingly complex. Although the ultimate goal of multilevel analysis is to bridge levels of analysis, the *Corollary of Proximity* suggests that this effort may be more straightforward for more closely related levels since the complexity of the mappings increases geometrically as one moves linearly across levels of organization. Skip levels, and the mappings can become impenetrably complex. This is not to suggest that bridging across broader levels of analysis is not possible or desirable; rather, it is a realization that the establishment of smaller bridges may be more efficient and can provide the foundation for more expansive bridge-building efforts.

The principle of *Nonadditive Determinism* reflects the fact that the properties of the whole cannot always be predicted by the properties of its parts. The sources of variance from higher-level processes are often broader than those for lower levels of organization; so, higher-level systems tend to be more complex. The increased complexity inherent in behavioral and

psychological processes can limit the utility of reductionistic approaches in the full explication of complex phenomena. For example, while understanding the contribution of isolated genes to psychiatric conditions can be quite useful, in order to understand pleiotropic effects of genetic networks one needs to understand how the gene products interact with each other and attempt to incorporate this emergent behavior into more comprehensive models. Thus, phenomena of interest should include observations at the highest level of organization at which it manifests, as it may not be understood by appeal exclusively to a priori understandings derived solely from lower levels of analysis, a concept termed the *Corollary of Asymmetry*. The corollary of asymmetry does not deny the utility of measurement at strictly lower-level analyses (e.g., cellular processes), but does assert that a single level of analysis may not universally provide the optimal description of scientific phenomena.

Lastly, the principle of *Reciprocal Determinism* asserts that there may be mutual, reciprocal influences among levels of organization where the direction of causation or explanation need not always flow from lower- to higher-level phenomena. One may be tempted to view causation as an entirely bottom-up process where lower-level operations (e.g., genes) strictly determine activity at higher levels (cellular, organ system, or behavior). While such bottom-up strategies have provided countless scientific breakthroughs, they do not provide a complete picture. For example, environmental influences can reprogram the expression of particular genes, which can then be passed on to subsequent generations through epigenetic inheritance. Therefore, because causal influences among levels can be bidirectional, the *Corollary of Interdependence* states

that a single level of analysis may not yield a comprehensive account of multilevel phenomena, and that no single level of analysis applies uniformly. Importantly, this is not to suggest that research conducted within individual levels is not important as multilevel research is necessarily dependent on the work done within single-level analysis. However, the corollary suggests that multilevel analysis may be necessary for a comprehensive understanding of phenomena as complex as human behavior.

Application of Psychophysiological Measurement

Psychophysiological measures of neurobehavioral processes provide a unique perspective on human behavior. Indeed, psychophysiological measures provide a global view of the emergent behavior of integrated neurophysiological systems that present a picture of neurobehavioral systems that may not be apparent through the isolated measurement of molecular or molar processes. Generally, neurophysiological measures are of interest primarily to the extent to which they allow one to index a psychological process (Figure 1). For example, the analysis of sympathetic and parasympathetic regulation of cardiac functioning is widely used to index the activity of neurobiological processes associated with psychological states including anxiety, attention, and arousal. In this regard, differential patterns of sympathetic and parasympathetic activation of the heart can provide valuable information on the neurobiological and psychological processes that control autonomic output. In the following section, we highlight some applications of psychophysiological measurement within the context of multilevel analysis.

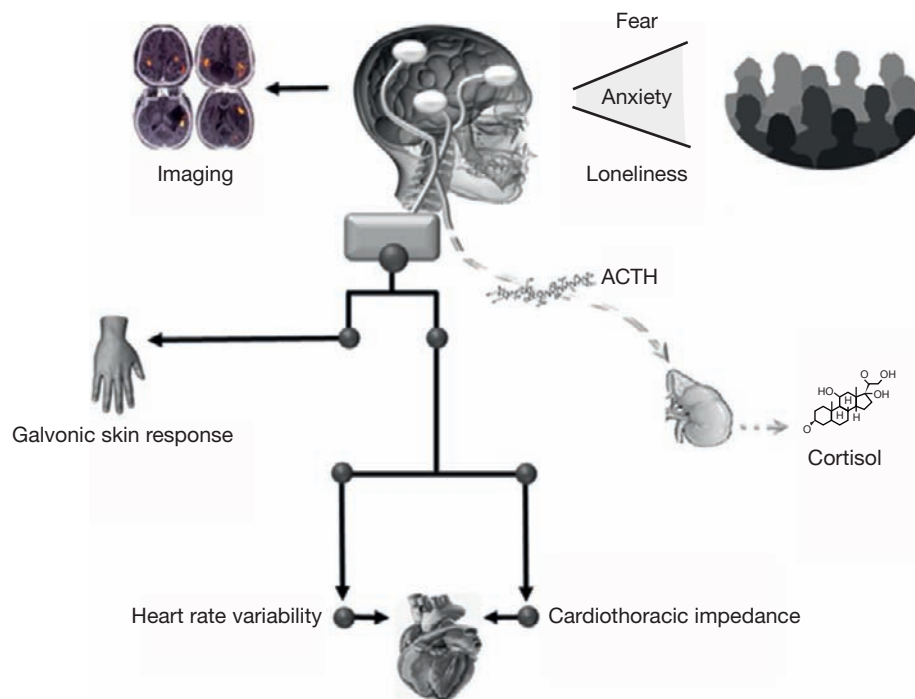


Figure 1 Summary of commonly used measurement of psychophysiological measurement. Environmental stimuli modulate neurobiological processes, which subsequently modify psychobiological processing that can be indexed through imaging technologies (e.g., fMRI), cardiac autonomic control measurement, skin conductance alterations, and variations in stress hormone levels.

Measurement of Autonomic Nervous System Function in Neurobehavioral Processes

The theoretical underpinning of multilevel analysis to human behavior has existed for decades with contemporary views beginning to take shape at the turn of the nineteenth century. In his essay "Evolution and dissolution of the nervous system," Jackson (1884) laid the foundation for multilevel characterizations of neuroarchitectural developments. Jackson argued that the emergence of higher levels of neuronal organization does not involve a replacement of lower levels. Instead, higher-level brain structures (e.g., cerebral cortex) can be characterized by a hierarchical organizational pattern composed of simple reflex-like circuits at the lowest levels (brainstem and spinal cord) and distributed neural networks for more integrative computations at higher levels. Together these interacting hierarchical structures allow neural systems to respond to environmental and neurophysiological perturbations via rapid low-level processing (e.g., startle reflex) allowing more rostral neural substrates sufficient time to develop strategic responses.

Early hierarchical models of autonomic control were perhaps most visibly articulated by Walter Cannon in the early twentieth century. Cannon's work revolved around the concept of 'homeostasis' which proposed that a primary role of autonomic nervous system (ANS) was maintaining the constancy in vital neurophysiological processes (e.g., blood pressure). Cannon proposed that the sympathetic nervous system served as the primary modulator of homeostatic processes with activity in the parasympathetic branch serving to fine-tune end-organ responses. Based in part on Cannon's work, parasympathetic and sympathetic outputs, which generally have opposing actions, have been considered to be reciprocally regulated by central systems. Reciprocal activation patterns, where activity in one autonomic branch increases and the other decreases, are often observed in reflex responses where the reciprocal changes in the independent branches act in concert to expand dynamic control of end-organ responses.

In addition to hierarchical patterns of autonomic control, descending neural projections are capable of regulating

lower-level neural structures such as the brainstem and spinal cord through the activation of descending projections that bypass intermediate hierarchical structures. This *heterarchical* neuroarchitectural organization likely affords higher-level neural structures the ability to control autonomic and behavioral output patterns independent of intermediate processing levels. Importantly, heterarchical models have all the components of hierarchical systems but have the additional capacity to orchestrate complex behavioral responses through direct control over widely separated levels via direct connections.

Heterarchical control is apparent in central autonomic regulation. Although baroreflex responses typically entail reciprocal patterns of autonomic control, the autonomic branches are capable of independent activation. This has necessitated an expansion in the simple reciprocal bipolar model of autonomic control, in which autonomic states are considered to lie along a single continuum with maximal sympathetic (and minimal parasympathetic) activity at one end and maximal parasympathetic (and minimal sympathetic) activity at the other. Although this bipolar model may apply to reflexive brainstem circuits, the greater flexibility of more rostral neural systems, together with long heterarchical pathways, requires an expanded model of autonomic control that can account for the coactivation (or coinhibition) of the two autonomic branches. Additionally, there may be far greater individual differences in autonomic responses arising from the operations of neural systems controlling complex psychological and behavioral outputs. At a group level, the heart rate responses of human subjects to orthostatic stress and to standard psychological stressors (mental arithmetic, speech stress, reaction time task) are similar. Analysis of the separate contributions of the two autonomic branches by the use of pharmacological blockades revealed that activation of the baroreflex by orthostatic stress (transition from sitting to standing) yielded a rather consistent response across subjects, characterized by reciprocal autonomic output (sympathetic activation and parasympathetic withdrawal). However, psychological stress is capable of producing more varied autonomic responses across subjects, with no overall correlation between the responses of the autonomic branches (Figure 2).

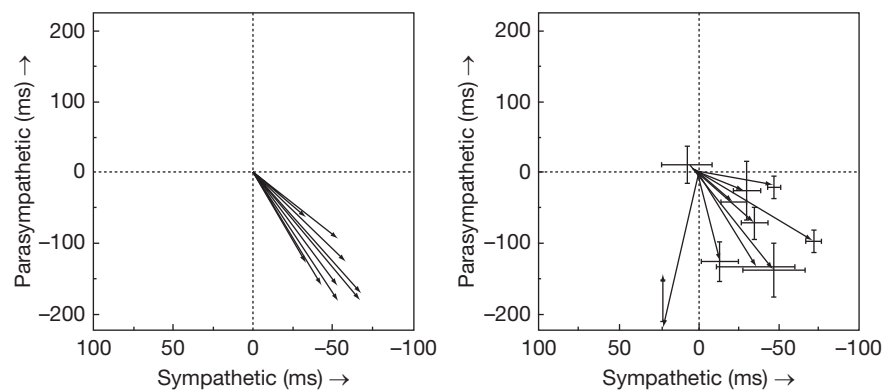


Figure 2 Orthostatic versus psychological stress. Left panel: Group mean responses to orthostatic and psychological stressors depicted as response vectors on the autonomic plane, from baseline (intersection of horizontal and vertical dotted lines) to the stress conditions (arrowheads). Axes depict millisecond of heart period change related to sympathetic and parasympathetic control. Right panel: Individual response vectors to the psychological stressors revealing individual differences in the direction of response. Reprinted from Berntson GG, Cacioppo JT, Binkley PF, Uchino BN, Quigley KS, and Fieldstone A (1994) Autonomic cardiac control. III. Psychological stress and cardiac response in autonomic space as revealed by pharmacological blockades. *Psychophysiology* 31: 599–608, with permission from Blackwell.

The importance of the measurement model is illustrated by a study of a population-based sample in Chicago (Chicago Health and Social Relations Study, CHASRS). Based upon a bipolar model of autonomic control, a cardiac autonomic balance (CAB) metric was derived as a scale extending from maximal sympathetic activation on one end of a continuum to maximal parasympathetic activation at the other extreme (sympathetic minus parasympathetic control). While CAB was not associated with most aspects of health in a population-based sample (CHASRS), it was predictive of diabetes mellitus (Figure 3). In contrast to reciprocal models of autonomic activation, as noted earlier, contemporary models of psychophysiological processes emphasize the bivariate structure of autonomic regulation and the overall capacity for autonomic flexibility and variability. Accordingly, an index of cardiac autonomic regulatory capacity (CAR) was also derived as the sum of activities of the autonomic branches. In contrast to the reciprocal diagonal represented by CAB, CAR is a metric that captures the coactivation or independent activation of the autonomic branches. Analysis of the CHASRS sample revealed that CAR was a better predictor of overall health status and was a significant predictor of the occurrence of myocardial infarction (Figure 3). These results suggest that distinct patterns of autonomic control may be associated with distinct health dimensions.

Electrodermal Skin Response

In addition to the analysis of cardiac functioning described above, estimates of autonomic output can be determined through the measurement of electrodermal activity (EDA). The basis for such measurement derives from the innervation of the eccrine sweat glands by the sympathetic nervous system. Importantly, the eccrine sweat glands are outside the control of parasympathetic responses and this fact allows for relatively unbiased estimates of sympathetic output. EDA is widely used within psychological contexts as it is thought to reflect variations in emotional and neurophysiological arousal. Thus, EDA has been used as an objective index of affective processes, in controlled experimental contexts where extraneous variables are accounted for, and has been shown, for example, to be readily elicited by threatening stimuli.

Electrodermal and other psychophysiological measures are also influenced by higher subcortical and cortical brain areas associated with attention, anxiety, and decision making. These areas include the amygdala, anterior cingulate cortex, and prefrontal cortex among others, and EDA responses can be elicited by electrical stimulation of each of these structures. This neuroautonomic coupling confers utility on psychophysiological measures as markers of psychological processes. In fact, visceral/autonomic responses may not only reflect but also impact psychological processes. Since the writings of William James before the turn of the twentieth century, somatovisceral feedback has variously been speculated to be important in the evocation or regulation of emotion and behavioral guidance. Performance in decision-making tasks is associated with anticipatory EDA responses prior to risky or suboptimal choices, and this reactivity antedates conscious awareness of the outcome contingencies and has been suggested to guide learning and future adaptive choices. In this paradigm, damage to

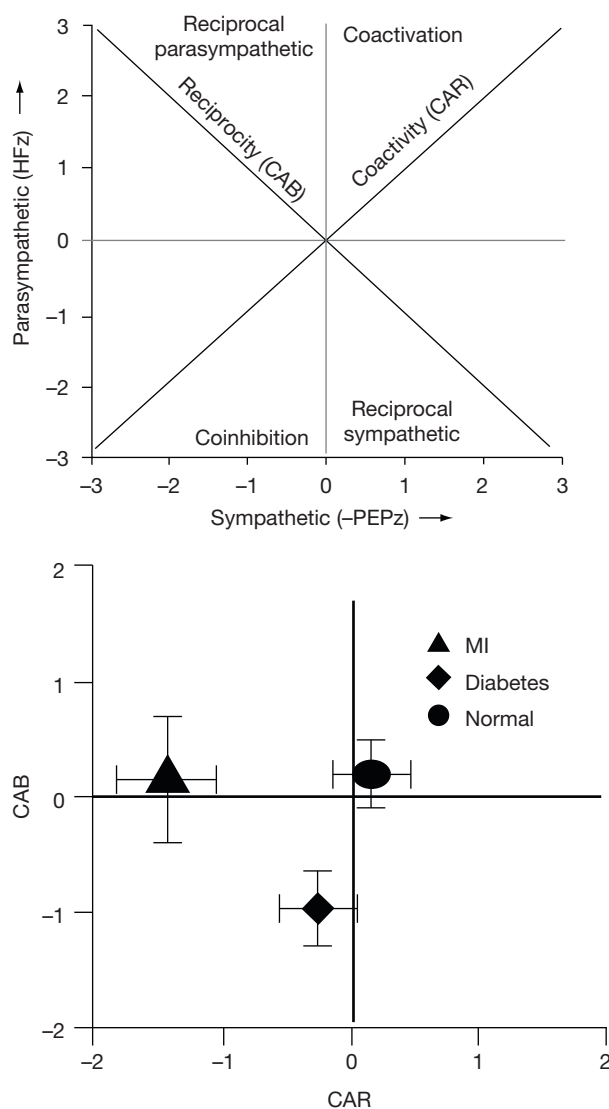


Figure 3 Left panel: Bipolar versus bivariate representations of sympathetic and parasympathetic control. Right panel: CAR and CAB in disease states. Data points illustrate means and standard errors of CAR and CAB as a function of participant group, relative to the population. Compared to other participants, subjects with a prior myocardial infarction (MI) had lower CAR scores, indicating lower overall cardiac regulatory capacity, but were not highly deviant on CAB. In contrast, those with diabetes showed a lower CAB score, reflective of a predominant sympathetic balance, but were not highly deviant on CAR. Adapted from Berntson GG, Norman GJ, Hawkley LC, and Cacioppo JT (2008) Cardiac autonomic balance versus cardiac regulatory capacity. *Psychophysiology* 45(4): 643–652, with permission from Wiley.

ventromedial prefrontal cortex results in dysregulated emotional processes associated with abnormalities in strategic decision-making characterized by a failure to change disadvantageous behavioral patterns. While typical individuals alter their behavior to avoid punishment, patients with ventromedial prefrontal damage continue using the same pattern of behavior, even if this behavior is repeatedly associated with punishing outcomes. These patients also display abnormalities in the generation of EDA responses that manifest as a reduction

in normal anticipatory arousal in the decision-making task. The defect in anticipatory autonomic arousal may contribute to the behavioral deficit, as somatovisceral afference may normally serve to bias emotional behavior and sculpt strategic decision-making processes. Consistent with Jackson's view of evolutionary representation of function, the association between sympathetic output and decision making is likely the result of higher-level (e.g., prefrontal cortex) structures 'listening' to more primitive lower-level processes that reflect rapid changes in neurophysiological states in response to environmental stimuli. Measurement of EDA or other psychophysiological responses may thus provide a window into the psychological processes that reflect the activity of neurobiological structures important in integrating emotion and cognitive responses.

Serum Factors and Behavior

Hormones are in continuous reciprocal interaction with the operations of the central nervous system. The acute elevation of stress hormones represents an adaptive process that serves to coordinate metabolic, cardiovascular, and behavioral responses to environmental and neurophysiological perturbations. However, when stress and subsequent release of stress hormones becomes chronic, it can predispose individuals to a myriad of pathophysiological processes. The most well-studied stress hormone system is the hypothalamic–pituitary–adrenal (HPA) axis. The HPA consists of multiple peptide and hormonal signaling molecules that orchestrate broad alterations in metabolic functioning. The cascade is initiated by the detection of threat stimuli leading to an increase in corticotropin-releasing hormone (CRH) within the hypothalamus. The increased CRH then induces the systemic release of adrenocorticotropin-releasing hormone (ACTH) from the anterior pituitary, which subsequently increases the release of cortisol (or corticosterone in rats and mice) from the adrenal cortex. Cortisol levels are continuously monitored by nearly every cell of the body through activation of intracellular glucocorticoid receptors. Finally, the system is subject to servo control, as it is inhibited by high levels of cortisol binding at receptors in the hippocampus, which serve to inhibit further production and release of CRH.

Given the broad effects of HPA function on metabolic, immunological, and neurobiological functioning, psychophysiologicalists routinely quantify circulating levels of cortisol and ACTH as an index of psychological stress. While this research has provided numerous important empirical and theoretical insights into the interface between physiology and psychology, important interpretative caveats exist for the application of such measures to psychophysiological science. For example, circulating levels of ACTH and cortisol are released in a pulsatile manner, necessitating the measurement across multiple time points, or other approaches to provide an integrated metric. Furthermore, circulating levels of HPA hormones display large diurnal variations with highest levels typically observed in the early morning, requiring attention to the timing of measurements. In addition, alteration in diurnal variation in HPA axis output may itself be a relevant metric, as it has been found to be sensitive to various psychopathological conditions, such as depression and anxiety.

Another common method for analyzing HPA axis function is the dexamethasone suppression test (DST). Dexamethasone

is a synthetic glucocorticoid that, when given to healthy individuals, activates the negative feedback servo mechanisms described above, leading to significant reductions in circulating levels of endogenous glucocorticoids. In comparison to a single measure of glucocorticoid levels, the dexamethasone suppression possesses high construct validity and minimizes many of the measurement issues described earlier. Individuals suffering from any number of psychopathological conditions such as depression show diminished negative feedback indicative of glucocorticoid insensitivity. The inability to appropriately control HPA axis functioning can result in chronic elevations in circulating hormone levels, which have broad effects on structure and function in various brain regions associated with cognitive and affective processes. Furthermore, chronic levels of cortisol can result in the downregulation of glucocorticoid receptors in immune cells. Since cortisol has potent anti-inflammatory effects, the phenomena of glucocorticoid resistance can diminish the ability to regulate systemic inflammatory processes, which can have a negative influence on psychological and neurophysiological health outcomes.

An additional methodological consideration stems from the fact that the majority of circulating cortisol is bound to corticosteroid-binding globulin. Bound cortisol is unable to access intracellular glucocorticoid receptors, rendering it biologically inactive. Thus, measurements of circulating cortisol levels reflect both free and bound states making interpretation of such data more difficult. However, because binding proteins do not readily enter the salivary glands, salivary measures primarily reflect unbound cortisol. Furthermore, as compared to serum measures, measurement of salivary cortisol is easily collected and thus can be used across wide contexts and time points.

In addition to classical stress hormones, the neuropeptide oxytocin (OT) has recently become the focus of extensive research in the field of psychophysiology as a result of its potent and selective influence on social processes. OT is synthesized within the hypothalamus and released systemically and centrally. The release of OT within the brain is thought to prime neurobiological networks for social behavior. OT has been implicated in the social behavior of various species, including monkeys, rats, and humans. Indeed, functional OT signaling is necessary for social recognition within rodents. Central administration of OT can induce maternal behavior in virgin rats and increases social interaction between adults. Furthermore, the role of OT in human social behavior has recently become a topic of intense interest as it has been shown that the oxytocinergic system is remarkably sensitive to the neural processing of social information. The experience of early childhood neglect, for example, impairs the increase in peripheral OT levels typically triggered by mother–infant interaction and early parental separation has been proposed to alter central OT receptor sensitivity. In contrast, positive social interactions, such as social support, lead to increased levels of OT, and OT has been suggested to mediate the well-known beneficial effects of social support on stress responsivity and health, a topic discussed in further detail later. Intranasal administration of OT has been shown to attenuate amygdala activity and reduces amygdala–brainstem coupling in response to threatening social stimuli. Similarly, OT modulates the evaluation of socially relevant faces by influencing the activity of

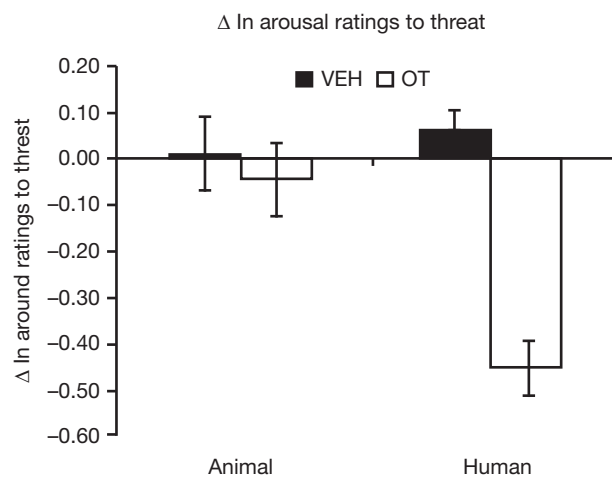


Figure 4 Oxytocin effects on threat ratings. Mean (SEM). Prepost change scores in emotional arousal to threatening stimuli. Oxytocin selectively decreased emotional arousal to human but not nonhuman threatening stimuli. Reprinted with permission from Norman GJ, Cacioppo JT, Morris JS, Malarkey WB, DeVries AC, and Berntson GG (2010) Selective influences of oxytocin on the evaluative processing of social stimuli. *Psychopharmacology*, Epub ahead of print.

the amygdala. Recently, we have demonstrated that OT has potent and rather selective influences on affect as it decreases emotional arousal to threatening human but not animal stimuli (Figure 4). The effects of OT on neurobiological functioning translate into observable changes in behavior. Indeed, intranasal OT increases trust, independent of risk taking, and improves the ability to correctly infer the mental state of others and increases the duration of gazes toward the eye region of faces, an important behavior for the recognition of emotion in social interactions. Furthermore, OT receptor gene variants are associated with loneliness, empathy, and autism spectrum disorder. The recent expansion of research on the role of OT in human social behavior, with improvements in OT assays, may provide novel perspectives on psychophysiological relations.

Psychophysiological Relations

As discussed earlier, technological advances have allowed for ever more precise measurement of psychophysiological relations. However, even with the use of more sophisticated measures, the question arises as to how signals are to be interpreted and inferences drawn. Psychophysiological processes represent interactions between psychological (ψ) and neurophysiological (φ) domains. Psychophysiological processes entail multiple logical relationships between elements, and this fact has important implications in inferences derived from psychophysiological measures. Important to the measurement of psychophysiological processes, psychological relations can be characterized by five general categories of mappings between elements in the psychological and neurophysiological domains (Figure 5).

- I. No significant association between psychological and neurophysiological domains.
- II. One-to-one: psychological domain is associated with one, and only one, neurophysiological process.

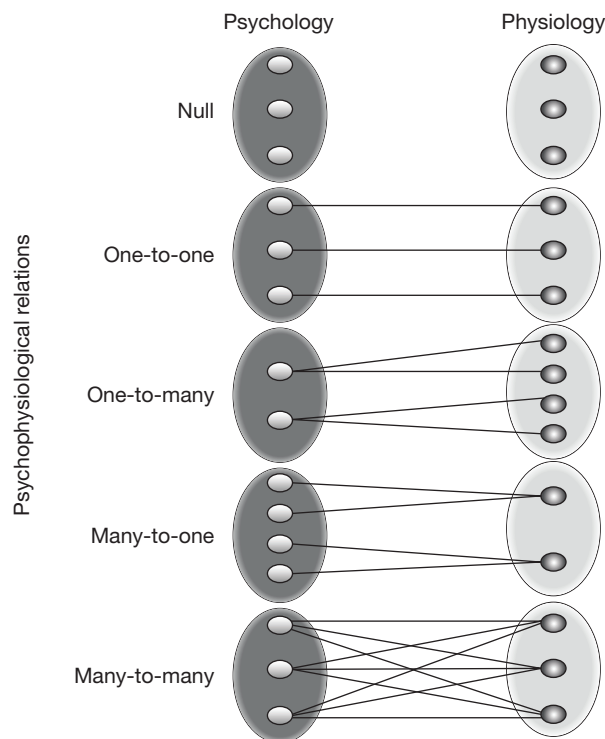


Figure 5 Schematic of psychophysiological relations consisting of (I) No significant association between psychological and neurophysiological domains. (II) One-to-one: psychological domain is associated with one, and only one, neurophysiological process. (III) One-to-many: in which elements in psychological domain are related to more than one element in the neurophysiological domain. (IV) Many-to-one: in which two or more psychological elements are associated with a single element in the neurophysiological domain. (V) Many-to-many: where two or more psychological elements are associated with overlapping neurophysiological elements.

- III. One-to-many: in which elements in psychological domain are related to more than one element in the neurophysiological domain.
- IV. Many-to-one: in which two or more psychological elements are associated with a single element in the neurophysiological domain.
- V. Many-to-many: where two or more psychological elements are associated with overlapping neurophysiological elements.

As presented above, the first category includes relations that represent irrelevant sources of variance in psychophysiological associations and need to be accounted for in order to avoid spurious associations between psychological and neurophysiological domains. The second category includes one-to-one relationships where the psychological domain is associated with one, and only one, neurophysiological process. Next is the one-to-many relation where elements in the psychological domain are related to more than one element in the neurophysiological domain. The fourth domain is the many-to-one relationship where two or more psychological states are associated with a single neurophysiological process. The final category is the many-to-many relationship where two or more psychological elements are associated with overlapping neurophysiological elements.

Unfortunately, one-to-one relationships are not common in psychophysiology, whereas relationships involving one-to-many (category III) and many-to-many (category V) are common. The latter are far more problematic for interpreting psychophysiological relations. One approach to this problem is to reconceptualize the neurophysiological elements of a one-to-many relationship as composed of a combination of psychophysiological elements. Similarly, the consolidation of neurophysiological elements of many-to-many relationships into particular patterns of activation may serve to simplify relations into a many-to-one or even one-to-one relationship. However, caution should be applied in such instances as the inherent complexity of psychophysiological relations may not always be reducible to one-to-one or even one-to-many relationships. Appreciation of the distinct psychophysiological relations, along with their strengths and weaknesses, is vital for the appropriate interpretation of data involving broad levels of analysis, and maximizes the utility of such measures by limiting the occurrence of logical inconsistencies.

Inference in Psychophysiological Measurement

An overarching goal behind the measurement of psychophysiological relations is the elucidation of basic relationships between the mind and the body. With multilevel analysis come particular methodological and theoretical challenges associated with the complexity of interactions between levels ranging from the molecular to the psychological. However, advances in psychophysiology have provided important insights into human behavior that can serve as the basis for future multilevel analysis. Regardless of the precision of the particular methodology used, the interpretation of such broad-based data continues to be challenging and rife with pitfalls. Generally, the measurement of neurophysiological processes is useful to the extent to which they reflect psychological processes.

The table above details the classes of relations that may obtain between a psychological process (ψ) and neurophysiological measure (φ). In a hypothesis regarding the indexing of a psychological process (ψ) by a neurophysiological measure (φ) we seek the relation if (φ) then (ψ), but that only holds with a one-to-one relationship. However, as mentioned above, one-to-one relations are rare in psychophysiological science. Causal hypotheses regarding the involvement of a brain structure (φ) in a particular psychological processes (ψ) are of the form $\psi = f(\varphi)$. This logical relationship postulates that the occurrence of φ (e.g., amygdala activation) is a sufficient condition for ψ (fear), but it does not imply that ψ is necessarily preceded by φ . Furthermore, the activation of particular brain structures is often used as an index of a psychological state. Thus, in this instance the inference is of the form $\psi = f(\varphi)$ rather than not- $\psi = f(\text{not-}\varphi)$. Consequently, the goal of psychophysiology can be characterized by the conditional probability of ψ given φ : $P(\psi|\varphi) = 1$.

One common approach that attempts to address some of the logical issues discussed above is the subtractive method, where experimental and control conditions differ by one element with the particular outcome measure reflecting the impact of that single element. Through the application of this method, neurophysiological correlates of psychological

processes can be identified and concepts and theories can be refined and tested. The application of imaging technology (e.g., functional magnetic resonance imaging, fMRI) is one example of this methodology. Indeed, differences in neural activation patterns under experimental and control conditions are taken to reflect the activity specifically associated with the experimental condition. While this approach provides a unique perspective into psychophysiological relations, it does not allow for the determination of causal relationships, or the application of strong inference.

One potential issue with the interpretation of the data resulting from the subtractive method revolves around the fact that researchers sometimes treat their results as if neurobiological substrates were being manipulated directly (e.g., inhibition of prefrontal cortex) and psychological outcomes measured (e.g., elevations in depression). Indeed, causal hypotheses regarding the involvement of a brain structure (φ) in a particular psychological process (ψ) are of the form $\psi = f(\varphi)$. This logical relationship implies that the occurrence of φ (e.g., amygdala activation) is a sufficient condition for ψ (fear), but it does not imply that ψ is necessarily preceded by φ . Furthermore, the activation of particular brain structures is often used as an index of a psychological state. However, with the application of ever more powerful imaging technologies, many researchers succumb to the temptation to use the inverse logical argument generally in the form of $P(\varphi|\psi) = ?$ Psychophysiological measures provide information on φ as a function of ψ , but the conditional probabilities are equivalent [$P(\psi|\varphi) = P(\varphi|\psi)$] only if there is a one-to-one relationship between the neurophysiological element φ and the psychological element ψ .

In the interpretation of psychophysiological data, isomorphism between a psychological variable and neurophysiological variables (one-to-one relationship) must be directly tested, and deviations from isomorphism should be accounted for. In this regard, interdisciplinary, multilevel approaches to the measurement of psychophysiological variables are uniquely positioned such that they can provide complementary and converging evidence from direct manipulations of the neurophysiological variables (φ as independent variable). Using this methodology, one can bolster the confidence in the interpretation of the data by demonstrating that specific patterns of neural activation consistently covary across a broad range of conditions and contexts. However, while the covariation of neurophysiological and psychological realms may increase the confidence of inference of ψ from φ , causal inferences can only be determined through the application of converging evidence. For example, if a clinician observes an increase in amygdala activation in response to aversive stimuli across various contexts, and wants to determine whether or not a causal relationship exists, then the demonstration that manipulations of amygdala functioning (e.g., stimulation, ablation) modulate fear behavior in mice would allow for more valid inferences of causal mechanisms. Furthermore, with recent advances in transcranial magnetic stimulation technology as well as the application of deep brain stimulators to treat psychiatric disease has come the increased ability to apply more in-depth research into the causal mechanisms mediating psychophysiological relations. Thus, the application of converging lines of evidence can routinely deal with many of the weaknesses inherent in the subtractive method while still maintaining the strengths of this approach.

Conclusion

The use of measures spanning multiple levels of analysis has become increasingly common in contemporary psychological and neuroscientific research. Advancements in technology and conceptual understanding of human behavior will likely increase this trend. The expansion of knowledge and measurement of the molecular, systems, and psychological concomitants of human behavior will necessitate a similar increase in the application of methodologies that appropriately integrate facts across multiple levels of analysis. While such developments are important, it is imperative to couch these new measurements within a theoretical framework that appreciates multilevel analysis while simultaneously avoiding category errors through an understanding of particular limitations inherent in the measurement used. Thus, the future of psychophysiological research is promising, and as technological and theoretical constructs continue to advance across levels of analysis, so too will our understanding of psychophysiological processes.

See also: [Clinical Assessment](#); [Psychopathology: Diagnosis, Assessment, and Classification](#).

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Behavioral Economics

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Glossary

Behavioral game theory The application of limited rationality to strategic human interaction.

Discount factor A function of time that captures the degree to which current consumption is more important than future consumption.

Heuristics Rules of thumb used by individuals that substitute for fully optimizing behavior based on classical statistics.

Intrinsic reciprocity The desire to reciprocate based on the notion that one is hardwired to do so.

Liberalism versus paternalism The study of the policy response to less than perfect rationality.

Loss aversion The tendency of losses to bite more than gains of an equivalent magnitude.

Neuroeconomics The use of the methods of neuroscience in economics.

Probability weighting function A function that captures the subjective probability weight assigned by an individual to various events.

Reference point A level of outcome such that any outcome which is numerically greater is coded as a gain and any that is numerically lower is coded as a loss.

Social preferences The presence of bundles of goods of others, in addition to one's own, in one's utility function.

Utility function A function that assigns to bundles of goods and services, some level of human satisfaction that can be numerically measured.

Introduction

Traditional economics is based on the assumptions of fully rational and self-interested behavior. A very large body of evidence casts serious doubts on both these assumptions. A serious consideration of the psychological evidence for human motivation in economic phenomena and the construction of new theoretical models based on this evidence has given rise to behavioral economics. This new field is growing at a rapid pace and gaining increased acceptance in mainstream economics. In this essay, we provide a brief overview of behavioral economics and some of the insights that it offers.

Decision Theories

For simplicity, let x_1, x_2, \dots, x_n be real numbers, which we interpret as different levels of wealth (n can be any positive integer). We assume that we can rank the wealth levels in the following manner: $x_1 \leq x_2 \leq \dots \leq x_n$. Economists use the term lottery for the following entity

$$\mathcal{L} = (x_1, p_1; x_2, p_2; \dots; x_n, p_n) \quad [1]$$

where outcome, x_i , occurs with probability, p_i . So, in the lottery \mathcal{L} , outcome x_1 arises with probability p_1 , outcome x_2 arises with probability p_2 , and so on. We assume that the probabilities are nonnegative and sum up to one. Thus, a lottery is simply a description of all possible outcomes that could arise, along with their respective probabilities.

When the probabilities are verifiable independently of the decision maker, we have a situation of *risk*. On the other hand, if the probabilities can be inferred only from the actions of the decision maker, then we have a situation

of *uncertainty*. For instance, while objectively verifiable probabilities of the risk from the MMR (measles, mumps, and rubella) vaccine were shown to be low in almost all scientific studies, many individuals assigned high subjective probabilities, leading them to refuse the vaccination. Denote the set of all lotteries of the form in eqn [1] by \mathcal{L} . Which lottery in \mathcal{L} should be chosen?

Expected Utility Theory

The most widely used theory in economics under risk is the expected utility (EU) theory. Under axioms on individual preferences, known as the *axioms of rationality*, it can be shown that, for each decision maker, there exists a utility function u such that one may think of $u(x_i)$ as the utility or satisfaction arising from the outcome x_i . $u(x_i)$ is simply some real number. The utility function has the following main properties. (i) If the individual strictly prefers an outcome x_i to another outcome x_j then it must be the case that $u(x_i) > u(x_j)$, and (ii) if $x_i > x_j$ then $u(x_i) > u(x_j)$. Furthermore, for any lottery $\mathcal{L} = (x_1, p_1; x_2, p_2; \dots; x_n, p_n)$, the expected utility to the decision maker, denoted by $EU(\mathcal{L})$, is defined as follows.

$$EU(\mathcal{L}) = \sum_{i=1}^n p_i u(x_i) \quad [2]$$

In eqn [2] we have used the shorthand notation $\sum_{i=1}^n p_i u(x_i) = p_1 u(x_1) + p_2 u(x_2) + \dots + p_n u(x_n)$. This is standard notation and we shall use it throughout this essay so it is best if the reader who has not encountered this before invests in understanding it at this point.

The decision maker is assumed to choose the lottery that gives the highest expected utility. EU allows for a rich pattern of attitudes to risk. However, EU incorporates risk preferences through the shape of the utility function (rather than through the probabilities).

Definition 1 Risk aversion

A decision maker is said to be risk averse if he/she prefers the expected value of the lottery to playing the lottery. The converse behavior is risk loving and indifference between the two is referred to as risk neutrality.

It can be shown that risk-neutrality/risk-aversion/risk-seeking are equivalent, respectively, to the utility function, u , being linear/concave/convex, respectively. Risk aversion, arising from a concave utility function, underpins important explanations of economic phenomena in most areas of economics. These include the study of insurance, the design of contract schemes in principal-agent problems, the optimal rates of taxes, determination of wage rates etc. A lottery L_p first-order stochastically dominates lottery L_q if the distribution function of L_p lies everywhere below that of L_q . Decision makers under EU do not choose stochastically dominated options.

The axioms of rationality that underpin EU appear intuitive and plausible. However, they are only assumptions about human behavior. In particular, they should not be confused with the notions of rationality as used in logic, psychology, or law. And, in fact, a large number of rigorous tests have rejected these axioms. This induced a major effort to propose auxiliary assumptions to EU in order to save it, but without much success.

Behavioral Decision Theories

Behavioral economics provides several alternative, axiomatically founded, theories that explain the evidence better than EU, yet are tractable. The EU formula in eqn [2] has two salient features. (1) It is linear in probabilities. (2) Utility is defined over final wealth levels. Behavioral alternatives have relaxed both these assumptions.

Rank-dependent utility (RDU) relaxes the linearity in probability assumption. The most satisfactory decision theory in economics, and the one with the strongest psychological foundation, is the Nobel Prize winning work on prospect theory (PT) due to the seminal paper in 1979 by Daniel Kahneman and Amos Tversky. However, PT allows for violations of first-order

stochastic dominance. Following the insights of RDU, PT was modified to cumulative prospect theory (CP). CP does not allow for the choice of stochastically dominated options. Since RDU is a special case of CP, it suffices to explain CP.

In CP (like PT but unlike EU and RDU) the carriers of utility are not final levels of wealth but deviations of these from a reference point; a well-established idea from psychology. For instance, dip your right hand in cold water and your left hand in warm water. After a few seconds put them both in lukewarm water. Your right hand then feels warm and your left hand feels cold, although they are both gauging the same temperature. The status quo turns out to be a useful reference point in many applications. But some other possible choices could be an expected level, a fair level or a legal entitlement. If the outcome turns out to be superior (respectively inferior) to the reference point, then the decision maker is in the domain of gains (respectively losses).

CP also incorporates experimental and field evidence, which suggests that utility is evaluated differently in the domain of gains and losses. First, losses bite more than equivalent gains (loss aversion). Second, the utility function is concave for gains and convex for losses. Thus, in each domain, there is diminished sensitivity to gains/losses. Tversky and Kahneman propose the following (axiomatically founded) utility function that captures all these facts.

$$v(x) = \begin{cases} x^\gamma & \text{if } x \geq 0 \\ -\lambda(-x)^\theta & \text{if } x < 0 \end{cases} \quad [3]$$

where x is the deviation of some outcome relative to the reference point. γ , θ , λ are constants; $0 < \gamma < 1$, $0 < \theta < 1$. $\lambda > 1$ is known as the *coefficient of loss aversion*. Experimental results initially suggested that γ and θ are approximately equal to 0.88 and λ is approximately equal to 2.25. However, subsequent research showed that the parameter of loss aversion is variable and depends on the context. The properties of the value function are illustrated in Figure 1. Notice that the reference point is at zero and the function is relatively steeper for negative values. It is also concave for positive values but convex for negative values.

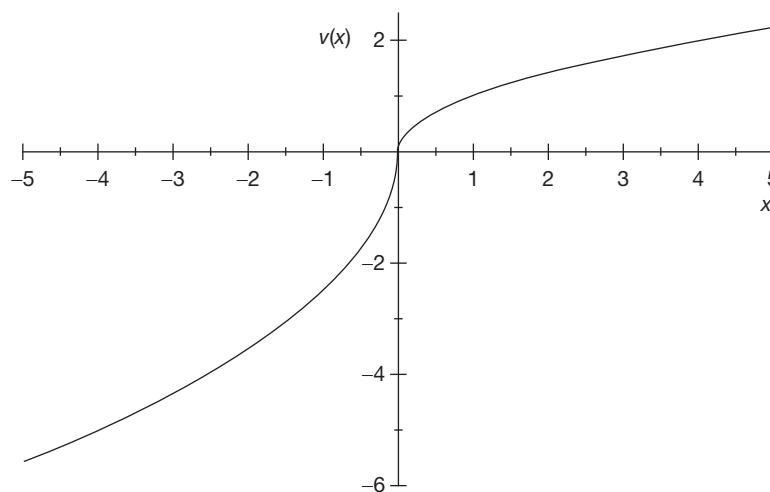


Figure 1 The utility function under CCP.

The second main feature of CP (which it shares with PT and RDU but not EU) is that probabilities are transformed in a nonlinear manner, using the device of a probability weighting function (PWF), w . One may think of $w(p)$ as a real number, lying between zero and one, that captures the subjective weight assigned by the individual to the probability p . A PWF has the property that the individual assigns a higher subjective weight to higher probabilities, and

$$w(0) = 0, \quad w(1) = 1 \quad [4]$$

that is, a probability zero is assigned a subjective weight of zero and a probability one is assigned the maximum probability weight of one. Many PWF's have been proposed in the literature. The most satisfactory is the one by Drazen Prelec, which depends on two parameters and takes the following form

$$w(p) = \exp\{-\beta[-\ln p]^\alpha\}, \quad 0 < p \leq 1, \quad \alpha > 0, \quad \beta > 0 \quad [5]$$

A plot of the Prelec function is shown in Figure 2. For the particular parameter values chosen in the plot, it is consistent with the empirically verified inverse S-shape.

Let w^+ , w^- , respectively, be the PWF's for the domain of gains and losses. There is evidence that $w^+(p) = w^-(p) = w(p)$. Suppose that the reference income level is y_0 and the individual is presented with the following lottery (see our explanation of a lottery above):

$$L = (y_{-m}, p_{-m}; y_{-m+1}, p_{-m+1}; \dots; y_0, p_0; y_1, p_1; y_2, p_2; \dots; y_n, p_n) \quad [6]$$

where $y_{-m} < y_{-m+1} < \dots < y_0 < y_1 < y_2 < \dots < y_n$ are the $m+n$ outcomes such that there are m outcomes in the domain of loss (incomes lower than y_0) and n outcomes in the domain of gains (incomes higher than y_0).

Under PT or CP, individuals care about the level of income relative to the reference point. Define income relative to the reference point by

$$x_i = y_i - y_0; \quad i = -m, -m+1, \dots, 0, 1, 2, \dots, n. \quad [7]$$

Subtracting income relative to the reference income from each of the income levels in the lottery in eqn [6] and using eqn [7] we get the following lottery, which we denote by \bar{L}

$$\bar{L} = (x_{-m}, p_{-m}; x_{-m+1}, p_{-m+1}; \dots; x_0, p_0; x_1, p_1; x_2, p_2; \dots; x_n, p_n) \quad [8]$$

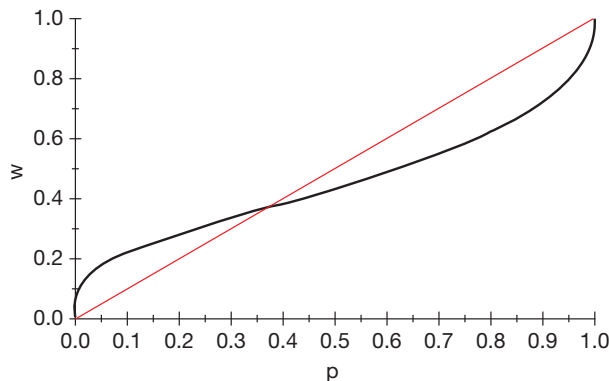


Figure 2 The Prelec function for $\beta=1$ and $\alpha=0.5$.

Define \mathcal{L}_p as the set of all possible lotteries of the form given in eqn [8]. Under PT and CP, decision makers wish to evaluate lotteries from the set \mathcal{L}_p . They do so by forming an appropriate value function. Definition 2 shows the value function for the lottery \bar{L} .

Definition 2 The value function under CP

The value of the lottery $L \in \mathcal{L}_p$ to the decision maker is given by

$$V(L) = \sum_{i=-m}^n \pi_i v(x_i) \quad [9]$$

Compare eqn [9] with eqn [2]. First we have used the summation notation in eqn [9] that we have explained above in the discussion following eqn [2]. Second, the utility function in eqn [9], $v(x_i)$, is defined so as to have the properties illustrated in eqn [3] above, while the utility function in eqn [2], $u(x_i)$, is not restricted to have these properties. Third, utilities are multiplied with probabilities in eqn [2] while in eqn [9] they are multiplied with decision weights, π_i , $i = -m, -m+1, \dots, 0, 1, 2, \dots, n$. The construction of decision weights is crucial in all versions of prospect theory (e.g., PT, CP, and CCP, which we describe below). We first formally describe the construction of decision weights in Definition 3, followed by some intuition. We shall use the summation notation, which we have described in the text following eqn [2] above.

Definition 3 For CP, the decision weights, π_i , are defined as follows:

$$\begin{aligned} \pi_n &= w^+(p_n) \\ \pi_i &= w^+(\sum_{j=i}^n p_j) - w^+(\sum_{j=i+1}^n p_j), \\ \pi_{-m} &= w^-(p_{-m}) \\ \pi_j &= w^-(\sum_{i=-m}^j p_i) - w^-(\sum_{i=-m}^{j-1} p_i). \end{aligned}$$

Recall that $v(0) = 0$. Hence it is immaterial what value is chosen for π_0 . This is why π_0 is undefined in Definition 3. The method of constructing decision weights in Definition 3 was originally suggested in a brilliant undergraduate thesis by John Quiggen. The idea is that the decision weights transform probabilities in a cumulative fashion using the probability weighting function. The decision weight in Definition 3, associated with some outcome is the marginal increase in the probability weight as one moves from that outcome to the next best outcome. Decision makers who form decision weights in this manner do not choose stochastically dominated options. This solved an important shortcoming associated with PT.

RDU is the special case of CP when all outcomes are in the domain of gains. EU is the special case of RDU when, in addition, $w(p) = p$ ($\alpha = \beta = 1$ in eqn [5]).

CP allows for a rich set of attitudes to risk, that depend not only on the curvature of the utility function but also on the shape of the PWF. A fourfold classification of risk is predicted by CP. In particular, decision makers are risk averse for moderate probability moderate gains (as in EU) but (unlike EU) they are risk seeking for low probability high gains. By contrast, decision makers are risk averse for low probability high losses (as in EU) but (unlike EU) are risk seeking for moderate probability moderate losses. This fourfold pattern of attitudes to risk is confirmed in laboratory experiments and explains a wide range of economic phenomena that EU is either unable to explain or finds it difficult to explain. See, for instance, the Asian disease example in the section on mental

accounting below for separate attitudes to risk in the domain of gains and losses.

One criticism made in the recent work by al-Nowaihi and Dhami is that all standard PWF's used in RDU and CP are extremely steep at the end points (in the sense that $\lim_{p \rightarrow 0} (w(p)/p) = \infty$, and $\lim_{p \rightarrow 1} ([1 - w(p)]/[1 - p]) = \infty$). This makes very low and very high probabilities extremely salient to decision makers and leads RDU and CP to make predictions inconsistent with a range of important observed phenomena. For example, CP (and RDU) predicts far too much demand for insurance (as compared to the evidence) against low probability natural hazards, such as earthquakes, floods, and hurricanes. Another example is that CP (and RDU and EU) predicts that the imposition of the severest possible punishments (e.g., capital punishment), even with vanishingly small probability of detection, would deter all crime. This is contrary to the evidence. Other similar violations come from a range of other phenomena such as red traffic light running, driving, and talking on mobile phones and not taking up adequate health checks.

In recent research, al-Nowaihi and Dhami account for these problems by proposing composite cumulative prospect theory (CCP). This differs from CP in that it uses a composite Prelec probability weighting function (CPF), illustrated in Figure 3. It is made up of segments from three Prelec functions over the respective ranges, $[0, \underline{p}]$, (\underline{p}, \bar{p}) , $(\bar{p}, 1]$. Very low probabilities are hugely underweighted in the sense that $\lim_{p \rightarrow 0} (w(p)/p) = 0$. This allows CCP to predict human behavior, for instance, toward insurance and law enforcement, that is in better conformity with the evidence. CCP is much more general than the account that we have given here; it can do everything that EU, RDU, and CP can do, but the converse is false.

Collectively, PT, CP, and CCP successfully explain a wide range of otherwise unexplained phenomena. These include why it is hard to find a taxi on a rainy day in New York, asymmetric price elasticities, tax evasion problems, demand for insurance, the Allais paradox, the St. Petersburg paradox, paradoxes in the economics of crime and punishment, the endowment effect, the disposition effect, the equity premium puzzle, asset pricing, incentive schemes, etc.

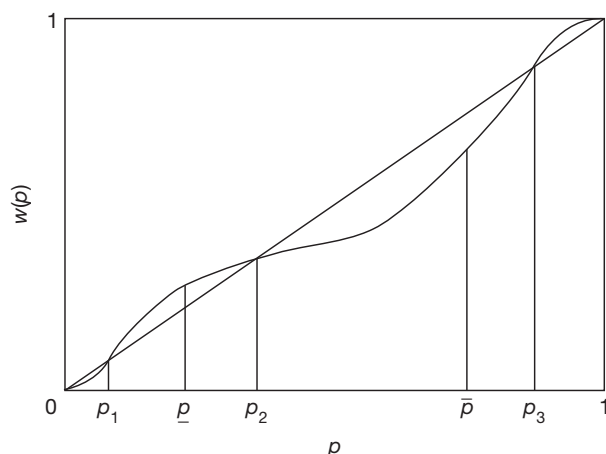


Figure 3 The composite prelec weighting function (CPF).

Heuristics and Biases

The heuristics and biases research program commenced with seminal papers by Tversky and Kahneman in the early 1970s. Its basic premise is that individuals are not fully rational, but they are not irrational either. Tversky and Kahneman took the middle ground that individuals solve problems by relying on some fast (in terms of time) and frugal (in terms of information acquisition and processing) heuristics. Because such heuristics do not optimize in the classical sense, the performance of the heuristics is not necessarily optimal.

For instance, individuals often judge distance of an object by the heuristic of how clear it is, sharper objects are thought to be closer. This heuristic is fast and frugal. While this heuristic often works well, it might also result in biased and misleading perceptions. For instance, when conditions are hazy, distances might be overestimated. Conversely, when conditions are very clear, distances might be underestimated.

The heuristics and biases approach demonstrates a systematic departure of actual behavior from that prescribed by the laws of classical statistics. Rather, individuals employ a range of judgement heuristics. The point or interval estimates arising from these judgement heuristics are often in conflict with classical inferences. Even statistically sophisticated researchers or experienced decision makers often rely on these judgment heuristics.

An important heuristic is the representativeness heuristic. When individuals use this heuristic they tend to assume that the properties of a small sample that they are familiar with is characteristic of the large population from which the sample was drawn. For example, an eminent colleague told us that up to quite late in his childhood he believed that most people in the world were Jewish members of the British Communist Party, because that was the circle of family and friends he grew up in. This is sometimes referred to as the law of small numbers. At other times, individuals exhibit the reverse bias, conservatism, that is, they underestimate the likelihood of a sample from a given distribution. For example, people typically underestimate the likelihood of getting a consecutive run of 3 heads in 10 random tosses of a fair coin. These heuristics explain many puzzles such as the gambler's fallacy (avoid betting on a number that has come up last time), hot hands and winning streaks (because a basketball player has scored the last few shots, he is even more likely to score this one).

The behavior of humans is inconsistent with Bayes' rule, especially when they are presented with probabilistic information (as opposed to frequency format information). In particular, individuals engage in base rate neglect. For example, consider the following question. "There is a rare condition whose probability is one in a million. There is a test whose success rate is 99%. You tested positive. What is the probability that you have this condition?" The typical answer is 99%. The true answer based on classical statistics is 0.01% (the reader can check this by applying Bayes' rule).

Anchoring is one of the most robust and important heuristics that people use. In situations where people do not know the answer to a question, they are unduly influenced by an initial suggestion or anchor. Interestingly, the anchor could be completely random and unrelated to the answer. For example, a roulette wheel is spun. The resulting number is, say, 50.

The subjects are then asked “how many countries are members of the UN?” The answers would then frequently be found to cluster around 50. Furthermore, once individuals fix an anchor in their minds, they adjust too slowly, and insufficiently, toward the target.

There is also a range of other judgement heuristics that the space constraint does not permit us to discuss further. These include hindsight-bias, false consensus, attribute substitution, conjunction fallacy, availability heuristic, affect heuristic, and taking a necessary condition to be sufficient.

Mental Accounting and Framing

The idea of mental accounts is a significant and important part of behavioral economics with wide ranging implications. Richard Thaler, whose name is most closely identified with this concept in economics, defines mental accounting as follows. “I wish to use the term mental accounting to describe the entire process of coding, categorizing, and evaluating events.” Elsewhere, he provides another definition that is useful in financial situations: “mental accounting is the set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities.”

Let us begin with two features of mental accounts.

1. Money is not fungible across the accounts. So, for instance, one might put aside money in a separate account for children’s education. This would be unnecessary if money were fully fungible across mental accounts.
2. The objective of the individual is not necessarily to maximize total financial wealth. An important objective that is highlighted in the mental accounts literature is to limit the size of loss in individual accounts.

Much of traditional theory makes the frame-invariance assumption. By contrast, individual decisions are sensitive to the framing of problems. In a famous experiment, Kahneman and Tversky use a representative sample of physicians and pose them the following question framed in two alternative, but classically equivalent, ways that, respectively, stress the positive and the negative aspects. The question posed was the following.

Example 1 Imagine that the United States is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

Positive Framing: If program A is adopted, 200 people will be saved. If program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved. Which of the two programs would you favor?

Under positive framing, the solution is framed in terms of ‘lives saved.’ The result was that 72% of physicians chose A, the safe strategy and 28% chose program B, the risky strategy.

Negative Framing: If program C is adopted, 400 people will die. If program D is adopted, there is a one-third probability that nobody will die and a two-thirds probability that 600 people will die. Which of the two programs would you favor?

For negative framing, only 28% of the physicians voted for the safe strategy C while 72% of them opted for D, the risky strategy.

The problem in each of the two frames (positive and negative) is identical. Thus, if A is preferred to B then C must be preferred to D (or vice versa). While the aim of Kahneman and Tversky was to show that individuals are risk averse for gains and risk loving for losses (see the discussion of prospect theory, above), the reframing of the same question leads to completely different choices. Framing matters, and it can determine which mental account an item of expenditure or income is put into.

The evidence from models of consumption suggests that the marginal propensity to consume out of distinct mental accounts could be different. Thus, the effect of salary composition, for instance, between wage and bonus could have an effect on the employee’s saving decision. Different pension plans that have otherwise identical effects in standard economics on account of perfect fungibility of money have distinct effects in the presence of nonfungibility and different marginal propensities to consume from different mental accounts. Hence, in the mental accounting framework, the effects of pension plans depend on which mental account is used to pay for the pension contributions.

Why does the ticking of the taxi meter reduce one’s pleasure from the taxi ride? Why do we normally prefer to prepay for a vacation? Why do we often prefer to pay for consumer durables in instalments? These simple facts fall outside the ambit of the workhorse life cycle model in macroeconomics. Prelec and Loewenstein argue that consumption that has already been paid for can be enjoyed as if it were free in the current period, which potentially increases its current enjoyment, hence, explaining prepayment of vacations. Similarly, the thought of future payments reduces current utility from the consumption of a good/service (hence, the unpleasantness arising from a ticking taxi meter). Consumer durables on the other hand lead to a stream of future benefits, often for several years, after the date of purchase. Hence, paying in instalments for them is not aversive as compared to a vacation, which is enjoyed for a small duration of time. The framework suggested by Prelec and Loewenstein can also explain the growing use of debit cards, use of tokens at casinos, dependence of mortgage payments on property values, popularity of fixed fee payment schemes, Club Med vacations and gift giving among couples, etc.

Individuals tend to break down complex problems into simpler ones that require less cognitive ability. Read, Loewenstein and Rabin term this as choice bracketing. An army General who focuses only on the battle at hand (narrow bracketing) might lose sight of winning the war (broad bracketing). Recall the problem of finding a taxi on a rainy day in New York. One possibility is that taxi drivers set a daily target for earnings (narrow bracketing) rather than an income target over a longer period (broad bracketing). The target is more quickly achieved on a busy rainy day leading to too many quits, too soon. The optimum for a taxi driver is, however, to work longer during rainy days because customers are more plentiful and the effective wage, higher.

Choice bracketing also takes the form of deciding on the horizon over which one would evaluate one’s portfolio. So, for

instance, if one holds stocks and evaluates one's portfolio too often then one would observe too many upward and downward movements in the return to equities relative to bonds, creating feelings of anxiety. Equities might then require a higher premium, relative to the predictions of standard theory, if they are to be held in a portfolio. This explains an important puzzle, the equity premium puzzle, namely, an excess of return on equities over bonds that cannot be justified on the grounds of risk alone. Choice bracketing can also explain strategies used at alcoholics anonymous and the desire for risk aggregation. Alcoholics under treatment are usually asked to take one day at a time (narrow bracketing) because the possibility of lifetime abstinence (broad bracketing) is too daunting. Similarly, when a range of risks are aggregated (broad bracketing) they might well seem less onerous because a low outcome under one form of risk could be mitigated by a high outcome under another form of risk.

In standard economic theory, actual choice is the result of well-defined initial preferences and well-defined subjective probability distributions over uncertain events. By contrast, Ariely, Loewenstein, and Prelec show that the initial framing of problems or situations can have an inordinate effect on ones initial preferences. In turn, this determines the individual's subsequent choices. One is then led to question the very notion of humans having well-defined initial preferences and subjective probability distributions over events. This helps to explain a range of phenomena, such as the initial hype before mega sporting events, or the advertisement blitz before the introduction of a new product.

An assortment of other mental accounting phenomena exists. An important category of such problems arises when individuals take actions to (mentally) justify sunk costs that have been incurred in the past. Hence, there is a tendency to hold on to loss making stocks for too long and sell winners too early. The reason is that individuals create a mental account for a particular category of expenditure. Sunk costs push this mental account into the red, which causes anxiety. Individuals then take wasteful actions to avoid closing accounts that are in red.

Recent research has also highlighted the mental accounting of goals. Individuals often form goals and targets, for example, completing term papers, referee reports, quitting an addiction, losing a prespecified amount of weight by a certain date and so on. While goals can be motivational, they can also be counter-productive. On account of loss aversion, missed goals impose large losses, and the individual might also engage in emotional repair following a missed goal, etc.

Mental accounting has also been applied to retirement savings. Of particular importance is the role of status-quo options. It has been found that if the default is that the individual is signed-into a pension plan (as opposed to the converse) then the take-up of pension plans increases. The number of options offered in an investment plan is also important. Too many options can make choice more difficult. Individuals also use the diversification heuristic to choose among alternative pension vehicles, which motivates individuals to spread their money evenly among the available options even when the prediction of standard economics is to engage in an uneven spread.

Emotions

In economics, it has become standard to focus on emotionless deliberation. However, much recent research shows that this view is not supported by the evidence. Emotions are central to humans and affect much of human deliberation.

We often worry about an uncertain future. Will my pension contributions be sufficient for my retired life? Will early retirement turn out to be a good decision? Should I buy or sell my stocks in the current economic environment? These and other temporal economic decisions produce a feeling of apprehension and unease: We shall simply refer to these feelings as anxiety. Anticipation of a (stressful) future event can create anxiety that in some cases is worse than the event itself. Think, for instance, of an impending visit to a dentist for treatment. Such feelings of anxiety have two features: (1) they are caused by anticipation of future events, and (2) they are aversive in the sense that we dread such future events. As a result, one might delay a visit to the dentist, with detrimental consequences for health.

Future events need not, however, always be unpleasant. We might savor a pleasurable experience such as waiting for a dessert at the end of a meal. Or, we might delay a pleasurable vacation. Pleasant events provide examples where an individual seems to exhibit a negative discount rate; a preference for the future rather than the present. Insofar as feelings of anxiety and savoring impact on intertemporal choice in important ways, we need to amend the standard model.

In one model by Caplin and Leahy, uncertainty is introduced into a model of anticipatory utility. In an interesting application they derived equilibrium prices of assets whose returns are ex-ante random. The randomness in the returns creates a current feeling of anxiety. Hence, the ownership of a risky stock reduces its price and increases its return relative to the no-anxiety case and relative to assets whose returns are not too random, such as bonds. This provides one possible explanation for the equity premium puzzle.

Most dynamic models assume that future tastes are known. However, tastes can change over time due to a variety of reasons, for example, habit formation, moods, social environment, maturity etc. Projection bias arises when individuals make predictions of their future tastes that are not realized in equilibrium. Evidence shows that people are disproportionately influenced by their current tastes in making predictions of their future tastes. For instance, when ordering food at the beginning of a meal we must predict how hungry we will be at the end of the meal. We often overestimate our future hunger and order more than we can eat. One can also make forecasting errors in mainstream economics but, in the dominant rational expectations view, there are no such errors in the absence of random shocks and, on average, such errors are zero. Both features are violated under projection bias.

Individuals who have projection bias make time inconsistent choices, without being aware of it. Under the influence of projection bias, individuals might end up buying goods in a hot state that they might regret later. In a hot state they might end up marrying or proposing a marriage/divorce without sufficient deliberation. Public policy in some cases provides a cooling-off period before which applications for marriage and

divorce cannot be filed. Projection bias also provides an alternative explanation for why individuals get addicted. First, people underestimate the (negative) effect of current consumption on future utility. Second, individuals might under-appreciate the formation of habit, for example, addiction to a harmful product. By contrast, in mainstream economics, individuals know the entire time path of costs and benefits of addiction and if they choose to be addicts, they do so rationally. This view is not in accord with the evidence.

Fairness and Reciprocity

Traditional economic theory relies on the assumption of self-interested behavior (or selfish preferences). This is contradicted by the evidence. A substantial fraction of individuals exhibit social preferences, that is, care about the consumption and well being of others. These preferences are more general than simply altruism (unconditional kindness) and spite (unconditional unkindness). In practice, however, altruism is unable to explain a very wide range of behaviors. For instance, it does not explain why many individuals are conditional cooperators, that is, cooperate only when others cooperate. Intrinsic reciprocity, on the other hand, takes the form of responding to kindness (unkindness) with kindness (unkindness) even in the absence of obvious longer term gains.

Purely selfish preferences are unable to explain a range of phenomena from many diverse areas such as collective action, contract theory, the structure of incentives, political economy and the results of several experimental games. Many of these phenomena can be accounted for by a model which recognizes that individuals have social preferences.

1. Wages are usually not lowered in a recession by firms for fear that this action could be construed by workers as unfair and can affect their morale and effort levels.
2. Voters voluntarily vote, when pure self interest might dictate them not to take the trouble of voting (almost all single votes are not pivotal, except in small committees, and voting is costly).
3. In an experiment, most respondents thought that a hardware store's actions to increase the price of shovels following a snowstorm was unfair. However, they did not perceive an increase in price following an increase in the cost of inputs as unfair.
4. Why does bargaining stall, with adverse consequences in a range of situations, such as civil litigation, labor unrest, domestic strife, and clashes among religious and ethnic groups? Individuals confuse what serves their self interest with what is fair. This self-serving bias can lead to a bargaining impasse.

Social preferences have been found in a range of experimental games that allow for small group or bilateral interaction. These experiments include the gift exchange game, the ultimatum game, the dictator game, the trust game, the public good game, among others. The most commonly replicated of these experiments is the ultimatum game.

The ultimatum game is a game played between two players who could share a cake (or prize) of some fixed size, say 100, that is finitely divisible into 100 equal parts. The first player,

the proposer, proposes to give a share of the cake s between 1 and 100 to the second player, the responder. If the responder accepts the offer, the cake is split according to the proposed split. If the responder rejects the offer, the cake is lost to both players. Under selfish preferences the subgame perfect outcome (which is the appropriate notion of the game theoretic equilibrium here) is $s = 1$, $1 - s = 99$. The basic idea being that if the responder does not engage in this game then he gets nothing, so he would accept the smallest indivisible unit of the cake. The experimental results reject the prediction $s = 1$, $1 - s = 99$. The gist of the results is as follows. (1) The mean offer is $s = 30 - 40$. (2) The median offer is $s = 40 - 50$. (3) There are rarely any unfair offers, $s = 0 - 10$ or over-fair offers $s > 50$. (4) Low offers are often rejected. These results continue to hold for high stake games. The outcome is easily explained by assuming that individuals have social preferences.

In public good games, the purpose is to explain human cooperation in undertaking a task for the common good. All individuals simultaneously make a voluntary contribution to a common pool. The experimenter then returns a fraction of the total sum of money to each participant; this captures the essence of a public good. The prediction of the standard model with selfish preferences is that everyone should free ride, that is, depend on others to make the contribution and make zero contributions themselves. The experimental results are that individuals start with a reasonably high level of contribution. However, in successive rounds the level of contributions drops off to a level that is consistent with the model of selfish preferences. Does the standard model stand vindicated then? Not necessarily. It does not explain why subjects start off with initially high levels of contribution. Furthermore, if these subjects start afresh then they again start with high levels of contributions. Negative reciprocity is a leading explanation. Most individuals start off by contributing reasonably high amounts but some do not. In subsequent rounds, negative reciprocity kicks in and everyone lowers their contribution amounts.

An important variant of the public good game is the public good game with punishment. What if contributors are allowed to punish the noncontributors at the end of the experiment. The prediction of standard theory is that individuals should treat by-gones as by-gones and not engage in any punishment. Anticipating this, noncooperators will not be deterred. The results of experiments do not support this prediction. Allowing for the possibility of punishment, contribution levels reach almost the first-best level and noncontributors are heavily punished. The public good experiments indicate that subjects are conditional cooperators. They cooperate when they think that others will cooperate. Furthermore, their preferences allow for the material payoffs of others (social preferences), thus giving them an incentive to punish even in games with a finite horizon. The implications of this result are deeper than just the current context.

Humans take account of the role of intentions. Humans do not punish unkind behavior if it was unintentional. However, intentionally unkind behavior can get severely punished. These issues are formally modeled in psychological game theory.

Some experimental evidence in certain contexts indicates that the split between individuals with selfish and social preferences is 40–60. An important and interesting issue for

theoretical and empirical research is to examine the implications of heterogeneity of preferences in the population. A range of theoretical and experimental work indicates that even a minority of individuals with social preferences can significantly alter the standard predictions.

Conditional reciprocity, inequity aversion, and the role of intentions explain several phenomena in contract theory such as the following. Why don't incentives always work? Why do we often observe cooperation in finitely repeated relationships? Why do we observe bonus contracts? Why are contracts often incomplete? Too great a use of the carrot and stick policy is likely to be perceived as hostile intent by workers, who could conditionally reciprocate by reducing effort. The standard model with purely selfish preferences is unable to provide a convincing explanation.

Time Discounting

Decisions that have a time dimension are central to many economic problems. The basic idea in most modern theories of time preference is the tension between immediate gratification and delayed, but greater, gratification. For example, if an individual or nation desires greater consumption in the future, then current consumption has to be reduced to increase saving and investment. This trade-off determines the consumption profile of individuals and nations. Models which are separable in time and outcome are sometimes called discounted utility models (DU).

Given two dates, t and $t + T$, let, $c_t = (c_t, c_{t+1}, \dots, c_{t+T})$, be a stream of dated consumption levels, or a consumption profile. A consumption profile could either be a historical record of the actual consumption levels, or a plan for future consumption formulated at a time, $t_0 \leq t$. The DU model states that the utility from this consumption profile is,

$$U(c_t) = \sum_{\tau=0}^T D(t+\tau)u(c_{t+\tau}) \quad [10]$$

where D is the discount function and u is the single-period utility function also known as felicity. Note that D is a function of time only and u depends on time only through the dependence of c on time.

An important question is the following. Suppose that the consumption profile, c_t , is optimal, in the sense that it maximizes eqn [10] subject to the constraints facing the consumer. Is the consumption profile $c_{t+s} = (c_{t+s}, c_{t+s+1}, \dots, c_{t+s+T})$ also optimal in the sense that it maximizes $U(c_{t+s}) = \sum_{\tau=0}^T D(t+s+\tau)u(c_{t+s+\tau})$? If this is the case then, c_t is said to be *time-consistent* otherwise it is said to be *time-inconsistent*.

Generally, optimal consumption plans are time-inconsistent. For example, as Richard Thaler argued in an influential example, a consumer may, now, prefer to have two apples in 51 days time to one apple in 50 days time but, come day 50, the consumer may prefer one apple that day to two apples the following day.

A special case of the DU model is the exponential discounted utility model (EDU) of Paul Samuelson, 1937. In this case the discount function takes the form

$$D(t) = e^{-\theta t}, \quad \theta > 0, \quad [11]$$

where θ is a constant parameter known as the discount rate and $\delta = e^{-\theta}$ is known as the discount factor. Thus, we also have $D(t) = \delta^t$, $0 < \delta < 1$. This model has proved extremely tractable and useful for many purposes. In particular, optimal consumption plans are always time-consistent if, and only if, the discount function is given by eqn [11]. However, EDU is rejected by the evidence.

Anomalies of EDU include the following. Under EDU, the discount rate between a time period of a given length remains the same irrespective of when the time period begins. However, the supposition of a constant discount rate is violated in many experiments; a finding that is known as the common difference effect. The most famous illustration of the common difference effect is Thaler's apples example, mentioned above. This led George Loewenstein and Drazen Prelec, in 1992, to propose the following hyperbolic discount function that can address the common difference effect:

$$D(t) = (1 + \alpha t)^{-\beta/\alpha}, \quad \alpha > 0, \quad \beta > 0. \quad [12]$$

Other anomalies of EDU include the following. Gains are more salient than losses (the sign effect), greater magnitudes are more salient than smaller ones (the magnitude effect), discounting over an interval depends on how that interval is subdivided (subadditive discounting), choices may appear to be cyclical (apparent intransitivity of preferences), choices may depend on the spread or monotonicity of the consumption sequence despite different sequences having the same discounted utility, and so on.

Loewenstein and Prelec explained the sign effect by proposing a per-period utility function or felicity (u in eqn [10]) with greater elasticity for losses as compared to gains. They explained gain-loss asymmetry by proposing that the elasticity of the felicity for losses exceeds that for gains. They explained the magnitude effect by assuming that the elasticity of the felicity is increasing. A functional form for the felicity that incorporates all these features was given by Ali al-Nowaihi and Sanjit Dhami. The combination of such a value function with the discount function [12] may be called the hyperbolically discounted utility model (HDU). This can explain the important violations of the EDU model.

Why do human and nonhuman subjects exhibit hyperbolic discounting? The work of Partha Dasgupta and Eric Maskin examines the evolutionary basis for this phenomenon. A wide range of puzzles that are largely unresolved with EDU can be explained by HDU. These include the following. Why does consumption track income so closely? Why do individuals under-save for retirement? Why is there a sharp drop in consumption at retirement? Why do individuals hold illiquid assets and credit card debt simultaneously? Why have national savings rates been declining? Why is marginal propensity to consume asset specific?

Unlike the EDU model, where the discount rate is constant across any two time periods of equal length, in the HDU model, the discount depends on the distance from the present, say, time t . In particular, under HDU, the discount rate over the interval $[t, s]$, $s > t$ is higher than the discount rate over the equal sized interval $[s, s + (s - t)]$. A higher discount rate implies a lower discount factor and, so, a lower weight on the

future. In this sense, the decision maker is said to be present-biased relative to the EDU model.

A second class of models that allows for a departure of the present from the future (relative to the EDU model) is the model of multiple selves. In this approach, the same individual, over time, can be viewed as a collection of different selves, one for each time period. Furthermore, the current self cannot perfectly control future selves by command. However, the current self can potentially take actions that can alter the constraints faced by future selves.

An important issue in the present-bias models is the degree of awareness that a current self has about the degree of present bias of one's own future selves. Experimental evidence is, at the moment, not conclusive about the degree of self awareness of the individual. It seems, however, that completely sophisticated behavior, that is, full awareness of one's future self-control problems and completely naive behavior, that is, no awareness of future self-control problems are both unreasonable relative to the intermediate case of partial awareness.

There are several applications of present biased preferences. Applied to the life cycle model it turns out that the present-bias of individuals leads to greater current consumption and lower savings relative to the time consistent behavior found in the EDU model. The current selves can, however, take certain actions to bind the future selves.

One possibility is for the current self to invest in illiquid assets, such as housing, that constrains the ability of the future selves to engage in excessive consumption. This can explain, for instance, why individuals simultaneously hold illiquid assets, such as housing (certainly illiquid as compared to financial assets), and credit card debt, a phenomenon that EDU cannot explain. The current self buys an illiquid asset to discipline the self-indulgent behavior of the future selves. The future self is now faced with mortgage payments (or a lack of cash due to the purchase of the house) and, so, this alters his/her budget constraint. However, the easy availability of credit cards could induce the future self to borrow and, so, successfully, relax the budget constraint. In so doing, the future self might believe that his/her future selves will be more responsible, which might well turn out to be a naive assumption.

Neuroeconomics

Neuroeconomics studies the neural activity in the human brain when one makes economic choices. One of the leading neuroeconomists, Colin Camerer, defines the subject matter in the following manner: neuroeconomics is a specialization of behavioral economics that plans to use neural data to create a mathematical and neurally disciplined approach to the micro-foundation of economics.

There is a wide variety of techniques used in neuroeconomics to measure brain activity. Some of these techniques are so invasive, for example, single neuron recordings, that they can only be used on animals. However, this is of value, as humans share a primitive mammalian brain with other mammals and so the lessons learnt from animal neuroeconomic experiments can provide valuable information. Other techniques, for example, functional magnetic resonance

imaging, FMRI, are less invasive and are able to measure the hemodynamic response, that is, the changes in blood flows to different parts of the brain while pinpointing, with varying accuracy, to relatively small and specific areas. Establishing causality is an issue with many of these techniques. Such is the speed of progress in neuroscience that it is now possible to be more sure of direct causality using very new techniques such as transcranial magnetic stimulation, TMS, whose method can be described as follows. Suppose that we suspect that some region, R , of the brain is responsible for some behavior, B , that is relevant to economics. Then TMS can temporarily curtail/stimulate area R . If this curtails/enhances behavior B then there is indeed a possibility that region R is responsible for behavior, B .

It is also possible to fruitfully apply older techniques that rely on psychophysical measurements, such as pupil dilation, heart rate, skin conductance etc. For instance, pupil dilation is enhanced when one sends false or misleading information. This has obvious implications for economics, for example, in predicting the truthfulness of messages in an asymmetric information game. When contributors punish noncontributors activation in the dorsal striatum (which is the brain's reward circuit) informs why the outcomes in the public good game with and without punishment are so different. Existing neoclassical models are unable to offer a convincing explanation.

Clearly, neuroeconomic variables have a direct role to play in economic models. But they can also be useful indirectly. Economic models are generally estimated by hypothesizing that some endogenous variable, y , is determined by a set of exogenous variables x_1, x_2, \dots, x_N and some noise term, ε . Typically, data is available on only a subset of the variables, x_1, x_2, \dots, x_s , $s < N$. The omitted variables are then, necessarily, subsumed within the noise term, ε . It is possible, however, that some neuroeconomic variables, z_1, z_2, \dots, z_m , influence y and are correlated with the omitted variables and, hence, can be used as instruments for them.

Usually, there are competing economic explanations for the same phenomenon. One can then ask which explanation is more neurally plausible, in the sense of being consistent with known findings from neuroeconomics. Thus, potentially, neuroeconomics could deliver an additional criterion for selecting among competing explanations.

We regard behavioral economics as an extension of mainstream (neoclassical) economics, using insights from psychology and sociology, into areas (and there are many) where mainstream economics has empirically failed. The neuroeconomic findings are suggestive of a dual-system functioning of the brain in which system 2 (the neocortex) determines cognition and system 1 (the limbic system) determines emotion. Thus, one may hypothesize that decisions made by system 2 would be in accord with rational choice theories while the interaction between the two systems would be in accord with alternative behavioral theories. Of course, the two systems need not be in conflict. Thus, both systems would, for example, urge us to breathe, eat and drink, seek shelter, and avoid hazardous situations. And, indeed, neuroeconomic findings have supported a range of rational choice models. Support for the rational choice models, however, seems to arise largely in environments that are stationary

and where evolution has had enough time to make an impact. Support for behavioral alternatives is more widespread; and include, for example, models of fairness and reciprocity, prospect theory, models of limited iterative thinking and hyperbolic time discounting.

Behavioral Game Theory

Game theory deals with situations in which a set of individuals (called players) take actions or play strategies that affect not only their own payoffs (or utilities) but also those of others. The fundamental concept in game theory is that of a noncooperative equilibrium, proposed by John Nash in 1950, hence, also known as a Nash equilibrium. In such an equilibrium, each player plays a strategy that is best for himself in terms of maximizing payoffs or utility (i.e., a best reply), given the equilibrium strategies of the other players. Nash proved that every finite game (finite number of players and finite number of actions) has a Nash equilibrium.

It is permitted for players to have a probability distribution over the play of their actions. To emphasize this point, sometimes strategies are referred to as mixed strategies. If each action is played with strictly positive probability, then the strategy is strictly mixed. By contrast, in a pure strategy, each action is played with probability 0 or 1. A strategy x dominates a strategy y , for player i , if x gives higher payoffs for i than y , irrespective of the strategies of the other players. One very simple method of searching for a Nash equilibrium is that of iterated elimination of dominated strategies.

A dynamic game is a game played over time in which players have the opportunity of observing and learning from the previous actions of other players. A simple way to find a Nash equilibrium of a dynamic game is by backward induction: find a Nash equilibrium for the subgame played in the final period. Then find a Nash equilibrium in the penultimate game, assuming that players, come the final period subgame, will play the Nash equilibrium already found for that subgame. Carry on till the initial subgame. Backward induction has the added attraction that it does not allow threats that are not credible (i.e., those that would never be used). Such an equilibrium is called a subgame perfect equilibrium.

Behavioral game theory has developed as a response to the violations of the predictions of (mainstream) game theory. Contrary to the prediction of game theory, players do not engage in iterated deletion of dominated strategies if this involves more than 2–3 steps of iteration. Within the context of two steps of iterated eliminations of dominated strategies, the outcome has also been shown to be sensitive to framing effects.

A test of the iterated deletion of dominated strategies is in the context of the Abreu–Matsushima mechanism design solution. This is a mechanism that is implementable by using very few steps of iterated elimination of dominated strategies. The results of Martin Sefton and Abdullah Yavas show empirically that the predictions of this mechanism fail. In conjunction with similar evidence from elsewhere, this casts doubt on the implementability of other mechanisms (most of which are even more complex).

The backward induction argument usually fails in experiments.

Multiple Nash equilibria arise in almost all areas of economics. An important question is whether players can coordinate (agree) on one of the equilibria (preferably the best for all, if such an equilibrium exists). Widespread failure to coordinate on any equilibrium (particularly the one that maximizes joint payoffs) is observed in experimental results. Preplay communication does not necessarily enhance coordination. History plays a powerful role in influencing the degree of coordination. Only under some conditions, for example, gradual growth of group sizes, successful coordination in small groups, knowledge of the history of such coordination, etc., does coordination emerge successfully. In experiments, if generations give public advice to their successors then coordination can be enhanced.

While players often seem to play mixed strategies they do not do so in the proportions predicted by a mixed strategy Nash equilibrium (MNE). Furthermore, while the aggregate proportions (across players) are sometimes found to be consistent with MNE, individual proportions of play are typically inconsistent with a MNE. Tennis and football professionals seem to play mixed strategies that are consistent with the evidence. However, the serial dependence of serves, in tennis for example, is inconsistent with the predictions of a MNE.

There is also a fascinating new literature that tests the predictions of standard game theory by directly attempting to infer the cognitive process when subjects play experimental games. Game theory does not make any assumptions on the cognitive process when subjects play games. Some traditionalists argue that a study of the cognitive process cannot confirm or reject anything in game theory. Consider, for instance, the work of Eric Johnson et al. They consider Rubinstein's alternative offers bargaining game played by two players over three rounds. The game is easily solved by backward induction. One would, therefore, expect that subjects will look to see the last round data such as payoffs, actions etc., then look at the penultimate round data and finally, the first round data. The authors use MOUSELAB software to observe if the pattern of searches made by experimental subjects is backward, beginning with the third period data. It turns out that subjects search forward rather than backward, that is, looking first at the first round data, then the second round data, and finally, the third round data.

The Nash equilibrium concept and its refinements have helped to shed light on many interesting questions in economics. Furthermore, the machinery of game theory has forced economists to be completely explicit about who the players are, what moves are open to them, the sequence of their moves, what objectives they have, what information they acquire and when, etc. This level of rigor gives modern economics a tremendous advantage over pre-game-theoretic economics. However, the empirical evidence on the Nash equilibrium and its refinements is not very encouraging, especially when individuals interact in bilateral or small group settings. More positive evidence is found at the level of market outcomes and in large groups.

There are now several alternative models of behavioral game theory that perform better than a MNE. These include the concept of a quantal response equilibrium (QRE). QRE has been able to explain a range of findings from experimental/field data that the classical equilibrium concepts have found

troubling to explain. In a QRE, players play strictly mixed strategies. In contrast to notions in classical game theory, such as trembling hand perfection, the trembles do not, in the limit, tend to zero in a QRE. Trembles are fundamental and remain significantly large in a QRE. This avoids a range of problems that arise in classical theory regarding assigning beliefs about actions that are not played in equilibrium. The reason is that, in a QRE, all paths of play are ex-ante possible. The main requirement of a QRE is that players form beliefs that are correct in equilibrium. However, because players randomize over all their actions in a QRE, they do not necessarily play best replies.

Forming beliefs that are correct in equilibrium, as in QRE, is cognitively challenging. This requirement is relaxed in a second class of behavioral game theory models, the level- k models. In these disequilibrium models, players' beliefs need not be correct. However, players play best responses, conditional on these, possibly incorrect, beliefs.

Game theorists steeped in classical theory might well react indignantly and ask how players could possibly hold on to beliefs that turn out to be incorrect? There are two responses. (1) Level- k models are motivated by actual experimental evidence which indicates disequilibrium beliefs. (2) Even when a process of learning might correct the beliefs of players over time, there are still good reasons to pay attention to level- k models. First, many important decisions that economic agents make in real life are of the nature of one-off decisions or decisions that are not repeated often enough. Second, in many experiments where long-term learning has a positive impact, the economic environment is held fixed. In real life, however, the economic environment is often too variable to permit the clean learning results of experiments.

Level- k models introduce heterogeneity among players by distinguishing between types of players, $L0$, $L1$, $L2$, ... The generic type is denoted by Lk . Type $L0$, the only nonstrategic type, typically chooses to simply randomize among the various available actions. In general, any type Lk , $k \geq 1$ assumes that all other players are of type $Lk - 1$ only. In its cognitive hierarchy version, type Lk , $k \geq 1$ assumes that there is a distribution of all the lower types of players. Fixing beliefs in this manner, each type of player then chooses a best response over its available actions. Type $L0$, sometimes known as the anchoring type, need not be physically present in the population. It can exist purely as a model of other players in the minds of type $L1$ players.

Consider the p -beauty contest. In the simplest such game, subjects are asked to guess numbers between 0 and 100. The subject whose guess is closest to $2/3$ times the average wins a prize. The Nash equilibrium prediction is for each player to choose 0 (the reader should check this).

However, the level- k model predicts that people will play the p -beauty contest as follows. A type $L0$ player simply randomizes and so chooses the number 50. A type $L1$ player thinks that all others are type $L0$ so chooses the number $\frac{2}{3}(50) \approx 33$. A type $L2$ player thinks that all others are type $L1$ and so chooses the number $50(\frac{2}{3})^2 \approx 22$, and so on. Thus, if players were indeed of types $L0$, $L1$, $L2$, ... then we would expect to see spikes in the data at the numbers $50(\frac{2}{3})^0$, $50(\frac{2}{3})^1$, $50(\frac{2}{3})^2$, ... This is a remarkably precise and unambiguous prediction. Moreover, this prediction has been verified in several empirical works even when played with very high ability subjects.

Level- k models can explain a range of phenomena that are difficult to explain with other models. These include results from auctions and market entry games, among many others. The evidence from MOUSELAB experiments indicates that types $L1$ and $L2$, in the level- k models, make up 67–89% of the population. This data is hard to reconcile with QRE models suggesting that the level- k models have better psychological foundations.

There is a range of other behavioral game theory models. These include the noisy introspection model, models that consider the role of memory explicitly, models of coarse thinking and mental categorization, analogy based equilibrium models, cursed equilibrium and so on. Some are more speculative than others.

We have not touched on behavioral models of learning because of space constraints and the fact that the technical requirements for understanding even the basics are beyond the scope of the current contribution.

Liberalism and Paternalism

A fundamental principle of classical liberalism is that people are the best judges of their own welfare. This lies, explicitly or implicitly, at the heart of traditional public economics. Thus, the role of government is limited to upholding the law, enforcing contracts and correcting for market failures, when practicable. Of course, it has always been recognized that some well-defined groups, children for example, are not fully able to judge their own interests. The opposite view that, in the main, people are not the best judges of their own welfare, is known as paternalism. Under paternalism, an institution is needed to judge people's welfare for them, for example a government, political party or religious establishment.

Paternalism has not often had a beneficial impact in human history. However, there is strong empirical evidence from behavioral economics that people are, by and large, not rational optimizers, unlike the assumption under liberalism. A small selected sample of the violation of the rationality assumption is as follows. Many individuals do not utilize the full limits of their 401k pension plans despite the fact that the company will match the extra contributions. There is also inadequate diversification of portfolios. People often use a range of judgement heuristics to make decisions. The evidence is largely (but not always) inconsistent with the use of Bayes' rule, rational expectations, and even strict optimization. People become obese without any apparent liking for the condition of obesity or addicts who then often need to be helped by others to get rid of the habit. There is also an overutilization of payday loans. These are loans that are repaid when the next paycheck arrives; the short-term interest rates on these loans are much higher than loans available elsewhere.

In some cases, the textbook rational behavior might not be observed on account of lack of information, or limited cognitive abilities. In other cases, it could be due to a current-bias in preferences, which lead to self-control problems and dynamic inconsistency. Examples are various forms of addictive behavior, the desire to quit, and the subsequent relapses that are often difficult to reconcile by using the traditional rationality framework. People exhibit preference reversals. Preferences are often not well-defined, are often incomplete, and dependent on the framing of information.

Shlomo Benartzi and Richard Thaler show that only 20% of the people in their sample prefer their own portfolio to the median portfolio. In other important contexts such as pensions, individuals sometimes use the $1/n$ heuristic to allocate their portfolio where n is the number of options available, hence, making outcomes very sensitive to what assets are available.

This evidence has disturbing implications for the debate between liberalism and paternalism. Aware of this, behavioral economists sometimes refer to paternalism in the traditional sense as heavy-handed paternalism. By contrast, the form of paternalism suggested by behavioral economists is sometimes called soft paternalism or light paternalism. It is this form of paternalism that we now briefly review.

Some view the relaxation of rationality in welfare economics as a natural progression of the relaxation of other restrictive assumptions in economics, such as perfect competition, perfect information, certainty etc.

At the heart of most proposals under the ambit of light paternalism is the need to distort individual decisions/choices as little as possible and use as little coercion as possible. The idea is that the mistakes (or misperceptions) of the bounded rational types will be nudged in the direction of a correction while the minimal intrusion associated with light paternalism should have little effect on the actions of the fully rational types. To operationalize light paternalism, one needs to specify what a mistake/misperception is. Furthermore, in the light of these mistakes/misperceptions, how should we judge the outcomes of light-paternalistic policies? The latter question requires us to have some behavioral welfare criteria. The reason that a traditional welfare criteria would not be suitable is that actual choices might not be indicative of an individual's best interests. Thus, unlike the classical analysis we cannot use preference based measures of welfare such as equivalent variation and/or compensating variation to seek the direction in which individual welfare is improving. As Loewenstein and Haisley put it: "Clearly, it doesn't make sense to assess whether someone is committing an error using a measure that is premised on the assumption that people don't commit errors."

Botond Koszegi and Matthew Rabin argue that unless one imposes ancillary assumptions, it is impossible to infer preferences from choice even with unlimited data and under the assumption that people are 100% rational. Consider, for instance, the possibility that people have social preferences. Suppose that we observe a set of choices in which an individual shares with others when there is an option to do so. From this, should we conclude that the individual is happy to share with others? Or that she would feel guilty if she did not? Or that she would prefer not to have an option to share? These distinctions cannot be made based on the choice data.

Although additional evidence is already accumulating at a rapid rate, behavioral economics is a relatively new field and many important effects and channels are not fully understood yet. For that reason one needs to be cautious and careful in testing the implications of various paternalistic policies. Some have advocated careful small-scale pilot studies as well as field studies before the actual implementation of paternalistic policies. The evidence suggests that not all people are subject to the relevant behavioral biases. Clearly regulation that is too stringent might have a negative effect on these rational types.

Many notions of behavioral paternalism have been advocated in the literature that the reader might wish to follow up on. These include libertarian paternalism attributable to Richard Thaler and Cass Sunstein, asymmetric paternalism attributable to Colin Camerer et al. and a pragmatic approach attributable to George Loewenstein and Emily Haisley.

Brief Conclusions

Behavioral economics is one of the most rapidly growing fields in economics and is gradually becoming mainstream. It relies on a strong respect for the evidence, falsifiability, and a recognition that experiments in the lab, and neuroeconomic evidence, can usefully complement field data. It draws its principles from several decades of research in psychology (and sociology). Behavioral economics has seriously questioned the rationality assumption in economics as well as the assumption of selfish preferences. While traditional economics did recognize the possibility of less than perfect rationality, it assumed that these errors would cancel out in the aggregate. Behavioral economics has, instead, shown that these errors might cumulate and snowball in one direction and lead to outcomes that are very different from those predicted by traditional economics. Behavioral economics has also stressed the importance of emotions in making decisions, role of framing in influencing outcomes, provided richer theories of decision-making under risk and over time and provided new solution concepts in strategic interactions. In this sense it has provided new theory to explain the emerging evidence that is both refutable, and based on empirically robust psychological principles.

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See also: Altruism and Helping Behavior; Anxiety and Fear; Cognitive Dissonance Theory; Consumer Psychology; Decision Making (Individuals); Preference Judgments (Individuals); Self-Fulfilling Prophecy.

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Behavioral Genetics

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Glossary

Allele An alternate form of a gene at a particular place (locus) on a chromosome.

Association Correlation between phenotypic variation and a marker (genetic, allelic, or DNA) of variation on a chromosome.

Dominance The ability of one allele (the dominant) to override the phenotypic expression of another allele (the recessive).

Epistasis Nonadditive effects of the combined actions of two or more genes, that is, gene–gene interaction.

Gene A segment of a chromosome (deoxyribonucleic acid or DNA) that codes for some aspect of protein synthesis.

Genotype The genetic composition of an individual.

Heritability The proportion of phenotypic variability that can be accounted for by genetic differences.

Inbreeding Matings between closely genetically related individuals.

Linkage The extent to which two genes near each other on the same chromosome are transmitted together instead of segregating and independently assorting.

Phenotype The variant of a measurable characteristic or trait.

Pleiotropy Multiple phenotypic effects of the same gene.

Behavioral genetics, as the name indicates, is the interdisciplinary research area concerned with determining if and how genetic factors influence any of the phenomena studied in the behavioral sciences, especially psychology. Behavioral geneticists apply the concepts and methodologies of molecular, population, and quantitative genetics to behavior as the trait of interest.

Introduction

Two readily apparent, related aspects of human behavior make a compelling case for the need to study genetic influences on behavior. These are stability and variability.

If a behavior, for example, scoring high on tests of intelligence, is consistently manifested by an individual across time and across many different situations, then the stability of this behavior must be due to some consistent set of physical determinants. Through consistent reinforcement and/or punishment of certain behaviors, plus generalization, a stable behavior could have been established by environmental influences on the individual. On the other hand, the behavior could be a manifestation of some consistent ‘hard-wired’ physiological process, for example, greater efficiency of the connections in the brain’s neural network. Since all physiological/biological processes ultimately begin from some genetic code, it could be inferred that the stable behavior is the result of the individual having inherited some gene or genes for the behavior.

In turn, both the lack of variability and the presence of variability in stable behaviors also require the influence of some set of consistent physical determinants. For example, all physiologically normal humans raised among other humans acquire the ability to use language. The lack of variability in this behavior among humans, plus the absence of this behavior in this form in other animal species, is consistent with the supposition that all normal humans inherit a set of genes that code for the physiological structures that are required for

language. Other stable behaviors, such as performance on intelligence tests, are characterized by great variability among humans, and this variability is maintained in spite of historical and social changes in the environmental factors thought to influence the behaviors. Since each individual is genetically unique, stable individual differences in behavior are also consistent with the supposition that genetic determinants may be involved.

Although behavioral genetics is concerned with establishing the genetic correlates of behavior, the discussion above makes clear that genes, in fact, do not directly cause behavior. **Figure 1** reiterates the idea that genes are basically a biochemical process for coding the synthesis of proteins which, in turn, are assembled into the physiological structures and processes of the organism. These physiological structures then become one of the determinants of behavior, and the study of this process is the realm of physiological psychology. Thus, any finding from behavioral genetics of significant genetic contributions to behavior automatically implies that some physiological mechanism is the more proximal determinant.

Behavior can also be influenced by the environment through learning, and one dotted line shows the presumption in physiological psychology that ultimately learning operates by modifying the physiology of the organism. It should also be noted that genetic influences always operate on physiology within the context of some set of environmental influences. The other dotted line presents the possibility (discussed below) that genetic processes can affect environmental influences.

In **Figure 1**, the understanding of how genetic processes are translated into physiology is noted to be the realm of molecular genetics/genomics. Molecular genetics is concerned with the sequence and operation of biochemically defined genetic material (the DNA base pairs described below) in transcribing, transmitting, and implementing the code for the synthesis of physiological structures and processes. Genomics focuses on gene expression, much of which has evolved to be responsive to intracellular and extracellular environmental effects.

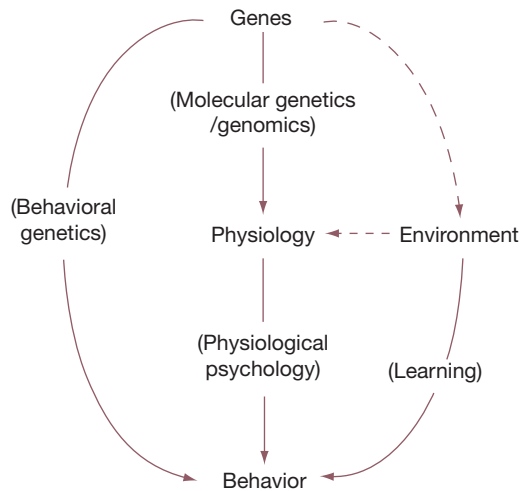


Figure 1 Relationship of genes to behavior.

Quantitative genetics estimates the relative contribution of genetic versus environmental influences to variation in a trait by comparing differential resemblances or patterns of differential variability among individuals with different degrees of genetic relatedness. Population genetics bridges molecular and quantitative genetic approaches, as well as evolutionary processes, by seeking to relate gene frequencies and degree of genetic influence with particular traits for populations of organisms operating within particular environmental contexts.

Since behavioral genetics is basically the application of genetics to a special set of traits, behavior, much of this article will be an overview of genetic concepts and methodologies. We begin with a discussion of Darwin's theory of evolution by natural selection and of Mendel's work on the logic of genetic transmission.

Evolution and Mendelian Genetics

The evolutionary theory of Charles Darwin (1809–1882) had a profound impact on Western thought. Even though it provides a basis for a unified understanding of all biological phenomena, the theory was and remains controversial. In psychology, it was integrated into the concepts of the nineteenth century physiological psychologists, became a major inspiration for William James' school of functionalism (the school which, somewhat ironically in this context, led to John B. Watson's behaviorism) and Sigmund Freud's school of psychoanalysis, and the work of Darwin's cousin Francis Galton, was also the starting point for the scientific study of individual differences and genetic influences on human behavior.

Darwin's theory, first published as *On the Origin of Species by Means of Natural Selection* in 1858, has three major components, each of which has important implications for the understanding of human behavior:

1. *Induction of variation* proposes that members of a species differ from each other at birth and through maturation along a multitude of different trait dimensions and that biological processes continually create these individual

differences. Not only are such differences ubiquitous for any species, they are absolutely essential for the survival of the species in the face of relentless changes in environmental conditions. One obvious implication of this for psychology is that, in contrast to the ideas of several early behaviorists, individual members of a species, including humans, are biologically unique and should not be expected to respond to the same environmental influences on behavior in exactly the same way.

2. *Maintenance of variation* proposes that individual differences in the traits that vary within a species are biologically transmissible from one generation to the next. Again, this is absolutely essential for the survival of the species. This idea leads to the immediate inference that behavior must also be biologically transmissible, since stable patterns of behavior are undoubtedly essential aspects of species survival. Thousands of years of humans breeding animals for behavioral traits supported the idea of genetic bases for behavior, even for humans.
3. *Natural selection* assumes that there are always more members of a species born at any one time than will ever survive to reproduce. Darwin proposed that environmental conditions at a particular time, for example, availability of food, nature of predators and parasites, climate, etc., tend to give some individuals born with one set of traits, an advantage in being able to survive, reproduce, and rear offsprings to maturity over other individuals with different levels of these traits. Over several generations of this natural selection, more individuals with the advantageous characteristics are born with and transmit these characteristics, while there is a decreased incidence and transmission of the disadvantageous characteristics. Darwin argued that over a sufficient number of generations, particularly in response to some major change in the environment, the members of a species may now possess such different traits from the starting population that they constitute a new species.

As noted above, Darwin's theory clearly reinforces the importance of genetic transmission and biologically based individual differences as determinants of the characteristics of organisms, including behavioral characteristics. The theory also implies that all species, including humans, are biologically related on some level to every other species. The similarities and differences between and within species could be understood solely in terms of the interactions between the genetic endowments of a species and the selection pressures in the environment. Research into the determinants of behavior in other animal species in order to understand human behavior is justified, because other animals and humans have some of the same or similar physiological structures and processes that determine behavior. Other implications include the expectation that humans retain physiological structures that were once adaptive or neutral in reproductive fitness value in natural environments, but which may be maladaptive in rapidly changing modern societies (e.g., the 'fight or flight' response). Another implication is that even those 'higher' aspects of human behavior and mental processes that supposedly differentiate us from other animals can be related to genetically transmitted physiological functions that resulted from natural selection.

Although natural selection was the most parsimonious and successful proposed mechanism for accounting for species change, at the time Darwin published his theory the way that traits were biologically transmitted was poorly understood. Darwin himself realized that the then current concept that parents gave off biological particles ('gemmules') that merged and blended in the offspring would, in fact, invalidate his principles of induction and maintenance of variation. Due to regression toward the mean, generations of blending traits would result in all individuals having the same averaged trait, that is, no variation. It was only after the work of Mendel and the beginning of modern genetics that a mechanism for the maintenance of variation was established.

Gregor Mendel (1822–1884) studied the types and frequencies of plant characteristics that resulted when members of a species possessing one kind of characteristic were crossed with members having a different characteristic. For his most famous work on pea plants, such characteristics included green versus yellow pea color, smooth versus wrinkled pea form, long versus short plant stem, etc. His cross-breeding studies led him to infer two principles for genetic transmission.

The *law of segregation* stated that every character (the phenotype) is determined by the combination of two elements (genes), one from each parent. These elements split off cleanly (segregate) from each other in the production of the sex cells and are transmitted intact to the offspring. Since it is possible for one form of the gene (a dominant allele) to prevent the expression of the other form (the recessive allele), a process called dominance, the same phenotype could result from different combinations of genetic elements (the genotype). For example, a green pea would result whether the genotype consisted of both alleles coding for green color (homozygous dominant) or a genotype with both green and yellow coding alleles (heterozygous), since the green allele was dominant. This was apparent when Mendel crossed 'pure' green and 'pure' yellow pea plants and found that the next generation all had green peas. When this second generation was crossed with each other, however, Mendel found that one-fourth of the succeeding generation again manifested yellow peas (both alleles coding for yellow; homozygous recessive). Thus, the yellow alleles were not blended, the frequency of the recessive phenotype could be predicted from the random combination of the dominant and recessive alleles, and the variability of the genes determining green versus yellow pea color was maintained.

The *law of independent assortment* stated that different genes determined different characteristics. These genes were randomly combined in the sex cells and, hence, independently transmitted to the offspring. Mendel found that when he looked at the results of crossing plants for two different traits, for example, green pea color/long stem with yellow pea color/short stem plants, the odds of a plant possessing green versus yellow peas were completely independent of the odds of the plant having a long versus a short stem. This was also important for Darwin's theory, since it meant that one trait could be selected for without affecting some other trait.

As it turned out, modern genetic findings have turned up several exceptions to Mendel's laws. Many genetic/physiological and/or environmental factors can result in a genotype not being completely manifested in the phenotype (*incomplete*

expression/penetrance). Many traits determined by single genes (one pair of alleles) do not show dominance, such that heterozygous genotypes may result in phenotypes intermediate between phenotypes resulting from the two homozygous genotypes. Heterozygous genotypes may produce more extreme phenotypes (*overdominance*). Genes on the X-chromosome (discussed below) are differentially transmitted to male versus female offspring. Recent findings suggest that parents in a few genetic systems may be able to determine the expression of both alleles of an offspring (*genomic imprinting* and *uniparental disomy*). An important recent discovery concerns *simple sequence repeats* or *gene amplification*, where three-nucleotide base-pair sequences within genes increase in number over generations, leading to disruptions in normal gene functioning. With regard to independent assortment, it is now known that genes that are close to each other on the same chromosome are often transmitted together (*linkage*) and that single genes can have multiple phenotypic effects (*pleiotropy*). Nevertheless, Mendel's laws more than adequately accounted for observations of genetic transmission at the phenotypic level long before the biochemical nature of genes was understood.

Although Mendel presented his findings at a scientific meeting in 1865, they were 'lost' until 1900, when several biologists (Erich Tschermak von Seysenegg, Hugo, de Vries, and Carl Correns) rediscovered and started widely applying the laws. In the meantime, Darwin's cousin Francis Galton (1822–1911) was using the theory of evolution to establish the science of behavioral genetics.

Galton immediately inferred from Darwin's theory that all human behaviors had a biological/genetic basis and were the result of natural selection. With his book *Hereditary Genius: An Inquiry Into It's Laws and Consequences* (1869), he asserted that social eminence (reflective of intelligence) was genetically determined. He demonstrated this by showing how the incidence of eminence in the male relatives (fathers, sons, uncles, cousins, etc.) of eminent men was a strict function of the degree of biological relatedness between the probands (the index cases from whom other family members are identified) and the relatives. He developed the idea of the twin research design, when he studied more physically similar twins versus less similar twins and asserted that the former's greater similarity on psychological traits also indicated a genetic basis for psychological as well as physical characteristics. He established laboratories for the systematic measurement of thousands of individuals on physical (height, weight, etc.) and psychological (acuity of eyesight, acuity of hearing, reaction time, etc.) traits in hopes of establishing the large data bases he knew were required to delineate genetically based distributional characteristics, social class differences, developmental trends, and familial resemblances.

Besides his enormous contributions to psychology in establishing ways of measuring psychological phenomena of all sorts, Galton's quest for ways to demonstrate genetic transmission in relatives led to the development of new statistical techniques. His student, Karl Pearson, developed the correlation coefficient to quantify familial resemblances in some standardized fashion, and genetic questions spurred the development of statistical procedures commonly used in the social sciences (e.g., Fisher's chi-square and *F*-tests).

Thus, much of the logic and methodologies of modern behavioral genetics had been laid down by Galton and his

students by the time Mendel's ideas were rediscovered. Ironically, it took some time and controversy to reconcile Galton's ideas, that accumulations of genetic elements of some sort produce continuous, typically normal distributions of traits, such as intelligence, with Mendel's ideas about discrete traits under the control of only a few combinations of alleles. The reconciliation involved the recognition that the random combination (consistent with independent assortment) of several discrete genetic elements, all of which have some influence on the trait, would produce the continuous, normal distributions Galton saw. It is still important, though, to distinguish between traits thought to be under the control of a single gene versus those under the control of several genes.

Although Darwin's ideas were important for the school of functionalism established in the United States by William James and others at the end of the nineteenth century, and Galton's ideas were the starting point for trait theories of intelligence and personality, genetic explanations for behavior were largely eclipsed by behaviorism throughout most of the twentieth century. There was also a great amount of philosophical resistance in the general public to the idea of biological/genetic determinants of human behavior. For instance, there was considerable public controversy following the publication of Arthur Jensen's 1969 paper asserting that, due to the high heritability of intelligence, educational programs would have only minimal effects in ameliorating race differences in I.Q. Ironically, this same controversy was resuscitated by the 1994 publication of Richard Herrnstein and Charles Murray's *The Bell Curve*.

Several historical developments have led to the much greater acceptance today of behavioral genetics in both mainstream psychology and the general public. The discovery of the structure of deoxyribonucleic acid (DNA), the fundamental molecule of heredity, by Watson and Crick in 1953 spurred the vast expansion of knowledge in recent years on the biochemical characteristics and processes of what had up to then been only a hypothetical genetic mechanism. Discoveries about the biochemical workings of genes and gene products continue and will continue to be among the most exciting findings in science. The findings from physiological psychology and neuroscience have greatly expanded our understanding of the biological processes that determine behavior, while the idea of learning as the sole basis for behavior no longer has ascendancy. Meanwhile, the accumulation of findings from pedigree, twin, and adoption studies has provided compelling evidence for the significant heritability of intelligence, personality, schizophrenia, alcoholism, etc.

Population Genetics

Prior to the development of the techniques discussed below under Molecular Genetics for identifying markers of DNA variation, genetics research involved inferring underlying genetic mechanisms from observed phenotypic variations. Both population and quantitative genetics primarily analyze such informative phenotypic variation, and both fields are moving toward the greater incorporation of DNA markers into research designs for more precise analyses of genetic processes.

As noted above, population genetics seeks to understand the frequencies and relative contributions of genes on

particular variations in traits for a group of organisms operating within a particular environmental context. An important starting point for population genetics was the statistical derivation of the Hardy-Weinberg-Castle equilibrium, which showed that, in the absence of influences that produce disequilibrium (discussed below), the relative frequencies of alleles (dominant vs. recessive, etc.) and genotypes (homozygous dominant, heterozygous, etc.) for a phenotype remain at a constant ratio over generations. This was basically just a restatement of Darwin's idea of maintenance of genetic variation, but in this case it was derived through mathematically following the logic of genetic transmission defined by Mendel.

There are four major forces that can change allelic frequencies, that is, the relative frequencies of one form of a gene versus another, in a population:

Migration can change allelic frequencies if individuals who move into or out of a population differ from the original population in their allelic frequencies. For example, it can be argued that the waves of immigrants who came to the United States throughout its history were more likely to carry genes for such phenotypes as adventurousness, hardiness, rebelliousness, etc., compared to the populations left behind.

Random genetic drift can affect small populations, when chance causes some alleles and not others to accumulate over several generations.

Mutation is the ultimate source of inducing genetic variations, as alleles are altered by errors in genetic replication and transmission and by environmental influences. The spontaneous mutation rate, however, is thought to be quite low, and the effect of mutation on allelic frequencies in most cases is minor compared to natural selection.

Natural selection is the prime basis for genetic change described by Darwin. Natural selection operates on the basis of the phenotypes that give an organism some advantage or disadvantage (relative fitness) in surviving to reproduce offspring who, in turn, will pass on the genes that determine the phenotype. If a phenotype, such as schizophrenia, is selected against by the environment, that is, the phenotype reduces the reproductive success of the individual, and is determined by a dominant allele, then both homozygous dominant and heterozygous genotypes will be selected against. In this case, natural selection will rapidly decrease the frequency of the dominant allele. If, however, the maladaptive phenotype is coded for by a recessive allele, as is the case for phenylketonuria (discussed below), then only homozygous recessive genotypes will be selected against, and large numbers of heterozygotes (*carriers*) will continue to transmit the 'bad' allele to some of their offspring. This process tends to ensure that adaptive phenotypes are coded for by dominant alleles, while maladaptive phenotypes are carried and maintained on recessives in populations. This picture becomes more complicated when there is not complete dominance for a gene. In the extreme case, selection may eliminate all but one form of a gene for an adaptive trait in a population or species, and this trait then becomes a species characteristic (i.e., there is no variability for the trait).

Natural selection may also act to maintain or even increase the variability of a trait in the population, creating a so-called balanced polymorphism. For example, sickle-cell anemia is a typically fatal medical condition in individuals of African

ancestry. The disease is caused by an autosomal recessive gene, thus homozygous recessive genotypes are selected against. Heterozygotes, however, manifest a greater resistance to malaria in malarial environments than homozygous dominants, and both alleles are maintained in the population, in spite of the deleterious effects of the recessive gene by itself. Predator–prey and parasite–host relationships also often manifest balanced polymorphisms, as natural selection for adaptations in one organism are constantly being compensated for by corresponding natural selection for adaptations in the other organism.

Since characteristics that increase the probability of being chosen as a mate also directly affect reproductive success, sexual selection is a special form of natural selection and can produce many of the same effects described above. On the other hand, the phenotypes chosen by mates may not be consistent with those resulting from natural selection, that is, as a result of sexual selection, species may come to manifest traits that appear to be maladaptive.

Besides forces that change allelic frequencies, population geneticists also consider two forces, inbreeding, and assortative mating, that change genotypic (but not allelic) frequencies by increasing the similarity of the genes that both parents transmit to their offspring. This is important, because such parental similarities in the genes they transmit would increase the relative frequencies of homozygous dominant and recessive genotypes, while decreasing the proportion of heterozygotes. This, in turn, typically has the effect of increasing the variability of the trait in the offspring generation, since there would be higher frequencies of the extreme genotypes. This increased variability might counter the reduction in trait variability resulting from unidirectional natural selection.

Inbreeding is the mating of closely genetically related individuals and, as described above, causes parents to be more similar in the genes they transmit to offspring. Since recessive alleles often code for deleterious phenotypes but are not expressed, due to their being paired with a dominant, the increased incidence of homozygous recessive genotypes resulting from inbreeding often results in decreased fitness for the offspring of such matings (*inbreeding depression*). The counterpart to this is the increased fitness (*hybrid vigor*) found when more genetically unrelated individuals are mated. Some evidence for both inbreeding depression and hybrid vigor effects on intelligence have been found in studies of offspring from first cousin versus those from cross-ethnic group marriages.

Assortative mating (which is ubiquitous for human behavioral traits) is where mates are similar in their phenotypes, whether due to mate choice or environmental factors. There are three different ways in which assortative mating may occur:

In *genetic similarity*, mates select each other or are selected for each other on the basis on having similar genes, and the effects of this on offspring genotypic frequencies are similar to inbreeding. This phenomenon has been demonstrated in some animal species, but is controversial in humans.

In *phenotypic assortment*, mates select each other on the basis of similarities in observable characteristics. Phenotypic assortment can only produce greater genetic similarity between the parents if there is a significant relationship between the genotype and the phenotype, that is, if the characteristic is heritable. In fact, many human behaviors, such as intelligence, personality, attitudes, some psychopathology, etc., have been shown

to produce moderate to high spouse correlations indicative of phenotypic assortment.

In *social homogamy*, mates are similar in their phenotypes simply because the environments in which they meet and mate only have individuals possessing certain characteristics. In a highly stratified society, social class differences can cause human mates to be highly similar in several behaviors relative to mates from other classes, even when there is no active phenotypic assortment. Social homogamy can only produce greater parental genetic similarity if the phenotypes of interest are heritable and there's a significant gene–environment correlation (discussed below).

Phenotypes may also be found to be similar in mates due to mates influencing each other after getting together, a phenomenon sometimes called *contagion*.

One important offshoot of population genetics is *sociobiology*, which seeks to determine the evolutionary significance (i.e., fitness value) of behavioral systems. For example, sociobiologists are interested in the environmental conditions, physiological characteristics of the organism, and available genetically transmissible behaviors that cause one animal species to be characterized by altruistic behaviors, while other otherwise similar species are not altruistic. While behavioral geneticists generally attempt to determine the relative contribution of genetic factors on variations in behavior within a species, sociobiologists tend to look at the influence of such factors on variations in behavior across species. In turn, sociobiological ideas spurred the development of *evolutionary psychology*, which seeks to relate variations in contemporary human behavior to a history of natural selection.

Quantitative Genetics

Quantitative genetics assesses the relative contribution of genetic versus environmental factors (nature vs. nurture) in determining individual variations in traits within a species or population. If only the phenotypes are measured, and the genetic bases for the familial resemblances discussed below only assumed, quantitative genetics must rely heavily on statistical techniques to arrive at its conclusions. It should also be noted that, as with population genetics, quantitative genetic findings are descriptive of relative genetic and environmental influences averaged across a particular population operating in a particular environmental context and subject to all of the forces discussed above that change allelic and genotypic frequencies.

The starting point for quantitative genetics is variability. As discussed at the beginning of this article, stable individual differences in behavior or any other trait must be the result of genetic and/or environmental processes that are both unique for each individual and consistent in their effects across time. Heritability is defined as that proportion of the variability of a phenotype that can be accounted for by genetic factors or $h^2 = V_G/V_P$, where V_G and V_P are the genetic and phenotypic variabilities, respectively. Traits without any variability, such as the ability to use language in humans, may be entirely under genetic control, but the lack of variability for the trait precludes any statistical tests to determine the relative influence of genes and environment.

The counterpart to the assumptions about variability is that, if relatives resemble each other (i.e., do not vary) for some trait, it must be because they share the same genetic and/or environmental determinants of the variability of the trait. By comparing the relative degrees of resemblance (correlations) for the phenotype of interest across relationship types that theoretically differ in their underlying shared genetic and environmental determinants, the quantitative geneticist can infer the extent to which genetic versus environmental variability accounted for the variability of the phenotype.

For the commonly used study of twins reared together, identical (monozygotic or MZ) twins are known to share all of their genetic variability (they literally have the same genes), as well as sharing the same family environment. Fraternal (dizygotic or DZ) twins are like nontwin siblings in only sharing half of their additive (additive vs. nonadditive genetic effects are discussed below) genetic variance, but they are like MZ twins in sharing the same family environment. Hence, if MZ twins are more alike than DZ twins, it is assumed that this is because the former share twice as much genetic variability as the latter. Thus, doubling the difference between the MZ and DZ correlations should estimate the heritability. For example, adult MZ twins reared together typically correlate around 0.75 on tests of intelligence, while DZ twins reared together correlate around 0.50. Thus the heritability would be $h^2 = 2(r_{MZ} - r_{DZ}) = 2(0.75 - 0.50) = 0.50$, or 50% of the variability in intelligence is accounted for by genetic factors. Fifty percent heritability means that part of the MZ resemblance of 0.75 is still unaccounted for. This part, 0.25 or 25%, is presumably due to the effects of shared family environment.

Genetic influences can be classified as additive or nonadditive. Additive effects are analogous to the idea of 'gene dosage,' in that for polygenically determined traits familial resemblances are predicted from the extent of the linear accumulation of shared genes. For example, each parent shares on average 50% of the additive genetic variability for a phenotype with his/her offspring by transmitting half of the offspring's genome. Siblings share with each other on average 50% of the additive genetic variability, because for each of the two parents the probability is 25% that the same genes were transmitted to both siblings (50% to one sibling \times 50% to the other). Additive genetic variability is important in that it determines the extent to which a trait can be changed in a population through natural or artificial selection.

The two types of nonadditive genetic effects, *dominance* and *epistasis*, can be thought of as being analogous to statistical interactions. The dominance effects described above for single genes are interallele interactions, where the effect of one allele cannot be predicted without knowing the effect of the other allele. Thus, parents and offspring do not share any dominance genetic variability, since dominance effects require particular combinations of alleles from both parents. Siblings, on the other hand, do share 25% of dominance genetic variability, since that is the probability of both siblings receiving exactly the same combination of alleles (at least for a two-allele gene) from both parents.

Epistasis is an intergene interaction, where the effect of one gene cannot be predicted without knowing the effect of some other gene or genes. Only identical twins share epistatic genetic variability, since they inherit not only the same genes, but also the exact same combination and ordering of the genes.

Environmental effects can be classified as shared (common), special twin, and unshared (specific). Shared environmental variability represents the assumption that individuals growing up in the same family may resemble each other, because they are influenced by the same environmental determinants of the phenotype. Adoptive siblings and adoptive parents and their offspring provide strong tests of shared environmental effects, since presumably this is the only factor that would create any familial resemblances. Special twin environmental variability is a special form of shared environmental effects that assumes that twins may share more similar environmental influences, perhaps due to being of the same age, than nontwin siblings.

Unshared environmental effects make family members different from each other. This may be due to idiosyncratic events in a person's life and differential treatment of siblings by parents, as well as measurement unreliability. Differences between identical twins reared together must be due to unshared environmental variability, since that is the only factor MZs don't have in common.

Genetic effects may also be correlated with environmental effects. *Gene-environment correlations* can be *passive*, where the child is born into a family environment in which environmental conditions created by the parents are consistent with the parents' and the offspring's genotype. They can be *evocative*, where the environment changes in response to the offspring's genotype, or *active*, where the offspring's genotype causes him/her to change the environment to make it more consistent with his/her genotype. Positive gene-environment correlations can presumably magnify genetic effects, while negative gene-environment correlations can diminish them. Gene-environment correlations also create the possibility that measures of the family environment used by psychologists, such as parents' socioeconomic status, may in fact be confounded by genetic factors.

Finally, there is the possibility of *gene-environment interactions*, where genetic effects cannot be predicted unless the environmental conditions are known. For example, genes determining high intelligence appear to be better expressed if a child is raised in an enriched environment.

Table 1 presents the theoretical extents to which the factors presented above can cause relatives to resemble each other across various relationship types. Quantitative genetic studies typically compare phenotypic resemblances across two and occasionally more relationship types, and some of the most commonly used designs will be described below. For several of these factors, the differences across relationship types are too small to reliably detect their effects. For instance, it can be seen that dominance and epistatic genetic effects are basically indistinguishable, and gene-environment correlations and interactions are barely distinguishable from pure genetic effects.

Before describing quantitative genetic designs used to estimate heritabilities for human behavior, animal behavioral genetic studies should be mentioned. To the extent that, due to evolutionary reasons, other animal species, such as *Drosophila* (fruit flies), nematodes, mice, and rats, share with humans the same genes and resultant physiological structures and processes that determine behavior, animal genetic studies have a number of advantages in providing information about the genetic determinants of human behavior. Unlike human

Table 1 Components of shared variance for different familial relationships

	<i>Genetic</i>			<i>Environmental</i>			<i>Gene–environment</i>	
	Additive	Dominance	Epistatic	Shared	Twin	Specific	Correlation	Interaction
Identical (MZ) twins	1.0	1.0	1.0	1.0	1.0	0	1.0	1.0
Fraternal (DZ) twins	0.5	0.25	0	1.0	1.0	0	< 0.5?	< 0.5?
Nontwin siblings	0.5	0.25	0	1.0	0	0	< 0.5?	< 0.5?
Parents/offspring	0.5	0	0	1.0	0	0	< 0.5?	< 0.5?
Half-siblings	0.25	0	0	1.0	0	0	< 0.25?	< 0.25?
Uncles-aunts/nephew-nieces	0.25	0	0	0?	0	0	< 0.25?	< 0.25?
First cousins	0.125	0	0	0?	0	0	< 0.125?	< 0.125?
Adoptees	0	0	0	1.0	0	0	0	0

adoption studies, in research with animals prenatal environments can be controlled by transplanting fetuses across animals with different genotypes. Rearing environments can be controlled to eliminate the effects of such environmental differences or manipulated to test for gene–environment interactions. Inbred strains of genetically identical animals can be used to control for genetic variability. Heritabilities can be estimated by assessing the phenotypic response to selective breeding for extremes on the trait.

Family studies with humans involve obtaining parent–offspring and/or sibling correlations. As can be seen in [Table 1](#), such studies cannot disentangle the effects of genetic influences from shared environmental influences, although they can provide an ‘upper limit’ for heritability. The extension of a family design to the examination of large pedigrees can provide evidence for the Mendelian transmission of a trait under the control of a single gene.

Comparisons of reared-together identical versus fraternal twin resemblances can provide an estimate of heritability, but cannot easily disentangle additive versus nonadditive genetic effects. As can be seen in [Table 1](#), MZs may resemble each other more than DZs also due to greater shared gene–environment correlations and interactions. In addition, these comparisons assume that greater MZ than DZ resemblances for a trait are not the result of MZs being treated more alike than DZs causing more phenotypic similarity in MZs. Studies have validated this ‘equal environments’ assumption for intelligence and personality, but it remains untested for many other phenotypes.

Adoption studies involve some combination of comparing resemblances of biological parents with their adopted-away offspring versus the resemblances of the adoptive parents with the offspring or comparing adoptive versus nonadoptive sibling resemblances. Such designs have the advantage of theoretically separating additive genetic and shared environmental influences, although pre- and neonatal environmental effects cannot be controlled for. Attempts by adoption agencies to match adoptive parents with the biological parents (*selective placement*) could confound the analyzes, but this effect has been found to be negligible in studies of intelligence and personality. The typically narrower range of rearing environments for samples of adoptive parents compared to biological parents may also attenuate shared environment effects.

In order to illustrate two other important aspects of quantitative genetic analysis, [Figure 2](#) presents a path model for the genetic transmission of two different phenotypes (subscripts x and y) from fathers (subscript F) and mothers (subscript M) to

their biological offspring (subscript O). In the model, each phenotype P is determined by a genetic factor G and an environmental factor E. The Gs of the parents are linked to the Gs of the offspring by 1/2, reflecting the 50% of shared additive genetic variability of parents and offspring, which in this case is confounded by shared environment.

The first additional aspect of note is the arrows connecting the Ps at the top of the figure. These represent phenotypic assortative mating between fathers and mothers and, as can be seen, these arrows allow for greater similarity of the genetic variability transmitted by both parents to the offspring. For instance, mother’s transmission of G_{Mx} to G_{Ox} is augmented by an additional path from father’s G_{Fx} through the assortative mating path to G_{Mx} . This must be accounted for in estimating the heritability h^2 .

The other aspect of note is the r_G arrows connecting the G_x s and G_y s. These represent the *genetic correlations* discussed above in terms of linkage and pleiotropy. As can be seen in [Figure 1](#), these genetic correlations are shared genetic effects, and they may be indicative of functional genetic relationships. For example, a significant genetic correlation between performance on tests of verbal ability and performance on tests of spatial ability would indicate some common physiological/genetic process for these abilities.

Several important caveats should be reiterated. As was the case for population genetics, heritabilities reflect the relative contribution of genetic factors on the variability of a trait for just the particular sample of individuals studied and the particular environmental conditions in which they are living. Heritability estimates may not generalize to other populations, and they may greatly change if environmental conditions change. Similarly, high heritabilities do not preclude a trait from being influenced by the environment. Another caveat refers back to the idea that high heritability is dependent on high phenotypic variability, but high phenotypic variability is associated with traits that have not been highly selected for, that is, are not important for biological fitness, unless there is a balanced polymorphism.

Molecular Genetics

The DNA molecules in every living cell consist of two strands of phosphate and deoxyribose sugar groups held at a fixed distance from each other by pairs of nitrogenous compounds called bases. Each of the four bases is attached to one strand

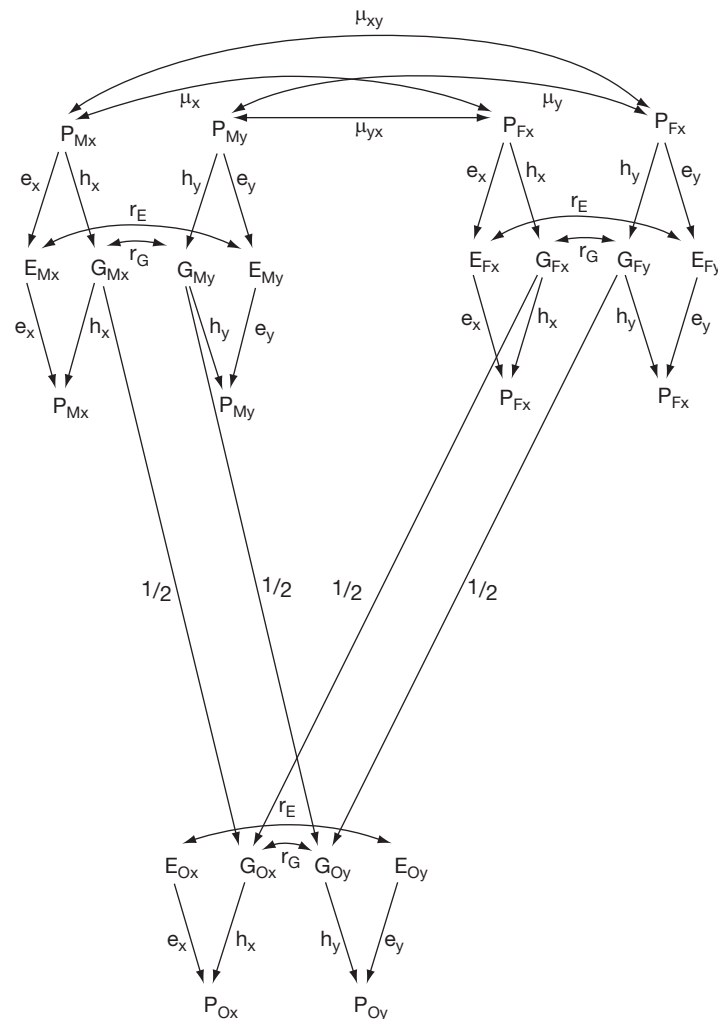


Figure 2 Path model of bivariate parent-offspring genetic transmission.

and can only pair with the corresponding base on the other strand in a particular combination: adenine with thymine and guanine with cytosine. The molecule itself is held together by its double helix structure, as discovered by Watson and Crick. When the molecule is 'unzipped,' each strand thus is a mirror-image of the other strand and can be used as a template for the construction of proteins and enzymes, when three-base ribonucleic acid (RNA) units carrying amino acids link up with the DNA strand in the order dictated by the exposed base pairs.

Through this transcription and replication mechanism, each cell programs the synthesis of the structures and chemicals needed to maintain itself, and the DNA in the cell's nucleus carries the program to create new cells. Also through this mechanism multicellular organisms transmit the program for the creation of new organisms. These strands of nuclear DNA are called chromosomes, and a gene is simply a segment (*locus*) of the chromosome that codes for some protein or enzyme. In sexually reproducing organisms, the 'blueprint' for the organism resides in one or more pairs of chromosomes (26 pairs in humans), and each parent transmits one half of each pair of chromosomes in the sex cells to the offspring. This is the biochemical basis for Mendel's hypothetical genes and alleles.

Autosomal genes are those that are on the 'normal' chromosomes not involved in determining gender. When the gene (allele) from one parent pairs up with the gene from the other parent at a locus, one gene may biochemically 'turn off' the transcription mechanism of the other gene. This is what Mendel observed as dominance.

Chromosomes that determine gender are often different from the other chromosomes in that both members of the pair may not be equivalent in size and, hence, amount of genetic material. In humans, females carry one pair of so-called X-chromosomes, while males carry an X-chromosome paired up with a much smaller Y-chromosome, which carries almost no genetic information other than to turn on the process for altering the developmental course of the embryo to become a male. Traits coded for by genes on the X-chromosome in males (which is transmitted by the mother) will thus be expressed, including traits on recessive genes that might otherwise have been inactivated by a dominant gene on the other X-chromosome that females receive from the father. The results of so-called X-linkage are seen, for example, in the higher incidence in males of the relatively common form of congenital mental retardation called the fragile-X syndrome, where a

piece of the X-chromosome is 'loose' or broken off and the genes on that piece are disrupted.

One theme that emerges from an understanding of the mechanisms of genetic transmission is the Darwinian idea of the importance of maintaining variability in a species. Sexual reproduction itself, although costly to the organism in terms of energy use, lost opportunities for food gathering, and vulnerability to predation, is clearly meant to create new genetic combinations in the offspring by combining genes from both parents. The process of splitting the chromosome pairs for the sex cells also involves recombination of genetic material, as the members of the pair cross over each other and exchange genes. Mutations that spontaneously occur as a result of DNA replication errors or environmental insults can alter the transmitted genes.

Another theme that emerged early on from molecular genetics was that some human behaviors, particularly mental retardation, were clearly the result of simple genetic mechanisms. Errors in chromosomal replication and division at times result in missing or duplicated chromosomes in the sex cells transmitted to the offspring. The offspring then end up with a missing member or piece of a member of a chromosome pair or with an extra chromosome (*trisomy*). These chromosomal defects are usually fatal for the fetus, when they occur on the larger chromosomes, and usually result in some degree of mental retardation, when they occur on the smaller chromosomes of a viable offspring. Besides the fragile-X syndrome noted above, another common form of mental retardation is Down's syndrome, which is a product of a trisomy on chromosome 21.

Another good example of a simple genetic mechanism responsible for mental retardation is phenylketonuria, which is caused by a recessive autosomal gene that fails to code for the synthesis of an active enzyme responsible for the breakdown of the amino acid phenylalanine. The build-up of phenylalanine in the infant depresses the transport of amino acids to the brain and hinders normal nervous system development. The pleiotropic effects of this genetic defect include hyperactivity, irritability, and moderate to severe mental retardation. This syndrome is also interesting in demonstrating that genetically determined traits can be modified by the environment. Infants who are detected early with the double recessive genotype can be put on a low phenylalanine diet, and this diet has been shown to be effective in virtually eliminating the deleterious effects of the gene.

A technique called linkage analysis is used to confirm the relationship of the transmission of genes or genetic markers with the transmission of specific traits in families. This involves identifying several large family pedigrees (two or more generations, with large numbers of siblings in each generation) or large numbers of sibling pairs with a high incidence of the trait of interest (e.g., some form of mental retardation). Each individual in a pedigree is assessed for the occurrence or absence of the trait, and the pattern of transmission of the trait through the pedigree can be tested against the pattern expected by different kinds of Mendelian single-gene transmission modes, for example, autosomal dominant, X-linked recessive, etc. In addition, each individual is also tested for the co-occurrence of some other trait (a genetic marker), for example, a blood group type, known to be controlled by a single gene at an

approximate locus on a particular chromosome. If the trait of interest consistently co-occurs with the linkage marker, that is, there is a genetic correlation, then the traits are not independently assorting and must be close to each other on the same now-identified chromosome. The deviation from expected Mendelian ratios for independent assortment, indicative of linkage, is expressed as a so-called LOD (logarithmic odds) score.

Linkage analysis is a special case of an *association study*, where the aim is to correlate markers of DNA variation (particularly allelic variation) with phenotypic variation across individuals. The simplest association study design is a two-group comparison (*case control*) of individuals differing in some phenotype of interest. While this design is most advantageous in terms of ease of recruiting subjects and consequent generalizability, its internal validity is compromised by numerous factors, including the problem of population stratification, where DNA differences between groups may result from irrelevant DNA differences in different genetic lineages within the groups. *Sibling pair* designs that compare siblings who are similar versus different in the phenotype of interest eliminate the problem of population stratification but cannot delineate the mode of genetic transmission. Family data, such as parents + child trios, are a special case of an association study, which allows combining linkage and allelic association information. The *full pedigree* design described above is the most sensitive for finding genetic associations, but recruiting such pedigrees is difficult, which often limits generalizability.

Today markers of DNA differences typically involve *microsatellite markers*, involving many alleles, or more commonly *single nucleotide polymorphisms (SNPs)* based on a nucleotide base difference across individuals on a short strand of DNA. SNPs are detected through *microarrays* of DNA probes that fluoresce when they find their match (*hybridize*) in a sample of DNA (typically amplified through a replication process called *polymerase chain reaction*). With the mapping of the entire human genome in 2001 and the concomitant and subsequent developments in biochemical and computing technologies for high-throughput genotyping, research is moving away from *candidate gene* studies that look at a few promising genes to *genome-wide association* studies that use tens of thousands of SNPs to detect associations across all the known genes.

By now, however, molecular genetic studies have confirmed that for nearly all behavioral traits of interest, whether for normal behavioral variation or psychopathology, multiple genes are associated with their etiology. Furthermore, the Human Genome Project determined that, instead of the 100 000–140 000 genes formerly thought to be in the human genome, there are only 25 000 genes, and research has shown that the same genes are often involved in diverse phenotypes, for example, in schizophrenia and bipolar disorder. These findings have emphasized the importance of searching for *quantitative trait loci (QTLs)*, small genetic effects for polygenically determined, continuously distributed phenotypes, but to be able to detect such small effects requires massive sample sizes. Genetic effects must clearly be looked at from a developmental perspective that not only considers what genes are involved, but also when they are turned on and off in development, how they interact with other genes, and how they interact with environmental factors over the lifespan of the individual.

Behavioral Genetics and Psychology

After a contentious start, behavioral genetics has become an accepted part of mainstream psychology. By now significant heritability has been well-established for most stable individual differences in behavioral domains of interest to psychologists, and association studies are rapidly linking these phenotypes to particular genes. However, the early hope of finding simple genetic mechanisms for these behaviors, mechanisms which could be easily targeted for physiological interventions to eliminate psychopathology or enhance normal behavioral attainments, was clearly overly optimistic. Perhaps this should not have been surprising, given the iterative, dynamic, and systemic nature of Darwinian evolution. Ironically, behavioral genetics has confirmed the importance of

the environment as a determinant of behavior, but has led to a more nuanced understanding of how that environment works in conjunction with the genes and physiology of the individual.

See also: [The Behavior-Genetics of Intelligence](#); [Evolutionary Psychology](#); [Human Intelligence](#); [Intellectual Disabilities](#).

Further Reading

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Behavioral Medicine

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Glossary

Behavioral intervention Theory-based strategies and activities aimed at promoting healthy behaviors.

Behavioral medicine An interdisciplinary field concerned with the development and integration of behavioral and biomedical science, knowledge and techniques relevant to health and illness, and application of this knowledge, and techniques relevant to prevention, diagnosis, treatment, and rehabilitation.

Ecological models Models proposing that behaviors are influenced by the interactions between multiple levels of the social environment: intrapersonal, sociocultural, policy, and physical environmental factors.

Health behavior Psychological processes, such as values, perceptions, beliefs, personality traits, and mood, as well as overt behavioral patterns, actions, and habits that relate to health.

Health promotion Any planned combination of educational, political, environmental, regulatory, or organizational mechanisms that support actions and conditions of living conducive to individuals, group, or communities.

Health psychology The study of psychological processes related to health and health care.

Primary prevention Efforts to forestall the onset of illness or injury during the prepathogenesis period.

Psychoneuroimmunology The study of interactions among the behavioral, neural, endocrine, and immune systems on maintenance of healthy functioning, and development and progression of illness.

Secondary prevention Efforts that occur after individuals are experiencing symptoms or who have been diagnosed with a disease.

Tertiary prevention Efforts aimed at individuals who are already severely affected by a disease (e.g., impairment or disability).

Introduction

Much progress was made in the twentieth century to improve health and prolong life. At the turn of the century, the leading causes of death were mostly communicable in nature, however, advances in science produced improvements in sanitation and hygiene, medication therapies, and vaccines to control – and in some cases eradicate – infectious diseases. As a result, in many industrialized and some developing nations there has been a shift in disease patterns. Currently cardiovascular diseases, which have complex etiologies and are associated with numerous lifestyle behaviors, are the leading cause of death worldwide. Modifiable behaviors such as exposure to tobacco products, consumption of high-fat diets, and physical inactivity are responsible for approximately one-third of all deaths within the United States.

Understanding how lifestyle behaviors work in concert with genetic, biological, and psychosocial factors to protect against or exacerbate disease requires a multifaceted approach. Behavioral medicine is an interdisciplinary field that studies the interplay among psychosocial, biological, and behavioral pathways on the natural progression of disease. Perhaps what sets behavioral medicine apart from other related fields is that in addition to studying the mechanisms of disease, it focuses on transferring this knowledge to behavioral interventions that can be delivered in medical and community settings. Behavioral medicine brings together theoretical knowledge and methodological innovations from the social sciences (psychology, sociology, anthropology, epidemiology, and health promotion) as well as the biomedical sciences (psychiatry, physiology, endocrinology, immunology, pharmacology, nutrition, biology, and chemistry). Moreover, the field of behavioral

medicine unites academic researchers as well as health professionals, such as physicians, nurses, dentists, and health educators.

Brief Historical Context

The concept of behavioral medicine predates the formal discipline of psychology, and can be traced to Hippocrates. Its evolution is a result of innovations in related disciplines, such as medicine, psychology, psychiatry, and psychosomatic medicine. There were several landmark events that helped shape the field as we know it today. A few of these are mentioned herein. In 1800s, Wilhelm Wundt, the founder of experimental psychology, and Emil Kraepelin began to integrate psychology within a medical setting. By 1869, all symptoms that were derived from the mind were classified as psychogenetic; thus, there was a formal delineation between symptoms of physical origin versus those of psychological origin. Claude Bernard introduced the concept of *homeostasis*, which refers to the body's ability to self-regulate its internal milieu in order to maintain healthy functioning. Bernard's work focused on the role of the nervous system in maintaining homeostasis. Building on Bernard's research, in 1932 Walter Cannon produced a detailed account of the relationship between the body's reactivity to stress and negative emotions, such as anger and fear. He later coined the term *fight or flight* response to describe the body's physiological reactions when confronted with stressful stimuli. Based on this seminal work, Hans Selye and Harold Wolf in the 1950s would go on to study the physiological responses to prolonged stress, and find that chronic stress weakened the body, making it vulnerable

to infection. This work would not only contribute to the field of behavioral medicine, but also to other related fields such as biopsychology and psychoneuroimmunology (PNI).

By the 1930s, the field of psychiatry had emerged as an important medical specialty. In 1936, the Menningers, a well-known family of psychiatrists, noted that aggressive men were more prone to cardiovascular conditions. Physicians interested in mind–body interactions were compelled by the psychoanalytical approaches of Sigmund Freud. There was an interest in understanding how conscious and unconscious emotional states contributed to the development of pathologies. The assumption was that if the psychological conflict could be resolved then its associated physiological manifestations would also diminish, and eventually disappear. In 1938, the psychiatrist Helen Flanders Dunbar was appointed as the first editor of a new journal – *Psychosomatic Medicine* – which later became the official publication of the American Psychosomatic Society, founded in 1942. Dunbar and her contemporaries contributed valuable knowledge about the interplay between external stress, psychological conflict, and organic disease; however, the field of psychosomatic medicine was initially criticized for its lack of scientific rigor and failure to provide efficacious treatments. As a result, psychosomatic medicine began to adopt more rigorous research methods, and integrated the sociobehavioral and biological sciences. Behavioral medicine was developed, in part, as a response to the initial shortcomings and narrower focus of psychosomatic medicine.

Prior to the 1970s, the reigning paradigm on disease and health was focused on biological explanations; however, increasing awareness about lifestyle behaviors and environmental factors ushered in a new paradigm on health and disease. George Engel called for a medical model that accounted for the interactive process between biological, psychological, and social factors on health and disease progression. Engel asserted that in situations of loss the ‘giving up’ response may precede the development of illness among individuals who already had a genetic predisposition for a given illness. This new model was referred to as biopsychology, an integrative approach that demonstrated the interdependence between contextual factors, coping, and biological pathways. Concurrently, Skinnerian psychology fell out of favor, and Albert Bandura’s social learning theory gained popularity. Social learning theory and other cognitive behavioral models that followed focused on the role of individual choice, and how these choices were influenced by perceptions, emotions, and social norms. Thus, the changing paradigm highlighted the role of personal responsibility, cognitions, behavior, and the social environment in which the behavior took place.

The Emergence of Behavioral Medicine

While there is no one event that marked the creation of behavioral medicine, the 1970s gave way to a culmination of events that defined and formalized the field. In 1974, Canada produced a national report on the role of lifestyle behaviors, and environmental influences on health. In the same year, the United States passed the Health Information and Health Promotion Act, which created what is now known as Office of Disease Prevention and Health Promotion. In 1979, the United States produced the first Healthy People

report, which was a summation of the literature to-date on the relationship between personal behavior and health status. Healthy People gave policymakers and the general public a user friendly guide to lifestyle behaviors that may reduce disease risk. It was also in the late 1970s that the US government recognized the field of behavioral medicine and initiated mechanisms for the funding of behavioral medical research. In 1979, the National Institutes for Health (NIH) established a study section on behavioral medicine, and soon after other government agencies followed suit. In 1984, the Centers for Disease Control and Prevention (CDC) established the Behavioral Risk Factor Surveillance System (BRFSS), which is a state-based telephone survey that collects information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury. At first only 15 states administered the BRFSS, but by 1994 the system was nationwide. In 1995, the NIH established the Office of Behavioral and Social Sciences Research (OBSSR) in recognition of the dynamic relationship between behavior and social factors on morbidity and mortality. The purpose of OBSSR is to stimulate behavioral and social sciences research throughout NIH and to integrate these areas of research into other NIH centers.

Formalization of the Field

Behavioral medicine was formally recognized as a new field in 1977 at the Yale Conference for Behavioral Medicine. In 1978, the United States National Academy of Science’s Institute for Medicine developed the definition that remains today, which centers on the integration of behavioral and biomedical sciences, and application of this knowledge to prevent, diagnosis, and treat illness. In 1979, Ovide Pomerleau and Paul Brady established one of the earliest behavioral medicine research centers at the University of Pittsburgh, and in the same year they established the *Society of Behavioral Medicine* (SBM). At first the society’s main emphasis was on medication habits associated with stress, obesity, and smoking; however, they received criticism for this narrow focus and widened their focus to include a larger breadth of health problems. Today SBM entertains a wide range of topics, including: adolescent health, aging, anxiety, cardiovascular disease, chronic pain, depression, diabetes, eating disorders, environmental health, headaches, HIV/AIDS, insomnia, minority health, quality of life, sexually transmitted diseases, social support, and substance abuse. The SBM sponsors an annual meeting to bring together researchers and clinical practitioners. The society’s official journal is the *Annals of Behavioral Medicine*, which publishes original empirical articles – including reports of randomized controlled trials, observational studies, or other basic and clinical investigations – and integrative reviews of the evidence for the application of behavioral interventions in health care. Since the establishment of SBM, an international federation of over 20 behavioral medicine societies across the globe formed the *International Society Behavioral Medicine* (ISBM). The first ISBM meeting was held in Sweden in 1990, and the first issue of their journal *International Journal of Behavioral Medicine* was published in 1994. The goals of ISBM are to stimulate research and practice as well as disseminate behavioral medicine research via the society’s journal, and international teaching seminars.

Understanding Interactive Pathways of Disease

During the latter half of the twentieth century, many lifestyle behaviors and psychosocial variables were found to be associated with the development and progression of chronic diseases. This stimulated further scientific investigation into the mechanisms or pathways of disease. Without understanding the underlying catalysts of disease it is difficult, if not impossible, to prevent, diagnose, and treat the condition. There are many pathways of disease; herein we note some of the most widely researched behavioral, psychosocial, and biological mechanisms associated with chronic disease, as well as highlight current and future research directions.

Behavioral Pathways

As disease patterns have shifted, so has the emphasis on understanding the influence of lifestyle and behaviors on health outcomes. Currently, tobacco, high-fat diets, and physical inactivity are the leading actual causes of death in the United States. Actual causes of death are defined as lifestyle and behavioral factors that contribute to mortality. While it will not be discussed in detail here, it is fair to note that lifestyle behaviors also interact with each other, which in turn can have additive or multipliable effects on risk of disease development or exacerbate already existing conditions. That is to say that many times risky behaviors cluster together, and their compounded effects can diminish health and well-being.

Tobacco exposure

The World Health Organization (WHO) reports that it is the second leading cause of death worldwide. Exposure to tobacco products is associated with the development of cardiovascular disease, cancers of the mouth, lung, and esophagus, as well as respiratory conditions including emphysema, bronchitis, and chronic obstructive lung disease. In 2006, the US Surgeon General reported that there is no risk-free level of tobacco exposure. While the effects of first- and second-hand smoke have been well documented and are associated with multiple negative health outcomes, there is a growing body of literature that suggests that third-hand smoke may also be of concern. Third-hand smoke is currently defined as residual tobacco smoke contamination that remains after the cigarette has been extinguished.

The WHO reports that while global tobacco consumption is leveling off and even decreasing in some countries; more people are smoking, and smokers are consuming more cigarettes. It is projected that by the year 2030 industrialized nations will have approximately 3 million smoking related deaths, and it is projected that developing nations will have approximately 7 million deaths. The WHO estimates that smoking prevalence will continue to increase as a function of population growth; however, while prevalence rates may go down, the actual number of smokers worldwide may increase.

Physical inactivity and diet

There has been a dramatic increase in prevalence rates of obesity and type 2 diabetes mellitus. In the United States in particular, many researchers claim that obesity has reached epidemic proportions. This is disconcerting because obesity

and diabetes are major risk factors for many chronic conditions, including cardiovascular diseases. Concurrent with the increase in obesity, there has been a rise in the prevalence of type 2 diabetes mellitus. Unlike type 1 diabetes mellitus, which is an autoimmune disease that develops in childhood, type 2 diabetes often develops in adulthood as a result of obesity and poor lifestyle behaviors. Type 2 diabetes usually begins as an insulin resistance disorder in which the cells do not use insulin properly, and the pancreas gradually loses its ability to produce insulin. If not treated, patients can suffer innumerable adverse consequences, including impaired circulation to the lower limbs (which may result in chronic unhealing wounds and/or amputation), glaucoma, and cardiovascular diseases.

Obesity and diabetes are associated with poor diet and physical inactivity. The WHO estimates that physical inactivity causes 2 million deaths per year. With regard to diet, there has been a push to increase fruit and vegetable consumption, however, many individuals partake in high-fat diets, and this coupled with physical inactivity contributes to the rising rates of obesity.

Psychosocial Pathways

Psychosocial factors have been associated with lifestyle behaviors as well as biological outcomes. In particular, the field of health psychology, which is encompassed within the field of behavioral medicine, has made significant contributions to understanding the role of core psychological processes on health, including social support, stress and coping, personality disorders, and adaption to chronic illness. The field of Health Psychology seeks to advance contributions of psychology to the understanding of health and illness and encourages the integration of biomedical information with current psychological knowledge. Psychosocial factors can be grouped into three categories: intrapersonal, interpersonal, and societal. The constructs within these groupings are interrelated and interdependent in ways that may affect health outcomes. While many psychosocial factors have been studied, we will only attend to the most widely studied constructs related to health and disease processes in this article.

Intrapersonal factors

Intrapersonal characteristics refer to self-attributes, and these can include personality traits and mood disorders. The construct of self-esteem has been related to many health-protective behaviors and favorable clinical outcomes. It refers to evaluations of self-worth and the extent to which people value or approve of themselves. Self-efficacy, a personal belief in one's ability to perform a behavior or set of behaviors in a way that will produce a desired outcome, has also been related to increased frequency of health-protective behaviors. For example, one's ability to use condoms correctly has been associated with increased intentions to use condoms as well as frequency of use. Personal control can be defined as personal expectancies related to the extent to which individuals believe an outcome is within their control. Personal control has also been associated with increased conduct of health-protective behaviors, including weight loss and exercise. However, while theoretically higher levels of self-esteem and personal control are generally considered to be favorable, the literature presents

inconclusive results, that is, these constructs are not always associated with health, and in some cases they have been associated with negative health outcomes.

Negative emotions have been widely associated with health-damaging behaviors and poor clinical outcomes. Depression is a mental disorder that presents with low mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep or appetite, low energy, and/or poor concentration. The WHO reports that depression is the leading cause of disability worldwide and that its prevalence is quickly rising. In particular, depression is comorbidity for many chronic diseases. Some researchers argue that the prevalence of comorbid depression is a result of limitations on physical and, many times, cognitive functioning associated with living with a chronic disease. However, there is a body of evidence to suggest that depression shares many biological pathways with chronic diseases such as heart failure and other cardiovascular conditions. Thus, in some cases comorbid depression is not merely an emotional reaction to the challenges of living with a chronic disease, but also the result of biological mechanism that explains mood change. Increased depression symptomatology has been associated with increased risk of smoking, physical inactivity, and nonadherence to medication as prescribed by a physician.

Hostility has also been associated with negative health outcomes. Hostility is composed of cognitive, affective, and behavioral components: (1) cognitive aspects include negative beliefs about and attitudes toward others; (2) affective components include the frequency, and intensity of unpleasant emotions ranging from irritation to rage; and (3) behavioral aspects of hostility include actions or intentions to either verbally or physically harm others. Cognitive aspects of hostility have been associated with coronary heart disease, and affective aspects associated with hypertension. Hostility is also associated with a variety of health behaviors, including smoking, alcohol consumption, and obesity.

Interpersonal factors

Interpersonal factors refer to the influence of social interactions on health and well-being. This can include formal and informal exchanges with family members, friends, neighbors, and coworkers. Perceived social support has been widely discussed in behavioral medicine literature. Social support refers to the social resources that individuals perceive are available to them. They are usually classified into one of three main categories: emotional, instrumental, and informational support. Emotional support refers to the availability of one or more persons who can listen sympathetically, as well as provide signs of caring and acceptance. Theoretically this type of support should enhance self-worth, reduce negative affect, and motivate coping behaviors. Instrumental support refers to tangible aid and practical help, such as help with childcare and provisions of transportation or money. Theoretically, this type of support should help individuals solve practical problems, which allows for increased rest and relaxation and a reduction of psychological stress. Finally, informational support refers to receiving information about resources. An example of this type of support might be helping a friend develop an effective course of action to resolve a problem or suggesting a resource (shelter, counselor, community organization, etc.). In general,

social support is thought to have positive effects on health because it 'buffers' stress. Thus, those who report higher levels of social support hypothetically should have better health outcomes. Studies indicate that higher levels of social support, particularly emotional support, is widely associated with psychological well-being, including lower levels of depression. Higher levels of social support have also been linked to lower physiological (e.g., blood pressure and/or heart rate) responses to stress.

Social conflict is another interpersonal dimension that may affect health; however, it has received much less attention than social support. Social conflict refers to negative social interactions that may occur within social relationships including arguments, criticism, and unwanted demands. Social conflict has been related to elevated cardiovascular and neuroendocrine biomarkers.

Societal factors

Societal factors refer to education, income, occupation, race, and ethnicity as well as neighborhood and community context. In the 1980s, there was a growing consciousness that lifestyle factors and disease were unevenly distributed across the US population. Moreover, some populations were experiencing greater prevalence and incidence, as well as morbidity and mortality associated with particular diseases. Many epidemiological studies, such as the Whitehall Study conducted by Michael Marmot, have demonstrated that lower socioeconomic status (SES) or position is associated with higher prevalence of health-damaging behaviors, and poorer health outcomes. Traditionally, SES has been defined by education, income, and occupation. These variables have been assessed individually, and have also been combined to form composite scores. While the pathways between SES and health are complex, and still not well-defined, increased funding opportunities and the subsequent research in this area have provided some important findings. Lower SES has been associated with higher smoking prevalence, lower consumption of fiber and fresh fruits, physical inactivity, and heavy drinking. Moreover, those living in lower SES environments may experience more chronic stress associated with financial strain, crowding, noise exposure, and unsafe neighborhoods. There are vast differences in health and quality of life across different racial and ethnic groups. In particular, there is a growing body of research showing that minority populations have less access to quality healthcare, and many groups have a higher prevalence of risk behaviors associated with chronic disease. Within the United States, there has been an interest in chronic psychological stress associated with the perception of being treated unfairly based on race or ethnicity. This construct has been linked to hypertension, self-reported poor health, breast cancer, and mood disorders, as well as obesity, smoking, infrequent condom use, and substance use. Prolonged exposure to discrimination may prepare the body to be more physically reactive to stressful situations. Increased reactivity and engagement in unhealthy behaviors may moderate the relationship between perceived discrimination and health. With regard to environmental factors geomapping software, and census data have helped researchers to look more closely at neighborhood and community characteristics, including the availability of fruit and vegetables and the number of fast food restaurants. The integration

of biodemography, a field concerned with the synergistic effects of demographic and biological determinants on disease and aging patterns, into behavioral medicine has helped to reveal how environmental context interplays with behaviors, psychological, and biological factors.

Health throughout the life course

In order to better understand these factors, many researchers have adopted a lifespan approach. From this perspective, health is viewed as a product of risk behaviors, protective factors, and environmental agents that are encountered throughout the lifespan. The lifespan approach provides a framework for interpreting how experiences during early years of life can later affect health and functioning in adulthood. Moreover, this approach allows for us to calculate cumulative, additive, and even multiplicative impacts of risk behaviors and protective factors on health outcomes. Improvements in longitudinal study design and statistical methodologies have allowed behavioral medicine research to study multiple risk and protective factors on the natural progression of disease over time.

Biological Pathways

An important aspect of behavioral medicine is that it links behavioral and psychosocial factors to physiological activity and biological outcomes. Since its inception, the field of behavioral medicine has been keenly interested in the sympathetic nervous system (SNS). This is because the SNS has far ranging relevance to almost all areas of health, including acute and chronic stress, mood, psychiatric disorders, neuroimmune regulation, cancer, and cardiovascular diseases. However, further examination of mind-body interactions indicates that there are many reciprocal relationships among the central nervous system, the autonomic and neuroendocrine system, and the immune system that affect health.

Psychoneuroimmunology

The field of PNI provides an integrative framework to study complex interactions amongst neural, endocrine, and immune systems, as well as behavioral and psychosocial factors on maintenance of healthy functioning, and development and progression of illness. PNI has helped advance behavioral medicine investigation of the pathophysiology of many chronic diseases, especially cardiovascular disorders. The PsychoNeuro-Immunology Research Society is an international organization that supports all aspects of PNI research. Its international journal, *Brain, Behavior, and Immunity*, was founded in 1987 and publishes peer-reviewed basic, experimental, and clinical studies dealing with behavioral, neural, endocrine, and immune system interactions in humans and animals.

The three main biological systems examined in PNI include: (1) the central nervous system, which recognizes and records experiences; (2) the autonomic and neuroendocrine systems, which govern bodily functions; and (3) the immune system, which organizes responses to infections and eliminates tumor cells. Normal functioning of the multiple interconnected regulatory pathways across these systems is necessary to maintain health; when pathways are compromised through loss of regulation, disease can ensue. While each of these systems has been studied separately, the innovation of PNI is that it aims to

understand how these systems work together in concert. It is important to recognize that although the function of a single hormone, cytokine, or neurotransmitter can be studied in isolation, when taken out of the context of the broader physiological milieu, the ability to fully understand its role is severely limited.

PNI and behavioral medicine: acute stress and vaccination response

Behavioral medicine researchers often use findings from the field of PNI to inform intervention design. One way that PNI research has been applied to behavioral medicine is through research on acute stress and vaccination response. We focus here on some of the acute stress and vaccination response findings because it is one of the most clinically relevant and promising applications of PNI that has been applied to behavioral medicine. Understanding SNS and endocrine effects on immune functioning has been of considerable interest. Some researchers have found that the acute stress response enhances subsequent immune responses if the stress is experienced shortly before the immune system is presented with certain types of challenges. From an evolutionary perspective, it would enhance survival, and subsequently fitness of the species to have robust immune responses during times of stress, considering that stress can also suppress immune functioning, which in turn makes the body more vulnerable to illness. Researchers tested this hypothesis in rodent models, and found that rats that were exposed to an acute stressor in close temporal proximity to receiving a vaccination had higher levels of antibody response than rats that experienced chronic stressors or those who were not exposed to any kind of stressor. Additional research on acute stress and vaccination suggests that rodents with compromised immune systems experience higher levels of antibodies compared to healthy rats; findings recently replicated in humans. Studies in young healthy adults find that concentric cycling, acute psychological stress, and weight training exercise enhance responses to influenza and meningococcal vaccination. Studies also suggest that immunocompromised individuals have greater increases in levels of antibodies produced as compared to healthy adults; thus, those with impaired immune systems may experience greater benefits from being acutely stressed before receiving a vaccination. The exact mechanism of the relationship between acute stress and the vaccination-induced immune response is still under investigation. However, it is believed that stress-induced redistribution of certain subclasses of lymphocytes is responsible for the enhanced antibody response.

Behavioral Interventions

By understanding the mechanisms of disease, scientists are better able to intervene in causal pathways to prevent or slow disease progression. Empirical evidence gained from studying interactions between behavioral, psychosocial, and biological factors has helped to shape and develop prevention and treatment efforts. Traditionally, behavioral medicine focused on biofeedback models for pain disorders, mood disorders, etc. Biofeedback is a modality of treatment that monitors physiological characteristics, and relays this information back to the patient in real time. Patients learn to control and modify

the physiological responses being measured. A current example of biofeedback is a pedometer. A pedometer indicates the number of steps taken, and patients can monitor and use this information to increase their physical activity. In particular, the field of health promotion, which is encompassed within behavioral medicine, has pioneered the design, operationalization, and integration of many behavioral interventions into medical and community settings. A behavioral intervention usually refers to one or a series of activities that focus on reducing risk behaviors (e.g., smoking), and increasing and strengthening protective factors (e.g., spending time with non-smokers). The time points at which these activities occur are based upon the knowledge of disease etiology as well as the theories of behavior change. In essence, behavioral interventions are concerned with achieving behavioral changes that maximize health and improve quality of life. Behavioral interventions have been classified using two distinct approaches. The first approach classifies interventions based on the point at which they occur along the health continuum: prepathogenesis, early stages of pathogenesis, or severe pathogenesis. The second classifies interventions based on the level of the social ecology that they target: interpersonal, community, organizational, or societal.

Primary, Secondary, and Tertiary Prevention Efforts

This intervention approach conceptualizes the progression of disease on a continuum where at one end is good health and other is death. Interventions can be conducted at any point along this continuum. Primary prevention refers to interventions that forestall the onset of illness or injury during the prepathogenesis period. These interventions are focused on reducing risk behaviors among individuals who do not have the specified disease or disorder. For example, primary prevention efforts include interventions to promote safe and frequent condom use among HIV-negative individuals. Secondary prevention refers to efforts that occur after the individual has been diagnosed with a condition. In this case, secondary prevention might include efforts to promote condom use among partners who are both HIV positive, but have different strains of the virus. Condom use would then reduce the chances of coinfection by another strain of HIV. Tertiary prevention efforts are aimed at individuals who are already severely affected by a disease (e.g., impairment or disability). In the case of HIV, tertiary prevention efforts target people with progressive AIDS or HIV infection, and caretakers and health care professionals involved with the ill person. These efforts are concerned with preventing as many of the disabling aspects of AIDS as possible.

Levels of Intervention

Historically, behavioral interventions have been designed based on individual-level theories, with little regard for the influence of contextual factors on behavior change. As our understanding of pathways of health and illness has evolved, it has become evident that individual behaviors cannot be treated without considering the context in which they occur. Thus, there has been a movement to integrate individual-level

theories into the larger social ecology. It is important to note that there are over 65 theories of behavior change (which will not be discussed here); however, we reference ecological models because behavioral interventions are often classified according to the particular stratum of the social ecology that they target.

Levels of intervention can be defined as individual, community, organizational, and societal. However, some sources further divide these levels into sublevels. The societal level is the broadest, and it usually refers to nation-wide prevention efforts. For example, the United States has produced several social media campaigns to increase awareness and change social norms about many behaviors, including smoking and seatbelt use. Intervention strategies included billboards, television advertisements, as well as policies that increase taxes on tobacco products and financial penalties for not wearing a seat belt. Interventions conducted at a societal level often have simple messages that are relevant to the majority of the target audience. Behavioral interventions conducted at the organizational and community levels are targeted at a specific subset of the population who hold membership to a particular organization or community. These interventions might target members of schools, neighborhoods, or even a particular racial or ethnic group. With regard to the latter, within the past three decades there have been increased efforts to reduce health disparities. One way that public health and behavioral medicine has responded has been to create and deliver culturally relevant behavioral interventions targeted toward members of a specific racial and ethnic community. Finally, interventions focused on the individual are characterized by high levels of interpersonal interactions between the targets of the interventions and the health providers. Psychotherapy or HIV case management programs are examples of individual-level interventions.

Challenges in Behavioral Medicine

In spite of great developments, the field of behavioral medicine has also encountered challenges. Behavior change can be slow and difficult to sustain. Many times individual-level interventions are not successful because there are social or environmental influences that impede the adoption of new behaviors. For example, there are inconsistent research findings on the effects of psychological therapies (e.g., cognitive behavioral therapy, mediation and relaxation therapies) to modify immune pathways and disease outcomes. The WHO and leading national health authorities estimate that the prevalence of depression is rapidly increasing worldwide. Depression has also been strongly associated with many chronic diseases. While there are several behavioral therapies to reduce depressive symptoms, the prevalence continues to rise. Newer theoretical models of behavioral medicine are guided by socioecological frameworks, which intervene at multiple levels of the patient's social ecology (e.g., intrapersonal, interpersonal, community, national laws). For example, environmental interventions such as increased parks, sidewalks, and bike lanes are promising, and have been associated with increased physical activity and reductions in weight.

Innovations in Behavioral Medicine

Evidence-Based Practice

Within the past decade there has been a movement to integrate individual care with the best available practices, which are determined by a systematic review of the literature. Historically, it has been challenging to compare across behavioral interventions due to differences in measurement, sampling, and theoretical fidelity. Thus, an evidence-based approach calls for standardized study methods and evaluation in order to compare findings across studies. Proponents of an evidence-based approach believe it helps clinicians and health practitioners maximize effective intervention strategies as well as reduce less effective strategies, and ultimately, improve clinical outcomes. Those against evidence-based approaches believe that researchers are uninformed and out of touch with the realities of clinical practice, and that stringent evaluation protocols adversely influence the ability of physicians to make unimpeded clinical decisions.

Nevertheless, the movement for evidence-based practices continues to grow. For example, the CDC developed a compendium of best-evidence HIV behavioral interventions. The CDC states that these interventions have been 'rigorously' evaluated and have shown significant effects in eliminating or reducing HIV risk behaviors. Some US government funding agencies and programs have started to only fund clinics and community organizations that implement interventions that have been evaluated and shown consistently, in literature, to reduce risk behaviors and increase positive health outcomes.

Measurement Technology

Behavioral medicine has always been interested in obtaining physiological and biochemical measurements. Such measurements typically include cardiovascular measures such as blood pressure, heart rate, stroke volume, and peripheral resistance, as well as biochemical measures of the autonomic nervous system, hormones, and immune system peptides that are found in blood and/or urine. More recently, the validated use of saliva for the assessment of certain neurohormones and inflammatory products has greatly expanded the ability of behavioral researchers to obtain biochemical measurements in field research. Ambulatory measures (e.g., 24 h ambulatory blood pressure monitoring and sleep actigraphy monitors) have enabled researchers to look outside their laboratories and monitor research participants for extended time periods in their home environments. Newer technological advances include the use of dried bloodspot (DBS) samples for the collection of biochemical markers. This latter relatively noninvasive methodology, which involves collecting drops of whole blood on filter paper (typically from a finger prick), supports the ability to assay a wide range of circulating biomarkers. This methodology is still being refined, and protocols and assays for many biomarkers are not as yet as reliable as what can be determined from larger blood volumes obtained from venipuncture.

Within behavioral interventions, there has been increased integration of objective measures in addition to traditional self-report instruments. For example, studies of children's

physical activity have collected self-report measures as well as research assistant's observed playground activity or counted number of toys that a child uses to be physically active (e.g., bike, trampoline, etc.). Moreover, there has been an increased use of accelerometers, a device that participants can wear that continuously records time and intensity of physical activity. With regard to delivery of behavioral interventions, there continues to be increased use of web-based interventions as well as text messaging. For example, some programs remind and encourage participants to be physically active or take their medication via text message. More recently researchers are working on behavioral interventions that promote physical activity using interactive video games, such as Nintendo's Wii.

Conclusions

As disease patterns have shifted, so has the emphasis on understanding the influence of lifestyle behaviors on health outcomes. Currently, cardiovascular conditions and cancers are the leading causes of death in many countries. Modifiable behaviors such as exposure to tobacco products, high-fat diets, and physical inactivity are responsible for high rates of morbidity and mortality associated with many chronic conditions. Chronic diseases have complex etiologies and are interdependent upon lifestyle behaviors. Understanding how these behaviors work in concert with biological and psychosocial factors to protect against, or exacerbate, disease requires a multifaceted approach. Behavioral medicine is an interdisciplinary field that studies the interplay among psychosocial, biological, and behavior pathways on the natural progression of disease. Perhaps what sets behavioral medicine apart from other related fields is that in addition to studying the mechanisms of disease, it focuses on transferring this knowledge to behavioral interventions that can be delivered in medical and community settings. Recent advancements in the field center on studying mechanisms of health disparities, developing behavioral interventions to address these gaps, refinement of measurement techniques, use of web-based and video games to deliver behavioral interventions as well as systematic and standardized evaluation to determine best practices. Overall, the field of behavioral medicine is concerned with advancements that promote improvements in clinical outcomes, and quality of life.

See also: Biofeedback Therapy; Catecholamines and Behavior; Central Nervous System; Cultural Psychology; Depression; Drugs, the Brain, and Behavior; Hormones and Behavior; Media Influence on Behavior; Operant Conditioning; Positive Psychology; Psychological Predictors of Heart Disease; Psychotherapy; Social Support.

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Relevant Websites

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- www.isbm.info – International Society of Behavioral Medicine.
- <http://pmbcii.psy.cmu.edu> – Pittsburg Mind and Body Center.
- www.pnirs.org/index.cfm – PsychoNeuroImmunology Research Society.
- www.sbm.org – Society of Behavioral Medicine.

Behavioral Pharmacology

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Glossary

Classical conditioning A phenomenon first studied by Pavlov in which a previously neutral stimulus is paired with a stimulus that elicits a reflexive response. Eventually the neutral stimulus will elicit the reflexive behavior.

Discriminative stimulus A stimulus that signals that a response will be followed by the presentation of a reinforcer.

Operant behavior Behavior that is maintained by its past consequences rather than elicited or evoked by a stimulus or antecedent condition.

Physical dependence The state in which a withdrawal symptom is observed upon the abrupt discontinuation of chronic drug administration.

Reinforcing stimulus A stimulus that increases the frequency of a response upon which its presentation is contingent.

Schedule of reinforcement This term describes the relationship between the delivery of a reinforcing stimulus and operant response or responses it follows. The most common ones are ratio schedules where the reinforcer is delivered when a number of responses have been emitted, and interval schedules where the reinforcer is delivered after a response on the basis of the passage of time.

Skinner box A chamber of a type invented by B. F. Skinner used to study operant behavior in laboratory animals. The chamber is isolated from external stimulation and contains devices activated by responses of the animal which permit delivery and recording of reinforcements.

Tolerance A lessening of the effect of a drug when the same dose is repeatedly administered, or conversely, the necessity of giving a higher dose with repeated administrations in order to achieve the same effect.

Behavioral pharmacology may be defined in one of two ways. The term was initially used by Peter Dews of Harvard Medical School to refer to the analysis of drug effects using operant analysis of behavior as developed by B. F. Skinner. More recently the term is being used in a broader sense to refer to the study of the effects of drugs on behavior using any of the experimental techniques of modern behaviorally oriented psychology. The key word here is 'behavior,' since this expansion in definition does not extend to include mentalistic concepts such as emotion, motivation, or cognition unless they are defined in terms of observable behavior. Before Dews suggested the term 'behavioral pharmacology' in the 1950s, research in this area was commonly referred to as 'psychopharmacology' – a combination of the fields of psychology and pharmacology. 'Psychopharmacology' is still used, but is generally taken to include research involving any aspect of psychology, including the mentalistic, and is used particularly to refer to the study of drugs in the treatment of mental illness or psychological disorders.

It is important to note that there may be several aims of research in behavioral pharmacology. As Travis Thompson and Charles Schuster, the authors of the first text in the field, put it, 'The behavioral pharmacologist is not only interested in observing behavioral changes produced by drugs, but analyzing the mechanisms of the drug's effect.' In addition, Peter Dews has pointed out that not only are behavioral techniques useful in helping analyze the behavioral mechanisms through which drugs alter behavior, but just as often, drugs may be used as tools to help untangle complex problems in the analysis of behavior.

History of Behavioral Pharmacology

Humans have always been curious about substances that alter the mind. Alcohol, cannabis, and opium have been used for

millennia. Aristotle commented on the effects of alcohol, and the analgesic effects of opium were noted by the very earliest Greek and Egyptian physicians. Up until the beginning of the twentieth century, however, investigations of these substances involved only verbal descriptions of the effects of the drug on the subjective experience, more often with literary rather than scientific intent. Such descriptions as DeQuincey's *Confessions of an English Opium Eater* and Gautier's *La Club des Hachichins* were fascinating descriptions of the drug experience, but were of limited value to science.

Systematic studies of the effects of these substances had to await two developments. First, there was the development of modern chemical techniques in the nineteenth century that permitted the isolation of drugs from natural substances, and the synthesis of substances that do not occur naturally.

The second important development was a precise, systematic and replicable means of describing, recording, and analyzing behavior. Three such systems were developed. In Russia, the Nobel Prize-winning physiologist Ivan P. Pavlov discovered and did extensive research on the conditioning of reflexes, what we now call *respondent behavior*. The conditioning of respondent behaviors is often referred to as *classical conditioning*. In his laboratory in St. Petersburg, caffeine and other drugs were administered to dogs and their effects on acquisition and extinction of conditioned reflexes were observed. In addition, Pavlov also successfully conditioned the effects of drugs to previously neutral stimuli. His work produced interesting results, but Pavlov did not pursue this line of research further.

In North America, Thorndike and his followers pioneered the study of learning in laboratory animals using repeated single discrete trials in an apparatus such as a maze or a runway etc. This method became known as *instrumental learning*. In the 1920s, Macht acquired a maze from Thorndike and in a series

of studies investigated the effects of a number of different drugs on rat behavior. Once again, this work did not immediately stimulate much further investigation until later when people started looking for methods to screen newly discovered, behaviorally active drugs such as chlorpromazine.

Also in North America, B. F. Skinner and his coworkers developed the technique known as the *operant analysis of behavior*. Skinner and his students developed a technology whereby the behavior of an animal in an isolated environment (Skinner box) could be manipulated by altering the schedule of reinforcement, that is, by precisely controlling the contingency between performance of a specific action such as pressing a lever, and the delivery of a reinforcer such as food. Using these techniques, the rate and pattern of responding of experimental animals, usually rats and pigeons, could be controlled with a precision not previously possible, and remained stable throughout lengthy experimental sessions and over repeated sessions. Skinner and Heron recognized early that this technique could be particularly useful in studying the effects of drugs and in 1937 they published a paper describing the effects of DL-amphetamine and caffeine on the behavior of rats. Their study was published in the psychological literature rather than in a pharmacology journal and it appears not to have been noticed by pharmacologists.

After Skinner and Heron, there were other attempts to investigate the effects of various drugs using operant techniques, but up until the mid-1950s such studies were sporadic and uncoordinated.

At this time there was a growing interest among pharmacologists in drugs that affected the central nervous system; however, most pharmacologists were unaware of the techniques developed by psychologists. Consequently, behavioral research carried out by pharmacologists mostly involved observing laboratory animals after they had been given a drug, and quantifying the total amount of activity in an unstructured situation. If the drug increased locomotor activity it was taken to indicate that the drug was a central nervous system 'stimulant'; if activity decreased, the drug was a 'depressant.'

Even though both psychologists and pharmacologists were doing behavioral research with drugs, up until the 1950s there could not be considered to be a separate discipline of behavioral pharmacology. The impetus to develop such a field came in the early 1950s and arose largely from two events. The first was the tremendous therapeutic and commercial success of chlorpromazine and other antipsychotic drugs, and the resulting need to find tests in laboratory animals that were useful in screening drugs for potential therapeutic effects on behavior of humans. The second was the compelling demonstration by Peter B. Dews of the usefulness of Skinner's operant techniques to study drug effects.

Chlorpromazine

Chlorpromazine was marketed by the French pharmaceutical company Rhône-Poulenc as an antipsychotic drug in 1952. Initially it was used to prevent surgical shock, but it was soon discovered that it was also effective in treating the specific symptoms of schizophrenia and other psychoses. The success of chlorpromazine demonstrated the tremendous economic potential of behaviorally active drugs, and an intensive

search for new drugs and new medical applications of older drugs began.

In the development of chlorpromazine, behavioral techniques had been used to confirm that chlorpromazine and other phenothiazines had antipsychotic properties. In fact, one of the techniques used to identify the important behavioral properties of the phenothiazine antipsychotics was a rope-climbing task developed by Macht in the tradition of instrumental learning. It became obvious that there was a need for better understanding of how drugs altered behavior, and that the synthesis of pharmacology and behavioral techniques would be useful, not only to pharmaceutical companies wanting to develop and test new compounds, but as a separate field of investigation that could lead to a better understanding of the interaction of drugs and behavioral processes.

Operant Analysis of Behavior

In 1955, Peter Dews began publishing a series of papers in pharmacology journals in which he reported using Skinner's operant technology to demonstrate some remarkable and surprising drug effects. Dews was trained as a physician in England and came to the United States where he worked for Burroughs Wellcome Co. and later earned a Ph.D. in physiology from the University of Minnesota. In 1952, he took a position at Harvard Medical School. Earlier in his career he had attempted to study the effects of THC on behavior (THC is one of the active ingredients in cannabis), but had given up in frustration because '... there were no promising techniques in pharmacology for studying behavioral effects.' He went on to do experiments on the effects of histamines and antihistamines on isolated smooth muscles of guinea pigs and blood pressure of cats. These techniques involved the continuous recording of physiological responses in real time on a polygraph.

When he arrived at Harvard, Dews went across the river to Cambridge "... to see B. F. Skinner who introduced me to C. B. Ferster who in turn took me into their laboratory. And there they were recording something they called operant behavior as ups and downs of a continuous line in real time. I was at home at once and was determined to follow the lead of Skinner and Heron 15 years before and to apply the techniques to behavioral pharmacology."

Of particular appeal to Dews was the fact that operant techniques recorded a steady-state behavior for an extended period of time during which the effects of a pharmacological treatment could be continuously monitored and recorded. Initially comparisons between drug and control conditions during a single session were made for each individual animal. As the techniques developed, comparisons were made between drug and control conditions between different sessions in individual animals.

It has been pointed out by M. Jackson Marr that the reason that Dews felt so comfortable with operant technology was its similarity to the methodology he was using in his physiological investigations. This methodology had been developed many years earlier by Claude Bernard, the French physiologist of the nineteenth century who is considered to be the founder of modern physiology and the field of experiential medicine. Bernard studied the function of individual organs by continuously recording their response to the exposure and then the

removal of various environmental and chemical changes such as temperature and drugs.

Dews was soon to demonstrate how useful operant methodology could be when he published a series of papers that are now considered to be the seminal works of the field that was to become Behavioral Pharmacology. Figure 1 is from Dews' 1955 paper, which shows the effect of different doses of pentobarbital on the rate of key pecking of pigeons responding for food on two different schedules of reinforcement. Pentobarbital had a distinctly different effect depending on the schedule in effect when the drug was administered. At doses of 1.0–2.0 mg, the drug increased response rates if the pigeon was responding on a fixed ratio 50 schedule (FR 50 – every 50th response was followed by an exposure to food), but decreased responding if a 15-min fixed interval was in effect (FI 15 min – the first response after 15 min had elapsed was followed by an exposure to food).

Dews showed that pentobarbital altered the behavior of the pigeon in a different manner depending on the schedule of reinforcement in effect at the time the drug was given. This showed convincingly that drug effects depend on the type of behavior that is occurring rather than simply 'depressing' or 'stimulating' all behavior. This paper and several more like it were published in pharmacology journals. Operant techniques finally captured the attention of pharmacologists and became the method of choice for studying the effects of drugs on behavior. Roy Pickens has pointed out that prior to 1955, 83% of published studies involving animal testing of drugs involved instrumental techniques and only 10% involved operant techniques, but between 1955 and 1963, 42% of all drug studies used instrumental procedures and the number studies using operant methodology had increased fivefold to 52%. The use of respondent behavior remained at 6–7%.

In addition to the work of Dews, in the mid- and late-1950s, Joseph V. Brady established the first university-related

laboratory using operant technology for the study of drug-behavior interactions at Walter Reed Army Medical Center and later at the University of Maryland. Brady stimulated the development of behavioral pharmacology by training many young researchers and urging the pharmaceutical industry and the federal government of the United States to support this new field.

In 1956, a conference was held on 'The Techniques for the Study of the Behavioral Effects on Drugs' sponsored by the New York Academy of Science. It was chaired by Dews and Skinner and the participants included D. S. Blough, Richard Herrnstein, H. F. Hunt, Neil Miller, William Morse, Murray Sidman, and many others who had made significant contributions to the field at that time. Also in 1956, Skinner made a formal call for the development of a new science of behavioral pharmacology. The new science got its formal start when the Behavioral Pharmacology Society was founded. In about 1955, a group interested in pharmacology started having informal evening dinner meetings during the annual meeting of the Eastern Psychological Association. The Society evolved a year or two later.

Behavioral Pharmacology in Europe

Early interest in the behavioral analysis of drug effects was not confined to North America. In Britain, interest in the field was stimulated by a pioneering symposium held in London sponsored by the Ciba Foundation in 1963. It was attended by many prominent European researchers of the time as well as those from North America, including Len Cook and Peter Dews. The proceedings were edited by Hannah Steinberg and published in 1964. Since that time, researchers such as D. E. Blackman, David Sanger, Susan Iverson, Trevor Robbins, and Ian Stolerman and their students have had an extensive impact on the field.

The operant tradition of behavioral analysis of drug effects also spread to the continent. Marc Richelle, after spending a year at Harvard with B. F. Skinner returned to Belgium in 1959 where he set up a behavioral pharmacology laboratory and began publishing in European journals. Other prominent Belgian behavioral pharmacologists include C. Niemegeers and F. Colpaert. Other European pioneers in the field include R. Dantzer in France, J. Slangen in Holland, and Daniel Bovet, G. L. Gatti, and Georgio Bignami in Italy. The continued expansion of behavioral pharmacology in Europe was marked by the founding of The European Behavioural Pharmacology Society in 1986. In 1989, the journal *Behavioural Pharmacology* was started and the official journal of the European Behavioural Pharmacology Society.

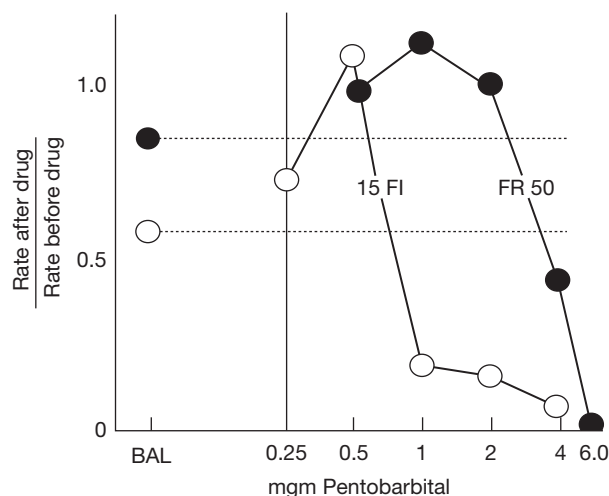


Figure 1 The log dose-effect curves for pentobarbital on the relative response rate of pigeons responding on FI 15-min (open circles) and FR 50 schedules (closed circles). The dotted lines indicate response levels after a control injection of saline. Reproduced from Dews PB (1955) Studies on behavior: 1. Differential sensitivity to pentobarbital of pecking performance in a pigeon depending on the schedule of reward. *Journal of Pharmacology and Experimental Therapeutics* 113(4): 393–401, with permission from Aspet.

Graduate Training in Behavioral Pharmacology

Until the 1990s, most researchers in behavioral pharmacology came from one of two backgrounds; either they had been trained as psychologists and acquired an understanding of pharmacology, or they had been trained as pharmacologists and taught themselves the techniques of behavioral analysis. For several decades now, a number of graduate programs have been developed which combine training in both traditions.

Environmental Influences on Drug Effects

As James Barrett has put it "... a drug is not simply a molecule with static unitary behavioral effects. The same dose of a drug can exert an array of effects on behavior depending on the immediate consequences of responding, the prior experience of the organism, and the total environmental context in which the behavior takes place."

In the years since Dews's early studies, many behavioral pharmacologists have explored the complex interaction between environmental factors and the effect of various drugs. In addition to schedule of reinforcement, these factors include rate of responding, extent of stimulus control, the nature of the reinforcer, and the behavioral and pharmacological history of the organism.

Schedule of Reinforcement

Dews's 1955 study showed that the effects of a barbiturate depend on the schedule of reinforcement. It has been demonstrated that each class of drugs has a unique pattern of effects on various schedules. Drugs such as cocaine and amphetamine, for example, have effects quite different from barbiturates. When various doses of amphetamine are administered to animals responding on an FI and FR schedule similar to those used in the Dews experiment, a dose range is encountered where FI responding is increased considerably above control levels and FR responding is nearly eliminated – exactly the opposite of the barbiturates.

Rate of Responding

The rate at which an operant response is emitted has traditionally been the primary dependent variable analyzed by operant psychologists, and early in the development of the field it was discovered that response rate had a pervasive influence on the effect of many drugs. In one of his early experiments with amphetamine, Dews noticed that the drug seemed to be interacting specifically with the rate of responding. He noticed that the drug increased low rates of responding, while at the same time it decreased responding in situations that normally engendered high rates. This phenomenon has become known as the rate dependency effect. It appears to be responsible for the observation described earlier that responding on FI (which normally engenders comparatively low rates of responding) is increased, and responding on FR (which normally engenders high rates) is slowed by amphetamine. In fact, it is likely that drugs often affect different schedules differently because different schedules produce different base rates of responding.

Rate-dependent effects are caused by many different drugs in many different species responding on a wide variety of tasks. At one point, in fact, rate-dependent effects were thought to be so universal that many researchers were more interested in exceptions to rate-dependent effects than in rate effects themselves.

Other Factors

Many other environmental influences have been shown to interact dynamically with drug effects, but the pervasiveness of rate has made it necessary to eliminate the influence of

rate before the role of these other factors can be demonstrated. For example, different reinforcing events must be presented in such a manner that they engender identical rates and patterns of behavior before it is possible to show that in some cases a drug will differentially alter behavior controlled by different reinforcers. James Barrett trained monkeys to respond on an FI 5-min schedule. The reinforcing event was either food or a brief electric shock. (Shock can serve as a reinforcer if the organism has a suitable history of responding.) Responding on both schedules was identical in terms of rate and pattern, but the effect of several drugs was different depending on whether the reinforcing event was food or shock. Pentobarbital, for example, slowed the food reinforced performance, but created a considerable increase in the shock reinforced behavior.

Drugs as Discriminative Stimuli

A large and productive branch of contemporary behavioral pharmacology deals with drugs as discriminative stimuli. Investigations into the discriminative properties of drugs originated with research in the instrumental learning tradition and the early neurophysiological theories of Donald Hebb at McGill University.

For years there had been anecdotal accounts that suggested that events experienced in a drugged state might not have the ability to control behavior when the organism was undrugged and vice versa. This phenomenon is called dissociation or state-dependent learning.

While investigating dissociation, Donald Overton, then a graduate student at McGill University's Psychology Department, did a series of experiments with rats using an instrumental learning task; shock avoidance in a T-maze. Overton was easily able to demonstrate that rats that learned to avoid the shock in the maze when drugged with pentobarbital were unable to avoid the shock later when given a placebo and vice versa.

To explore the extent of dissociation, Overton wanted to determine whether information learned on drug days (turn right) would interfere with information acquired on saline days (turn left) and vice versa. On alternate days, the rats were administered pentobarbital and one arm led directly to safety. On other days, they were given a saline placebo and the other arm was safe. Overton discovered that the rats very quickly learned to make the appropriate response depending on whether they were drugged or not. In other words, he showed that the drug administration was acting as a discriminative stimulus which controlled the direction the rat would turn at the choice point of the maze on the first trial each day. He also found that rats would learn to make the appropriate response at doses much lower than those required to cause complete dissociation.

Since Overton's early experiments, research on the discriminative stimulus properties of drugs has rapidly expanded, and the electrified T-maze has been replaced with the Skinner box. Herbert Barry III, then at Yale, is generally credited with applying operant techniques to the field. Barry trained experimental animals to press a lever for food in a two-lever Skinner box. On days when a drug is administered, presses on one lever are reinforced, and on saline days, the other lever is reinforced. Animals rapidly learn to respond to the appropriate lever depending on whether they had been injected with a drug or saline.

Using these techniques, it has been demonstrated that most centrally acting drugs have discriminative stimulus properties, although some classes of drugs such as the barbiturates appear to be more easily discriminable than other classes. Such drugs can acquire discriminative control at least as rapidly and, in some cases, more rapidly than more conventional stimuli like noises and lights. It has also been shown that as well as discriminating between a drug and saline, laboratory animals can discriminate between different doses of the same drug and between different drugs.

In addition to determining whether a drug can act as a discriminative stimulus, behavioral pharmacologists have also been able to test for generalization between drugs. In this situation, an animal is trained to discriminate between saline and a drug and then is tested with a different drug, a technique similar to generalization. Animals will usually generalize responses between drugs of the same pharmacological class, thus making it a valuable in drug screening and drug development.

The drug discrimination paradigm has been successfully used to investigate many aspects of drug action including the temporal and kinetic features of drug action, reversibility of receptor binding, stereo-specificity and other structure-activity relationships, agonist-antagonist interactions, and receptor sensitivity changes, to mention a few. It continues to be applied to new and interesting problems including investigations of genetic manipulations on responses to drugs.

In 1978, The Society for the Stimulus Properties of Drugs (SPDD) was founded by Donald Overton, Herbert Barry III, and John Roseceans. In 2008, a special edition of the journal *Psychopharmacology* was issued to mark its 30th anniversary.

Ian Stolerman and others have maintained a drug discrimination database online for many years. It contains a searchable record of all drug discrimination studies. The project is now supported by NIDA in the United States and in 2009 was combined with a similar database for drug self-administration studies.

Drugs as Reinforcing Stimuli

Research with Nonhumans

Early research was generally not able to demonstrate that laboratory animals would administer drugs to themselves in the same manner humans do. Most of these studies involved the oral administration of drugs, usually alcohol, and even though some studies showed that animals could demonstrate a preference for some drugs, they were seldom ever able to show that animals would make themselves physically dependent on a drug, that is, voluntarily consume enough drug that withdrawal symptoms would develop if the drug were discontinued. Physical dependence was believed to be the defining characteristic of addiction at the time. Also, these studies were not able to demonstrate the compulsiveness usually associated with human drug-seeking behavior. Because of these failures and other widespread beliefs about the nature of drug addiction, it was generally believed that drug addiction was restricted to humans.

In 1962, three groups of researchers announced at a meeting of The Committee on Problems of Drug Dependence in Ann Arbor, Michigan, that they had developed the now

classic technique which permits laboratory animals to administer drugs to themselves intravenously. The technique involves implanting a cannula into a vein of a laboratory animal and attaching the cannula to a motor-driven pump. The pump is connected to programming apparatus so that it can be operated by the animal when it depresses a lever. Thus, the animal can administer an intravenous injection to itself. Using this method, Travis Thompson and Charles Schuster of the University of Maryland, and Gerald Deneau, Tomoji Yanagita, and M. H. Seevers at the University of Michigan showed that monkeys would self-administer morphine, and James Weeks and James Collins demonstrated that rats would self-administer morphine.

The importance of these experiments was that they demonstrate quite clearly that the administration of a drug can be a reinforcing event in the same manner as food to a hungry animal or water to a thirsty one. They showed that there is nothing special or different about drug taking and that the general principles that have been learned about operant behavior are applicable to drug self-administration. Furthermore, they showed that drug use is not a result of a pathology or a disease and is not independent of normal psychological processes.

One of the earliest important findings using this technique was that physical dependence is not necessary for drug self-administration. Travis Thompson and Roy Pickens demonstrated that drugs such as cocaine would be self-administered even though they do not normally induce physical dependence. This made it clear that drugs are self-administered because they are positive reinforcers, not negative reinforcers, that is, they are not self-administered to delay or relieve unpleasant withdrawal symptoms.

Research with Humans

A number of very successful attempts have been made to apply operant learning techniques to the study of human drug taking. Pioneers in this field are Jack Mendelson and Nancy Mello. At The Massachusetts General Hospital and later at McLean Hospital in Belmont, Massachusetts, they studied drug self-administration of human volunteers living on a research ward. Volunteers, all with previous drug experience, could earn drugs by performing some activity such as riding an exercise bicycle or pushing a button. Using these techniques, it is possible to meet the scientific standards achieved previously with laboratory animal subjects and also satisfy ethical and safety standards required by governments and institutions.

Drugs studied in such situations include heroin, methadone, cocaine, diazepam, barbiturates, THC, nicotine, and caffeine. These studies have also made it possible to concurrently observe the effects of self-administered drugs on variables such as health, mood, and human social behavior, and provide a model to evaluate drug abuse treatment strategies.

Similarities Between Human and Nonhuman Self-Administration

It has been shown that most drugs consumed by humans are also self-administered by nonhumans. These include alcohol, nicotine, caffeine, barbiturates, opiates, anxiolytic or benzodiazepine, amphetamines, and THC. It is also clear that the

patterns of behavior generated by different schedules of drug reinforcement are similar in both humans and nonhumans to those generated when more traditional reinforcers are used, and that other phenomena such as extinction, discriminative stimulus control, chaining, second-order schedules, etc., are also observed.

Drug administration patterns over time appear to be very similar for humans and nonhumans. For example, a human volunteer drinking alcohol in a research ward in a hospital and a rhesus monkey self-administering ethanol through a cannula both show an erratic pattern of intake and abstinence with occasional self-inflicted withdrawal symptoms: a pattern very similar to that shown by alcoholics in the natural environment. Moreover, both humans and nonhumans administering opiate drugs show a smooth gradual increase in intake from day to day without severe daily fluctuations, and the cocaine pattern in both humans and animals involves cycles of intake and abstinence when the drug is freely available.

Factors that Affect Reinforcing Properties of Drugs

The drug self-administration studies have provided much useful information into the nature of drug use and abuse. For example, it provides a method for assessing which drugs are the most reinforcing and consequently, the most likely to be abused. Several methods have been used to answer this question. In one, known as the progressive ratio schedule, the schedule demand increases as the session progresses. For example, a drug may be available on an FR 25 schedule, meaning that the animal must make 25 responses for an infusion. After the first infusion, however, the schedule changes to an FR 50 and then to an FR 100 and so on. Eventually, the schedule value will reach a point where responding will not continue. This is known as the breaking point. Drugs that are highly reinforcing would be expected to have high breaking points. Experiments such as these generally show that cocaine and amphetamine have higher breaking points than other drugs. Analogous results have been found in choice experiments where the animal must make a choice between two levers, each of which delivers an infusion of a different drug or a different dose of the same drug.

Apart from assessing the inherent abuse liability of a drug, techniques such as the progressive ratio and choice have been used to assess the effect of situational and pharmacological and even genetic variables on reinforcing strength of drugs. For example, the influence of such variables as the extent of previous exposure to the same or a different drug, the relief of unpleasant symptoms such as withdrawal sickness, drug dose, task demand, stress and the extent of other motivations such as hunger have all been investigated.

Behavioral Economics

The use of operant procedures has facilitated the application of the principles of behavioral economics to drug and abuse. For example, the choice procedure has also been used to present animals with a choice between a drug and some other reinforcer such as food. Generally, it has been shown that acquisition of drug self-administration and total consumption of a drug will be reduced when other attractive reinforcers such as

sweetened water and social interaction are made simultaneously available. This observation may well explain why drug abuse appears to thrive in environments where there is unemployment, poverty, and boredom, that is, environments where there are few other sources of reinforcement to compete with drugs as reinforcers of behavior.

Experiments such as these have shown that many of the rules of microeconomics apply to drug use both by humans and nonhumans. For example, if the cost of a drug infusion increases (the animal is required to make more responses to earn the infusion), fewer and fewer infusions will be earned. This is similar to the demand function described by economists where consumption of a commodity decreases as the price increases.

In the early 1970s, people doing research on drug self-administration started the International Study Group Investigating Drugs as Reinforcers (ISGIDAR), which meets once a year in conjunction with the College on Problems of Drug Dependence (CPDD) in the United States and publishes a newsletter. ISGIDAR also maintains a database of research of self-administration studies which is now available online in conjunction with the Drug Discrimination Database.

Conditioned Drug Effects

One area of research of modern behavioral pharmacology has its origin in classical or respondent conditioning rather than operant analysis of behavior. This involves the study of the conditioning of drug effects. Many years ago, a student of Pavlov's laboratory in Leningrad gave a dog an injection of apomorphine and then sounded a tone when the drug began to have its effect of causing the dog to salivate. After a few pairings of the tone and the drug, the tone by itself caused the dog to exhibit this effect of the drug, that is, it caused the dog to salivate. In Pavlov's terminology, the drug was the UCS (unconditioned stimulus), the salivation was the UCR (unconditioned response), the tone was the CS (conditioned stimulus), and the salivation produced by the tone was the CR (conditioned response).

Since that time, there have been many demonstrations of conditioned drug effects. Shepard Siegel of McMaster University in Hamilton has shown that in many cases, the CR is in fact, opposite to the UCR. In other words, if the effect of the drug is in one direction, an increase in body temperature, for example, then the conditioned effect of the drug will be in the opposite direction, a decrease in body temperature.

Siegel and other researchers have shown that this conditioned effect in the opposite direction, called a conditioned compensatory effect, follows the principles of classical conditioning. Siegel also demonstrated that in many cases this compensatory response is responsible for the development of tolerance for drugs. If a stimulus reliably precedes the delivery of a drug, the conditioned compensatory response will occur in response to the stimulus. Because this response is physiologically opposite to the effect of the drug, the normal drug effect is diminished. This lessening of the drug effect after repeated administrations is a type of tolerance. Siegel has shown that tolerance to many effects of drugs will disappear if the stimulus condition normally present when the drug is taken is no longer present, that is, there is no stimulus to evoke the conditioned

compensatory effect. This is an example of a type of tolerance called behavioral tolerance to distinguish it from other types of tolerance that arise from metabolic and physiological mechanisms.

The reinforcing effects of a drug can also be conditioned to environmental stimuli. Sights, sounds, and even places that have reliably been associated with drug administration can acquire reinforcing properties which can also control behavior in the same manner as the drug. Animals will bar press for lights that have been paired with a reinforcing drug, and will actively seek out and return to places where they have experienced the effect of the drug in the past, an effect called place conditioning. Place conditioning techniques have been used to investigate the reinforcing effects of many drugs.

See also: [Classical Conditioning](#); [Operant Conditioning](#).

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The Behavior-Genetics of Intelligence

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Glossary

Adoption studies Comparisons of (a) biological mothers and their children with (b) adoptive parents and their foster children.

Dizygotic twins Also known as fraternal twins; they share approximately 50% of their genetic makeup.

Heritability A statistical index of genetic contributions.

Monozygotic twins Also known as identical twins; they share approximately 100% of their genetic makeup.

Nature A label for genetic, biological, nonenvironmental contributions to development and behavior.

Nurture A label for environmental, experiential, nongenetic contributions to development and behavior.

Range of reaction It indicates an interaction of nature (which determines a range of potentials) and nurture (which determines how much genetic potential is fulfilled).

The nature and nurture of intelligence has been debated for centuries. One of the more significant breakthroughs on this topic resulted from the development and refinement of methods in behavioral genetics. This ensured that objective data would be brought to bear and that theories could go beyond a simple either/or theory of 'nature *or* nurture' to the more reasonable view that biology and environment both play a role. This article briefly reviews the behavioral genetic approach to intelligence and summarizes the key findings, as well as the limitations and remaining issues. It has a historical flavor which reflects the fact that methods in behavioral genetics were developed before more sophisticated and accurate chemical analyses of genes were available. Still, there is much to learn from the behavioral genetics research on intelligence, especially when findings agree with those obtained with the other more recently developed methodologies.

The starting point must be the definition of 'intelligence.' As is implied by the claim that behavioral genetics research would allow objective data to be brought to bear on the topic, some sort of operational definition and reliable assessment of intelligence is required. Unfortunately, the assessment of cognitive abilities is itself a hotly debated topic. Paradoxically, the 'intelligence quotient,' or IQ, is both the most employed and the most infamous of the standardized measures of intelligence. The debate concerning its reliability, validity, and utility has now extended through several decades. Arthur Jensen, one of the most vocal and prolific advocates, holds that the evidence in favor of reliable IQ testing is more than convincing. Stephen Jay Gould, in one of the most informative and least political of critiques, suggested that reliable testing is not possible because the IQ assumes the existence of one general intelligence, known as 'g.' Gould insisted that there is no mathematical, psychological, or even theoretical justification for 'g.' He concluded that 'g' is a statistical artifact, and in particular, an artifact of subjective factor analyses. Many other critics of IQ testing concur that IQ is only a 'hypothetical construct' which has no inherent, objective validity.

There is little doubt that many of the tasks contained in IQ tests can be biased by experience. Some tasks seem to draw mostly on factual information, and thus individuals who

receive a good education or have intellectual resources readily at hand are likely to have an advantage. Yet psychometricians deny this is a bias. They argue that individuals who score high on an IQ test have above average information processing capabilities. These in turn allow the individual to perceive, evaluate, and remember more and more accurate information from their experiences, compared to other individuals in the same population. In other words, the psychometric view is that having experience is by itself not enough for intelligence. The person needs the intellectual ability to benefit from experience as well. As a historical aside, this view parallels what Donald Hebb said long ago about bright canines making better use of the stimuli in their environments.

In another corner there are those who feel that IQ tests are too strongly tied to the personality factors that can facilitate or inhibit intellectual performance. Examples of this perspective are numerous, but two stand out. John Loehlin, Arthur Lindsey, and J. Spuhler pointed to an inflation of ability resulting from an individual's tendency to actively seek cognitive challenges. The second example is that of Sandra Scarr, who gave a detailed description of how personality factors determine whether an individual (a) maximizes intellectual opportunities or (b) passively accepts whatever is available. To what degree the relevant personality factors are genetically or environmentally based is, once again, an ongoing debate, but it does appear that IQ performance may be a function of both personality and cognitive abilities.

Those in favor of IQ hold that, even if not a perfect measure of cognitive capacity, IQ is still useful. Phillip Vernon wrote, "Psychometry is quite entitled to use its own brand of operationalism, regardless of philosophical theories of scientific method, provided it works." Certainly IQ tests offer a standardized assessment. As a matter of fact, they have demonstrated a high level of utility specifically in the area of behavioral genetics.

Behavioral Genetics Methods

The idea of calculating an accurate 'heritability' of intelligence was advanced over 60 years ago. At that point the size of the

human genome was being estimated and enormous variation was acknowledged. One early estimate was that there are 2^{23} alternative genomes based on the human chromosomal supply. Variety is insured by mutation, recombination, and meiosis of the genes; and since these can occur at different loci at different times with different frequencies, a probabilistic index of heritability was the goal. Two methods were used to that end.

In the first, identical or monozygotic (MZ) twins are examined. MZ twins have a virtually identical genetic makeup, and if they happen to be separated shortly after birth, any eventual differences between them can be attributed to environmental discrepancies. The second behavioral genetic method compares an adopted child and her or his biological parents and the same child with his or her foster parents. Presumably, any correlations between the former can be attributed to genetic similarity – an implication of the Mendelian principle that the closer the biological kinship, the higher the genetic similarity – while any correlations between the latter can be attributed to the environment. Typically, a regression coefficient is used in both the within-family and the between-family studies.

In one study, using these methods Alice Mary Leahy compared 194 adopted children to a large control group. The two groups were matched in terms of age, sex, education, and parental SES. The experimental group had been placed in their foster homes before they were 6 months of age, and they had lived there for at least 5 years. The controls were, of course, raised by their own parents. Leahy found an average correlation of 0.56 between the control's IQ scores and their parents' educational level, parents' vocabulary, parents' IQ, and a general index about the home atmosphere. The correlation for the adopted children and their adoptive parents was 0.20. As a check for *selective placement*, Leahy correlated the biological mothers' education with the foster parents' occupation and education. The results were high enough to show that the placement agencies did in fact select the foster parents so as to match the child's background. Consequently, the differences between the two groups are on the conservative side, and the correlational discrepancies between them are even more impressive. Leahy concluded that the 'measurable environment' could only alter the IQ from three to five points in either direction. She reported that the genetic component in IQ is far more influential than the environmental impact.

Longitudinal research with adoptive children and their biological and foster parents often allows collection of more data about the samples. In one such investigation 180 children born to unwed mothers were tested five times between 1949 and 1966. Notably, they were not typical, even for adopted children. For example, their biological mothers had subnormal IQ scores (an average between 83 and 86). Also, selective placement was again evidenced by moderate correlations between the biological mothers' average educational level and the foster parents' ('midparent') average educational level. For this research the children were first tested with the Kuhlmann test and then with the Stanford-Binet. The correlation coefficient calculated between the children and their biological mothers increased at each testing, peaking at 0.44. Correlations with nonbiological mothers never exceeded 0.10. One caveat: the average IQ of the children at 13.5 years was 107–120 points above the mothers' average. With such low scores for the

mothers, 'regressions effects' are likely, with the children tending to score closer to the mean.

Sandra Scarr and Robert Weinberg reported similar findings with adoptive families, but they too had atypical samples. In particular, SES and IQ averages were one standard deviation above the norm. This implies a restricted range, though Scarr and Weinberg argued that the patterns of variables were 'sufficiently similar' to more representative samples. They therefore endorsed the generalization of the empirical findings. More specifically, they felt that the 'relative magnitude' of the coefficients was accurate and valid. Using 150 adopted children and 122 matched controls they compared Wechsler adult intelligence scale (WAIS) scores. The children were adopted quite young, averaging only 2.6 months at the time of placement. Analyses indicated that the parental educational level, family income, and parental IQ were each highly correlated in the biological parent-child analyses. The adoptive parent-child correlations were very low. Family size was unrelated to the child's IQ in the adoptive families, and negatively related in the biological families. Birth rank was significantly related to IQ in both families, with later born children having a marked disadvantage. The correlation between the adoptive fathers' IQ and the child's IQ averaged 0.15, and the correlation between the mothers' and the child's IQ's averaged 0.04. The correlations between the biological mothers' educational level and the adoptive mothers' IQ averaged 0.20 and 0.10 with the adoptive fathers' IQ. Here again there is evidence for selective placement.

Similar patterns and heritabilities are apparent in twin studies. Alan Gottesman, for instance, described one study in which MZ twins, reared apart, were found to have an average Stanford-Binet difference of 24 points. A second study used another measure of mental age, but still found an average difference of 14 points on verbal tasks and an average difference of 10 points on nonverbal tasks.

Another analytic method uses additive variances. Here within-groups variability on IQ tests is delineated. In particular, the variance attributed to genetic differences is added to the variance due to environmental differences, and this is added to the variance due to errors in measurement. When this method was used variability attributable to genetic factors was very close to 60%! A similar analytic method involves subtracting MZ correlations from dizygotic (DZ) twin correlations, with the difference attributed to the environment. As expected, given the heritabilities already cited, the results show genetic influence to be greater than the environmental ones.

L. Erlenmeyer-Kimling and Lissy Jarvik summarized all of the research available when the behavioral genetic approach was the most sophisticated methodology available. Their summary, which was according to Robert Plomin and Stephen Petrill one of the most influential publications on the behavioral genetics of intelligence, clearly supported the genetic view. In particular:

In 14 studies with MZ twins reared together, when the genetic expectation was 1.00 (MZ twins sharing virtually all genes), the median correlation was 0.87. In the four studies when MZ twins were reared apart, that coefficient dropped only to 0.75.

In 11 studies with DZ like-sex twins reared together, the genetic expectation being 0.50, the coefficient was 0.56. When unlike DZ twins were reared together it was 0.49.

In 36 studies with siblings (not twins) reared together, the genetic expectation again being 0.50, the median coefficient was 0.55. In three studies with siblings (nontwins) reared apart, this dropped to 0.47.

In 12 studies with biological parents and their children, the genetic expectation again being 0.50, the median coefficient was in fact 0.50. This is in direct contrast to the three studies with foster parents and their children, the genetic expectation being 0.00, the median correlation being 0.20. In five studies with unrelated children raised together, and thus a 0.00 genetic expectation, the median correlation was 0.24. Finally, in four studies with unrelated children reared apart, the median correlation was -0.01 .

The median correlations were remarkably close to the expected values in almost every case. Note especially the MZ twins reared apart in contrast to other siblings reared apart and unrelated children reared apart. These medians are even more impressive considering that the data came from a diverse set of investigations. Certainly experimenter effects can be disregarded. Importantly, much more recently Plomin and Petrill reviewed the available research and again concluded that the highest correlations of IQ are for MZ twins reared together, and then MZ twins reared apart. All other twins, siblings, and intrafamily correlations are lower, even when individuals were reared together or shared the home.

Cross-cultural studies tended to result in the same correlational patterns. That is, the environmental impact was detectable, but small in comparison to the genetic influence. Findings such as these led to conclusions about a high heritability of IQ. Yet methodological weaknesses in all behavioral genetic studies – not just the cross-cultural investigations – bring this into question. Clearly the measurement concerns outlined earlier, especially those focused on the IQ, are relevant to any correlation calculated from parent–child or intratwin IQs.

The behavioral genetic approach itself has notable limitations. Adoption studies, for example, tend to be restricted. When there is a restricted range of scores, there is not as much variability and correlations are attenuated. Additionally, as noted above, restricted samples severely limit generalizations. If the sample is restricted, generalizations about heritability to other samples or a population are not warranted. Certainly the children in adoption studies were not typical: by definition adopted children will have unusual emotional and physical personal histories, histories that are different from those of nonadopted children. Their backgrounds are simply atypical, even if entirely healthy. Also, the placement of the children is far from random. Adoption agencies use screening techniques, checking the prospective foster homes for income, family size, and the like. All of these are pertinent and very possibly could exaggerate intrafamilial correlations. A last concern along these lines is that the biological parents are often unknown, or their mental ages only estimated from educational level or from equally noncomparable indices.

A major concern in the twin studies is that the home atmosphere always holds some similarities. There are constants

across all homes and all families. Such similarity will probably contribute to correlations. Finally, assortative mating is common. Surely no one chooses a mate at random! The parents probably share some of the same child-rearing ideals and attitudes, and thus intrafamilial correlations would be increased relative to interfamilial correlations.

Conclusions

Behavioral genetics research often leads to high heritability estimates for IQ, but the validity of that conclusion is often questioned because of methodological concerns, including the meaning of the term 'IQ'. Additionally, the heritability reported in behavioral genetics research probably has low generalizability. Urie Bronfenbrenner was correct when he described heritability as contextual: it is applicable to one trait, for one population, at one point in time. And very importantly, high heritability does not exclude environmental effects. On the contrary, both genetic givens and environmental inputs are required for human growth of any kind, but either or both may cause differences between individuals. Intelligence grows, but it grows only particular potentials.

Plomin and Petrill offered a careful and precise view in their 1997 overview of behavioral genetics:

The word genetics is used very narrowly to refer to DNA differences among individuals that are inherited from generation to generation. It does not refer to the vast majority of DNA that is the same for all of us or to the many DNA events that are not inherited, such as mutations in DNA in cells other than the sex cells. Furthermore, genetic research describes what the genetic and environmental origins of differences among individuals in a particular population at a particular time are. It does not predict what could be, nor does it prescribe what should be. Evidence for genetic influence (what is) does not imply that differences among individuals are immutable or irremediable—novel environmental factors could make a difference (what could be).

The most important term in behavior-genetics is the *range of reaction*. Everyone has a different responsiveness to similar conditions, and that is hardwired. Technically put, different genotypes may have the same phenotype, and different phenotypes may be expressed by the same genotype. Some researchers have accepted the heritability statistic as an index of genetic influence, but with questionable methodologies and the reliance on IQ as a dependent measure, any generalizations must be strongly qualified. Still, it is possible to conclude that every individual has a range of alternative developmental outcomes. IQ and the entire phenotype are products of a bipartite system (environment and genes) and reactions within ranges. Behavioral genetic research suggested that the genetic contribution to intelligence was larger than the environmental, and as Plomin and Petrill pointed out in 1997, that conclusion was consistent with research on the heritability of psychopathology. It is fortunate that large strides are being made with more accurate molecular genetic methodologies.

See also: Behavior Genetics of Personality; Behavioral Genetics; Human Intelligence; Molecular Genetics and Human Behavior.

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Big Five Model and Personality Disorders

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Glossary

Big Five Dimensional model of personality structure, consisting of five broad domains of neuroticism, extraversion, openness, agreeableness, and conscientiousness. Each broad domain is differentiated into six more specific facets.

Categorical Describing personality disorders in terms of distinct types, each having distinct etiology, pathology, and treatment implications. Differential diagnosis is focused on identifying which specific disorder best describes the person's condition.

Dimensional Describing personality disorder multifactorially, which each person characterized by a

relatively unique profile or constellation of maladaptive and adaptive personality traits, with each component having specific implications for etiology, pathology, and treatment.

DSM-IV-TR The official manual of the American Psychiatric Association for the diagnosis of mental disorders (i.e., *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn., text revision).

Personality One's characteristic manner of thinking, feeling, behaving, and relating to others.

Personality disorder The presence of personality traits that result in clinically significant impairment to social or occupational functioning or personal distress.

An alternative to DSM-IV-TR is to consider personality disorders to be maladaptive variants of general personality structure. The predominant model for general personality structure within psychology is the Big Five, otherwise known as the five-factor model (FFM). The FFM consists of five broad domains: neuroticism (or emotional instability), extraversion versus introversion, openness versus closedness, agreeableness versus antagonism, and conscientiousness. The FFM was derived originally through empirical studies of the trait terms within the English language. Language can be understood as a sedimentary deposit of the observations of persons over the thousands of years of the language's development and transformation. The most important domains of personality functioning are those with the most number of trait terms to describe and differentiate the various manifestations and nuances of a respective domain, and the structure of personality is suggested by the empirical relationships among these trait terms. The initial lexical studies of the English language converged well onto the five-factor structure. Subsequent lexical studies have been conducted on many additional languages (e.g., German, Dutch, Czech, Polish, Russian, Italian, Spanish, Hebrew, Hungarian, Turkish, Korean, and Filipino) and these have confirmed well the existence of the five broad domains. The five domains have been differentiated into 30 more specific facets on the basis of their development of and research with the NEO Personality Inventory-Revised (NEO PI-R), by far the most commonly used and heavily researched measure of the FFM. Table 1 provides a brief characterization of both the normal and abnormal variants of each of the 60 poles of the 30 facets of the FFM in terms of the five-factor form (FFF), a more elaborated version of the FFM rating form (FFMRF).

Advantages of Integrating DSM-IV-TR with the Big Five

Integrating the diagnosis of personality disorders with the Big Five has a number of distinct advantages, including

the resolution of the many failures of the existing diagnostic system, such as the heterogeneity among persons sharing the same categorical diagnosis, the excessive diagnostic comorbidity, inadequate coverage, the inadequate scientific base, and the arbitrary and unstable boundary with normal psychological functioning. Each of these will be discussed in turn.

Heterogeneity of Persons Sharing the Same Diagnosis

The DSM-IV-TR personality disorders describe prototypic cases, yet very few actual cases are prototypic. As a result, a personality disorder diagnosis provides a misleading description of any particular patient's unique personality profile. Persons can in fact be provided the same diagnosis of antisocial personality disorder yet not share one feature in common, as any three of seven diagnostic criteria can be used to make the diagnosis.

Heterogeneity among persons is addressed by the Big Five through the provision of multifactorial descriptions of an individual's psychopathology (personality disorder) profile that matches well his or her actual constellation of maladaptive personality traits. In addition, the Big Five or FFM allows for the inclusion of normal and adaptive personality traits within the profile description, thereby providing a more complete and comprehensive description. Personality disorder diagnoses can be quite stigmatizing, suggesting that the person's characteristic manner of thinking, feeling, and relating to others (i.e., the person's sense of self) is itself a mental disorder. The FFM's inclusion of normal and adaptive personality traits provides a means to recognize and appreciate that a person is more than just the personality disorder and that there are aspects to the self that can be adaptive, even commendable, despite the presence of the personality disorder. Some of these strengths may also be quite relevant to treatment, such as openness to experience indicating an interest in exploratory psychotherapy, agreeableness indicating an engagement in group therapy, and conscientiousness indicating a willingness and ability to adhere to the demands and rigors of dialectical behavior therapy.

Table 1 Adaptive and maladaptive variants of the five-factor model as presented in five-factor form

	<i>Maladaptively high</i>	<i>Normal high</i>	<i>Normal low</i>	<i>Maladaptively low</i>
<i>Neuroticism</i>				
Anxiousness	Fearful, anxious	Vigilant, worrisome, wary	Relaxed, calm	Fearless
Angry hostility	Rageful	Brooding, resentful, defiant	Even-tempered	Won't even protest exploitation
Depressiveness	Depressed, suicidal	Pessimistic, discouraged	Not easily discouraged	Unrealistic, overly optimistic
Self-consciousness	Uncertain of self or identity	Self-conscious, embarrassed	Self-assured, charming	Glib, shameless
Impulsivity	Unable to resist impulses	Self-indulgent	Restrained	Overly restrained
Vulnerability	Helpless, emotionally unstable	Vulnerable	Resilient	Feels invincible, oblivious
<i>Extraversion</i>				
Warmth	Intense attachments	Affectionate, warm	Formal, reserved	Cold, distant
Gregariousness	Attention-seeking	Sociable, outgoing, personable	Independent	Isolated
Assertiveness	Dominant, pushy	Assertive, forceful	Passive	Resigned, uninfluential
Activity	Frantic	Energetic	Slow-paced	Lethargic, sedentary
Excitement-seeking	Reckless, foolhardy	Adventurous	Cautious	Dull, listless
Positive emotions	Melodramatic, manic	High-spirited, cheerful, joyful	Placid, sober, serious	Grim, anhedonic
<i>Openness</i>				
Fantasy	Unrealistic, lives in fantasy	Imaginative	Practical, realistic	Concrete
Esthetics	Bizarre interests	Esthetic interests	Minimal esthetic interests	Disinterested
Feelings	Intense, in turmoil	Self-aware, expressive	Constricted, blunted	Alexithymic
Actions	Eccentric	Unconventional	Predictable	Mechanized, stuck in routine
Ideas	Peculiar, weird	Creative, curious	Pragmatic	Closed-minded
Values	Radical	Open, flexible	Traditional	Dogmatic, moralistically intolerant
<i>Agreeableness</i>				
Trust	Gullible	Trusting	Cautious, skeptical	Cynical, suspicious
Straightforwardness	Guileless	Honest, forthright	Savvy, cunning, shrewd	Deceptive, dishonest, manipulative
Altruism	Self-sacrificial, selfless	Giving, generous	Frugal, withholding	Greedy, exploitative
Compliance	Yielding, docile, meek	Cooperative, obedient, deferential	Critical, contrary	Combative, aggressive
Modesty	Self-effacing, self-denigrating	Humble, modest, unassuming	Confident, self-assured	Boastful, pretentious, arrogant
Tender-Mindedness	Overly soft-hearted	Empathic, sympathetic, gentle	Strong, tough	Callous, merciless, ruthless
<i>Conscientiousness</i>				
Competence	Perfectionistic	Efficient, resourceful	Casual	Disinclined, lax
Order	Preoccupied w/organization	Organized, methodical	Disorganized	Careless, sloppy, haphazard
Dutifulness	Rigidly principled	Dependable, reliable, responsible	Easy-going, capricious	Irresponsible, undependable, immoral
Achievement	Workaholic	Purposeful, diligent, ambitious	Carefree, content	Aimless, shiftless, desultory
Self-discipline	Single-minded doggedness	Self-disciplined, willpower	Leisurely	Negligent, hedonistic
Deliberation	Ruminative, indecisive	Thoughtful, reflective, circumspect	Quick to make decisions	Hasty, rash

Excessive Diagnostic Co-occurrence

DSM-IV-TR provides diagnostic criterion sets to help guide a clinician toward a correct diagnosis and an additional section devoted to differential diagnosis when persons meet diagnostic criteria for more than one disorder. The intention of this information is to help the clinician determine which particular mental disorder is present, the identification of which would hopefully indicate the presence of a specific pathology and suggest a specific treatment. It is evident, however, that DSM-IV-TR routinely fails in this goal, despite the best efforts of the leading clinicians and researchers who have authored the manual.

The authors of the diagnostic manual construct personality syndromes and then hope that persons will share the same

precise profile and not have any traits of any other profile. This assumption of distinct types is not supported empirically, contributing not only to the heterogeneity of persons sharing the same diagnosis but also the need to provide multiple diagnoses to the same patient in order to fully describe all of his or her maladaptive personality traits. The problem is further compounded by the considerable overlap among the personality syndromes included within DSM-IV-TR, a comorbidity that is well explained by overlap in FFM personality traits (e.g., most of the personality disorders are heavily saturated with neuroticism; schizoid, avoidant, and schizotypal share traits of introversion; antisocial, narcissistic, and paranoid share traits of antagonism).

Inadequate Coverage

Clinicians provide a diagnosis of not otherwise specified (NOS) when they determine that a person has that particular class of mental disorder but the symptoms are not adequately represented by any one of the individual diagnostic categories. Personality disorder NOS (PDNOS) is often the single most frequently used diagnosis in clinical practice, as indicated in studies of clinical records and in a meta-analysis of NOS usage across structured and unstructured assessments.

The FFM is considered to be a reasonably comprehensive dimensional model of general personality structure. One of its strengths is its ability to accommodate the personality traits included within alternative models of personality. The FFM also accommodates well the maladaptive personality traits included within the DSM-IV-TR diagnostic categories, as well as additional maladaptive personality traits not included within the existing nomenclature. Table 2 provides a description of each of the DSM-IV-TR personality disorders in terms of the FFM. For example, the FFM includes the traits of

DSM-IV-TR antisocial personality disorder (deception, exploitation, aggression, irresponsibility, negligence, rashness, angry hostility, impulsivity, excitement-seeking, and assertiveness), and goes beyond DSM-IV-TR to include additional traits within the widely popular Psychopathy Checklist-Revised (PCL-R), such as glib charm (low self-consciousness), arrogance, and lack of empathy (tough-minded callousness) and goes even further to include traits of psychopathy emphasized originally by Cleckely but not included within either the DSM-IV-TR or the PCL-R, such as low anxiousness and low vulnerability or fearlessness.

It is evident from Table 2 that there is considerable overlap among the DSM-IV-TR personality disorders with respect to their FFM profile. For example, many of the personality disorders are characterized by facets of high neuroticism and low agreeableness, contributing to their considerable diagnostic co-occurrence. However, the FFM also identifies traits that are relatively unique to a respective diagnosis. For example, the FFM has the social withdrawal evident not only in the

Table 2 DSM-IV-TR personality disorders from the perspective of the five-factor model of general personality structure

	PRN	SZD	SZT	ATS	BDL	HST	NCS	AVD	DPD	OCP
<i>Neuroticism (vs. emotional stability)</i>										
Anxiousness (vs. unconcerned)			H	L	H			H	H	H
Angry hostility (vs. dispassionate)	H			H	H		H			
Depressiveness (vs. optimistic)					H					
Self-consciousness (vs. shameless)			H	L	H	L	L	H	H	
Impulsivity (vs. restrained)				H	H	H				L
Vulnerability (vs. fearless)				L	H			H	H	
<i>Extraversion (vs. introversion)</i>										
Warmth (vs. coldness)	L	L	L				L		H	
Gregariousness (vs. withdrawal)	L	L	L	H		H		L		
Assertiveness (vs. submissiveness)				H			H	L	L	
Activity (vs. passivity)		L		H		H				
Excitement-seeking (vs. dullness)		L		H		H	H	L		L
Positive emotionality (vs. anhedonia)		L	L			H				
<i>Openness (vs. closedness)</i>										
Fantasy (vs. concrete)						H				
Aesthetics (vs. disinterest)										
Feelings (vs. alexithymia)		L			H	H	L			L
Actions (vs. routine)	L	L		H	H	H	H	L		L
Ideas (vs. closed-minded)			H							L
Values (vs. dogmatic)	L									L
<i>Agreeableness (vs. antagonism)</i>										
Trust (vs. mistrust)	L		L	L	L	H	L		H	
Straightforwardness (vs. deception)	L			L			L			
Altruism (vs. exploitation)				L			L			
Compliance (vs. opposition, aggression)	L			L	L		L		H	
Modesty (vs. arrogance)				L			L	H	H	
Tender-mindedness (vs. tough-minded)	L			L			L			
<i>Conscientiousness (vs. disinhibition)</i>										
Competence (vs. ineptitude)									L	H
Order (vs. disordered)			L							H
Dutifulness (vs. irresponsibility)				L						H
Achievement-striving (vs. lackadaisical)										H
Self-discipline (vs. negligence)				L		L				H
Deliberation (vs. rashness)				L	L	L				H

PRN, paranoid; SZD, schizoid; SZT, schizotypal; ATS, antisocial; BDL, borderline; HST, histrionic; NCS, narcissistic; AVD, avoidant; DPD, dependent; OCP, obsessive-compulsive; H, high; L, low.

avoidant, schizoid, and schizotypal personality disorders, but also the anxiousness and self-consciousness of the avoidant, the anhedonia that is considered to be specific to the schizoid, and the cognitive-perceptual aberrations of the schizotypal. The FFM has the intense attachment needs, the deference, and the self-conscious anxiousness of the dependent, the perfectionism and workaholism of the obsessive-compulsive, and the fragile vulnerability and emotional dysregulation of the borderline. The FFM also goes beyond the DSM-IV-TR nomenclature to include (for instance) closed-mindedness (evident in racist, prejudicial persons) and alexithymia.

Most individual persons will have personality profiles that fail to match perfectly any one of the 10 DSM-IV-TR prototypes provided in Table 2. The need for the frequently used wastebasket NOS diagnosis would decrease substantially if the DSM-V shifted to a profile description in terms of the domains and facets of the FFM as subthreshold, atypical, and idiosyncratic profiles of individual cases would be readily described in terms of the 60 poles of the 30 facets of the FFM.

Scientific Foundation

One fundamental benefit of integrating the DSM-IV-TR with the FFM is the presence of a considerable body of basic scientific research to support the validity of the FFM in contrast to the inadequate scientific foundation for at least half of the DSM-IV-TR personality disorders. Briefly discussed here will be genetics, childhood antecedents, temporal stability, and universality.

Genetics

There is behavior genetic research to support the validity of the DSM-IV-TR personality disorders but the extent of support does pale in comparison to the FFM. In addition, research concerning the FFM has gone beyond univariate behavior genetics that simply indicate extent of heritability to multivariate behavior genetics to provide validity for the specific FFM personality structure. There is also quite a bit of molecular genetic research on FFM neuroticism. In contrast, it might be difficult to find even one molecular genetic study of a DSM-IV-TR personality disorder as the heterogeneous constellations of maladaptive personality traits that describe each of them are antithetical to discovering a specific genetic contribution.

Childhood Antecedents

Very little is said in DSM-IV-TR on the childhood antecedents for most of the personality disorders because little is in fact known. Much has been written on childhood antecedents but this literature is based largely on clinical experience, theoretical expectations, and retrospective studies. There has been only one longitudinal prospective study providing information concerning the histrionic, dependent, avoidant, obsessive-compulsive, paranoid, schizoid, schizotypal, and narcissistic personality disorders, and this project was sorely limited by the absence of adequate assessments in childhood and adolescence.

In contrast, there is a considerable body of research on childhood personality traits and temperaments all of which has been well integrated within the FFM. Rather than seek an understanding of the childhood antecedents of personality disorder from studies of personality disorder symptomatology in children and adolescents, it might be more fruitful to seek an understanding from the study of childhood temperaments. If childhood temperaments do not provide an initial foundation or disposition toward the development of an adult personality disorder, what would be the genetic foundation for an adult personality disorder?

However, the adult outcome of childhood temperaments is well understood to be a general personality structure. It would be rather incongruous to suggest that the temperaments of childhood and adolescence provide a disposition or vulnerability to adult personality disorder, yet they also suggest that these personality disorders cannot themselves be understood as maladaptive variants of these temperaments and traits within adulthood. Researchers have even developed a model and instrument for the assessment of FFM personality disorder in childhood and adolescence.

Temporal Stability

Temporal stability is central to the validity of personality traits. Fundamental to the distinction between a personality disorder and most other mental disorders is the temporal stability of personality. However, there is increasing concern regarding the temporal stability of the DSM-IV-TR personality disorder diagnoses and DSM-IV-TR personality disorder researchers are now even suggesting that it should no longer be a defining feature of a personality disorder.

In contrast, there is considerable support for the temporal stability of FFM personality traits across the lifespan. A meta-analysis of the findings of 152 longitudinal studies was conducted, involving 3217 test-retest correlations that covered various spans of time from childhood to old age. The conclusion was that the FFM traits are quite consistent over the life course. One prominent study compared directly the temporal stability of the DSM-IV-TR diagnoses and FFM personality traits over a 2-year span of time, and reported weak stability for the DSM-IV-TR diagnoses but strong stability for the FFM traits.

Universality

A common distinction in cross-cultural research is between etic and emic studies. Etic studies use constructs and measures from one culture imported into another, determining (in part) whether the importation reproduces the nomological net of predictions previously obtained in other cultures. Emic studies use constructs and measures that are indigenous to a particular culture, determining whether a particular model of personality structure is evident from the perspective or experiences of that culture.

There is only limited etic support for the universality of the DSM-IV-TR nomenclature and virtually no emic support. It is perhaps noteworthy that DSM-IV-TR narcissistic personality disorder was not included within the World Health Organization's (WHO) International Classification of Diseases (ICD-10) despite its presence since 1980 within DSM-III. Of course,

it now appears that ICD-11 may simply accept whatever nomenclature is developed by the APA so there will no longer be any inconsistency.

The universality of the FFM is supported by extensive etic and emic research. Emic support for the FFM is provided by the many lexical studies of the trait terms within the indigenous languages of other cultures (e.g., German, Dutch, Czech, Polish, Russian, Italian, Spanish, Hebrew, Hungarian, Turkish, Korean, and Filipino). Etic support is provided by a replication of the FFM personality structure using observer ratings of 11 985 individuals obtained in 51 different cultures. The largest cross-cultural study of the FFM to date included 100 researchers and 17 837 participants from 56 countries. Results indicated that the five-dimensional structure was highly robust across major regions of the world, including North America, South America, Western Europe, Eastern Europe, Southern Europe, the Middle East, Africa, Oceania, South-Southeast Asia, and East Asia.

FFM Personality Disorder Diagnosis

The FFM or Big Five personality disorder diagnosis consists of four steps. The first step is to obtain an FFM description of the patient. This can be accomplished most easily through the scoring of a one-page rating form that covers all of the domains and facets of the FFM, as assessed (for instance) by the FFF (see [Table 1](#)), or through a self-report inventory (e.g., NEO PI-R) or through a semistructured interview (e.g., Structured Interview for the FFM, SIFFM). There are also many other available measures of the FFM.

The second step is to identify impairments associated with any elevations on a respective facet of the FFM. [Table 1](#) provides typical impairments associated with each of the 60 poles of the 30 facets of the FFM. More detailed descriptions are available elsewhere (see Further Reading). This assessment is included explicitly within the administration of the SIFFM. For example, if persons endorse going out of their way to help others (high altruism) they are asked if they do this at the sacrifice of their own needs; if persons endorse confiding in others (high trust) they are asked in the SIFFM if they have ever been mistreated or used by others as a result.

The third step of the FFM four-step procedure is to determine whether the impairments are at a clinically significant level warranting the diagnosis of a personality disorder. This step is in contrast to the thresholds for the diagnosis of individual personality disorders provided within the DSM-IV-TR (e.g., five of nine diagnostic criteria for borderline, three of seven for antisocial). There has never been an effort to set a consistent diagnostic threshold for the personality disorders within any edition of the APA diagnostic manual. In each instance, the thresholds have been set independently of one another. The diagnostic thresholds in DSM-IV-TR (with the exception of antisocial) were determined by an individual assigned to that diagnosis who selected a threshold which seemed on the basis of a visual inspection of the criterion set to be an optimal point of demarcation.

The DSM-III and DSM-III-R personality disorder diagnostic thresholds (with two exceptions) were never based on any explicit or published rationale. The two exceptions are the

diagnostic thresholds for the DSM-III versions of the borderline and schizotypal personality disorders. Their DSM-III cutoff points were selected on the basis of maximizing agreement with diagnoses provided by a large sample of clinicians. However, it evident there have since been so many revisions, deletions, and additions to their criterion sets that the current diagnostic thresholds no longer relate well to the original thresholds. There was never an effort to provide any rationale for the diagnostic thresholds for the DSM-III paranoid, schizoid, narcissistic, histrionic, antisocial, avoidant, dependent, or obsessive-compulsive personality disorders. With the exception of the DSM-IV-TR antisocial personality disorder, no effort has been taken to maintain a consistent threshold across revisions to the diagnostic manual. Hence, with each revision, remarkable, unanticipated, and unintended changes to prevalence rates have occurred.

The FFM of personality disorder, in contrast, proposes using a uniform and consistent basis for determining when a personality disorder is present. The cutoff point is modeled after the Global Assessment of Functioning (GAF) scale provided on Axis V of DSM-IV-TR that has itself been used in quite a number of studies within clinical populations. A score of 71 or above on the GAF indicates a normal range of functioning (e.g., problems are transient and expectable reactions to stressors); a score of 60 or below represents a clinically significant level of impairment (moderate difficulty in social or occupational functioning, such as having few friends or significant conflicts with coworkers) that would warrant a diagnosis of personality disorder. Further explication of this scale is provided by the Global Assessment of Relational Functioning and the Social and Occupational Functioning scales. This approach to setting the diagnostic threshold would bring to the diagnosis research that has been conducted with the GAF and would provide a threshold that would be consistent across all personality disorders as well as facilitate consistency across all future revisions to the nomenclature.

The fourth step, prototypal matching, is an optional step for those who still wish to provide single diagnostic terms to describe a particular patient's personality profile. In this step, one correlates the patient's actual FFM profile with the FFM description of a prototypic case (see [Table 2](#)). Research has demonstrated that these personality disorder indices are just as valid for the assessment of the borderline, the psychopathic and other personality disorders as any two explicit measures of these personality disorders. In other words, one can readily translate an FFM description back into a DSM-IV-TR personality disorder construct. In most cases, however, the quantitative matching will serve primarily to indicate the extent to which any single construct (e.g., antisocial) is inadequately descriptive of the individual person. In the vast majority of cases, the optimal description will be provided by the actual FFM profile of the person rather than the extent to which the person's FFM profile resembles a hypothetical prototype.

Feasibility

Most clinicians may understandably respond with a deep breath of concern upon first inspection of [Table 1](#), finding it daunting to conceive of having to become familiar with

both the adaptive and maladaptive variants of all 60 poles of all 30 facets of the FFM. However, there are a few points to keep in mind. First, the language of the FFM is the language with which one is already familiar. FFM constructs are already known to anyone who understands his or her own language. This is not to say that the FFM fails to accommodate sophisticated clinical constructs. Research has indicated that constructs within the California Q-set, the Shedler–Westen Assessment Procedure-200, and the DSM-IV-TR personality disorder criterion sets are well understood and articulated in terms of the FFM.

The FFM structure is also not difficult to learn as it is the structure within which one already conceptualizes and thinks about these traits. The FFM structure reproduces the naturally occurring structure within one's language. It is no accident that persons reviewing disparate trait research concerning (for instance) gender differences, childhood temperament, health psychology, consequential outcomes of personality, and even animal behavior have all used the FFM as the structure with which to organize these vast trait literatures.

The administration of the SIFFM, a structured interview assessment of the FFM, takes approximately half the time it takes to administer a DSM-IV-TR personality disorder semistructured interview, despite the fact that it is assessing normal as well as abnormal personality traits. The reason is in part that the SIFFM assessment of maladaptive personality traits is appreciably less redundant than an assessment of the markedly overlapping DSM-IV-TR personality disorder criterion sets. In addition, much of the time spent in the administration of a DSM-IV-TR personality disorder semistructured interview is spent in the assessment of diagnostic criteria that are not present. The DSM-IV-TR requires that all of the diagnostic criteria for each personality disorder be assessed in every patient. A substantial proportion of this time is eliminated in the FFM of personality disorder as abnormal variants are not assessed if the respective normal variant is not present.

Nevertheless, clinicians may still find it daunting to have to consider (potentially) 60 maladaptive traits for each patient, in contrast to just the ten personality disorders of DSM-IV-TR.

Figure 1 provides an abbreviated version of the FFM of personality disorder. Figure 1 reduces the 60 maladaptive variants to just 26. This reduction was achieved in part by eliminating poles of facets that were considered to be relatively less frequent or even obscure (e.g., maladaptively high openness to esthetics) for most clinical use.

Figure 2 provides further detail on how the domain and maladaptive variants could be assessed. Provided within Figure 2 are draft diagnostic criteria for neuroticism and for the eight respective maladaptive facets for that domain included within the abbreviated version (additional domains are covered in papers listed in the section for Further Reading). A patient is first assessed with respect to the six facets of FFM neuroticism. Each facet is rated on a 1–5 Likert scale, consistent with the FFMRF and FFF. If the person receives an elevated score for the domain of neuroticism, then the clinician would assess for the presence of the six maladaptive variants of high neuroticism (i.e., anxiousness, depressiveness, angry hostility, emotional instability, self pathology, and helplessness) and would not need to assess for the maladaptive variants of low neuroticism. If the person receives a low score for neuroticism, then the clinician would not need to assess for any of the maladaptive variants of high neuroticism and would assess instead the two maladaptive variants of low neuroticism (i.e., glib, shameless charm, and fearlessness). If the person receives a score within the middle range, then no further assessment would typically be necessary.

The abbreviated version does naturally fail to include all of the maladaptive traits present within the FFM, as illustrated within Table 1. Missing from the abbreviated version, for instance, are such maladaptive variants as attention-seeking (high gregariousness), gullibility (high trust), guilelessness (high straightforwardness), exploitativeness and greed (low altruism), callousness (high tough-mindedness), ruminative indecisiveness (high deliberation), hedonism (low self-discipline), and aimlessness (low achievement-striving). Any one of these could, in some instances, be very clinically important. One cannot have an abbreviated model without losing

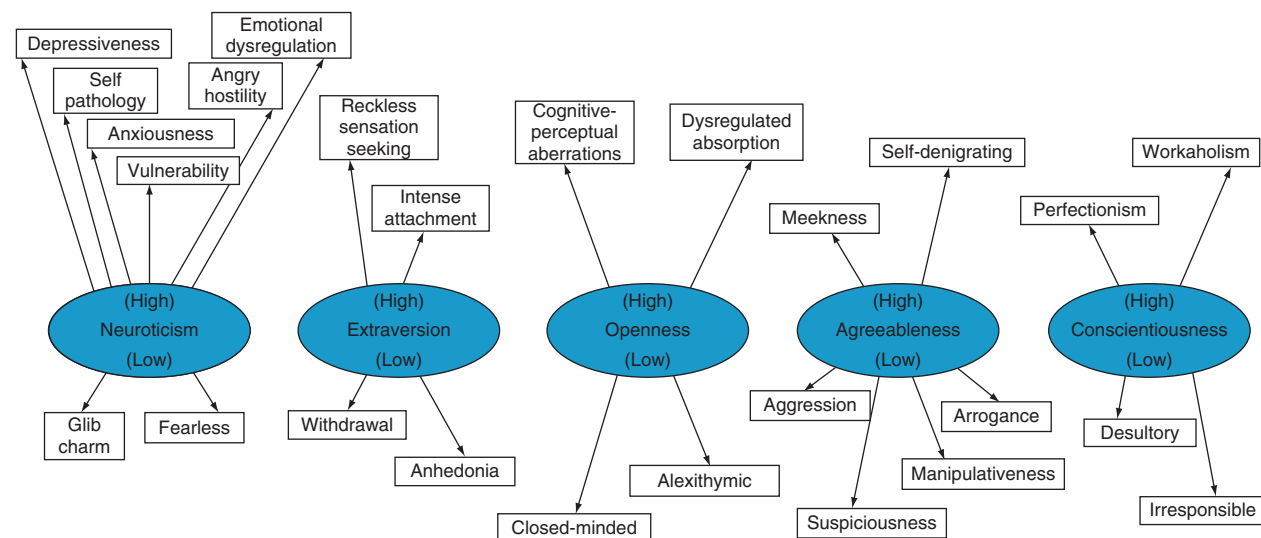


Figure 1 Abbreviated version of FFM proposal for DSM-V.

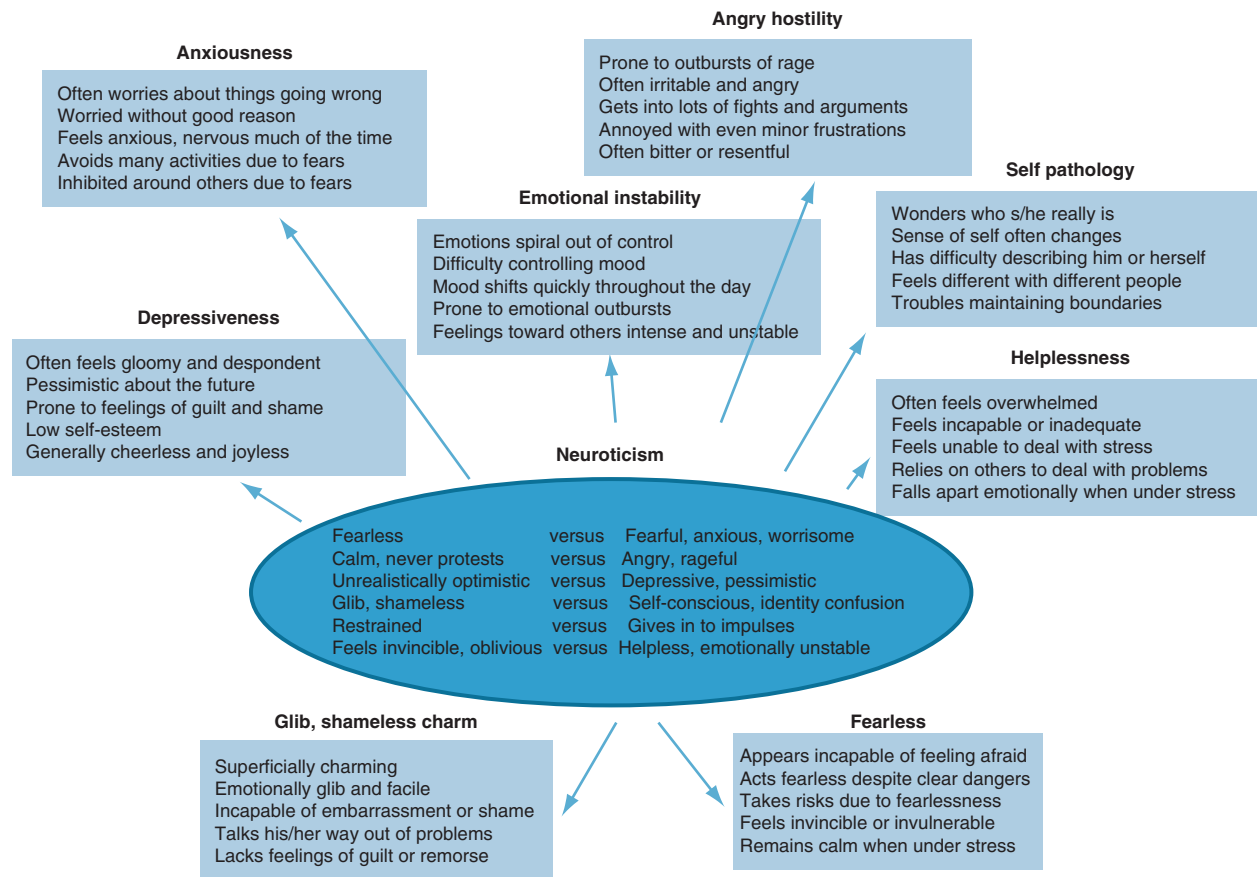


Figure 2 FFM diagnosis of maladaptive neuroticism.

information and some of this information will at times have important clinical significance. In addition, in the abbreviated model it will be relatively more difficult to identify complex profiles (e.g., elevations in opposite directions on facets within the same domain). Many clinicians will then likely prefer the complete model, once they become familiar with the simpler, abbreviated model.

However, even in the abbreviated version clinicians would be alerted to the potential presence of the additional maladaptivity through elevations on specifically relevant facet scales within each of the five domains. If a person receives a high (or low) score on a respective facet for which no maladaptive variant is provided within the abbreviated version (e.g., a score of 5 for the facet of impulsivity for neuroticism, suggesting a potential difficulty in control affectively driven impulses and urges, or a score of 1 for angry hostility, suggesting the potential for never standing up for oneself in protest or justifiable anger; see [Table 1](#)) the maladaptive personality functioning could still be assessed, if wished, through an implementation of the more complete, full version of the FFM of personality disorder.

Conclusions

There are many advantages of shifting the classification of personality disorder to the FFM. One straightforward advantage is the provision of a description of abnormal personality

functioning with the same model and language used to describe general personality structure. It would address the many fundamental limitations of the categorical model (e.g., heterogeneity within diagnoses, inadequate coverage, lack of consistent diagnostic thresholds, excessive diagnostic co-occurrence, and inadequate scientific base). It would contain the means of providing more comprehensive and individually specific descriptions of each patient's normal and abnormal personality structure and, it would transfer to the psychiatric nomenclature a wealth of knowledge concerning the origins, childhood antecedents, stability, and universality of the dispositions that underlie personality disorder.

See also: [Avoidant Personality Disorder](#); [Borderline Personality Disorder](#); [Extraversion–Introversion](#); [Histrionic Personality Disorder](#); [Individual Differences in Temperament: Definition, Measurement, and Outcomes](#); [Personality Disorders](#); [Personality, Structure](#); [Psychopathology: Diagnosis, Assessment, and Classification](#); [Schizoid and Schizotypal Personality Disorder](#); [Temperament and Individual Differences](#).

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Bilingualism and Multilingualism

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Glossary

Affective filter hypothesis Emotions function as a filter that reduces the amount of language input the learner is able to comprehend. Negative emotions such as anxiety, self-doubt, and mere boredom interfere with the process of acquiring a second language. Positive emotions such as interest and self-esteem can facilitate the process.

BAMFLA Bilingual and multilingual first language acquisition, that is, acquiring more than one language simultaneously as first language from birth.

Code-switching Alternation between languages in the same conversational interaction or across different modalities such as sign and speech.

Compound bilingual A bilingual who has learned two languages at the same time and often in the same context.

Coordinative bilingual A bilingual who has learned two languages in different contexts and kept the two languages fairly separately.

Critical period hypothesis A hypothesis that claims that there is an ideal 'window' of time to acquire language, after which this is no longer possible, that is, language acquisition is biologically linked to age.

Input hypothesis Also known as the comprehensible input hypothesis, it claims that learners acquire a language only when they receive comprehensible input.

Interaction hypothesis A hypothesis that proposes that language acquisition is strongly facilitated by the use of the target language in interaction.

Language contact Situations where groups of speakers of different languages are in contact with each other. Language contact is the main cause of bilingualism and multilingualism.

Language ideology or linguistic ideology The explicit and implicit attitudes regarding language that define what is perceived as proper speech or good language behavior. It also encompasses what people believe a particular language can do for its users and the user community.

Language socialization A process whereby children and other novices in society acquire tacit knowledge of principles of social order and systems of belief through exposure to and participation in language-mediated interaction. It involves both socialization through language and socialization to use language.

Negative motivation A response that involves the undertaking of tasks for fear that there should be undesirable outcomes.

Negotiation of identity A process through which people reach agreements regarding 'who is who' in their relationships. It helps to establish what people can expect of one another.

Output hypothesis A hypothesis that claims that meaningful output is as necessary to language learning as meaningful input.

Positive motivation A response which includes enjoyment and optimism about the tasks that the learner is involved in.

Sign bilingualism Dual modality bilingualism of sign language and other human languages.

Subordinative bilingual A bilingual whose two languages are not of equal status or proficiency level, with one being subordinate to the other in structure, cognitive processing, and usage.

Introduction

One of the major discoveries of modern linguistic science is that human beings have the capacity to learn as many languages as they are willing to and as they are allowed to by the social conditions. In principle then, anybody can be bilingual and multilingual. Indeed, the vast majority of the world's population is bilingual and multilingual. Nevertheless, there are different pathways to bilingualism and multilingualism, and there are plenty of examples of people who have failed to acquire a language sufficiently to communicate with others in it, or those who, despite knowing other languages, function as monolinguals. The questions then are the following:

- What are the conditions that facilitate the learning and use of multiple languages?
- As far as individuals are concerned, what does it mean to be bilingual or multilingual?

Pathways to Bilingualism and Multilingualism

People often assume that bilingualism and multilingualism are for the privileged few – those who have had a good schooling where they learned new languages and those who have traveled a lot or lived in different countries. Education and migration, either temporary or long-term, are clearly opportunities for learning languages, but most people become bilingual and multilingual within their immediate families and communities. **Table 1** illustrates six different processes whereby children can become bilingual or multilingual at home.

There are many other factors that can lead individuals on to a path to bilingualism and multilingualism. Most of them are external to the individual's cognitive capacities but have something to do with the broader social environment. For example, political or military acts such as colonization, annexation, resettlement, and federation of a country or region can have critical linguistic effects. People may become refugees, either in

Table 1 Processes of bilingual acquisition

	<i>Parent</i>	<i>Community</i>	<i>Strategy</i>
1. One person one language	The parents have different native languages with each having some degree of competence in the other's language	The language of one of the parents is the dominant language of the community	The parents each speak their own language to the child from birth
2. Nondominant home language/one language one environment	The parents have different native languages	The language of one of the parents is the dominant language of the community	Both parents speak the nondominant language to the child, who is fully exposed to the dominant language only when outside the home, and in particular in nursery school
3. Nondominant home language without community support	The parents share the same native language	The dominant language is not that of the parents	The parents speak their own language to the child
4. Double nondominant home language without community support	The parents have different native languages	The dominant language is different from either of the parents' languages	The parents each speak their own language to the child from birth
5. Nonnative parents	The parents share the same native language	The dominant language is the same as that of the parents	One of the parents always addresses the child in a language which is not his/her native language
6. Mixed languages	The parents are bilingual	Sectors of community may also be bilingual	Parents code-switch and mix languages

a new place or in their homeland, and be required to learn the language of their new environment. After a successful military invasion, the indigenous population may have to learn the invader's language in order to prosper. Colonization is exemplified by the former British, French, Spanish, Portuguese, and Dutch colonies in Africa, Asia, and South America, most of which achieved independence in the nineteenth century. A modern example of annexation can be found in the absorption of the Baltic republics – Lithuania, Latvia, and Estonia – into the Soviet Union after the Second World War. In the latter part of the twentieth century, military conflicts in Central Africa and the former Yugoslavia have seen the resettlement of people of different ethnic backgrounds. Examples of federations where diverse ethnic groups or nationalities are united under the political control of one state include Switzerland, Belgium, and Cameroon. Individuals in these countries and regions may have the opportunity to become bilingual or multilingual. Similarly, natural disasters such as famine, floods, and volcanic eruptions can be the cause of major movements of population. New language contact situations emerge as people begin to resettle. Some of the Irish and Chinese resettlements in North America have been the result of natural disasters. People are exposed to new languages as a result of the resettlements. In today's world, the availability of information and communication technologies (ICT), such as the Internet, has led to a further expansion of the use of certain languages across the world. People who wish to use modern technologies need to learn and use the languages of the media.

Some of the pathways to bilingualism and multilingualism may be more personal than environmental. For instance, people may wish to live in a country because of its religious significance, or to leave a country because of its religious oppression. In either case, a new language may have to be learned. The Russian speakers in Israel are a case in point. Similarly, very large numbers of people across the world have migrated to find work and to improve their standard of living. The economic

factor accounts for most of the linguistic diversity of the United States and for the increasing proportion of multilingualism in present-day Europe.

Factors Contributing to the Success or Failure of Becoming Bilingual and Multilingual

From the above list, one can easily conclude that becoming bilingual or multilingual is a consequence of what the environment provides the individual with and has little to do with individuals' mental capacity. Yes, it is true that in theory anyone could learn as many languages as he or she wishes to. But the reality is that not everyone becomes bilingual or multilingual even if the environmental conditions are favorable for language learning. It is certainly a fact that not everyone becomes equally proficient in the languages he or she learns even if he or she is exposed to the same learning conditions. Linguists have spent a great deal of time investigating the various factors that lead to success or failure in becoming bilingual and multilingual. Some of the factors appear to be learner-internal, that is, they are conditioned by the learner's biological and cognitive capacities, while others are more social.

Research evidence suggests that human beings' ability to learn languages is closely related to age and memory capacity. Infants seem to be able to acquire new languages with great ease, whereas adults often have difficulty in achieving the same level of fluency or accuracy in the later-learned languages. Such facts gave rise to the 'critical period hypothesis,' which claims that there is an ideal age to acquire a language in a linguistically rich environment, after which the individual will never achieve a full command of the language. However, there is little agreement as to what that critical period is. Research results are varied: some demonstrate that prepubescent children acquire language easily, and some that older learners have a certain advantage and can achieve native-level

proficiency. Brain plasticity has often been cited as the factor underlying the critical period. More recently, it has been suggested that the delayed development of the prefrontal cortex in children and a concomitant delay in the development of cognitive control may facilitate convention learning, allowing young children to learn language far more easily than cognitively mature adults and older children. Nevertheless, this is a highly controversial and vital topic for research. Advances in brain imaging technologies are generating new findings all the time.

Many researchers do not believe in the existence of the critical period for language learning at all. Instead, they point to social and environmental factors, attitude, motivation, input and interaction, as well as pedagogical effect, and language policy. Individuals learn languages for very different reasons and with very different motivations: some learn new languages because they are married to speakers of other languages, while others seek employments that require the use of certain languages. Community attitudes toward the language being learned can also have a profound impact on the individual learners. Where the community has a broadly negative view of the target language and its speakers, or a negative view of its relation to them, learning is typically much more difficult. At the same time, the learner's direct contact with the target language, that is, input, has a crucial impact on the learning process and learning outcome.

Generally speaking, the amount of input a learner receives is one of the most important factors affecting his or her learning. However, it must be at a level that is comprehensible to the learner. In his study of second language learning, Stephen Krashen advanced the idea that language input should be at the 'i + 1' level, that is, just beyond what the learner can fully understand. In other words, the input is comprehensible, but contains structures that are not yet fully understood. While there has been criticism of Krashen's theory that factors other than structural difficulty (such as interest or presentation) can affect the actual conversion of input into intake, the i + 1 idea has been found useful in language teaching.

In contrast, Merrill Swain proposed an Output Hypothesis that meaningful output is as necessary to language learning as meaningful input. However, most studies have shown little if any correlation between learning and quantity of output. It is likely that meaningful output is important to language learning because the experience of producing language leads to more effective processing of input.

A rather different perspective on success or failure of language learning is the so-called Interaction Hypothesis, which proposes that language acquisition is strongly facilitated by the use of the target language in interaction. In particular, the negotiation of meaning has been shown to contribute greatly to the acquisition of vocabulary.

In addition to the Input Hypothesis, Krashen also proposed an Affective Filter Hypothesis, which claims that the relative success or failure of language learning is often filtered through motivation, attitude, and other affective factors. Many researchers have suggested that more motivated learners tend to be more successful. Motivation involves four key aspects:

1. A Goal
2. An Effort

3. A Desire to attain the goal
4. Favorable attitude toward the activity in question.

It has been suggested that good L2 learners have the following characteristics. They

- are willing and accurate guessers;
- have a strong drive to communicate;
- are often uninhibited, and if they are, they combat inhibition by using positive self-talk, by extensive use of practicing in private, and by putting themselves in situations where they have to participate communicatively;
- are willing to make mistakes;
- focus on form by looking for patterns and analyzing;
- take advantage of all practice opportunities;
- monitor their speech as well as that of others; and
- pay attention to meaning.

In short, they are more motivated and have a more positive attitude toward learning the language.

Motivation is a desire to achieve a goal, combined with the energy to work toward that goal. It determines the extent of active, personal involvement in L2 learning.

Sometimes, a distinction is made between positive and negative motivation. Positive motivation is a response which includes enjoyment and optimism about the tasks that you are involved in, whereas negative motivation involves undertaking tasks for fear that there should be undesirable outcomes. Questions then arise as to where positive and negative motivations came from, the answer to which lies largely in individuals' personal experience. A person growing up in a multilingual environment where the majority of people he or she interacts with on a routine basis speak a variety of different languages freely and where there is no societal control over which language should be used in what manner would, at least in principle, have a more positive attitude toward learning new languages and using different languages. In contrast, a person who has been forced to learn or to drop a particular language or experienced drama in a particular language may develop a negative motivation. The links between personal experience and motivation and other affective and emotional aspects of language learning are an area worthy of further investigation.

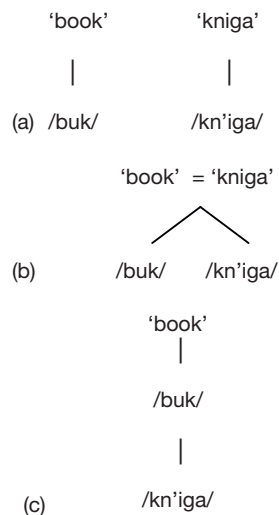
Other factors that researchers have examined in terms of success or failure of becoming bilingual and multilingual include gender and personality. These factors are at the interface between learners' internal and external dimensions. Evidence from neuroscience suggests that boys and girls use different parts of their brains to process some basic aspects of grammar. Sociolinguists have shown that men and women use languages in different ways for communicative purposes. However, there is very little research into the gender differences in bilingual or second language acquisition. Some researchers have suggested that there are gender differences in motivations for language learning. It certainly seems to be the case that more girls than boys prefer to learn modern languages in schools and have somewhat better attainment in school-based language examinations. Yet none of the apparent difference can be solely attributed to biological differences between the two genders. It is more likely to be a sociocultural effect in that language learning and use is closely related to the different

roles of girls and boys and women and men in society. Similarly, some personality traits have been linked to the relative success or failure in second or additional language learning. Extraverts or unreserved and outgoing people tend to acquire a second language better than introverts or shy people. But extraversion and introversion are sociocultural constructs, rather than biologically determined.

What Does it Mean to Be Bilingual or Multilingual?

In theory, these different routes to bilingualism would result in different language behaviors and cognitive organizations of the bilingual brain. But at the moment, there is very little systematic research linking the process of bilingual acquisition with the outcome of bilinguality at the individual level. What we do know, however, is that the different languages being acquired by the child do not always develop at the same speed or to the same level, resulting in different configurations of language dominance in individual children and different proficiencies in the languages.

In an early study, Uriel Weinreich proposed three types of bilinguals representing three types of relationship between the linguistic sign (or signifier) and the semantic content (signified). In Type A, the individual combines a signifier from each language with a separate unit of signified. Weinreich called them 'coordinative' (later often called 'coordinate') bilinguals. In Type B, the individual identifies two signifiers but regards them as a single compound, or composite, unit of signified; hence they are called 'compound' bilinguals. Type C relates to people who learn a new language with the help of a previously acquired one. They are called 'subordinative' (or 'subordinate') bilinguals. His examples were from English and Russian:



Weinreich's typology is often misinterpreted in the literature as referring to differences in the degree of proficiency in the languages. But it is a fact that the relationship between the language proficiency and cognitive organization of the bilingual individual, as conceptualized in Weinreich's model, is far from clear. Some 'subordinate' bilinguals demonstrate a very high level of proficiency in processing both languages,

as evidenced in grammaticality and fluency of speech, while some 'coordinative' bilinguals show difficulties in processing two languages simultaneously (i.e., in code-switching or in 'foreign' words identification tasks). It must also be stressed that, using Weinreich's distinctions, bilingual individuals are distributed along a continuum from a subordinate or compound end to a coordinate end, and can at the same time be more subordinate or compound for certain concepts and more coordinate for others, depending on, among other things, the age and context of acquisition. There are now a number of psycholinguistic models of the bilingual lexicon, including the Concept Mediation Model, the Word Association model, and the Revised Hierarchical Model. These models take into consideration factors such as proficiency level, age, and context of acquisition and have much more explanatory power than the earlier models for bilingual language use.

In terms of bilingual and multilingual first language acquisition (BAMFLA), that is, acquiring multiple languages from birth, both linguists and psychologists have spent a considerable amount of time investigating the developmental patterns of bilingual and multilingual children. Earlier studies suggested that bilingual acquisition went through three key stages:

- Stage I: The child has one lexical system comprising words from both languages.
- Stage II: The child distinguishes two different lexicons, but applies the same syntactic rules to both languages.
- Stage III: The child speaks two languages that are different both in lexicon and syntax, but each language is associated with the person who uses that language.

Although some studies have produced evidence supporting the model, there has been much criticism, particularly of the claims made regarding the first two stages. This is generally known as the 'one-system-or-two' debate, that is, whether bilingual children begin with a fused linguistic system and gradually differentiate the two languages, or whether they start with a differentiated system. Part of this debate centers around the question: What counts as evidence for differentiation or fusion? Some researchers based their decision on whether the child made appropriate sociolinguistic choices, that is, whether the child spoke the 'right' language to the 'right' person. It was argued that awareness of the two languages as distinct plays a crucial role in deciding the issue of differentiation, and a child's ability to make appropriate language choices reflects that awareness. However, the argument that bilingual children separate the languages when they are aware that there are two systems is circular, unless some criterion is provided for assessing whether awareness means anything other than children separating the languages. In any case, we need to bear in mind that a child's apparent (in)ability to choose the right language for the right addressee is a rather different issue from whether the child has one or two linguistic systems. Part of the problem is the familiar one of what we can infer about competence from performance. There now exists a large body of literature rebutting the 'fused' system hypothesis, arguing instead that bilinguals have two distinct but interdependent systems from the very start.

Is bilingual acquisition the same as monolingual acquisition? Theoretically, separate development is possible without

there being any similarity with monolingual acquisition. Most researchers argue that bilingual children's language development is by and large the same as that of monolingual children. In very general terms, both bilingual and monolingual children go through an initial babbling stage, followed by the one-word stage, the two-word stage, the multiword stage, and the multiclausal stage. At the morphosyntactic level, a number of studies have reported similarities rather than differences between bilingual and monolingual acquisition. Nevertheless, one needs to be careful in the kinds of conclusions one draws from such evidence. Similarities between bilingual and monolingual acquisition do not mean that (1) the two languages a bilingual child is acquiring develop in the same way or at the same speed; (2) the two languages a bilingual child is acquiring do not influence and interact with each other. For example, studies have found that while 2–3-year-old French–English bilingual children displayed patterns that characterize the performance of monolingual children acquiring these languages separately and they acquired these patterns within the same age range as monolingual children, they (1) used finite verb forms earlier in French than in English; (2) used subject pronouns in French exclusively with finite verbs but subject pronouns in English with both finite and nonfinite verbs, in accordance with the status of French clitic subject pronouns (or agreement markers) as against full NPs in English; and (3) placed verbal negatives after lexical verbs in French (e.g., *n'aime pas*) but before lexical verbs in English (*do not like*).

There is one area in which bilingual children clearly differ from monolingual children, namely, code-mixing. Studies show that bilingual children mix elements from both languages in the same utterance as soon as they can produce two-word utterances. As with adult code switching, bilingual children's language mixing is highly structured. The operation of constraints based on surface features of grammar, such as word order, is evident from the two-word/-morpheme stage onward, and the operation of constraints based on abstract notions of grammatical knowledge is most evident in bilingual children once they demonstrate such knowledge overtly (e.g., verb tense and agreement markings), usually around 2.6 years of age and older. These findings suggest that, in addition to the linguistic competence to formulate correct monolingual strings, bilingual children have the added capacity to coordinate their two languages online in accordance with the grammatical constraints of both languages during mixing. While these studies provide further evidence for the separate development, or two-systems, argument, they also suggest that there are both quantitative and qualitative differences between bilingual acquisition and monolingual acquisition.

The ability to switch from one language to another turns out to be a crucial aspect of being bilingual and multilingual. Indeed, one cannot tell who is or who isn't a bilingual until the person uses two or more languages in the same conversation. There is a widespread impression that bilingual speakers code-switch because they cannot express themselves adequately in one language. This may be true to some extent when a bilingual is momentarily lost for words in one of his or her languages. However, code-switching is an extremely common practice among bilinguals and takes many forms. A long narrative may be divided into different parts which are expressed in different languages; sentences may begin in one language

and finish in another; words and phrases from different languages may succeed each other. Linguists have devoted much attention to the study of code-switching. It has been demonstrated that code-switching involves skilled manipulation of overlapping sections of two (or more) grammars, and that there is virtually no instance of ungrammatical combination of two languages in code-switching, regardless of the bilingual ability of the speaker. Some suggest that code-switching is itself a discrete mode of speaking.

One important aspect of code-switching is that the two languages involved do not play the same role in sentence making. Typically, one language sets the grammatical framework, with the other providing certain items to fit into the framework. Code-switching therefore is not a simple combination of two sets of grammatical rules but grammatical integration of one language in another. Bilingual speakers of different proficiency levels in their two languages or speaking two typologically different languages can engage in code-switching and indeed vary it according to their needs.

There is a group of bilinguals who engage themselves in cross-modality language production. This is the case with speech–sign bilinguals who, in addition to the oral modality, use the manual–visual modality in everyday communication. They are special in one aspect: that is, the two different modalities allow for the simultaneous production of the two languages. In other words, one can speak and sign at the same time. Research has shown that such simultaneous bimodal production is typically exemplified by the use of lexical items from both languages but only one set of grammatical rules, which is usually from the spoken language. Right now, we know relatively little about how the two linguistic systems interact in the language production and processing of speech–sign bilinguals. Indeed, much more work needs to be undertaken before we can fully appreciate the complexity of the language behavior of bilinguals in general.

It should be emphasized that code-switching is not only an effective means of communication but also an act of identity. Every time bilingual speakers say something in one language when they might just as easily have said it in another, they are reconnecting with people, situations, and power configurations from their history of past interactions and imprinting on that history their attitudes toward the people and languages concerned. Through language choice, they maintain and change ethnic group boundaries and personal relationships, and construct and define 'self' and 'other' within a broader political economy and historical context. So, the issue of language use of bilinguals and multilinguals becomes an issue of identity and identification.

The notion of identity has gone through considerable change in sociolinguistics. In the earlier variationist sociolinguistic work, identity was taken to mean the speaker's socioeconomic class, gender, age, or place of origin. It is assumed that speakers express, rather than negotiate, identities through their language use. Several scholars later criticized such assumptions and argued instead that identities are negotiated through social interaction. Linguistic forms and strategies have multiple functions and cannot be directly linked to particular identities outside of interactional contexts. More recent studies by sociolinguists have emphasized the negotiation of identities and demonstrated that identities are local constructions.

Parallel to the work on multilingualism and negotiation of identities, sociolinguists critically examine some of the concepts and notions commonly used by other researchers in the field of bilingualism and multilingualism. For example, the very idea of code-switching raises questions as to what a language is. Instead of thinking of languages as discrete systems, sociolinguists tend to see multilingual speakers as actors of social life who draw on complex sets of communicative resources which are unevenly distributed and unevenly valued. The linguistic systematicity therefore appears to be at least as much a function of historically rooted ideologies (of nation and ethnicity) and of the ordering practices of social life as of language per se. This perspective goes beyond a focus on mental representation of linguistic knowledge and opens up the possibility of looking at bilingualism and multilingualism as a matter of ideology, communicative practice, and social process.

This particular sociolinguistic perspective has important implications for the way researchers collect, analyze, and interpret data. Informed by developments in anthropology, sociology, and cultural studies, sociolinguists have examined communicative practices within and across sites that can be ethnographically demonstrated to be linked. Working with the ideas of *trajectories* (of speakers, linguistic resources, discourses, institutions) across time and space and of *discursive spaces* which allow for, and also constrain, the production and circulation of discourses, sociolinguists have examined multilingual practices in a number of communities and argued that multilingual practices contribute to the construction of social boundaries and of the resources those boundaries regulate. They therefore also raise the question of the social and historical conditions that allow for the development of particular regimes of language, for their reproduction, their contestation, and, eventually, their modification or transformation.

A further, closely related, area in which sociolinguists have extended the work by linguists and psycholinguists on bilingualism is that of the acquisition of linguistic knowledge. Building on earlier research on language socialization, which focused on young children acquiring their first language in culturally specific ways, they have examined bilingual and multilingual children's developing competence in various speech and literacy events. Particular attention is given to the range of linguistic resources available, or not, in bilingual and multilingual communities and the ways in which children, as well as adolescents and adults, learn to choose among these resources for their symbolic value. The researchers emphasized language socialization as an interactive process, in which those being socialized also act as agents rather than as mere passive initiates. This line of inquiry also demonstrates how domains of knowledge are constructed through language and cultural practices, and how the individual's positioning affects the process of knowledge acquisition and construction.

Conclusion

Increased contacts with peoples speaking different languages as a result of globalization mean that bilingualism and multilingualism are becoming more commonplace a phenomenon for

today's world. People are more aware of the linguistic diversity around them. As the article shows, there is a considerable amount of knowledge related to bilingual and multilingual individuals, the manner in which they acquire languages, and the way they use them in daily life. Paradoxically, however, much of the research still uses the monolingual as the yardstick and often sees bilingualism as a deviation from the norm. Many issues also require further empirical research: for example, the organization of the bilingual brain; the structure and organization of the bilingual's different languages; the various processing operations involved in the perception, production, and memorization of language when the speaker is using one or all his or her languages; and the linguistic and psycholinguistic differences and similarities between code-switching, borrowing, and interference. Advances in research technologies will clearly help the field to develop more sophisticated methods. Research findings will have impacts on policy and practice regarding the bilingual and multilingual individuals as well as the communities they form and live in.

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Biofeedback Therapy

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Glossary

Classical conditioning The formation of a conditioned reflex through the temporal pairing of an unconditioned stimulus, which reflexively elicits a response, and a neutral conditioned stimulus. After the pairing, the formerly neutral conditioned stimulus acquires the ability to elicit a response similar to the one elicited by the unconditioned stimulus.

Operant conditioning The presentation of a stimulus dependent on the occurrence of a response for the purpose of modifying the strength or the frequency of the response.
Reinforcer In operant conditioning, any stimulus when presented or removed depending on the occurrence of a response results in the modification of the response. In a classical conditioning, the presentation of a conditioned stimulus and an unconditioned stimulus is in a close temporal proximity.

Underlying Learning Theory and Biologic Mechanism

Learning Theory

Learning theories have traditionally distinguished between two types of learning. One type, called classical conditioning, involves the pairing of two stimuli in a close temporal proximity. One of the two stimuli, known as the unconditioned stimulus, normally elicits some reflex behavior such as salivation, eye blink, or a change in skin conductance. The other stimulus, known as the conditioned stimulus, is neutral prior to the pairing but acquires the ability to elicit a response similar to the unconditioned response after the pairing process. The second type of learning recognized by learning theorists is known as operant conditioning. In operant conditioning, the response is generally thought of as emitted on a more or less voluntary basis, rather than being reflexively elicited by any particular stimulus. Also, the operant conditioning process involves the pairing of the stimulus dependent on the occurrence of a response. The paired stimulus leads to an increase in the frequency or the magnitude of the response and it is known as a negative reinforce if its removal leads to an increase in the frequency or the magnitude of the response.

Between 1928, when the two types of learning were formally distinguished, and the early 1960s, it was generally assumed that operant and classical conditioning were mutually exclusive processes. All voluntary skeletal motor behaviors were assumed to be subject to operant conditioning, while visceral and glandular responses mediated by the autonomic nervous system were assumed to be involuntary and modifiable only through classical conditioning. It was thought impossible that salivation to a light stimulus could be operantly reinforced by food. This view was retained until the early 1960s when groups of researchers in the Soviet Union, Canada, and the United States began a series of experiments designed to show that responses mediated by the autonomic nervous system can, in fact, be brought under a voluntary control through techniques that closely resemble operant conditioning.

Since the first suggestion regarding instrumental learning and operant conditioning, it demonstrated the medical potential of biofeedback by showing that the normally involuntary

autonomic nervous system can be operantly conditioned with the use of an appropriate feedback. By means of instruments, patients acquire information about the status of involuntary biological functions such as skin temperature and electrical conductivity, muscle tension, blood pressure, heart rate, and brain wave activity. Patients, then, learn to regulate one or more of these biological states that affect symptoms.

Biological Mechanisms

Biofeedback makes physiologic change possible by means of operant conditioning or trial-and-error learning, in which a response is learned and performed depending on whether that response is followed by reinforcement. For biofeedback to be useful, four conditions must be satisfied. First, there must be a readily detectable and measurable response such as the bladder pressure or the pelvic floor muscle activity. Second, there must be variability in that response with a detectable change as opposed to total paralysis. Third, there must be a perceptible cue such as the sensation of urgency that indicates to the patient when control should be performed. Fourth, because biofeedback is based on learning, it requires the active involvement of a motivated patient.

Taking basketball as an example, the information about where the ball went with each shot is called feedback. If both the coach and the novice were blindfolded, there would be no feedback, and the novice would not learn to improve. Some tense patients may not be aware of the fact that certain muscles are tense, and patients with neuromuscular disorders, or even their therapists, may not be able to discriminate small increases in the activity of paralyzed muscles or decreases in the contractions of spastic ones. They are like a blindfolded basketball novice and coach. However, a display of the electrical activity of the muscles (the EMG) can remove the blindfold and give them a better feedback about what the muscles are doing. This feedback might be in the form of a series of auditory clicks that get faster when the muscle contracts more or a tracing of the activity of one or more muscles as a dot draws the curve of a graph on a TV screen. Feedback from a measuring instrument that yields moment-to-moment information about a biological function is called biofeedback.

One of the advantages of biofeedback is that it allows small changes in the correct direction to be noticed and rewarded as success so that they gradually can be built up into larger changes. Eventually, patients learn to perceive these changes without the measuring instrument so that they can practice by themselves. Biofeedback should be especially effective in those cases where the patients cannot perceive their initial small correct responses or even may have the wrong perception of what they are doing.

Other advantages of biofeedback are that by making the early signs of slight progress conspicuous, it can encourage and motivate the patients, relieve their sense of helplessness, and serve as a coping response to reduce symptoms of stress. Instead of having something done to the patients, it teaches them to do something for themselves, increasing their confidence, or what has been called self-efficacy. This factor is particularly important when biofeedback is being used to treat symptoms that are elicited or aggravated by stress.

Early Development

Experiments on Humans

It was first shown that human subjects could learn to voluntarily dilate blood vessels of the finger in order to avoid or escape an electric shock if they were provided with visual information about their vasomotor activity. Subjects provided with an amplified auditory representation of their heart beat also were trained to accelerate their heart rate to avoid an electric shock to the ankle. Other responses generally considered involuntary were brought under voluntary control by providing subjects with feedback information about the targeted response and some form of operant reinforcement. Studies conducted in the 1960s also demonstrated operant conditioning of the skin conductance response and brain wave activity. Voluntary control over the firing of single motor units was demonstrated by providing subjects with auditory and visual displays of individual myoelectric potentials recorded from fine wire intramuscular electrodes.

Experiments on Animals

At about the same time that voluntary control of autonomically mediated behavior was being demonstrated in humans, parallel lines of research were in progress using various animal species. For example, thirsty dogs were trained to increase and decrease the flow of saliva using water as a reinforcer. Bidirectional changes in heart rate and blood pressure were also shown to be subject to operant conditioning in monkeys and rats.

Methods

The feedback instrument used depends on the patient and the specific problem. The most effective instruments are the electromyogram (EMG), which measures the electrical potentials of muscle fibers; the electroencephalogram (EEG), which measures alpha waves that occur in a relaxed state and the thermistor, which measures skin temperature (which drops during tension because of peripheral vasoconstriction). Recently,

fMRI (functional magnetic resonance imaging) has been used to identify both positive and negative emotional stimuli for stress management (neurofeedback).

Patients are attached to one of the instruments that measure a physiological function and translate the measurement into an audible or visual signal that the patients use to gauge their responses. For example, in the treatment of bruxism, an EMG is attached to the masseter muscle. The EMG emits a high tone when the muscle is contracted and a low tone when at rest. Patients can learn to alter the tone to indicate relaxation. Patients receive feedback about the masseter muscle, the tone reinforces the learning, and the condition ameliorates, with all of these events interacting synergistically.

Many less specific clinical applications (e.g., treating insomnia, dysmenorrhea, and speech problems; improving athletic performance; treating volitional disorders; achieving altered states of consciousness; managing stress; and supplementing psychotherapy for anxiety associated with somatoform disorders) use a model, in which frontalis muscle EMG biofeedback is combined with thermal biofeedback and verbal instructions in progressive relaxation.

Relaxation Therapy

Learning relaxation, therefore, involves cultivating a muscle sense. To develop the muscle sense further, patients are taught to isolate and contract specific muscles or muscle groups, one at a time. For example, patients flex the forearm while the therapist holds it back to observe tenseness in the biceps muscle. Patients are repeatedly reminded that relaxation involves no effort. In fact 'making an effort is being tense and therefore is not to relax.' As the session progresses, patients are instructed to let go further and further, even past the point when the body part seemed perfectly relaxed.

Patients would work in this fashion with different muscle groups, often over more than 50 sessions. Patients were also frequently left alone while the therapist attended to other patients.

Neurofeedback

Neurofeedback allowed, for the first time, voluntary self-regulation of brain activity through feedback and reward. Expectancies ran high and many premature announcements of clinical success based on single case studies or uncontrolled observations discredited the field early on. In the 1970s, Miller's demonstrations of operant control of autonomic (and central nervous system (CNS)) functions in curarized rats, supposedly proving 'voluntary' operant regulation of many bodily functions excluding mediation of the motor system through curarization, turned out to be difficult to replicate. Together with the clinical overstatements in the field of biofeedback, this historic incident virtually halted funding from the public sources and blocked large controlled clinical studies despite some indications of its efficiency. However, more recent studies suggested that some patients with drug-resistant epilepsy (mostly with secondarily generalized seizures) experienced a reduction in the number of ictal events during and after training consisting of self-regulation of slow cortical potentials (SCPs), an effect also reported using biofeedback of skin conductance

responses (GSR). Nagai et al. showed that learned increase in autonomic arousal through reduction of skin conductance decreased negative SCPs at the cortical level and thus increased seizures thresholds confirming earlier reports.

The clinical target populations for brain-machine interface (BMI) treatment consist primarily of patients with amyotrophic lateral sclerosis (ALS) and severe CNS damage including spinal cord injuries and stroke, resulting in substantial deficits in communication and motor function. However, an extensive body of literature started in the 1970s using neurofeedback training. Such training implemented to control various EEG-measures provided solid evidence of positive effects in patients with otherwise pharmacologically intractable epilepsy, attention deficit disorder, and hyperactivity ADHD. More recently, the successful introduction and testing of real-time fMRI and a near-infrared spectroscopy (NIRS)-BMI has opened an exciting field of interest in patients with psychopathological conditions.

Clinical Applications

Gastrointestinal Diseases

In the field of gastroenterology, an initial study focused on biofeedback applications in patients with fecal incontinence. Later, biofeedback applications for the treatment of chronic constipation due to pelvic floor dyssynergia (anismus, spastic pelvic floor syndrome, and puborectalis paradox), had been widely performed by pediatric and adult doctors. The goal of biofeedback training in gastroenterology is to restore a normal pattern of defecation. In patients with dyssynergic defecation, the goal of neuromuscular training is twofold: to correct the dyssynergia in coordination of the abdominal, rectal, and anal sphincter muscles to achieve a normal and complete evacuation; and to enhance rectal sensory perception in patients with impaired rectal sensation. This training consisted of improving the abdominal push efforts (diaphragmatic muscle training) together with manometric-guided pelvic floor relaxation followed by simulated defecation training.

The symptomatic improvement rate has varied between 44% and 100% in recent randomized controlled trials of adults with dyssynergic defecation. All of these studies have concluded, however, that biofeedback therapy is superior to controlled treatment approaches, such as diet, exercise, and laxatives, or use of polyethylene glycol, diazepam, or placebo, balloon defecation therapy, or sham feedback therapy.

Recently published meta-analysis showed that biofeedback in fecal incontinence was equally effective as nonbiofeedback therapy. For constipation, more than threefold superiority of biofeedback to nonbiofeedback, but equal efficacy of EMG biofeedback to other applications was shown. Other indications, including chronic proctalgia, irritable bowel syndrome, and functional dyspepsia, still need more data with prospectively designed randomized controlled studies.

Urinary Diseases

Biofeedback is a very specific treatment that can restore bladder control by teaching patients to modulate the mechanisms of continence using a pelvic perineal reeducation technique,

which uses a signal that is usually visual, but may be auditory, which allows the patient with an anorectal or perineal functional anomaly to understand and correct the trouble. Biofeedback has now gained several potential applications for urologic conditions, having been successfully used for patients with urologic disorders such as detrusor instability, detrusor sphincter dyssynergia, and enuresis. In a randomized trial involving older women with urgent urinary incontinence, the percent reduction in incontinence episodes was similar after 8 weeks of behavioral therapy with biofeedback therapy, after 8 weeks of behavioral therapy without biofeedback therapy, and after self-administered behavioral treatment according to a self-help booklet.

Enuresis describes intermittent incontinence at night and refers to any discrete leakage of urine at night. Therefore, dysfunctional voiding has been used as a broad term. The reason of dysfunctional voiding in children could include hyperactive pelvic floor, overactive bladder, incontinence, or lazy bladder syndrome. For children with hyperactive pelvic floor, biofeedback therapy focuses on the relaxation and a return of normal flow. For children with overactive bladder and incontinence, use of the guarding reflex of the pelvic floor musculature can maintain continence during uninhibited contractions. In addition, biofeedback can be used for these children to void optimally and ensure that there is no decompensation of the detrusor muscle that occurs with the lazy bladder syndrome.

Cardiovascular Diseases

Since the beginning of biofeedback in the 1970s, biofeedback was used to control heart rate and blood pressure in patients diagnosed with cardiovascular diseases. It remains unclear whether the biofeedback regarding heart rate variability has more or less potential than other types of biofeedback in patients with cardiovascular disease, but these preliminary observations suggest that it may be useful in improving symptoms and the quality of life. Regarding hypertension, blood pressure can be lowered by 6–10 mmHg when biofeedback is effective, which is less of an effect than what is observed with most antihypertensive medications. Thus, although biofeedback has a potential in hypertension, its efficacy is not well proven and the systemic trials are lacking.

Neurologic Diseases

Biofeedback methods in the treatment of migraine are based on the concept that various relaxation skills, including diaphragmatic breathing or visualization, were helpful to induce the relaxation response, which includes relaxation of the sympathetic nervous system and activation of the parasympathetic nervous system. Recently published meta-analysis showed that biofeedback can be supported as an efficacious treatment option for migraine and tension-type headache according to the Association for Applied Psychophysiology and Biofeedback and the International Society for Neurofeedback and Research criteria.

Epileptic patients who were refractory to anticonvulsant medications have been treated with biofeedback therapy based on EEG. Several positive outcomes were reported

especially regarding complex-partial seizures, an extremely difficult-to-treat seizure type. However, it still needs a randomized, controlled study to prove its efficacy.

Others

Early studies in patients with Raynaud's syndrome demonstrated that biofeedback alone or in combination with various procedures reduced the occurrence of vasospastic episodes, based on the concept that cold hands and cold feet are frequent concomitants of anxiety and also occur in Raynaud's syndrome. Exposure to cold during temperature biofeedback may enhance the effects of biofeedback alone.

Fibromyalgia syndrome and other myofascial pain had been treated with biofeedback therapy. Recently randomized controlled study regarding fibromyalgia based on EEG showed the significant efficacy by a significantly decreased theta/sensory motor rhythm ratio by EEG waves compared to baseline.

Biofeedback therapy based on EMG was also tried in treating bronchial asthma. Children who were instructed to reduce frontalis muscle tension via biofeedback and continue their strategies in the home setting showed improvement in pulmonary function testing compared with children who were instructed to maintain frontalis tension.

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Bipolar Disorder

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Glossary

Depression Depression is complementary to mania, with an extended period of depressed mood and increased sleep time accompanied by reduced speech, lack of motivation, and excessive caution. The very high risk of suicide in bipolar disorder is most apparent at the time when there is a switch between mania and depression. While there are many different accounts of the mechanism of the cyclicity and the opposite polarity of the two phases, the only compelling theory involves an interhemispheric switch that alternates between the complementary cognitive styles of the two hemispheres and becomes stuck on one side during an episode.

Fractal time A function (after Mandelbrot) of time that shows self-similarity, such that a change at one temporal scale affects all temporal scales. One of the first examples suggesting fractal time in the nervous system came from work on the neural clocks of *Drosophila*. A mutant fly with an altered *per* gene had a longer circadian period than normal (25–30 h), but was also found unexpectedly to have a longer period of the courtship rhythm, which is measured in seconds. The underlying mechanism of this finding is still not clear, despite much progress on the understanding of neural clocks, but there are now many more examples of fractal time in the nervous system. For example, humans with a prolonged perceptual rivalry cycle also have prolongation of other cycles, such as the nasal cycle, which may be many hours long instead of the normal 1.5 h. The concept of fractal time could explain why the prolonged perceptual rivalry cycle of bipolar disorder (8–10s instead of 1–2s) is also associated with much longer lasting alterations (>days) in mood.

Interhemispheric switch A neural mechanism that switches activation from one cerebral hemisphere to the opposite hemisphere. Because of the speed of the switch, it is difficult to visualize it in scanning studies such as fMRI that have time constants around 8–10s. The switch is present in all vertebrate brains, so its location and physiology can be determined by comparative studies. Neuropharmacological studies have further defined the properties of the switch. Activation of the cerebral hemispheres is achieved by dopamine, which produces an 'up' physiological state of activation and readiness for plastic change via the NMDA channels that are turned on. The rhythmicity of the switch is determined by serotonin input using serotonin 1A receptors, whose activation slows the rate of the switch. The most likely physical correlate of the switch in the human brain is the dopaminergic ventral tegmental area (VTA) in the ventral midbrain, with the rhythmic serotonin input coming from the raphe nucleus.

Mania An extended period of elevated mood and sleeplessness. Lack of sleep is not accompanied by tiredness, and perceptual rivalry studies of mania suggest that there is a

primary sleep–wakefulness alteration, rather than one secondary to the mania, mediated by increased time spent by the interhemispheric switch in the left hemisphere at the expense of the right. Manics have increased verbal fluency and may show great facility at fitting rhyme, alliteration, and rhythm to words. They lack caution and may spend unwisely, indulge readily in sexual adventures, and put themselves in harm's way. In an effort to reverse mania speedily, psychiatrists rarely pay any attention to the introspective aspects of mania. These involve striking alterations in the perception of space–time with a dramatic alteration in the feeling of causation that the manic attributes to his/her will for events happening around them. Manics are also attracted by light, bodies of water, and the horizon. In keeping with the interhemispheric switch formulation, there are a number of pieces of evidence that activation is 'stuck' in the left hemisphere during mania. These include a large, almost complete preference for the left hemisphere percept in perceptual rivalry and continuous blockage of the left nostril (left hemisphere activation), instead of the usual alternation between right and left nostril over hours as part of the interhemispheric nasal cycle.

Mood stabilizer These drugs are the key agents for the prevention and treatment of the manic and depressive episodes of bipolar disorder. Mode of action is hard to define in the absence of an accepted model for the episodes of bipolar disorder and given the diverse pharmacology of these agents. One element of their action may be anticonvulsant, since many mood stabilizers (but not all) also act to prevent convulsions, such as valproate, carbamazepine, and topiramate. The 'kindling' process, by which cortical neurons progressively increase their sensitivity to the same input, is moderated by anticonvulsants and could explain a role in bipolar disorder where 'kindling' has been implicated in the triggering of later episodes and the 'falling in love with one's mania' phenomenon. Lithium ions are not particularly anticonvulsant, but do have an effect in development that might be relevant to the likely role of interhemispheric switching in bipolar disorder: right–left asymmetrical structures are eliminated during development by lithium. Since the ventral midbrain of the adult has many aspects shared with embryonic brain, such as high concentrations of retinoic acid not seen in other parts of the adult brain, lithium may be acting by reducing the right–left asymmetry (and thereby the magnitude of the interhemispheric swing from right to left) in this part of the brain. The complexity of the circuit from midbrain nuclei to cortex and back again leaves open many possible sites of action for mood stabilizers.

Nasal cycle This is caused by a slow interhemispheric switch in the hypothalamus. The modal period of the cycle

is 90 min, but in some individuals, the cycle can end even as fast as 20 min, and such individuals are considered to be rare. Many more individuals are found in the long tail of the distribution which stretches to many hours, where those who suffer from bipolar disorders are also found. The link between a slow nasal cycle and a slow rivalry cycle illustrates the principle of 'fractal time' where a slow switcher in perceptual rivalry (seconds) is also a slow switcher on other interhemispheric rhythms such as the nasal cycle (many hours). The alternating, side-to-side patency of the nasal passages can be readily visualized using MRI, but a satisfactory, economical method involves subjective estimation of patency by breathing out through each nostril alternately while the opposite nostril is occluded. Occlusion of one nasal passage is brought about by increased blood supply to that side, which is accompanied by increased blood supply to the brain on that side. In other words, increased activity in the Right hemisphere (as in depression) is accompanied by occlusion of the R nostril and patency of

the L nostril, which can be a diagnostic sign of depression if it is unrelieved by a switch.

Perceptual rivalry A constant, unvarying stimulus may nevertheless be accompanied by an oscillatory perception. By definition, the perceptual oscillation must arise in the brain rather than the stimulus and has been used repeatedly as a tool for the study of consciousness. The oscillation is usually binary, between two alternative interpretations, in keeping with experimental work showing that the perceptual alternation corresponds to a switch between activation of the two hemispheres. In some cases (e.g., plaid motion rivalry where the coherent, 'diamonds' alternative is associated with the left hemisphere and the incoherent, 'sliding' percept with the right) it is possible to gauge which hemisphere is active from the choice of the two alternatives, but in many cases the 'hemispheric assignment' is arbitrary. A variety of perceptual rivalries can be seen at www.uq.edu.au/nuq/jack/rivalry.html

Bipolar disorder, formerly manic depression, is a cyclical disturbance of mood in which episodes of mania and depression alternate.

Mechanism

Basic biological principles clearly underpin bipolar disorder because it is the most heritable of all mental health disorders. The probability is better than 60% that an identical twin will develop bipolar disorder if the other twin is affected. An acute episode of mania certainly has a 'biochemical feel' because of the sleeplessness, elevated mood, and accelerated verbal behavior, so it is easy to understand the emphasis on a biochemical basis for the disorder. But it needs to be realized that biochemical theories provide only a unidimensional gradation of symptoms and do not deal with the bipolar aspect of the disorder, in which there is a switch between complementary aspects, mania, and depression. In contrast to wholly biochemical accounts, there is an interhemispheric mechanism of bipolar disorder that adequately accounts for the complementary aspects.

The dynamics of the interhemispheric switch are determined genetically, as shown by studies of monozygotic twins, and show significant slowing in bipolar disorder. The disorder has the highest heritability of all mental disorders, a fact that may be connected to the high heritability of the interhemispheric switch rate.

Prevention

Post and Weiss have shown that the first episode is always triggered by an environmental stressor, but that later episodes may become spontaneous. This finding has the important implication that bipolar disorder is preventable. One needs to only identify a vulnerable individual before the first episode and then intervene with lifestyle modification

or mood-stabilizer medication. Since the dynamics of the interhemispheric switch are highly heritable and relatively stable throughout life, they can be measured noninvasively using perceptual rivalry. Interindividual variation in rivalry switch rate is more than an order of magnitude, making those susceptible individuals with the slowest switch rates prominent.

Medications

The key medications for bipolar disorder are 'mood stabilizers.' These drugs have an obscure mode of action and have commonly been used to search for the etiology of bipolar disorder.

Mood Stabilizers

1. *Lithium ions*: Have longest history of any mood stabilizers, since Cade showed almost miraculous elimination of mania using lithium. The long history probably explains the longer list of side effects compared with more recent, popular, drugs such as sodium valproate, which have not had time to accumulate such a list. The dose of lithium and its blood level are based on its antimanic effect and may be higher than that required for a maintenance mood-stabilizing effect, whose longer time course is difficult to titrate.

Lithium has nearly a dozen documented biochemical effects. Two effects of lithium are relevant to the interhemispheric hypothesis, a reduction in the degree of asymmetry in brain development and a phase reduction of circadian rhythm.

2. *Sodium valproate*: Its anticonvulsant action may relate to 'kindling' in the very plastic hemispheres.
3. *Omega-3 fatty acids, DHA, and EPA*: These naturally occurring molecules from seafood have a mild, mood-stabilizing effect that is best supplemented with more powerful drugs such as lithium. They may play an important role in prevention.

4. *Carbamazepine*: Powerful mood stabilizer and anticonvulsant that is complicated by a high incidence of serious side effects.
5. *Lamotrigine*: Has the opposite phase reduction to lithium and is more effective, in consequence, on the depressive phase of bipolar disorder. Now often combined with lithium to control both manic and depressive phases.
6. *Topiramate*: Has a powerful effect on the interhemispheric switch and is used as a mood stabilizer of last resort, in addition to its role as an anticonvulsant.
7. *Dopamine antagonists*: Haloperidol and olanzapine (dopamine antagonists) are sometimes used as mood stabilizers in a maintenance role in addition to their well-accepted role in acute treatment of mania. They have major side effects, such as massive weight gain, which limit their long-term use.

Age of Onset

The disorder can appear first at any age, but peaks in late adolescence/early adulthood when sexual relations provide the greatest source of environmental stressors.

Medication and Mood Stabilization

There are two broad classes of medications used in bipolar disorder: (1) mood stabilizers and (2) antidepressants (neuro-transmitter (usually 5HT) re-uptake inhibitors).

The first class does not have any obvious subjective effects. For example, putting aside initial side effects such as nausea, there is no subjective effect of lithium ions, which could be placed in a person's breakfast cereal without him or her noticing. Instead of expecting subjective effects, one needs to keep an extended record of mood changes, which are moderated by lithium ions even though there may not be a detectable introspective mood shift that is attributable to lithium.

Mood Stabilizers: Mode of Action

Understanding the mode of action of mood stabilizers is limited by the lack of an underlying model of bipolar disorder. In fact, many researchers have tried to 'reverse engineer' the basis of bipolar disorder by starting with the actions of the mood stabilizer and then working backwards to try to understand how it might moderate the fundamental cause of bipolar disorder. This approach has not been successful. However, if the evidence that bipolar disorder is based upon a dysrhythmia of interhemispheric switches is accepted, there is plenty of evidence that illuminates the mode of action of the mood stabilizers. For example, it is known that the hypothalamic, suprachiasmatic nuclei can act as a daily interhemispheric switch, whose circadian rhythm is differentially affected by lithium and lamotrigine. Lithium acts to reduce the action of the phase advance mechanism, while lamotrigine acts on the phase retardation mechanism in the circadian cycle. This would explain the action of these two mood stabilizers, with lithium being most effective on mania and lamotrigine most effective on the depressive part of the manic—depressive cycle, since

mania is triggered by a phase advance and depression by a phase retardation. Related to these effects is lithium's action to reduce hemispheric asymmetry. Episodes are characterized by an extreme asymmetry in the interhemispheric switch ('Stuck switch'), with a Left (L) bias in mania and a Right (R) bias in depression. Lithium has a strong action in eliminating R—L asymmetry during development and this is likely to apply also to the interhemispheric switch because it retains many embryonic features not found elsewhere in the adult brain, such as a high concentration of retinoic acid.

Antidepressants (Reuptake Inhibitors)

Billions of dollars in profits flow from this class of drugs. The first of the antidepressants was Prozac, but there are now dozens with a similar action. In view of the large profits, one might expect a detailed mode of action to have appeared that would help one to understand how these drugs bring about mood change. There is detailed biochemical information about how they inhibit the reuptake mechanism in 5HT nerve terminals, but one has to go to animal studies to get a more global understanding of these drugs. One key fact is that the hemispheric asymmetry that is no obvious in the motor and speech system is also present at the level of transmitters like 5HT, with the 5HT system much more well developed in the Right (R) hemisphere. So increasing the overall level of 5HT by blocking reuptake will desensitize the R hemisphere, which has more 5HT transmitter and receptors. In other words, these drugs will enhance the relative activity of the Left (L) hemisphere, thus improving mood because of its cognitive style to choose an alternative and to ignore the rest. The enhancement of L hemisphere action by these drugs have been observed in a number of different animal models.

The danger of this mechanism of action is that it can precipitate mania, also an L hemisphere paroxysm. Mania is a frequent outcome when a depressed person, treated with one of these antidepressants, is actually suffering from unrecognized 'bipolar depression'.

Perceptual Rivalry and Interhemispheric Switching

The cerebral hemispheres have complementary cognitive styles, according to the work of Ramachandran and Pascual-Leone. It makes logical sense to alternate between the denying, choosing, hypothesis-forming abilities of the left hemisphere and the all-accepting, discrepancy-detecting abilities of the right hemisphere. An oscillatory interhemispheric switch has been identified using psychophysics, comparative studies, and neuropharmacology. Caloric vestibular stimulation can be used to activate one hemisphere for around 30 min and can be used to induce a manic-like state (left hemisphere activation), a depressive state (right hemisphere activation), or to reverse mania by activating the right hemisphere. The temporal precision of transcranial magnetic stimulation's disruptive effects can be used to manipulate the switch so that left hemisphere phenomena are interrupted when the left hemisphere, but not the right hemisphere, is manipulated. And vice versa for the right hemisphere. The switch is difficult to demonstrate with functional magnetic resonance imaging (fMRI) because of

the sluggish response of this brain scanning method, but Mao used a very slow version of perceptual rivalry to show an associated interhemispheric switch using fMRI.

Perceptual rivalry is an oscillation of perception that switches between different alternatives in the face of an unchanging, if ambiguous, stimulus. The source of the oscillation must be endogenous to the brain, because the sensory input is unchanging. Extensive work has shown that the source of perceptual rivalry is interhemispheric switching. Caloric stimulation activates one hemisphere and simultaneously increases the proportion of time spent seeing the percept linked to that hemisphere. Likewise, transcranial magnetic stimulation applied to one hemisphere interferes in a highly specific and time-locked fashion with one percept but not the other.

The interhemispheric model predicts that perceptual rivalry will be linked specifically to mania or depression, and this is what occurs. The onset of mania is accompanied by increasing predominance of the left hemisphere percept (e.g., horizontal in H/V rivalry, or coherent 'diamonds' in plaid motion rivalry and approaching motion in form from motion sprees, etc.). Depression is accompanied by increasing predominance of the right hemisphere percept. The bias for one percept disappears and returns to the balanced state where the two percepts are seen for roughly equal amounts of time during recovery.

It is commonly assumed that the interhemispheric switch mechanism is the corpus callosum, the large bundle of fibers that interconnects the hemispheres, but this is not true. Interhemispheric switching is universally phylogenetical in vertebrates and both fish and birds switch without a corpus callosum. Moreover, a back-and-forth mechanism between the hemispheres would be slow and clumsy compared with bilateral projections from the brainstem that have balanced conduction velocities.

The switch has been dissected pharmacologically by examining the effects upon perceptual rivalry of catecholamine and serotonin analogues. The oscillatory mechanism, responsible for the individual's stable and highly heritable switch rate, involves 5HT-1A receptors, whose location in the brainstem help provide confidence about the location of the switch. The switch itself is probably a collection of cortically projecting dopaminergic neurons in the ventral midbrain.

Jet Lag

The circadian shifts of jet lag provide one of the most powerful triggers of an episode. For example, a manic tendency can be triggered to full mania by flying eastward 7–10 h. Similarly depression can be triggered by westward flight.

Fractal Time

There is strong support from a number of independent studies for a prolongation of the perceptual rivalry cycle in bipolar disorder. In turn, this cycle measured in seconds, has been shown to be an interhemispheric cycle. Interhemispheric switches can explain all the features of bipolar disorder, but there is a problem linking the seconds time course of the interhemispheric switch of perceptual rivalry and the days/weeks time course of the switches between mania and depression. This problem is solved by the realization that there are many interhemispheric switches of different time course, such

as the nasal cycle, whose time course is measured in hours and the information from the genetics of circadian cycles that a mutant cycle with a prolonged circadian cycle will have prolonged cycles at all scales from seconds to days ('fractal time').

Bipolar I Versus Bipolar II

A diagnosis of Bipolar I requires at least one hospital admission for mania and has an incidence in the general population around 1%. Those with this diagnosis have a bias of the interhemispheric switch for the left hemisphere, so that if the switch gets stuck it is more likely on the left, that is, mania. Bipolar II is more common, around 3%, and involves recurrent episodes of depression without frank mania. Normal members of the population as a whole show a bias toward the right hemisphere (the 'realistic' side) in the interhemispheric switch. This bias is reflected in a similar rightward bias in the slower switch of Bipolar II, which is therefore more likely to get stuck on the right, depressive side.

Famous Bipolars

The genes for bipolar disorder are widespread in all cultures. The incidence of Bipolar I is around 1% and for Bipolar II much higher; so it can be inferred that there is a selective advantage for these genes that prevents them from being eliminated from the population. The 'Bipolar trait' of a prolonged interhemispheric switch time has consequences that are independent of possible episodes. These include a prolonged attention span that is useful in creative problem solving and composition. Since time is a proxy for sensitivity when receptor activation can be prolonged but receptor numbers not increased, a prolonged switch rate means increased sensitivity. Virginia Woolf illustrates this extraordinary sensitivity in her ability to detect fine nuances and injustices in the interactions of others and to place them in her writings. Woolf was also acutely aware of the rise of Hitler, whose presence was felt nearby despite an actual distance of hundreds of miles, and this sensitivity to the dictator ultimately contributed to her suicide. In a family of children with one bipolar, its sensitivity is commonly recognized as the first to detect the onset of an approaching storm, presumably via barometric pressure changes, and to recognize subtle nuances in interpersonal relations that escape other family members.

Winston Churchill (Bipolar II) was voted the man of the twentieth century, along with Albert Einstein, because of Churchill's leadership in the Battle of Britain. His success may be attributable to a number of features of his bipolar brain, such as the ability to hold the same problem in his mind for much longer than the usual time, extreme sensitivity to small cues about the enemy's intentions provided by their movements, and the lack of normal sleep patterns that enabled a problem to be faced at any time.

Kay Jamison has shown that the chances of finding a bipolar among a group of poets or artists is 20× normal and has further shown the cyclic musical output of Schumann that was linked to the oscillations of bipolar disorder and eventually resulted in his suicide.

fMRI

fMRI relies on the magnetic signal that can be induced by a powerful magnet in hemoglobin molecules that have the Fe^{2+} molecule exposed to water by the loss of an oxygen molecule. In other words, the system detects deoxyhemoglobin in venous blood that is draining from an area of intense activity. It takes about 8s for the deoxygenated venous blood to flow after neural activity begins; so this technique is relatively sluggish and does not pick up the rapid changes when the hemispheres switch back and forth. Some studies have seen switching using fMRI by choosing a form of perceptual rivalry that has a very slow switch rate.

Conclusion

Advances in neuroscience are beginning to clarify the underlying cause of bipolar disorder. Recognition of the predisposing

conditions of this highly heritable disorder may soon be possible and lead to its prevention, by intervention before the first episode.

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Birth Order, Effect on Personality, and Behavior

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Glossary

Big five Personality trait model that proposes five basic dimensions of personality, conscientiousness, agreeableness, extraversion, openness to experience, and neuroticism.

Birth order An individual's rank by age within their family of birth. For example, in a family of three children, there is a firstborn, secondborn (or middleborn), and a lastborn.

In a family of four children, there is a firstborn, secondborn, thirdborn, and lastborn. In this case, both the second- and thirdborn could also be considered middleborn.

Fitness Fitness can be thought of as the relative probability of survival and reproduction of an individual.

Niche theory Frank Sulloway's theory suggesting that birth order influences the strategies siblings use to gain resources and minimize sibling conflict.

Parental investment Any parental expenditure (time, energy, etc.) that benefits one offspring (through increased

chance of survival and reproduction) at the expense of investing elsewhere (in other offspring, mating opportunities, etc.).

Parent-offspring conflict The conflict resulting from differences in optimal parental investment to an offspring from the perspectives of parent and offspring. Typically, an offspring will desire greater levels of investment for a longer period of time than is optimal from the parental perspective. Well-studied examples include weaning conflict and maternal-fetal conflict.

Personality A set of characteristics possessed by an individual that influence their thoughts, attitudes, and behaviors.

Reproductive value An individual's expected future reproduction.

Sibling competition Conflict between siblings, often over parental investment or other resources. It is also referred to as sibling rivalry.

Introduction

Psychologists have long been fascinated with birth order and its possible role in shaping personality. Over 75 years ago, Adler suggested that personality traits are related to an individual's ordinal position within the family. He believed that firstborns would be resentful when they were displaced by the arrival of a new child and that this would lead to neuroticism and substance abuse; that lastborns would be spoiled and emotionally immature; and that middle children would be the most stable as they were never dethroned or spoiled. Adler's work led to a plethora of studies examining the relationships between birth order and just about everything from personality to psychiatric disorders, intelligence, and creativity. Today, there is reasonable agreement that genetic influences account for a substantial portion (around 40%) of the variance in personality but that an almost equal amount of variance (about 35%) is due to nonshared environment with the remainder due to shared environment and measurement error. Birth order is one part of that nonshared environment, for while siblings usually grow up in the same family, they do not experience that environment in the same way. Recently, researchers such as Frank Sulloway have suggested that birth order shapes strategies for dealing with the family environment that are part and parcel of our personalities. This article will highlight the current thinking on birth order as a strategy shaped by differential parental investment and sibling competition (as originally proposed by Sulloway) and its effects on personality and behavior.

Parental Investment

Many nonhuman species do not engage in parental care. The fact that people do invest significantly in their own offspring is

testament to the substantial reproductive benefits that result from such costly care. Not only do parents provide the basic physical means for survival (food, shelter, and protection), they invest greatly in fostering the development of skills that are required for offspring success across the life span. Theoretical models of the evolution of parental solicitude suggest that parents will often treat their offspring differently in relation to a number of variables including offspring age, sex, birth order, parental age, and cues of phenotypic quality.

Parental investment in an offspring (as first elucidated by Robert Trivers) is any investment that a parent makes that increases the likelihood of that offspring's survival and reproduction at the cost of that parent's ability to invest in other offspring (either current siblings or future ones). In birds, we conceive of this in terms of feeding and nest protection. In people, it covers a wide range of activities from food and shelter to education, piano lessons, or figure skating. Generally, an offspring's fitness increases with the amount of parental care received. Extremely low levels of parental investment can result in the loss of an offspring; a minimum amount is required for survival. But there is also a point of diminishing returns at very high levels of investment beyond which offspring are unable to capitalize on any further investment.

The relevance of birth order to parental investment is related to several factors, including age of the offspring and age of the mother. An offspring's expected contribution to parental fitness rests mainly in their reproductive value. This value increases with age until puberty, making older immature offspring more valuable from a parental fitness perspective than younger ones. It is this assurance of parental favoritism, as well as an early absence of sibling contenders for a share of parental attention, that makes firstborn children defenders of parental values and the status quo while laterborns are more likely to be rebellious.

However, offspring age is not the whole story. As parents themselves grow older, the fitness value of any one offspring increases relative to the parent's residual reproductive value. As parents grow older, their own chance of reproducing again drops, thus older parents have been observed to invest more in offspring, all else being equal, than younger parents. This can be clearly seen in the dramatic decreases in maternally perpetrated infanticide as a function of maternal age. As a result, while firstborns may have an inherent advantage in terms of parental investment, there is a growing willingness of older parents to invest highly in their lastborn, their last chance to invest so to speak. In fact, lastborns are the only birth order to receive their parental investment without the competing demands of a younger sibling. This would seem to imply that middleborns may lose out in terms of parental investment and attention and there are a number of recent studies that support this. However, relatively few researchers have focused on middleborns; the majority have focused on the contrast between firstborns and laterborns.

Sibling Competition

But parental investment on its own does not tell the whole story. Sibling competition has a role in how the battle for parental resources plays out among a group of siblings. Natural selection shaped mechanisms for sibling competition just as it shaped mechanisms for discriminative parental solicitude. Strategies for sibling competition can manifest in several ways including dominance hierarchies, niche picking, and deidentification.

Dominance Hierarchies

In dominance hierarchies, the type of strategy siblings adopt in order to deal with resource competition is influenced by differences in size and strength (usually related to age). Older siblings are able to physically intimidate their younger and smaller brothers and sisters. Several aspects of personality, including dominance and assertiveness on the part of firstborns, can result from this dynamic. Typically, the younger sibling is best served by low-power strategies. Rather than physical force or the threat of it, the baby of the family often appeals directly to the parent in any sibling dispute. The middleborn is typically forced to negotiate on their own, with the parental support given to the youngest.

Niche Picking

Sulloway has argued that children adopt different roles or niches within the family. Some of this are the result of genetic differences, some are connected to sex differences, and some are due to birth order. Specialization of roles within the family, like specialization of species in the wild (the most famous example being Darwin's finches), reduces levels of competition. Specialization also makes children more unique. If your older brother is an awesome football player, a younger brother may be better served by a different niche, attempting to excel in a different sport or a totally different area such as academics or arts. Eldest siblings also often occupy the role of surrogate parent with its sense of responsibility and adherence to rules.

For later born children, there is no advantage to trying to duplicate that role; they have to find their own niche and their openness to experience with less adherence to rules and authority facilitates this.

Deidentification

Deidentification is the process by which siblings try to differentiate themselves from one another. In particular, when there is a very short birth interval and siblings are close in age, their needs are very similar and so competition for parental resources is more acute. Diversifying in terms of strategies leads each sibling to their own niche in the family, reducing direct sibling competition. This type of process is likely to lead to greater differences between siblings who are next to each other in birth order (such as first- and secondborn as opposed to first- and thirdborn).

Personality: The Big Five

Thousands of articles have been published focusing on birth order and its effects on personality, behavior, and intelligence. Recently, attention has been called to methodological issues, in particular the need to control for differences in such variables as socioeconomic status (SES) and family size. While relatively little attention has been paid to the possible interaction of gender and birth order, some evidence suggests that there is a special role, with costs and benefits, for the firstborn boy, whether or not he has an older sister. There have been some researchers who have suggested that birth order differences are nonexistent, while others have documented through individual studies and meta-analysis that there are a number of consistent patterns to be found. One useful way to think about personality in this setting is as a strategy. Birth order differences in personality reflect the different strategies siblings adopt in their attempts to acquire the resources they need, whether they are acquired from family or friends. Here, I will concentrate on the Big five classification of personality dimensions which focuses on the dimensions of conscientiousness, agreeableness, extraversion, openness to experience, and neuroticism. This is not the only model of personality, but it is the one most often focused on (in whole or in part) in studies of birth order and personality. While not all studies of birth order and these factors are consistent, they are quite frequently in accordance with evolutionarily informed predictions.

Conscientiousness

Characteristics associated with conscientiousness include: organized, neat, perfectionist, responsible, practical, and dependable. People who score high on conscientiousness are those that tend to get ahead in life, the industrious go-getters. The result is success in a variety of domains including elementary/high school and college as well as high job performance and satisfaction. High conscientious translates into playing by the rules which usually results not only in job success but also success at maintaining relationships, those that are sexual or romantic as well as family ties.

As one would predict from niche theory, firstborns generally score higher on conscientiousness than their later born

siblings. Family and peers rate them as more disciplined and thorough than their younger siblings. This should not be surprising for several reasons. One is that firstborns often adopt a surrogate parent role within the family, looking after and perhaps also bossing around their younger brothers and sisters. Responsibilities and organizational skills develop along with this role. Two, because of their privileged status as the first child, it is in their best interests to be the supporters of the status quo which generally means being parent-like, reinforcing the parental view of them as not only dependable but obedient. They identify with parents and typically take the resulting traditional approach. This family role is not typically available to laterborns. They must find another parental investment route, exploring and developing their abilities in other areas. The lastborn rarely gets, given the responsibilities that foster the development of conscientiousness, though middleborns sometimes do.

Agreeableness

Those traits most highly associated with the factor of agreeableness are: kind, understanding, helpful, cooperative, trusting, and softhearted. People who score high in agreeableness are highly invested in getting along well with others. They favor strategies of negotiation rather than those of power and are likely to withdraw from confrontation, finding such discord distressing. Harmony and cooperation are important to them in all their relationships, especially with family and friends. As a result, they tend to be well liked by others and are often best served by finding careers where this trait can pay off for them, in particular, those where establishing a friendly relationship with the customer or client is essential.

Generally, laterborns score higher than firstborns here. While firstborns have the physical size advantage with which to dominate their younger siblings, laterborns need to find other strategies to get their way. Rather than power strategies, laterborns use such tactics as negotiation, appealing to their sibling's sense of fairness (not usually the most effective), and puppy-like appeals to parents for help. Middle children, stuck between the dominant firstborns and babies of the family, are often rated most highly on agreeableness. These traits allow them to get what they need, whether at home or from friends. Their negotiating and mediating skills are forged by their position in the middle. They are neither the favored first nor the indulged last. Overall, laterborns tend to score high in social popularity, a reflection of how easy others find their company.

Extraversion

Extraversion includes traits such as talkative, energetic, assertive, and outgoing. Social interaction is the key here. Extraverts often take on positions of leadership; first to offer their opinion and suggestions. They are often quick to approach others, especially on the dating scene. They often report greater levels of happiness. Many people consider extraversion a very positive trait but it can be problematic as they are often easily distracted from a task by their social interactions which can be hazardous under some circumstances (such as driving down the LA freeways!).

Birth order effects on extraversion have often been confusing because some of the specific components, like assertiveness and dominance, are ones that firstborns score highest on.

On the other hand, components such as sociability are ones on which laterborns score higher than firstborns. As a result, many studies do not show clear birth order effects on extraversion unless they break it down into those aspects associated with dominance and those associated with sociability. It should not be surprising that firstborns score high in dominance-related aspects of extraversion considering their often pseudo parental (and sometimes physical) authority in the family and the expectations parents typically have for them and their future success. Laterborns follow a different strategy, one of being outgoing, willing to try new things, meet new people; they are extraverted in a highly sociable way, finding pleasure and excitement in the company of others.

Openness to Experience

Traits associated with openness to experience include being imaginative and creative, inventive, open to unusual ideas, adventure, and nonconformity. Those scoring high in this dimension are independent-minded and willing to tolerate more ambiguity (or less certainty). As a result, they are often the first to entertain new concepts and beliefs (which are sometimes later confirmed and other times refuted). Some studies have indicated a relationship between openness and IQ.

Birth order effects on this factor are also somewhat mixed with firstborns scoring higher on aspects that focus more on intellect and intelligence, while laterborns score higher on measures that center on the desire for novelty, experimentation, and a taste for the unconventional. This interest in being unconventional is perhaps behind the tendency for laterborns to identify themselves (as well as for others to identify them) as rebellious, or the rebel of the family. Some studies have indicated that middleborns may be the most rebellious birth order as they are the ones most disadvantaged in the distribution of parental investment. This personality trait facilitates their ability to find their own unique niche by making them more willing than others to embrace the new and untried.

Neuroticism

The factor represented by neuroticism is also sometimes referred to as emotional instability. Individuals who score high on neuroticism are emotionally reactive and tend to experience persistent negative emotional states such as anger and anxiety. Life is full of challenges and emotional instability reflects the way people deal with such stressful events. Those that are emotionally stable weather the storms of life; they react but not disproportionately. Those that score high on neuroticism are rocked by challenges; they disrupt their lives and emotional balance so that they are often perceived as moody or unpredictable. They are more likely to have high levels of anxiety and are more likely to develop posttraumatic stress disorder in response to highly emotional negative events. As you might imagine, this can put a strain on their personal and professional relationships.

The relationship between birth order and this factor seems quite small. However, one related birth order effect that shows up relatively consistently is that middleborns score lower in self-esteem than their siblings. This may be a result of the lower levels of parental investment they receive in combination with their unclear role in terms of family structure and parental

expectations. They do not know quite where they fit in and this anxiety may be contributing to their issues of self-esteem. There are also a few studies that suggest higher levels of neuroticism in firstborns but the results are typically trends rather than significant relationships. If the connection is there, it is more likely related to the higher levels of anxiety and concern over success (and meeting parental expectations) that sometimes play a role in firstborns' drive to succeed.

Birth Order and Behavior

The impact of birth order on behavior has been demonstrated in a number of domains including interactions with family, friends, sexual partners, the workplace, religion and politics, consumer behavior, risk-taking, and trust and cooperation. While a majority of people recognize that birth order plays a role in the family setting, the magnitude of birth order effects outside the family is still open to debate. This section will illustrate some of the better-documented connections between birth order and behavior, emphasizing that birth order effects are often strongest when the context or situation activates those strategies that were effective in the family setting. We will return to this issue of context in the section on methodology.

Family Interactions

While a significant proportion of personality can be attributed to genetics, birth order differences in personality are forged by the family environment. Birth order is not a genetic trait; it is a proxy for the differences that exist between siblings such as size, power, experience/skills, etc. As such, we would expect birth order to have a greater impact on family relationships and family-related behavior than in any other domain. This has been demonstrated in a wide range of studies looking at everything from emotional closeness and gift-giving to frequency of contact with family members. Firstborns tend to have more contact with siblings and parents than laterborns. First- and lastborns report family identity to be more important to their sense of self as well as feeling closer to parents than middleborns. Middleborns are also less likely to be family genealogists. While firstborns spend more money on gifts for family, middleborns spend more on friends. Middleborns generally have less contact (once they are no longer living at home) with parents than first or lastborns. However, middle-born children do tend to have solid sibling ties, reporting being more satisfied with sibling support than other birth orders. In the absence of strong relationships with parents, they tend to be more sibling- and peer-oriented, seeking advice and support from peers as opposed to parents. Such birth order differences, particularly those of middleborns, are a reflection of the degree of perceived parental investment as well as their sense of their natal family as a source of support. They are more likely to report friends as their greatest social support and they appear to invest more in them, as discussed in the next section.

Friends and Lovers

People often remark on how friends can be like family and many individuals share intensely close friendships. Does birth

order influence the quality or quantity of friendship? What about romantic relationships? Studies in the past several decades have suggested that laterborns, in some cases particularly middleborns, are more popular with their peers. They certainly score highly on the prosocial aspects of extraversion as well as agreeableness, something you would expect from those who seek out friends and get a good response. Middleborns also hold more positive views on friends and friendship generally, seeing them as confidants, reliable sources of help, support. In turn, they are perceived as being good friends, empathetic, reliable, and trustworthy. And middleborns do seem to care about being seen this way, wanting to be perceived as good friends.

When it comes to sexual relations, there are some interesting birth order differences. Firstborns tend to wait until a later age for their first sexual experience. They tend to be slightly younger, however, when they first have a child and seem to have slightly more children overall. Waiting a bit in terms of having sex fits with their more conscientious and cautious nature, as opposed to the move of adventurous lastborns who have often also heard about the sexual exploits of their older siblings. When it comes to marriage, reports from research and marriage counselors seem to suggest that the most happy marriages are those between a first- and a lastborn or anyone with a middleborn. This is another place where the ability to negotiate and mediate conflict that middleborns learn from being sandwiched between siblings comes in handy. Two firstborns seem to produce the most unstable marriages. And some data suggests that there are differences in the likelihood of cheating when in a monogamous relationship with middleborns being the least likely to cheat, followed by firstborns, while lastborns were the most likely to stray.

Workplace

Workplaces are highly variable in nature. People may interact with the same small group of people all the time, or with many different people most of the time. There may be a clear chain of command or a more horizontal structure. But for most people, coworkers are not family. And yet, work can be one place where birth order can have a significant impact not only in terms of such things as occupational choice but also personal dynamics. There are indications that career choice can be influenced by birth order. Firstborns tend to be drawn to the business field as well as accounting and finance. Middle children are often found in greater numbers in service fields, or ones focusing on justice or interpersonal ties between clients or coworkers. Lastborns tend to often gravitate to creative environments, teachers, and performers.

Business leaders and CEOs may also conduct their business differently as a result of their own birth order and resulting personality. They are often assumed to be firstborns, and many are, as many firstborn-associated traits are likely to lead to success at the top of the business world, such as dominance, tough-mindedness, and competitiveness. All part of the perception of the traits required for the drive to the top. But there are also leaders who are laterborns and they have a very different business style producing working environments more characterized by a personable style of interaction with employees and a willingness to take risks with strategies and products,

shaped by the inclination of laterborns to believe in the new and untested. It is not so much that one birth order is more successful here than another but that the style of their success is different. Firstborns tend to find their success in traditional established environments. Laterborns often find a more creative nontraditional style, characterized by flexible and original approaches.

Religion and Politics

Religion and politics are two topics often to be avoided in social situations. Both can be influenced by birth order. As Frank Sulloway thoroughly documented in his 1996 book, *Born to Rebel*, birth order has had a significant impact on who supports radical political and scientific change with laterborns leading the charge. Laterborns, like middleborn Darwin himself, provided much of the initial support for his theory of evolution by natural selection, a concept incredibly revolutionary for the time. A majority of those most resistant to radical change have been firstborns and when firstborns are leaders of revolutions, they typically have less ideological implications (Einstein and relativity, for example). Laterborns' openness to experience makes them more willing to adopt new and radical ideas perhaps especially when there are strong ideological implications (such as Copernicus' theory that the earth revolved around the sun as opposed to the traditional sun rotating around the earth viewpoint).

When it comes to being a politician, firstborns are overrepresented among holders of political office. Perhaps that is one reason that they are predisposed to use political rhetoric in their political speeches. My own study on the use of kin terminology in political speech indicated that both firstborns and lastborns were somewhat susceptible to the use of such language. Appeals to 'my brothers and sisters' were more influential with these birth orders. Interestingly, middleborns were least responsive to such overtures. From an evolutionary perspective, this is not surprising. If middleborns receive less attention and investment from parents, they are less likely to see family as a valuable resource with shared best interests. Instead, friends may be a better source of resources and shared interests and, in fact, middleborns were more responsive to the use of terms indicating friendship in political speech than they were to those of kinship.

There have been relatively few examinations of birth order and religion. Some indicate middleborns score lowest on the importance of religion in their lives, perhaps a reflection of their tendency to score highest on rebelliousness. An individual's sense of religiosity is highly influenced by parental religiosity and the nature of the parent-offspring relationship. Adhering to parental religious views reflects a willingness to conform to parental desires and expectations (i.e., more commonly seen in firstborns). Middleborns, in the unconventional and rebellious way, are less likely to accept the family religious tradition. They do, however, often score high in terms of spirituality.

Consumer Behavior

This is an area you might not immediately assume is influenced by birth order. But there have been a number of

intriguing findings that suggest birth order can shape aspects of consumer behavior. Consider, for example, the middleborn son. In the face of firstborn parental favoritism, he has striven to be the best he can be, not always the top dog but in the top echelon. What kind of marketing campaign might get him to buy your product? Perhaps one that signals that he is not second best, that he is a winner. A study by Reid Claxton suggested that indeed, in an ad campaign that focused on exactly that train of thought, a secondborn son who was second in his class etc. and finally purchased a first-class pen, middleborns were more likely to identify with the character in the ad copy (with the assumption that this would be likely to lead to a future product purchase of this brand of pen). One might also predict that laterborns would be more open to innovative or new products and perhaps less attached to brand names. And indeed it does appear that laterborns are more open to product innovation while firstborns seem to be more susceptible to the influence of others (normative influences and status markers) when it comes to product choices.

Risk-Taking

Considering the impact of birth order on openness to experience, it should not be surprising that studies have noted birth order effects on risk-taking. They are a variety of ways to look at risk-taking, from survey instruments to actual behaviors. Greater participation in high-risk sports such as skydiving, automobile, and motorcycle racing, which are highly correlated with sensation seeking and related to aspects of openness to experience, has been widely noted on the part of laterborns in comparison to firstborns. In fact, a recent study by Sulloway and Zweigenhaft on the risk-taking behaviors of brothers in major league baseball demonstrated that younger brothers were more likely to attempt the high-risk strategy of base stealing and were also more likely to succeed at it than their older siblings. Older siblings were more successful in terms of batting success. While both birth orders were successful, they went after their success in different ways, excelling at different aspects of the game. Other work has indicated that laterborns are at greater risk of indulging in binge drinking, smoking, pot, and more likely to engage in acts of civil disobedience. Sulloway in his 1996 book also documented that laterborns were more likely than firstborns to travel to remote parts of the world, risking death due to accident or disease.

Trust and Cooperation

There are a number of reasons to expect birth order to have an impact on trust and cooperative behaviors. For one thing, birth order influences scores on such personality aspects as altruism and tendermindedness (components of agreeableness) with laterborns scoring higher than firstborns. Being altruistic, agreeable, and tender minded would tend to increase the willingness to give others the benefit of the doubt and engage in activities that would be to everybody's benefit. Some studies have indicated that laterborns are perceived by others as more trusting and straightforward than firstborns. Firstborns even describe themselves as more self-centered and less empathetic than others. Firstborns are also less trustful. There is also some evidence that middleborns may be the most trustful of the

three birth orders toward nonkin and the most concerned with maintaining the balance of reciprocity from their side (in other words, they want to be seen as good reciprocators or cooperators).

Some Methodological Issues

There are several methodological issues relevant to any discussion of the impact of birth order on personality or behavior. The first concerns surveys and personality inventories. Much personality research relies on self-report personality inventories, such as the Revised Neo Personality Inventory (NEO PI-R) which measures the five-factor model. Are people being honest in their responses and are they the best judge of their own traits? Research has compared self-report with peer or parental reports (even sibling pair reports), with a number describing similar findings, some only finding effects for one of the report types. For those who argue that birth order only has an impact within the family domain, if peer reports agree with self or parental, they have a problem to explain as this provides support for the claim that the influence of birth order extends outside the family domain. Another approach is to look at actual behavior, rather than self-report or inventories. Measures of actual behavior rather than surveys may provide more clear and consistent results. An additional problem is the number of participants needed to get reliable birth order effects. Some of the clearest evidence is in the largest sample size studies which make some study designs a challenge for many psychologists.

A related issue also has to do with study design. Most of the early work, and much current research still, involves studies that compare birth orders across, as opposed to within, families. Obviously, there are significant benefits to a within-family design as it controls for between family differences in SES, ethnicity, and family size. Siblings are in direct conflict with their own brothers and sisters, not siblings from other families (for parental investment anyway) so that comparisons between first- and lastborns, for example, are best done with siblings from the same family, such as in Paulhus, Trapnell, and Chen's study of personality and achievement and Sullo-way and Zweigenhaft's recent study of birth order and baseball performance of brothers in the major league.

The question of the relevance of birth order outside the family setting is a good one that needs to be further addressed. Some behaviors are very much situation-specific. Perhaps some of the best approaches to the impact of birth order on behavior are ones that attend to this and look for birth order effects in relevant domains (ones where the context is similar to that of the family or contains family-type cues) in the real world (like major league baseball) or by recreating appropriate situations in the laboratory. For example, I conducted a study, mentioned previously, that examined the impact of kin terms in political speech. This is a context where we might expect susceptibility to kin cues. The speaker is usually trying to convince his audience of their shared agenda and best interests, reinforcing the sense of the people and the orator as a group with common goals. It is a situation ripe for the manipulation of kin cues and there are many documented examples of the use of such terminology in speeches on public record. I expected such techniques with kin language would be less

effective for middleborns who are perhaps less inclined to see their family as always having their best interests at heart (as opposed to their siblings). Similarly, my work with Martin Daly on genealogists and those people who chronicle their family histories was a real world behavioral test of birth order's influence on such a behavior. Again we found that middleborns were underrepresented among family historians. More work needs to be done with attention to the behavioral context and how it may or may not trigger family sentiments and psychology.

One final methodological consideration is that of the specific birth orders. Historically, the majority of birth order research has lumped middleborns and lastborns together and compared them to firstborns or simply compared first and last. Based on a Darwinian or niche model, this is simply not the best approach. We would expect substantial differences between middleborns and both firstborns and lastborns not only on personality dimensions but also in terms of behavior. A number of those who have separated the middleborns out have indeed found such differences. Hopefully more researchers will continue to attend to the relevance of all three birth positions and not merely consider firstborn versus all others. Middleborns are in fact unique in their particular parental investment situation (eldest and youngest do tend to have periods of parental monopolization that the middleborn never has). This has consequences for middleborn traits and behaviors beyond simply not being the first.

Summary

Birth order is one of many environmental factors that play a role in the development of personality and a variety of behaviors. A Darwinian family niche perspective makes clear predictions about the ways in which birth order effects will play out and many of them have been tested in numerous research programs over the past 10 years. In general, higher scores on conscientiousness are found in firstborns while laterborns score higher on agreeableness, and openness to experience. The dominance aspects of extraversion are high-scoring for firstborns while the sociability ones are high-scoring for lastborns. Neuroticism has much smaller and less clear-cut results. These distributions of personality traits serve individuals of different birth orders in their attempts to secure the best resource acquisition outcome possible. In turn, they also shape their behavioral tendencies as children and adults.

See also: Big Five Model and Personality Disorders; Competition; Family Systems; Parenting; Parent–Offspring Conflict.

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Body Dysmorphic Disorder: A Review

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Glossary

Cognitive behavior therapy A type of therapy used in either individual or group settings in which the therapist attempts to change distorted thoughts and problem behaviors through the identification and modification of these thoughts and changing the rewards for behaviors.

Compulsion Repetitive behaviors (e.g., mirror-checking, camouflaging with makeup or hats, etc.) or mental acts (e.g., comparing with others) undertaken to prevent or reduce anxiety or stress and not to provide pleasure or gratification.

Double-blind A research method in which the identity of the treatment and control groups is concealed (or 'blinded')

from the researchers administering the treatment condition and research subjects involved in the study to eliminate biased results.

Impulsivity A predisposition toward rapid, unplanned reactions to either internal or external stimuli with diminished regard for negative consequences.

Obsession Persistent ideas, thoughts, impulses, or images which are experienced as intrusive and inappropriate and which cause marked anxiety and/or distress.

Serotonin-reuptake inhibitor A class of drug that acts as a neurotransmitter uptake inhibitor on serotonin receptors within the brain.

Introduction

Most people are dissatisfied with some aspect of their appearance. In fact, more than half of all women and nearly half of all men in the United States are dissatisfied with the way they look. For some people, however, the preoccupation with perceived defects in physical appearance is excessive. These patients suffer from body dysmorphic disorder (BDD), a disorder characterized by significant distress, impaired functioning, social withdrawal, and repeated attempts to hide or correct a perceived defect in appearance.

Despite having been described around the world for more than a century, BDD was not included in diagnostic systems until DSM-III and ICD-10. DSM-III included BDD as an example of an atypical somatoform disorder and DSM-III-R provided the diagnostic criteria. Although DSM-IV allows people with delusional BDD to receive a diagnosis of both delusional disorder and BDD, ICD-10 classifies delusional BDD as a variant of delusional syndrome.

BDD is a relatively common disorder. Although studies within the general population have found prevalence rates ranging from 0.7% to 2.4%, studies of clinical samples suggest higher rates: 7% among cosmetic surgery patients; 8.0% in patients with major depression; 8.8% among dermatology patients; 11% in patients with social phobia; 8–12% in patients with obsessive–compulsive disorder (OCD); 13.1% among psychiatric inpatients; and 39% in patients with anorexia nervosa.

BDD affects both children and adults. BDD usually starts in adolescence and appears to be about equally common in men and women or slightly more common in women.

Clinical Characteristics

Individuals with BDD are preoccupied with the idea that some aspect, or aspects, of their appearance look abnormal. They may describe these body areas as being unattractive, deformed, disfigured, ugly, hideous, or 'not right.' Although any body part

can be the focus of concern, and most individuals with BDD are preoccupied with numerous body areas, the face or head is commonly the body area that troubles BDD patients, with a focus on skin flaws, defects, blemishes, wrinkles, scars, or supposed acne. Typical patients are preoccupied with their appearance for several hours each day. The majority also have ideas of reference, thinking that others notice their imagined defect and react to it with dislike or disgust. As a result, many BDD patients limit their social interactions and may become quite isolated. In response to their obsessive thoughts, patients may spend hours checking their skin in the mirror and camouflaging their skin with excessive and unneeded makeup.

Nearly all persons with BDD perform repetitive, time-consuming behaviors. These behaviors focus on examining, improving, being reassured about, or hiding the perceived defect. These behaviors are often described as 'compulsive' in the sense that the urge to perform them is strong and difficult to resist. They are also sometimes referred to as 'safety behaviors,' meaning that they are performed to prevent a feared catastrophe (e.g., camouflaging 'ghost-like' skin with bronzer to prevent feared scrutiny by other people).

The most common behaviors are camouflaging (e.g., with hair, a wig, makeup, body position, sunglasses, a hat, or other clothing), comparing one's appearance with that of other people, excessively checking the perceived flaw in mirrors or other reflecting surfaces (e.g., windows), excessively grooming (e.g., applying makeup or tweezing, styling, or cutting hair), and seeking reassurance that the body area looks normal or acceptable to others. The behaviors are unlimited and varied, however, and may consist of dieting, excessive exercising or weightlifting, touching or measuring the body part, tanning, buying excessive amounts of beauty products and compulsive shopping, (which can lead to financial indebtedness), repeated clothes changing, seeking surgery or medical treatment, and using potentially dangerous anabolic steroids to bulk up.

Nearly all patients with BDD experience impairment in social and occupational/academic functioning as a result of their appearance concerns. People with BDD also have

markedly poor quality of life, and approximately one quarter of patients with BDD are so distressed that they attempt suicide. However, the severity of BDD varies, with some people appearing to lead relatively normal lives despite the suffering and interference they experience.

Gender Differences

The prevalence of BDD appears to have a fairly equal gender distribution. A study examining gender disparities in 200 individuals with BDD reported more similarities than differences. While men were more likely to be older and single, women were significantly more likely to have a lifetime diagnosis of an eating disorder (42.3%), pick at their skin (52.6%), and use camouflaging techniques such as wearing concealing clothing or using makeup. Women were also more likely to be concerned with their buttocks (28.5%) and thighs (28.5%) while men were more concerned with body building (36.5% vs. 9.5%). Men are also more likely to report an alcohol use disorder (55.6% vs. 36.5%) and engage in weight-lifting behavior (25.4%), however, both men and women equally engage in behaviors such as dieting (37.5%) and excessive exercise (21.5%).

Diagnosing BDD

Numerous studies have found that BDD usually goes unrecognized in clinical settings, probably because clinicians fail to screen for the disorder and patients are too ashamed of their symptoms to spontaneously reveal them. Diagnosing BDD, however, is usually straightforward and can be accomplished by asking patients if they are unhappy with how they look or if they worry excessively about their appearance. An affirmative answer can be followed up with questions determining the degree of distress that these concerns cause and whether they cause functional impairment. DSM-IV criteria are met when the patient reports being preoccupied with a nonexistent or minimal appearance flaw that causes clinically significant distress or impairs functioning. It must also be ascertained that the appearance concerns are not better accounted for by an eating disorder. Simple self-report and clinician-administered screening and diagnostic measures are available. It is especially important to screen for BDD in patients who present with some of the disorder's clues – for example, the behaviors described above, histories of seeking cosmetic surgeries, ideas or delusions of reference, or being housebound.

Comorbidity

Most individuals with BDD have other co-occurring psychiatric disorders. Lifetime major depression (84%), substance use (49%), social phobia (40%), and OCD (33%) are the most common. Personality disorders, particularly avoidant (38%), paranoid (38%), and obsessive-compulsive (28%), are also common.

In a recent study of 176 BDD subjects, 49% had a lifetime substance use disorder and a majority of subjects (68%)

reported that BDD symptoms contributed to their substance use. The lifetime substance use disorder rate in subjects with BDD in this study is notably higher than reported rates in the general population (26.6–29.0%). In addition, those with a lifetime substance use disorder had a significantly higher rate of suicide attempts. The high lifetime rate of substance use disorders and the very high rate of suicide attempts in subjects with a substance use disorder suggest that clinicians should carefully screen BDD patients for a substance use disorder, as the presence of a lifetime substance use disorder may have treatment implications.

Relationship to Other Mental Illnesses

Obsessive-Compulsive Disorder

Although BDD is classified as a somatoform disorder in DSM-IV, it has many similarities to OCD – most notably, the presence of prominent obsessions and repetitive compulsive behaviors. There also appear to be differences between these disorders; for example, BDD patients are less likely to be married, possibly because of their avoidance of dating due to an intense fear of evaluation by others. BDD subjects also have poorer insight into their illness and are more likely to think about suicide or make a suicide attempt because of their disorder. They also have higher lifetime rates of major depression and social phobia than individuals with OCD. In addition, BDD appears more often characterized by shame, embarrassment, low self-esteem, and rejection sensitivity – features that it shares with social phobia.

Major Depressive Disorder

BDD and depression often co-occur and both disorders are characterized by low self-esteem, rejection sensitivity, and feelings of unworthiness. Unlike depression, however, a core feature of BDD is prominent obsessional preoccupations and repetitive compulsive behaviors. Many depressed patients focus less on their appearance, even neglecting it, rather than overfocusing on it. In addition, onset of BDD usually precedes that of major depression, suggesting that BDD is not simply a symptom of depression. Perhaps most important, BDD appears to respond to serotonin-reuptake inhibitors (SRIs) but not non-SRI antidepressants, which is an important difference between BDD and depression that has clinical implications. Another apparent difference is that BDD does not appear to respond to ECT, although data on this topic are very limited.

Anorexia Nervosa

BDD and anorexia nervosa share disturbed body image and a preoccupation with perceived appearance flaws. Many patients with anorexia are preoccupied with nonweight aspects of appearance, such as the size of the stomach or thighs, or even body areas such as the skin or nose. Conversely, some BDD patients are preoccupied with body weight and body shape. Both disorders involve intrusive thoughts about appearance, dissatisfaction with appearance, and an overemphasis on the importance of appearance to the evaluation of self-worth.

Both BDD and anorexia may also involve appearance-related ritualistic or repetitive behaviors (e.g., mirror checking

and body measuring), and some BDD patients diet or excessively exercise. Furthermore, people with anorexia or BDD may avoid places, activities, and ways of dressing that provoke self-consciousness about how they look. In addition, in both disorders a quest to improve appearance drives attempts to change the body's appearance – for example, through weight control in anorexia and excessive grooming or cosmetic surgery in BDD.

While anorexia and BDD have similarities (as noted above), as well as a hazy area of overlap, they also appear to have some important differences. For example, while 90% of patients with anorexia are women, this appears to be the case for only 50–60% of patients with BDD. The two disorders also have somewhat different comorbidity patterns. In a controlled family study of OCD, BDD was more common in first-degree relatives of OCD probands than control probands, whereas the eating disorders were not; this finding suggests that BDD and not eating disorders be considered part of a familial OCD spectrum. In addition, a study examining 45 patients with anorexia or bulimia nervosa, 51 patients with BDD, and 50 nonclinical controls, found that the eating disorder and BDD groups had equally severe body image disturbance and negative self-esteem. However, the eating disorder subjects had more widespread psychopathology, whereas the BDD subjects reported more negative self-evaluation due to appearance and more avoidance of activities due to self-consciousness about appearance. Importantly, BDD and anorexia seem to respond differently to treatment. Unlike patients with anorexia, a majority of patients with BDD improve with SRIs, some very robustly. And while preliminary data indicate that BDD often responds well to cognitive behavioral therapy (CBT), CBT has generally been less effective for anorexia nervosa.

Although BDD and anorexia nervosa have various similarities and differences, it is also important to recognize that the disorders may also co-occur. Recognizing BDD in patients with anorexia nervosa is important because the co-occurrence of the two disorders may have clinical implications. In the only study of this issue, 16 patients with both disorders were compared to 25 women with anorexia nervosa alone. Those who had anorexia nervosa plus BDD had significantly poorer functioning, had been psychiatrically hospitalized more often (6.3 times vs. 3.8), and had three times the rate of suicide attempts (63% vs. 20%).

Social Phobia

Previous research has indicated high rates of lifetime co-occurring social phobia in patients with BDD (31.1–37%). The fear of negative evaluation by others and social reclusiveness are hallmarks of both disorders and, in some cultures, BDD is actually regarded as a form of social phobia. Treatment regimens for both disorders have indicated the efficaciousness of certain serotonergic medications, including fluoxetine and clomipramine, indicating at least some shared neurobiological processes between BDD and social phobia. Research specifically examining those with social phobia alone or those with BDD alone, however, has yet to be obtained. Given the significant overlap between the two disorders, screening patients with either social phobia or BDD for the co-occurrence of the other disorder is imperative.

Pathologic Skin Picking

Some research suggests that BDD and pathologic skin picking may share common phenomenological links. In fact, a previous study of patients with BDD found that 81.8% picked at their skin to improve appearance. Therefore picking behaviour may be viewed as a symptom of BDD in many individuals. A recent study of 53 individuals diagnosed with pathological skin picking (excluding those individuals who picked primarily because of appearance), however, found that no individual had co-occurring BDD. This study highlights the heterogeneity of picking. Picking may be a symptom of a disorder such as BDD as well as an independent compulsive behavior. Clinicians should therefore be aware of the possible heterogeneity of picking as treatment options may differ. If seen as an independent disorder, picking may respond to glutamate agents but may respond preferentially to serotonergic medications when it is a symptom of BDD.

Neurobiology

Although the etiology of BDD is most likely multifactorial (biological, psychological, sociocultural), serotonin dysregulation has been associated with BDD. BDD symptoms have been exacerbated after tryptophan depletion and have had their onset after abuse of ciproheptadine, a serotonin antagonist.

Neuropsychological and brain imaging studies have also suggested that there may be impairment of the frontal–striatal and temporo–parietal–occipital circuits which process facial images and emotional information. In previous neuroimaging studies, subjects with BDD demonstrated greater total white matter compared with controls and a leftward shift in caudate asymmetry, which might be suggestive of a striatal pathophysiology similar to that of OCD.

A small functional imaging study of six BDD patients, using single photon emission computed tomography (SPECT), showed variable, discrepant findings including relative perfusion deficits in bilateral anterior–medial temporal and occipital regions and asymmetric perfusion in parietal lobes.

Clinical observation and neuropsychological testing indicate that BDD patients hone in on details of certain appearance features, usually their face, at the expense of global or configural aspects. BDD patients may process faces in a piecemeal manner, whereas healthy controls' perception of faces may be more configural and holistic. The left inferior frontal gyrus and right amygdala in individuals with BDD demonstrate functional hyperactivity for processing faces and their size correlates with symptom severity. These regions may be involved in pathological face processing that underlies the core symptoms of BDD.

Two recent functional magnetic resonance imaging studies in BDD that examined visual processing of faces found that individuals with BDD demonstrated abnormal activation patterns that included greater left hemisphere activity in regions including the inferior frontal gyrus, as well as abnormal amygdala activation compared to controls. Using voxel-based morphometry, a second study found significant positive correlations between severity of BDD and volumes of the left inferior frontal gyrus and the right amygdala.

The structural and functional studies to date suggest a visual and emotional processing deficit involving the inferior frontal

gyrus and amygdala. Caution, however, is required when attempting to interpret data from preliminary studies conducted in small samples of BDD patients in whom comorbidity is common. Although important early insights have been gleaned from research to date, our understanding of the neurobiology of BDD remains lacking.

Treatment

Many people suffering from BDD seek and receive surgical and nonpsychiatric medical treatments (e.g., dermatologic) for their perceived appearance flaws. Available data suggest that such treatments are usually ineffective and that appearance concerns usually persist unchanged. Many patients do not report their symptoms to their physician. A study of 50 patients with BDD reported that only 38% had told their general practitioner of their body concerns. For patients who do report their symptoms, 92% report feeling dissatisfied with their treatment. This makes sense, since BDD involves an obsessional body image disturbance that is not based on reality; changing a physical feature would not be expected to diminish the disorder's core pathology.

Nonpsychiatric Treatments

Individuals with BDD often seek and receive treatment from nonpsychiatric sources. Approximately 63% of BDD patients have sought treatment from dermatologists and almost 75% of those requesting dermatological treatment received it. Antibiotics were most commonly prescribed, as well as isotretinoin or dermabrasion for perceived acne. Only 9.8% of all dermatological treatments led to an improvement in BDD. In a study of 11 patients with BDD, 7 (63.6%) sought treatment from a dermatologist and four of those patients actually received treatment. In the cases in which treatment was received, no improvements in BDD were observed.

Surgical treatments are also common. A study assessing cosmetic surgery patients found that 7% met BDD criteria. Studies on BDD patients have illustrated that 23.2–26% have undergone one or more surgical interventions on their perceived defect. However, unlike most cosmetic surgeries which result in fairly high levels of satisfaction (78–90%), patients with BDD report dissatisfaction with surgical inventions more often than not. In fact, a survey of 178 cosmetic surgeons who had operated on patients with BDD found that in 43% of cases the patient was more preoccupied with the perceived defect after the surgery than before it. Furthermore, despite the high number of surgeries performed, only 1% reported satisfaction and free of BDD symptoms following surgery.

Pharmacotherapy

Case series and open-label studies suggest that selective serotonin reuptake inhibitors (SSRIs), such as citalopram, escitalopram, and fluvoxamine have shown benefit in treating BDD. In addition, the antiepileptic medication levetiracetam has recently demonstrated promise in reducing BDD symptoms in an open-label study of 17 subjects treated for 12 weeks (mean dose of 2044.1 ± 1065.2 mg day⁻¹).

Two placebo-controlled trials of serotonergic medications have been conducted. In the first, 29 subjects with BDD were

randomized to a 16-week cross-over study of clomipramine (mean dose of 138 mg day⁻¹) and desipramine (mean dose 147 mg day⁻¹). Clomipramine was superior to desipramine in the acute treatment of BDD symptoms.

In the second placebo-controlled study, 67 subjects with BDD were randomized to either 12 weeks of fluoxetine (mean dose of 78 mg day⁻¹) or placebo. Fluoxetine was significantly more effective than placebo for BDD beginning at week 8. Eighteen (53%) of 34 assigned to fluoxetine and 6 (18%) of 33 assigned to placebo were responders.

Although some treatments, including serotonergic medications such as fluoxetine and clomipramine, are encouraging treatments for BDD, there is insufficient evidence at this time to definitively recommend these as first-line treatments. Consequently, larger controlled studies are necessary to properly identify efficacious treatments (Table 1).

Psychotherapy

CBT is another promising approach for BDD. Studies have found that BDD often significantly improves when the following approaches are used: cognitive restructuring (e.g., developing more accurate and helpful beliefs about appearance), exposure (e.g., exposing the perceived defect in social situations and preventing avoidance behaviors), response prevention (stopping compulsive behaviors, such as mirror checking), and behavioral experiments (empirically testing hypotheses – i.e., dysfunctional thoughts and beliefs). Additional components, such as mirror retraining and mindfulness, may also be used. CBT has demonstrated effectiveness in treating BDD in both individual and group formats.

There have been three controlled psychotherapy studies in BDD. In the first two, 12 weeks of CBT was compared to wait list. In one study, 22 of 27 subjects with BDD no longer met diagnostic criteria for BDD after treatment with eight 2-h sessions of CBT. In the second study, those subjects receiving CBT reported significant changes on specific measures of BDD and depressed mood compared to those assigned to wait list.

In the only other controlled study, ten subjects with BDD participated in a 6-week course of behavioral therapy followed by 6 months of maintenance treatment. Subjects received a standard behavior therapy protocol which consisted of exposure in vivo and in imagery, with response prevention. Following treatment, a 6-month maintenance program was instituted for five subjects, with the other five serving as controls. Subjects improved when using exposure with response prevention. Although all subjects remained symptom free at follow-up, those in the maintenance program continued to improve. Longer follow-up demonstrated that at 12-, 18-, and 24-month follow-up assessments, subjects participating in the maintenance program were more efficient in managing limited symptom return and had significantly lower anxiety and depression. It is unclear, however, whether participants in the maintenance program were more efficient in managing limited symptom return etc., relative to their pretreatment assessment or relative to the control group.

Similar to conclusions reached for pharmacotherapeutic interventions for BDD, a dearth of information currently exists on psychotherapeutic treatment efficacy. CBT appears very promising, however, larger studies are needed to decipher

Table 1 Medication trials in body dysmorphic disorder

Medication	Mean dose (mg day ⁻¹)	Study design	Subjects	Duration	Results ^a
Clomipramine; Desipramine	138.0 ± 87.0	Double-blind cross-over design	29 randomized; 18 completed	16 weeks	Clomipramine significantly more effective than desipramine; 65% of clomipramine and 35% of desipramine subjects were responders
Fluoxetine	77.7 ± 8.0	Double-blind	67 randomized (fluoxetine = 34; placebo = 33); 59 completed (fluoxetine = 31; placebo = 28)	1 week placebo lead-in; 12 weeks of treatment	Fluoxetine significantly more effective at weeks 8–12; 53% of active and 18% of placebo group were responders
Pimozide augmentation of fluoxetine	1.7 ± 1.0	Double-blind	28 randomized (pimozide = 11; placebo = 17); 19 completed (pimozide = 6; placebo = 13)	8 weeks	Pimozide augmentation of fluoxetine was not more effective than placebo; 18.2% of active and 17.6% of placebo group were responders
Fluvoxamine	238.3 ± 85.8	Open-label	30 enrolled; 18 completed	16 weeks	63.3% responders
Fluvoxamine	208.3 ± 63.4	Open-label	15 enrolled; 12 completed	10 weeks	66.6% responders
Citalopram	51.3 ± 16.9	Open-label	15 enrolled; 11 completed	12 weeks	73.3% responders
Levetiracetam	2044.1 ± 1065.2	Open-label	17 enrolled; 11 completed	12 weeks	60% responders

^aResults are presented for intent-to-treat analyses, except for the clomipramine study, which used a minimum treatment analysis.

whether CBT or another form of therapeutic intervention should be utilized for BDD.

Conclusion

BDD causes significant distress and impairment in functioning, and it is associated with an unusually poor quality of life. Because this disorder appears relatively common, it is important to screen for BDD in clinical settings. Research on the treatment of BDD is in an early stage, so our understanding of the most effective treatments is still incomplete. SRIs, however, appear efficacious, particularly when used at relatively high doses. In addition, CBT, using a combination of cognitive and behavioral techniques, may also be beneficial.

Future research needs to address clinical strategies to minimize the underrecognition of BDD and to improve proper treatment. Because of the high rates of comorbidity in patients with BDD, treatment studies need to include subjects with co-occurring disorders and thereby attempt to understand how these other disorders affect treatment response. Finally, more research is needed to address the pathophysiology of BDD (e.g., by incorporating imaging and genetics). As with any disorder, understanding etiology should allow for more effective treatments.

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Relevant Website

<http://www.ocfoundation.org> – International OCD Foundation.

See also: Body Image; Cognitive Behavior Therapy; Obsessive–Compulsive Disorder.

Body Image

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Glossary

Body image A generic term used to describe a variety of specific phenomena that relate to an individual's perception of his or her body.

Body image disturbance Any form of affective, cognitive, behavioral, or perceptual disturbance that is directly concerned with an aspect of physical appearance.

Body mass index (BMI) This is the most widely used index of weight status. It is a ratio of weight (kg) per height

squared (m). Cutoffs for weight status in adults are: underweight (19.99 or less), average weight (20–24.99), overweight (25–29.99), obese (30 and above).

Incidence The number of new cases of a disease or disorder in a defined population during a specific period of time.

Meta-analysis A method of combining effect sizes across studies with similar independent variables and outcomes.

Prevalence The number of cases of a disease or disorder that exists in a defined population at a specified time.

Introduction

Body image is a subjective, self-evaluation of appearance. It can have a profound effect on how one perceives his or her world and, among other things, can affect an individual's self-esteem, mood, eating behaviors, and social interactions. Negative body image is often described as body image dissatisfaction or body image disturbance. The two terms are often used interchangeably; however, some experts highlight a very important distinction. Body image dissatisfaction is just one component of body image disturbance. The latter is a combination of body-related dissatisfaction, significant emotional distress as a result of the dissatisfaction, and impairment in psychosocial functioning. An extreme form of body image disturbance is body dysmorphic disorder.

Body image disturbance used to be considered a phenomenon that occurred in primarily Western societies, but this trend has shifted in recent decades with the export of Westernized culture and fashion trends via television, magazines, and the Internet. Unfortunately, this has likely contributed to the increased prevalence of body image dissatisfaction and body image disturbance throughout the world. A recent global study reconfirmed these results. The study consisted of females aged 15–64 from 10 countries: Brazil, Canada, China, Germany, Italy, Japan, Mexico, Saudi Arabia, the United Kingdom, and the United States. This investigation found that appearance-related body image disturbance is indeed a global phenomenon: 67% of females avoid doing basic activities (e.g., going to work/school, voicing their opinion, engaging in physical activity, etc.) because they feel badly about the way they look and 90% of females want to change the way they look with the greatest dissatisfaction stemming from body weight and shape followed by height.

Weight, shape, and height are the primary areas of body image dissatisfaction for females worldwide, but there is variation among what aspects of appearance they most want to change after that. The variation is partially dependent on traditional, culturally accepted ideals of beauty and partially dependent on more contemporary, cross-cultural comparisons of beauty. Depending on country, females have varying levels of desire to change their hair, skin complexion, eye shape, eye color, and the overall appearance of their face.

Although much of the research in this area has focused on adult women, recent investigations of younger women, boys, and men indicate that there is also a high level of disturbance in these groups. For men and boys, the particular dimension of dissatisfaction appears to primarily focus on muscularity concerns, rather than level of body fat or overall size. In particular, over the past 10 years, a relatively new subtype of body dysmorphic disorder, muscle dysmorphia, has been described in males who have extreme concerns regarding their level of muscularity.

History

Body image has a rich history in the fields of philosophy, medicine, and psychology. The term body image originated during the late 1800s. Neurologists, with the help of Gestalt psychologists, were trying to understand phenomena that alter body perception as a result of traumatic brain insult or injury. They concluded that there may be an internal mental representation of body information, which they called body image. The concept of body schema is credited to Head, one of the foremost researchers at that time. The concept arose from the discovery that sensory changes accompanied brain lesions.

Although Gestalt psychologists were part of the early discoveries in body image, neuropathology dominated the investigation of body experience. Psychology and psychological variables were rarely considered until Schilder, a neurologist, reconceptualized body image as a multidisciplinary field of study. Schilder argued that body image should be studied from neurological, sociocultural, and psychological viewpoints. Since that time, psychology has embraced the study of body image, and it has been studied from the social, developmental, and clinical perspectives.

Within clinical psychology, body image has been studied from several schools of thought. For decades, psychodynamic theory was the predominant lens through which body image was conceptualized and researched. One of the leading psychodynamic researchers, Fisher, pioneered the theory of body image boundaries. According to the theory, the body is a boundary between the self and the external world. Projective

techniques were used to test the concepts of barriers and penetration, which were considered measures of the strength and permeability of the body image boundary. Shontz was a key figure in shifting the focus of body image from a psychodynamic viewpoint to one that focused more on the physical aspects of the body. He suggested body image be studied from the viewpoints of cognitive theory, field theory, and Gestalt psychology. Since Shontz's time, the study of body image has almost exclusively remained in the realm of physical aspects of the body. The majority of current research focuses on physical appearance, body weight, and body shape concerns. There are several theories that seek to explain body image and body image disturbance within these contexts. The following section offers a brief review of contemporary theories of body image disturbance, as well as emerging evidence in support of each theory.

Theories of Body Image Disturbance

Sociocultural Approach

The sociocultural perspective is an approach to understanding human behavior that focuses on how the values of society affect the values and behaviors of individuals. A sociocultural theoretical model of body image and body image disturbance posits that current societal standards of beauty emphasize the importance of thinness for women and muscularity for men. While this ideal is omnipresent and regularly reinforced through media, parents, and peers, it is often very difficult to achieve, if not completely unattainable.

Social comparison theory is a subcomponent of a sociocultural approach that proposes that humans engage in continuous comparisons of themselves with others in their social environment as a process of collecting information about one's standing on some dimension. Within the context of body image, comparison of one's weight, shape, and overall appearance to that of others provides information about that individual's relative appearance. Research has shown that while women frequently make body-focused comparisons, individuals vary in the degree to which they engage in social comparisons of appearance and in their tendency toward upward or downward comparisons. As would be anticipated, research has suggested that individuals with greater body dissatisfaction tend to engage in more appearance-focused comparisons. When upward comparisons are made, they are associated with an increase in negative affect, body dissatisfaction, and thoughts of exercise, especially among women who report high preexisting levels of body dissatisfaction. A recent meta-analysis of 170 studies revealed a significant relationship between social comparisons and increased body dissatisfaction ($d = 0.77$), which was strongest among young women, compared to men and older women. This indicates a strong and reliable link between appearance-based comparisons and feelings of dissatisfaction with one's body.

Media exposure studies, in which participants view depictions of the thin or muscular ideal, have also provided support to the sociocultural perspective of body dissatisfaction. A meta-analysis on the role of media in body image concerns among women brought together the findings of experimental and correlational research to examine the effect of media exposure on internalization of the thin ideal and body dissatisfaction.

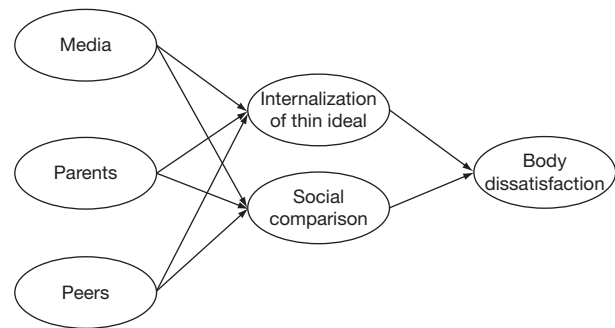


Figure 1 Tripartite influence model of body dissatisfaction. Reproduced from Thompson JK, Heinberg LJ, Altabe M, and Tantleff-Dunn S (1999) *Exacting Beauty*. Washington, DC: American Psychological Association, with permission from American Psychological Association.

Using a sample of 77 studies (141 effect sizes), the authors found strong support for the negative impact of exposure to media depictions of the thin ideal on each of these domains.

The tripartite model of body image is one well-supported socioculturally based approach for understanding how particular formative influences operate to produce body image problems. In this model, three primary influences (peers, parents, and media) are thought to directly and indirectly contribute to body image problems (see [Figure 1](#)). The indirect, or mediated pathways, include an influence through appearance comparison and internalization of societal values regarding appearance norms.

Interpersonal Approach

An interpersonal approach to understanding body image disturbance focuses on the influence of relationships and person-to-person interactions on the development of body dissatisfaction. While sociocultural theory tends to look at macro-level influences (e.g., society, the media), an interpersonal perspective takes a more micro-level approach to examine more proximal subcultural influences on body dissatisfaction. Research has investigated the impact of numerous sources of interpersonal influence, including parents, peers, romantic partners, and personal acquaintances or strangers.

A wealth of research has focused on the influence of appearance-related commentary and has consistently demonstrated the detrimental effect of receiving negative comments about one's appearance. Moreover, actual verbalization of the negative appearance evaluation is not necessary to produce a negative impact. Research has demonstrated that subtle gestures or negative looks (i.e., nonverbal communication) can convey this negative appearance evaluation as well and may have a negative effect on the recipient of the evaluation.

Finally, strong evidence is mounting in support of the role of appearance and weight-related teasing during childhood and adolescence in the development of body dissatisfaction. Numerous studies have investigated both the frequency and effect of such teasing, as well as the differential impact of various sources of teasing (e.g., family, peers). A new meta-analysis compiled the findings of 58 studies, revealing a reliable moderate association between weight-based teasing

($d = 0.39$) or appearance-based teasing ($d = 0.32$) and current levels of body dissatisfaction.

Cognitive–Behavioral Approach

As the name implies, the cognitive–behavioral perspective on body image draws from both cognitive and behavioral paradigms to create a more integrated and comprehensive understanding of body image and its related processes. The cognitive–behavioral model first distinguishes between historical or developmental influences on body image and more proximal events and process. Historical influences refer to personal attributes or past experiences that lay the foundation for the way a person thinks, feels, or acts in relation to his or her body. These historical influences include cultural socialization, interpersonal experiences (e.g., being teased about weight), physical characteristics, and personality attributes (e.g., perfectionism). Each of these factors contributes to one's body image schema (i.e., the cognitive organization of the information about one's physical self), which includes both body image investment (the perceived importance of the physical self to overall self-evaluations) and body image evaluations (satisfaction or dissatisfaction with one's body). Proximal events and process refer to current life events and cognitive processes that activate or maintain appearance schemas. This may include precipitating events such as standing in front of a mirror, receiving an appearance-related comment, or feeling that one's body is being exposed or evaluated. Such events then activate internal dialogues regarding one's appearance, which may include emotion-laden thoughts, inferences, or interpretations about one's appearance. Regarding individuals with body image disturbance, these dialogues are often automatic, inaccurate, and upsetting. Notably, the cognitive–behavioral perspective is the most widely accepted explanation for the formation of individuals' body image. Moreover, there is strong empirical support for the efficacy of cognitive–behavioral therapy (CBT) in the treatment of body image disturbance among community and clinical samples.

Feminist Approach

The feminist perspective of body image disturbance has, in part, grown out of the historical gender disparities in the rates of body dissatisfaction and eating disorders. Feminist theory notes that body image disturbance is significantly more prevalent among women than among men and suggests that these differential rates are born out of differences in the way that society views women and their bodies. While significant diversity in feminist approaches to understanding body image disturbances exists, at its core feminist theory contends that Western culture places an inordinate amount of value and emphasis on women's bodies and their appearance. Moreover, this culture teaches women to equate physical attractiveness with self-worth. Within this appearance-focused environment, women over-identify with their bodies, and their self-esteem becomes contingent upon conforming to the prevailing standards for thinness and attractiveness.

One notable and increasingly studied contribution to the understanding of the etiology of body dissatisfaction is objectification theory. This theory asserts that women are

consistently sexually objectified through multiple modalities including sexual harassment, leering glances, and exposure to both insidious and explicit sexualized media portrayals of women. As a result of this constant sexual objectification from the social environment, girls learn to view themselves from a third-person perspective and subsequently internalize that outsider's perspective as their own primary view of themselves (self-objectification). This leads to habitual body monitoring, which in turn, leads to increased body shame, body anxiety, lowered bodily awareness, and finally, to body dissatisfaction. Indeed, the role of self-objectification in body image disturbance and women's disordered eating has recently received empirical support, although further research in this area is warranted.

Risk Factors for Negative Body Image

There are several risk factors that influence the development of body image dissatisfaction and body image disturbance. This section will focus on four of those factors: biology, family, peers, and media.

Biology

Biological factors may affect body image dissatisfaction in three general ways. First, certain neurological disorders can lead to misperceptions of body image. One of the most intriguing examples of this is the phantom limb phenomenon. With phantom limb phenomenon, a person who has lost a body part (e.g., by way of accident or surgical removal) still feels – mentally and physically – that the body part is still there. Second, certain naturally occurring body parts or features may contribute to disturbances with body image. Examples of this are disproportionately large breasts, a pregnant body, or certain physical disabilities. Third, biological characteristics that are outside of social norms may affect body image, for example, physical deformity.

Family

In general, parents are thought to influence their child's body image in two ways. The first way is that parents' dissatisfaction with their own bodies may indirectly affect the child. For instance, parents model certain weight and body behaviors (e.g., negative comments on their own appearance, dieting behaviors) that the child then internalizes. The second way that parents may influence their child's behavior is by making direct comments to the child about his or her weight or appearance. When parents make critical or derogatory comments about the child's body or encourage the child to lose weight, he or she is more likely to have a poorer body image.

Most of the work regarding family and body image has focused on the parent–child relationship. Far less research has been conducted on sibling relationships. This is unfortunate as it stands to reason that siblings would play an important role in the development of body image in similar ways as parents, that is, indirectly by modeling or directly by targeted critical (or positive) comments. The few studies that include

siblings focus on the frequency and effect of weight- and appearance-based teasing by family members. (The majority of those studies include only female participants.) Researchers have found that the greatest amount of teasing within families is perpetrated by siblings. Approximately 20–30% of siblings engage in weight- or appearance-based teasing.

Peers

Peers can play a significant role in body image development and maintenance. Childhood and adolescence are particularly vulnerable times for influence by peer groups. One of the reasons is the amount of peer-related teasing. Estimates of weight- and appearance-based teasing by peers are as high as 60%. This is problematic as some researchers have established a causal link between weight and shape-related teasing and body image dissatisfaction.

Although it is not clear if people seek groups with similar views on body image or converge on similar body image views over time, it is known that peer groups tend to share ideas on body image and similar levels of body dissatisfaction. In addition, peers are frequently the targets of body comparison. Individuals often compare themselves to the weights and shapes of their peers and use these comparisons to rate their place in the subjective appearance hierarchy.

Media

Media plays a significant role in the development of body image disturbance for certain individuals. In advertisements and fashion magazines, women are extremely thin and tall; men are increasingly overly muscular. The images of both are often further enhanced by graphic alteration of images (i.e., digitally enhanced or reshaped). Even young children are exposed to images of exaggerated, unobtainable body shapes from some of their toys, dolls, and action figures. These idealized images are portrayed as beautiful and successful, but the actual body shapes and sizes are not attainable for the majority of individuals. Studies show that women exposed to thin media images report significantly more negative body image compared to women not exposed to these images in a laboratory setting. The duration of the effect is not known, but some theorize a dose-response effect; more prolonged exposure may result in greater body image disturbance. While some have found support for this, others have found it only holds true with certain types of media. Still other researchers propose that the association between the media and body image is complex and may be moderated by several variables including age, engagement in social comparison, and initial body image dissatisfaction. Specifically, effects of the media are higher for those who are younger, tend to engage in social comparisons, and have higher levels of initial body image dissatisfaction.

Gender Differences

Both males and females become aware of body image at a very young age, typically between the ages of 4 and 6. During this time, there do not appear to be any gender differences in

appraisals of body image. Differences emerge in preadolescence with a larger percentage of girls reporting body image dissatisfaction than boys. Notably, recent studies have concluded that this differential may be changing on at least one aspect of appearance – the desire for thinness. There are now similar proportions of preadolescent boys and girls desiring to be thinner, which may be an artifact of the growing problem of childhood overweight and obesity.

Puberty is considered a pivotal time period for the development of body image disturbance. During this time, females have marked body changes like weight gain and widening hips. These changes are in contrast to societal pressures to obtain the thin ideal and result in a discrepancy between real and ideal images of self. This discrepancy is considered to be one of the greatest precursors to body image disturbance in females. For both sexes, being overweight or obese is associated with higher body dissatisfaction, but as adolescent males reach puberty, being underweight and lacking muscularity are often catalysts for body image dissatisfaction. In this way, in contrast to females, weight gain in adolescent males is not necessarily as taboo. Males are as equally likely to want to be thinner as they are to be larger and more muscular. Overall, body image dissatisfaction is significantly greater in females than males during this time.

In adulthood, body image dissatisfaction and body image disturbance remain considerably higher for females compared to males. Of note, however, the prevalence of negative body image has increased for both genders over the past few decades. Nevertheless, perhaps one of the single greatest differences between the genders in the field lies within research methodology. The overwhelming amount of research in the field of body image has been conducted with females. The amount of research conducted with males is increasing, but is still regrettably far behind that of their female counterparts.

A relatively new area of research on gender differences is on body image and sexual orientation. According to the earliest research in the area, there seems to be an interaction between gender and sexual orientation. As a group, lesbians are less dissatisfied with their bodies than heterosexual females. Conversely, gay males are more dissatisfied with their bodies than heterosexual males. More recent research in the area supports the difference between gay males and heterosexual males, but has not supported a difference in body image dissatisfaction between lesbians and heterosexual females. Clearly, more research is needed to clarify the relationships between sexual orientation, gender, and body image dissatisfaction.

Assessment of Body Image and Body Image Disturbance

In recent years, the field of body image has undergone remarkable growth, which has been partially manifested in the expansion of assessment techniques and measures aimed at evaluating various dimensions of body image. While perceptual measures of body image were once widely used, there is currently considerable debate regarding whether these measures represent a distinct aspect of body image and, over time, newer techniques have largely eclipsed the use of perceptual measures. Current measures generally focus on the

attitudinal component of body image (as opposed to the perceptual component) and can be classified into three dimensions: subjective and affective, cognitive, and behavioral. While it is impossible to cover the full breadth of available measures of body image, the following offers a description of each of these categories as well as a brief review of relevant measures.

Subjective and Affective Measures

Subjective and affective measures essentially assess satisfaction with one's body. Such measures may range from a global rating of overall body satisfaction, to slightly more specific assessment of weight or shape satisfaction, and on to measures of very site-specific satisfaction (e.g., satisfaction with one's thighs, hips, chest). Subjective and affective measures can be further subdivided into figural rating methods and questionnaire measures. The former involves presenting an individual with line drawings of human silhouettes ranging in size and shape (e.g., very thin to very overweight). The individual is instructed to indicate the figure that represents their ideal body as well as the figure that represents their current size. Discrepancy scores (i.e., the difference between these two figures) provide an index of body dissatisfaction. The Contour Drawing Rating Scale is a commonly used figural rating scale with both male and female figures that range from underweight to overweight. The somatomorphic matrix is a computerized measure that presents a more lifelike two-dimensional figure and allows for assessment of dissatisfaction regarding overall body fat and muscularity for both men and women.

Questionnaire measures vary widely in their level of specificity regarding body image concerns. Some provide an estimate of global body dissatisfaction, while others measure satisfaction with specific areas of the body. The Appearance Subscale of the Multidimensional Body Self-Relations Questionnaire is a widely used 7-item measure of overall body dissatisfaction that has been used with both men and women of various ethnicities. An example statement from this scale is 'I like my looks just the way they are.' The Body Shape Questionnaire is a 34-item global assessment measure, which taps overall concerns with one's shape and weight. Finally, the Body Esteem Scale for Adolescents and Adults and the Body Image subscale of the Self-Image Questionnaire for Young Adolescents offer a global measure of body satisfaction for adolescents.

As discussed, other measures provide a more site-specific assessment of body dissatisfaction. The Body Areas Satisfaction Scale (BASS), a subscale of the Multidimensional Body Self-Relations Questionnaire, asks individuals to rate their degree of satisfaction with their overall appearance and with eight specific areas/attributes (e.g., face, hair, lower torso, mid-torso, upper torso, muscle tone, height, and weight). Additionally, the Body Uneasiness Scale, which has been used for adolescent and adult men and women, contains 34 items that assess overall body dissatisfaction, as well as 37 items that assess more specific concerns about individual body parts. Finally, the Physical Appearance State and Trait Anxiety Scale addresses the affective component of body image and assesses both trait and state anxiety regarding 16 body sites. A sample item from the state version of this scale is 'Right now I feel anxious, tense, or nervous about my thighs.'

Cognitive Measures

Cognitive measures of body image attempt to address the thoughts, beliefs, attributions, and attitudes related to an individual's appearance. For example, the Appearance Schemas Inventory-Revised is a 20-item scale that assesses beliefs and assumptions about both the importance (Self-Evaluative subscale) and influence (Motivational Salience subscale) of appearance in one's life. The Beliefs About Appearance Scale (BAAS) contains 20-items that assess an individual's beliefs regarding consequences of their appearance on relationships, achievement, self-perception, and emotions. Sample items from the BAAS include: 'How I feel about myself is largely based on my appearance,' 'My relationships would improve if I looked the way I wished,' and 'The opportunities that are available to me depend upon how I look.' The Drive for Muscularity Scale measures men's desire for a muscular appearance and strategies to obtain this physique. Finally, the Internalization subscale of the Sociocultural Attitudes Toward Appearance Scale-3 assesses the degree to which an individual has internalized or accepted the thin ideal. A sample item from this subscale of the SATAQ-3 is 'I would like my body to look like the models who appear in magazines.'

Behavioral Measures

Behavioral measures of body image have received less attention than subjective, affective, and cognitive measures primarily because of the largely intrapsychic nature of the disturbance. In other words, while body image disturbance can lead to behaviors aimed at avoiding, changing, or constantly monitoring one's appearance, aspects of the disturbance are more readily tapped using self-report assessments of the individual's attitudes and experiences. True objective behavioral measures would ideally require an outside observer to rate the person's body image-related behaviors such as avoidance of mirrors or body-monitoring behaviors. Given the often difficult and time-intensive nature of such assessments, current behavioral assessments of body image rely almost exclusively on subjective self-reports from individuals regarding their frequency of various behavioral manifestations of body disturbance. For example, the Body Image Avoidance Questionnaire assesses the frequency of body image avoidance behaviors including avoiding being weighed or wearing very loose-fitting clothing to avoid body exposure. Example items include: "I don't wear 'revealing' clothes (e.g., bathing suits, tank tops, or shorts)," "I do not go out socially if it involves eating" and "I avoid physical intimacy." The Body Checking Questionnaire is a more recent 23-item measure that assesses frequency of body-checking behaviors related to overall appearance and specific body parts in adult women, while the newly developed Male Body Checking Questionnaire (MBCQ) assesses these behaviors in men. An example item from the MBCQ asks the individual to rate how often he 'checks muscles in most reflective surfaces.'

Recent Advances in Assessment

Assessment measures have received wide utilization in a variety of contexts, including basic and applied research in the field of

eating disorders and body image disturbance. More recently, there has been an application to relatively new topics, such as the inclusion of body image assessment in the evaluation of the effectiveness of pharmacological agents as a treatment for eating disorders and body image problems. Additionally, there has been a tremendous increase in the last decade in the use of cosmetic and plastic surgery options for the modification of the body, and researchers have begun to use selected measures of body image to evaluate the role of these approaches as strategies to modify body satisfaction.

Treatment and Prevention

Body image disturbance has often been treated using CBT. CBT has been found to be effective in improving perceptual distortions, body image evaluations, and body image dysphoria. It improves other areas of psychosocial functioning such as self-esteem, social anxiety, depression, and eating behaviors. An empirically validated, manualized CBT treatment for body image was developed by Cash and colleagues. The treatment adheres to the general tenets of CBT, but is specifically tailored to the challenges of those with body image disturbance.

Research on body image interventions with obese populations is relatively recent but extremely relevant given both the scope of the obesity problem and the research that indicates obese people report higher body image dissatisfaction and distress than those of average weight. Treatment for body image within obese populations occurs mostly within weight loss interventions. Improvements in body image occur for many, but not all, who lose weight. Weight loss is often not sustained, however, and improvements in body image may be lost. However, there is some evidence that body image may be improved, even in the absence of weight loss. Some researchers propose adding a body image treatment post weight loss to aid in long-term weight maintenance. There is also growing empirical support for CBT in the treatment of body dysmorphic disorder. Evidence from randomized controlled trials reveals significant reductions in body dysmorphic disorder symptoms.

Although treatment of body image disturbance is important, prevention is the way to decrease overall prevalence by decreasing rates of incidence. Considering the early onset of body image disturbance, most prevention programs have been developed for and targeted to children and adolescents. As with treatment, outcomes on the prevention of body image disturbance are often part of larger studies on eating disorders. These prevention programs are universal, selective, or targeted. The goal of both universal and selective prevention programs is to reduce the incidence of the disorder. Selective prevention is aimed at asymptomatic, but at-risk individuals, whereas universal prevention programs are aimed at the population at large including those not considered at risk for the disorder. Targeted prevention programs are for subclinical populations that have been identified as high risk because of clear precursors or warning signs. Targeted programs are important for the reduction of symptoms, but do not reduce incidence.

Researchers have found that universal and selective programs show small, but significant effects in the reduction of body image dissatisfaction and internalization of the thin

beauty ideal, but targeted prevention programs are the most effective at reducing body image dissatisfaction and thin-ideal internalization. Targeted prevention programs for children younger than high school age have yet to be developed even though those are critical years in the development of body image disturbance.

Stice and colleagues developed a targeted prevention program for adolescent girls 14 years and older with elevated levels of body image dissatisfaction. The cognitive dissonance program consists of verbal, written, and behavioral activities where the thin ideal is critiqued and challenged. The program has been empirically validated and has been shown to reduce internalization of the thin ideal, body image dissatisfaction, negative affect, and psychosocial impairment. Comparative outcome studies and follow-up studies confirm the superiority of the cognitive dissonance program over other active treatments, active controls, and no-treatment controls. Stice and colleagues also developed another viable treatment alternative called the healthy weight program which focuses on making gradual and healthy diet, exercise, and lifestyle changes. The program leads to reductions in body image dissatisfaction and eating disorder symptomatology as well.

Conclusion

The field of body image has expanded greatly since its humble beginnings in neurology, but there is still much to learn. In the future, researchers should further investigate understudied populations including elderly persons, young children, and males. There should be a push not only to understand the intricacies of various risk factors of negative body image, but to understand protective factors and what leads to the development of a healthy body image across the life span. Researchers should also continue to explore the role of culture and country to appreciate the subtle or stark differences that will aid in prevention and treatment efforts.

See also: [Body Dysmorphic Disorder: A Review; Cognitive Behavior Therapy; Interpersonal Psychotherapy.](#)

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Relevant Websites

- www.bodyimagedisturbance.org – Body Image Research Group.
- www.womenshealth.gov/bodyimage – Body image: Loving your body inside and out.

Borderline Personality Disorder

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Glossary

Affective instability (emotion dysregulation) A tendency for mood to change rapidly in relation to environmental cues.

Borderline personality disorder A disorder that affects mood, impulse control, and interpersonal relationships over many years.

Impulsivity A tendency to act on feelings rather than taking the time to consider them.

Personality disorder Maladaptive personality traits beginning early in life that have consistent and serious effects on long-term functioning.

Clinical Features and Diagnosis of Borderline Personality Disorder

Personality disorder (PD) describes one of the major forms of psychopathology. In the DSM-IV-TR system (American Psychiatric Association, 2000), one first makes an overall PD diagnosis, and then determines whether a patient can fit into any of the ten listed categories. PDs as a group are defined by maladaptive personality traits, beginning early in life, that have consistent and serious effects on long-term functioning. To make a diagnosis, one must establish that personality problems affecting cognition, mood, interpersonal functioning, and impulse control account for dysfunction.

Borderline PD (BPD) differs somewhat from other PDs in that it is associated with serious and distressing symptoms. And since BPD is frequently seen in practice and is problematic for management, it has been the subject of a very large body of research.

The use of the term 'borderline' has led to some confusion. It was originally based on a theory that psychopathology can lie on a border between psychosis and neurosis. While that idea is out of date, nobody has found a better label; so the term has been retained.

BPD is a complex syndrome with dysfunction in mood, impulse control, and interpersonal relationships. The common pattern for all BPD symptoms is *instability*. Mood is characterized by intense and painful affective states that shift rapidly – often within hours – leading to emotional turmoil and enraged outbursts, with a loss of control. These affective symptoms are associated with chronic suicidality, in which patients can think about killing themselves on a daily basis for years on end. BPD patients are also impulsive, and most make repetitive suicide attempts, primarily by overdose. About half of all patients seen in emergency rooms with repeat suicide attempts can be diagnosed with BPD. These incidents often follow disappointments in interpersonal relationships.

BPD patients can show a wide range of other impulsive behaviors, such as substance abuse, bulimia nervosa, sexual promiscuity, and shoplifting. One of the most common features is self-cutting – usually on the wrists or arms. But that is *not* suicidal behavior. BPD patients rarely slash deeply; rather, they cut themselves to relieve tension.

Interpersonal relations in BPD are typically stormy and unstable. These patients have trouble being alone, and all too quickly get involved with people, many of whom take advantage of their neediness. Intimate relations are marked by serious quarrels, as patients require constant reassurance that they will not be abandoned. It is, therefore, not surprising that many of their relationships end in sorrow.

One of the least understood aspects of BPD is that about half of patients show micropsychotic symptoms (transient hallucinations, paranoid trends, or depersonalization). That is the most 'borderline' aspect of the disorder. However, full-blown psychotic episodes are uncommon.

To make a formal diagnosis of BPD, DSM-IV-TR lists nine criteria but requires only five of them to be present. This 'polythetic' structure makes for a heterogeneous diagnostic group. Research definitions have been developed to narrow down the scope of BPD, requiring that patients score high in all pathological domains (affective instability (AI), impulsivity, cognitive symptoms, and interpersonal relationships). DSM-5, scheduled for 2013, will define BPD somewhat differently, based on a rating as to whether cases have prototypical symptoms, supplemented by a trait profile.

PD can, in general, be understood as pathological amplifications of normal personality trait dimensions. One of the most important traits underlying BPD is AI, also known as emotion dysregulation (ED). AI is a construct that describes ultra-rapid mood shifts, in which emotional states are highly responsive to changes in the interpersonal environment. These phenomena must be distinguished from bipolar disorder, in which mood changes remain stable for days at a time and are much less responsive to environmental triggers. When AI is monitored with standardized instruments, emotions are found to be intense, but reactive to circumstances, with more of a tendency to anger than to grandiosity.

AI is a basic aspect of BPD that appears early in development and which can still be found in patients who have recovered from all other symptoms of the disorder. It appears to have a heritable basis in temperament. However, the neurobiological nature of AI remains largely unknown. Understanding may benefit from the large body of recent research on the psychology of emotions, as well as from experience sampling methods that can measure emotional shifts in the course of daily life.

The second fundamental trait behind BPD is impulsivity. This personality dimension has also been the subject of a large body of research. The impulsivity seen in BPD has been sometimes been thought to be secondary to AI. However, patients who are only emotionally dysregulated (and have other mental disorders) do not necessarily overdose, cut, or feel chronically suicidal. Evidence from imaging and from neuropsychological methods suggests that impulsivity is associated with defective executive functioning (a failure of the prefrontal cortex to modulate input from the limbic system), while neurochemical studies have suggested that trait impulsivity is associated with dysfunction of the central serotonergic system.

What is most characteristic of BPD is the combination of AI with impulsivity. These trait dimensions account for most aspects of its clinical presentation, including suicidality and instability of interpersonal relations.

There is a very wide range of symptoms seen in BPD, many of which overlap other diagnoses (mood and anxiety disorders, substance abuse, and eating disorders). This has led to a tendency among clinicians to focus on 'comorbid' diagnoses, and to withhold a diagnosis of PD. However, there are important differences in how any of these symptoms develop when BPD is also present.

The most common comorbidity in BPD patients is with depression or dysthymia. However in BPD patients, depressive symptoms are not episodic but continuous, that is, not necessarily associated with extended and continuous periods of low mood. Unlike classical melancholia, emotions can shift rapidly with changes in environmental circumstances.

In the same way, mood swings in BPD differ greatly from those in bipolar disorder, since patients do not show continuously elevated mood (hypomania), but a pattern of rapid shifts in affect related to life events, with 'high' periods that last only for hours (rather than for days or weeks). Unfortunately, recent enthusiasm for extension of the bipolar diagnosis has led some clinicians to diagnose many BPD patients with mood swings as falling within a bipolar spectrum.

BPD need not be mistaken for schizophrenia. Instead of long-term psychotic symptoms, one sees 'micropsychotic' phenomena of short duration, in which patients hear voices or experience paranoid thoughts under stress, followed by long periods in which these symptoms completely disappear.

BPD is a diagnosis with important implications for clinical management. But it must be recognized that this construct, like almost all other mental disorders, depends entirely on observable signs and symptoms. Unlike general medicine, psychiatry lacks specific markers associated with specific genes, neurochemical changes, or brain imaging. It is possible that BPD is not a single disorder but reflects multiple endophenotypes leading to a common final pathway marked by a cluster of psychological symptoms.

Epidemiology and Cross-Cultural Prevalence

Systematic epidemiological studies of mental disorders have been carried out for several decades. However, data on the community prevalence of PDs has only emerged in the last 10 years.

Most of these community surveys indicate that the prevalence of BPD is close to 1%, a rate similar to that of

schizophrenia. While about 80% of patients receiving treatment are women, gender differences have not been found in most community samples. The explanation is that men with BPD are less likely to seek treatment. This supposition is supported by psychological autopsy studies that have found BPD to be common in young males who commit suicide; most of these patients were never seen in the mental health system. The other notable demographic is that, as is the case for PDs in general, BPD is more common in patients with a lower socioeconomic level and lower levels of education.

There have been no systematic studies of BPD across cultures. The disorder has been described by psychiatrists in large urban centers in countries such as India and China, but its community prevalence in these locations is not known. However, indirect evidence suggests that BPD is more common in modern societies undergoing rapid social change. There has been an increase over the last few decades in developed countries in many of its associated symptoms (youth suicide, self-harm, suicide attempts).

Even if the vulnerability to BPD is rooted in universal trait dimensions, prevalence could vary across cultures. The explanation is that mental disorders present different symptoms in different societies. Similar illness processes need not lead to identical clinical presentations, since specific pictures can be determined by mechanisms of social contagion. Many psychological problems express themselves as physical symptoms, and patients may not report abnormal mental states. Moreover, impulsive ('externalizing') symptoms are less common in traditional societies than are 'internalizing' symptoms. Thus, it is not really surprising that behaviors such as cutting and repetitive overdosing do not seem to have been common historically, but have become more frequent in modern urban societies.

Etiology: Biological, Psychological, and Social

We are only beginning to understand the causes of BPD. As is the case for most mental disorders, no single factor can explain its development. Instead, multiple risk factors (biological, psychological, and social), in interaction with each other, seem to play a role.

The biological vulnerability for PDs depends on temperamental (inborn and/or heritable) characteristics that can be assessed in adulthood as personality traits, that is, stable patterns of thought, affect, and behavior that characterize individuals, and that persist over time. Behavioral genetic research shows that nearly half the variability in personality traits can be accounted for by heritable influences.

Both AI and impulsivity have a similar genetic component. Moreover, most twin studies have found that BPD itself shows a level of heritable influence of about 50%. While it is unusual for BPD itself to be found in first-degree relatives of probands, genetic influences are confirmed by family history studies showing that impulsive disorders such as antisocial personality and substance abuse, as well as mood disorders such as depression, are common.

A heritable vulnerability to BPD would be expected, in principle, to be associated with biological markers. But neuroscience is at an early stage of development, and most

pathological behavioral patterns are not consistently associated with any measurable changes in brain function. No markers specific to the diagnosis of BPD as a whole have been identified. The most robust findings thus far have come from studies of central neurotransmitter activity, which have shown that impulsive traits in these patients tend to be associated with deficits in central serotonergic functioning. While some initial research on AI has been conducted, its biological correlates are largely unknown.

Age of onset can provide clues about the development of the disorder. BPD usually begins around puberty, but first presents clinically at a mean age of 18. (Most patients experience symptoms for a number of years without seeking help.) An adolescent onset suggests that biological changes during puberty (hormonal shifts and synaptic pruning) might convert a temperamental vulnerability into an overt disorder. But it might also suggest that when a diathesis exists, the developmental stressors associated with adolescence can lead to the emergence of overt psychopathology.

There has been a great deal of research on the psychological factors leading to BPD. The results have been striking but not really consistent. Many patients describe experiences reflecting family dysfunction and psychological trauma during childhood. However, other patients state that they felt normal before puberty.

Statistically, one finds a high frequency of reported traumatic events (sexual or physical abuse, parental neglect, family violence) during childhood in patients who develop BPD. There is also support for this relationship from prospective community studies that have examined the precursors of PD symptoms. Even so, one should not conclude that all patients with BPD have had a traumatic childhood, since many do not report such experiences.

Nor should one conclude that children who undergo trauma are necessarily at risk for BPD. Longitudinal studies of the outcome of adversities during childhood show that such early traumatic experiences are risk factors, but not predictable causes, of mental disorders. Moreover, community studies document extensive resilience following trauma, particularly following less severe adversities.

The relationship between childhood abuse and BPD has aroused great interest. However, the most careful studies show that only about a quarter of patients describe sexual abuse over time from a caretaker (community studies show this to be the most damaging type of trauma). In contrast, most incidents of sexual abuse reported by BPD patients have occurred on one occasion, and involve strangers, and about a third of patients do not report any abuse at all. The data on physical abuse are less consistent, although one prospective study of child abuse cases that ended up in court found BPD to be more likely as an outcome.

One crucial issue is that child abuse is a risk factor for mental disorder in general rather than being specific to BPD. But since trauma is a marker for a wide variety of other adversities, and is strongly associated with family dysfunction, the effects may be due more to overall upbringing than to specific events.

Another crucial point concerns interactions between genetic vulnerability and adverse life experiences. By and large, childhood trauma is most likely to produce pathological sequelae in those who are temperamentally vulnerable.

These gene–environment interactions are crucial, and support a stress–diathesis model of BPD.

Finally, social factors play a role in the development of BPD. It is possible that modern societies, which require young people to find their own social roles, may lower the threshold for a disorder in which mood becomes unstable, impulsive actions common, and identity uncertain. It is also possible that the propensity to BPD takes other forms in other societies, and that the specific picture seen in developed countries is a cultural product.

In summary, none of the risk factors for BPD are necessary conditions for the development of the disorder. The sufficient conditions require a combination of biological, psychological, and social vulnerability.

Course and Prognosis

Most patients with BPD improve with time. Follow-up studies show that by age 35–40, about 75% function at close to normal levels. By the age of 50, 90% have recovered from the disorder. Prospective studies have shown that many patients stop meeting diagnostic criteria after a few years, when they stop overdosing and cutting. Social functioning does not improve that rapidly, and full remission usually takes many years. Even so, the fact that most patients improve – and never commit suicide in spite of having threatened to end their lives on multiple occasions – suggests that BPD has a more positive prognosis than previously thought. It is not necessarily a lifelong illness, but most often a disorder of youth.

Nonetheless, about one out of ten BPD patients will eventually commit suicide. The problem is that this outcome is notoriously difficult to predict. But by and large, the patients who die by suicide are those who fail to recover. The peak for completion takes place after age 35, usually after a series of unsuccessful treatments. On the other hand, younger BPD patients are not at so high a risk, so that clinicians who feel alarmed by their dramatic suicidal threats and actions should feel reassured.

The mechanism of improvement in BPD over time is not fully understood. Impulsivity generally decreases with age in everyone. Moreover, many BPD patients learn over time how to avoid the situations that give them the most trouble (intense intimate relationships). Most eventually find stable social and occupational niches that provide them with the structure they need. Once they stop acting impulsively, they no longer meet diagnostic criteria. The minority of patients who fail to find stable employment may remain in the mental health system. Finally, even in those who function well, some traces of AI can be observed.

Nonetheless, earlier perceptions that BPD is an incurable condition have been disproven, and patients should be informed that they are likely to improve. They can also be told that treatment may make recovery proceed more rapidly.

Treatment

BPD is a therapeutic challenge. However, recent research has shown that treatment specifically designed for the disorder

can be successful. While this is a disorder that can remit with time, treatment effects that can be documented over shorter periods, and which are superior to control conditions, are likely to be truly therapeutic.

In modern psychiatry, most patients tend to be managed with drugs. However, no pharmacological agents specific for the symptoms of BPD have been developed. Thus, patients are generally prescribed agents that were originally developed for other purposes, such as antidepressants, mood stabilizers, and antipsychotics.

Quite a few randomized controlled trials of pharmacotherapy for BPD have been published. But this research suffers from a number of defects: small sample size, attrition, as well as durations too short to assess treatment of a chronic disorder. Thus most of these studies have been conducted on less than 20 subjects observed for only a few months. Finally, outcomes in these studies are generally based on self-report, and one cannot tell whether the clinical picture has shown full remission.

In general, clinical trials document only a mild degree of symptomatic improvement with drug therapy. There have not been enough studies to merit a meta-analysis, and neither the British National Institute of Clinical Excellence (NICE) guidelines nor the Cochrane report has found enough data to recommend any specific agent. However, while drugs are over-prescribed for BPD patients, they are sometimes useful to control symptoms. A number of agents, including low-dose atypical neuroleptics, specific serotonin reuptake inhibitors, and mood stabilizers, can reduce impulsive behaviors. However, antidepressants are much less effective for mood symptoms than in patients who have no PD. Again, pharmacological agents only 'take the edge off' symptoms, and do not produce remission of BPD.

The most evidence-based method of treatment for BPD is psychotherapy. However, ordinary methods (sometimes called 'treatment as usual') are unsuitable for these patients. In general, the best results are associated with treatments specifically designed for this group, rather than general methods that can be useful for other clients.

The evidence-based psychotherapies for BPD are highly structured and have specific elements designed to manage symptoms. 'Dialectical behavior therapy' (DBT) is a form of cognitive-behavioral therapy targeting AI and impulsivity, using group and individual sessions to teach patients how to regulate their emotions. In eight clinical trials comparing the method to various types of standard treatment, DBT was more effective in bringing suicidal behaviors under control within a year. However, it is not clear whether effects are entirely specific to the method, or whether they reflect the advantage of using a highly structured treatment. One study that compared DBT with a manualized form of psychiatric management found no difference in outcome.

While DBT has the most evidence supporting it, two clinical trials point to the efficacy of 'mentalization-based treatment' (MBT), a therapy that combines cognitive and psychoanalytic techniques. MBT, like DBT, teaches patients how to self-observe interpersonal situations so as to reduce levels of conflict. These studies showed an advantage for MBT over treatment as usual, both in a day hospital setting, and in an outpatient clinic.

While there have been a few successful trials of other psychotherapy methods for BPD, again suggesting that structured therapies work better than treatment as usual, the main contenders are DBT and MBT. Although there are insufficient data for meta-analysis, the evidence was sufficient for a recommendation for some form of cognitive therapy in both the NICE and Cochrane guidelines.

Unfortunately specialized forms of psychotherapy for BPD are expensive, since they require highly trained personnel and a dedicated team. In most settings, these specific therapies are not readily available.

Nonetheless, psychotherapists conducting a more general practice can learn from evidence-based approaches. It is not enough to sympathize with distress or 'put out fires' every time a crisis arises. It is also not helpful to focus too much on past events. BPD requires a practical and structured approach that teaches patients how to manage emotional dysregulation and impulsivity.

Chronic Suicidality in BPD

One of the main qualifications for therapists treating BPD patients is a thick skin. Chronic suicidality is a troubling problem. But many of the methods that have been used to handle suicidal threats and actions were developed for acute suicidality associated with episodes of depression. In BPD, these approaches are not effective, and they can even make matters worse.

Clinicians are sometimes advised to hospitalize patients who threaten to commit suicide. In BPD, this often leads to unproductive and regressive admissions. These patients need to learn life skills, which is not possible under a suicide watch in a hospital ward. There has been little research on the effectiveness of hospitalization, no evidence that admission prevents completion of suicide, and no evidence that it is an effective treatment modality that can change the course of the disorder.

Suicidity in BPD peaks when patients are in their early 20s. But as we have seen, completions are most common after age 30, in patients who fail to recover. Thus, impulsive overdoses, most often seen in younger patients, do not carry a high short-term risk. These behaviors need to be understood as communicating distress. Self-harming behaviors such as chronic cutting are not even truly 'suicidal.' Given that these behaviors are an attempt to regulate dysphoric emotional states, it is the task of therapists to teach patients better ways of doing so.

In summary, therapists should not be paralyzed by fear of chronic suicidality. Instead, they should respect the need that BPD patients have to contemplate an 'exit' when their life is going badly, and focus on modifying the emotions and behaviors that feed hopelessness.

Conclusions

We need more research to understand the causes and treatment of BPD. If we understood the etiology and pathogenesis of this disorder better, we would be in a position to develop

more evidence-based approaches to therapy. However, an important start has been made, and we can feel hopeful about most cases seen in practice. Management of these patients has improved much over the last few decades. While not all will recover completely, we can help most of them.

See also: Big Five Model and Personality Disorders; Psychotherapy; Suicide.

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The Brain

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Glossary

Amygdala It is a complex of nuclei in anterior midline areas of the temporal lobe implicated in the perception and expression of emotions and in emotional memory.

Association cortex It includes areas that lack direct sensory or motor connections important for higher aspects of sensory perception, sensorimotor integration, and cognitive processes including language, memory, and executive functions.

Basal ganglia These are a group of nuclei at the base of the forebrain that are strongly connected to cerebral cortex. They play a critical role in selection and initiation of motor responses, procedural learning, and executive functions of prefrontal cortex.

Hypothalamus It consists of a number of nuclei located below thalamus and just in front of the midbrain that

regulate behavior state and functions related to homeostasis: feeding, drinking, thermoregulation, and reproduction.

Motor cortex This includes areas that play a critical role in voluntary control of movements, particularly involving the hands. These include primary motor cortex, which executes voluntary movements, and premotor and supplementary motor areas, which plan and program sequential movements.

Sensory cortex It includes areas of cortex that receive and process information from the senses. These include primary sensory areas that receive direct input from sensory nuclei in thalamus (or olfactory bulb for primary olfactory cortex) and sensory association areas that process sensory input into coherent sensory perceptions.

In many ways, the brain is the ultimate product of evolution. Vertebrate and invertebrate brains share many features that allow organisms to survive and reproduce in ever-changing and sometimes unpredictable environments. The human brain consists of 100–150 billion neurons, organized into systems that allow individuals to sense important information and to perceive the external world, to act adaptively, to maintain internal homeostasis, to think and plan, to learn and remember, and to communicate with other individuals. The human brain evolved from common ancestors and thus shares important cellular and molecular properties with simpler nervous systems found in invertebrate and vertebrate species. The anatomical organization of the human brain bears a striking resemblance to the anatomical organization of the brains of other vertebrates, particularly mammals.

Anatomical Organization of the Brain

Cells

The brain contains two main types of cells: *neurons*, electrically active cells that are specialized to process and transmit information, and *glial cells*, cells that serve a number of functions that support the activity of neurons. Neurons typically have four main divisions (**Figure 1**). *Dendrites* are appendages that serve as input zones, conducting electrical activity toward the cell body. Inputs to neurons are transmitted across *synapses* (points of contact with other neurons). Neurons often have multiple dendrites that tend to branch extensively in the area of the cell body allowing neurons to summate inputs from many other neurons. The *cell body* (or *soma*) contains the nucleus and can act as both an input zone and an integrative zone, summing inputs from multiple dendrites. *Axons* transmit activity away from the cell body, often in the form of brief electrical

impulses called action potentials. Neurons tend to have one axon that can extend up to a meter or more in the peripheral nervous system. Axons are of constant diameter throughout their length. Thicker axons conduct signals more rapidly but are more expensive to maintain metabolically. *Axon terminals* are the output zones. In most neurons, these contain synaptic vesicles that hold molecules of neurotransmitters that are released from specialized areas of presynaptic membranes in response to action potentials transmitted along the axon.

Neurons come in many sizes and shapes. The structure of a neuron can provide important clues about its function. Interneurons (or local circuit neurons) connect between afferent and efferent neurons in neural pathways and tend to be involved in local processing of information. Projection neurons have long axons that communicate between areas of the brain. The organization of dendrites determines what inputs drive a neuron and how they are integrated. Large neurons with thick axons tend to conduct high priority information rapidly (such as visual signals from rapidly moving objects or signals to fast acting muscles). The speed of axonal conduction is also increased by *myelin* sheaths. These are processes of glial cells (oligodendrocytes in the central nervous system, Schwann cells in the peripheral nervous system) that wrap around axons. Myelin increases the speed of conduction by increasing electrical resistance of axonal membranes and causing action potentials to jump between small gaps in the myelin (nodes of Ranvier).

Gross Anatomy

Nervous systems in simple invertebrates, like the sea anemone, consist of nets of interconnected neurons. More complex invertebrates like the fly have nervous systems that include peripheral masses of neurons (ganglia) that are connected to central

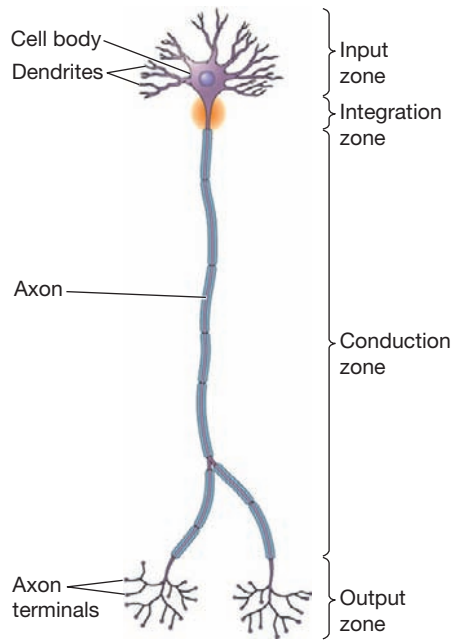


Figure 1 Typical organization of the neuron. Dendrites and cell bodies receive inputs from thousands of synapses with other neurons. Dendrites conduct electrical activity toward the cell body, while axons conduct activity away from cell bodies. Axon terminals transmit activity through synapses with postsynaptic neurons. In most mammalian neurons, this involves the release of neurotransmitter molecules that act on receptors on the postsynaptic membrane. This figure is reproduced from Breedlove SM, Watson NV, and Rosenzweig MR (2010) *Biological Psychology*. Sunderland, MA: Sinauer with permission from Sinauer Associates, Inc.

lobes that function as a primitive brain. Many invertebrates have populations of neurons that mediate basic drives, sleep and wakefulness, and species-specific reproductive behaviors. Invertebrates can also demonstrate simple forms of learning and memory. *Vertebrate brains* share the distinction between central and peripheral nervous systems and the evolutionary trend toward central control of peripheral ganglia. Vertebrates tend to have larger numbers of neurons, increased reliance on myelin as a means to speed neural conduction, and central nervous systems encased in a bony skull and spinal column. The vertebrate *peripheral nervous system* consists of *cranial nerves* (12 in humans) that connect directly to the brain, *spinal nerves* (31 in humans) that connect at segments of the spinal cord, and the *autonomic nervous system*, which regulates internal organs. Spinal nerves consist of a dorsal (toward the back) root that consists of sensory projections from the body and a ventral (toward the front) root that consists of motor projections to the muscles. The autonomic nervous system has two divisions (sympathetic and parasympathetic) that have opposite effects on the organs they innervate. The *sympathetic system* mobilizes the body's resources in response to stress, producing the 'flight or fight' response. The *parasympathetic system* promotes vegetative and restorative functions, producing the 'rest and digest' response.

The *vertebrate central nervous system* has four main divisions: spinal cord, hindbrain, midbrain, and forebrain (Figure 2). The *spinal cord* extends caudal (toward the tail) from the

medulla connecting the brain to segments of the body through paired spinal nerves. Spinal nerves provide sensory input to the brain from the body, innervate skeletal muscles to produce movement, and control visceral functions through the autonomic nervous system.

The *hindbrain* is immediately in front of the spinal cord and consists of the medulla, pons, and cerebellum. The *medulla* relays signals between the brain and the spinal cord and contains nuclei that control vital functions related to respiration, cardiac and vasomotor function, and reflex control of swallowing, vomiting, coughing, and sneezing. The *pons* (Latin for 'bridge') is the point at which many fiber tracks connecting the brain to the spinal cord cross (decussate) so that the right side of the brain controls the left side of the body and the left side of the brain the right side of the body. The ascending reticular formation runs through deep areas of the pons extending caudally into medulla and rostrally into the midbrain. This is a poorly differentiated area that plays an important role in arousal and the regulation of sleep-waking cycles. The medulla and pons contain nuclei of cranial nerves that mediate sensory input from the head, taste, auditory (hearing), and vestibular (body orientation) sensations, sensory input from and motor output to bodily organs, and control of chewing, facial expression, salivary and tear glands, and movements of the neck and tongue. The pons is also the point at which the cerebellum connects to the brain. The *cerebellum* is a specialized enlargement at the back of the brain that regulates movement. It receives input from sensory and association areas of cortex, peripheral proprioception (relative position of limbs and other body parts), and the vestibular system (bodily orientation and acceleration) and provides outputs to higher and lower motor control systems. Cerebellum does not directly activate movement, but plays a critical role in the planning and sensory guidance of movements. Ataxia (gross incoordination of muscle movements) is the cardinal sign of cerebellar damage.

The *midbrain* contains the tectum along its ceiling and tegmentum along its floor. The *tectum* consists of two paired structures: the inferior and superior colliculi. The superior colliculi receive input from visual and other sensory systems and play a critical role directing behavioral responses in ego-centric (body centered) space. The inferior colliculi are an important auditory center that receives inputs from brainstem auditory nuclei. The *tegmentum* contains the periaqueductal gray, a site of action of opiates that plays an important role regulating the response to pain. It is also the main source of dopamine in the brain (substantia nigra pars compacta, ventral tegmental area). Dopamine is a neurotransmitter that plays an important regulatory role in voluntary movement, motivation, reward, and executive functions of prefrontal cortex.

The *forebrain* has two main divisions: the diencephalon, which forms an inner segment attached to the midbrain, and the cerebral hemispheres, outer segments extending from the diencephalon. The diencephalon consists of two main areas: hypothalamus and thalamus. *Hypothalamus* is located below thalamus and just in front of the midbrain. It consists of a number of nuclei (clusters of neurons) that regulate behavior state and functions related to homeostasis: feeding, drinking, thermoregulation, and reproduction. The *pituitary* is attached to the base of hypothalamus by a thin stalk (the infundibulum). The pituitary acts as the master gland releasing hormones that

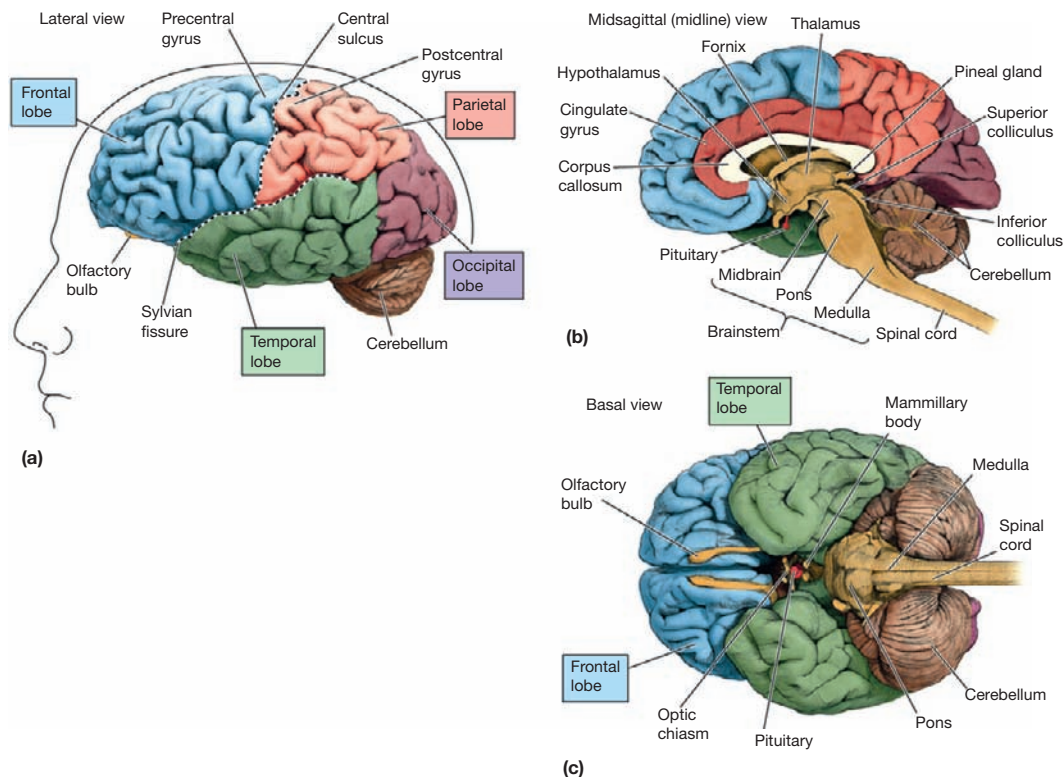


Figure 2 The organization of the human brain as viewed from (a) lateral, (b) midsagittal (midline), and (c) inferior (beneath) perspectives. The major lobes and important divisions are color coded and labeled. This figure is reproduced from Breedlove SM, Watson NV, and Rosenzweig MR (2010) *Biological Psychology*. Sunderland, MA: Sinauer with permission from Sinauer Associates, Inc.

regulate responses related to stress, metabolism, sexual differentiation, reproduction, growth, fluid balance, and blood pressure. The anterior lobe of the pituitary is under humoral control, secreting tropic hormones in response to releasing hormones that originate in hypothalamus and reach the pituitary gland through the portal vein. The posterior lobe is directly controlled by neurons with cell bodies in hypothalamus and axons terminating on secretory cells in the pituitary. The *thalamus* is the gateway to cerebral cortex. Thalamus provides the main source of sensory input to cortex leading to conscious perception of visual, auditory, somatosensory, and taste sensations as well as inputs from the basal ganglia and cerebellum that give rise to intentional responses. Thalamus is also a major target of descending projections from cortex that reciprocate thalamocortical projections and provide information to other areas of cortex. Beyond pathways carrying specific information to distinct areas of cortex, thalamus contains 'nonspecific' midline and intralaminar nuclei. These nuclei have common inputs from arousal- and visceral-related systems in the brainstem and influence the activity of extended neural networks that involve widespread areas of cerebral cortex, the basal ganglia, and the limbic system.

The *cerebral hemispheres* consist of an outer rind, cerebral cortex, and subcortical structures that include amygdala and the basal ganglia. Cerebral cortex includes olfactory cortex, hippocampus, and neocortex. The *amygdala* is a complex of nuclei in anterior midline areas of the temporal lobe that have been implicated in the formation of emotional memories and the perception and production of emotions, particularly fear.

Amygdala is a prominent component of the *limbic system*, a series of interconnected structures that also includes hippocampus and portions of neocortex that are important for learning, memory, and emotions. *Hippocampus* is a primitive cortical area located behind amygdala in medial temporal lobe. Hippocampus has been implicated with adjacent areas of entorhinal and perirhinal cortex as a site of pathology causing profound amnesia. The *basal ganglia* constitute a subcortical system intimately connected with frontal cortex that plays a critical role in cognitive and motor function. *Striatum*, the input side of the basal ganglia, is divided into two main areas in humans: caudate and putamen. The caudate receives input from prefrontal cortex and related cortical areas and is primarily concerned with cognitive functions. The putamen receives inputs from premotor and motor cortex and related cortical areas and is primarily concerned with the selection and initiation of motor responses. *Pallidum*, the output side of the basal ganglia consists of several interconnected structures: globus pallidus, substantia nigra pars reticulata, and the subthalamic nucleus. Globus pallidus and substantia nigra project through thalamus to prefrontal and premotor areas of cortex. The basal ganglia are organized in a series of parallel loop pathways that originate in cortex and project through discrete areas of striatum, pallidum, and then thalamus, that project back to the cortical area of their origin. Each of these parallel cortico-striato-pallido-thalamo-cortical pathways is thought to mediate a distinct aspect of cognitive or motor function. Diseases of the basal ganglia, such as Parkinson's disease and Huntington's chorea can affect the ability to select responses, inhibit

unwanted responses, initiate voluntary movements, cognitive aspects of motor function, executive functions mediated by prefrontal cortex, and the capacity for learning and memory, particularly the incremental acquisition of habits or stimulus-response associations.

Neocortex (or isocortex) consists of six distinct layers of neuropil that form the outer shell of cortex (Latin for 'bark') of the cerebral hemispheres. The expansion of cortex in humans caused cortex to fold into a series of sulci (fissures) and gyri (ridges). Human cortex is divided into four main lobes (**Figure 2**). *Frontal cortex* is in front of the central sulcus. *Parietal cortex* is located behind the central sulcus (in front of occipital and above temporal cortices). *Occipital cortex* is at the back of the brain behind the occipito-parietal sulcus. *Temporal cortex* is located below the Sylvian fissure (lateral sulcus or fissure), in front of the occipital lobe and below the parietal and frontal cortices. There are extensive connections between homologous areas of cortex in the right and left hemispheres that travel through two white matter tracts. The *corpus callosum* is the main source of interhemispheric cortical communication. The *anterior commissure* carries fibers connecting portions of temporal cortex. Although all areas of neocortex have a comparable six-layer organization, there are systematic differences across different areas of cortex in the extent to which the six layers of cortex are developed. In motor cortex, for instance, layer V (which contains large neurons projecting beyond local areas of cortex) is well developed. By contrast, layer IV (which receives specific inputs from thalamus) is well-developed primary sensory cortices. Classic neuroanatomists mapped these differences in detail long before neuropsychologists described the localization of function in cortex. The results were maps based purely on structural anatomical differences. One of the great discoveries of twentieth century neuroscience was the recognition that maps based on subtle anatomical differences correspond to the localization of function in cortex. The most widely used map was developed by the German anatomist Brodmann in 1909 and still serves as a standard system to refer to different areas of cerebral cortex.

How do human brains differ? Humans have unique cognitive capabilities that include the abilities to communicate with language and to use tools flexibly in complex ways. Neuroscientists have long been interested in understanding how the human brain evolved to give rise to these abilities. It seems unlikely that human cognitive function reflects a fundamental change in the organization of the brain. The human brain follows a general blueprint shared with brains of other vertebrate species. Behavioral neuroscience studies have revealed similar functions in homologous brain structures in humans and in other mammalian species. Humans have relatively large brains for their body mass compared to other species. The fossil record reveals evidence of a tremendous increase that nearly tripled the size of the human brain within the last 2 million years. This increase must have conferred substantial evolutionary advantages as it came with a steep metabolic cost – brain activity consumes about 20% of our calories. Careful analyses have revealed important changes in cerebral cortex that may account for our unique cognitive abilities. The human brain has relatively large amounts of neocortex and subcortical structures that communicate with neocortex, including the lateral cerebellar

hemispheres, basal ganglia, and thalamus. Human cortex has relatively large numbers of cells/ unit area of cortex, particularly within later developing, more superficial layers thought to play a critical role in processing information. Human cortex is more clearly differentiated with more distinct signs of structural specialization from area to area. Human cortex has relatively less area dedicated to primary motor and sensory function and thus more association cortex available for integrative functions.

Functional Organization of the Brain

Sensation and Perception

Sensory systems consist of peripheral receptor cells specialized to detect and encode sensory signals, pathways by which this information is processed and transmitted to primary sensory cortex, and sensory association cortices that further process this information to give rise to perception. There are many potential sensory signals in the environment. Organisms sample and process a small fraction of the available signals, focusing on sensory information that fits species-specific needs.

Vertebrate *vision* begins with photoreceptor cells in the *retina*, a thin band of tissue at the back of the eye. Photoreceptor cells contain photopigments that absorb visible wavelengths of light and release neurotransmitters that affect the activity of second order visual neurons (bipolar cells). These interact with interneurons within the retina (horizontal and amacrine cells) to control the activity of ganglion cells, the output neurons of the eye. The wavelengths of electromagnetic radiation detected by vertebrate photoreceptors are in a narrow range that is ideal for detecting the objects in the external world including color information useful for finding food and detecting predators. Shorter wavelengths (X-rays) can penetrate the surface of objects. Longer wavelengths (radio waves) are better suited for detecting large distant objects (like planets). The physiological properties of visual neurons are likewise specialized to encode motions consistent with the speed of moving animals (rather than say a speeding bullet or a moving glacier). Axons originating in the eye terminate in the *lateral geniculate nucleus* of thalamus as well as in subcortical nuclei specialized to direct attention to objects of interest (superior colliculus) and to entrain the brain to daily rhythms of light and dark (suprachiasmatic nucleus). The projections responsible for visual perception run from the lateral geniculate nucleus to primary visual (*striate*) cortex in the occipital lobe (**Figure 2**). From here, the visual system diverges to areas of visual *association cortex*, extending from the occipital lobe ventrally into inferior temporal cortex and dorsally into posterior parietal cortex, responsible for processing specific aspects of vision, such as color, motion, and spatial relationships. Rare cases of brain disease will sometimes affect these discrete areas of cortex and leave individuals without the ability to perceive color (achromatopsia), motion (akinetopsia), or spatial relationships ('Balint's syndrome'). Lesions damaging visual association areas can sometimes interfere with the ability to recognize objects visually without affecting more elementary visual processes (visual agnosia).

The *auditory system* converts vibrations (pressure waves) to sound. Species differ in the range of both loudness (amplitude)

and pitch (frequency) of vibrations that they hear. The range of sounds heard by different species reflect use of sound for communication, detection of prey and avoidance of predators, and the media through which auditory signals travel (air, water, or the ground). In humans, pressure waves are collected by the *outer ear* and mechanically amplified during transmission through the eardrum and the three bones of the *middle ear* (the ossicles) to the oval window of the cochlea. The *cochlea* is a spiral shaped bony structure. Pressure waves travel from the oval window through fluid filled cavities of cochlea where they cause vibrations of the basilar membrane. Vibrations of the basilar membrane displace ciliary appendages of hair cells (stereocilia), which then activate terminals of the auditory nerve. The frequency (or pitch) of a sound is encoded by the point that the basilar membrane vibrates maximally (place coding) and by the timing of action potentials produced by the vibrations (volley coding). The pattern of activation that emerges from the cochlea is represented tonotopically as auditory information and is transmitted through the *cochlear nucleus* to the *inferior colliculus*, the *medial geniculate nucleus* in thalamus, and then primary auditory cortex (*Heschl's gyrus*) in superior temporal cortex extending into the Sylvian fissure. In tonotopic coding, different frequencies of sound are represented topologically as a spatial map. Conscious awareness of sound depends on activation of primary auditory cortex. Auditory association cortices adjacent to primary cortex play critical roles in the ability to perceive complex patterns of sound as music, language, or elements of a complex and changing environment.

Somatosensory information (touch) is transduced by different types of receptor end organs distributed across the skin. These include end organs specialized to detect different aspects of touch (pressure, vibration, stretch, tickle, itch) and temperature (warm, cool). *Pain* is detected by receptors with higher thresholds for activation (nociceptors) and by high levels of activation of somatosensory nerve endings. *Somatosensory* information travels through the dorsal columns of the spinal cord to the medulla where they synapse with neurons that send axons to the *ventral basal complex* in thalamus. From here, somatosensory information travels to primary somatosensory cortex in the *postcentral gyrus* and to somatosensory association areas in adjacent regions of parietal cortex (Figure 2).

Chemorensory information is detected by the olfactory (smell), gustatory (taste), vomeronasal, and trigeminal systems. What we commonly experience as flavor of foods or strong smells are often produced by stimulation of multiple chemorensory systems. Free nerve endings of the *trigeminal nerve* line the nasal cavities and respond to irritating concentrations of odorants (which can happen at low concentrations for particularly noxious chemicals). For the untrained observer, the sting associated with trigeminal stimulation is often perceived as an integral component of a strong smell. *Flavor* is a complex perception based on a combination of taste, olfaction (often through retro-nasal stimulation), and texture (somatosensory input from the mouth and tongue). There are five basic *tastes*: salty, sour, sweet, bitter, and umami. These are detected by receptors on taste buds in papillae on the tongue and at the back of the throat. Taste information travels over three different cranial nerves (facial, glossopharyngeal, and vagus) through axons that terminate in the *nucleus of the solitary tract*. From here, taste pathways are closely aligned with somatosensory areas in thalamus and

cortex. Axons from second order gustatory neurons terminate in the *ventral posterior medial thalamic nucleus*, which project in turn to the cortical taste area in somatosensory cortex.

Smells are detected by receptor molecules located on cilia projecting from receptor neurons into the mucus layer in the upper portions of the nasal cavity. Vertebrates have about 1000 different types of olfactory receptors, about 350 of which are functional in humans. The ability of humans to perceive novel synthesized molecules that are not found in nature demonstrates the ability of at least some of these receptors to respond to a wide range of novel stimulus substances. Axons from receptor neurons cross the cribriform plate and synapse with dendrites from mitral cells in the glomeruli of the *olfactory bulb*. Each glomerulus receives inputs from receptor cells that express the same receptor molecule. Mitral cell axons travel into basal areas of the forebrain where they terminate in primitive cortical areas collectively called *primary olfactory cortex*. The ability to discriminate diverse smells results from a diversity of receptor molecules that are organized to produce distinct topographic patterns of neural activity across the receptor epithelium. This topographic patterning is preserved within olfactory bulb and primary olfactory cortex. The *vomeronasal organ* is located in the base of the nasal cavity, just above the palate, in many animals. It is specialized to detect pheromones (chemical signals that trigger social responses). Although the vomeronasal organ has been identified in humans, recent evidence suggest that humans lack functional genes for vomeronasal receptor molecules and thus that the vomeronasal organ is vestigial in humans.

Acting on the External World

We act on the world by contracting muscles as Sir Charles Sherrington noted "whether in whispering a syllable or in felling a forest." Our ability to act purposively is organized hierarchically. In 1889, John Hughlings Jackson characterized three levels of organization that continue to guide modern thinking about motor control. The lowest level consists of the spinal cord and brainstem motor nuclei, the middle level of sensorimotor cortex, and the highest level of premotor and prefrontal cortex. Jackson emphasized the role of the brain in organizing movement and the ultimate control of lower motor centers by higher motor centers.

Spinal mechanisms: Skeletal muscles contract when *extrafusal muscle fibers* are excited by axons of α -motoneurons that are located in the ventral horn of the spinal cord. As muscles can only exert force in one direction (by contraction), they are generally organized in groups of *agonists* (or synergists) producing movement in one direction and *antagonists* that produce movement in the other direction. In limbs, these pairs consist of *extensors* (muscles that resist the force of gravity or straighten limbs) and *flexors* (muscles that bend limbs, moving them in the opposite direction as extensors). The spinal cord receives inputs from proprioceptors that provide information about muscle length and tension. *Muscle spindles* consist of intrafusal muscle fibers aligned in parallel with extrafusal muscles. Sensory endings in muscle spindles signal information about the length of muscles and provide the sensory component of the stretch reflex. *Golgi tendon organs* are located at the insertion of muscle fibers into tendons – in series with skeletal

muscles. They sense the force exerted on muscles and provide the sensory component of the autogenic inhibition reflex.

Spinal reflexes provide control over the activation of skeletal muscles by α -motoneurons. In the *stretch reflex*, activation of muscle spindles directly excites α -motoneurons producing contractions of agonist muscles to compensate for an increase in muscle length. At the same time, the spindles activate interneurons to reciprocally inhibit antagonist muscles that would otherwise resist the compensatory movement. The stretch reflex is what allows a waiter to hold a tray steady while it grows lighter as food is served or heavier as dishes are placed on it. The *autogenic inhibition reflex* occurs when Golgi tendon organs are activated by muscle force and excite spinal cord interneurons to inhibit agonist α -motoneurons. This was once thought to function as protective response, preventing muscles from being damaged by strong forces. It is now recognized that Golgi tendon organs are activated by much weaker forces, where the inhibitory reflex is thought to spread work out evenly across a population of muscle fibers. The spinal cord also contains circuits that mediate protective reflexes. The *flexion reflex* causes a limb to withdraw in response to a noxious stimulus (like stepping on a tack). Here, flexors are excited and extensors inhibited for the limb involved, while extensors are excited for the opposite limb (crossed extension) to maintain sufficient extensor activity to resist the force of gravity (and remain upright).

Central pattern generators are neural networks that activate motoneurons in rhythmic patterns to produce stereotyped movements. They spare higher motor centers the cost of programming individual muscles to produce routine, repetitive sequences of contractions. Some central pattern generators, like those that control breathing, are active at rest. Others, such as those that control locomotion or chewing, are activated by descending projections from higher motor centers. Central pattern generators are influenced by sensory feedback that can modify the duration of phases of the activity cycle to adapt responding to environmental conditions – for instance adjusting one's stride when stepping on a rock while hiking. Central pattern generators for locomotion are localized in spinal cord, while those controlling breathing, chewing, swallowing, and eye movements are located in brainstem motor nuclei.

Cortical control of movement is mediated by projections from *primary motor cortex* in the precentral gyrus (Figure 2) to the spinal cord (corticospinal tract) and to brain stem nuclei that project to spinal motor centers (such as the rubrospinal, vestibulospinal, and reticulospinal tracts). The corticospinal tract also contains projections from *supplementary* and *premotor* cortices, located just in front of primary motor cortex, and somatosensory cortex, in the postcentral gyrus. The supplementary and premotor areas project heavily to primary motor cortex and play important roles in planning movements, particularly complex sequential movements. While lesions of primary motor cortex have profound effects on muscular strength (particularly for the hands), lesions in premotor and supplementary motor areas impair the ability to develop sequential strategies for movement but have little effect on strength. Primary motor cortex contains populations of neurons that respond to the activation of specific muscles and others that code direction of movement regardless of the muscles involved. Neurons in primary motor cortex are coarsely tuned, exhibiting

responses coding movements in a large range of directions. The ability to make precise movements is thought to depend on the ability to sum responses across a large population of neurons to determine a precise average vector. The motor map is not rigidly fixed, but can be changed by motor learning. Larger areas of motor cortex are activated when well-trained movements are performed. This presumably reflects an increased level of precision for well-practiced motor skills like playing a musical instrument. Neurons in premotor and supplementary motor areas exhibit responses that seem consistent with a role in motor planning. They tend to respond earlier before the onset of movement, in response to stimuli that indicate the direction of an impending movement. Studies of brain-injured patients and results of functional imaging studies suggest that higher order motor skills such as skilled tool use or pantomime of tool use depend on large-scale distributed neural networks that connect the premotor and supplementary motor areas to association areas in prefrontal and parietal areas of cortex in the left (dominant) hemisphere of the brain.

The *cerebellum* and *basal ganglia* have important effects on motor function at multiple levels of the central nervous system. Virtually all areas of cerebral cortex project to *striatum*, the input area of the basal ganglia. Striatum projects back to much of frontal cortex through topographically organized pathways that pass through pallidum and thalamus. These cortico-striato-pallido-thalamo-cortical projections provide parallel pathways that link functionally related areas of cortex, basal ganglia, and thalamus. Current theories emphasize the role of the basal ganglia in action selection – deciding which of several possible actions to execute at a given point in time. Basal ganglia areas associated with motor cortex are thought to mediate sensory-guided responding, while areas associated with prefrontal cortex are thought to guide responding on the basis of information represented within the brain as working memory. The *cerebellum* guides responding on the basis of sensory input from sensory areas of cortex, peripheral proprioceptors, and the vestibular system. Cerebellum is divided into regions having distinct phylogenetic origins. The *vestibulocerebellum* (flocculomodular lobe) targets motor nuclei controlling axial muscles and primarily affects balance. It is well developed in fish and reptiles and is regarded as the oldest part of cerebellum in evolutionary terms. The *spinocerebellum* consists of the medial and intermediate zones. It projects to brainstem and midbrain motor nuclei and is primarily concerned with the modulation and execution of ongoing movements. The *cerebrocerebellum* consists of the lateral zone of the cerebellar hemispheres. These are particularly well developed in humans and project to thalamus to provide input to premotor cortex. These are regarded as the most recently evolved part of cerebellum and play an important role in the initiation, planning, and timing of movements.

Adapting to the Environment

Humans, like other mammals, have evolved mechanisms that allow us to adapt to changing conditions in external and internal environments. These include systems specialized to maintain homeostasis of internal conditions, to regulate behavioral states to maintain beneficial levels of wakefulness and arousal, to attend to critical tasks and information needed

to optimize cognitive and perceptual function, and to express and perceive emotions to facilitate social interactions.

Homeostasis

In the middle of the nineteenth century, the French physiologist Claude Bernard called attention to the importance of having a constant internal environment in the body. He emphasized the organic composition of blood as the nutritional medium of cells. In the 1920s, the American physiologist Walter Cannon drew attention to the role of coordinated physiological mechanisms in regulating internal state conditions. He coined the term homeostasis to characterize these functions. It is now well established that the *hypothalamus* interacts with brainstem nuclei to control homeostasis through actions of the peripheral nervous system and hormones released by the pituitary gland. *Thermoregulation* maintains body temperature within a narrow range for mammals and other homeotherms. Body temperature is sensed by cutaneous thermoreceptors and by temperature sensitive cells in hypothalamus. Regulator circuits in spinal cord, brainstem, and hypothalamus sense deviations from the setpoint (normally 98.6°F for humans) and trigger both compensatory behaviors (heat seeking/avoiding) and reflex actions (vasoconstriction/dilation, sweating, respiration, brown fat metabolism, thyroid hormone secretion) to restore homeostasis. *Fluid balance* is monitored by cardiac and kidney baroreceptors that signal hypovolemia (low blood volume) and hypothalamic osmoreceptors that signal increased concentrations of solutes in extracellular fluids. These signals are processed in hypothalamus to give rise to behavioral adaptations (motivated drinking, salt appetite) and reflex responses (water and salt retention by the kidneys, vasoconstriction to maintain blood pressure) that maintain homeostasis. *Energy balance* is a more complex process. Appetite is influenced by short-term factors signaling hunger, satiation, and the palatability of available food and by long-term factors related to the amount of energy stored in adipose tissue. The arcuate nucleus in hypothalamus acts as an appetite controller, responding to hormones released in the gut reflecting both short-term (insulin, ghrelin, obestatin peptide YY) and long-term (leptin) factors. Feeding behavior is regulated by nuclei in hypothalamus and hindbrain based on input from the arcuate nucleus, neural signals from the gut, and nutrient sensing neurons in the brain.

Behavioral state control

Almost all living species exhibit *circadian rhythms*, daily patterns of biochemical, physiological, or behavioral processes that allow organisms to adapt to regular changes in the external environment. Circadian rhythms result from internal circadian clocks that typically run slightly longer than 24 h and zeitgeber ('time giver') stimuli (most commonly light) that reset the clock in phase with the daily cycles of the external environment. The primary circadian clock in mammals is located in the *suprachiasmatic nuclei*. These are small nuclei located just above the optic chiasm (Figure 2). They contain neurons that exhibit endogenous circadian rhythms and receive direct input from specialized cells in the retina that allow light to serve as a zeitgeber. Circadian rhythms of the suprachiasmatic nuclei regulate daily patterns of sleep and wakefulness that are characteristic of most mammalian species. Mammalian brains exhibit different rhythms of neural activity that correspond to

states of vigilance (or alertness). In most general terms, these consist of the wake state, associated with a low amplitude, desynchronized EEG activity; slow-wave sleep, divided into four stages associated with slow-wave EEG activity; and rapid eye movement (REM) sleep, associated with small-amplitude, fast EEG waves, lack of muscle tone, and rapid eye movements. *Wakefulness* is regulated by neurons in the lateral hypothalamic area and posterior hypothalamus that release the neuropeptides orexin A and orexin B (also known as hypocretin1 and 2) in neurochemically specific wake-promoting nuclei that are located in the brainstem. These *wake-promoting nuclei* include noradrenergic neurons in locus coeruleus, serotonergic neurons in the raphe nuclei, cholinergic neurons in pedunculo-pontine tegmental and laterodorsal tegmental nuclei, glutamatergic neurons in the midbrain, dopaminergic neurons in tegmentum, and histaminergic neurons in the tuberomammillary nucleus. They produce arousal through direct effects on neurons throughout thalamus and neocortex and through actions on neuromodulatory systems in the basal forebrain. *Slow-wave sleep* results from decreased activity of wake-promoting systems by substances like adenosine that build up during prolonged periods of wakefulness and by descending inhibitory projections that originate in the preoptic area of hypothalamus. *Rapid eye movement sleep* is triggered by cholinergic neurons in the pons and maintained by cell groups in the brainstem that activate cortex and produce muscular atonia.

Attention

William James famously described attention in *The Principles of Psychology* (1890): "Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects of trains of thought. Focalization, concentration, of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others, and it is a condition which has a real opposite in the confused, dazed, scatter-brained state ..." Modern theories have unpacked James' description into a number of components. *Top-down attention* (endogenous or voluntary attention) is the ability to deploy attention according to internal behavioral goals. *Bottom-up attention* (exogenous, involuntary attention) is the tendency for highly salient stimuli like the ring of a cell phone or a flashing light to attract attention automatically. Stimulus saliency depends on both the nature of the stimulus and the environment in which it is experienced. Working memory is a temporary store of information used to carry out cognitive functions like decision-making or planning complex behaviors. Working memory can hold only a limited amount of information at a given moment in time. Both top-down and bottom-up attention determine which of multiple types or sources of information is held in working memory (and is thus available for decision-making or planning). At the same time, working memory plays an important role in directing top-down control of attention. Convergent evidence supports a critical role for prefrontal cortex in working memory and prefrontal and posterior parietal cortices in both top-down and bottom-up attention. The capacity for attention depends critically on the level of alertness and arousal and thus many of the neurochemical systems that control wakefulness (see above). The relationship between arousal and attention is

characterized by an inverted-U (Yerkes-Dodson) function: too little arousal results in drowsy inattentiveness and too much arousal produces the frazzled, 'dazed, scatterbrained' state described by James.

Emotion

In 1872 Charles Darwin published *The Expression of the Emotions in Man and Animals* in which he characterized emotions as instinctive reflex actions that serve as an important means of communication and an efficient way to adapt to changing environmental demands or opportunities. Modern theories largely accept the idea that there are fundamental types of emotion that are expressed through stereotyped motor responses (primarily facial expressions in humans) and physiological changes. According to cognitive theory, emotions are activated by cortical mechanisms that perceive and interpret sensory stimuli within a particular context and separately trigger both emotions and autonomic nervous system responses. The autonomic responses are thought to influence how the emotion is experienced and this overall experience of emotion then provides feedback signals that affect subsequent interpretation of sensory inputs. Neurological theories emphasize the role of amygdala in processing socially and emotionally relevant stimuli. The amygdala receives sensory information from thalamus and cortex and contextual information from hippocampus required for this function. The central nucleus of the amygdala sends projections to brainstem areas that trigger visceral and somatic responses and to hypothalamic nuclei that control autonomic and hormonal responses. The role of amygdala in perception and expression of emotions has been confirmed by convergent evidence from studies of lesion effects on experimental animals and human patients and analyses of neural activity in animals and functional imaging in human subjects. The amygdala is interconnected with two regions of frontal cortex, the orbitofrontal and anterior cingulate areas, with which it interacts to produce normal patterns of emotion and social behavior.

Higher cortical functions in homosapiens

Localization of function in cerebral cortex: Nineteenth century neurology established beyond doubt that cerebral cortex is necessary for cognitive function. Controversy remains however over the extent to which cognitive functions are localized in discrete areas of cortex. Cortex is broadly divided into motor areas that give rise to voluntary movements, sensory areas that receive and process information in the senses, and association areas that lack direct sensory or motor connections and mediate cognitive functions like perception, attention, language, and memory. Apart from simple functions of primary motor or sensory cortex, like flexion of a finger or perception of visual stimuli in a discrete part of the retina, evidence of localized cortical function must be treated with caution. Association areas participate in large-scale distributed neural circuits that involve other areas of cortex and subcortical areas like thalamus, amygdala, and the basal ganglia. It may be misleading to identify discrete cortical locations with functions like reading, tool use, or working memory that depend on interactions between multiple brain areas. A second concern is that cognitive functions, as currently understood, may not accurately characterize what a particular brain area does. The human

brain is a biological system that evolved gradually over many millions of years. Cognitive functions are psychological constructs that do not necessarily reflect the physiological functions performed by a particular brain area. These concerns aside, there are strong arguments that support localization of function. Cerebral cortex is not a homogeneous mass. Human cerebral cortex is anatomically differentiated by cytoarchitecture (cellular composition), anatomical connections, gene expression, and neurochemistry. There are many compelling examples of structure–function relationships that suggest specialized functions of localized areas of cortex. Similarly, there are many examples of well-defined cognitive deficits that result from lesions damaging discrete areas of cortex and of local areas of cortex exhibiting alterations in neural activity, metabolic function, and early or intermediate gene expression when individuals perform specific cognitive tasks. The bottom line is that while there is abundant evidence that cerebral cortex is topographically organized into discrete areas that serve specialized functions, there are also good reasons to be cautious in identifying specific cognitive functions with discrete areas of cortex.

Language: Much of what we know about the organization of language in the brain has come from the study of aphasia, the loss of language ability as a result of brain damage. The modern study of aphasia began in the early 1860s when Paul Broca described several patients who lost the ability to speak ('aphemia') with lesions that damaged the third frontal convolution in the left hemisphere of cerebral cortex (now known as Broca's area). Broca noted that this inability to speak did not result from an inability to move muscles needed for speech, to understand spoken speech, or to communicate nonverbally. In 1868, Hughlings Jackson argued that the emissive symptoms described by Broca reflect a higher-level inability to express a proposition in words. He based this on observations that expressive aphasia commonly spares the ability to utter emotional oaths or overlearned phrases or to produce words in the context of automatic speech (saying 'no' to indicate something not to be done, while being unable to say 'no' as a voluntary answer to a question). He also noted that speaking and writing are often similarly impaired. In 1874, Carl Wernicke, a 26-year-old medical student, published a short monograph based on ten cases of aphasia (only four autopsied) that described a new type of aphasia and proposed a framework for understanding aphasia that remains relevant today. Wernicke described sensory aphasia, a syndrome characterized by diminished comprehension of speech (but not deafness), fluent and nonsensical speech, and frequent paraphasias (errors in speech production). Wernicke attributed sensory aphasia to lesions damaging the posterior portion of the superior temporal gyrus in the left hemisphere (now known as Wernicke's area). Wernicke predicted a third type of aphasia (conduction aphasia) primarily affecting the ability to repeat spoken language when lesions disconnect the anterior (Broca's) and posterior (Wernicke's) language centers. The current view of aphasia accepts Wernicke's view of functionally distinct anterior and posterior language areas located in the left hemisphere of most individuals (virtually all right-handed individuals). Current analyses emphasize the involvement of broader areas of cortex surrounding the classic Broca's and Wernicke's areas, particularly for cases in which severe symptoms persist. Current

descriptions of aphasic syndromes have also changed. Broca's aphasia is characterized by slow and effortful speech production, word-finding difficulty, and grossly intact comprehension of speech. Aphasiologists emphasize a fundamental deficit in grammar (agrammaticism) affecting comprehension of grammatically complex sentences, the lack of grammatical endings on words and words carrying grammatical meaning in spontaneous speech, and the difficulty of producing more than one or two word utterances (telegraphic speech). Wernicke's aphasia is characterized by a fundamental inability to use language to express ideas. This is reflected in fluent speech rife with paraphasic errors, naming errors (often bizarre misnamings), and impaired comprehension and repetition of speech.

Memory is defined by what we remember, that is the influence on ongoing thought processes or behaviors of information that is no longer present in the environment (and thus must be represented in the brain). Failure to retrieve is generally taken as evidence that a memory no longer exists. Memory is necessary for any cognitive process that is on the basis of more than information immediately available to the senses. For the most part, remembering is an automatic, effortless process. At a cellular level *synaptic plasticity*, the ability of synapses between neurons to change in strength, is thought to underlie learning and memory. Newly learned information exists in a labile state of altered synaptic strength for a limited period of time. With the passage of time information becomes consolidated in a more permanent form. When information is retrieved, it is reactivated into a labile form for a brief time before it is reconsolidated back into a more stable form. While synaptic plasticity seems to be a general feature of many neurons, neurons in memory circuits are organized to represent information in neural networks that allow for information to be retrieved and to influence systems that guide responding. Most information stored in memory is represented in cerebral cortex, particularly within association areas of cortex. Perceptual memories are stored in sensory association cortex while motor memories such as skilled tool use are stored in premotor and posterior parietal areas. Working memory, the ability to hold and manipulate information in consciousness, is encoded by the activity of neurons in prefrontal cortex. Cortical memories are accessed by different neural systems that mediate distinct types of memory. The cerebellum and basal ganglia mediate *procedural memories*, including habit learning, skill learning, and sensorimotor adaptation. The lateral cerebellum (cerebrocerebellum) receives its main inputs from parietal and premotor areas of cortex. The basal ganglia receive convergent corticostriatal projections from widespread areas of cortex. The amygdala mediates implicit (subconscious) *emotional memories*. The amygdala has prominent reciprocal connections with limbic-related areas of cortex (frontal, cingulate, and insular areas) and projections that control autonomic and hormonal aspects of emotional responses. Hippocampus and adjacent areas of parahippocampal cortex mediate *declarative (explicit) memories*. Parahippocampal cortex has extensive reciprocal connections with association areas of cortex and is

connected in turn with hippocampus. The hippocampal system is thought to facilitate the formation of associations between memories represented in different areas of association cortex. Declarative memories are of information like facts or events that can be consciously recalled. These include both episodic memories of specific personal experiences and semantic memory of facts that are not necessarily tied to a particular context.

Executive functions are core activities of prefrontal cortex that optimize behavioral performance, particularly in situations that place demands on cognition. Executive function is critical for cognitive flexibility, the ability to adapt ongoing behavior on the basis of the status of external events and internal intentions. Executive functions include working memory, supervisory (top-down) control of attention, and cognitive control. *Working memory* is active, short-term memory that has been related to activation of neurons in dorsolateral prefrontal cortex. Working memory holds information about external stimuli, intended actions, and internal goals in consciousness so that it can be used to guide both overt actions and covert thinking. *Supervisory (top-down) control of attention* promotes control over thoughts and actions by resolving conflicts between stimulus or response elements. Convergent evidence suggests that supervisory control of attention depends on interactions between dorsolateral and anterior cingulate areas of prefrontal cortex. *Cognitive control* reflects the ability to orchestrate thought and action in relation to internal goals. In a sense, it is an emergent property of working memory and supervisory attentional control. Cognitive control is thought to depend on lateral prefrontal cortex and to exert its effects through top-down control of premotor and posterior association areas of cerebral cortex. Cognitive control appears to be organized hierarchically in a caudal to rostral fashion with more caudal areas mediating sensory control and more rostral areas mediating higher-level aspects of cognitive control.

See also: Amnesia and the Brain; Appetite; Attention; Glial Cells; Hippocampal Formation; Memory, Neural Substrates; Neuroexecutive Function; Sense of Smell; Sense of Taste (Effect on Behavior); Visual Perception.

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Brain and Behavior Relationships

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Glossary

Achromatopsia Also known as cortical colorblindness, it refers to the loss of ability to perceive colors.

Agnosia It is loss or diminution of the ability to recognize familiar objects or stimuli. Agnosia may refer to visual, auditory, or tactile perceptions.

Alexia It is the loss of ability to read.

Amusia It is the inability to produce or comprehend music.

Aphasia It is the loss or impairment of the power to use or comprehend words.

Aprosody It is the absence of the normal pitch, rhythm, and variations in melodic intonations of speech.

Declarative memory A type of memory that requires conscious recollection of information previously learned.

Dysarthria It is the difficulty in articulating words.

Hierarchical (serial) processing A type of processing where information is relayed in hierarchy from one center to the next.

Neuronal/synaptic plasticity The property of synapse and neurons to change their functionality, connectivity, and internal parameters based on activity level.

Nondeclarative memory A type of memory that does not require conscious or intentional recollection of what was learned.

Nuclei A collection of central nervous system gray matter (neuronal cell bodies) embedded in white matter.

Parallel-processing model Processing of different aspects of information simultaneously in different regions of the brain.

Prosopagnosia It is the loss or inability to recognize human faces.

Historical Background

From the time of Aristotle to the modern age, human behavior has been understood in the context of the ideological trends and philosophy of the historical period. During the last millennium, the natural sciences have developed testable theories, which explain observed phenomena in terms of physical laws. The development of this scientific method of inquiry has resulted in a shift from exclusively theological or philosophical explanations to those that are subject to measurement and testing.

The Greek physician, Hippocrates (460–377 BC), maintained that “not only our pleasure, our joy and our laughter but also our sorrow, pain, grief and tears rise from the brain and brain alone” (Figure 1). Hippocrates’ ideas were overshadowed by those of the influential Greek philosopher, Aristotle (384–322 BC), who proposed that the heart was the organ of thought and mental processes while relegating the brain to the role of a cooling organ for hot blood from the heart. The second century AD physician, Galen of Pergamum, advanced the theory that the brain was the seat of mental activity, and like the rest of the body, it functioned by the balance of the four vital humors. The bodily humors hypothesis proposed that differences in human moods come as a consequence of imbalances in one of the four bodily fluids: blood, yellow bile, black bile, and phlegm. According to Galen, an imbalance of each humor corresponded with a particular human temperament (blood-sanguine, black bile-melancholic, yellow bile-choleric, and phlegm-phlegmatic). Individuals with sanguine temperaments are extroverted and social. Choleric people have energy, passion, and charisma. Melancholics are creative, kind, and considerate. Phlegmatic temperaments are characterized by dependability, kindness, and affection.

For the next 1500 years until the time of the Enlightenment, the understanding of brain function was highly influenced by

the teachings of Galen. As Western Europe gradually emerged from the Dark Ages, the dissection of human cadavers became more common. From dissections, artists like Leonardo da Vinci prepared anatomic atlases of the human body and nervous system. The seventeenth century French philosopher and mathematician, René Descartes, argued that physical laws could not account for the full range of human behavior such as the intellect. From this hypothesis arose the modern formulation of the mind – body dichotomy, known as Cartesian Dualism, which to this day continues to be a point of philosophical debate (Figure 2).

The proponents of the mind–brain dichotomy have contended that human consciousness is unlike any other physical phenomena, and cannot be fully accounted for by mere biological processes. This mind–brain division led to the divergence of psychiatry and neurology in twentieth century medicine, with psychiatry focusing on the psychological and emotional underpinnings of behavior while neurology focused on brain physiology and pathology. Sigmund Freud (1856–1939), the founder of the psychoanalytic school of psychiatry and a neurologist by training, focused mainly on the psychological foundations of behavior (Figure 3). Freud did, however, believe that brain physiological studies would eventually lead to a better understanding of mental processes. Contemporary neuroscience views the brain as the source of all behavior and mental functions. Human cognitive abilities and behaviors are seen as having varying degrees of representation and homology with those found in other members of the animal kingdom.

By the nineteenth century, the gross anatomy of the human nervous system had been well documented. Through careful microscopic examination of brain sections, Santiago Ramon y Cajal (1852–1934) prepared drawings of brain cells, which continue to be referenced today. Korbinian Brodmann (1868–1918) defined regions of the cerebral cortex based on histological

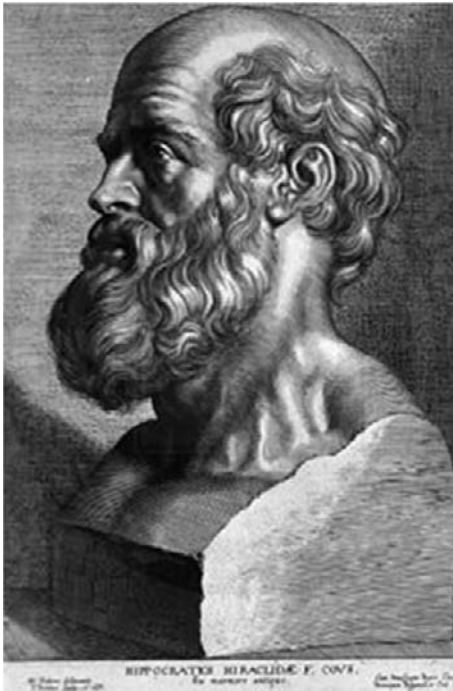


Figure 1 Hippocrates. Engraving by Peter Paul Rubens, 1638. Courtesy of the National Library of Medicine.



Figure 2 Portrait of René Descartes by Frans Hals, Louvre.

characteristics. These regions, named Brodmann areas, correspond to functional regions (see [Figure 4](#)). The work of Paul Broca (1824–1880) and Carl Wernicke (1848–1905) contributed to our understanding that the brain has regions dedicated to the performance of discrete functions. The origin of such intricate specialization was a mystery but it would soon be less so. In 1859, in his book *On the Origin of Species*, Darwin proposed that natural selection was the means by which nature crafted biological specialization. This theory proposed that the

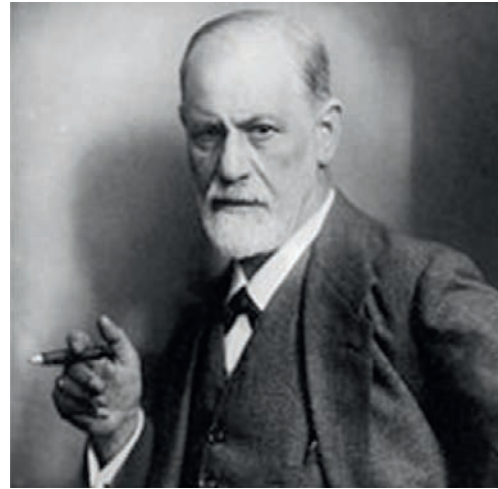


Figure 3 Sigmund Freud. Photograph by Max Halberstadt, 1921.

characteristics of organisms result from a long process of natural selection. Organisms, and therefore the nervous system, were shaped by adaptation to ever-changing environmental pressures. Since the introduction of this theory, scientists have analyzed physical and behavioral characteristics in terms of their adaptive advantages to the organism ([Figure 5](#)).

The substance that encoded biological evolutionary changes and allowed them to be transmitted from generation to generation was still unknown. In the mid-nineteenth century, a Catholic monk, Gregor Mendel, while experimenting with horticulture and insects, observed that organisms inherit traits via discrete units of inheritance. Mendel's observations served as a foundation for the modern science of genetics. It was not until 1953 that James Watson and Francis Crick, using X-ray diffraction data, deduced the double helix structure of the DNA molecule. In 1963, they were awarded the Nobel Prize for their discoveries which ultimately revealed how information was transferred from generation to generation in living organisms. Subsequent research has identified a genetic basis for numerous neurobehavioral disorders such as Huntington's disease, frontotemporal dementia, Down's syndrome, and Wilson's disease. The genetic factors that alter susceptibility to many diseases, such as Alzheimer's disease, schizophrenia, mood disorders, alcohol dependence, and certain personality disorders, have also been identified.

The germ theory of disease and the development of microbiology helped elucidate brain and behavior relationships as well. Although many individuals have made monumental contributions to the development of microbiology, it was Robert Koch who published a series of proofs in 1890 verifying the germ theory of disease. Microbiology research led to identification of the *Treponema pallidum* bacterium in 1905 by Shaudinn and Hofmann as the causative agent for syphilis. Eight years later, Hideyo Noguchi demonstrated the presence of the syphilis spirochete in the brain of a patient with generalized paresis of the insane (GPI). Before this, GPI was largely thought to be a mental illness caused by weakness of personality or defective moral character. After this discovery, it became the first neuropsychiatric syndrome caused by an identifiable infectious agent. A study published in 1930 looking at more

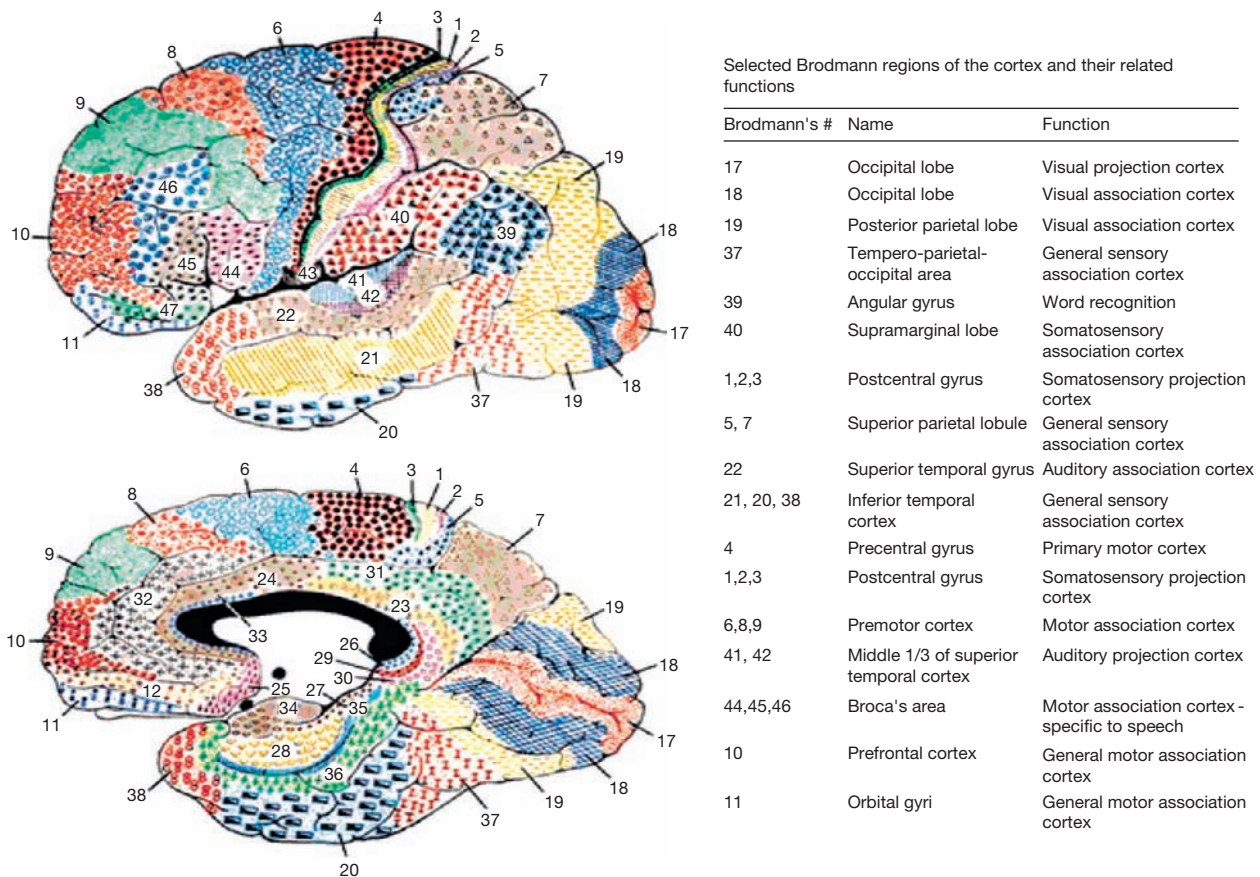


Figure 4 Selected Brodmann regions of the cortex and their related functions. Reproduced with modification from Mesulam MM (ed.) (2000) *Principles of Cognitive and Behavioral Neurology*. New York: Oxford University Press.



Figure 5 Charles Darwin 1868.

than 2000 consecutive admissions to an insane asylum estimated that one in six patients may have had syphilis infection. The 1930s and 1940s saw the beginning of the antibiotic revolution in medicine. The introduction of penicillin, an

effective treatment for syphilis, resulted in a dramatic reduction of syphilis-related psychiatric illness.

Principles of Behavioral Neuroanatomy

From simple reflexes to complex reasoning, behavior is generated in a hierarchal fashion in the nervous system. Many aspects of behavior are mediated almost reflexively, with more complex mental tasks requiring engagement and coordination of multiple higher brain centers. Simple reflexes, such as tendon stretch reflexes, are mediated at the level of the spinal cord, while brain stem structures control semiautomated motor aspects of behaviors such as crying, laughing, chewing, and sucking without the absolute requirement of cortical involvement. Anencephalic babies, born without the cerebral cortex, are able to suckle, chew, and cry just like their healthy counterparts. Nevertheless, there is a bidirectional modulation between subcortical and cortical centers, with the cortex exerting regulatory control over lower-level reflexes under normal circumstances. The hypothalamus is a subcortical structure which mediates homeostatic functions such as temperature, appetites, and sexual drive. The cortex regulates behaviors which address the biological needs arising from lower centers.

Cerebral function may be analyzed from the vantage point of a number of disciplines: neurochemistry, neurophysiology,

histology, and at the gross anatomical level. None of these alone is sufficient for achieving a comprehensive understanding of behavioral neurobiology. Neurotransmitters, receptors, synaptic plasticity, and neural connectivity form a continuum of elements which are the basis of nervous system function. On a higher organizational level, corticocortical and corticosubcortical brain networks link and coordinate distant brain regions. These networks function in parallel to generate our mental representations of the internal milieu and the external world.

Chemical and Neural Basis of Behavior

Neurotransmission

For millennia, various cultures have used perception and mood-altering substances in religious or shamanic rituals to facilitate healing, divination, communication with spirits, and to mark coming-of-age ceremonies. Some plant derivatives, such as opiates and cocaine, have been used in modern times for their medicinal benefits and abilities to induce euphoria. The misuse of drugs has resulted in medical, legal, and social problems for which society has not been able to find adequate solutions. Yet, they also have opened up new and profound opportunities to study human behavior. The mechanism of the profound behavioral effects of psychoactive ethnobotanical substances did not receive wide scientific attention until the twentieth century when, in 1938, Albert Hofmann synthesized a hallucinogenic drug, lysergic acid diethyl amide (LSD), from the ergot fungus. In 1943, Hofmann became inadvertently intoxicated by LSD and is remembered for his colorful description of his bicycle ride home while in an intoxicated condition. Early researchers observed that the drug's effects were similar to the naturally occurring symptoms of schizophrenia. In the decades that followed, psychiatrists developed an interest in the properties of hallucinogenic drugs as a model for understanding psychosis. The structural similarity of serotonin (5-HT) to LSD offered support to researchers who hypothesized that alteration of brain 5-HT might be involved in mental illness.

The early 1950s witnessed the birth of psychopharmacology with the serendipitous discovery that the administration of chlorpromazine reduced psychotic symptoms in patients. The introduction of first-generation antipsychotics, over three decades, significantly reduced the number of chronically psychotic patients institutionalized in long-term treatment facilities and returned them to the community. The antidepressant effects of antihistamine derivatives with a tricyclic structure led to a subsequent revolution in the pharmacotherapy of depressive illness. Julius Axelrod and his colleagues received the Nobel Prize for their work performed in the late 1950s describing the synthesis, storage, release, and inactivation of catecholamine (i.e., epinephrine, norepinephrine, and dopamine) neurotransmitters. Many classes of medications have since been developed for treatment of psychosis, depression, mania, anxiety, obsessive-compulsive disorder, and insomnia: selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, second-generation (atypical) antipsychotics, tetracyclic antidepressants, and monoamine oxidase inhibitors. This revolution in pharmacology opened new avenues for investigating the chemical mediation of behavior. Research clarified that

antipsychotic medications exert benefits through their ability to block dopamine D2 receptor binding. Amphetamines were demonstrated to increase brain norepinephrine and dopamine levels, and large doses or prolonged use of this medication were observed to cause psychosis. These lines of evidence converged to support the 'dopamine hypothesis' of schizophrenia. This hypothesis postulated that psychosis results from disturbed and hyperactive dopaminergic signal transduction. Another model based partly on the mind-altering effects of drugs, namely, phencyclidine (PCP) and ketamine, which act upon glutamatergic signaling systems, is that of the 'glutamate hypothesis.'

Learning and Memory

Connectivity between neurons is a dynamic process, continually being modified by the level of neuronal activity. Synapses with high activity levels are maintained and strengthened, while low activity leads to weakening of synaptic transmission or even dissolution of the connection. This process continues throughout life and is a critical substrate for learning, memory, and the brain's ability to adapt to environmental demands. In 2000, Eric Kandel was awarded the Nobel Prize in medicine for his work describing the physiological processes by which memory and learning occur in *aplysia* (sea slug). This work ultimately shed light on how individual personality styles might be shaped by experience, why children start to speak the language they are most exposed to, and why practice improves subsequent performance.

Localization of Brain Functions

The cortex has discrete regions dedicated to the processing of language, visual, auditory, and olfactory information as well as areas for cognitive and emotional processing. There are higher-order cortical association areas that are specialized to process color, form, fine details of visual objects, motion, and even areas specific to human face recognition. The brain has semantic stores, located in association cortices, where knowledge about the world is categorized and organized. These stores attach semantic knowledge to primary modalities of perception and action located in primary sensory and motor cortices. Hence, the brain is a collection of highly subspecialized, interconnected functional regions (see [Figure 6](#)). The processing of different characteristics of a stimulus in discrete brain regions may seem counterintuitive to our subjective experience. After all, when we see a red car speeding down the street, we do not perceive the color, shape, noise, or speed of the car separately. Rather, we see and hear the car as an integrated whole. How the brain binds these various percepts into one experience is not fully understood. It is clear that it is dependent on the rich reciprocal connections among distributed specialized cortical and subcortical regions which create a type of parallel processing network.

Early functional maps of the cerebral cortex were prepared from postmortem studies of patients with brain insults. Later, the famous neurosurgeon, Wilder Penfield (1891–1976), refined a technique of testing the function of various brain regions. While experimenting with ways to limit brain injury during surgery, he applied electrical stimulation to specific brain regions via small probes while the patients were

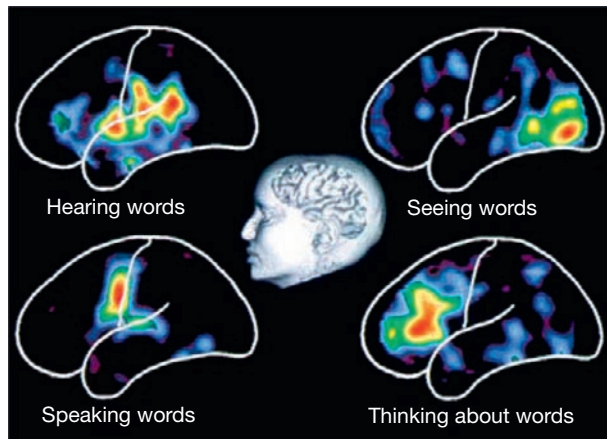


Figure 6 Positron emission tomography (PET) imaging of the brain demonstrating that different brain regions are activated when people perform four different language tasks, showing anatomical localization of the various language tasks. Courtesy of Marcus Raichle.

conscious on the operating table under only local anesthesia. Penfield observed their responses and accurately mapped the major sensory, motor, and language areas, thereby allowing some ability to minimize injury to these areas during surgery. He also charted the connections from sensory and motor cortices (homunculus) to the various limbs and organs of the body. Strikingly, he observed that in his epilepsy patients, stimulation applied to regions of the temporal lobes could trigger vivid recall of past experiences. As of yet this has not been reproduced in patients without epilepsy. The functional maps Penfield produced are still in use today. Functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) scans are imaging technologies which have led to refinements of functional brain maps (see [Figure 6](#)). fMRI uses signal changes which arise from blood flow and/or oxygenation changes caused by local neural activity. These signal changes serve to indicate regional brain activity during the performance of a defined task. PET scans use radio-labeled tracer molecules which may target receptors, molecules, or be incorporated into metabolic processes to allow visualization.

Cognitive–Behavioral Neuroanatomy

Two general principles of brain organization can be discerned (see [Figure 4](#)). Perceptual areas such as the somatosensory, visual, and auditory cortices are located posterior to the central sulcus, while effector (output) areas such as the prefrontal and motor cortices are found anterior to the central sulcus. Speech production (Broca's area) and speech perceptual areas (Wernicke's area) also follow this anterior–posterior pattern of organization. In addition to anterior–posterior localization, the brain also shows lateralization of function between the hemispheres. The left and right hemispheres of the brain look similar but they are not exact mirror images of each other in terms of anatomy or function. Each hemisphere receives sensory information from and controls motor activity to the opposite side of the body.

The left hemisphere is dominant for language function in over 90% of all right-handed and about 60% of left-handed

people, while the right hemisphere is involved in the emotional content (prosody) of language. Hence, damage to the left Broca's area results in hesitant, agrammatical speech with short utterances consisting of few words. A lesion in the homologous right hemisphere will result in impairment of emotional inflection in speech. In such patients, speech may be flat, monotonous, and lacking in gestures, but with fairly normal content and grammar. The parietal, frontal, and cingulate cortices interact to generate attention to the opposite side of space. Lesions in these cortices produce contralateral sensory neglect, directional hypokinesia, and reduced motivational value, respectively. Neglect most often occurs with respect to the left side of space, indicating the importance of the nondominant hemisphere (usually, the right hemisphere) in spatial attention. Neglect syndromes show that focal lesions may affect specific aspects of self-awareness while sparing others. Focal lesions resulting in neglect syndromes illustrate that self-awareness is a composite consisting of the interconnected functions of many brain regions.

Cortical Organization

The cerebral cortex can be divided into five major functional subtypes: primary sensorimotor, unimodal association, heteromodal association, paralimbic, and limbic (see [Figure 7](#)). The primary sensory areas are the point of entry for sensory information into the cortical circuitry. The primary motor cortex conveys motor programs to motor neurons in the brain stem and spinal cord. Further processing of sensory information occurs as information moves from primary sensory areas to the adjacent unimodal association areas. The unimodal and heteromodal cortexes are involved in perceptual processing and motor planning. The complexity of processing increases as information is then transmitted to heteromodal association areas, which receive input from more than one sensory modality. Examples of heteromodal association areas include prefrontal cortex, posterior parietal cortex, parts of the lateral temporal cortex, and portions of the parahippocampal cortex. The highest level of cognitive processing occurs in regions referred to as transmodal areas. These areas are composed of heteromodal, paralimbic, and limbic regions, which are collectively linked in parallel to other transmodal regions. Interconnections among transmodal areas such as Wernicke's area, posterior parietal cortex, and the hippocampal–entorhinal cortex allow the integration of distributed perceptual processing systems resulting in perceptual recognition, such as scenes and events becoming experiences or words taking on meaning.

The limbic region has strong connectivity with the prefrontal cortex and is intimately involved with regulation of emotion, memory, motivation, and autonomic and endocrine function. Limbic system dysfunction has been described in several psychiatric syndromes such as schizophrenia, bipolar illness, and depressive disorders. The amygdala, located in the mesial temporal lobe, is important for both the acquisition and expression of emotions. Its strong connectivity with the hypothalamus is the underpinning for the autonomic and visceral manifestations and sensations accompanying emotions such as fear. The critical role of the amygdala for emotional processing is demonstrated in individuals who have Klüver–Bucy syndrome. Klüver–Bucy syndrome is a behavioral syndrome characterized by psychic blindness (visual agnosia), a tendency to

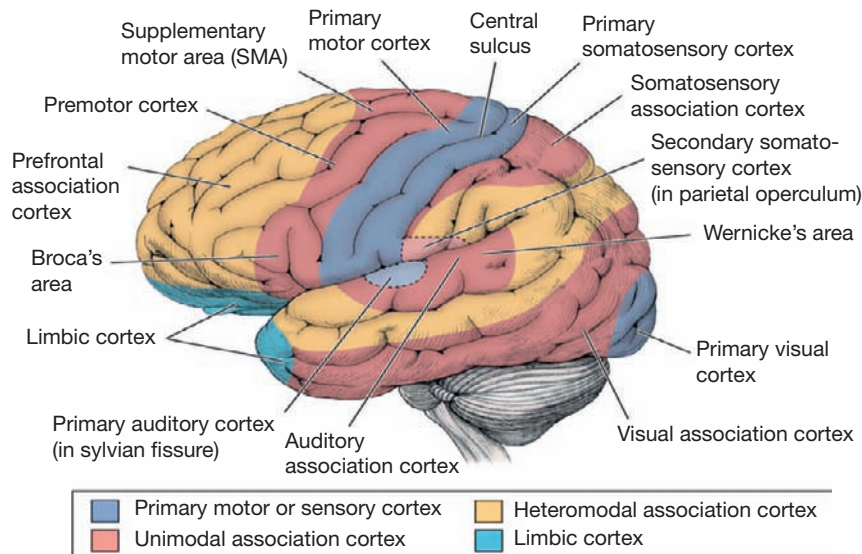


Figure 7 Showing major functional areas of the brain. Reproduced with permission from Blumenfeld H (2010) *Neuroanatomy Through Clinical Cases*, 2nd edn. Sunderland, MA: Sinauer Associates.

examine objects orally, distractability, hypersexuality, loss of aggressiveness (placidity), and a striking inability to display or experience fear or anxiety. Klüver–Bucy syndrome occurs with injury to the amygdale or medial temporal lesions on both sides. Potential causes include traumatic brain injury, anoxia, herpes encephalitis, and frontotemporal dementia. In contrast, seizures arising from the amygdala often produce intense anxiety or fear, through overactivation of this circuit.

Cortical Networks

Five distinct cortical network regions govern specific aspects of cognitive functioning: (1) the language network, which includes transmodal regions in Broca's and Wernicke's areas; (2) the spatial awareness network dependent on transmodal regions in the posterior parietal area, frontal eye fields; (3) the memory and emotional network located in the hippocampal entorhinal region and amygdala; (4) the executive function-working-memory network dependent on transmodal regions in the lateral prefrontal cortex and possibly in the inferior parietal cortices; and (5) the face–object recognition network based in the temporopolar and midtemporal cortices. Lesions of transmodal cortical areas result in global impairments such as hemineglect, anosognosia, amnesia, and multimodal anomia. Disconnection of transmodal regions from a specific unimodal input will result in selective impairments such as category-specific anomias, prosopagnosia, pure word deafness, or pure word blindness (alexia).

Cortical networks underlie the ability to empathize with another person's psychological and physical circumstances. Empathy is a necessary foundation for social and moral behavior. Originally identified in monkey premotor cortex, mirror neurons are a specific class of visuomotor neuron that discharges in a subject when a particular action is performed and when an action is observed in another individual. The human mirror neuron system is the neural network now postulated

to be involved in comprehending the actions of others and the intentions behind the actions. It may also provide the basis for observational learning. The parietofrontal mirror system, which includes the parietal lobe and the premotor cortex plus the caudal part of the inferior frontal gyrus, is involved in recognition of voluntary behavior in other people. The limbic mirror system, formed by the insula and the anterior mesial frontal cortex, is devoted to the recognition of affective behavior. Dysfunction of this system may underlie deficits in theory of mind and has been proposed as an explanation for the social deficits seen in autistic disorders. Theory of mind is a model of how a person understands and infers other people's intentions, desires, mental states, and emotions.

Frontosubcortical Networks

Cognition, behavior, and movement are dependent on five frontosubcortical circuits. All share the same principal components: (1) frontal cortex; (2) striatum (caudate, putamen, ventral striatum); (3) globus pallidus and substantia nigra; and (4) thalamus. While two of these circuits are concerned with somatic motor and oculomotor functions, the other three are intimately involved in cognition and behavior. These circuits originate in the dorsolateral prefrontal, orbitofrontal, and anterior cingulate cortices.

The dorsolateral prefrontal circuit governs executive functions, including the ability to plan and maintain attention, problem-solve, learn, retrieve remote memories, sequence the temporal order of events, shift cognitive and behavioral sets, and generate motor programs. Executive dysfunction is a principal component of subcortical dementias. Common deficits in subcortical dementias include slowed information processing, memory retrieval deficits, mood and behavioral changes, gait disturbance, dysarthria, and other motor impairments. Vascular dementias, Parkinson's disease, and Huntington's disease are examples of conditions that affect this circuit.

The orbitofrontal circuit connects frontal monitoring functions to the limbic system. This circuit governs appropriate responses to social cues, empathy, social judgment, and interpersonal sensitivity. It pairs thoughts, memories, and experiences with corresponding visceral and emotional states. This circuit is heavily involved in the process of decision-making and evaluating the costs and benefits of specific behavioral responses to the environment. The medial orbitofrontal cortex (OFC) evaluates reward, whereas the lateral OFC monitors and decodes punishment as it pertains to motivating behavioral change. There is an anterior–posterior gradient in which the reward value for more abstract and complex secondary reinforcing factors, such as money, is encoded in the anterior regions, and more concrete factors such as touch and taste are encoded in the posterior OFC areas. The posterior OFC is thought to have an important role in evaluating the emotional significance of stimuli. Dysfunction in this circuit can lead to disinhibition, irritability, aggressive outbursts, inappropriate social responses, and impulsive decision-making. Persons with OFC lesions may show deficits in both the production and recognition of emotional expression from the face, voice, or gestures. Bilateral OFC lesions may result in theory of mind deficits.

The anterior cingulate circuit includes the nucleus accumbens and has both afferent and efferent connections to the dorsolateral prefrontal cortex (DLPFC) and amygdala. It is involved in motivated behavior. Lesions in this circuit result in apathy, loss of the ability to act or to make decisions (abulia), and akinetic mutism (loss or impairment of voluntary activity and communication). Apathy can have affective (flat and unchanging facial expressions), emotional (loss of interest or excitement and lack of emotional reactivity), cognitive (lack of interest in learning and a decreased ability to understand new thoughts and participate in creative thought processes), and motoric dimensions (lack of effort, reduced productivity, and decreased ability to sustain activities). The medial prefrontal cortex is thought to play a significant role in the generation of emotions related to empathy, cognitive functions related to ‘theory of mind,’ and the ability to recognize a moral dilemma. The ventromedial frontal lobe evaluates the current relative value of stimuli helping to guide decision-making by determining the goals toward which behavior is directed and through judging outcomes. Various conditions that may affect this circuit include Alzheimer’s disease, frontotemporal dementia, Parkinson’s disease, and Huntington’s disease, head trauma, brain tumors, cerebral infarcts, and obstructive hydrocephalus.

Cerebrocerebellar Networks

Once thought to mainly coordinate movement, the cerebellum has been shown to have a role in the regulation of cognition, mood, and behavior. Cognitive processing tasks such as language, working memory, and spatial and executive tasks are associated with activation of the posterior cerebellar lobes. The posterior cerebellar vermis may function as a putative limbic cerebellum modulating emotional processing. Distractibility, executive and working memory problems, impaired judgment, reduced verbal fluency, disinhibition, irritability, anxiety, emotional lability or blunting, and obsessive–compulsive

behaviors as well as depression and psychosis have been reported in association with cerebellar pathology.

Neuropsychiatry

Neuropsychiatric symptoms can result from dysfunction in specific anatomic regions. Any disease, toxin, drug, or process that affects a region can manifest with changes in behavior mediated by the circuitry dependent upon that region. Brain pathologies may result in loss of function (negative symptoms, e.g., apathy), appearance of symptoms which should not be there (positive symptoms, e.g., hallucinations), or a combination of the two. **Table 1** summarizes neuropsychiatric symptoms and their anatomic correlates.

Not all brain lesions, however, will have observable behavioral consequences. There is also wide individual variability in the behavioral manifestations of focal brain lesions. Observational studies have shown that depression is common following left anterior or left subcortical stroke, but not all patients with such lesions develop depression. When temporal lobe epilepsy or Huntington’s disease begins in adolescence, a higher incidence of psychosis is noted than when their onset occurs later in life. This variability in behavioral manifestation of brain lesions may be due to factors specific to the lesion (e.g., size, location, laterality) and factors related to the individual such as the cerebral reserve, genes, and developmental stage of the brain (**Table 2**).

The case of Phineas Gage illustrates how regional brain injury may result in profound behavioral changes in the absence of

Table 1 Neuropsychiatric symptoms and proposed corresponding neuroanatomy

<i>Symptom</i>	<i>Neuroanatomic region</i>
Depression	Frontal lobes, left anterior frontal cortex, anterior cingulate gyrus, subgenum of the corpus callosum, basal ganglia, left caudate
Mania	Inferomedial and ventromedial frontal cortex, right inferomedial frontal cortex, anterior cingulate, caudate nucleus, thalamus, and temporothalamic projections
Apathy	Anterior cingulate gyrus, nucleus accumbens, globus pallidus, thalamus
Obsessive–compulsive disorder	Orbital or medial frontal cortex, caudate nucleus, globus pallidus
Disinhibition	Orbitofrontal cortex, hypothalamus, septum
Paraphilias	Mediotemporal cortex, hypothalamus, septum, rostral brain stem
Hallucinations	Unimodal association cortex, orbitofrontal cortex, paralimbic cortex, limbic cortex, striatum, thalamus, midbrain
Delusions	Orbitofrontal cortex, amygdala, striatum, thalamus
Psychosis	Frontal lobes, left temporal cortex

Reproduced with permission from Murray ED and Price BH (2008) Depression and psychosis in neurological practice. In: Bradley WG, Daroff RB, Fenichel GM, and Jankovic J (eds.) *Neurology in Clinical Practice*, 5th edn., pp. 101–120. Philadelphia, PA: Butterworth-Heinemann.

Table 2 Selected neurobehavioral manifestations of focal brain lesions

	<i>Hemispheric side of the lesion</i>		
	<i>Left</i>	<i>Right</i>	<i>Bilateral</i>
<i>Temporal lobes</i>			
Mesial	Anterograde amnesia for verbal material	Anterograde amnesia for nonverbal material	Severe anterograde amnesia for verbal and nonverbal material
Occipitotemporal junction	Prosopagnosia	Transient or mild prosopagnosia	Prosopagnosia, visual agnosia
<i>Occipital lobes</i>			
Ventral	Right hemiachromatopsia, alexia	Left hemiachromatopsia, visual agnosia	Full-field achromatopsia, visual agnosia
<i>Parietal lobes</i>			
Temporoparietal junction	Wernicke's aphasia	Amusia	Auditory agnosia
Inferior parietal lobule	Tactile agnosia	Neglect, anosognosia, tactile agnosia	Body schema disturbances, anosognosia
<i>Frontal lobes</i>			
Frontal operculum	Broca's aphasia	Expressive aprosody	Broca's aphasia
Superior mesial region	Akinetic mutism	Akinetic mutism	Severe akinetic mutism
Basal forebrain	Anterograde and retrograde amnesia with confabulation	Anterograde and retrograde amnesia with confabulation	Anterograde and retrograde amnesia with confabulation
Orbital (inferior mesial region)	Defective social contact, acquired sociopathy	Defective social contact, acquired sociopathy	Defective social contact, acquired sociopathy
Dorsolateral prefrontal region	Impaired working memory for verbal material, impaired executive function	Impaired working memory for nonverbal material, impaired executive function	Impaired working memory for verbal and nonverbal material, impaired executive function
<i>Subcortical structures</i>			
Basal ganglia	Dysarthria, aprosody, impaired nondeclarative memory	Dysarthria, aprosody, impaired nondeclarative memory	Dysarthria, aprosody, impaired nondeclarative memory
Thalamus	Thalamic aphasia, amnesia with confabulation, impairments in attention and 'executive functions'	Thalamic aphasia, amnesia with confabulation, impairments in attention and 'executive functions'	Thalamic aphasia, amnesia with confabulation, impairments in attention and 'executive functions'

Refer to Glossary for definition of medical terms. Reproduced with permission from Yudofsky SC and Hales RE (eds.) (2002) *Textbook of Neuropsychiatry and Clinical Neurosciences*, 5th edn. Arlington, VA: American Psychiatric Publishing, Inc.

memory dysfunction, language deficits, or sensorimotor symptoms. Gage was the foreman of a railroad construction crew working in Vermont on September 13, 1848. He was known to be the company's 'most efficient and capable foreman' with a well-balanced mind and a shrewd business sense. He was tamping an explosive charge into the bottom of a borehole with a tamping iron when the charge accidentally exploded resulting in the tamping iron rocketing through his left cheekbone, prefrontal cortex, and anterior dorsal skull finally landing 25–30 yards away. Gage survived the massive penetrating injury but displayed personality changes which his physician, Dr. John M. Harlow, described in 1848 as follows: "He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires." According to his friends, Gage 'was no longer Gage.' Demasio and colleagues performed an analysis using clues from the remains of Gage's skull and found that Gage's brain injury likely involved bilateral anterior orbitofrontal cortex, polar and anterior mesial frontal cortices, and the rostral portion of the anterior cingulate gyrus, with underlying white matter more extensively involved in the left hemisphere than in the right (see [Figure 8](#)).

Depression and Schizophrenia: Nature and Nurture

Depression and schizophrenia are conditions which both appear to result from a complex interplay of environmental and biological factors. Depression occurs with a prevalence of 20–60% in persons with stroke, neurodegenerative diseases, multiple sclerosis, headache, HIV, traumatic brain injury, epilepsy, chronic pain, obstructive sleep apnea, intracranial neoplasms, and motor neuron disease. It has been proposed that primary depression is due to dysfunction in a network that includes two known pathways: the orbitofrontal – basal ganglia – thalamic circuit and the basotemporal limbic circuit that links the orbitofrontal cortex and the anterior temporal cortex by the uncinate fasciculus. This has been expanded into a unifying depression circuit model which consists of four interconnected functional compartments. Each functional compartment consists of strongly interconnected anatomic structures upon which that compartment is dependent. The functional compartments are as follows: mood regulation (medial frontal, medial orbital-frontal and pregenual anterior cingulate cortex), mood monitoring (ventral striatum-caudate, amygdale, dorsomedial thalamus, midbrain-ventral tegmental area), interoception (subcallosal cingulate, ventral-anterior hippocampus, anterior insula, brain stem, hypothalamus), and exteroception

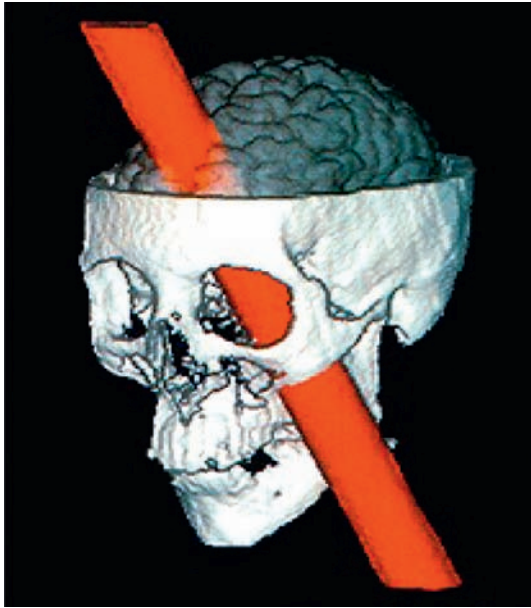


Figure 8 Damasio and colleagues' digital reconstruction of the penetrating brain injury sustained by Phineas Gage in 1848 which led to profound personality changes likely due to orbitofrontal cortical damage. (The metal rod shown in red.)

(prefrontal, premotor, parietal, mid-cingulate, and posterior cingulate cortices with dorsal-posterior hippocampus).

Efforts to link single genes to major depressive disorder (MDD) have been unsuccessful, despite exhaustive mapping attempts. Consequently, behavioral geneticists have turned to the study of genetic polymorphisms in establishing a predisposition to depression and in shaping the response to environmental stressors. The most extensive studies in this field have focused on polymorphisms in the serotonin transporter (5-HTT) gene. Behavioral genetics research based on diathesis-stress models of depression demonstrate that the risk of depression after a stressful event is enhanced in populations carrying genetic risk factors and is diminished in populations lacking such risk factors. Genotype-environment interactions are ubiquitous, because genes not only impact the risk for depression by creating susceptibility to specific environmental stressors but also cause individuals to persistently place themselves in highly stressful environments.

Among several etiological hypotheses for schizophrenia, the neurodevelopmental model is most prominent. This model generally posits that schizophrenia results from processes that begin long before the onset of clinical symptoms and is caused by a combination of environmental and genetic factors. Environmental factors include being a first-generation immigrant or the child of a first-generation immigrant, urban living, drug use, head injury, prenatal infection, maternal malnutrition, obstetrical complications during delivery, and winter birth. Genetic risks are clearly present but not well understood. The majority of patients with schizophrenia lack a family history of the disorder. The population lifetime risk for schizophrenia is 1%, 10% for first-degree relatives, and 4% for second-degree relatives. There is an ~50% concordance rate for monozygotic twins compared to that of ~15% for dizygotic twins. It is most likely that many

different genes make small, but important, contributions to susceptibility. The disease manifests only when these genes are combined or certain environmental factors are present. A number of susceptibility genes show association with schizophrenia. A small proportion of schizophrenia incidence may be explained by genomic structural variations known as copy number variants (CNVs). CNVs consist of inherited or de novo small duplications, deletions, or inversions in genes or regulatory regions. These genomic structural variations contribute to normal variability, disease risk, and developmental anomalies as well as acting as a major mutational mechanism in evolution. The most common CNV disorder, 22q11.2 deletion syndrome (velocardiofacial syndrome), has a 20-fold increased risk for schizophrenia and constitute about 0.9–1.0% of schizophrenia patients.

Functional imaging studies in schizophrenics show decreased cerebral blood flow in the DLPFC during specific cognitive tasks. Schizophrenic patients with prominent negative symptoms display reduced glucose utilization in the frontal lobes. Functional imaging studies suggest that disruption in distributed functional circuits is important in the development of schizophrenia. These functional circuit locations include the DLPFC, OFC, mediofrontal cortex, anterior cingulate gyrus, thalamus, temporal lobe subregions, and the cerebellum. Several conditions which may manifest psychosis, such as Huntington's disease, Parkinson's disease, frontotemporal dementia, and stroke, are commonly associated with frontal and subcortical dysfunction. Dorsolateral and mediofrontal hypoperfusion on functional imaging has been demonstrated in a subset of Alzheimer's disease patients with delusions.

Wisdom

The neurobiology of wisdom warrants special mention since it lies on the exciting frontier of our ability to model sophisticated cognitive processes. A consensus definition for wisdom is not available. Since the dawn of civilization, definitions have been advanced from different cultural, religious, and philosophical viewpoints. A theoretical definition that takes into account many cultural, religious, and philosophical themes is that wisdom represents a demonstrated superior ability to understand the nature and behavior of things, people, or events. This results in an increased ability to predict behavior or events which then may be used to benefit self or others. There is more often a desire to share the accrued benefits with a larger group for the purpose of promoting survival, cohesion, or well-being of that group. The benefits do not result from malicious or antisocial intents or inequitable behavior. Environmental factors, such as family, education, socioeconomic status, culture, and religion, are involved in generating the milieu in which the personal value system develops. Many of these same factors also influence how a given community decides whether wisdom is present or not.

This model of wisdom relies on the individual's ability to generate a mental representation of the self (cognitive, emotional, and physical), the external world, and the dynamic relationship of the self with the external world. The neural systems critical to enable these functions are distributed but heavily dependent on those that support memory, learning, understanding other people's mental states (Theory of Mind), and assigning relative value to information. The three

frontosubcortical neural networks, the limbic system, and the mirror neuron system are of particular importance for supporting these activities. These neural systems work in concert to weigh and estimate the risks and benefits of various mentally modeled courses of action to generate wisdom. The neural substrates of empathy may be conceptualized as biasing the information processing network in favor of valuing others, interpersonal communication, cooperation, and community.

Summary

Advances in the natural sciences and medicine have resulted in a shift from analysis with theological or philosophical explanations of human behavior to those that are subject to scientific methods. With this revolution in scientific thought has come the understanding that emotions, behavior, and cognition are produced and controlled by distributed neural networks. The brain and, in turn, behavior are shaped by genetics and a host of environmental factors throughout life. New technologies, such as fMRI and PET, enable scientists to study brain function in vivo and are beginning to yield insights into mental illness and normal cognitive functions such as empathy and wisdom which have traditionally been left to philosophical speculations. Advances in neuroscience will continue to change our understanding of ourselves and our relationship with the world around us.

See also: [Agnosia \(including Prosopagnosia and Anosognosia\);](#) [Agraphia and Alexia;](#) [Aphasia;](#) [Behavioral Pharmacology;](#) [The Brain;](#) [Brain Chemicals: Global Projections of Ancient Aromatic](#)

[Neurotransmitters;](#) [Depression;](#) [Drugs, the Brain, and Behavior;](#) [Empathy;](#) [Empirical Challenges to Conventional Mind–Brain Theory;](#) [Memory, Neural Substrates;](#) [The Mind–Body Problem;](#) [Neuroexecutive Function;](#) [Neurotechnologies;](#) [Schizophrenia.](#)

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Brain Chemicals: Global Projections of Ancient Aromatic Neurotransmitters

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Glossary

Aromatic structures They are usually six member carbon (benzene) or five (pyrrole) or six member (Pyridine) carbon–nitrogen ring structures having alternating single and double bonds. These ring structures are biologically important because they are able to absorb the energy from a photon which has the energy equivalent to that of a hydrogen electron. Aromatic (ring) hydrocarbons can be used as electron donors aerobically. The benzene-based amino acids (tyrosine, phenylalanine) do not lead to initiation of photosynthesis. However, indole-based amino acids (tryptophan), which have a five member aromatic ring with a nitrogen molecule attached to the benzene, donate an electron to a heavy metal and begin the process of photosynthesis.

Glial cells There are three main types of glial cells: the oligodendroglia cells, the astrocytes, and the microglia cells. These cells made their appearance in the brain as it became more complex during animal development. The oligodendroglia cells wrap themselves around axons and provide guidance, stability, and insulation to the axons of PTP neurons. The astrocytes function to support neurons by providing trophic factors (e.g., S100B, GFAP, and GDNF), energy (e.g., glucose), ions (e.g., K^+), and guidance factors (e.g., laminin). Microglial cells are of mesoderm origin (as opposed to the ectodermal origin of most other brain cells – blood vessels are also of mesodermal origin). These aggressive cells multiply, are mobile, and contribute principally to inflammation processes which occur after brain injury.

Global neurons These neurons are evolutionarily ancient and have extensive connections throughout the brain. They have their cells of origin in the brainstem regions but appear to connect with most neurons in the cortex, cerebellum, and spinal cord. These neurons use monoamines as neurotransmitters. These chemicals, made from indole or benzene structures, have powerful actions using a multiple number of specific receptors. Brain chemicals are indole and benzene ring-containing amino acids.

Interneurons These neurons are almost always inhibitory, using GABA as their neurotransmitter, and are mainly involved in the regulation of the local circuitry. The interneurons are involved in feedback inhibition and in defining the limits of neuron activity as best seen in sensory systems. The interneurons develop by a different pattern than that seen with either the global or PTP neurons. The interneurons principally use GABA, a derivative of the principal excitatory PTP chemical glutamate.

Limbic system James Papez first conceived the idea of a limbic system in 1937 after reviewing brain injuries in soldiers that resulted in emotional problems. The Papez circuit consisted of the hippocampus, mammillary bodies,

anterior thalamus, and the cingulate cortex. Over the years, many regions have been added to the emotional brain as part of the limbic system. These include the raphe serotonin system, amygdala, and septum; some even include the cerebellum, hypothalamus, parahippocampal gyrus, olfactory bulbs, and orbitalfrontal gyrus. As the number of structures increases in this 'emotional circuit,' its utility as an interesting concept decreases.

Medial forebrain bundle and lateral forebrain

bundle These two, largely unmyelinated, ancient fiber tracts have fibers extending to and from the midbrain-pons and the forebrain of the reptilian and mammalian brain. These tracts are used by the aromatic neurotransmitters systems (serotonin, dopamine, and noradrenaline) to reach all areas of the telencephalon and diencephalon, brain regions rostral to the midbrain. All cells of the forebrain are near one of these aromatic neurotransmitter axons.

Neuromuscular neurons These neurons project from the spinal cord and brainstem to innervate and activate skeletal muscle. These neurons use the brain chemical acetylcholine. Acetylcholine is also used by other PTP systems in the limbic system and also as a global cortical projecting system from the rostral brainstem.

Neurosecretory neurons These cells project from the hypothalamus to directly reach the posterior pituitary or the blood vessels going to the endocrine cells of the anterior pituitary. These neurons are part of the limbic pathway or in close association with the global neurons. The brain chemicals used by these secretory cells are almost predominately large peptides such as ACTH, oxytocin, anandamide, or vasopressin.

Photosynthesis This is a process whereby solar energy is converted to biological energy that converts carbon dioxide into organic compounds, especially sugars, resulting in the release of O_2 and the creation of ATP and reduced cofactors such as NADH. In the second stage of photosynthesis, ATP and NADH can be used to convert CO_2 to sugars.

Point to point (PTP) neurons These neurons are evolutionarily a more recent addition in that they are part of what is referred to as the hard wiring of the brain. The neurons have specific and localized projections and are used to relay specific bits of information into and out of the brain. These neurons use glutamate as the excitatory and glycine as the inhibitory neurotransmitters. Brain chemicals are amino acids with simple side chains such as glutamate and glycine.

Terminal neurons There are two types of neurons that are involved in transmitting the results of brain activity to the rest of the body. Motoneurons serve to move muscles and cause the body to move. The neurosecretory neurons release hormones (i.e., steroids and peptides) into the blood.

I was sitting writing at my textbook but the work did not progress; my thoughts were elsewhere. I turned my chair to the fire and dozed. Again the atoms were gambolling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by the repeated visions of the kind, could now distinguish larger structures of manifold confirmation: long rows, sometimes more closely fitted together all twining and twisting in snake like motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke; and this time also I spent the rest of the night in working out the rest of the hypothesis. Let us learn to dream, gentlemen, then perhaps we shall find the truth ... But let us beware of publishing our dreams till they have been tested by waking understanding. (August Kekulé, 1890)

Introduction

In the first edition of the *Encyclopedia of Human Behavior*, I presented an article on brain chemicals that focused on neurotransmitters and neurotrophic molecules. Neurotransmitters were placed into three different categories depending on the size, rate of synthesis, and binding characteristics to receptors. A fast system used acetylcholine, glutamate, or GABA, which are small molecules rapidly available to the neuron with minimal synthetic processing. These chemicals could bind to their receptors with relatively low affinity to enable quick on and off states. The slow systems used peptides such as enkephalin, oxytocin, substance-P, or anandamide, which are large molecules stored in dense core vesicles and slowly available for synaptic release. The synthesis of these peptides begins in the neuronal soma and involves extensive axonal processing. These chemicals bind to their receptors with high affinity to produce very slow on and off states and prolonged activation.

The intermediate system used the aromatic monoamines such as serotonin, dopamine, and noradrenaline. These aromatic neurotransmitters are available in limited quantities because the amino acids tryptophan (indole ring) and tyrosine (benzene ring) must be obtained from the diet. Once the aromatic amino acids are stored in the neurons, the synthesis

requires molecular oxygen and reduced cofactors (both chemicals important for mitochondrial production of ATP) to produce the final monoamine chemical. These transmitters are ancient and have multiple binding proteins in the human brain, ranging from low to high affinity to permit a wide range of actions. The intent of the present article is not to expand on the previous edition, but to focus on the brain aromatic chemicals required for the intermediate system as these brain chemicals form a global projecting system involved in brain homeostasis.

Obviously, the range of human behavior is dependent on the neural circuits contained in the human brain. Most of the research strategies utilized to study human behavior focus on the point to point (PTP) circuits (Figure 1). For example, to understand vision, the processes begin in the eye, but then the connections of the eye with the lateral geniculate and the visual cortex are followed and examined. Similar pathways are available for the behaviors involved in all the senses where there is a PTP progression from the principal sensory receptors to a final stop in a specific region of the sensory cortex, with relays occurring in thalamus or brainstem. The ancient system of olfaction is different, but still possesses a PTP circuit that can be drawn, usually utilizing black arrows. PTP diagrams are also available to illustrate the limbic system and cortical processing, with information transfer moving neatly from one point to another. The brain chemicals required for this type of network would be as vast as all the receptors needed, neurotransmitters released, and trophic factors required to build and maintain each PTP connection. It is not the intention of this article to discuss the neurotransmitters of the PTP circuits.

Rather, I will focus on the aromatic compounds – indole and benzene – which form the backbone of the amino acids of tryptophan and tyrosine. These are the essential chemicals needed by the global systems that utilize the monoamines. The unique properties of the aromatic chemicals were central to the unicellular process of photosynthesis, and regulated such processes as cell division and motility. The presence of these aromatic amino acids (AAA) and their derivatives enable the survival and growth of solar powered oxygen producing

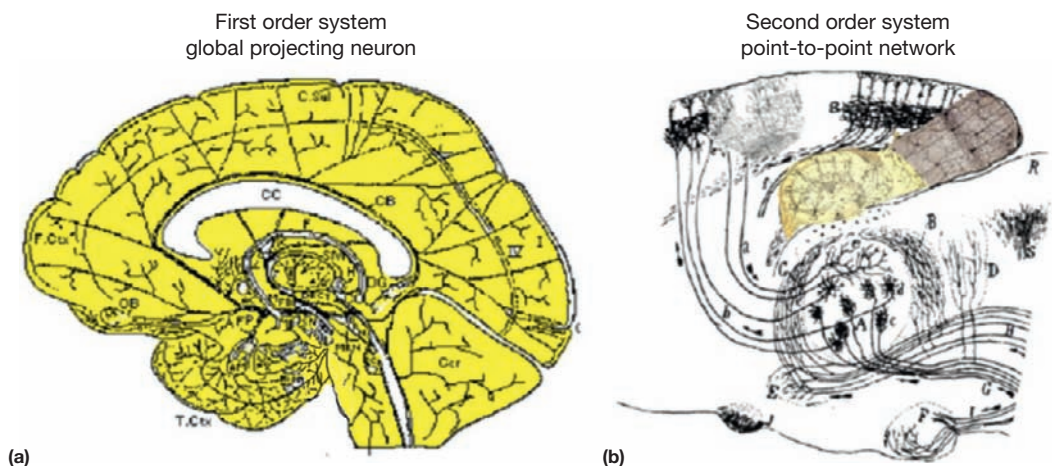


Figure 1 The figure illustrates drawings showing global projecting system (a) and point-to-point (PTP) systems (b). The global systems are proposed to be more primitive and are called first-order systems while the PTP systems are a more recent addition and considered as second-order systems.

organisms. However, when the animal kingdom separated from the plant kingdom, the AAA could no longer be produced endogenously because of the loss of chloroplast and genes necessary for indole and benzene synthesis. These chemicals have to be obtained from the diet.

During the evolution of the brain, the AAA developed a global system for the distribution of aromatic neurotransmitters that depended on the medial and lateral forebrain bundles to reach target areas and then on multiple receptors to transmit their physiological actions. The important aspect of receptor-mediated actions is that the neurotransmitters are not degraded, and reuptake mechanisms are used to return these chemicals to the aromatic neurotransmitter axon. This extensive distribution of the global neurotransmitter system provides insights into many of the human behaviors influenced by these chemicals. Not only are many of these behaviors linked to the primitive networks of the limbic system but they also regulate many glial trophic factors necessary for the maintenance of the PTP networks throughout the forebrain. Thus, the concept is that these global neurons are involved in the homeostatic regulation of the brain itself, and its interaction with the rest of the body functioning within the external environment. Furthermore, an understanding of these brain chemicals in the global neurons provides fresh insights into concepts such as awareness, depression, and consciousness.

Aromatic Chemicals

Many of the chemicals found in the brain that are involved in important behaviors in humans also served important roles in the life, growth, and division of unicellular organs. Three billion years ago, unicellular organisms began to produce oxygen by the process of photosynthesis. To make the monoamine neurotransmitters, oxygen is needed (Figure 2). In the earliest geological times, the earth's atmosphere had little oxygen. Thus, the monoamines were made specifically in unicellular systems capable of photosynthesis and the cellular production of oxygen. The conserved monoamine biosynthetic pathway began in the unicellular systems of cyanobacteria, green algae, and fungi, and continually evolved to its current position in the human brain.

Benzenes

Two amino acids have a benzene backbone: phenylalanine and tyrosine. The delocalization of electrons is one explanation for the thermodynamic stability of benzene and related ringed molecules. It is likely that it is this stability that contributes to the peculiar molecular and chemical properties known as aromaticity, a term originally used to describe their fragrance. The concept of quantum-mechanical resonance was developed by W. Heisenberg in 1926 and applied to the benzene molecule by L. Pauling. Pauling wrote that benzene bonds 'would then be expected to be a sort of average of the properties of the individual molecules.'

Catechols

Benzenes can be oxidized by both bacteria and eukaryotes. In bacteria, the dioxygenase enzyme adds two oxygen molecules

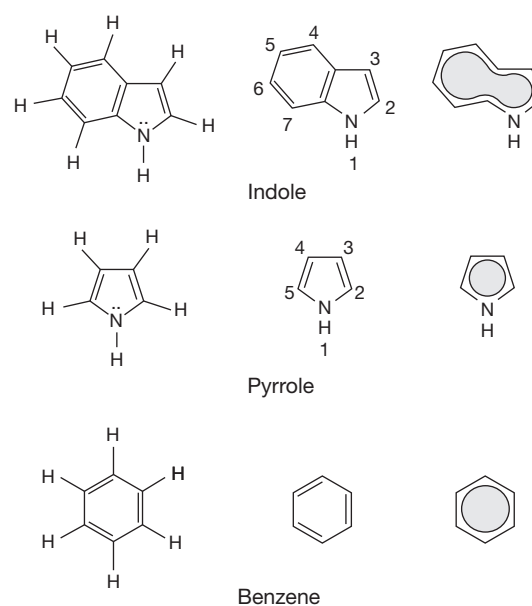


Figure 2 This figure shows the molecular structures of benzene, pyrrole, and indole rings. Double bonds are illustrated as localized in the first two structures, and as being nonlocalized in the third structure of each set.

to the ring, and the unstable product is immediately reduced (by the cofactor NADH) to a cyclic diol with two double bonds, breaking the aromaticity. Next, the diol is reduced by NADH to form catechol. Catechol can be metabolized to acetyl CoA and succinyl CoA, used by organisms mainly in the Krebs Cycle for energy production. The catechol skeleton occurs in catecholamines, drugs derived from them (such as MDMA), urushiols (skin-irritating poisons found in plants like poison ivy), and catechin (found in tea).

Pyrrole

Pyrrole is an aromatic five-member ring containing four carbons and a single protonated nitrogen. There are two double bonds which alternate between the five atoms. It is an important component of such complex light gathering macromolecules as chlorophyll.

Indole

This ring structure is an organic compound consisting of a benzene ring and a pyrrole ring (Figure 3). The most reactive position on indole for electrophilic aromatic substitution is C-3, which is 10^{13} times more reactive than benzene. The origin of the first photosynthetic pathway is proposed to be the photooxidation of uroporphyrinogen (an indole-rich compound) by sunlight and this oxidation is accompanied by the release of molecular hydrogen. The indole structure can be found in the amino acid tryptophan. This molecule also forms the light-sensitive component of such molecules as, niacin, melatonin, tryptophan-containing enzymes and receptors, alkaloids, and pigments. The indole ring is electron rich and will easily lose a nitrogen electron (oxidized) to an electrophilic compound, like a heavy metal.

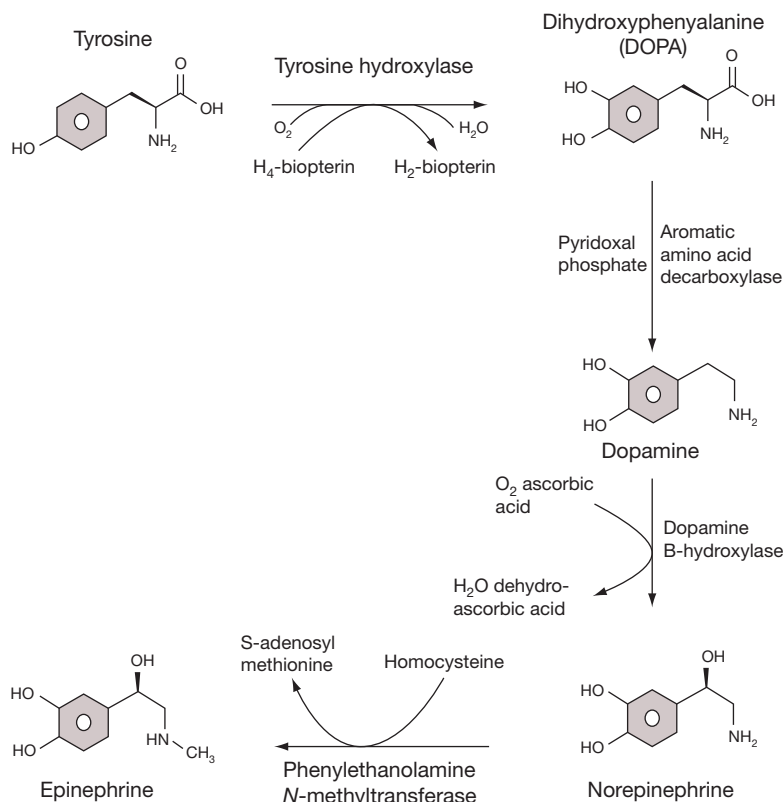


Figure 3 The biosynthetic steps are shown for the enzymatic conversion of tyrosine to dihydroxyphenylalanine (DOPA), dopamine, norepinephrine (noradrenaline), and epinephrine (adrenaline). The names of the enzymatic steps as well as the main cofactors are given.

Biosynthesis of Aromatic Amino Acids

Hydroxylation

Hydroxylase is the first enzyme in the synthesis of the aromatic neurotransmitters serotonin and catecholamines. In animals, tryptophan, phenylalanine, and tyrosine are obtained exclusively from the diet. Tyrosine can be converted from phenylalanine by the enzyme phenylalanine hydroxylase. The next step is also mediated by a hydroxylase enzyme, tyrosine hydroxylation. This enzyme produces L-DOPA, which retains the catechol structure.

The three enzymes involved in aromatic hydroxylation evolved from a single primitive enzyme that reacted with phenylalanine, tyrosine, and tryptophan, which were all sensitive to light. The hydroxylase enzyme was involved in the synthesis of large number of complex alkaloids in plants, all of which are potent antioxidants in their own right. Cellular oxidation is important for cell maturation and division, but excess oxidation results in cell death. The synthesis of pharmaceutically important indoles also involves decarboxylase enzymes (3.2), discussed below.

The hydroxylase enzyme, which utilizes molecular oxygen and H_4 -biopterin, is the first enzyme in the pathway for both serotonin and catecholamine synthesis. 5-HTP, the immediate precursor of serotonin, is formed from tryptophan and L-DOPA, the immediate precursor of noradrenaline, is formed from tyrosine. The ubiquitous carboxylase enzyme, working in reverse to function as an aromatic amino acid

decarboxylase, rapidly converts both these molecules to serotonin or dopamine (Figure 4).

Decarboxylase

The second enzyme in serotonin biosynthesis is tryptophan decarboxylase. The first organisms to contain this enzyme may have been the bacteria, *Enterobacteria cloacae* strains, which are normally associated with plant roots, and help produce the plant hormone auxin by using the enzyme indolepyruvate decarboxylase. Aromatic L-amino acid decarboxylase occurs in plants. For example, tryptophan decarboxylase in plants leads to the biosynthesis of pharmaceutically active indole alkaloids. These compounds are abundant throughout the plant kingdom, and are known to produce strong psychic or hallucinogenic responses in humans (see Figure 3). In animals, this enzyme loses its specificity for tryptophan and becomes a general aromatic acid decarboxylase. It is likely that as animal cells had a marked reduction in tryptophan because of loss of tryptophan synthesizing enzymes, there was less evolutionary need for a specific tryptophan decarboxylase enzyme.

Thus, enzymes commonly used in anaerobic organisms before O_2 was formed inside cells produce serotonin and the catecholamines. Besides the algae, fungi, and molds, the most efficient generators of O_2 and monoamines are plants. In humans, the collection of the AAA is quite complex because these structures are no longer made endogenously. A single transport system exists for phenylalanine, tyrosine, and tryptophan

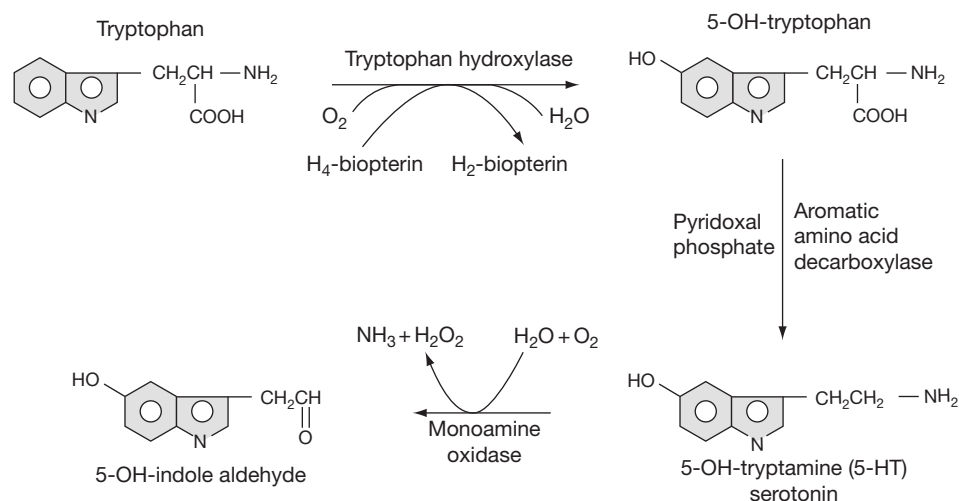


Figure 4 The biosynthetic steps are shown for the enzymatic conversion of tryptophan to 5-hydroxytryptamine, serotonin, and 5-OH-indole aldehyde (5-HIAA). The names of the enzymatic steps are given as well as the main cofactors.

to carry these molecules to the brain. Once in the brain, the amino acids have specific uptake into the global neurons where they are converted into the neurotransmitter chemicals. This conversion occurs in the axon in the terminal areas of the brain. The neurotransmitters are released either in vesicles after an action potential or from the cytoplasm not in vesicles by a Ca^{2+} -independent process. These chemicals have multiple receptor systems to translate their biological actions without the metabolism of the neurotransmitter. The neurons also contain a very effective reuptake protein that removes the neurotransmitter from the synapse and either releases it again or retrogradely transports it back to the neuronal soma in the brainstem.

Derivatives of Aromatic Neurotransmitters

As bacteria and plants became very efficient at converting light into biological energy (NADH and ATP), the excess production of O_2 became a biochemical problem: oxygen can easily generate free radicals that are very destructive to the interior of the cell. The remedy was to have O_2 bind directly to tryptophan and tyrosine. Many of the biochemical derivatives of tryptophan and tyrosine evolved to function as antioxidant molecules in simple cells long before they assumed more complex functions in animals and humans as hallucinogens and mind-altering drugs.

Catecholamine

Catecholamine derivatives are known to serve important regulatory roles in plants and in humans. The sympathetic component of the peripheral nervous system (PNS) uses noradrenaline and the adrenal gland secretes adrenaline during stress response. Many of the benzene based alkaloid and synthetic compounds are also hallucinogenic. These chemicals act as dopamine and noradrenaline agonists with actions on both the central nervous system (CNS) and PNS. In addition to their hallucinogenic effects, they produce nausea, psychosis, racing, mania, and panic attacks (Figure 5).

Catecholamines

They are called catecholamines because they contain a catechol or 3,4-dihydroxyphenyl group. They are derived from the amino acid tyrosine. Catecholamines are produced mainly by the chromaffin cells of the adrenal medulla and the postganglionic fibers of the sympathetic nervous system. Noradrenaline neurons, part of the global neurons, are largely confined to melanin-pigmented cell bodies of the locus ceruleus in the Pons. Dopamine, a global neurotransmitter in the CNS, is largely produced in neuronal cell bodies in two areas of the brainstem: the substantia nigra and the ventral tegmental area.

Epinephrine (adrenaline)

It is a hormone and neurotransmitter. It increases heart rate, contracts blood vessels, dilates air passages, and participates in the fight-or-flight response of the sympathetic nervous system. Epinephrine acts on nearly all body tissues. Its actions depend on the receptor expression of the tissue. For example, epinephrine causes smooth muscle relaxation in the esophagus, but causes contraction of the smooth muscle that lines arterioles. Adrenaline is a nonselective agonist of all adrenergic receptors.

Mescaline

Peyote is found in high levels in the buds from the cactus pants in Mexico. This drug can produce deep introspection and insight described as being of a metaphysical or spiritual nature. This hallucinogen is rich in both visual and auditory effects (synesthesia). Mescaline was first isolated and identified in 1897. Its side effects include paralysis, breathing difficulty, vomiting, tremors in the legs, and anorexia.

Phenethylamine

The group of phenethylamine derivatives is referred to as the phenethylamines. Substituted phenethylamines, substituted amphetamines, and substituted methylenedioxyphenethylamines are a series of broad and diverse classes of compounds derived from phenethylamine that include stimulants, psychedelics, and entactogens, as well as anorectics, bronchodilators, decongestants, and antidepressants, among others.

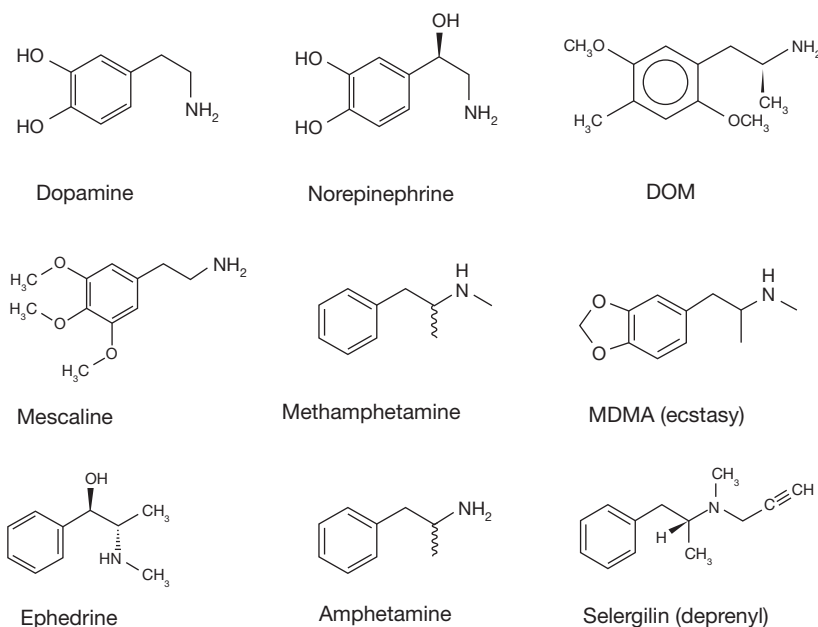


Figure 5 The physiologically relevant derivatives from catecholamines are shown. These include the principal neurotransmitters dopamine and noradrenaline. Mescaline is a strong hallucinogen while the phenethylamines include ephedrine and selegiline. These are all alkaloids with mind-altering properties. Amphetamine, DOM (2,5-dimethoxy-4-methylamphetamine), methamphetamine, and ecstasy are designer drugs. They are synthetic phenethylamines with strong sympathetic and mind-altering properties.

Ephedrine

Chemically, it is an alkaloid derived from various plants in the genus *Ephedra* (family *Ephedraceae*). Ephedrine is a sympathomimetic amine. The principal mechanism of its action is on the nonvesicular release of noradrenaline in the sympathetic nervous system of the PNS. Ephedrine crosses the blood–brain barrier weakly. Behavior effects of this drug include mania, hallucinations, delusions, agitation, confusion, mild euphoria, paranoia, hostility, and panic.

Selegiline (deprenyl)

It is a synthetic phenethylamine which functions as a potent inhibitor of the enzymes MAOA and MAOB, the principle routes for the degradation of the aromatic neurotransmitters. The drug results in intraneuronal concentration of these aromatic neural transmitters and is commonly used as an adjunct to L-DOPA therapy or ecstasy and amphetamine abuse. Effects of these sympathomimetic stimulants include hallucinations, dizziness, dry mouth, severe headache, tachycardia, arrhythmia, and panic.

Designer drugs

They have been synthesized from using the amphetamine backbone. Many of these compounds were first synthesized by Alexander Shugun and are discussed in his book *PiHKAL (Phenethylamines I Have Known And Loved)*.

Amphetamine

It is a synthetic psychostimulant drug of the phenethylamine class. This drug effects the release of dopamine and noradrenaline in the CNS and PNS by a Ca^{2+} -independent nonvesicular release mechanism. The drug is a stimulant coupled with a

feeling of euphoria. The class includes prescription CNS drugs paradoxically used to treat attention-deficit hyperactivity disorder (ADHD).

Methamphetamine

It has high potential for abuse and addiction by activating the psychological reward system via increasing levels of dopamine, noradrenaline, and serotonin in the brain. The US Food and Drug Administration (FDA) has approved methamphetamine for the treatment of attention-deficit hyperactivity disorder (ADHD) and exogenous obesity. Methamphetamine is marketed in the United States under the trademark name Desoxyn.

DOM (2,5-dimethoxy-4-methylamphetamine)

It is also known as STP, an abbreviation for 'serenity, tranquility, and peace.' This is a powerful psychedelic (hallucinogenic drug) and a substituted amphetamine which has its hallucinogenic properties by stimulating serotonin receptors. DOM is a very potent agonist of the serotonin 5-HT family of receptors; mainly of the 5-HT₂ subtype. Effects of this drug include substantial perceptual alterations such as visual hallucinations, double vision, distortions, vibration of objects, slowing of time, and panic.

Serotonin

This is the principle substance used as a neurotransmitter in the nervous system of all animals, and has been found in nearly all photosynthetic organisms. Two major compounds with structural similarities to serotonin are auxin and melatonin, which serve important regulatory processes in plants and humans. Other structural derivatives of serotonin function as antioxidants, trophic molecules, or strong hallucinogenic drugs.

Auxin (hydroxyindole acetic acid)

It is also a protective, antioxidant compound found in unicellular organisms and functions to stimulate growth and survival. Auxin acts as an important phototropic hormone in plants and induces cell elongation and cell division, with all the subsequent results for plant growth and development. Its specific function in leaves is to move the entire photogenerating organ toward the source of sunlight.

Melatonin

It functions as a powerful antioxidant. Melatonin is found in all plants and animals, including algae and is involved in microtubule function in flagella and in mitosis. Melatonin levels have a diurnal rhythm in many protists and plants, as well as in humans. Melatonin functions as an antioxidant in plants and as a biological signal for the organization of day-length-dependent annual functions such as reproduction, behavior, coat growth, and camouflage coloring.

Indolamines

There are many natural psychoactive drugs synthesized in plants from tryptophan. All these compounds function as

antioxidants in single-cell organisms, and have been used by man as entheogens for thousands of years. The ability of these drugs to induce a feeling of closeness to God is a special property of the indoles and this property is attributed to activation of the cortical 2A serotonin receptor. Substituted indoles are derivatives of the tryptophan-based tryptamine alkaloids, such as serotonin, melatonin, and auxin; the hallucinogens psilocybin, DMT, and 5-MeO-DMT; and the ergots, such as ergotamine and LSD. *N*-Formylkynurenine, 5-methoxytryptamine, auxin, and melatonin in prokaryotes function as photosensors, antioxidants, and pattern generators for flagella movement, and in defense mechanisms. These alkaloids produced from tryptophan have powerful actions on the human brain by acting through the serotonin receptors or reuptake proteins. The structures of some of these compounds are shown in Figure 6.

Psilocybin mushrooms

Psilocybin mushrooms are found mainly in South and Central America. Native Americans (e.g., Aztecs, Mayans) used this hallucinogenic drug for thousands of years. It was almost always used in religious ceremonies with the users believing

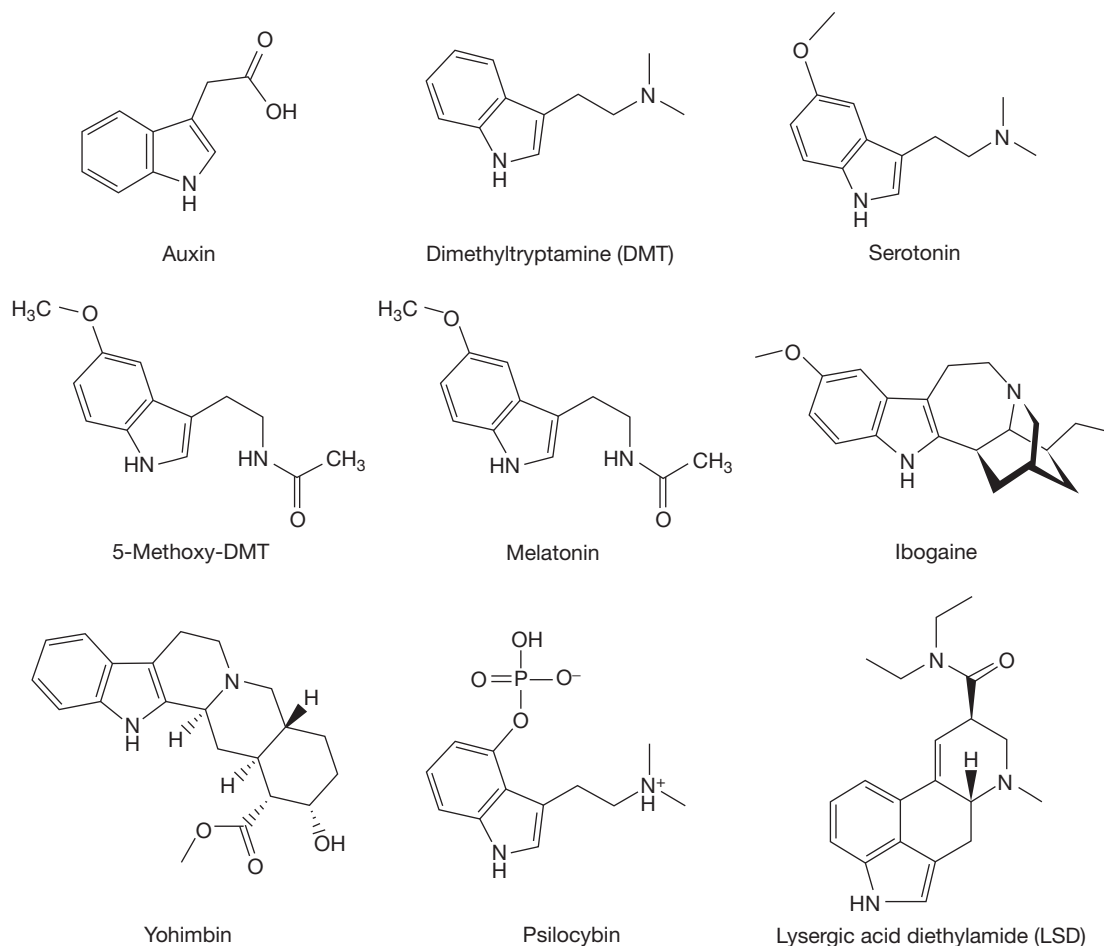


Figure 6 The physiologically relevant derivatives from indolamines are shown. Auxin is a powerful plant hormone. Melatonin is a powerful hormone in humans and found in plants. The indoleamines are powerful hallucinogens. The alkaloids include psilocybin, *N,N*-dimethyltryptamine (DMT), 5-methoxytryptamine, ibogaine, and yohimbin. LSD is a semisynthetic psychedelic drug of the ergoline family, which is one of the most powerful mind-altering drugs known.

they were moving between the earthly and supernatural realms. Its properties are due to activation of the cortical 2A serotonin receptor.

N,N-Dimethyltryptamine (DMT)

This alkaloid occurs in many species of plants and in trace amounts in the human brain. *N,N*-Dimethyltryptamine (DMT) is a naturally occurring hallucinogenic drug of the indoleamine family and functions as a nonselective agonist at most or all of the serotonin receptors (including 5-HT_{2A}) with some affinity for dopamine adrenergic receptors. DMT can produce depersonalization, near-death experiences and mystical states.

Ibogaine

It is found in a number of plants, principally in a member of the dogbane family known as iboga (*Tabernanthe iboga*). Ibogaine-containing preparations are used in medicinal and ritual purposes within African spiritual traditions. Ibogaine experience occurs as two distinct phases: the visual phase and the introspective phase. The visual phase is visual distortion often accompanied by laughing, euphoria, fear, and temporary short-term memory impairment. The introspective phase is elevated mood, calm, and euphoria, and intellectual and emotional clarity.

Yohimbine

It is the principal alkaloid of the bark of the West-African evergreen *Pausinystalia yohimbe*. In Africa, yohimbine has traditionally been used as an aphrodisiac. Yohimbine is used as a dietary supplement in herbal extract form and as a prescription medicine in pure form for the treatment of sexual dysfunction. Yohimbine can produce hallucinations, anxiety reactions, rapid heart rate, high blood pressure, insomnia, seizures, and panic attacks.

Lysergic acid diethylamide (LSD)

LSD is a semisynthetic psychedelic drug of the ergoline family. The parent compound of the major hallucinogen LSD has long been known to be produced by a fungus, genus *Claviceps*. The hallucinogen was synthesized by the addition of diethylamide to ergotamine by the chemist Albert Hofmann at the Sandoz Laboratory. LSD is believed to be one of the most potent mind-altering compounds discovered to date. LSD causes hallucinations, distortions, and an altered experience of senses, emotions, memories, time, and awareness. There can be distortions of sensory perception such as synaesthesia, the experience of additional spatial or temporal dimensions, and temporary dissociation.

Homeostasis

In a discussion of brain chemicals and human behavior, the aromatic neurotransmitters are an important topic not only for the variety of behavior under their control, but also for the intensity and 'mind-altering' aspects of the induced states. Serotonin is involved in aggression, dominance, memory, mood, appetite, and sleep. Biologically, it is implicated in neurogenesis, movement, cell division, and apoptosis. Dopamine is directly implicated in addiction, pleasure, and repetitive motor activity. Noradrenaline has actions on all the

sympathetic responses in the PNS and CNS. The derivatives of these compounds, many found in plants, produce hallucinations and altered states of consciousness. To appreciate the spectrum and nature of these actions in human behavior, it helps to have an evolutionary perspective.

The aromatic neurotransmitters were found in very high levels in unicellular organisms and plants because of the availability of aromatic amino acids and oxygen. The aromatic amino acids were largely synthesized in plastids (chloroplast), which are the major organelles in the cells of plants and algae. Most proteins have an intrinsic UV fluorescence as a result of photoabsorption because of the aromatic amino acids in their structure, particularly phenylalanine, tyrosine, and tryptophan. Comparing the latter two aromatic amino acids, tryptophan has the higher fluorescence quantum yield, overshadowing markedly the emissions of the tyrosine. The amino acid tryptophan contains an indole backbone with a reactive pyrrole ring and absorbs light very effectively. Free tryptophan has characteristic fluorescence absorption at UVB (450–480 nm wavelength), and the fluorescence emission is in the range of UVA-blue light. This amino acid in proteins is needed for solar energy to drive photosynthesis in cyanobacteria, algae, and plants. The absorption of a UVB photon (energy of a photon of blue light of wavelength 450 nm = 2.76 eV) is equivalent to the energy of a hydrogen electron. Therefore, it appears that the primary photoionization pathway involves base ionization of tryptophan followed by deprotonation. The energy equivalent of solar energy conversion in photosynthesis involves electron transfer between an excited donor molecule and an acceptor molecule that are contained in the reaction center, an intrinsic membrane protein pigment complex. In the photosynthetic reaction centers of *Rhodobacter sphaeroides*, there are 39 tryptophan residues. The importance and abundance of tryptophan, as well as the catecholamines, have made these chemicals central to many cellular functions such as energy production and cytoskeleton stability that regulates cell mobility and cell division (Figure 7).

As cells began to produce large amounts of O₂, the formation of free oxygen radicals became a serious problem. The hydroxylation of aromatic amino acids removed not only a molecule of O₂, but also the aromatic amino acid. Over time, many of these aromatic amines became effective antioxidants and served to regulate the homeostasis of algae and plants.

When animals diverted from plants, the plant plastid organelle (chloroplast) was lost and with it the ability to produce aromatic amino acids. Animals could only survive if they were symbiotic to plants or algae or digest their material. The animals were still largely dependent on the aromatic chemicals, but now developed a new strategy for maximizing the effects from these compounds by evolving receptor molecules that could produce a metabolic response without metabolizing the neurotransmitter. The neurons developed global projections throughout the brain using the ancient forebrain bundles and the largely unmyelinated axons also traveled near blood vessels and in the ventricular space. The aromatic neurotransmitters were synthesized from products obtained in the target regions. They evolved reuptake proteins for retrieving any secreted aromatic amino acid and are able to transport chemicals made in the terminals back to the cell somas in the mid-brain and pons. Because of this extensive network and multiple receptors, the human brain has maintained a homeostatic role

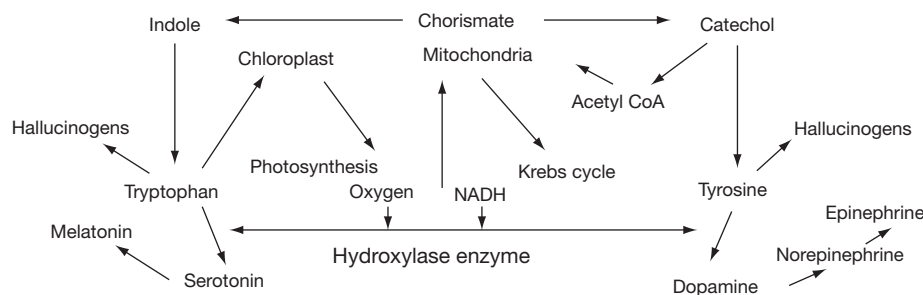


Figure 7 This is a line diagram illustrating the close biological interactions between the aromatic amino acids in the production of neurotransmitters (serotonin and catecholamine) and hormones (melatonin and adrenaline). The key process of photosynthesis in producing oxygen and NADH in the biosynthesis of these chemicals is shown. The importance of chloroplast (plant plastid) and mitochondria organelles is illustrated. The hallucinogenic derivatives are included as these compounds are alkaloids and serve antioxidant functions in the algae and plant cells.

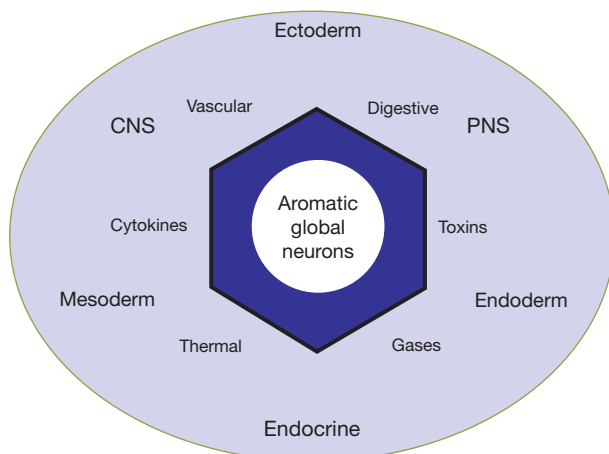


Figure 8 This drawing shows the central role of aromatic global neurons in the homeostasis of the brain. The various biological components that interact with these neurons are shown in small type and include vascular and digestive processes. The biological impact of these neurons can be seen on tissues from all three types of cells: endoderm, mesoderm, and ectoderm. The influence of these neurons affects CNS, PNS, and endocrine systems.

for aromatic neurotransmitters, despite an inability to synthesize the precursor amino acids. This is consistent with the early proposal of Brodie and Shore (1964). In their hypothesis, noradrenaline and serotonin modulated opposite systems in the brain on the basis of [Walter Hess's \(1949\)](#) concept of the functional integration of the autonomic system with the CNS. The PNS uses acetylcholine to mediate the sympathetic response and noradrenaline to mediate parasympathetic response. Serotonin was the modulator of the trophotropic system, which integrates behavioral patterns that are recuperative in nature. This was considered a recessive system, which normally functions during sleep or hibernation ([Figure 8](#)).

A new concept of consciousness proposes that the mind is an amalgamation of the actions of the PTP and global neurons. Therefore, not only do the aromatic amino acids serve homeostasis involved in cellular and behavioral processes, but deal with inner process of the mind. Many of the alkaloid and synthetic derivatives have mind-altering properties in humans. The actions of the aromatic amino acids in early life to capture solar energy may explain why decreases in aromatic

neurotransmitters in the human brain lead to feelings of worthlessness and suicidal ideation. In certain conditions, these states in humans are elevated by exposure to blue light. Brain chemicals are found in all the primitive cells, and the most interesting of these may be the aromatics.

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See also: [Behavioral Pharmacology](#); [Brain and Behavior Relationships](#); [Catecholamines and Behavior](#); [Depression](#); [Drugs, the Brain, and Behavior](#); [Evolutionary Developmental Psychology](#); [Evolutionary Psychology](#); [Hallucinations](#); [Suicide](#).

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Brainwashing and Totalitarian Influence

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Glossary

Attitudes The evaluations, whether positive or negative, of social objects or persons, as linked to specific beliefs and ideas, and an alteration in this response based on exposure to new information or social cues.

Automatic thought Thought and association that occurs with little investment of mental effort, attention, and without the need for conscious control.

Conscious thought It is the processing of information in awareness versus without it.

Cult A group, usually of a religious or political nature, that tends to be all-consuming for members and is highly controlling of members' thoughts and actions, even if participation is voluntary.

Dissociative states Atypical states of consciousness with little or no self-awareness of one's own ordinary identity and that often accompany behavior that is atypical for the individual.

Heuristic processing This means responding to new information by taking recourse to simple, common rules (e.g., likeability = credibility) rather than engaging in careful systematic processing.

Hypersuggestibility It is the unusual suggestibility in one's own beliefs and actions to influence by the beliefs, actions, or commands of another.

Identity It is the person's own sense of self as an individual, and also in terms of his or her important relationships (relational identity) and identification with groups (social identity).

New religious movements These are new groups reflecting a nonconventional approach to religion and spirituality, not necessarily highly controlling and thus not precisely cults.

Systematic processing It is the conscious evaluation, integration, and weighing of new information.

Brainwashing can be defined, in succinct terms, as a process by which an individual's values, beliefs, and behaviors, usually of a religious or political nature, are systematically, intentionally, and forcefully compromised and replaced with those determined by another person by deceptive, manipulative, and coercive means. The term is most likely to be evoked when the brainwashing agent has the intention of totally controlling the other person, inducing him or her to engage in a sequence of actions at variance with the individual's prior beliefs, particularly in a relatively short time frame and with little awareness on the part of the person or preexisting familiarity with the change agent. The aim of brainwashing is to break down the individual's capacity for critical thought, systematic decision-making, and self-reflection involving long-held values, beliefs, preferences, and norms. At the same time, brainwashing remains sufficiently ill-defined that its existence is open to question.

The term brainwashing was first used by journalist and US intelligence agent Edward Hunter, who derived it from the Chinese term 洗腦 (*xǐ nǎo*), and popularized it through news articles and a book in the early 1950s. The term was purportedly used by a Chinese citizen, whom Hunter interviewed, to refer to reeducation experiences in Communist China, and although it was brought to the attention of Western society in a negative light, as a kind of mental rape of the person, adherents of Chinese Communism apparently viewed it in a more positive light, as a 'morally uplifting' process by which the person is freed from the grip of imperialist ideology.

Uses of the Term

Brainwashing has been applied to influence exerted by both small and large groups of people, including religious 'cults' and

political organizations, for example, Jim Jones' Peoples Temple movement in Jonestown where the mass suicide/massacre occurred in 1978, as well as one-to-one dyads, such as the case of Lee Boyd Malvo, the teenage sniper in the Washington, DC, suburbs in 2002. It has been termed a social weapon aimed at nonmainstream movements, such as religious 'cults,' or new religious movements. Legally, the concept has been evoked to defend the crimes committed by members of cults (or other kinds of groups) that allegedly employ brainwashing, as was presumed in the case of the members of Aum Shinrikyo, a Japanese group responsible for the 1995 Tokyo subway gas attacks.

Brainwashing is a concept commonly evoked by the media and the lay public to fill in gaps in their understanding of extreme experiences and transformations of individuals they care about as intimates, community members, or well-known individuals, including someone like Patty Hearst, the young American heiress kidnapped by the Symbionese Liberation Army in the 1970s who then confounded the public and police by proceeding to actively participate in a bank robbery with her captors. The term has been raised to try to explain any number of unconventional or hard-to-comprehend acts perpetrated by members of a particular group (e.g., by cult members), and as a label, it creates an illusion of understanding and delineates perpetrators relative to victims.

The concept has also been evoked to justify kidnapping and deprogramming of cult members who are loved ones and are presumed to have succumbed to untoward influence, and then this process is carried out with the aim of erasing the effects of the putative brainwashing and bringing the individual back into alignment with mainstream values, itself potentially a kind of brainwashing.

The Mythic Definition: Induced by Exotic Techniques

The most exotic techniques that laypeople assume are involved in brainwashing, whether severe exposure to drugs, sensory deprivation, or hypnosis, are often presumed to have the power to transform the human being into a programmed machine that enters dissociative states when cued by physical triggers (e.g., a code word) and will follow directives that would otherwise be refused based on individual identity and morality, and with no memory of doing so, as a kind of Manchurian Candidate. Although controversial at best, this definition of brainwashing involves exotic techniques that were purportedly developed, used, and researched by the erstwhile Soviet Union (e.g., revealed in the Moscow show trials of the 1930s), by German Nazi intelligence agencies in the Second World War, by China during the Communist Revolution and Korean War, by the Central Intelligence Agency (CIA) in research projects (e.g., MKULTRA) conducted after the Second World War, and by some religious or political cults. Since such activities tend to occur in secret, behavioral science researchers are generally not in a position to judge the veracity and comprehensiveness of the available accounts.

A distinguishing aspect of this definition of brainwashing seems to be its complete lack of regard for ethics, human rights, and the personhood of the individual, as evidenced by the extreme and sensational nature of the techniques used and their presumed results. The hallmarks are the complete control of thought and behavior that is sought, the direct harm to the recipient and to others, and the brainwasher's intent to use targeted individuals to engage in violent acts. The most vivid feature of such brainwashing is the intent of the brainwasher to systematically and persistently manipulate, through any available means, the individual's attitudes and behaviors to align them with the brainwasher's vision. Beyond changing the subject's attitudes and behaviors and achieving complete control over the individual, the goal can also be extracting secret information from a captive or creating a deployable agent who will carry out pro-organization tasks (e.g., a suicide attack) regardless of personal costs or moral or legal concerns. The results of the search for methods of brainwashing, defined as such, have at best been mixed.

These oft-discussed techniques include

- Pharmacological substances such as hallucinogens
- Hypnosis to produce dissociative states
- Physical exhaustion, sleep deprivation, heavy labor, withholding food and water, etc.
- Abuse and torture in the form of sensory deprivation, sensory overstimulation, extended confinement, spinning, supersonic vibrations, electroshock, lobotomy, extreme temperatures, cold-heat alternation, near-death experiences, oxygen deprivation, gasses, etc.
- Psychic driving (i.e., exposure to looped audio messages during drug-induced coma)

There is little doubt that efforts have been made to brainwash specific individuals using such procedures and to study the consequences of it. Existing evidence, however, does not support the claim that these efforts uncovered a set of exotic techniques that will render a person sufficiently robotic that he

or she can be programmed to carry out an elaborate sequence of actions without awareness, upon command, that he or she otherwise would not. This version of brainwashing, then, is essentially a myth. Such interventions in fact are better known for disorienting, disabling, or killing the person rather than effectively programming him or her to do one's bidding.

The Social-Psychological Definition: Coercive Persuasion Through Mundane Social Influences

Exercise of influence over the mental processes and behaviors of other individuals may be more profound and controlling when based on mundane social-psychological processes common in daily life (such as those typically employed by legitimate socializing agents like parents, the state, etc., and others in relevant social roles such as salespersons) than when reliant on exotic techniques. Although there is no consensually used term for this social-psychological understanding of brainwashing as contrasted with the mythic sense of this concept, the terms, coercive persuasion and mind control, are sometimes used to denote well-understood social influence processes that have been heavily researched in social psychology, as noted by Andersen and Zimbardo. The term coercive persuasion is the scientific term most commonly in use and we restrict ourselves to that term here. This conceptualization of coercive persuasion builds on classical work in social psychology, such as that of Asch, Sherif, Festinger, Milgram, and Zimbardo, whose research on conformity, compliance, obedience, the power of social roles, and cognitive dissonance is well known. Contemporary scientific research on social influence, persuasion, and attitude change is also central. For instance, Cialdini has identified numerous 'weapons' of social influence that can be considered the core aspects of coercive persuasion when used in combination and to an exaggerated extent, including use of a persuader who is an authority and is likeable, playing on norms of reciprocity, focus on the scarcity of the desired outcome, use of the social proof that 'everyone else is doing it, including those you trust,' and fostering a relevant commitment in order to tap people's need to respond consistently. These techniques are crucial in social influence and thus in coercive persuasion.

Whether this is an appropriate replacement for the otherwise mythic concept of brainwashing depends on the perceived goals of the brainwasher. For instance, Solomon has argued that the foundational techniques used by the Chinese should be distinguished from those used by the Russians because the former sought conversion, not mere compliance. In this view, the Chinese model may be better understood from a social-psychological perspective than from the perspective of the mythic brainwashing concept.

Social influence stems from the desire of a social system (e.g., a religious organization) to propagate itself, socializing recruits into its network of values and behavioral norms via systematic use of a combination of ordinary social influence tactics. An individual may choose to subject himself or herself to such tactics when he or she expects benefits such as in purchasing a used car or joining like-minded others for spiritual guidance and growth. However, when a social system, for various reasons (e.g., high ambitions and incentives for growth), comes to exert an unacceptable level of influence and control through the systematic and combined use of

nonexotic social-psychological influence techniques at exaggerated levels, this may be tantamount to coercive persuasion. Such influence techniques may be viewed as safe and legitimate under normal conditions, such as when used separately and at milder levels. Such coercive persuasion may or may not involve untoward, malignant intent or complete disregard for the rights of the target individual, unlike the more dramatic definition or version of brainwashing, which is virtually always considered to involve those factors and leads to no positive outcome for the individual.

While severe distress and duress would be a core aspect of brainwashing, coercive persuasion can proceed more subtly, relying exclusively on the psychological tactics. Through more subtle means of coercive persuasion, there is the potential to socialize the person into the organization in a way that leaves largely intact the individual's psychological integrity and his or her decision-making abilities, even while significantly limiting his or her personal freedom of choice and action.

Identifying Coercive Persuasion

When attempting to identify agents of coercive persuasion, a persistent problem is overcategorization of deviance from mainstream culture, religion, ethicality as involving untoward influence. When there is demonstrable harm to the individual or to society, however, the question of whether or not there is an intolerable control exerted over individual freedom, based, for instance, on the joint use of social-psychological techniques noted below, this can be a viable alternative. Coercive persuasion arises from a strong and uniform authority structure, and the elicitation of complete commitment by members, creating the potential for exploitation of individuals. When coercion and deception are also involved, the totalitarian aspects of the organization become increasingly evident. This may also be considered cult-like, though the use of this term, like brainwashing, is also fraught. Such an organization can be religious or political or may involve a dyadic familial structure, as with battered spouses.

Mundane influences on persuasion and compliance

- The illusion of common ground, that is, perceived similarity fostering the belief that the persuader (and other group members) shares the individual's values, needs, goals, etc., whether or not this is true
- Fostering a sense of belonging, acceptance, and relationship, appealing to the inner pressure to bond with others
- The illusion of free choice through offers to the individual of only prosystem choices, while legitimate options that do not fit the group's goals are omitted
- Limiting the information available (external sources of information), even as the individual is asked to choose freely
- Inducing complexity, uncertainty, and confusion via jargon, euphemisms, false analogies, rhetorical labels, semantic distortions, misleading abstractions, and so on to capitalize on the natural tendency to seek simple answers (e.g., from a strong leader or cohesive group, or simply for convenience), to engage in heuristic processing rather than reasoning critically
- Playing on norms about reciprocity (i.e., to reciprocate disclosures or gestures of another)
- Use of contingent social reward (e.g., love, support, emotional comforting) that depends on expressed beliefs and actions reflecting the preferred worldview or ideology
- Assigning the individual to one or more roles, ranks, or positions to bestow significance and guide behavior, possibly capitalizing on the tendency to take on a complementary social role (e.g., to become strong or the helper when somebody else is weak)
- Use of a step-by-step indoctrination strategy to render recruits unaware of the intended end results of the recruitment process
- Emotions, especially negative ones, like fear or guilt, induced, and then resolved, as when an insurance salesperson first makes the customer feel fearful and then offers the solution of an insurance policy
- Use of artificial pressures to create group unanimity (e.g., censoring, intolerance of diversity, discouraging questions), potentially resulting in groupthink, and poor decisions under the guise of consensus
- Restriction of communication and prohibition of certain linguistic expressions, in favor of a coded language, labels, or jargon
- Evoking reactance, as when a behavioral choice is presented as scarce and limited to only a select few, in order to induce the person to become more intrigued by it, desiring it more

Psychological coercion

In some combinations, social-psychological influence strategies can approach psychological coercion, if used systematically by the persuader, and hence, these are worthy of note as particularly controlling:

- Isolation of the individual from his or her usual social network and prior sources of social support
- Stripping the individual from familiar environments, symbols, and possessions that remind the individual of his or her identity
- Systematic induction of relatively intense psychological duress, whose simplest resolution is a further commitment to the group
- Division of the world into the 'good us' and the 'evil them,' and the dehumanization and possibly demonization of the other using facile, derogatory labels for outsiders
- Elicitation of confessions, potentially to obtain knowledge of the individual's deepest vulnerabilities, which can then be abused, possibly for blackmail
- Overstimulation by prosystem information (e.g., interactions or rehearsals with members, proselytizing activities, etc.)
- Exhaustion through extended labor and sleep deprivation
- Lack of or elimination of privacy
- Threat of sanctions for failure to adhere to the group view, whether subtle or overt
- Threat of psychological or spiritual punishment (e.g., to 'burn in hell')
- Threat of physical harm

The relevance of deception

The use of outright deception may also be present and exacerbate psychological coercion, making it most insidious. This can include

- Providing inaccurate information about the group in the form of overt lies about the group (e.g., via a front organization) or other misleading identification about the group presented to outsiders, for example, to potential recruits, family members of existing recruits, etc.
- Omitting crucial information about the group and its aims and activities.

Other factors

The groups or organizations that grab hold of an individual and exert special control over him or her may also enable persuasion by other factors, including

- The presence of a charismatic leader or guru, and referring to him or her as God or God-like
- The fostered belief that there is only one true authority (e.g., the group leader)
- Special appeals to individuals not anchored in social networks, who are alienated from society, and/or who feel excluded
- Love bombing (showering with love and praise).

Dyadic Coercive Persuasion

Coercive persuasion is not limited to groups. Spousal battery in marital relationships, for example, may make use of forms of coercive persuasion, by involving (1) verbal and/or physical dominance; (2) isolation or imprisonment; (3) fear arousal and maintenance; (4) guilt induction; (5) contingent expressions of 'love'; (6) enforced loyalty to the aggressor and self-denunciation; (7) promotion of powerlessness and helplessness; (8) pathological expressions of jealousy; (9) hope-instilling behaviors (that somehow the battering will end if...); and (10) required secrecy.

Coercive Persuasion in Organizations Involved in Terrorism

While coercive persuasion has often been discussed in the context of religious cults, and to a lesser extent, spousal abuse, the potential application of these ideas to terrorism is of special contemporary interest. In recent years, scholars have paid increasing attention to terrorism, especially in the Islamic world, following events such as 9/11 and the bombings in Madrid, London, and elsewhere. What is known about coercive persuasion has potential applicability to recruitment and training of individuals by extremist organizations, luring young people and readying them to conduct suicide attacks. Kruglanski and colleagues have argued that personal qualities (e.g., trauma, social exclusion, alienation, etc.) may heighten individuals' quest for personal significance and meaning. In the context of high levels of intergroup conflict and threat to the ingroup, terrorism-justifying ideologies may provide the means to restore significance and overcome death anxiety that stems from earlier traumas and lacking of a sense of belonging. Consistent with the foundational work of Lifton, Schein, and others, it is this

particular constellation of personal and social factors that may create vulnerability in the individual to the indoctrination techniques of terrorist organizations. Terrorist organizations are likely to make use of the same social-psychological influence strategies as other kinds of organizations do (see above) and to deliberately engineer their messages to fulfill the significant quest for potential recruits, seeking out individuals from the backgrounds noted (e.g., traumatized, alienated individuals). Like some religious groups, terrorist organizations may be led by a charismatic and megalomaniacal leader aiming to undertake spectacular acts.

Coercive Persuasion versus Ordinary Social Influence

The aforementioned techniques, used in moderation, may be common, if not ubiquitous, in modern society. However, when many social influence strategies are combined in extreme form and used systematically, this level of influence may constitute a qualitative difference that demarcates what is an acceptable level of relatively nonmanipulative social influence. This is akin to a mild versus severe exposure model, as in the example of radiation in which mild exposure can be tolerated well by the person (the body), whereas exposure from multiple sources over extended periods or in the extreme may result in cancer.

One reason that a combination of techniques results in a qualitatively different kind of social influence is their effect on attentional capacity. Robert Baron has argued, on the basis of social-psychological research, that the stress and emotional arousal that is a part of intense indoctrination experiences leads to significant decreases in attentional capacity, which in turn makes subjects highly vulnerable to social influence tactics. Research shows that factors that lessen attentional capacity increase (a) compliance, (b) heuristic (vs. systematic) message processing, (c) conformity, (d) stereotypical thinking, and (e) cognitive dissonance effects. For instance, individuals under intense indoctrination, even when they are motivated to do otherwise, should be less able (have less capacity) to process messages systematically (in the sense of Chaiken's attitude theory) and should be more influenced by heuristic qualities of persuasion and cues associated with heuristic processing. Minimally, the lure of engaging in relatively little thought (processing information automatically) without systematic deliberation is quite considerable in most situations, and further enabling this is not particularly difficult. Individuals under intense indoctrination should be more influenced by heuristic qualities in a persuasion context, such as the responses of others around them (who may be well-socialized members who have been trained to give a uniform response) and how confident or likeable the persuader appears, rather than critically scrutinizing the substance of the information provided. This kind of heuristic processing can lead to attitude change based on little conscious thought or deliberation, which is solidified later, for example through continued socialization into the group and reinforcing activities and discussions that enable the new information to be incorporated into aspects of one's own identity. Increased stereotypical thinking among indoctrinees suggests that individuals are easily led to endorse a stark 'us versus them' distinction and to have a fostered paranoia about outsiders and the outside world,

which the stereotyping measure may tap. Intense indoctrination situations increase conformity and reliance on authority, as manifested perhaps in the Stockholm Syndrome in which a captive becomes sympathetic to and collaborates with his or her captors.

Theories of Brainwashing

Foundational Work

The foundational research of Robert J. Lifton and Edgar Schein on Korean War prisoners of war (POWs) (and also those of others in the same era, such as Hinkle and Wolff) reached the conclusion that the Communists had no especially influential techniques at their disposal, and whoever among the POWs converted, defected, or refused repatriation (22 out of about 4500 American soldiers; none of the Turkish soldiers) under their influence did so either out of emotional and physical needs or due to prior ideological leanings. For instance, captors placed POWs under harsh conditions and rewarded them for their pro-Communist behavior by improving their conditions, such as giving them better food, blankets, and a more comfortable sleeping arrangement. While the behavior of some POWs changed to align with their captors' desire, for most of them, cognitive (e.g., beliefs, values) changes did not accompany. None of Lifton's and Schein's subjects actually converted to Communism, though a small number can be said to be influenced in the direction of their captors. It must be noted, however, that foundational research has been criticized for its small samples (e.g., $N = 40$ in Lifton's study). This foundational research attributed such influence (and conversion to Communist ideology, when it occurred) among POWs to personality characteristics that existed prior to the exposure to Communist messages and not to induced dissociation or to other more exotic factors.

Powerful social influence strategies are thus not particularly exotic, but rather, mundane in their influence on behavior and central to a social-psychological conceptualization of coercive persuasion. While early research did suggest a variety of potentially influential techniques, it also refuted an initial allegation by Hunter that a person's belief system can be completely replaced against his or her will by powerful, external influences. For this reason, both of the foundational researchers stayed away from the term brainwashing and instead used the term *coercive persuasion* (Schein) and the terms *thought reform* and *totalism* (Lifton). Despite this, the term brainwashing stuck in the public consciousness and continued to fuel paranoia about the Eastern bloc in the Western hemisphere, in the United States during the Cold War.

Foundational researchers like Schein also viewed thought reform or coercive persuasion in terms of stages such as unfreezing, changing, and refreezing (see also Kruglanski's work). Lifton in particular asserted eight stages of the process of thought reform and ideological totalism beginning with assault on identity and ending with final confession and rebirth. In particular, these proposed stages track well with techniques identified as influential earlier, and involve the following:

- Milieu control: Control of information and also internal dialog of the subject

- Mystical manipulation: Covertly orchestrating events while simultaneously making them appear spontaneous to argue for the special powers or divine status of the organization/leader
- Demand for purity: Imposing a dualistic view of the world in terms of us/them, good/evil, saved/damned, etc., and arguing that outgroups should be eliminated or otherwise prevented from contaminating the ingroup
- Cult of confession: Use of public confessions to destroy privacy and exploit the subject
- Sacred science: Imposing a view of organizational ideology as morally unchallengeable and scientifically exact
- Loading the language: Use of simple language (thought-terminating clichés) to reduce complexities regarding organizational ideology, thereby discouraging critical thinking and creating the illusion of group unanimity
- The primacy of doctrine over person: The view that nothing the person experiences can have more importance than, and potential to discredit, organizational ideology
- Dispensing of existence: The view that the organization has the right to determine the fates of its members and also its opponents.

Cultic Brainwashing Theory

A number of scholars, such as Singer and Ofshe (in the United States) and Abgrall (in Europe), have characterized brainwashing in the context of conversion to cults (and in related legal cases), and have referred to their approach as 'cultic brainwashing theory.' Owing to its tacit assumptions about personhood and free will, it has also been referred to as Robot Theory or the Involuntarist Theory of Brainwashing. While it references the foundational work of Lifton and Schein, its formulation is closer to the mythic definition of brainwashing than to the social-psychological definition. The gist of its understanding of brainwashing is that the unsolicited use of a set of techniques by cults on recruits can put the latter into disoriented or dissociative states of consciousness in which their capacity to make rational choices for themselves is vastly diminished or destroyed, and hypersuggestibility reigns that leads to the uncritical adoption of any propaganda imposed on them. The victim then may become addicted to the new set of beliefs programmed into his or her mind and thus may not be able to rationally contradict these beliefs unless deprogrammed by experts. Such brainwashing is assumed to be irresistible and potentially irreversible, and this is the approach that has been central in the anticult literature and movement, although empirical evidence for it is lacking and it has been roundly criticized.

Primitive states of consciousness (e.g., the dissociative, the hypnotic) were not central to or a part of Communist indoctrination and thus, the foundational researchers accorded no special role to them. The foundational researchers also recognized more complexity in human behavior and thus offered a 'soft determinism' rather than an exotic model in which human beings can be transformed into tools or robots ('hard determinism') by means of hypnosis. As criticism of the cultic brainwashing theory, scholars like Robbins and Richardson have argued that there is little evidence of any special illegality of religious 'cults' in terms of unacceptable means or levels of

influence (e.g., physical coercion) or other illegality, that these are protected under the First Amendment, and that the theory ignores findings showing that participation in some unconventional religious movements is beneficial to the well-being of recruits. These authors also argue that the theory overemphasizes and makes overly broad claims about hypnosis and its influence in the light of research that has discredited the notion that hypnosis can be used to obtain complete control over an individual's behavior, that it underemphasizes predisposing characteristics of religious converts, and that the recruitment process is typically entirely volitional (voluntary). Indeed, Richardson argues that parents, fraternities and sororities, marine boot camp, and juvenile detention halls – all use isolation for attitude and behavior change, so even the more dramatic strategies are not unprecedented. Use of such strategies, as in preventing a recruit from being exposed to dissenters, should thus be treated as no more problematic than a car salesman preventing a customer from talking to someone who previously refused the same offer, the great deal. Some argue then that cultic brainwashing theory is not a proper scientific theory in that it is ambiguous, internally contradictory, and not falsifiable.

Other scholars have sought to study brainwashing from a more scientific perspective. For example, Zablocki has argued that both those who claim that there is a pandemic of brainwashing and those who claim that brainwashing does not exist at all are both incorrect, and has attempted to construct a precise and falsifiable definition of brainwashing, reviewing ethnographic evidence on cults and interviews with ex-members and leaders to support it. This approach has been strongly criticized as well by anticultic brainwashing scholars, though Zablocki argues that ignoring the situation of former members of cults who were psychologically and/or physically harmed prioritizes legal proceedings and concerns about religious liberty over scientific study.

Activist View of Conversion: Eschewing the Brainwashing Concept

Based on such criticism, Richardson offered a view of the recruitment and conversion as an interactive negotiation, drawing heavily on Moreland and Levine's work on socialization in small groups. Other scholars, mostly sociologists of religion (vs. mental health professionals), support such a view. The main contrast between passivist views (such as cultic brainwashing theory) and the more activist (subject-centered) view of conversion is that the individual's capability to act autonomously and make choices to advance his or her own goals is intact and not entirely compromised, though it may be manipulated to whatever degree. This includes the active seeking of recruitment and the ability to withdraw from the group. The group is not seen as omnipotent. The group can also choose to withdraw from the effort to recruit the individual or may kick existing members out. The levels of commitment of individual to group and group to individual fluctuate over time, and recruits can exert minority influence on the group once they are members. This offers a more balanced view of a greater proportion of recruit-group interactions as may occur in non-traditional religious movements that does not take recourse in the brainwashing concept.

Difficulties with the Scientific Study of Brainwashing

There are a number of difficulties with the scientific study of brainwashing whether defined in mythic or social-psychological terms. The concept has suffered from loose definition as well as distortion in the mass media, in popular culture, and in political propaganda. As a result, its definition is less coherent and less widely agreed upon than is the case for other scientific constructs, and its scientific status is debatable. Some scholars have thus suggested that the concept be abandoned. Concepts at the heart of the brainwashing debate are themselves controversial, such as the nature of free will, consciousness, dissociative states, and the definition of pathological. Relatively few solid theoretical advances have emerged since the so-called foundational theories of brainwashing (such as Lifton's and Schein's) were developed, and these foundational theories themselves are often misinterpreted or presented in misleading ways. As a result of court cases making reference to brainwashing and in which a binary decision needs to be reached, scientific attempts to answer questions about brainwashing have also taken on an either/or flavor (e.g., Does it exist or not? Is it effective or not? Do religious movements use it or not?), whereas the answer to most pertinent questions along these lines is likely to lie in the gray area as with every other reasonable scientific question.

Because brainwashing cannot be created in the laboratory, for obvious ethical reasons at minimum, direct scientific evidence pertaining to it is scant. There remains no consensus on how to determine whether or not a person has been brainwashed, making the concept highly problematic to assess. For example, determining through interviews whether or not an individual who joined a movement did so by consent will be highly problematic after the individual is already a well-socialized member of the group. Indeed, some scholars have argued that the more successful the brainwashing is in any given case, the fewer the symptoms the person should show, making assessment all but impossible. Further, if brainwashing is thought to be psychologically damaging, those who were allegedly brainwashed may be seen as lacking psychological integrity and credibility. And, even if not psychologically compromised, a person who has had negative experiences in a religious group and thus exits the group may be motivated to go against it or even to take revenge on it, thus making evaluation of the veracity of their accounts highly problematic. Sound evidence on the matter thus clearly calls for longitudinal (pre-post) data collection, and yet it remains unclear how researchers should know in advance whom to follow based on the individual being likely to join such a movement.

Scholars interested in the brainwashing concept have tended to focus on movements that have clearly harmed individuals, such as Aum Shinrikyo, People's Temple, Heaven's Gate, Solar Temple, and Charles Manson's group, whereas those opposing the use of the brainwashing concept have tended to focus instead on movements that obviously contribute positive value and innovation to society. The difficulty in establishing a scientific consensus on the brainwashing concept is evidenced by the rejection, in 1987, of the report of the American Psychological Association's (APA) Task Force on deceptive and indirect techniques of persuasion and control (DIMPAC) by APA's board of social and ethical

responsibility for psychology (BSERP) on the basis that it did not provide sufficiently rigorous and evenhanded analysis of the issue.

Conclusion

Brainwashing is a sufficiently ill-defined concept that it may not be scientifically useful. There is a lack of evidence for it in its mythic form which is presumed to rely on exotic techniques and to lead surreptitiously to total control. Even half a century ago, the foundational researchers in this area eschewed the term brainwashing for good reason. Instead, the most fruitful approach has been to examine mundane but powerful social influence processes, which may, under some circumstances, take an extreme form in a particular social group or organization, whether religious, political, or otherwise, or even in a dyadic relationship. An alternative term sometimes used, rather than brainwashing, is coercive persuasion or thought reform, with grounding in basic social influence processes and factors that have an impact on human thought processes and persuasion, and the operation of which is well understood on the basis of the science in social psychology.

See also: Anxiety and Fear; Attitude Change; Attitude Formation; Child Abuse; Cognitive Dissonance Theory; Confabulation and Reality Filtering; Conformity and Obedience; Crowding: Effects on Health and Behavior; Delusions; Dissociative Disorders; Drugs, the Brain, and Behavior; Eyewitness Identification; Interpersonal Perception and Communication; Jury Psychology; Perceived Control; Psychology and Religion; Psychology, Science, and Astrology; Risk-Taking Behavior (Young Male Syndrome); Sense of Taste (Effect on Behavior); Terrorism; Violence; War.

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Relevant Websites

- <http://www.icsahome.com/> – International Cultic Studies Association.
- <http://www.cesnur.org/> – Center for Studies on New Religions.
- <http://www.apologeticsindex.org/> – Apologetics Research Resources on religious movements, cults, sects, world religions and related issues.

Bulimia Nervosa

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Glossary

Binge eating Consuming a large amount of food in a short period of time accompanied by a sense of loss of control.

DSM-IV The 4th edition of the Diagnostic and Statistical Manual of the American Psychiatric Association.

Eating disorders not otherwise specified (EDNOS) An eating disorder that is clinically significant but does not meet criteria for anorexia nervosa or bulimia nervosa.

Incidence New cases per period of time.

Pharmacotherapy Drug treatment.

Prevalence Total cases at any given time.

Introduction

Bulimia nervosa (BN) involves three behavioral and cognitive components: binge eating, inappropriate compensatory measures, and body image disturbance. Binge eating is defined as (1) eating a large amount of food in a discrete amount of time which would be atypical of others in similar circumstances and (2) a sense of loss of control during these eating episodes. Binge-eating episodes are often followed by a negative emotional state, and often occur in response to stressors or after a period of fasting. The food consumed during binge-eating episodes is usually high in calories and often has fat content, for example, sweets. Research also suggests that the disorder has a significant financial cost (i.e., \$1599.45 per year in the United States) associated with purchasing the food that patients consume during their eating episodes.

Compensatory behaviors can involve multiple methods including vomiting; laxative, diuretic, or enema misuse; fasting; or overexercising. DSM-IV suggests that binge-eating and purging behaviors occur in combination and at least twice weekly for 3 months. Body image disturbance is defined such that self-evaluation is unduly influenced by body shape and weight. These symptoms must not occur during the course of anorexia nervosa (AN), which is marked by maintenance of low weight.

BN can be specified in two ways: purging and nonpurging. Purging behavior includes vomiting, and misuse of laxative, diuretics, or enemas. Nonpurging BN is diagnosed when the patient only engages in fasting or overexercise.

BN includes ~25.5% of outpatient eating-disorder (ED) diagnoses. Many ED patients tend to fall into the ED not otherwise specified (EDNOS) category, as many patients' symptoms do not meet the full criteria for BN. EDNOS is the most common ED diagnosis, constituting nearly 60% of outpatient ED cases. Given this large grouping which lacks specifying detail, many clinicians and researchers are looking to the DSM-V to define the diagnostic criteria for subgroups of EDNOS. A future direction for the next edition of the DSM may be to operationalize the amount of food needed to define an 'objectively' large binge-eating episode. Some ED patients report experiencing 'subjective' binge-eating episodes, wherein the amount of food consumed is not necessarily considered larger than what others would eat (e.g., two cookies); however, the patient reports a feeling of loss of control during the consumption of the food. Further research is needed to better

understand the caloric differences between objective and subjective binge-eating episodes. Additionally, recent attention has been paid to 'purging disorder,' which is similar to BN but is marked by compensatory behavior in the absence of objectively large binge-eating episodes. Limited research has explored this disorder, which is currently classified as a form of EDNOS.

Clinical Characteristics

BN most often occurs in females (i.e., 90%), although a research literature has developed on males and eating disorders. EDs have generally been studied, and likely are most prevalent in western cultures. Research has suggested, however, that the cultural bias on thinness is impacting other regions of the world as Western influences become more prevalent. Individuals suffering from BN are typically of normal weight. Patients can experience comorbid substance abuse, especially alcohol abuse, mood disturbance, anxiety disorders, and personality disorders.

BN often first appears during adolescence or in the early 20s. Patients tend to begin restricting food intake, which is followed by episodes of overeating and subsequent purging. These behaviors become cyclical. As mentioned, the binge-purge cycle appears to become a means to cope with negative emotional states. The most commonly used method of compensating for binge eating is vomiting, which can occur somewhat effortlessly after recurrent vomiting. Oftentimes, the pattern of purging can lead to medical complications such as electrolyte imbalances, edema, and dental complications such as erosion of dental enamel. Laxative abuse can engender various gastrointestinal complications. Given the sometimes chronic course of BN, ongoing medical complications can occasionally become life threatening.

Epidemiology

The DSM-IV estimates the prevalence of BN to be between 1 and 3% for women and between 0.1 and 0.3% for men. As numerous epidemiological studies have indicated, the prevalence and incidence of BN and its subthreshold variants are considerably more complicated issues. There have been a

number of significant difficulties and methodological limitations inherent in studying the epidemiology of EDs, including the relatively low prevalence of eating disorders in the overall population and the general reluctance of individuals affected with EDs to seek professional help. Considerations of this nature must be taken into account when discussing epidemiological issues in BN.

The incidence of BN has been estimated in several studies in industrialized nations. In the United States, the incidence of BN has been estimated at 13.5 affected individuals per 100 000 people for the period between 1980 and 1990. An incidence of 12.2 per 100 000 was observed in the United Kingdom in 1993 by Turnbull and colleagues.

Several prevalence studies of BN have also been conducted in industrialized nations. Fairburn and Beglin in 1990 provided the generally accepted prevalence of estimate of 1.0% when taking into account BN as it was defined in DSM-III, DSM-III-R, and Russel's original description in 1979. Kendler and colleagues in 1991 reported a lifetime prevalence of the narrow BN phenotype at 2.8% in the United States. In 2006, a replication of the National Comorbidity Survey reported in a paper by Hudson and colleagues a lifetime prevalence of 1.5% for women and 0.5% for men and a point prevalence of 0.5% in women and 0.1% in men.

In addition, it is important to consider individuals affected by subclinical variants of BN when discussing epidemiological issues. The prevalence of subclinical BN is ~3–4 times that of full-syndrome BN.

Longitudinal Course

The course of BN is highly variable. One-quarter of individuals with BN who do not receive treatment still improve, while upwards of 70% who are treated respond. Literature has suggested that there may be considerable crossover among AN, BN, and EDNOS. In fact, it is likely that many individuals fluctuate between these disorders, and in the severity of their psychopathology. Research generally has focused on full-threshold disorders (e.g., AN and BN). However, it has been suggested that AN and BN may in fact exist on a continuum with EDNOS. Indeed, patients with AN often cross over to BN. Although BN patients can also cross to AN, it is less common. Periods of symptom remission are also possible. For example, research suggests that nearly 30% of BN patients and 12–30% of patients with EDNOS resembling BN or purging disorder had a previous diagnosis of AN. Most women who transition to AN from BN appear to meet criteria for AN-B/P, and fewer transition from AN-R. It appears most likely that patients with BN tend to fluctuate to partial remission or full resolution of symptoms. These changes in diagnostic classification and in symptom severity speak of the importance of continued monitoring of symptoms and assessment of treatment effectiveness throughout the course.

Psychotherapy

Cognitive behavioral therapy (CBT) is generally considered the treatment of choice for patients with BN. The treatment can be

delivered in either group or individual formats. Recently, the NICE guidelines in the United Kingdom assigned the grade of A for CBT for BN, attesting to the efficacy of this treatment. Interpersonal therapy (IPT) has also been monitored in two large studies, and although the effectiveness is substantial, the therapy appears to take longer to have an effect. From a theoretical standpoint, this is quite interesting. IPT was developed to be used as a maintenance treatment for depression and does not include a focus on the specific symptoms of BN. A third treatment, which has also been modified from its original application for use with ED patients, is dialectic behavior therapy (DBT). This therapy was originally given to patients with self-injurious behavior and suicidality but has subsequently also been shown to be effective in BN. While CBT focuses on specific bulimic behaviors and IPT focuses on interpersonal relationships, DBT focuses on both behavioral change and self-acceptance. Several other treatments have been suggested in the literature but have not been empirically validated.

Unfortunately, the treatment of choice, CBT, often results in low rates of complete remission, usually in the range of 30–40% in most studies. For this reason, increasing emphasis is being placed on the development of new therapies. One such therapy is an enhanced form of CBT (CBT-E) developed by Fairburn, Cooper, and Shafran at Oxford University. This therapy expands on the existing form of CBT to embrace four additional domains that are assumed to be maintaining mechanisms: clinical perfectionism, interpersonal difficulties, low core self-esteem, and mood intolerance. This therapy is designed to be transdiagnostic and may be used for patients with any ED. Another new therapy developed at the Neuropsychiatric Research Institute and the University of Minnesota also appears promising. This therapy, called Integrative Cognitive-Affective Therapy (ICAT), expands on traditional CBT by placing greater emphasis on cultural factors, self-oriented cognitions, interpersonal schemas, interpersonal patterns, and emotional experience.

CBT rests on the cognitive view of the maintenance of BN, which assumes that low self-esteem generates extreme concerns about weight and shape; this leads to strict dieting which subsequently leads to binge eating and then to self-induced vomiting. Each level of this cascade then feeds back on the other levels. Traditional CBT is delivered in 20 sessions over 16 weeks with twice-weekly appointments in the initial month. There are generally three treatment phases. The first 8 sessions focus on explaining the rationale for CBT and replacing binge-eating behavior with a stable eating pattern. The second treatment phase, from sessions 9–16, continues to focus on behavioral strategies but also focuses on cognitive issues, including an examination of all forms of 'dieting,' weight and shape issues and cognitive distortions, and includes training in behavioral problem solving. The third phase, from sessions 17–20, focuses on relapse prevention. There is a strong emphasis on self-monitoring in this treatment.

Pharmacotherapy

The first report of pharmacotherapy as a treatment method for BN appeared in 1983, 4 years after Gerald Russell first

described the condition. Over the last 30 years, several pharmacological agents have been shown to have efficacy for BN, beginning with early trials with tricyclic antidepressants (TCAs) and continuing through more recent trials with the antiepileptic drug topiramate. Despite the presence of positive efficacy data with several classes of medications in BN, significant room for improvement in the pharmacological treatment of this disorder remains, as remission rates are low, often only around 10–15%.

Typically, patients with BN fall within the normal weight range and are likely to have at least one comorbid psychiatric condition. For example, approximately half the patients with BN have a lifetime diagnosis of major depressive disorder. In addition to targeting the recurrent binge eating and compensatory mechanisms that characterize this condition, pharmacotherapy trials have also investigated the impact of medication on comorbid psychopathology and body weight.

A number of placebo-controlled trials of TCAs were published in the 1980s and early 1990s, including imipramine, desipramine, and amitriptyline. With a few exceptions, the results of these trials demonstrated the ability of TCAs to reduce the frequency of binge eating in patients with BN. A secondary outcome measure in many of these studies was a reduction in depression symptoms. The TCAs generally, although not always, led to a significantly greater reduction in depression symptoms relative to placebo.

Despite research showing overall favorable efficacy with the TCAs, tolerability was not optimal. With varying degrees of potency, the TCAs act as antagonists at muscarinic, α -1 adrenergic, and histamine-1 receptors. These pharmacological attributes can generate adverse effects including anticholinergic effects (e.g., dry mouth, urinary retention, and constipation), orthostatic hypotension, sedation, and weight gain. These drugs are also known to have serious or fatal consequences in overdose. Also beginning in the mid-1980s, several controlled trials with monoamine oxidase inhibitors (MAOIs) were reported. Later, the selective, reversible MAOIs brofaromine and moclobemide were investigated. Neither of the latter two MAOIs are currently available in the United States. Similar to the TCA trials, most, although not all, of the placebo-controlled MAOI trials demonstrated efficacy for reducing the frequency of binge eating. Also in similarity to the TCAs, the MAOIs have unique tolerability and safety concerns. While the TCAs and MAOIs may remain effective and appropriate options for selected patients, the marketing of the first selective serotonin reuptake inhibitor (SSRI), fluoxetine, in the late 1980s resulted in a shift toward the use of newer antidepressant medications for BN.

Investigations shifted to the SSRIs in the 1990s. The US Food and Drug Administration approved fluoxetine 60 mg day⁻¹ for BN treatment. Romano and colleagues examined whether fluoxetine could prevent relapse in BN following successful acute treatment. Although the data were positive, the study suffered from a high drop-out rate.

Two novel treatment approaches, ondansetron and topiramate, have also been investigated in controlled trials over the past decade. Ondansetron, a serotonin-3 receptor antagonist used for the prevention and treatment of nausea and vomiting, was shown to significantly reduce binge-eating and vomiting episodes in a 4-week, placebo-controlled trial at a daily dose of 24 mg, divided into six 4-mg doses.

Topiramate, an anticonvulsant medication with a complex mechanism of action, has been examined in two 10-week, placebo-controlled trials for BN. Results from both these trials showed a reduction in binge-eating and purging frequency along with a reduction in body weight with topiramate relative to placebo.

Interspersed throughout the timeline of the previously discussed studies were trials that examined an assortment of other compounds. Results from clinical trials with the opioid receptor antagonist naltrexone have been mixed. Rebexetine, a selective norepinephrine reuptake inhibitor that is not currently available in the United States, has been reported to reduce symptoms of binge eating, vomiting, and depression in a small case series and subsequent uncontrolled pilot study. A variety of other medications have also been explored in BN, including D-fenfluramine, flutamide, phenytoin, an anti-androgenic oral contraceptive, spironolactone, and methylphenidate. Concerns over efficacy, safety, tolerability, or the need for additional data exclude these compounds from routine clinical use for the treatment of BN at the present time.

Although pharmacotherapy trials for BN have consisted of a variety of medications and have often resulted in positive efficacy data, the majority have been of short duration. For many of these medications, it is unclear whether improvements gained during the acute treatment are sustained over a longer duration of treatment.

Psychobiology

EDs in general and BN in particular in our discussion here are probably best considered as examples of gene–environment interactions. Clearly environmental factors are important, but the available study suggests a strong influence of genetic factors for the liability for this disorder. Relative to specific genetic risk factors, seven linkage regions have been identified in genome-wide screens of patients with AN and BN, but no consistent association between a candidate gene and BN has been identified. These problems can be overcome only with larger genetic association studies involving multicenter collaborations. Also, the heterogeneity of eating disorders (ED) phenotypes represents a major problem, and it will be necessary for future studies to focus on more homogenous groups using selective phenotypes and perhaps focusing on specific ED traits. Also, there is some interesting work suggesting poor treatment response in patients with bulimic syndromes who have low functioning alleles of 5-HTTLPR and -1438 G/A, suggesting hereditary factors involving the serotonin system. Relative to the psychobiology of BN, several areas have developed over the last few decades. One such area has been an examination of baseline concentrations and physiological responses of various gut peptides in patients with eating disorders. This work has been recently reviewed. Results in these studies have been somewhat inconsistent as have the conclusions that have been drawn from these studies. Some results suggest elevations in gut peptides such as ghrelin, PYY, and cholecystokinin. Others have not replicated these findings. There has also been an interest in examining biogenic amines and their metabolites in various bodily fluids. Also various brain imaging techniques have been used to examine possible structural and

functional changes in the CNS including magnetic resonance imaging, positron emission tomography and single photon emission computed tomography. CT studies have generally found some evidence of decreased cortical mass in patients with BN. There have also been studies in general showing the significant correlations between measures of harm avoidance and binding for the 5HT_{1A} and 5HT_{2A} D2/D3 receptors in certain brain areas such as the mesial temporal lobe, and harm avoidance appears to be elevated after recovery from BN. There also appear to be interesting changes in frontal striatal circuits across multiple childhood psychopathologies including BN as well as altered striatal responses to reward in recovered women with BN.

Conclusions

BN is a prevalent, serious, ED among young women. It can be associated with serious medical and psychosocial complications. Many patients with BN have other psychiatric problems. Antidepressant drugs improve the symptoms of BN. However, CBT appears to be more effective and is the treatment of choice. Both genetic and environmental factors play a role in the etiology of this disorder.

See also: Body Image; The Mind–Body Problem; Obsessive–Compulsive Disorder; Self-Esteem.

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Relevant Websites

- www.aed.org – Academy for Eating Disorders.
- www.nationaleatingdisorders.org – National Eating Disorders Association.

Bullying

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Glossary

Bully/victim continuum Bullying behaviors are depicted on a continuum of four behaviors: bullying, victimization, experiencing both, and watching bullying occur.

Bullying A relationship that occurs between two or more individuals, with repeated interactions characterized by an imbalance of power and the intent to harm.

Cyberbullying An individual or a group willfully using information and communication involving electronic technologies to facilitate deliberate and repeated harassment or threat to another individual or group by sending or

posting cruel text and/or graphics using technological means.

Dating aggression Physical, sexual, and/or emotional aggression carried out by a dating partner.

Direct behaviors A form of bullying that includes behaviors that are overt, usually involve a face-to-face interaction, and can be either physical or verbal.

Indirect behaviors A form of bullying that includes behaviors that are covert, possibly relationally aggressive, including cyberbullying.

Intimate partner aggression Physical, sexual, and/or emotional aggression carried out by an intimate partner in the context of control.

Definition

Bullying is most commonly defined as any form of aggression in which one or more individuals repeatedly verbally or physically harass a victim without provocation. According to the American Psychological Association, bullying is persistent, threatening, and aggressive behavior directed toward others, especially those who are smaller or weaker. There are three common characteristics found in most definitions of bullying: (a) an imbalance of power, (b) the intent to harm, and (c) the display of repetitive behavior. An imbalance of power is stereotypically characterized as a physical issue, with the bully being much larger and stronger than the victim. While this is the stereotypical image of bullying, an imbalance of power can also include characteristics such as intellectual ability, social status, or social prowess. To illustrate this issue, consider the example of a high school senior who is physically shorter and weaker than a high school freshman; however, the freshman does not believe he can defend himself because he is an underclassman. Because of the senior's greater social status, he is able to repeatedly make the freshman stand in a hallway trashcan. Thus, the senior's behavior is considered as bullying, despite his physical size.

The behaviors that constitute bullying can be divided into two forms: (a) direct behaviors and (b) indirect behaviors. Direct behaviors are more overt, can be both physical and verbal, and involve face-to-face interactions between the bully and the victim (e.g., hitting, shoving, and calling names). Indirect bullying behaviors can be relationally aggressive, are typically covert in nature (e.g., spreading rumors, excluding someone from a group), and can also include cyberbullying (e.g., bullying through technology such as cell phones and computers). The underlying factor distinguishing direct forms of bullying from indirect forms is whether or not there is a face-to-face interaction between the bully and the victim.

Bullying behaviors exist on a continuum and are not permanently set in fixed roles in individuals. There are four

behaviors along the bully/victim continuum: (a) bullying, (b) victimization, (c) experiencing both (bullying-victimization), and (d) watching bullying take place. Bullies are those individuals who exhibit only bullying behaviors, while victims are those who are targeted by bullies. Bully-victims are those individuals who both bully others and are bullied by others. Relative to only bullies or only victims, bully-victims are typically more impulsive, have greater difficulty regulating their emotions and reactions, and experience the greatest psychological impact from their involvement in the bullying continuum. Bystanders are those who witness bullying but are involved neither as a bully nor as a victim. Individuals involved in bullying may move between roles or hold multiple roles on the bully/victim continuum. Thus, bullying/victimization should be considered a dynamic, evolving experience, and not a static, fixed experience.

Prevalence

Bullying is a worldwide phenomenon. Studies have shown that bullying behaviors exist with similar prevalence rates across countries (e.g., Australia, United States, Japan, Italy, the Netherlands). Bullying occurs in rural and urban populations, across social classes, large and small schools, single-sex and coeducational schools, romantic relationships, and the workplace. In short, bullying is an issue that is present in the majority of the world. Although the fact that bullying exists is clear, the determination of reliable and valid prevalence rates of bullying is more difficult.

The prevalence rates of bullying in schools vary based on the definition and methodology used in the research. One of the largest samples of bullying behavior in the United States found that, of 15 686 students in grades 6 through 10, 13% reported frequent involvement as bullies, 10.6% as victims, and 6% as bully-victims for a total rate of 29.9% for frequent involvement in bullying. However, when examining students

who were bullied 'regularly,' a separate study found victimization rates to be between 5% and 9%. Participants across cultures or countries may also report differing prevalence rates. In Australia, for example, within a sample of 2680 students with an average age of 13, 33% of students reported being bullied at one time. A study of over 5000 Swedish students, however, found that 20.2% were repeatedly victimized every month. Cultural differences may partially explain the differences in prevalence rates found between countries. For example, Japan is considered to be a more collectivist country compared to the United States and the topography of bullying is influenced by this cultural difference. In Japan, bullying is referred to as 'ijime' and is rarely a one-to-one interaction. The majority of bullying incidents that occur in Japanese schools involve multiple students directly or indirectly bullying an individual student. Given these differences, perhaps it is not surprising that such different prevalence rates have been found across studies.

At this time, there is no universally accepted method for measuring bullying. The most common methods used for measuring bullying behaviors are self-report from students, teachers, and parents, direct observations, and teacher and peer nominations. Each method has strengths and limitations, making it difficult for one method to be considered the 'gold standard.' Additionally, other factors can influence reported prevalence rates. For instance, some studies assess relational bullying, while others only examine more direct behaviors such as hitting or name-calling. Despite the differing cultures, methodologies, and definitions, the overall range of prevalence rates in the majority of research on bullying suggests that bullying is an important issue.

Development

When examining bullying across students' school career, we see that it typically increases at the end of elementary school (grades 4 and 5), peaks in the middle school years (grades 6–8), and begins to decline in high school (grades 9–12). Despite this developmental trend, research on the bullying behaviors of younger children (under age 6) and adults is less abundant. The method of bullying may also change depending on the age of a student. In earlier grades, bullying is typically more direct and physical, while relational bullying increases as students progress through school. Furthermore, as children become more cognitively and socially mature, the topography and methods they use to bully others change.

Although the majority of research begins measuring bullying in middle childhood, bullying behaviors have been found as early as preschool. Relative to older students, preschoolers show higher rates of physical aggression. This is often explained by the lack of social skills and problem-solving abilities children have at younger ages. Supporting this argument is the finding that at the beginning of the school year, preschool children typically show increased rates of physical and verbal aggression, which decline over the year. Relational bullying does occur during preschool, but it is less frequent and more direct than in older children (e.g., 'You can't play with our group unless you give me your toy'). Preschool bullying behavior has also been linked to future behavioral problems. More

specifically, preschool children who bullied others were more likely to be diagnosed with Conduct Disorder in adolescence. This suggests that as early as preschool, children engage in bullying behaviors, and the effects of those experiences are carried forth into adolescence.

As students enter middle school, the topography of bullying begins to change. By middle school, bullying tends to become more covert and relational. A student might replace the overt physical bullying behavior of hitting with the more covert behavior of spreading rumors. As students enter early adolescence, their social group is increasingly used for emotional support. Thus, bullying behaviors target these social areas as they are important for adolescents. It is also during this time that cyberbullying becomes more prevalent. As parents give their children more independence and privileges (e.g., cell phones, less restrictive Internet access), the opportunity for bullying increases. Additionally, romantic relationships begin to play a role in the experience of bullies at this time. Bullies have been shown to begin romantic relationships earlier than students not involved in bullying. While bullies begin dating earlier, and in more advanced forms, they also report less emotional support in their relationships. On the basis of this research, bullies appear to be at a greater risk for developing unhealthy romantic relationships (e.g., domestic violence and sexual harassment).

During middle to late adolescence, bullying behaviors once more begin to change. Physical bullying becomes even less frequent as the consequences for physical aggression become more severe. With the increased cross-sex interactions that occur during adolescence, a new context for bullying emerges. For example, in high school, rumors may be spread that a female student is pregnant. While these types of bullying behaviors do occur in earlier grades, it is during high school that they become more prevalent. Also during this time, and into adulthood, bullying behaviors may transfer into romantic relationships. Research has suggested, for example, that bullying may turn into sexual harassment as students become more aware of their own and others' sexuality. Additionally, bullying in the workplace does occur, although less frequently than during the primary and secondary school years.

Impact

The experience of being victimized has been found to be associated with a wide range of consequences. Children who are victimized by their peers have been found to show more internalizing (e.g., anxiety and depression) and externalizing (e.g., delinquent and aggressive behaviors) problems. Similarly, adolescent victims have reported more trauma symptoms, a higher rate of substance abuse, lower levels of self-esteem, poorer health, and higher rates of suicidal ideation. The experience of being a victim of bullying may be linked to students' decisions to carry out physical attacks, and even lethal attacks. Clearly, there are a variety of negative, even potentially fatal, short- and long-term effects of bullying. However, the adverse effects of bullying may be dependent on the type of victimization one experiences. It has been found, for example, that students who experienced verbal victimization, physical victimization, or sexual harassment had a higher risk of

experiencing behavioral problems, while being relationally victimized was not associated with these negative effects.

Research has shown that individuals who bully are also at risk for adverse effects. Both bullies and victims of bullying have been found to be more likely than their nonbullying peers to experience depressive symptoms. Additionally, students who bully others have shown higher general misconduct in a variety of settings, greater levels of impulsivity, significantly greater levels of anger, and more feelings of depression compared to peers who do not bully. Such negative effects may be even more pronounced for students who are bully-victims, as one study found that such students were significantly more likely to show symptoms of depression compared to their peers who bullied, were victims, or were not involved. In fact, compared to other groups, bully-victims were four times more likely to lack a positive self-image and three times more likely to report feeling insecure within the school setting.

Research suggests that negative psychosocial outcomes exist for those individuals who bully, those who are victimized, and those who are bully-victims. The same appears to be true for bystanders. One study found that adults who witnessed workplace bullying were more likely to suffer poor mental and physical health compared to employees who neither experienced nor witnessed workplace bullying. Additionally, a recent study found that people who had witnessed a great deal of bullying in their youth reported clinical levels of distress and psychological trauma similar to the levels exhibited by people who had witnessed catastrophic events such as earthquakes. This evidence is used to support the claim that if bullying was truly a normal, natural part of growing up, it would not result in such devastating levels of distress and psychological trauma. Thus, it is clear that bullying can cause serious harm to all the parties involved, even to those who 'simply' witness the bullying incident.

Gender Differences

At this point of time, there is little consensus regarding whether or not boys and girls differ in the frequency with which they bully. After analyzing seventh- and eighth-grade students' responses to questionnaire items assessing the frequency with which they bullied, one study found that males were significantly more likely to bully others than their female peers. However, Crick and Grotpeter found that approximately equal numbers of boys and girls (27.0% and 21.7%, respectively) were classified as aggressive, meaning that they engaged in some type of bullying. Therefore, it is not clear whether boys and girls bully at similar rates.

Furthermore, it is not clear whether boys and girls use different types of bullying with similar frequencies. When measuring overt types of aggression, which included physical and verbal aggression, Crick and Grotpeter found that 15.6% of boys but only 0.4% of girls were classified as overtly aggressive. In addition, when examining relational aggression, defined as attempts or threats to harm another's peer relationship, 17.4% of girls but only 2.0% of boys were classified as relationally aggressive. Thus, boys were significantly more likely than girls to be overtly aggressive, while girls were significantly more likely than boys to be relationally aggressive.

This is consistent with other research findings that females are more likely to be involved in relational and indirect forms of bullying, while males are more likely to be involved in direct forms of bullying.

However, other research studies suggest that gender differences in relational aggression are not as clear. When the study undertaken by Crick and Grotpeter was replicated using a sample of third- and sixth-grade students, the results showed that there were no gender differences in the percentage of boys and girls found to be relationally aggressive. Furthermore, although the replicated study, like that of Crick and Grotpeter, found that boys were more overtly aggressive than girls, it acknowledged that their definition of overt aggression included only physical aggression and theorized that had they included verbal aggression in their measure of overt aggression, they would not have found gender differences either.

Aside from school-age children and adolescents, gender differences with respect to bullying have been studied among adult populations as well. One study found that, within a sample of male and female university students, males reported using physical aggression significantly more often than females but there were no gender differences in the reported use of relational aggression. A separate study measuring workplace bullying among a sample of adults employed in nine companies in Iceland, found that men reported bullying significantly more often than women. Although men and women reported being victimized at similar rates, gender differences emerged in the manner in which these adults responded to such victimization. Specifically, women were more likely to seek help, while men were more likely to confront the perpetrator(s) of the aggression.

Additional evidence shows that there may be gender differences in the effects of bullying. While some studies have found a significant relationship between bullying others and depressive symptoms for both genders, others have found that females were more likely to develop internalizing symptoms due to bullying. Looking at specific types of bullying separately, Crick and Grotpeter found that relationally aggressive girls reported significantly higher levels of loneliness and significantly lower levels of peer acceptance compared to relationally aggressive boys, nonaggressive girls, and nonaggressive boys. Relationally aggressive boys did not experience these problems at significantly higher levels than their peers. It appears as though girls, but not boys, who perpetrate acts of relational aggression, are at a higher risk for feelings of loneliness and low peer acceptance. Furthermore, in one study, female university students who were physically aggressive were more likely to be depressed than their nonaggressive peers, while physically aggressive males were no more likely than peers to be depressed. Thus, physical aggression, too, seems to be associated with negative outcomes for females but not for males.

Although it is difficult to conclusively say that gender differences exist in any area of bullying, it is clear that (a) both boys and girls engage in bullying, (b) the use of physical, verbal, or relational aggression is not limited to just one gender, and (c) the act of bullying is associated with negative outcomes, females being more likely to experience these outcomes. Further research is needed to clarify the remaining questions surrounding potential gender differences in bullying.

Cyberbullying

Cyberbullying is a relatively new medium through which bullying occurs (e.g., chat rooms, text messages). Cyberbullying has been defined as an individual or a group willfully using information and communication involving electronic technologies to facilitate deliberate and repeated harassment or threat to another individual or group by sending or posting cruel text and/or graphics using technological means. Many of the methods used in traditional bullying are used in cyberbullying. Direct cyberbullying can occur when one person calls another a name through an electronic message. Relational bullying can also occur online. For example, with the numerous social networking sites now online (e.g., Facebook, MySpace), 'hate groups' have become a popular approach to bullying. In a hate group, a student creates an online social group against a schoolmate, allows others to join, and collectively the group posts negative comments about the student. Fortunately, social networking sites have begun taking action against the creation of hate groups. When creating a group on Facebook, for instance, a warning is placed near the bottom of the page that reads, "Note: groups that attack a specific person or group of people (e.g., racist, sexist, or other hate groups) will not be tolerated. Creating such a group will result in the immediate termination of your Facebook account." There are several similarities between cyberbullying and traditional bullying. Examining the overlap between cyberbullying and traditional bullying, one study found that 56% of online victims were also victims of traditional bullying. Unfortunately, no information exists on whether the cyberbully was the same person who also bullied the victim in traditional ways. Interestingly, this also means that some victims are targets of only online bullying. One explanation that has been proposed for this phenomenon involves the anonymity an individual has on the Internet. In traditional bullying, the person bullying a victim is almost always known. Online, however, individuals are represented by screen names that do not necessarily correspond with their real-life identity. The psychological outcomes of bullies and victims of cyberbullying are also similar in relation to traditional bullying. Approximately 38% of youth who are harassed online report emotional distress about the event. Additionally, the type of harassment perpetrated has an effect on the degree of emotional distress one experiences. One of the most emotionally distressing types of harassment mentioned by youth includes being propositioned to send a picture of oneself.

Some research has shown that there are also differences between cyberbullying and traditional forms of bullying. As with traditional bullying, prevalence rates of cyberbullying vary depending upon the method of assessment and the definition of cyberbullying. A synthesis of research findings suggests that 10–30% of youth are involved in cyberbullying. There are also gender differences in cyberbullying. One study found that the gender of online harassers was split evenly between males and females. These findings, however, may be influenced by the lack of physical bullying that can occur on the Internet. In another contrast to traditional bullying, in which prevalence rates decrease with age, cyberbullying has been shown to increase with age. This may be due to the increased availability of the Internet to older students. With

an increasing number of adolescents and younger children going online, cyberbullying is an important area for further research.

Workplace Bullying and Sexual Harassment

Bullying is a very common occurrence in schools, but it is not limited to this domain. In fact, bullying has been found to occur in a variety of contexts, including among adults within the workplace. A 2001 study found that nearly half (i.e., 46.5%) of a sample of 5288 employees reported being bystanders of workplace bullying in the past 5 years. Workplace bullying is known by many names, such as mobbing and harassment, and has been defined in a multitude of ways. It is a complex phenomenon that has yet to be consistently defined.

For their purposes, Baillien, Neyens, De Witte, and De Cuyper defined workplace bullying as negative behaviors in the workplace that persist for a minimum of 6 months and may be psychological, physical, or sexual. To explore individual and work-related factors that may lead to workplace bullying, Baillien et al. interviewed 87 informants who reported that they had knowledge of bullying occurring in the workplace. The results showed three 'pathways' that could lead to the development of workplace bullying: (a) frustration and ineffective coping, (b) interpersonal conflict, and (c) a negative culture and/or harmful habits within the organization. A better understanding of these antecedents may lead to more efficient ways of preventing workplace bullying from occurring.

In order to further understand workplace bullying, it has sometimes been studied in conjunction with sexual harassment, another form of workplace aggression. Sexual harassment has been defined as behaviors with sexual content that negatively affect one or more people by humiliating, ridiculing, and/or intimidating them. Sexual harassment can be verbal (e.g., telling sexual stories or making sexual comments about a person), nonverbal (e.g., wolf whistling or other gestures with sexual connotations), or physical (i.e., unwanted touching) and can range from telling jokes with sexual content to criminal actions such as rape. When considering the range of aggressive behaviors in the workplace, it has been theorized that these could be thought of as residing upon a continuum, with acts as harmless as channeling aggression into effective work practices on one end of the continuum and something as violent as homicide in the workplace on the other end. Workplace bullying would fall somewhere in the middle of this continuum, as would sexual harassment.

To explore the relationship between sexual harassment and workplace bullying, one study queried male and female employees at a large university to complete questionnaires that asked about several work-related subjects. Path analysis revealed that the occurrence of workplace bullying was closely related to aspects of work organization for both men and women but that sexual harassment was related to work organization for women only. Specifically, the relationship between workplace bullying, conflicts at work, and gender differences was significant for men and women, although it was stronger for women. Informal decision structures were related to bullying for men, while lack of equality and conflicts were related to

sexual harassment for women. In addition to these gender differences, a greater number of women experienced both sexual harassment (9% of women vs. 2% of men) and bullying (13% of women vs. 9% of men).

The relationship between sexual harassment and bullying has also been studied among adolescents in the school context. In one study, middle and high school students completed questionnaires measuring bullying, sexual harassment, and sexual orientation. The results were analyzed to explore whether the frequency and/or health effects of bullying and sexual harassment differed by gender and/or sexual orientation. Bullying was found to occur more frequently than sexual harassment and members of sexual minorities reported higher rates of both bullying and sexual harassment. While both bullying and sexual harassment had adverse effects on students' health, sexual harassment had more negative effects on health than bullying, especially for girls and members of sexual minorities. Although this study is limited by the small numbers of ethnically and racially diverse students as well as students of sexual minorities, it helps to demonstrate the need to study bullying in conjunction with sexual harassment.

Intimate Partner Aggression

Like sexual harassment, intimate partner aggression and dating violence are unfortunate realities for adults as well as adolescents. These forms of aggression are of particular concern because, in addition to causing direct harm to the victims, children who witness such aggression appear to be more likely to engage in bullying (see section 'Cycle of Aggression'). Within a sample of 1059 elementary and middle school children in one study, a substantial proportion (17.4%) reported witnessing intimate partner aggression between their parents at home. Rates of intimate partner aggression appear to be even higher when women are directly asked about their experience or lack thereof with such aggression over their entire lifetimes. On interviewing 1401 women from 18 to 65 years of age, over half (55.1%) reported having experienced intimate partner aggression with a past or present male partner. Clearly, a woman's lifetime risk of experiencing intimate partner aggression is alarmingly high.

Equally disturbing is the fact that such aggression is not limited to adults. According to ninth- through twelfth-grade students' responses on the Youth Behavior Risk Survey, 10.3% of girls had experienced dating aggression, defined as being intentionally, physically hurt by a dating partner. Dating aggression was also found to be associated with involvement in other types of violence, substance use/abuse, risky sexual behavior, experiencing sad/hopeless feelings, and contemplating or having attempted suicide. Espelage and Holt found that the experience of dating aggression was also closely related to the experience of bullying for a sample of 685 male and female seventh- through twelfth-grade students. Specifically, students who reported being bully-victims reported experiencing higher levels of physical dating aggression than students who reported being bullies, victims, or uninvolved in bullying. Bully-victims also reported experiencing higher levels of sexual harassment compared to members of the other three groups and higher emotional abuse within a dating relationship

than victims and students uninvolved in bullying. Given this overlap between bullying, sexual harassment, and dating aggression, it appears as though a substantial proportion of adolescents are being victimized in numerous ways.

Cycle of Aggression

Existing research has shown that bullying, as well as other types of violence and aggression, may follow a cycle of aggression that begins at home. For instance, one study found that young adults who were maltreated as children were more likely to perpetrate acts of general aggression as well as intimate partner aggression. Furthermore, among a sample of 43 death row inmates convicted of homicide, childhood maltreatment was extremely prevalent. Over half of the inmates reported experiencing sexual abuse, 95% had been physically abused, and a substantial proportion (75%) had experienced multiple forms of victimization, including verbal, physical, and sexual abuse, neglect, and having witnessed others being victimized.

Additional evidence supports the notion that being a bystander is associated with later aggression. In addition to early childhood physical abuse, witnessing a parent suffer domestic abuse predicted later perpetration of intimate partner aggression. It has also been found that there is a significant association between children witnessing intimate partner aggression between their parents at home and bullying others at school. This association could be explained by Bandura's Social Learning Modeling Theory, which states that people, particularly children, learn certain behaviors by watching the adults in their lives model them. In other words, children who see themselves or others being victimized may learn to victimize, be it via bullying or other aggressive acts.

Not all children who witness or experience such aggression will later exhibit these same or similar violent behaviors, however. The pathway between the witnessing/experiencing of aggression and later perpetration of violent acts is not certain and, thus, the witnessing and/or experiencing of aggression does not guarantee that such people will fall prey to this 'cycle of aggression' and perpetrate violent acts themselves. Yet, as a whole, evidence seems to suggest that witnessing and/or experiencing aggression, particularly multiple forms of aggression, may be risk factors for the later perpetration of violent acts.

Conclusion

Bullying is a prevalent phenomenon that causes harm to those who perpetrate acts of bullying, experience acts of bullying, or witness bullying occurring. While bullying is frequently studied in middle childhood and in the context of schools, bullying occurs in a variety of contexts across the life span, from preschool to adulthood. Bullying also shares a close relationship with sexual harassment, intimate partner aggression, and childhood maltreatment. Such aggressive acts have been theorized to occur within a vicious cycle in which those who experience aggression are more likely to perpetrate acts of aggression in the future. In short, bullying can and does affect the lives of countless children and adults.

See also: Aggression; Jealousy; Self-Esteem; Suicide; Violence.

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Relevant Websites

- <http://brnet.unl.edu> – Bullying Research Network.
- www.bullying.org – bullying.org.
- www.education.com/bullying – Bullying at school and online.
- <http://www.ncsvprp.org> – Consortium to Prevent School Violence.
- <http://www.safeyouth.gov> – Striving to Reduce Youth Violence Everywhere.

Caffeine

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Glossary

Adenosine A neuromodulator associated with regulating the degree of alertness in central nervous system functioning. A1 adenosine receptors inhibit excitatory neurotransmitters, while A2 receptors facilitate neurotransmission by inhibiting A1 receptors.

Affect The feeling state associated with an emotion. Affect is typically used in terms of direction of approach (positive affect) and avoidance (negative affect). It is most typically measured by self-reports of positive and negative affect.

Arousal A construct used to organize the common behavioral effects of exercise, stimulant drugs, sleep deprivation (negatively), time of day, and time on task. Arousal is associated with feelings of energy and tension. It is better thought of in terms of the two independent dimensions of energetic arousal and tense arousal. It typically involves increases in heart rate, blood pressure, skin conductance, and other autonomic indicators.

Caffeinism Chronic psychological distress, including sleep and anxiety disorders, associated with high levels of caffeine consumption.

Dose response The shape of the relationship between increasing dosage levels (measured in mg of caffeine/kg of body weight) with physical or psychological responses.

Energetic arousal One of the two dimensions of arousal, associated with self-reports of feeling energetic, lively, alert versus sleepy, tired, and drowsy. It is correlated with but separable from positive affect.

Negative affect A second unipolar dimension of affect. It is associated with self-reports of feeling sad, blue, unhappy, and depressed.

Positive affect One of the two unipolar dimensions of affect. It is associated with self-reports of feeling happy, pleased, delighted, and satisfied.

Tense arousal A second dimension of arousal, associated with self-reports of feeling scared, tense, nervous, afraid versus calm, relaxed, and at ease. It is correlated with but separable from negative affect.

Vigilance task It is a monotonous task, typically requiring a rapid response to the detection of an infrequently occurring event. Most vigilance tasks require sustained performance over a long period.

Withdrawal Symptoms associated with an abrupt cessation of consumption of a drug (e.g., caffeine).

Introduction

Caffeine and its fellow xanthines, theophylline and theobromine, are the most consumed drugs in the world, surpassing alcohol and nicotine for popularity and universality. Caffeine, normally associated with coffee, is also a major ingredient of tea, as is theophylline, and is even found in chocolate, a source of theobromine. Caffeine may also be found in the kola nut (chewed in Africa), yerba mate (taken with hot water in South America), and guarana seeds (primarily added to soft drinks in Brazil but also included in various 'natural food supplements'). Moderate doses of caffeine enhance mood, alertness, and physical endurance, but at the cost of increased tolerance with use and withdrawal symptoms of severe headache, fatigue, and dysphoria. The affective, behavioral, and cognitive consequences of caffeine consumption are generally positive for moderate doses, but can lead to clinical diagnoses of anxiety disorder, as well as to physical tremor, twitching, and cognitive impairment at higher levels. Besides the obvious sources of coffee and tea, caffeine is also included as an active ingredient of colas, energy drinks, and energy bars, sold in over-the-counter pill or lozenge form, and is added to many over-the-counter and prescription drugs to alleviate other side effects.

Perhaps because of its common usage and lack of apparent danger, caffeine is generally not even considered a drug. Indeed, its very ubiquity makes it very much a part of modern society and hard to think of as a psychoactive drug. However,

given that its effects are similar to those of many other psychoactive drugs, if caffeine were to be discovered today, it is quite likely that it would be illegal or at least seriously regulated. Indeed, unsuccessful attempts at regulating caffeine have occurred since coffee's first introduction into Arabia and Europe.

Coffee came to Europe and then the rest of the world from Arabia (probably starting in Yemen) or Ethiopia where the legendary Ethiopian goat herder, Kaldi, saw his goats chew on the red berries of a bush and then show great energy. Trying the berries himself is said to have led him to the joys of coffee. More likely is that warriors of Ethiopia used a mixture of ground coffee beans and animal fat to provide nourishment and energy while conducting raids on their neighbors. This mixture spread to Arabia and then by the late sixteenth century to the rest of the world. However, tea had been consumed in India and China for millennia before being introduced to Europeans searching for spices. The guarana seed was a source of caffeine in pre-Columbian South America and remains a major source of caffeine in South America and in 'health food' stores. The introduction of coffee and tea into Europe as sources of caffeine had a revolutionary impact.

The ubiquity of caffeine and its cousins as drinks and candies around the world testifies to the ease of preparation and its perceived benefits for thinking clearly and feeling alert. Some attribute the European Enlightenment and subsequent Industrial Revolution to the introduction of coffee to Europe

in the early seventeenth century and the resulting replacement of beer by coffee or tea in workers' and intellectuals' diet. (The boiling of water necessary for tea and coffee purified the drinking water, making it a safe alternative to beer for breakfast. Workers could thus work longer and intellectuals argue with greater logic than had they started their day with beer.) Joining the classic association with writers and musicians who praised (and used) the powers of coffee (cf. Balzac, Johnson, Bach, Mozart), it is difficult today to think of software developers or college students without a nearby espresso maker, cans of cola, or more powerful forms of caffeine ('energy drinks'). A wonderful statement about the powers of caffeine frequently is attributed to the Hungarian mathematician, Erdos, although probably was made by his colleague, Rényi, who claimed that 'A mathematician is a machine for turning coffee into theorems.'

A negative consequence of the introduction of coffee and tea to Europe and then to the rest of the world was similar to the later introduction of electric lights: By allowing people to stay awake when tired or when it is dark, caffeine and the electric light have modified our sleep patterns in a manner that leads to sleep deprivation and insomnia. A society without caffeine or electricity is bound to the natural rhythms of day-light and spends more time sleeping than does one with caffeine and artificial lighting.

Sources and Consumption of Caffeine

Caffeine is typically consumed by drinking coffee or tea, although it is also found in chocolate, many soft drinks, and a variety of over-the-counter medicines. The amount of caffeine in these various preparations differs drastically with more variance in tea (at least a factor of 10 between the weakest and the strongest tea in one study) than in coffee (only a factor of 4 between the weakest and the strongest coffee). What makes estimates of caffeine consumption difficult is that the standard 'coffee cup' unit of 5 oz (150 ml) is probably used less often than a 'coffee mug' of 8 oz (237 ml) or the 'Grande' size (16 oz or 473 ml) of some coffee chains. A further difficulty is that coffee differs in the way it is prepared. In a comparison of coffees, home-brewed filtered coffee tends to be stronger than does instant coffee, perhaps because the process of making the latter is more efficient in extracting caffeine, as well as some of the other bitter flavors than found in a cup of freshly brewed and filtered coffee. (Table 1)

In the United States, 95% of the adult population consumes caffeine in some form, with an average daily consumption increasing with age to the late 50s and then declining slightly (Figure 1). Typically taken with breakfast, the serving of coffee or tea to visitors is an expected custom for many. In Europe and North America, the social aspect of caffeine consumption began with the establishment of coffee houses in seventeenth century Britain and continues to this day with the popularity of various coffee shop chains. Given caffeine's prevalence in modern society, it is hard to believe that four centuries ago, coffee and tea were considered revolutionary, and there was a move to ban coffee houses as sources of rebellion.

There are vast individual differences in the consumption of caffeine, probably due to self-titration, in that people

self-administer as much caffeine as they find to yield the positive effects on mood and alertness but not enough to produce some of the negative side effects of tension. As is true of most psychological variables, there are reliable individual differences in caffeine consumption and these differences are moderately heritable ($h^2 \geq 0.4$) with a higher heritability for heavy use ($h^2 \geq 0.7$). In addition to individual differences within countries, the consumption of caffeine varies a great deal between nations. While the average intake in the United States is roughly 2–3 mg kg⁻¹, this varies drastically, with the top 10% of the population consuming as much as 5 mg kg⁻¹. In the United Kingdom, the per capita consumption is about 4 mg kg⁻¹, with the top 10% consuming as much as 7 mg kg⁻¹, while in Scandinavia, the average is about 7.5 mg kg⁻¹, with the top 10% consuming almost 15 mg kg⁻¹!

Although given GRAS status (generally recognized as safe) by the US Food and Drug Administration as a supplement to cola-like beverages, in 2009, the FDA announced that it did not view it as GRAS as an additive to alcoholic beverages. This led to some controversy, as a variety of alcohol-producing and -marketing companies complained that this would limit their sale of caffeinated alcoholic beverages (CABs). The US Center for Disease Control has issued warnings about the use of CABs, as well as the mixing of 'energy drinks' containing caffeine with alcoholic beverages. The warning is that the stimulating effects of the caffeine when combined with the disinhibiting effects of alcohol can lead to binge drinking and increase the likelihood of driving under the influence of alcohol or to unsafe or undesired sexual behavior.

Physiology of Caffeine

The full chemical name for caffeine is 1,3,7-trimethylxanthine, and its chemical formula is C₈H₁₀N₄O₂. Caffeine is a member of the purine family of compounds, meaning that it has a double-ringed, crystalline organic base, C₅H₄N₄. When consumed orally, caffeine is rapidly and completely absorbed into the bloodstream through the gastrointestinal tract. Individual differences in the amount of time it takes to achieve peak plasma levels in the bloodstream can range from 15 to 120 min, with the majority of individuals reaching peak plasma levels approximately about 30–60 min after ingestion. Caffeine is broken down extensively by the liver into three primary metabolites, paraxanthine (84%), theobromine (12%), and theophylline (4%), each of which have their own effects on the body. The liver further breaks down these three metabolites into xanthine by removal of methyl groups. Xanthine is either excreted in urine or reused by the body. The average half-life of caffeine, the time it takes for half of the caffeine consumed to be eliminated, is 2.5–4.5 h. The half-life may vary depending on a number of factors; it is much longer in individuals with liver disease, reduced by up to 50% in smokers, may be doubled in women taking contraceptives, and increases throughout pregnancy (reaching a maximum time of 15 h during the last trimester of pregnancy). The half-life also depends on the amount of caffeine consumed. The pharmacokinetics for ~70–100 mg of caffeine are linear, but the clearance of caffeine is significantly reduced and its elimination half-life is prolonged at higher doses of 250–500 mg, indicating nonlinearity. Caffeine has no nutritional value.

Table 1 Common sources of caffeine

Source	Serving	Dose/serving	Dose per ml
<i>Coffee & tea</i>			
Espresso, generic	30 ml	30–90 mg ^a	1.00–3.00 mg ml ⁻¹
Coffee, generic, drip	237 ml	96–288 mg ^a	0.41–1.22 mg ml ⁻¹
Coffee, generic, percolated	237 ml	64–272 mg ^a	0.27–1.15 mg ml ⁻¹
Coffee, generic instant	237 ml	27–192 mg ^a	0.11–0.81 mg ml ⁻¹
Starbucks brewed coffee (Grande)	473 ml	320 mg	0.68 mg ml ⁻¹
Dunkin' donuts medium coffee	473 ml	206 mg	0.50 mg ml ⁻¹
Starbucks vanilla latte (Grande)	473 ml	150 mg	0.32 mg ml ⁻¹
Black tea, 1 teabag brewed 3 min	237 ml	25–110 mg ^b	0.11–0.46 mg ml ⁻¹
Starbucks chai tea latte (Grande)	473 ml	100 mg	0.21 mg ml ⁻¹
Oolong tea, 1 teabag brewed 3 min	237 ml	12–55 mg ^b	0.05–0.23 mg ml ⁻¹
Snapple-flavored iced teas	473 ml	42 mg	0.09 mg ml ⁻¹
Green tea, 1 teabag brewed 3 min	237 ml	8–30 mg ^b	0.03–0.13 mg ml ⁻¹
Arizona iced tea, black	473 ml	32 mg	0.07 mg ml ⁻¹
Coffee, generic decaffeinated	237 ml	3–12 mg ^a	0.01–0.05 mg ml ⁻¹
Arizona iced tea, green	473 ml	15 mg	0.03 mg ml ⁻¹
<i>Soft drinks</i>			
Jolt Cola	355 ml	140 mg	0.39 mg ml ⁻¹
Mountain Dew	355 ml	54 mg	0.15 mg ml ⁻¹
Diet Coke	355 ml	47 mg	0.13 mg ml ⁻¹
Dr. Pepper	355 ml	41 mg	0.12 mg ml ⁻¹
Pepsi	355 ml	38 mg	0.11 mg ml ⁻¹
Coca-Cola	355 ml	35 mg	0.10 mg ml ⁻¹
Diet Pepsi	355 ml	36 mg	0.10 mg ml ⁻¹
Guarana sodas	355 ml	30 mg	0.08 mg ml ⁻¹
<i>Energy drinks</i>			
AMP Energy	237 ml	80 mg	0.34 mg ml ⁻¹
Monster Energy	473 ml	160 mg	0.34 mg ml ⁻¹
Red Bull	250 ml	80 mg	0.32 mg ml ⁻¹
<i>Chocolate</i>			
Hershey's special dark chocolate bar	41 g	31 mg	
Hershey's unsweetened baking chocolate	14 g	15 mg	
Hershey's milk chocolate bar	43 g	9 mg	
Hershey's chocolate milk	237 ml	4 mg	0.02 mg ml ⁻¹
Starbucks coffee ice cream	101 g	40 mg	
<i>Over-the-counter medications</i>			
NoDoz (maximum strength)	1 tablet	200 mg	
Excedrin (extra strength)	2 tablets	130 mg	
Anacin (maximum strength)	2 tablets	64 mg	
<i>Other</i>			
AMP caffeinated gum	2 pieces	80 mg	
Enerjets lozenges	1 lozenge	75 mg	
GU energy gel	32 g pack	20 mg	

Adapted from the Center for Science in the Public Interest, the USDA National Nutrient Database for Standard Reference, Release 22 (2009), the International Coffee Organization, and company Web sites.

^aFactors affecting the range of caffeine in coffee include the type and origin of the coffee bean, roasting method, grinding method, and brewing method.

^bFactors affecting the range of caffeine in tea include the type, origin, and age of the tea plant, the location of the leaf on the plant, the method of steeping (loose leaf, bagged, etc.), and the length of steeping time (where longer steeping times release more caffeine). 1 fluid oz = 30 ml; 1 oz weight = 28 g.

Not only does caffeine rapidly disperse to all cells in the body, its chemical structure also allows it to easily cross the blood–brain barrier. Once in the brain, the principal mode of action is as a nonselective antagonist of adenosine receptors. The caffeine molecule is structurally similar to adenosine and binds to adenosine receptors on the surface of cells without activating them, therefore acting as a competitive inhibitor or 'antagonist' of adenosine. Caffeine's physiological and psychostimulant effects are thought to derive largely from inhibiting the effects of adenosine, particularly at the A1 and A2a

adenosine receptors. The A1 receptors are located in all parts of the brain with the heaviest concentration in the hippocampus, cerebral cortex, cerebellum, and certain thalamic nuclei. The A2a receptors are located in the dopamine-rich areas of the brain, including the striatum, nucleus accumbens, and olfactory tubercle. Adenosine transmission normally decreases the neuronal firing rate and inhibits both synaptic transmission and the release of most neurotransmitters; it promotes sleepiness, dilates blood vessels, reduces the contractions of the stomach and intestines, slows the reaction to stress, and lowers

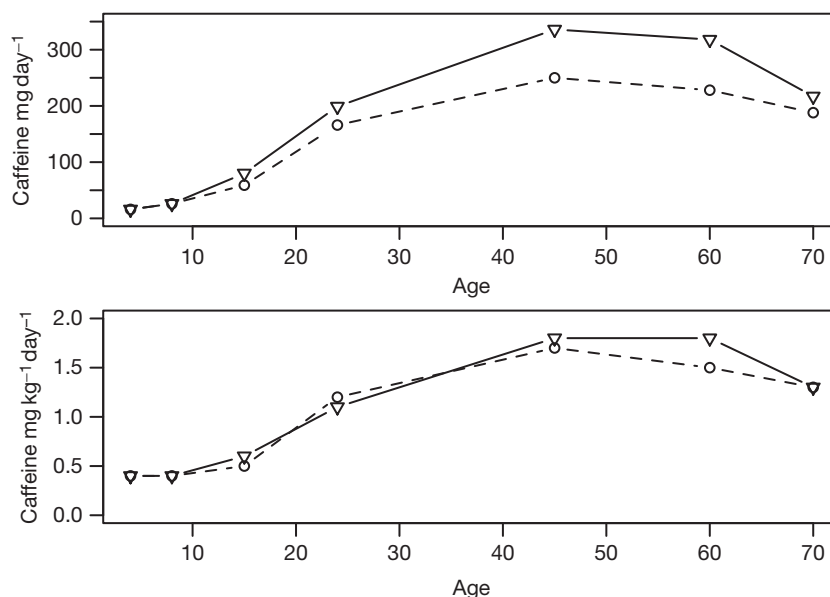


Figure 1 Caffeine consumption increases by a factor of 21 with age and differs between men and women. However, when considering body weight, the sex difference is diminished, and the increase with age is less than a factor of 5.

the heart rate, blood pressure, and body temperature. After caffeine connects to the A1 and A2a receptors, an adenosine blockage forms, thus reversing the effects of adenosine. Caffeine is classified as a psychostimulant because it produces heightened central nervous system (CNS) arousal, which increases the dominance of the sympathetic branch of the autonomic nervous system. The result of this shift is to increase the levels of activity in physiological systems that mobilize the body for aggressive or defensive activity, including the cardiovascular system, the respiratory apparatus, and the digestive system. Under continued stress, the pituitary gland is instructed by the hypothalamus to increase the release of hormones that cause the adrenal glands to produce epinephrine and cortisol. These hormones cause increased heart rate, dilation of the bronchi, a release of sugar into the bloodstream from the liver, increased blood flow to the muscles, and a tightening of muscles for action.

Caffeine also affects dopaminergic transmission. By inhibiting adenosine A2a receptors, caffeine reduces the negative modulatory effects of adenosine receptors on dopamine D2r receptors, thus causing potentiation of dopaminergic neuro transmission. This mechanism is thought to be related to the ability of caffeine to induce a positive mood state that includes mild euphoria. However, in contrast to the drugs of abuse that selectively lead to a release of dopamine in the shell of the nucleus accumbens, caffeine increases dopamine release in the caudate nucleus. Dopamine release in the caudate nucleus relates to the stimulatory properties of caffeine on locomotor activity. Only at doses not likely to be consumed by humans does caffeine cause release of dopamine in the nucleus accumbens; however, this dose is associated with nonspecific activation in the brain and aversive effects such as anxiety. Repeated administration of caffeine quickly leads to tolerance of the physiological effects previously described; tolerance refers to an acquired change in responsiveness after repeated exposure to a drug. Usually developing within a few days, tolerance to caffeine's effects on blood pressure, heart rate, diuresis, plasma

epinephrine and norepinephrine levels, renin activity, tension, anxiety, jitteriness, and nervousness has also been demonstrated. Tolerance to sleep disruption can develop within 1 week with doses as low as two cups of coffee per day. Nonhuman animals also develop a tolerance to caffeine-induced locomotor stimulation, cerebral electrical activity, and reinforcement thresholds for electrical brain stimulation. The alerting and attentional focus effects of the drug do, however, continue.

Withdrawal

Physiological dependence is a state induced by repeated drug use that results in a withdrawal syndrome when the drug is discontinued or an antagonist is administered. It is important to distinguish a withdrawal syndrome from a rebound phenomenon. Withdrawal comprises a number of signs and symptoms not present during administration of the drug, whereas rebound refers to a single sign or symptom that is the reverse of the drug effect. Additionally, withdrawal most often occurs after discontinuation of repeated drug administration; rebound can occur after single administrations of a drug. The most oft-reported symptoms of caffeine withdrawal are headaches, fatigue, weakness, drowsiness, impaired concentration, work difficulty, depression, anxiety, irritability, increased muscle tension, decreased energy and activeness, decreased alertness, drowsiness, and irritability. Onset of symptoms can appear within only 3–6 h after abstinence and can last for one week, although the incidence or severity of the symptoms increases with increases in daily dose; symptoms can appear with doses as low as 100 mg day⁻¹. It is important to note, however, that the intensity of withdrawal symptomatology is subject to substantial individual differences, based, in part, on genetic predispositions. Some people experience quite extreme withdrawal symptoms, while others experience almost none.

Although there is an overall, general withdrawal factor, withdrawal symptoms can be grouped into lower-level factors

of fatigue/headache, dysphoric mood, and flu-like symptoms. The effects of withdrawal are most clearly dose-dependent for the first two sets of symptoms: compared to light caffeine consumers (less than 100 mg day⁻¹), heavy consumers (greater than 200 mg day⁻¹) are more than four times as likely to report headache and fatigue as well as more than three times as likely to report dysphoric mood.

The effect of acute withdrawal from caffeine is seen commonly in headache and fatigue. Indeed, office workers who consume high doses during the week and then do not consume caffeine on the weekend find that the resulting weekend headaches are easily treated with pain relievers that contain caffeine. Perhaps one cause of postoperative headache is the preoperative withdrawal from caffeine rather than the acute aftereffects of anesthesia.

Some of the physiological underpinnings of common withdrawal effects have just recently been discovered. Acute caffeine abstinence results in increases in blood flow velocity in middle and anterior cerebral arteries and decreases in variability of blood flow velocity in the middle cerebral artery. These effects suggest that a vascular mechanism causes the caffeine withdrawal symptom of headache. Acute caffeine abstinence also produces significant changes in electrical activity in the brain corresponding with increased drowsiness and decreased alertness.

Withdrawal effects complicate the study of caffeine effects on mood and performance. Because most participants normally consume caffeine, it has been proposed that the beneficial effects of caffeine on mood, behavior, and cognitive performance are actually due to antiwithdrawal effects. That is, caffeine does not elevate mood or improve alertness, but rather withdrawal leads to tension and sleepiness. The logic of this position is that most double-blind caffeine studies are done after 12–24 h of caffeine withdrawal (e.g., participants are requested not to consume any caffeine after 8 pm prior to a morning study), and thus, participants are in acute caffeine withdrawal. Evidence against this proposal comes from comparing predrug administration measures of mood and performance for heavy and light caffeine consumers as well as the observation that both nonconsumers and normal consumers of caffeine report increased alertness following caffeine consumption when compared to a placebo. Further evidence against the withdrawal hypothesis comes from the pattern of cognitive performance effects of caffeine as they interact with personality and the time of day.

Affective, Behavioral, and Cognitive Effects of Caffeine

Caffeine is most commonly consumed because it improves alertness, attentional focus, and mood and fights off the effects of fatigue, though it is also used by athletes because of its effects on motor speed, power, and endurance. However, as with most things, moderation is important, for too much caffeine will mimic the symptoms of anxiety, induce hand tremor, and hinder performance in a variety of ways. Though the cognitive, affective, and behavioral effects of caffeine are addressed in turn in the following sections, it is important to acknowledge that the distinct causal mechanisms for these effects are often complicated by the fact that caffeine affects

several physiological systems simultaneously. In addition to the central nervous system, each of the cardiovascular, muscular, pulmonary, hormonal, and metabolic systems are affected by the presence of caffeine in the bloodstream.

Affective Effects of Caffeine

Coffee and tea are part of the morning routines for many around the world because they help people to feel more awake. In low to moderate doses, caffeine consumption enhances mood, increases levels of self-reported alertness, and decreases self-reported fatigue. While some effects of caffeine consumption decrease with increasing tolerance, this is generally not the case with enhancements to mood and mental alertness, though considerable evidence suggesting an interaction effect of caffeine and expectancy may play a role in the preservation of these effects.

The effect of caffeine on affect needs to be considered in terms of at least four distinct but correlated constructs. Energetic arousal (EA), indicated by such terms as alert, energetic, and wide awake as contrasted to tired, sleepy, or drowsy, is increased with caffeine. This is, after all, why coffee and tea are consumed! Orthogonal to EA is Tense arousal (TA), which is indicated by words such as tense, anxious, nervous, or afraid as contrasted with calm, relaxed, or at ease. State levels of TA are seen as a response to stressful situations, while more stable individual differences (trait levels) are associated with anxiety and neuroticism. TA increases with caffeine, particularly at higher doses (i.e., ≥ 4 mg kg⁻¹). Positive affect (PA), although highly correlated with energetic arousal and indexed by words such as cheerful, pleased, and happy, is an interactive effect of caffeine and situational cue for happiness. Without such cues, caffeine has a small positive effect on PA. The dimension of negative affect (NA) as indicated by unhappy, depressed, and blue, is highly positively correlated with TA and slightly negatively correlated with PA. NA is less affected by caffeine than it is by situational manipulations of affect (e.g., sad or depressing movies or other negative mood inductions).

In higher doses, and among individuals with lower tolerances, caffeine also increases 'jitteriness,' nervousness, and general anxiety, and these side effects are more common among clinically anxious individuals. Indeed, caffeinism is a recognized anxiety disorder associated with high levels of caffeine intake. The current diagnostic and statistical manual of mental disorders (DSM-IV-TR) lists four caffeine-related psychiatric disorders: caffeine intoxication, caffeine-induced anxiety disorder, caffeine-induced sleep disorder, and other caffeine disorders not otherwise specified. Caffeine intoxication is shown by having recently consumed more than 250 mg of caffeine and showing at least five of the following symptoms: restlessness, nervousness, excitement, insomnia, flushed face, diuresis, gastrointestinal disturbance, muscle twitching, rambling flow of thought and speech, tachycardia or cardiac arrhythmia, periods of inexcitability, or psychomotor agitation. For a diagnosis, these symptoms must be causing clinically significant distress or impairment of functioning. Caffeine-induced anxiety disorder includes symptoms of anxiety associated with high levels of caffeine intake. Caffeine-induced sleep disorder is associated with high caffeine consumption and sleep disorders not otherwise explained. Because the symptoms of high levels of caffeine

consumption are similar to those of the anxiety disorders, physicians are encouraged to inquire about the level of caffeine intake for patients complaining about anxiety symptoms.

Behavioral Effects of Caffeine

Of course, many of these affective effects carry over into more overtly physical behaviors. The most renowned behavioral effect of caffeine is increased alertness. Performance on monotonous tasks that require detection of rare events (e.g., vigilance tasks such as long distance truck driving or looking for weapons in airport scanners) normally deteriorates over time. Moderate doses of caffeine ameliorate this decrease. A more subtle, but equally reliable effect is the speeding up of reaction time, particularly when choice is not required.

In addition to these benefits, moderate doses of caffeine enhance physical endurance by increasing both work output and the time to exhaustion. Caffeine's effect on shorter-term physical behavior is less well documented, perhaps because shorter durations make effects more difficult to reliably detect. Nevertheless, the effect of caffeine on physical exercise of short duration suggests that peak power output, speed, and isokinetic strength are improved for very short bouts (lasting less than 10 s). For longer bouts (greater than 15 s), which rely on the glycolytic system, these same improvements are not maintained; in fact, some findings suggest a detrimental effect of caffeine on power for bouts of 15 s to 3 min. These discrepancies reflect the likelihood that the effects of caffeine result from a combination of mechanisms at work simultaneously. In addition to the central nervous system, these mechanisms result from changes to the cardiovascular, muscular, pulmonary, hormonal, and metabolic systems.

The effects of caffeine on physical performance have led to its widespread use among elite athletes and performers, even though the benefits are not well established across activities. With respect to elite athletic performance, it is important to note that very small variations in performance are the difference between being on the victory stand and being one of the crowd. The unit of analysis is thus not the percent change in performance so much as change as a percent of the coefficient of variation in performance, that is, the size of the effect in terms of the standard deviation rather than in terms of the raw performance.

In an effort to maintain parity, the International Olympic Committee classified caffeine as a doping agent in 1984 by setting an acceptable threshold level of $15 \mu\text{g ml}^{-1}$ in urinary samples (the level was reduced to $12 \mu\text{g ml}^{-1}$ the following year). In 2004, however, this prohibition was revoked when doping for most international sporting events (including the Olympics) fell under the administration of the world anti-doping agency (WADA). Under the current WADA policy, the concentration of caffeine in the bloodstream is monitored through urine samples for signs of potential abuse, though the threshold level constituting abuse has not been officially declared. In the past, threshold levels have been subject to criticism on the basis that they fail to take into account high interindividual variability in terms of caffeine metabolism (several studies suggest a 15–20-fold range across individuals) as well as the fact that most performance-enhancing benefits of caffeine have been documented at levels consistent with

moderate daily use. Estimates vary dramatically depending on many factors, but peak urinary caffeine concentrations of $12 \mu\text{g ml}^{-1}$ would be expected to occur 105 min after a mean caffeine intake of at least 10.5 mg kg^{-1} of body weight.

Cognitive Effects of Caffeine

The effects of caffeine on cognitive performance are not as clear-cut as they are for feelings of alertness. They are complex, for they depend upon the type of task, the situational demands, and characteristics of the individual. To make it more complicated, there is reliable evidence for systematic interactions with the various combinations of person, situation, and task variables.

To understand these effects, it is useful to organize a number of cognitive tasks along three dimensions: the requirements for sustained attention, the requirements for working or immediate memory, and the requirements for integrating long-term memories with immediate memory. Tasks can be high or low on each of these three dimensions. The positive effects of caffeine on the first (sustained attention) are quite clear, whereas effects on the latter two dimensions are more complicated.

Sustained attention tasks such as long distance truck driving, security scanning at airports, or other examples of vigilance that require detection of rare events in the presence of many repetitive but nontarget signals are correlated with general alertness. Performance on these tasks is hindered by manipulations that lead to lower alertness: alcohol, sleep deprivation, the time of day (the optimal time depends upon the participant), or the time on task. In particular, performance on these tasks decays over time, with very good performance upon starting with a (negatively accelerating) exponential decay over time. Performance may be indexed by reaction time or by accuracy. Reaction time increases and accuracy diminishes over time. Caffeine as well as brief exercise, or even an increase in the signal frequency inhibits this decay, although effort instructions ('try harder' or 'do not go to sleep') do not. The clearest evidence for caffeine effects on vigilance are found following sleep deprivation and after a period of time on the task. That is, caffeine helps the most when the subject is most fatigued. These effects are associated with increases in energetic arousal.

Although the effect of caffeine on vigilance is quite clear, the pattern on working memory tasks is much less so. Part of the confusion is that caffeine facilitates alertness which is, in turn, related to detection of the material to be remembered. In addition, caffeine enhances speed of performance which in turn can reduce accuracy. Thus, in some studies, memory for recent events is enhanced, probably because the detection was better, rather than improvements in storage or retrieval. An example of the complexity of the results may be seen in proof-reading where caffeine hinders the detection of interword errors (e.g., subject-verb agreement) which requires more working memory than does the detection of intraword errors (e.g., spelling or broken typography) which has a more complicated relationship with caffeine (a small decrease in detection is associated with an increase in the speed of processing).

Information acquired when one is alert is recalled better later (after at least a day) than is information acquired when

one is sleepy. This effect may be shown using sleep deprivation, the time of day, exercise, and variation in personality dimensions associated with arousal (impulsivity and extraversion). Similar effects are found with caffeine: caffeine taken when learning new material facilitates long-term recall and recognition of that material.

For complex cognitive tasks, similar to the sort of ability tests given for admission to graduate school, the effects of caffeine are even more complicated and are an interactive function of individual differences in impulsivity and the time of day. In a series of studies using these complex tasks, it was shown that caffeine facilitated the performance of subjects thought to be less aroused (high impulsive participants in the morning, low impulsive participants in the evening) but had deleterious effects for those thought to be more highly aroused (low impulsiveness in the morning, high impulsiveness in the evening.)

The general conclusion for cognitive performance is that caffeine facilitates performance on tasks that require (sustained) attention, particularly among participants who are fatigued or less aroused. The beneficial effects of caffeine are harder to detect for alert subjects or for tasks that require more memory. For especially complicated tasks with highly aroused participants, caffeine can have a deleterious effect.

Caffeine as a Tool for Psychological Research

Much of the research on caffeine is just that: studies of the effects of caffeine on various psychological variables. A less recognized use of caffeine is as a tool for psychological research. By increasing the ways in which a participant's

energetic and tense arousal may be manipulated, caffeine allows the careful researcher to tease apart the effects of putative arousal and motivational-related variables such as the time of day, introversion–extraversion, impulsivity, exercise, or incentives. For example, in the study of the association between positive affect and energetic arousal, and negative affect and tense arousal, the differential effect of caffeine on these variables as contrasted to more typical mood manipulations allows for distinctions that would otherwise be difficult to achieve.

Conclusion

Caffeine, particularly in the form of coffee or tea, is used by a majority of adults worldwide. The benefits on feelings of alertness and positive affect, as well as on endurance and simple cognitive performance are clear, particularly in situations that would otherwise normally lead to fatigue or when sleep-deprived. However, the benefits come with some cost, in that performance on complex reasoning tasks can be hindered, and that high doses lead to unpleasant levels of tension. Although the effects of low to moderate doses seem positive, higher doses can lead to discomfort and impaired cognitive performance.

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Career Development

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Glossary

Career The succession of vocational activities through the life span.

Negative reinforcer Environmental event that reduces a positive response.

Occupational stereotype The image an occupation holds in the view of society in general.

Positive reinforcer Environmental event that satisfies an individual's needs.

Vocational maturity The degree to which an individual's vocational activities are congruent with the expectations of his/her life stage.

Vocational self-concept The individual's personal image in terms of work.

How It Began

Career development involves a lifelong series of vocational activities. It represents a series of work activities which may or may not have continuity. It is important to recognize that the work activities are a sum of specific tasks. The accumulation of these tasks makes up what is called a job. The sum of jobs engaged in represent a vocation. One's vocational history across the life span becomes a career. One can infer a person's career only in retrospect. The process begins with a decision about educational objectives. This results in a chain of events which leads to vocational entrance. For some people, the vocational activity that follows may have little variance. That is, the vocation chosen may not change much over the course of a lifetime. For others, there may be considerable change, as skills develop and opportunities present themselves.

History of Career Development

The concept of career development is a relatively new one, generally thought to have its origins in the early part of the twentieth century. Prior to that time no one thought that careers were developmental in nature. Careers, or rather jobs and work, were thought to be discrete. In other words, for upper class or professional workers, some training might occur such as in law or medicine, after which the worker would enter and remain in the vocation doing essentially the same thing throughout the entire work life. For middle class workers such as small business owners, jobs were largely inherited. A family business, for example, a store, a farm, or a trade, was usually passed along from parent to child. For lower class workers there was little continuity from job to job. Work was obtained where it could be found and when it was exhausted jobs were sought elsewhere. While some transferability of skills and experience might occur from one job to another, no one thought that there was that significant continuity in work tasks. The question of choosing a career was hardly considered. Except for the professional level jobs, choice was not a factor to be considered. Even in these limited circumstances individual choices were likely to be somewhat constrained depending on family background.

As the Industrial Revolution continued to develop, discrete industries were developed. Except for the lowest skill level jobs, some training and/or experience was needed for entry and advancement. As industries became increasingly differentiated, the degree to which individual choices were possible increased. However, the choices were still constrained to a significant degree. Furthermore, what choices existed were limited to males for the most part, since women were not significant players in the work place outside of the home. Except for careers in teaching or in nursing, women did not have a similar range of choices available to them as did men. Not until the late nineteenth century when office technology created the typewriter and the telephone were women seen in office jobs, and even then for a long time men did those jobs because the work was considered to be too hard for women.

In the early part of the twentieth century more attention was given to the role that inherent abilities played in work effectiveness, along with that individual interests might be differentially satisfied in different kinds of work. Interests and abilities were of increasing interest as methods to measure them were developed. As a result, the concept of fitting people to jobs (e.g., round pegs for round holes) as Parsons proposed, became a cornerstone in the creation of the concept of career development. Institutions devoted to the 'test them and tell them' approach to careers began to occur. However, even then, the notion that there might be life stages or phases which would significantly influence career directions did not occur to those practicing career planning for men. Women were still excluded for the most part from career planning, again, except for nursing and teaching, typically seen to be women's work.

World War I accelerated the attention paid to differential psychology as applied to careers because the rapid mobilization of the work force into a war machine made it necessary to classify people (mostly men) according to their abilities in order to assign them to tasks most closely allied to their potential. World War II further accelerated this process because the number of candidates to be sorted was larger and the jobs more diverse and specialized. Furthermore, the methods of assessing people became more sophisticated.

With the advent of the 1920s and 1930s the measurement of interests became more sophisticated and became an equal

partner to the use of abilities in understanding the issues underlying career choices and ultimate adjustment to work.

Life Stages and Career Theories

Using knowledge developed from differential psychology it was but a small step to thinking about careers as associated with life stages. Adding to differential psychology was the knowledge based on psychometrics and developmental psychology, and, thus, gradually the concept of career development took shape. These developments largely took the form of theoretical ideas about how people choose, implement, and adjust to their career possibilities across the life span.

One of the first of these theories relied heavily on developmental psychology. It focused on stages of development through childhood, and adolescence into early adulthood, later extending into middle adulthood and into the retirement years. Career development was seen to be a process of growth, stability, and decline. The most influential advocate of this approach was Donald E. Super. According to Super, the earliest life stage critical to career development is exploration, during which individuals become increasingly aware of their physical and psychological environment in general and later as it applies personally. This process leads to a series of vocational developmental age related stages, each of which has tasks to be mastered.

To the degree that these tasks, called vocational developmental tasks, are mastered, the individual is seen to be vocationally mature. Later stages named by Super were crystallization (starting at age 14–18), specification (18–21), implementation (21–24), and stabilization (25–35). Less clearly described are the stages after stabilization. To the degree that an individual successfully negotiates the stages in an age appropriate way, he/she is seen to be vocationally mature. The vocationally mature individual presumably has a smoother and relatively trouble free career pattern.

Adequate vocational development requires the individual to fit his/her emerging self-concept with an increasing awareness of the world of work. In order to include individual continuity in career development, Super added the self-concept. The self-concept involves the integration of experiences that give feedback to the individual in terms of his/her interests, abilities, and values. The emerging self-concept leads to a more sophisticated way of fitting round pegs into round holes, as suggested by the early work of Parsons. In the approach proposed by Super, the development of a person's self-concept provides one-half of the equation while increasing knowledge about the world of work provides the other half. Career choice is, thus, the process of increasing the accuracy of self-concept implementation, which in turn leads to career development.

Measuring Vocational Interests

Vocational interests and their measurement have played a significant role in understanding the career development process. Starting with the early work of E.K. Strong, the measurement of interests has occupied the attention of investigators of career development. The rationale for their importance is obvious: if one is able to implement one's career interests in work,

then the only missing variable is the assessment of one's abilities. When interests and abilities do not coincide, the career development process is derailed.

Holland's Approach to Career Development

Another way to view the manner in which self-concept implementation occurs is the approach proposed by J.L. Holland to understanding career development. Holland has described the world of work as consisting of six occupational environments (i.e., realistic, investigative, artistic, social, enterprising, and conventional.) These environments correspond to six personal types having the same names. As an individual matures, his/her experiences lead to the development of a personality, which can be described in terms of the six personal types. People are seen to seek occupational environments that correspond to their personal type. This idea is similar to the self-concept implementation in work as described by Super. While Holland's theory does not explicitly describe the way these personal types occur, they do seem to have a developmental aspect.

Values and Career Development

The role of values in the career development process is another significant variable. Values seem to be an intervening variable having a shaping effect on interests. In other words, interests first develop based on individual reactions to activities. There is some reason to believe interests are shaped by success or failure experiences. That is, as the individual gets feedback from the environment about how his/her abilities interact with satisfaction resulting from engaging in various activities, interests flow from success experiences. At a later point in the process, the notion that some activities have more intrinsic value than others begins to play a role in the early expression of occupational choices.

Life Stages

Developmental psychologists have postulated that human development can be described in terms of stages of life. Specific stages and their names vary according to the investigator. Career psychologists have adopted some of the names and stages and also have described stages in ways that apply specifically to careers.

As noted earlier, the most prominent career development stage theorist is Super. Knowledge of life stages can direct career psychologists in useful ways. For instance, the career developmental stage determines issues such as the content of the tasks of career development that are to be faced, how they take shape, and how they shift over time. Thus, an individual in the earliest stage would largely be focused on information gathering and integration, while at a later stage, say midlife, would be dealing with the ability to maintain his/her career status.

The Theory of Work Adjustment

Rene Dawis and Lloyd Lofquist created a theory of work adjustment which postulates that a hierarchy of personal needs

develops as a function of the individual's interactions with the environment. The outcome variable of interest in this theory is the correspondence between work requirements and personal requirements. The degree to which these are in accord results in what the authors call work adjustment, which can be viewed as a developmental process over the life span.

The theory offers a substantial number of psychometric instruments designed to measure personal needs that are to be potentially satisfied in work as well as measures to assess the degree to which these needs are satisfied in different occupations. Where the individual's needs are satisfied in their occupation, job tenure is predicted to be high. As the individual's needs change through the life span, satisfaction in different jobs changes, leading the individual to strive to alter his/her occupation. People strive to maintain a correspondence between their work needs and work requirements. The degree to which these correspond is called work adjustment, which is measured in terms of job tenure, satisfaction, and effectiveness.

Social, Economic, and Technological Influences on Career Development

Not to be denied is the impact of society on how one's career develops. This includes the state of the economy, social mores, and technology. Thus, an individual from a simple, primitive society would have fewer choices and less control over them than an individual from a complex society.

Underlying the social context of choices is the state of the economy. In a thriving economy the range of career choices available exceeds that in a stagnant or declining economy. Not only is the range of choice larger in an expanding economy, but new industries are spawned, which, in turn, create new kinds of work opportunities and eliminate other, older jobs. Thus, for example, the invention of the cell phone has dramatically changed the communications industry. Jobs for telephone operators have changed. Not only are there fewer of them, but the nature of the work itself has changed. Office technology has had other significant effects on jobs. There are fewer secretaries, and those jobs that remain are different than they were formerly. There is less need for shorthand skills. The invention of the personal computer has reduced the number of typists, since workers can do their own typing. An examination of the total range of occupations demonstrates how technology has created new jobs in the health professions, among others.

Social conditions interact with the individual's life stage. The state of the economy when one first enters the labor market, affects the range of possible initial decisions. This range, in turn, has a long-term effect on what follows in later life, even when the economy may have changed significantly. Another example of how technology has changed career development is the existence of the automobile. Before the automobile, people were limited in the range of their choices to those occupations which could be performed within a short distance from their homes. After the car came into widespread use, people were able to travel extensively and so they could live at some distance from their place of employment. This made it possible for more drastic changes in one's career than possible earlier.

Another example of how technology has effected career development can be seen in how the computer has and

continues to create new kinds of jobs, and job settings. For the first time since the industrial revolution, the computer enables people to work at home, or to work at long distances from their primary place of employment.

Social changes have affected careers in a multitude of other ways. Women's entrance into the labor force in significant numbers changed existing jobs by creating new careers (such as child care) in large numbers, the need for married couples to accommodate to each other's careers, and because two income families resulted in greater affluence, more and different consumer goods on which to spend this new money. Issues that occur throughout one's career are subject to various interventions. Career counseling, an entirely new profession, has been developed to help people deal with the problems described below.

Issues Involved in Choice

Numerous events can cause difficulty in determining an individual's initial career choice. Among those are personal, familial, and society barriers to implementing a person's career choice.

Barriers Blocking Entrance to Desired Vocations

People may encounter barriers to their entrance into desired occupations. These barriers may include lack of appropriate abilities, unrealistic interests, lack of resources for training, social discrimination, and lack of family support, to name but a few. Clearly, some of the barriers are external to the individual, such as social, economic, and new technologies.

Other issues may interfere with advancement. These include poor performance, limited job opportunities, interpersonal barriers, and social discrimination, for example.

Issues that are involved in premature or untimely vocational termination are sometimes within the individual and others external. For example, one reason for termination may include failure to meet employers' goals, physical or mental limitation, employment in obsolete industries, and reaching retirement age.

Comparison of Theories

Examination of the various theories reveals some major similarities of their major concepts. For example, Super's notion of self-concept implementation in work choice has some of the overtones of Holland's concept of correspondence between an individual's personal type and the type of the work environment experienced. And both the Holland and Super approaches share similarities with the Dawis and Lofquist notion of satisfaction/satisfactoriness of jobs as related to the degree to which the work setting reinforces an individual's primary psychological needs. This trend toward similarity of concept and outcomes suggests that the theoretical approaches, different as they may seem superficially, are converging.

See also: Vocational Choice; Work Efficiency and Motivation.

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Catecholamines and Behavior

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Glossary

Catecholamines A class of neurohormones that are involved in various central and peripheral processes; includes epinephrine, norepinephrine, and dopamine.

Dopamine A catecholamine that is an important neurotransmitter in the central nervous system involved in movement, mood, and learning.

Epinephrine A catecholamine that is a neurotransmitter and hormone that is produced from activation of the sympathoadrenal-medullary axis with its primary effects in the periphery including increased heart rate, dilation of blood vessels in the skeletal muscular system, opening of airways, and constriction of blood vessels in the skin.

Learning Involves establishing a conditioned response to a stimulus that did not illicit the behavior prior to a series

of interactions providing a conditioned reinforcement and/or punishment.

Norepinephrine A catecholamine that acts as a neurotransmitter and hormone in the periphery, and is produced from activation of the sympathoadrenal-medullary axis. In the central nervous system, norepinephrine acts as a neurotransmitter affecting many behaviors such as mood, learning, and arousal.

Stress Is experienced when an organism perceives harm, loss, or threat to their homeostasis or well-being. Activation of the sympathoadrenal-medullary axis and release of catecholamines along with activation of the hypothalamus-pituitary-adrenal axis and release of glucocorticoids are the primary physiological responses associated with stress and drive many of the other physiological, cognitive, and psychological changes that occur.

Introduction

There has been a substantial focus on the relationship between catecholamines and behavior. Researchers have examined a number of topics, including catecholaminergic pathways in the brain that promote stereotypical behavior, motor abilities, operant learning, psychopathology, and other higher-order behavior. As newer methods have become available, we have been able to understand behavior at a more basic level. Technology has allowed research to explore the functions of catecholamines, how they are synthesized, how they influence the function of particular areas in the brain to promote behavior, and how imbalances in particular regions produce pathology (e.g., Parkinson's disease, depression, schizophrenia). Comprehension of the relationship between catecholamines and behavior is best facilitated using a step-wise approach. We start with basic knowledge regarding catecholamines, and then discuss how they are measured centrally and peripherally. The role catecholamines play in stress, mood, learning and reward, and movement is also discussed.

What are Catecholamines?

The most prevalent catecholamines are dopamine (DA), norepinephrine (NE), and epinephrine (E). Dopamine acts as a neurotransmitter in the central nervous system (CNS) and is a precursor for NE and E. Epinephrine and NE are the primary catecholamines responsible for peripheral changes. Norepinephrine also acts as a neurotransmitter in the CNS. Before discussing the widespread effects of catecholamines on behav-

ior, the types of catecholamines and how they are synthesized and transmitted, as well as their central pathways, are described.

Dopamine

Dopamine is synthesized from a tyrosine molecule into L-dihydroxyphenylalanine (L-DOPA) by tyrosine hydroxylase, which is a rate-limiting enzyme that determines the overall rate of DA synthesis and the subsequent synthesis of NE and E. (Figure 1) Tyrosine hydroxylase activity is regulated by (1) the quantity of catecholamines present, such that high levels of catecholamines will inhibit the rate of tyrosine production, and (2) the rate of neural activity. L-DOPA is then converted into DA by the enzyme, L-aromatic amino acid decarboxylase. The location of synthesis occurs in the presynaptic terminals (i.e., the sender) of central dopaminergic neurons and begins with the activation of these neurons through action potentials. Dopamine is released into the presynaptic cleft following the influx of calcium ions into the presynaptic terminal and the synthesis of dopamine from tyrosine. Once released into the presynaptic cleft, DA activates dopaminergic receptors on the postsynaptic terminals (i.e., the receiver). Areas of high dopamine activity are (a) the arcuate nucleus projecting to the infundibulum of the hypophysis (pituitary gland), (b) the ventral tegmental area (VTA) projecting to the limbic system, and (c) the substantia nigra that projects to the striatum. These differing projections are implicated in various behaviors such as homeostasis, motivation, and movement (these behaviors are further discussed later in this article).

Projections from the arcuate nucleus through the tuberohypophyseal to the adenohypophysis (anterior pituitary gland) comprise the tuberoinfundibular DA pathway. This system serves the regulation of releasing and inhibiting factors

[†]Deceased.

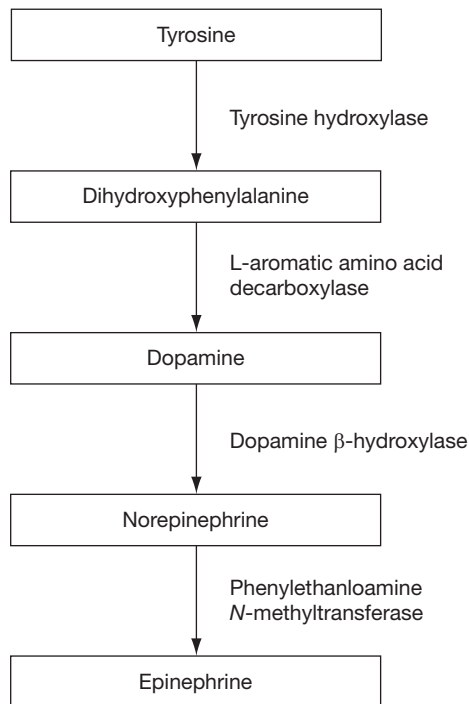


Figure 1 All catecholamines are derived from the precursor tyrosine. Its conversion by tyrosine hydroxylase is the rate-limiting factor in catecholamine synthesis and is highly regulated by catecholamine levels.

(hormones) that in turn synthesize their target hormones in the adenohypophysis and release them into the bloodstream. The hypothalamus exerts downstream effects from these hormonal pathways that include the regulation of food and water intake and thermoregulation. Damage or dysregulation of the tuberoinfundibular DA pathway therefore has serious consequences. For example, prolactin, one of the hormones regulated by this pathway, is responsible for lactation in nursing females. The production of prolactin is inhibited by DA, and a condition called hyperprolactinemia (too much prolactin) manifests when this inhibitory mechanism is disrupted. Symptoms of hyperprolactinemia for both sexes include inappropriate lactation, abnormal menstruation, and sexual side effects.

Dopaminergic projections originating from the VTA to cortical regions yield the ventral DA pathway. Additionally, there are two closely related subsidiaries of this pathway, the mesolimbic and mesocortical pathways. The mesolimbic pathway originates in the VTA and makes projections to the nucleus accumbens, septum, amygdala, and the hippocampus. The amygdala is involved in the emotional evaluation of a stimulus, whereas the medial prefrontal cortex modulates the mesolimbic pathway and facilitates both reward- and punishment-related motivation. Without adequate NE synthesis in the medial prefrontal cortex, dopaminergic transmission in the nucleus accumbens is abolished. This finding is supported by many studies that have demonstrated the suppressive effects of NE depletion on learned aversion behaviors and reversal learning. It is well established that the dopaminergic projections from the nucleus accumbens are responsible for reinforcement by activating reward and punishment neural regions. It has more recently been discovered that adrenergic projections from the medial

prefrontal cortex are a necessary forerunner in mediating this function. The mesocortical pathway connects the VTA to the frontal lobes, particularly the dorsolateral prefrontal cortices. These pathways are implicated in cognition, motivation, and reward circuitry. Particularly, psychiatric disorders, such as bipolar disorder and schizophrenia, have been associated with dysregulation of the ventral DA pathway.

The nigrostriatal or dorsal DA pathway originates from the substantia nigra to the striatum (both regions that comprise the basal ganglia). This pathway controls movement and dysfunction results in pathological conditions such as Parkinson's disease. Furthermore, medications, such as antipsychotics (e.g., haloperidol or thiorazine) can inhibit DA pathways and produce side effects such as tardive dyskinesia (Parkinson's-like symptoms).

Dopamine serves both inhibitory and excitatory functions in its pathways. For example, in the dopaminergic nigrostriatal pathway, there are both inhibitory and excitatory synapses with γ -aminobutyric acid (GABA) neurons: an inhibitory effect on the striatal GABA-ergic neurons of the lateral segment of the globus pallidus and an excitatory effect on the striatal GABA-ergic neurons of the medial segment of the globus pallidus and the pars reticulata of the substantia nigra. Essentially, these integrated networks provide a neural substrate for complex behaviors in organisms.

Norepinephrine

Norepinephrine acts as a neurotransmitter and as a hormone. The synthesis of NE occurs when DA is converted to NE by dopamine β -hydroxylase. This synthesis occurs in noradrenergic neurons in the central and sympathetic nervous systems (SNS), as well as in the cells in adrenal medulla. Peripherally, the main sources of NE are the sympathetic ganglia and the adrenal medulla.

There is a dorsal and a ventral NE pathway in the CNS. The dorsal NE pathway originates in the locus coeruleus (LC) and projects to the hippocampus and neocortex. The LC also has projections to the medulla oblongata that project to the SNS. The dorsal pathway is involved in the activation of the SNS following exposure to stressful stimuli. Conversely, the ventral NE pathway originates in the lateral tegmental field and projects to the diencephalon, particularly the hypothalamus. The major function of the central NE systems is to regulate arousal and modulate reward circuitry. In particular, these pathways constitute critical neural circuitry in reward and positive reinforcement. Many antidepressant drugs thus target noradrenergic projections to alleviate symptoms of depression. Additionally, nicotine stimulates significant increases in catecholamine activity in noradrenergic projections, contributing to its mood elevation properties.

Epinephrine

Epinephrine is synthesized from NE by the enzyme, phenylethanolamine *N*-methyltransferase (PNMT). Synthesis of E occurs primarily in the adrenal medulla and is released in conjunction with NE following activation of the SNS. Eighty percent of catecholamines released from the adrenal medulla following activation of the SNS are E; however, only 10% of

circulating catecholamines are E, indicating that additional sources of catecholamines lie outside the adrenal medulla. While the concentration of PNMT is highest in the adrenals, production of E still occurs in the rostral medulla oblongata. Consequently, E is the least ubiquitous catecholamine in the brain, and its neurochemical circuitry is isolated to the medulla oblongata. Nevertheless, it is important to consider that it does in fact exist in the CNS. Functionally, this region of the brainstem is particularly important in autonomic nervous system modulation, heart rate, and respiration. Glucocorticoids are often released in conjunction with catecholamines during stress responses. Glucocorticoids increase the expression of PNMT, thereby increasing the production of E.

Measurement of Catecholamines

Measurements of catecholamines can be used to determine the role they may play in behavior. Several techniques are used for measuring catecholamines, depending largely on whether central or peripheral measures are desired. Animal models are commonly used to directly measure catecholamines in the CNS. Brain dissection methods and tissue punching allow for rapid dissection of brain nuclei along major nerve terminal fields; however, these methods for measuring catecholamines and their neural pathways in the human brain are limited. Positron emission tomography (PET) is a current tool used to detect the radiofrequencies of neurotransmitters or the molecular weights of chemical substances in the human brain through the use of highly selective radiotracers. Otherwise, the detection of catecholamines in humans is muddled by the lack of available methods for distinguishing catecholaminergic function in the brain from that in the periphery.

Catecholamines, especially in humans, are more commonly measured in the periphery. Several common techniques are used for detection, including enzyme-linked immunosorbent assays (ELISA), radioimmunoassays (RIA), and high-performance liquid chromatography (HPLC). ELISA and RIA methods involve binding isolates of catecholamines to antibodies and use either color change (ELISA) or radioactive tracers (RIA) to detect levels. HPLC involves isolating catecholamines from proteins using electrospray ionization time-of-flight mass spectrometry and detection typically using an ultraviolet detector. Although HPLC is very sensitive and selective, it is also complicated and time-consuming. In comparison, ELISA is also sensitive and can be readily performed, especially by using commercially available kits.

Catecholamines and Stress

Catecholamines are an integral component of the stress response, in particular the release of NE and E from sympathoadrenal–medullary (SAM) axis activation. From an evolutionary perspective, the stress response is adapted out of the necessity for additional resources (energy) to be present in order to better prepare an individual to attend to a threatening stimulus or stressor. Following exposure to a stressful stimulus, the paraventricular nucleus (PVN) of the hypothalamus is activated. Activation of the PVN, in turn, activates two

neuroendocrine systems that release hormones into the periphery. The hypothalamic–pituitary–adrenal (HPA) axis is activated and releases corticosteroids from the adrenal cortex. Additionally, the PVN has projections to the LC, that then projects to the medulla oblongata, and ultimately to the SNS. Once the SNS is activated, NE is released from the sympathetic terminals that innervate certain vital organs, such as the heart and lungs. Additionally, activation of the SNS also causes the release of NE and E from the adrenal medulla. Circulating NE and E then have effects on the same vital organs, innervated by the SNS. The cells that comprise the organs in each system have β -adrenergic receptors or α -adrenergic receptors that bind selectively to NE or E, producing a myriad of effects, depending on the receptor subtypes. Although it is beyond the scope of this article to describe each of the subtypes, a general description of these SNS effects is provided subsequently.

When NE is released from the sympathetic ganglia and both NE and E are released from the adrenal medulla, these circulating levels of catecholamines can have profound effects on many important systems. For example, when the SNS is activated following stress, the release of these catecholamines results in increased heart rate and strength of cardiac contractions. Additionally, there is an increase in blood pressure by increased cardiac output and vasoconstriction of small arterioles. This occurs when NE binds to β -adrenergic receptors that are located on the cardiac muscle. This effect is further reinforced by E binding to these same receptors. The release of these catecholamines also leads to bronchodilation via β -adrenergic receptors to increase respiration. Glandular activity during SNS activation is greatly decreased with the exception of sweat glands. Increases in sweat gland activity follow activation of the SNS via α -adrenergic receptors. Additionally, during the stress response, NE and E influence smooth muscle of the gastrointestinal and urogenital tracts. The smooth muscles in these tracts will either contract due to activation of α -adrenergic receptors or relax due to activation of β -adrenergic receptors. Metabolic changes occur due to activation of the SNS, such that glucose and glycogen synthesis are favored in the liver, and lipid oxidation is favored as a primary function to provide energy to cells. The SNS activation also causes dilation of the pupils, increased saliva production, and inhibited digestion and sexual reflexes. Collectively, these physiological changes prepare an organism to fight the threatening stressor or flee from impending danger. These adjustments are adaptive and motivate individuals to function (physically and psychologically) effectively as they interact in a changing environment.

Catecholamines and Mood

Depression

Norepinephrine has a significant impact on neural activity, mainly through the extensive connections of the LC to various brain regions involved in mood, arousal, and endocrine functions. Epinephrine is involved in the peripheral response to SNS activation that triggers the ‘fight or flight’ response. Dopamine is involved in the reward pathway and movement. Studies have identified changes in the function of these neurotransmitters in patients with depression and anxiety disorders.

Additionally, serotonin has been shown to be involved in the pathophysiology of depression. There is evidence that in depressed patients, altered autoreceptor functions impair NE release, and that the response of second messenger systems to NE binding is blunted. In addition, some patients demonstrate blunted responses to exogenous activation of the SNS. These changes are seen in peripheral tissues, but some have also been identified in the frontal cortex of patients who committed suicide. Unfortunately, evidence of these changes is inconsistent in the literature, and there appears to be a distinction between patients with depression alone versus those with depression and anxiety or panic disorder. Preclinical studies have attempted to replicate these findings in animal models of depression that involve chronic mild and/or unpredictable stress. Animals subjected to chronic stress demonstrate changes in adrenergic receptor levels and functionality similar to those seen in depressed patients, lending further credence to the role of NE in depression.

Genomic studies have identified variants in some of the genes involved in catecholamine synthesis and metabolism that are associated with depression. Polymorphisms exist for the genes encoding tyrosine, hydroxylase, and dopamine beta-hydroxylase, and catechol-O-methyltransferase (COMT) as well as the genes encoding D₂ and D₄ dopamine receptors. From this, it is clear that genetic vulnerabilities exist for depression and that future treatments could target specific deficiencies – a model currently in use for chemotherapy drugs.

Several classes of drugs are used to treat depression: monoamine oxidase inhibitors, tricyclic antidepressants (TCA), selective serotonin reuptake inhibitors (SSRI), receptor antagonists, serotonin-norepinephrine reuptake inhibitors (SNRI), and norepinephrine-dopamine reuptake inhibitors (NDRI). Monoamine oxidase inhibitors, such as phenelzine, inhibit the action of monoamine oxidase, which is an enzyme that breaks down monoamines (NE, E, and DA) following release into the synaptic cleft. Tricyclic antidepressants like amitriptyline work by blocking several neurotransmitter receptors, such as adrenergic, noradrenergic, and serotonergic, to name a few. The SSRIs, such as sertraline, work by blocking serotonin reuptake following release from the presynaptic terminal of the neurons. The SNRIs (i.e., duloxetine) and NDRIs (i.e., bupropion) work in similar fashion to those of the SSRIs by blocking serotonin and NE, and NE and DA, respectively.

Studies comparing antidepressants that target monoamine functions have demonstrated similar efficacies for drugs that target NE and/or DA versus those that are serotonin-specific. Although older versions of these drugs were hindered by side effects (mainly due to peripheral adrenergic activity and toxicity due to monoamine oxidase deficiency), current treatments are much safer and demonstrate fewer side effects. The only concern when using antidepressants that target catecholamine activity is that some patients may experience increased anxiety as a result of enhanced NE binding.

Additional treatments are used for depression, including electroconvulsive therapy (ECT) and deep brain stimulation (DBS). Both of these therapies are invasive to the patients, so they are used as a last resort when pharmacological and talk therapies have not worked. Electroconvulsive therapy involves inducing a seizure in a patient through the use of electricity and requires several sessions in order to fully alleviate

depressive symptoms. The course of ECT begins with marked improvements in appetite and drive that is believed to be caused by an increase in DA receptor function. Following additional sessions of ECT, patients experience an increase in energy and attention, which is believed to be the result of an increase in synaptic NE. The final sessions of ECT see improvements in cognition and resolution of anxiety that is associated with depression. This is believed to occur through increased serotonin function. Deep brain stimulation involves the implantation of an electrode into the brain and stimulates that area with low-frequency electrical stimulation. This procedure is a new treatment for depression, so the areas that are stimulated are still being mapped. However, there has been some success in relieving depressive symptoms by stimulating Brodmann's Area 25. It is believed that this therapy works by inhibiting this area of the brain, which causes increased activation in other areas of the brain that have been implicated in the cause of depressive symptoms.

Through manipulation of the various neurotransmitter systems in the brain, alleviation of depressive symptoms is achieved. However, it is believed that certain neurotransmitters are responsible for the alleviation of certain symptoms. For example, manipulation of the NE system may be related to improvements in alertness, energy, and interest in life. Therapies targeted to the DA system show improvements in attention, motivation, pleasure, and reward. Additionally, negative affect is improved by changes in the NE and serotonin systems, whereas loss of positive affect is improved by manipulations of the NE and DA.

Current research is examining the role of HPA axis dysregulation in depression, and novel targets for pharmacotherapy have been identified in preliminary studies. Dysregulation of the HPA axis leads to excess catecholamine release and could cause the pathological changes in catecholamine functions seen in depressed individuals. Altered catecholamine activity and HPA axis dysregulation have both been found in studies of suicide victims. However, catecholamine markers have been found to differ between suicide victims and patients with depression who are not suicidal. This suggests that altered HPA axis and catecholamine functionality is a risk factor for suicide in patients with depression but not an indicator of depression alone. Continued research into the relationship between catecholamines and mood disorders may shed light on the underlying mechanisms that trigger the development of these conditions.

Schizophrenia

Schizophrenia is a psychotic disorder that involves positive symptoms, such as hallucinations, delusions, and disorganized thoughts, and negative symptoms, including lack of speech, cognitive deficits, and depressive symptoms. Dopamine has been identified as one of the neurotransmitter systems that contribute to this debilitating disorder. The different dopaminergic pathways contribute in different ways to both positive and negative symptoms. For example, increased dopaminergic activity in the mesolimbic pathway is thought to underlie the hallucinations, delusions, and disordered thoughts that are the positive symptoms. Additionally, decreased dopaminergic activity in the mesocortical pathway and function in the

prefrontal cortex have been associated with negative symptoms. Memory deficits that are common in schizophrenic patients may also be associated with decreases in D₁ receptor transmission in the dorsolateral prefrontal cortex. With available technology and strides in the creation of animal models, additional neurotransmitter systems, such as NE, serotonin, GABA, and glutamate, have been implicated in maintenance of schizophrenic symptoms.

It has been well established that an increase in DA in critical sites in the brain play a major role in psychosis. However, there is a growing interest in examining the role of NE dysfunction. Recently, it has been found that individuals with schizophrenia whose psychotic symptoms returned while on medication produced more dopamine- β -hydroxylase (the enzyme that synthesizes NE from DA) than those that did not relapse. Also, increases in NE were strongly correlated with increases in both negative and positive symptoms in schizophrenic patients. Research demonstrates that when NE is not synthesized proportionately with DA, the emotional valence is increased. The disproportion between DA and NE is thought to explain the extreme fear experienced in schizophrenic individuals.

Treatments for schizophrenia fall into two categories of drugs: typical and atypical antipsychotics. Typical antipsychotics, such as Chlorpromazine, are used to treat positive symptoms, and can exacerbate negative symptoms. Typical antipsychotics are similar to DA and bind to D₂ receptors in the mesocortical and nigrostriatal dopaminergic pathways in the CNS. Atypical antipsychotics are more effective in eliminating negative symptoms; however, they do not have as high affinity for D₂ receptors as typical antipsychotics. There has been some debate regarding how to effectively treat negative symptoms of schizophrenia. Recently, there have been some questions on the advantages of treating these symptoms with atypical antipsychotic drugs versus neuroleptics. These classes of drugs are not solely specific to manipulation of dopaminergic pathways, but also improve imbalances in the other neurotransmitters, such as serotonin, glutamate, and GABA, that are associated with schizophrenic symptoms.

The DA hypothesis of schizophrenia is further supported by the fact that normal individuals will experience some psychotic symptoms that mimic those involved in schizophrenia when they take DA agonists such as cocaine and amphetamines. Also, when the DA agonist, L-DOPA, is administered in Parkinsonian patients at too high a level, it can potentially induce schizophrenic-like symptoms, including hallucinations, paranoia, and the stereotypic behaviors. In another study, the ability to modulate auditory filtering, a hallmark of schizophrenia was lost when amphetamines were administered in an animal study. Further, there have been studies that demonstrate the use of monoamine- β inhibitors (mirtazapine) to inhibit DA that could potentially help in treating the negative symptoms of this disease. Together, this evidence supports the role of catecholaminergic function in the pathogenesis of schizophrenia.

Learning and Reward

Learning is associated with acquiring new skills and behaviors through a series of stimulus–response associations. Recall of these associations is important for the expression of future

behaviors and adaptations that are important for survival, such as locating high-quality food sources and avoiding areas where predators reside. The process of differentiating rewarding stimuli from those that have negative consequences aids in the ability to make predictions about the surrounding environment and serves as a foundation for goal-directed behavior. Catecholamines are intrinsically involved in learning as well as reward and motivation, as demonstrated by studies employing genetic knockouts, drugs that modify catecholamine synthesis, metabolism, and functionality, and behavioral paradigms designed to evaluate reward and aversion. Alterations in noradrenergic and dopaminergic pathways produce changes on behavior. For example, damage to the nigrostriatal areas reduces eating and drinking behaviors, while damage to the mesolimbic dopaminergic pathway causes deficits in movement that would facilitate these goal-directed behaviors. The central DA pathways facilitate learning and reward goal-directed behavior, such as seeking out food, water, or drugs, as demonstrated by numerous studies that have observed increases in consumptive behaviors with the administration of DA agonists. Additionally, DA antagonists reduce or block the rewarding nature of food, water, cocaine, and amphetamines.

Both noradrenergic and dopaminergic neurons fire when paired with a novel or unpredictable stimulus, and their activation is inhibited by a predictable stimulus. Levels of these catecholamines are also dose-dependent for learned behavior, in that both high and low doses of NE impair learning. Therefore, there is an optimal range to facilitate learning. The major difference between NE and DA in learning appears to be that NE is needed to start learning or changing of behavior. Its continued release is not needed to sustain the expression of a behavior, but DA is necessary to maintain the continued expression of such behaviors. In contrast, behavioral suppression occurs when the DA or NE functioning is impaired.

Other neurotransmitters appear to exert effects on the catecholamine pathways in learning, such as glutamate, GABA, and even serotonin. Glutamate is highly important in learning, as long-term potentiation is necessary for memory formation in the hippocampus. Many of the dopaminergic projections involved in learning interface with glutamatergic projections to the hippocampus, and both NE and DA terminals implicated in learning are regulated by glutamate receptor activity. Serotonin can also moderate catecholamine-dependent behavioral learning by changing the dose-dependence of catecholamines to initiate a learned behavior. Finally, drugs such as cocaine and amphetamine activate these same pathways for reward and learning. For example, amphetamine has a similar chemical structure to that of NE and produces similar effects in the reward and learning pathways.

Projections from the basal ganglia to the hypothalamus play a role in conditioning responses by reinforcing behaviors through stimulation of reward centers in the brain. The endogenous reward system yields a highly positive experience as evidenced by numerous studies that demonstrate that animals will voluntarily stimulate areas of their brain involved in reward by pressing a lever that applies an electric current to electrodes implanted on neurons in reward centers in the brain. The use of self-stimulation paradigms revealed that electrical stimulation associated with activation of central dopaminergic pathways is rewarding, despite the fact that no intrinsic

drive (such as hunger or thirst) is present. Additionally, administration of DA agonists increases self-stimulation and DA antagonists decrease it. Under normal circumstances, an activity associated with the reduction of a biological drive state would activate these same pathways, reinforcing the action as well as environmental cues associated with the reward.

Drugs of addiction directly or indirectly act upon the central dopaminergic pathways to produce a pleasurable sensation that is inherently rewarding. The response is so strong that the administration of drugs such as cocaine enhances self-stimulation and reduces the stimulus intensity required to reinforce this behavior. Unfortunately, repeated activation of the reward pathway by cocaine or amphetamines alters the postsynaptic response to dopamine release, and eventually, tolerance develops to the initial dose of drug, and the original euphoria can only be achieved through increased consumption. Eventually, the brain adapts to the continual presence of the drug, and addiction develops as an individual finds it necessary to continue using in order to achieve normalcy instead of euphoria.

Movement

The basal ganglia is an area of the brain responsible for the organization, execution, and timing of voluntary movements, such as writing on a chalkboard. The basal ganglia consist of several different nuclei, including the caudate nucleus, putamen, globus pallidus, substantia nigra, and the subthalamic nucleus. The circuitry of these different nuclei is responsible for the execution of voluntary movement. (Figure 2) The substantia nigra has projections to the putamen via two different dopaminergic pathways. The direct pathway that uses the D₁ dopamine receptors facilitates movement, whereas the indirect pathway that uses the D₂ dopamine receptors, inhibits movement. The direct pathway begins when the putamen receives excitatory dopaminergic projections from the substantia nigra. The putamen then sends inhibitory GABA projections to the

internal globus pallidus that sends inhibitory GABA-ergic projections to the thalamus. In the indirect pathway, the substantia nigra sends inhibitory dopaminergic projections to the putamen. The putamen sends inhibitory GABA-ergic projections to the external globus pallidus. The external globus pallidus sends inhibitory projections to either the internal globus pallidus or the subthalamic nucleus. The subthalamic nucleus sends excitatory glutamatergic projections back to the internal globus pallidus. The internal globus pallidus sends inhibitory projections to the thalamus. When projections from the internal globus pallidus reach the thalamus, the result is inhibition of thalamic neurons. Both of these pathways from the subthalamic nucleus are vital in the coordination of voluntary movement.

Parkinson's disease is a debilitating disorder that is marked by characteristic tremors at rest, difficulty initiating movement, and rigidity in movement. Additionally, there can be some emotional and cognitive deficits associated with the disease. Parkinson's disease is characterized by a depletion of dopaminergic neurons in the substantia nigra that projects to the putamen. Depletion of these neurons causes deficits in both the direct and indirect pathways. Activation of the dopaminergic neurons that contain D₁ receptors that project to the putamen from the substantia nigra causes a reduction in neuronal activity to the internal globus pallidus. This ultimately leads to increased neuronal activity in the projections from the internal globus pallidus to the thalamus. When this occurs, there is less inhibition of thalamic neurons. In the indirect pathway, the inhibition of dopaminergic neurons from the substantia nigra is greatly reduced, leading to increased neuronal activity to the external globus pallidus. The increase in neuronal activity of the external globus pallidus leads to decreased neuronal activity to the internal globus pallidus and the subthalamic nucleus. The reduction in neuronal activity ultimately leads to increased neuronal activity to the thalamus. The increases in thalamic activity following destruction of the dopaminergic neurons in the substantia nigra would lead to the characteristic rigidity that is the hallmark of Parkinson's disease.

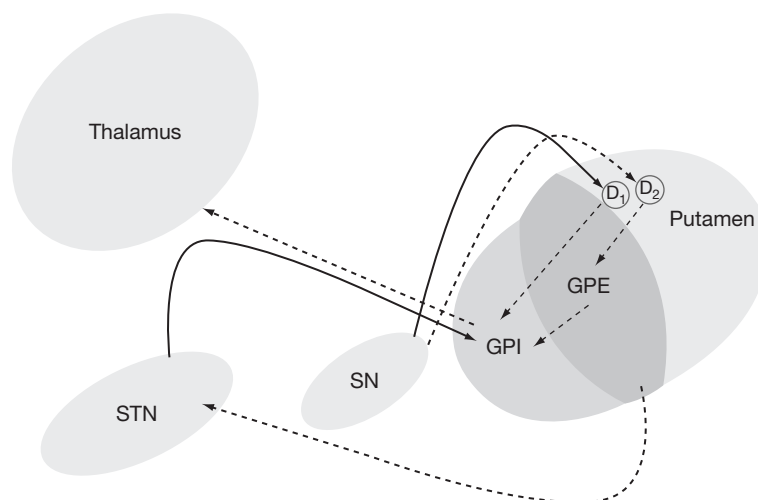


Figure 2 Neural circuitry of movement. This is simplified to include the dopaminergic pathways discussed in the text. Solid lines reflect excitatory activity and dashed lines reflect inhibition. SN, substantia nigra; STN, subthalamic nuclei; GPE, external globus pallidus; GPI, internal globus pallidus; and D1/D2 refer to specific dopamine receptor types.

In order to treat Parkinsonian symptoms, several treatments have been targeted to improve depleted DA levels in the basal ganglia. L-DOPA, which is the precursor to dopamine, is commonly used in Parkinsonian patients to regain motor control. L-DOPA influences the ability of damaged dopaminergic neurons to metabolize DA along the nigrostriatal path, a pathway largely involved in motor function. Recently, another DA agonist, pramipexole has been experimentally challenged as an adjunct to L-DOPA in order to improve motor deficits along with the depressive behaviors (e.g., dysphoria, social withdraw, cognitive deficits) that accompany the dopaminergic dysfunction associated with Parkinson's disease. Although L-DOPA is a common method of treatment for Parkinsonian symptoms, administration of this drug at too high a level can potentially induce schizophrenic-like symptoms, including hallucinations, paranoia, and the stereotypic behaviors. Deep brain stimulation of the basal ganglia has shown remarkable and immediate improvements in symptoms associated with Parkinson's disease.

Summary

The catecholamines, DA, NE, and E, are essential not only for survival during times of crisis but are also involved in learning, motivation, and reward processes that contribute to an organism's adaptive prowess. The actions of NE and E as part of the body's stress response system trigger an immediate response to threatening stimuli through increased arousal, priming of the cardiovascular system, and changes in blood flow that favor skeletal muscles over the organs of digestion. Mood is greatly affected by NE and DA, and disruptions to these systems can lead to depression, anxiety disorders, or schizophrenia. Dopamine's role in motivation and reward enables an organism to identify pleasurable events and also learn to avoid aversive conditions, a distinction that is vital for long-term survival. In addition, the delicate balance of DA and NE in

the CNS is responsible for voluntary movement, and any disruption to these neurotransmitters can lead to disorders of movement as seen in Parkinson's disease. Continued research into the factors that influence both central and peripheral catecholamines and disease states is essential for the creation of novel therapies that could prevent dysfunction and deleterious consequences.

See also: [Associative Learning](#); [Bipolar Disorder](#); [Classical Conditioning](#); [Depression](#); [Hormones and Behavior](#); [Operant Conditioning](#); [Schizophrenia](#).

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Central Auditory Processing Disorders

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Glossary

Amusia A selective impairment of the ability to appreciate music related to damage to the central nervous system.

Attention deficit hyperactivity disorder

A neurodevelopmental disorder characterized by inattentiveness, hyperactivity, and impulsivity.

Auditory agnosia A collection of disorders associated with loss of the ability to recognize sounds that is not attributable to sensory difficulties.

Auditory evoked potentials A series of minute electrical potentials that reflect the neurophysiologic activity generated in the auditory system in the course of processing an auditory stimulus.

Auditory processing disorder (APD) Disorders of auditory processing in children resulting from functional compromise of the central auditory processes underlying the analysis of auditory information.

Central deafness A broad term referring to conditions in which the detection of sound is impaired due to dysfunction of the central auditory nervous system.

Cortical deafness A relatively rare condition usually associated with bilateral temporal lobe damage resulting in functional deafness.

Developmental dyslexia or reading disorder (RD)

A neurodevelopmental disorder characterized by specific deficiencies in decoding written language.

Dichotic listening A task that evaluates a listener's ability to process competing signals by delivering different information simultaneously to each ear.

Hyperacusia Heightened sensitivity to auditory stimulation associated with an aversion to or intolerance for certain sounds at their typical sound levels.

Planum temporale An area on the dorsal surface of the superior temporal gyrus posterior to Heschl's gyrus thought to play a role in processing the rapid spectrotemporal cues in sound, including speech.

Pure word deafness A subtype of auditory agnosia characterized by severe difficulties in understanding spoken language with intact speech production, nonauditory language, and relative preservation of nonverbal sound recognition and identification.

Specific language impairment (SLI) A neurodevelopmental disorder characterized by problems in understanding or producing language in the absence of causal factors such as hearing impairment, mental retardation, neurological deficits, primary emotional disorder, or social deprivation.

Tinnitus The perception of sound in the absence of an external acoustic stimulus.

Introduction

The complexity of the central auditory nervous system (CANS) is unrivaled by other human sensory systems. Comprised of multiple parallel pathways consisting of many intricately interconnected nuclei, the system is capable of processing information with remarkable speed and efficiency. While information processing in other sensory modalities usually occurs on a timescale of milliseconds, the CANS is capable of coding time-based acoustic cues on the order of microseconds. Detailed knowledge of the function of the CANS has been slow to emerge and correspondingly there is also limited understanding of the central auditory processing disorders (CAPDs) that arise when its operation is impaired by disease, damage, or maldevelopment. Nevertheless, significant progress has been made in recent years both in recognizing these disorders and in developing a workable framework for their diagnosis and treatment.

The term CAPD encompasses a broad range of deficits that occur when neural processes underlying the analysis of auditory information by the brain are functionally compromised. Currently, it is defined by deficiencies in one or more of the following auditory behaviors: sound localization and lateralization, auditory discrimination, auditory pattern recognition, auditory temporal processing (e.g., resolution, integration,

masking, ordering), and performance with competing or degraded acoustic signals. Given the paramount role of hearing in everyday human communication, CAPD often comes to attention as difficulties in processing speech.

We begin this overview of CAPD with a brief synopsis of the organization and function of the CANS. This is followed by a summary of acquired syndromes that arise with lesions to the CANS. We then discuss idiopathic and developmental forms of CAPD and conclude with a discussion of treatment approaches.

Neural Architecture of Central Auditory Processing

The three primary functions of the auditory system are to detect sounds, localize their source, and determine their identity and meaningfulness. For the brain to interpret what we hear, sound vibrations must first be transduced into patterns of neuronal excitation. This is accomplished by ~3500 inner hair cells (IHCs) (see [Figure 1\(a\)](#)) that are organized in a single row on the ribbon-like basilar membrane that runs down the cochlea of the inner ear. Analogous to the arrangement of the strings on a piano, there is an orderly relationship between the frequency of a sound and the location of IHCs on the basilar

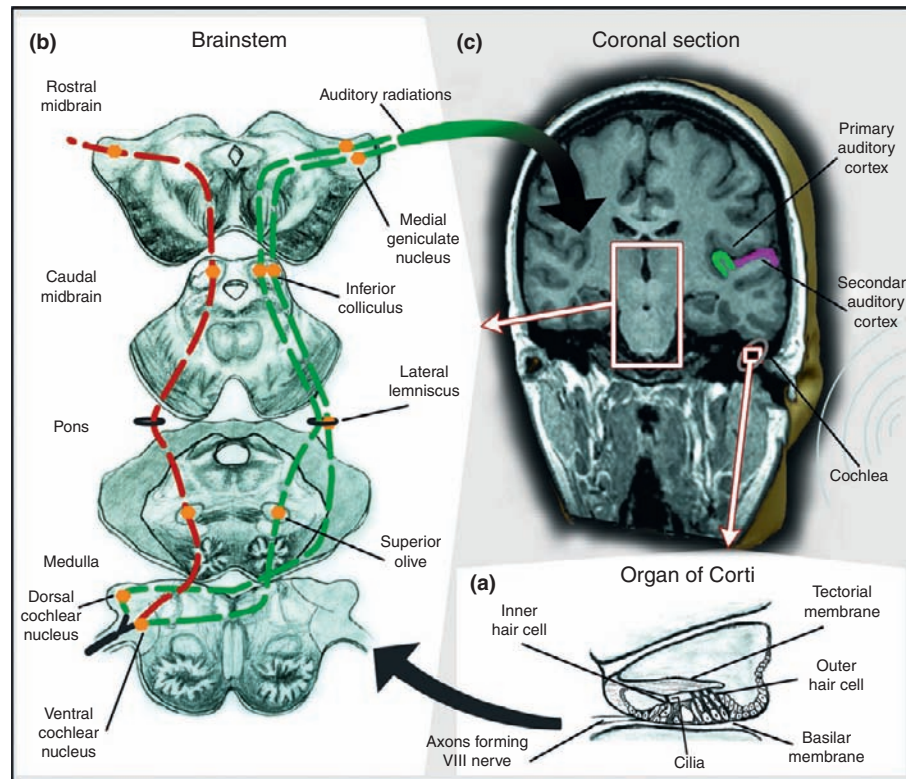


Figure 1 (a) Schematic drawing of a cross-section of the cochlea showing inner and outer hair cell on the basilar membrane. The fine filaments protruding upward from inner hair cells toward the tectorial membrane represent clusters of cilia of varying length. Movement of a bundle back and forth causes cycles of depolarization and hyperpolarization of the hair cell. These occur at a preferred time during the stimulus wave cycle resulting in pulsatile release of neurotransmitter and phase locking of the postsynaptic potentials of spiral ganglion cells. (b) Schematic diagram of the major nuclei of the ascending pathways. Colored lines represent the chief ipsilateral and contralateral pathways from the left cochlea to the auditory cortex. The same pathways from the right cochlea are not depicted here to allow a clear view of the anatomy of the brain stem. Similarly, no attempt is made to illustrate subdivisions of nuclei and connections within regions that transmit information both ipsilateral and contralateral to the ear of stimulation. (c) Coronal view of the brain illustrating the location Heschl's gyrus and secondary auditory cortex on the dorsal surface of the superior posterior temporal lobe. Courtesy of Patricia Hearons.

membrane that a sound maximally stimulates. This tonotopic organization enables the cochlea to act as a frequency analyzer, essentially decomposing spectrally complex sounds into constituent frequencies.

Stimulated IHCs release neurotransmitters that are detected by receptors on axons of nearby inner ear spiral ganglion cells, causing action potentials to be propagated along these axons toward the brainstem. Approximately 30 000 of these fibers comprise the bulk (95%) of the eighth cranial nerve, also known as the vestibulocochlear nerve (VN). Given that each spiral ganglion nerve cell axon carries action potentials originating from stimulation of a single IHC, the VN is also tonotopically organized. Indeed, tonotopy is preserved up to and including auditory cortex.

The frequency of a stimulus is coded not only by the location of the stimulated IHC on the basilar membrane, but also in the timing of the intervals between spikes. The firing rate of IHCs encode the intensity of sound which, up to a certain sound level (~ 50 dB), translates to an increase in the discharge rate and the number of spiral ganglion cells firing. Thus, critical information on the frequency, intensity, and timing of a stimulus is coded in activity of these afferents to the brainstem.

Ascending Auditory Pathways

VN fibers enter the brainstem at the posterior pontomedullary junction, bifurcate, and synapse with neurons of the cochlear nucleus (CN), the gateway to the CANS (see [Figure 1\(b\)](#)). Neurons of the CN begin the process of extracting and coding features of acoustic input, setting the stage for more refined processing of acoustic features at progressively higher levels of the CANS.

From the CN, coded impulses ascend the CANS in multiple, parallel, and hierarchically organized processing pathways that carry information regarding different aspects of sound to the auditory cortex. [Figure 1\(b\)](#) provides a highly simplified schematic representation of the flow of information. In reality, the system is exceedingly complex, involving at least nine nuclei in the ascending system. Each major division is characterized by a distinctive composition of cell types functionally specialized for performing particular computations on sensory input.

As shown in [Figure 1\(b\)](#), ascending fibers leave the CN and decussate, sending information to both the ipsilateral and contralateral superior olivary complex (SOC). Since each SOC receives input from both ears, critical binaural analyses

occur here relating to sound localization. Neurons in the lateral superior olive (LSO) process interaural sound level differences (ILDs), a cue used in the spatial localization of high-frequency sounds. By contrast, cells in the medial superior olive (MSO) assist in sound localization by detecting microsecond level disparities in the arrival time of sound at the two ears (intra-aural timing differences, ITDs). Overall, approximately five nuclei of the ascending CANS are involved in some aspect of sound-source localization.

Nearly all of the ascending auditory fibers converge in the central nucleus of the inferior colliculus (ICC) in the midbrain. The IC plays a critical role in integrating spectral and temporal information in order to localize sound sources and code dynamically varying stimulus attributes, such as changes in frequency and amplitude.

Two nuclei, the external nucleus of the IC (ICX) and the dorsal cortex of the IC (DCIC), comprise components of the so-called nonclassical or extralemniscal auditory system. This system receives its primary input from the ICC and follows a parallel course to the classical auditory pathway up to the thalamus, synapsing with the dorsal and medial parts of the medial geniculate body (MGB). The pathway then diverges from the classical pathway, which projects to primary auditory cortex (PAC). Instead, the extralemniscal system projects to secondary and association cortices and to regions not directly contacted by the classical auditory pathway, such as the basolateral nucleus of the amygdala and the cerebellum. Neurons of the nonclassical system differ from neurons of the classical auditory pathways in that they are not as sharply tuned to stimulus features and they respond to input from the auditory, visual, and somatosensory systems.

In the classical auditory system, the main target for projections of ICC neurons is the ventral nucleus of the MGB (MGv). From the MGv, projections go on to the PAC via the auditory radiations. These connections allow for extensive convergence and divergence of information. A single cortical locus can receive inputs from large regions of the thalamus and conversely individual axons can establish synaptic contacts spanning up to 7 mm of cortical surface.

Cells in MGv demonstrate greater selectivity of responses to stimulus features than neurons lower in the system. Many appear unresponsive to simple acoustic stimuli but show vigorous responses to specific parameters of complex time-varying stimuli (e.g., direction or rate of frequency change). The responses of neurons in MGv, to some degree, are tuned by cortical influences (directly or through the thalamic reticular nucleus) aimed at optimizing the processing of dynamic aspects of auditory input used to identify, localize, and ascribe meaning to sounds.

Auditory Cortex

Many computational transformations related to the processing of an auditory stimulus are completed before activation reaches the PAC, located on Heschl's gyrus in the superior temporal lobes (see [Figure 1\(c\)](#)). Nevertheless, further processing and integration occurs at the cortical level, evidenced by sensitivity of various cortical fields to a range of basic stimulus attributes such as frequency (tonotopic organization), bandwidth, intensity level, spatial location, and movement or

motion. Some response properties of PAC neurons are inherited from thalamic inputs while others undergo significant transformation or are generated intracortically. While most neurons in PAC are binaurally influenced, 10–20% show no evidence of binaural interaction.

Surrounding the PAC are so-called belt and parabelt regions, which are responsible for secondary and tertiary levels of cortical processing, respectively. While PAC responds to all types of auditory stimuli, secondary and association auditory cortex in anterolateral and ventral auditory areas show particular sensitivity to spectrally and temporally complex sounds, including speech. These areas form part of a hierarchically organized processing stream involved in auditory object and speech perception. This auditory analog of the so-called 'what' pathway in vision includes connections from anterior belt areas directly to ventrolateral prefrontal cortex (PFC). By contrast, a posterodorsal stream, analogous to the 'where' pathway in visual system, is involved in the perception of auditory space and motion as well as aspects of processing speech and language. This pathway extends from PAC to the posterior superior temporal gyrus, inferior parietal cortex, and eventually projects to dorsolateral PFC.

Experience plays an important role in determining the functional circuitry of the auditory cortex. Processing in the auditory cortex is dynamic, with reorganization occurring to optimize the apprehension of relevant stimuli. This plasticity is reflected in cortical tonotopic maps that can adaptively change in response to reinforcement, or fill in areas that may be otherwise deprived of input from cochlear lesions.

Ontogenetically, synaptogenesis of PAC peaks at 50 months of age and myelination of thalamocortical projections continues until ~6 years of age. Hence, auditory cortex function continues to evolve throughout early to middle childhood, maturing late relative to other sensory cortex. Many cortically mediated aspects of central auditory function are dependent on processing by secondary and association cortex and their intra- and interhemispheric connections. Consequently, some functions of the CANS do not fully mature until adolescence.

The auditory cortices of humans possess some hemispheric specialization of function. Auditory processes distributed in the left cerebral hemisphere appear to be particularly adept at processing rapid dynamic changes (up to a few tens of milliseconds) in the spectrotemporal form of sound, whether or not stimuli are speech. The right hemisphere appears to preferentially process stimulus features that vary more slowly or require integration over longer periods of time (e.g., melody, prosodic contours in speech, emotions in voice).

Efferent Auditory Pathways

The CANS contains an extensive network of structures and pathways that allow higher order auditory processing centers to exert 'top-down' influences over the activity of lower nuclei. The auditory corticofugal system (ACS) takes the form of descending cortical projections that reach every major element in the auditory system, extending as far as the cochlear hair cells. This system forms important feedback loops designed ultimately to adjust and improve input to the cortex for signal processing. The ACS temporarily or permanently influences the filtering, tuning, and response plasticity of the CANS.

CAPD: Diagnostic Considerations

Individuals diagnosed with CAPD present with a variety of symptoms that can range in severity from a lack of responsiveness to sound (cortical deafness) to a constellation of more subtle problems reflecting impaired listening skills or difficulties discriminating slight differences in sounds. The latter problems include difficulties attending to and remembering orally presented information, following multistep directions, and perceiving speech when it is presented in a noisy environment (e.g., classroom, cocktail party), at a rapid rate, or when signals are degraded (e.g., indistinctly articulated, transmitted via intercoms, public address systems, cell phones).

In considering the diagnosis, it is necessary to establish that a peripheral hearing loss cannot account for a presenting problem. Quantification of peripheral hearing sensitivity typically entails standard audiometric testing, such as pure tone and speech audiometry. This may be combined with immittance audiometry, otoacoustic emissions and possibly brainstem auditory evoked potentials. It is also necessary to evaluate potential 'top-down' contributions to auditory processing problems such as difficulties with attention, memory, linguistic processing, or other specific cognitive domains. The diagnosis of CAPD therefore often requires multidisciplinary input.

Three complementary approaches are used to identify the presence of deficits consistent with CAPD. The most common initial approach is behavioral assessment, which examines a listener's performance on structured auditory tests that evaluate several dimensions of processing commonly impaired individuals with CAPD. Behavioral assessments can be supplemented, when necessary, with electrophysiological testing measures and/or neuroimaging techniques. The essentials of these approaches are discussed in the following sections.

Behavioral Assessment

Behavioral assessments utilize psychoacoustic measures and norm-referenced, performance-based tests to identify deficiencies in auditory skills linked to CAPD. There is no standard approach to the assessment of CAPD, although some guidelines have been established. The tests can be conceptualized as falling into five broad categories of auditory behavior. A number of the measures commonly used in assessing CAPD are listed in [Table 1](#) along with the auditory skill to which they broadly relate. It is not possible to precisely match the behaviors associated with CAPD with specific measures in a one to one correspondence, in part due to the multifactorial nature of task demands.

The choice of diagnostic measures is driven by a careful review of the patient's history and presenting problems, but also by the characteristics of the tests themselves, such as the quality of the normative data and the discriminant validity. Details of the specific nature of the presenting problem(s), onset, progression, consistency, and the circumstances of manifestation help to define the scope of an evaluation. In addition, it is necessary to consider variables such as age, gender, medical and psychological history, and the presence of coexisting conditions or concerns.

Implicit in the overall approach is the notion that different patterns of auditory processing impairment can emerge depending on the location, extent, and nature of compromise of the

CANS. Pathophysiology of the brainstem frequently results in problems of binaural convergence and integration. As a consequence, conditions such as multiple sclerosis or brainstem stroke are associated with highly abnormal performance on tests examining sensitivity to ILD or ITD, due to both the need for integration and the microsecond level timing requirements for accurate ITD perception. Interestingly, sound localization can also be impaired in conditions such as albinism where the development of decussated pathways to the SOC is atypical.

By contrast, patients with unilateral lesions often but not invariably retain some ability to process either ILD or ITD measures, although their performance may differ from normal controls. Left hemisphere lesions can result in particular difficulty with ITD judgments. However, unilateral patients are more likely to have difficulty localizing sounds in the vertical plane or when spatial localization cues must be integrated with mental representations of space (as in free-field localization). They may have particular difficulty in localizing sound sources in the side of space contralateral to their lesions. This is most strikingly evident following right parietal lobe damage which acutely can result in auditory neglect. Individuals with neglect may be unresponsive to voices and environmental noises emanating from the left side of space or they may demonstrate alloacusis, systematically localizing these sounds to the right side of space.

Auditory discrimination is a fundamental skill necessary for a listener to consistently assign meaningful properties to an acoustic object. Auditory discrimination is typically tested by prompting the listener to decide whether two stimuli are the same or different, or by matching an auditory stimulus to one of several pictures of acoustically confusable objects. Stimuli may be contrasted in a number of domains including pitch, duration, intensity, and phonetic cues.

Dysfunction of the CANS often results in difficulty discriminating brief auditory temporal events in sound. These difficulties commonly become evident in poor speech perception, because phonemic discrimination and identification requires resolution of brief or rapidly changing acoustic cues in the speech signal such as consonantal bursts, formant frequency transitions, and voice onset time. These cues occur on the order of milliseconds to tens of milliseconds.

Discriminating the duration of particular cues is essential for recognition of voicing contrasts in stop consonants (e.g., /p/ vs. /b/, /t/ vs. /d/, /k/ vs. /g/), the timing of silent bursts in fricatives and vowel length. Resolution of rapid changes in frequency is essential for distinguishing acoustic cues related to the place of articulation in stop consonants and manner of articulation in stops and glides. Problems discriminating these temporal cues lead to errors in discrimination even though speech audiometry thresholds are normal.

Basic temporal resolution is commonly measured using psychoacoustic tasks such as click fusion, click differentiation, or gap detection. In click fusion, very brief (< 1 ms) spectrally broadband stimuli (clicks) are presented in rapid succession separated by a short intervening period of silence. When the silent interstimulus interval is extremely brief, the temporal boundary between each click is insufficient to result in separate percepts, so listeners fuse two clicks and report hearing only a single click. Extending the duration of the interstimulus interval beyond a threshold value results in the perception of two

Table 1 Summary of auditory behaviors and assessments for CAPD

<i>Auditory behavior</i>	<i>Assessment measure</i>
1. Localization and lateralization	Interaural intensity difference, interaural time difference (e.g., Kaga et al., 1997 [^])
2. Temporal processing	Click fusion, click differentiation (e.g., Lackner and Teuber, 1973; Stefanatos et al., 2005 [^])
Resolution, integration, discrimination, temporal ordering	Auditory fusion threshold test (McCroskey and Keith, 1996) Within and between channel gap detection (e.g., Phillips, 1999; Stefanatos et al., 2007 [^]) Random gap detection test (Keith, 2000) Gaps in Noise Test (Musiek et al., 2005) The Duration Pattern Test (DPT) (Musiek et al, 1990) Pitch Pattern Sequence Test (PPS) (Pinheiro, 1977)
3. Auditory discrimination	Newcastle Auditory Battery (Griffiths et al., 2001) Phoneme discrimination (Wepman and Reynolds, 1986; Benton et al., 1983) Test of Auditory Perceptual Skills (TAPS-R) (Gardner, 1997) [<i>Word Discrimination</i>] Environmental sound discrimination (e.g., Schnider et al., 1994 [^])
4. Processing low redundancy or degraded auditory signals (separation, closure) Time compressed, filtered, interrupted, competing with noise	Multiple Auditory Processing Assessment (MAPA) [<i>Monaural-Selective Auditory Attention Test (M-SAAT)</i>] (Schow et al., 2007) MAPA [<i>Speech in Noise for Children and Adults (SINCA)</i>] (Schow et al., 2007) Test for Auditory Processing Disorders in Children (SCAN-C) [<i>Filtered Words, Auditory Figure Ground</i>] (Keith, 2000) Performance Intensity for Phonetically Balanced Words (PIPB) (Boothroyd, 2008) Speech in Noise (SPIN) (Bilger et al., 1984) Bamford-Kowel-Bench speech in noise test (BKB SIN) (Nyquette, 2005) Willeford Battery [<i>Competing speech, filtered speech, binaural fusion, and rapidly alternating speech</i>] (Willeford, 1977) Compressed Speech Test (Beasley et al., 1972) Synthetic Sentence Identification (SSI-ICM) (Speaks and Jerger, 1965)
5. Processing auditory signal with competing acoustic signals (binaural competition) Consonant-vowel syllables, digits, words, and sentences	MAPA [<i>Dichotic Digits Test, Competing Sentences</i>] (Schow et al., 2007) SCAN-C [<i>Competing Words</i>] (Keith, 2000) Hugdahl Dichotic Listening Test (Hugdahl and Andersson, 1986) Staggered Spondaic Words (SSW) (Katz, 1968)
6. Auditory pattern recognition	MAPA [<i>Pitch Pattern Test, Auditory Fusion Test-Revised, Duration Patterns Test, Tap Test</i>] (Schow et al., 2007) Frequency (Pitch) Pattern Test (Musiek, 1994). Montreal Battery of Evaluation of Amusia (MBEA) (Peretz et al., 2003)

Note: [^]research articles. [*italics*] designates subtests.

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distinct clicks. For normal hearing adults, this threshold is in the order of 2–3 ms. By comparison, several studies have shown that patients with bitemporal lesions require prolonged periods of silence (15–300 ms) between two clicks before they are able to reliably discriminate one from two clicks. In rare instances, temporal lobe lesions can result in palinacousia, in which the percepts of sounds continue or recur beyond their cessation, leading to an echoing effect.

Gap detection is a similar but potentially more refined measure in which listeners must identify the presence or absence of brief gaps of silence inserted between two sounds (e.g., tones, noise bursts) lasting tens to hundreds of milliseconds. This paradigm allows the examination of the effects of gap duration as well as the influence of the frequency and duration of the sounds that precede and follow the gap (called markers). When the frequency characteristics of markers differ sufficiently, determination of whether or not a gap is present requires integration across frequency-specific channels. This so-called central gap detection task requires longer gap durations for detection of the intervening silent interval.

Gap detection is an auditory capacity that can be impaired with bilateral temporal dysfunction but also in individuals with aphasia secondary to left hemisphere stroke. Interestingly, impaired gap detection performance in children can be predictive of poor language development. Other temporal tasks sensitive to cortical lesions include the ability to judge the temporal order of rapid tonal sequences and the direction of rapid frequency sweeps.

Individuals presenting with possible CAPD commonly complain of difficulties with listening to speech in noisy environments. This is often a specific instance of more general problems detecting and processing a sound when it occurs in the presence of competing sounds. Formal assessment may involve the determination of masking level differences (threshold for tone detection in the presence of noise). Alternatively, a more direct approach would entail the presentation of speech (e.g., words) embedded in noise or measured amounts of background ‘cocktail party’ conversation. Interestingly, the use of a linguistically relevant background stimulus such as cocktail party chatter is more effective a masker than speech spectrum noise, white noise, or narrow band noise.

Many speech-in-noise or ‘auditory figure-ground’ tests of central auditory processing utilize low-redundancy monaurally presented stimuli. The low redundancy limits a listener’s ability to utilize compensatory mechanisms or strategies, while monaural presentation allows comparisons of the performance of the left and right ear. Comparing the ears can sometimes be informative since cortical lesions tend to impair performance in the ear contralateral to the lesion more so than the ipsilateral ear. However, relatively depressed performance can be observed in the ear ipsilateral or contralateral to subcortical lesions. While these tests are sensitive to functional compromise of the CANS, they are generally limited in their localization value. Other low redundancy monaural stimuli include low pass frequency-filtered speech, time-compressed speech, and time-expanded speech.

While auditory figure-ground measures assess the ability to hear target sounds in the presence of competing noise presented within the same ear, other measures assess the ability to isolate and separate different streams of information

presented to both ears. Dichotic tasks evaluate a listener’s ability to process competing signals by delivering different information concurrently to each ear. A dichotic words test, for example, may present a different word simultaneously to the left and right ear and require a listener to report both words if he/she can (free recall), just the stronger percept, or just the word from a predesignated ear.

In the vast majority of neurologically healthy right-handed individuals, free recall of verbal stimuli is better in the right ear than the left, reflecting hemispheric specialization of the contralateral (left) hemisphere for language processing. Unilateral temporal lobe damage commonly results in difficulties processing speech presented to the ear contralateral to the lesion. Indeed, patients may demonstrate extinction of the ear contralateral to the lesion, failing to recall most if not all of the stimuli presented to that ear. A related task, the Staggered Spondaic Word test, entails presentation of temporally overlapping bisyllabic compound words presented to the two ears (e.g., hotdog in one ear, baseball in the other, with only dog and base presented simultaneously).

One of the higher level demands on the auditory system involves auditory pattern recognition. Because of the complexity of tests of temporal pattern recognition, they are highly sensitive to a wide variety of cerebral lesions, including temporal, temporoparietal, frontoparietal, insular cortex as well as diffuse cerebral damage. These tasks are less sensitive to damage to the brainstem. Due to their differential sensitivity, such factorially complex tests are often useful for screening purposes.

Like speech processing, musical ability may be selectively impaired in neurological disease. The recent development of assessment measures specifically designed to examine the breakdown of musical ability provides an important expansion of the repertoire of measures used to evaluate pattern processing.

Electrophysiological Assessment

Electrophysiological measures examine the electrical potentials produced by the central auditory system in response to auditory stimulation. Auditory brainstem responses (ABR) have become a mainstay of the electrophysiological assessment of central auditory function. These far-field electrical potentials, recorded with electrodes placed on the vertex of the head and the mastoids, reflect neural activity generated by the auditory system in a 10-ms period following presentation of a stimulus (usually clicks) over headphones. The earliest components (Waves I and II) of this multiwave response occur within the first 3 ms and are thought to represent electrical activity generated in the distal and proximal portions of the VN, respectively. Wave III arises at about 4–5 ms from second-order neuron activity in or near the CN, while Wave IV likely reflects third-order neurons located in the vicinity of the SOC with possible contributions from the CN and the nucleus of the lateral lemniscus. Finally, Wave V, which follows Wave III by about 2 ms, is believed to originate in the vicinity of the IC, although it too likely has contributions from multiple anatomic structures. The actual site of generation of Waves VI and VII remains unclear, but they are believed to be thalamic in origin.

The procedure can disclose dysfunction of brainstem auditory nuclei and their afferents. For example, the existence of

eight cranial nerve tumors can be detected with ABRs in ~90% of cases. Specifically, Wave I is present but subsequent components (Waves III or V) are absent (10–20% of cases) or delayed. A prolonged interval between Wave I and Wave III is also common (40–60% of cases).

Later potentials in the range of 20–70 ms post stimulus comprise the so-called middle-latency responses. These potentials reflect a combination of diencephalic and cortical generators. They are small potentials that have received variable use in clinical settings.

Cortical dysfunction can be assessed using long-latency auditory event-related potentials (ERPs) such as mismatched negativity (MMN). This complex, evident between 150 and 250 ms poststimulus, reflects automatically generated preattentive cortical responses to a detected change in a stimulus. A late positive wave occurring at 300 ms, called the P300, can be an excellent neurophysiological marker of attention to auditory events and processes related to updating of working memory. Auditory steady-state responses provide a useful method of assessing the processing of rapidly changing auditory features such as amplitude and frequency modulations.

Structural and Functional Neuroimaging

Recent advances in magnetic resonance imaging permit the acquisition of very high resolution structural images of the brain and brainstem which correspondingly has improved the capacity to detect small lesions. Contrast agents such as gadolinium can further enhance detection of small lesions or masses (e.g., tumors) which can be missed with electrophysiological procedures alone or MRI without contrast. However, small lesions can still be missed with structural neuroimaging.

In the past decade, there has also been a dramatic increase in the use of functional magnetic resonance imaging (fMRI) which can examine metabolic changes in oxygen utilization in different areas of the brain related to neural activity produced in the performance of auditory tasks. Recent advances in the production of nonmagnetic transducers (e.g., electrostatic, piezoelectric) allows good quality sound in the MRI environment and sparse sampling sequences allow presentation of stimuli at a time when noise generated by the scanner during image acquisition does not interfere with perception.

Central Deafness

Central deafness (CD) is a broad term referring to conditions in which partial or complete loss of hearing occurs due to damage or dysfunction of the CANS. The model for this class of disorders is cortical deafness, a relatively rare condition that typically results from bilateral lesions of auditory cortex or auditory radiations. The impairments associated with cortical deafness are summarized in Table 2. Patients initially show substantial elevations of hearing thresholds when assessed with pure tone and speech audiometry, yet have normal or near normal function of the middle and inner ear as indexed by tympanograms, stapedius reflex, and otoacoustic emissions. Brainstem auditory evoked potentials also commonly reveal evidence of normal peripheral hearing, while middle-latency and cortical evoked responses are either variable, abnormal or absent. These cases emphasize the importance of objective electrophysiological assessments to accompany standard behavioral audiometry.

Deficits in hearing sensitivity are accompanied by profound difficulties in understanding or responding consistently to both speech and environmental sounds. While appearing deaf, some subcortically mediated reflex responses, such as orienting toward a sudden loud sound may be preserved. Hearing sensitivity sometimes improves over time, but generally remains clinically elevated. In some cases, the speech of affected individuals acquires the inflection and prosodic characteristics typically associated with profound peripheral hearing loss.

The most severe and persistent forms of cortical deafness arise from subcortical white matter lesions, involving the thalamocortical auditory radiations. These strategically placed lesions result in total or near total interruption of thalamocortical projection fibers from the medial geniculate bodies to primary and secondary auditory cortex (likely disrupting both classical and nonclassical auditory pathways).

Bitemporal lesions can result from a variety of circumstances but when caused by stroke, the history often reveals consecutive cerebrovascular events. An initial unilateral temporal lobe lesion may result in a selective cortical auditory processing disorder (APD) such as an auditory agnosia for environmental sounds, word sound deafness (WSD), or aphasia (discussed in later sections of this article). Cortical deafness

Table 2 Summary of impairment in classical syndromes of CAPD

Function	Cortical deafness	Word sound deafness	Word meaning deafness	Nonverbal auditory agnosia	Receptive amusia
Speech comprehension	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	⊙	⊙
Speech repetition	✓ ✓ ✓	✓ ✓ ✓	⊙	⊙	⊙
Writing to dictation	✓ ✓ ✓	✓ ✓ ✓	⊙	⊙	⊙
Spontaneous speech	✓ ✓	⊙	⊙	⊙	⊙
Reading comprehension	⊙	⊙	⊙	⊙	⊙
Spontaneous writing	⊙	⊙	⊙	⊙	⊙
Recognition of familiar nonspeech sounds	✓ ✓ ✓	⊙	⊙	✓ ✓ ✓	✓ ✓
Recognition of melody	✓ ✓ ✓	⊙	⊙	✓ ✓ ✓	✓ ✓ ✓
Hearing sensitivity	✓ ✓ ✓	⊙	⊙	⊙	⊙

Severity of impairment: ⊙, none/mild; ✓ ✓, moderate; ✓ ✓ ✓, Severe. Expanded from Bauer RM and McDonald CR (2003) Auditory agnosia and amusia. In: Farah MJ and Feinberg TE (eds.) *Patient-Based Approaches to Cognitive Neuroscience*, pp. 257–270. Cambridge, MA: MIT.

emerges when a second lesion occurs some time later and causes damage to PAC or subcortical afferents in the contralateral hemisphere. The syndrome can also emerge in children and has been described in association with a severe closed head injury and herpes encephalitis.

CD has also been described in individuals with subcortical lesions involving the MGB and the IC. Subcortical forms of CD can occur from a variety of etiologies including stroke. This generally entails a single event involving the vertebralbasilar artery system which perfuses the pons, midbrain, and thalamus, rather than the consecutive middle cerebral artery strokes implicated in cortical deafness.

Since virtually all ascending and descending auditory pathways synapse in the IC, bilateral lesions that result in complete destruction of the ICs should, in theory, result in complete deafness, since such a lesion presumably isolates the auditory cortex from information encoded at the ear. However, available clinical reports present a mixed picture. In two case reports, IC lesions resulted in complete deafness, while in three other reports, there was mild elevation of pure tone thresholds, but profound impairment of word recognition. In these cases, pure tone perception may have been mediated by the extralemniscal auditory brainstem pathway, whereas functional integrity of the IC is critical for speech processing, given its role in processing frequency modulation and other dynamic acoustic features.

General Auditory Agnosia

The term agnosia is derived from the Greek words for 'not knowing.' Auditory agnosia refers to a collection of disorders associated with the loss of the ability to recognize auditory objects that cannot be attributed to sensory difficulties. Auditory agnosia can be fairly selective, affecting particular classes of auditory input. Specifically, auditory agnosia can preferentially disrupt the processing of verbal information, music or environmental sounds. These specific forms of the disorders are discussed below. The term general auditory agnosia refers to a condition in which a neurologically based auditory recognition disorder is evident to both speech and nonverbal stimuli. Unlike cortical deafness, the processing impairment is not associated with clinically significant audiometric thresholds.

Verbal Auditory Agnosia

Word Sound Deafness

Word deafness is characterized by severe difficulties in understanding and reproducing spoken language, with otherwise intact speech production and nonauditory language comprehension (e.g., reading). In the context of marked deficits in processing speech sounds, words, phrases, and sentences, there is relative preservation of musical appreciation and the recognition of environmental sounds. The deficiencies in decoding language occur at an early stage of analysis and are relatively specific to the auditory modality. Given this, the condition has more recently been called WSD to distinguish it from other forms of verbal auditory agnosia, such as word meaning deafness (discussed below).

Phenomenological descriptions have implicated a range of disturbances of perceptual processing. In some cases, particularly those with bitemporal lesions, the dissolution of auditory perceptual processing is sufficient in severity to impede recognition of the acoustic characteristics of the human voice. Speech is described in such terms as 'a noise,' 'a garbled sound,' such as 'wind in the trees' or 'the rustling of leaves.' In others, spoken communications are recognized as speech, but a breakdown occurs in the process of mapping speech sounds to appropriate stored mental representations. Discourse sounds like 'jabbering,' 'a foreign language' or simply does not 'register.' There are frequent suggestions that perceptual resources are incapable of keeping up with the rate at which speech is produced: 'words just run together' or 'come too quickly.'

Some studies have noted systematic error patterns in speech discrimination and identification that implicate problems at phonetic levels of analysis, a stage of auditory processing specific to speech. Problems particularly impede the discrimination of stop consonants (e.g., /p/, /b/, /t/, /d/, /k/, /g/) while differentiation of vowels is relatively spared. This pattern of phonemic imperception is common in WSD but not necessarily specific to it.

Several reports have suggested that the symptoms characteristic of WSD are secondary to fundamental problems in basic aspects of auditory temporal processing. Problems noted in WSD include deficient intensity-duration functions and poor resolution of temporally distinct auditory events (click fusion, gap detection). In addition, individuals with WSD have difficulty detecting frequency modulations in sound and in judging the temporal order of sequential auditory stimuli. Based on such findings, some have argued that WSD is associated with general limitations in auditory temporal resolution that are particularly detrimental to language comprehension because they impede the ability to perceive brief spectrotemporal cues in speech necessary for the derivation of linguistic meaning.

There is disagreement regarding the anatomical basis of the syndrome. The majority of cases reported in the literature demonstrate bilateral temporal lobe lesions, particularly involving the mid portion of the superior temporal gyrus. However, WSD was first described in patients considered to have deep lesions confined to the left posterior temporal regions and a number of case reports have confirmed that a strategically placed unilateral left hemisphere lesion is sufficient to result in WSD. Unilateral lesions can impede the analysis of formant frequency modulation in speech sounds without causing impairment on basic temporal resolution tasks such as click fusion. WSD can also occur developmentally, and is the most common pattern of impairment associated with the Landau-Kleffner syndrome, a rare epileptic syndrome in childhood.

Word Meaning Deafness

Individuals with word meaning deafness have severe difficulties in understanding auditory language, yet can repeat and write to dictation sentences that they cannot comprehend. Curiously, they can also read and understand those sentences that they could write to dictation but not comprehend. The preservation of repetition and writing to dictation distinguishes this

condition from WSD and suggests that the analysis of phonological information is relatively intact. Rather, the breakdown in language comprehension appears to occur at the level of lexical access, possibly secondary to a failure to match the intact phonological code with corresponding representations in the lexicon or as a 'post access' failure of lexical items to activate corresponding representations in the semantic system.

Phonagnosia

Phonagnosia refers to disorders of familiar voice recognition. These individuals experience problems identifying coworkers, friends, and relatives by the sound of their voice. This deficit was first noted in patients with right hemisphere lesions who had difficulty recognizing the voice of famous individuals. A follow-up study revealed that temporal lobe damage of either hemisphere impaired the ability to discriminate famous voices, while deficits in discriminating and recognizing familiar voices was correlated with right parietal lobe damage.

Problems with familiar voice recognition typically occur in the context of other disorders of auditory processing, such as a broader auditory agnosia, amusia, or word deafness. However, some case reports suggest that it can occur in the context of unimpaired recognition of environmental sounds. Phonagnosia and amusia may be more closely tied, as both depend on auditory mechanisms required to distinguish the timbre of a sound. A developmental variant of the disorder has been described.

Nonverbal Auditory Agnosia

Sensory Amusia

Receptive amusia is associated with deficits in the ability to appreciate various characteristics of music such as pitch, harmony, and melody. While the disorder can occur as a fairly specific impairment dissociated from the perception of speech and environmental sounds, it is more commonly seen in the context of a broader nonverbal auditory agnosia. It has also been reported in cases of aphasia, suggesting that the left and right cerebral hemispheres contribute differentially to the multicomponent processes involved in music appreciation.

The right cerebral hemisphere appears to play an important role in the processing of some aspects of music such as the appreciation of melody. The left cerebral hemisphere appears particularly important for the processing of sequential, temporally organized information included in a series of musical notes. The left hemisphere's role may therefore increase with greater analytic analysis or with more attention to temporal patterns such as timing and rhythm. For example, there are reports of professional musicians who suffer from an amusia subsequent to a left temporoparietal stroke. These individuals may show normal performance on all aspects of melody processing but lose the ability to discriminate or produce rhythms. This arrhythmia is specific to auditory input and cannot be attributed to the impairment of supramodal temporal processing.

Other clinical studies also suggest a distinction between time-dependent processes governing melody recognition, such as the appreciation of rhythm or duration and the more instantaneous features of music, such as the pitch, harmony, timbre, and intensity. For example, double dissociations have

been described between pitch perception and the processing of temporal sequences. Similarly, the ability to appreciate expressive patterns of music indexed by pitch, timbre, and intensity (musical connotation) can be dissociated from the ability to appreciate the significance of lyrics (musical denotation). It has been further suggested that timbre-dependent skills such as recognition of specific voices and musical instruments can be distinguished from pitch-dependent skills, such as recognition of tunes.

A developmental form of amusia occurs in ~4% of the population. These individuals have difficulty discriminating pitch changes in melodies that cannot be explained by peripheral sensory impairment. The disorder, referred to as tone deafness or congenital amusia (CA), is frequently manifested by an individual's inability to carry a musical melody but seems unrelated to problems with musical time.

There is compelling evidence suggesting that CA is based in a congenital musical pitch disorder. The disorder is thought to have a genetic contribution insofar as in the families of individuals with CA, 39% of first-degree relatives have the disorder whereas only 3% have it in control families.

Neuroanatomical studies have suggested that CA is associated with abnormal gray and white matter in auditory cortex and the inferior frontal cortex. Neurophysiological evidence derived from recording auditory ERPs, has suggested that these individuals are capable of near-normal processing of musical pitch incongruities, suggesting that, similar to the visual phenomenon of blindsight, subjects with CA can process stimuli yet not have conscious access to that information. Their behavioral deficits therefore appear related to a limited awareness of pitch representations and a disconnection of these representations with their knowledge of pitch.

Environmental Sound Agnosia

Some clinical reports suggest that auditory agnosia can be restricted to environmental sounds. One case report with consecutive hemorrhagic lesions (left then right) sustained bilateral damage in the region of the putamen extending to the thalamocortical auditory radiations. Following the second infarct, the patient experienced a brief period of cortical deafness associated with bilateral sensorineural hearing loss of 55–100 dB at 1 kHz, in the context of normal brainstem-evoked responses. At this time, she could not distinguish broad categories of sounds, such as speech, music, or environmental sounds. However, this resolved over a 3-month period and was followed by a reportedly selective auditory agnosia for environmental sounds. Errors appeared discriminative rather than associative in nature. Processing of speech was relatively intact at this point. Unfortunately, neither this report nor previous reports directly compared environmental sound recognition to the perception of music. Consequently, they serve mainly to illustrate that environmental sound recognition can be impaired with relatively intact perception of speech.

Cortical Motion Deafness

A recent study described a patient with a selective deficit for the reception and discrimination of auditory motion. The disorder emerged following resection of the right anterior temporal lobe

and posterior temporal gyrus. While the patient could correctly identify and localize auditory objects in space, he failed to reveal normal responses indicative of the ability to process auditory movement.

Idiopathic Acquired CAPD

Hyperacusis

Hyperacusia is a term used to refer to raised sensitivity to auditory stimulation often associated with an aversion to or intolerance for certain sounds at their typical sound levels. A person with severe hyperacusis may have difficulty enduring the sound of everyday objects, such as a vacuum cleaner, a hair dryer or a food blender, indicating that they are unpleasantly loud when they are easily tolerated by others. While hyperacusis can occur with peripheral damage, it can also result from dysfunction or damage to the CANS. It is thought that efferent mechanisms from the SOC to the cochlea involving the auditory nerve (olivocochlear bundle) may be functioning abnormally in a proportion in these individuals.

It has been suggested that hyperacusis can be a symptom of a serotonin dysfunction, leading to suggestions that selective serotonin reuptake inhibitors (SSRI) may be helpful in treating the disorder. Though some case studies report improvement of hyperacusis from SSRIs, it has yet to be robustly clinically validated. Other etiologies associated with hyperacusis include exposure to certain medications or drugs, head trauma, and migraine. It is commonly described in children with autistic spectrum disorders and William's Syndrome. Finally, hyperacusia tends to accompany tinnitus.

Tinnitus

Tinnitus is the perception of sound in the absence of an external acoustic stimulus. It is often described as persistent ringing or buzzing in the ear and is commonly associated with presbycusis, a hearing loss due to aging. Indeed by 70 years of age, over 10% of all adults report episodes of tinnitus. Of those who experience tinnitus, 79% report hearing sounds like tones, while 21% report hearing a hissing or rushing noise. It is also a symptom of Ménière's disease and is common in individuals with tumors (acoustic neuroma or vestibular Schwannoma) growing in the space between the pons and cerebellum. Tinnitus may additionally occur as a result of exposure to loud noise (e.g., artillery fire, rock concerts) or after the use of certain antibiotics.

In ~60% of tinnitus cases, there is no known cause. Because of the association between cochlear pathology and tinnitus, it has been assumed that tinnitus is caused by hyperactivity of cochlear hair cells. It has often been compared to chronic pain, specifically phantom limb pain. However, evidence such as the persistence of tinnitus after cochlear ablation and a strong central effect of ototoxic medication suggests a central origin for persisting tinnitus.

Recent research has implicated the nontraditional extralemniscal auditory pathway in the disorder. Because the thalamic nuclei (medial and dorsal nuclei of the MGB) of the extralemniscal system project directly to the basolateral nucleus of the amygdala, involvement of this pathway may be fundamental

to understanding why some individuals experience tinnitus as a debilitating problem with affective symptoms.

Due to the commonalities between hyperacusis and tinnitus, SSRIs have also been proposed as a treatment for the latter. However, a recent randomized placebo-controlled study found that most subjects showed no consistent benefit from SSRIs.

Etiologic Heterogeneity/Diversity

Acquired forms of CAPD such as CD and the agnosias typically represent the sequelae of ischemic or hemorrhagic cerebrovascular accidents. Such syndromes can also result from a variety of other conditions such as head injury, herpes simplex encephalitis, tumor, and epilepsy. Less severe forms of CAPD have been described in association with aphasia, encephalitis, seizures disorders, brain tumors (e.g., cerebropontine angle tumors), as well as degenerative disorders (e.g., Alzheimer's disease), demyelinating disorders (e.g., multiple sclerosis), metabolic disorders (e.g., adrenoleukodystrophy), bacterial meningitis, Lyme disease, and drug toxicity.

A similar range of severity can be seen in children. Classic forms of either generalized auditory agnosia or verbal auditory agnosia are typical features of Landau-Kleffner syndrome, a relatively uncommon form of childhood epilepsy associated with continuous spike and wave activity. However, most children with CAPD have a developmental variant that is associated with less florid disturbances. In some of these cases, the disorder is specific to auditory processing, while in others CAPD is comorbid with other developmental disorders, such as attention deficit hyperactivity disorder (ADHD), specific language impairment (SLI), dyslexia, and autism.

Below, we briefly review the concept of developmental forms of CAPD as a distinct diagnosis and discuss its relation to various comorbid conditions.

Developmental CAPD

APD as a Distinct Diagnostic Entity

Children with CAPD often first come to attention when they experience difficulties in an academic setting, where success is dependent on absorbing highly structured auditory information, often in the presence of poor classroom acoustics and abundant background noise. An estimated 2–7% of school-aged children exhibit problems suggestive of the existence of a developmental form of CAPD. These children have difficulty attending to the teacher for an appropriate length of time and in following, remembering, or understanding verbal instructions. They often need to have spoken information repeated and are easily distracted or influenced by extraneous sounds in their environment. Though these children are intelligent and capable of attaining academic success, these deficits impede their academic performance and have the potential to be interpreted as a behavioral or motivational problem.

In 2000, a consensus statement by a group of 14 prominent scientists and clinicians on the problems related to diagnosing these disorders in school-aged children suggested relabeling the problem 'auditory processing disorders' (APDs) in order to 'keep with the goals of maintaining operational definitions,

avoid the imputation of anatomic loci, and (to) emphasize the interactions of disorders at both peripheral and central sites.' Many continue to utilize the qualifier 'Central,' if only parenthetically, with recognition of equivalence between the terms. Existing criteria that define APD are the same as those discuss for CAPD in the introduction to this articles.

Numerous controversies surround the concept itself and the pragmatic issues concerning its diagnosis. These issues include the extent to which a deficit must be restricted to the auditory domain to be called an APD and whether testing with nonspeech stimuli, such as tones is sufficient to indicate an APD, since evidence suggests that speech processing is computationally more taxing than other sounds, particularly with respect to the temporal processing demands. Moreover, given that speech processing is a special case of auditory processing, there is disagreement over where an APD ends and linguistic or neurocognitive impairment (e.g., memory, executive function) begins. Finally, the concept of APD in children is complicated further by comorbid presentation with developmental disorders, such as autism, dyslexia, SLI, and ADHD.

Despite objective evidence of normal peripheral hearing sensitivity, children with APD demonstrate a variety of deficits in behavioral batteries measuring central auditory function. In addition, their difficulties in remembering phonemes and manipulating them can result in problems with learning to read and spell. They may also have difficulty understanding persons with unfamiliar accents and may struggle in second language learning. Auditory memory span and sequencing auditory information can be problematic. Correspondingly, they may also demonstrate poor sense of rhythm and musical ability.

In a portion of children with CAPD, problems in central auditory processing may be confirmed using electrophysiological measures. While abnormal ABRs are observed in less than 10% of children with CAPD, as many as 42% show abnormal auditory middle-latency responses or P300 responses.

It is uncommon for individuals with developmental forms of CAPD to demonstrate an obvious structural lesion. Nevertheless, a recent case study is noteworthy insofar as it reported some characteristic anomalies in a developmental case of CAPD. The structural MRI revealed selective atrophy evident bilaterally in auditory cortex and subcortex. Positron emission tomography (PET), a functional neuroimaging procedure that can measure neural activation by imaging the brain's use of glucose, found bilateral hypometabolism in primary and secondary auditory cortices including Heschl's gyri. These findings underscore the potential future role that neuroimaging may play in the differential diagnosis of CAPD.

APD and Autism

Autism is a developmental disorder distinguished by impairment of social interaction and communication, accompanied by restricted interests and repetitive behaviors. Reports of auditory processing abnormalities are common, frequently including an absence of orienting reflex to sound, a lack or inconsistency in response to familiar sounds and noise, intolerance for certain sounds at their typical sound levels (hyperacusis), overselectivity when listening to multiple auditory streams, difficulty listening in the presence of background

noise and deficits in perception of emotional content and prosody in the human voice. In severe cases, the impairment can be as severe as functional deafness.

Neurophysiological and neuroimaging studies have implicated neurodevelopmental anomalies at multiple levels of the CANS, from the superior olive to auditory association cortex. Brainstems of children with autism are significantly smaller than typically developing peers and although findings are inconsistent, several studies have reported that auditory brainstem-evoked potentials show decreased amplitude and greater latency.

Functional neuroimaging studies have shown diminished activation of the auditory cortex when presented with nonverbal auditory stimuli. When listening to speech, a neurotypical brain shows bilateral activation in the superior posterior temporal lobes with a left-sided asymmetry involving posterior language areas. Studies of individuals with autism have shown a lack of activation in speech areas entirely or a reversal of the usual left hemispheric asymmetry. While failing to show activation of the superior temporal sulcus in response to the human voice, these studies generally report normal patterns of activation to nonvocal sounds.

APD and SLI

SLI is a neurodevelopmental disorder characterized by problems in understanding or producing language in the absence of causal factors such as hearing impairment, mental retardation, neurological deficits, primary emotional disorder, or social deprivation. A number of studies have suggested that these children have particular difficulties in discriminating speech sounds characterized by rapidly changing acoustic information (e.g., stop consonants) as well as in judging the temporal sequence of rapid presented complex tone patterns. These findings have prompted suggestions that a basic impairment of auditory temporal processing contributes to their difficulties with language acquisition, presumably resulting in unstable phonemic processing, which may interfere with encoding and producing spoken language.

Theories advocating a direct causal relationship of CAPD to SLI have been criticized. Several studies have found that while rapid auditory processing deficits are common in SLI, they are not universal. There also seems to be little or no relationship between the severity of a rapid auditory processing deficit and the SLI.

While the causal relationship between auditory processing difficulties and language problems remains in dispute, there appears to be ample evidence that auditory processing difficulties exist in a significant percentage of these children. Indeed, neurophysiological evidence of these deficits has been shown in the form of attenuated or absent MMN responses to vowel sounds and tones. In cases with severe receptive involvement, abnormal steady-state responses to rapid frequency changes may be observed. Recent studies have shown that impaired electrophysiological responses in some children with SLI may approach typicality as the child reaches adulthood. This eventual advance has led some to interpret these electrophysiological findings as evidence for a more general immature auditory processing system as a contributory factor to SLI.

APD and Dyslexia

There is also ongoing debate about the relationship between an auditory processing deficit and a specific reading disorder (dyslexia). Again, it has been suggested that children with dyslexia have low-level auditory and visual perceptual deficits, possibly related to anomalies impacting magnocellular visual and auditory systems. These deficits are thought to result in subtle perceptual problems that interfere with the development of phonology, reading, and spelling ability.

While numerous studies have provided evidence in support of magnocellular deficits in the visual system, data supporting comparable auditory system involvement are less compelling partly due to methods of subject selection and inadequate controls over potentially comorbid attentional problems. However, postmortem cytoarchitectural studies of a small number of brains of people with dyslexia have revealed smaller left MGN and planum temporale than expected. In addition, ectopias, and microgyria have been observed bilaterally in perisylvian cortex (including auditory cortex), greater on the left side. These findings suggest anomalies in cell migration during neurodevelopment that would impact auditory function in addition to language and reading. Some association has been observed between deficits in auditory temporal processing and problems with phonological processing, although this appears to be a weak or indirect association.

APD and ADHD

ADHD and APDs share many features which make their clinical presentation similar. Overlapping symptoms include poor concentration, distractibility, fidgetiness, and poor academic achievement. These similarities have led to the question of whether APD and ADHD are in fact distinct disorders. Though some authors have suggested that they are variants of the same disorder, noting that they share some prenatal and postnatal etiological factors, there is a general consensus that the two disorders are dissociable and discrete diagnostic entities.

The focus of the relationship between ADHD and APD has therefore shifted to diagnostic differentiation. Several approaches to differential diagnosis have been proposed, though none have been satisfactorily validated at this point in time. It has been suggested that a diagnosis be made only after comparing performance on a visual task with an auditory analogue, such as visual and auditory continuous performance tests, which examines a person's ability to sustain attention on a task. Others have attempted to differentiate ADHD from APD using electrophysiological measures with little success thus far. Finally, while stimulant medication such as methylphenidate has been used to control hyperactivity, impulsivity, and distractibility in ADHD, there is little evidence to suggest it improves deficits specific to CAPD.

Treatment

Because of the variability in presentation of CAPDs, intervention should be personalized to address each individual's specific deficits while building on their strengths. CAPDs may

be treated through environmental modification, teaching of compensatory strategies or direct treatment of the deficit. Intervention should be planned and executed by an interdisciplinary team.

Environmental modifications increase access to the acoustic information itself or facilitate learning through modified teaching methods. This can be achieved through assistive listening devices such as FM systems, removal of competing noise or preferential seating in a classroom environment. Instruction may be modified to include preteaching, reduced linguistic complexity, slower rates of speaking, and ample use of repetition/rephrasing. In addition, supplementing auditory information with visual presentation of information either in writing or using gestures is often helpful.

Teaching an individual with CAPD to use compensatory strategies is key to successful intervention in many cases. Compensatory strategies might include teaching an individual to ask for repetition of information if he/she did not comprehend it, independently choose seating away from noise or near a speaker, and to look at a speaker's mouth while listening. Individuals often need to take a proactive approach to becoming more aware of the impact of their deficits and the need to manage potential problems in different situations.

Direct treatment for CAPDs involves auditory training. This approach is designed to take advantage of brain plasticity to effect changes in the circuitry of the system through appropriate and often repeated practice. There is evidence indicating that sufficiently frequent, intense, and challenging auditory training can result in neurophysiologic and functional improvements in auditory skills. Many formal auditory training programs are available as commercial computer software packages.

See also: Academic Achievement; Aging and the Brain; Aphasia; Attention Deficit Hyperactivity Disorder; Autism and Pervasive Developmental Disorders; Behavior Measurement in Psychobiological Research; The Brain; Brain and Behavior Relationships; Central Nervous System; Clinical Assessment; Developmental Psychopathology; Drugs, the Brain, and Behavior; Dyslexia; Event-Related Potentials (ERPs); Language Development; Neuroimaging of Dementia; Perceptual Development; Phonetics; Psychophysics; Sentence Processing; Visual Neglect.

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- <http://www.ldonline.org/article/8056> – National Center for Learning Disabilities, 'Fact sheet: Auditory Processing Disorders'.
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Central Nervous System

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Glossary

Amnesia Partial or total loss of memory; anterograde amnesia occurs when an individual has no memory for events that happened after a traumatic event or surgery, while retrograde amnesia is the inability to recall earlier experiences, especially those preceding a traumatic injury.

Aphasia Impairment in the ability to express or comprehend language due to injury or disease of the brain.

Central nervous system The brain and spinal cord.

Executive functions A set of cognitive abilities that control and regulate other abilities and behaviors, including the ability to evaluate a problem, plan a response, carry out the

plan, and assess the adequacy of the response within the context of ongoing environmental cues.

Neurons The basic unit of the nervous system or the nerve cell that sends and receives electrical signals over long distances within the body. The neuron includes the cell body (soma), dendrites, and an axon.

Neurotransmitters Chemicals that regulate nervous system functioning. The chemicals are released from a nerve cell which thereby transmits an impulse from a nerve cell to another nerve, muscle, organ, or other tissue.

Synapse The synapse contains a small gap separating neurons. Information from one neuron flows to another neuron across a synapse; it is at the synapse that biochemical transmission occurs.

The central nervous system (CNS) consists of the brain (encephalon) and spinal cord (medulla spinalis). The brain is located in the cranial cavity and is protected by the skull. The spinal cord lies in the vertebral canal and is protected by the vertebrae. The CNS is distinguished from the peripheral nervous system, which is composed of the remaining network of neurons throughout the body. First, we review the basic neuroanatomy of the CNS. Next, we examine both reflexive and voluntary behaviors that are derived from the CNS. Specifically, behavioral domains that include sensation, perception, motor activity, and language are described.

Neuroanatomy

Basic Structures

The CNS consists of neurons and glial cells. Neurons consist of the nerve cell body and its processes – the dendrites and axons. Neurons constitute about 10% of the cells in the CNS while glial cells make up the remainder. Neuron cells conduct information while glial cells both protect and provide a variety of support information to neurons. The CNS may be divided into regions of gray matter that consist of densely packed glial cells, neurons, and white matter. White matter consists of myelinated fiber tracts that connect parts of the CNS. The long processes of neurons, which are termed axons, are also located in the white matter. Axons are responsible for carrying outgoing messages from the cell.

The brain is surrounded by three membranes known as the meninges, which are located beneath the cranium and vertebral column. The first membrane is a tough, outermost layer,

or the dura mater, which is closely attached to the inner surface of the skull, beneath the subdural space. Epidural hematomas are triggered by injury to the middle meningeal artery and are formed between the dura and the skull. Subdural hematomas form between the dura and arachnoid and are caused by rupture of bridging veins. The arachnoid mater is the second membrane, which is thin and delicate and resembles a cobweb, and beneath this is the fluid-filled subarachnoid space that is part of the cerebrospinal fluid system. The rupture of an aneurysm of a cerebral artery can result in a subarachnoid hemorrhage between the arachnoid and the pia. The third layer, or pia mater, is the thin and transparent innermost layer of the meninges and is attached to the brain and dips down into the fissures or sulci. The pia mater forms the inner boundary of the subarachnoid space.

Neural Tube and Ventricular System

The neural tube is an embryonic structure that is formed when the lips of the neural groove fuse and is the basis for the development of the entire CNS. This process generally begins around the fourth week of development. Differential growth along the walls of the neural tube occurs during development and gives rise to the four primary subdivisions of the embryonic brain: (1) the prosencephalon (forebrain), (2) the mesencephalon (midbrain), (3) the rhombencephalon (hindbrain), and (4) the spinal cord. As the fetus develops, the prosencephalon goes on to develop into the telencephalon and the diencephalon. The mesencephalon develops into the midbrain. The rhombencephalon develops into the metencephalon (the pons and cerebellum) and the myelencephalon (the

medulla oblongata). The spinal cord develops from the most caudal (toward the rear) portion of the neural tube.

The ventricular system develops from the cavity of the neural tube in the embryo and consists of interconnected fluid-filled cavities located in the core of the forebrain and brainstem. There are four ventricles including two lateral ventricles, the third ventricle, and the fourth ventricle. Each of the ventricles is filled with cerebrospinal fluid and is lined throughout the ependyma. The paired lateral ventricles communicate with the third ventricle through the interventricular foramina. The third ventricle is connected to the fourth ventricle by the cerebral aqueduct. At its caudal end, the aqueduct opens into the fourth ventricle. Cerebrospinal fluid is a clear and colorless fluid that acts as a buffer to protect the brain and the spinal cord from mechanical trauma. It is present in the ventricles as well as the central canal of the spinal cord and in the subarachnoid space that surrounds the brain and spinal cord. Each ventricle contains a choroid plexus that produces the cerebrospinal fluid which is continually being produced and reabsorbed as it circulates through this intricate system. The cerebrospinal fluid is reabsorbed via the arachnoid villi into the venous sinuses when the cerebrospinal fluid pressure exceeds the venous pressure in the sinus.

Major Subdivisions of the Brain

Diencephalon

The diencephalon is located deep within the cerebral hemispheres and encloses the third ventricle. The four major subdivisions of the diencephalon include the thalamus, hypothalamus, subthalamus, and the epithalamus. The primary function of the thalamus, which is the largest division, is the recognition of sensory stimuli and the relay of sensory impulses (other than olfaction) to the cerebral cortex. The thalamus is the chief relay station for all output to the cortex that comes from the cerebellum and basal ganglia. The thalamus also plays an integral role in motor and limbic functions. The thalamus contains a Y-shaped sheet of fibers termed the internal medullary lamina that may be divided into three large cell masses, anterior, mediodorsal, and lateral, each of which contains several discrete nuclei that are interconnected with specific cortical regions. The anterior and mediodorsal cell masses are associated with the thalamic division of the limbic system, and the lateral cell mass belongs to the sensory and motor systems. Problems from damage to the thalamus may include sensory abnormalities, visual-field deficits, and behavioral changes.

The hypothalamus is located below the cerebral cortex at the base of the diencephalon. The primary role of the hypothalamus is the central regulation of homeostasis, which occurs through interfacing with the endocrine system, the autonomic nervous system, and the limbic system. The hypothalamus controls the nervous system by synthesizing and releasing neurohormones at regular intervals. Homeostatic functions associated with the hypothalamus include energy and temperature regulation, water balance, appetite, cardiovascular functioning, sleep and circadian rhythms, reproduction, emotional behavior, stress response, blood pressure, and respiration. Autonomic, emotional, or endocrine dysfunction is associated with lesions in the hypothalamus.

The subthalamus and epithalamus are small divisions of the diencephalon, with the subthalamus situated under the optic thalamus, while the epithalamus is superior and posterior to the thalamus. The subthalamus contains fiber tracts and the subthalamic nucleus. The subthalamus and epithalamus are involved in secretion of melatonin by the pineal gland, the motor functions of the basal ganglia, and the control of the circadian rhythms.

Telencephalon

The telencephalon is the rostral part of the embryonic forebrain and consists of the cerebrum and the limbic system. The cerebrum is the uppermost and largest part of the human brain and is situated at the top of the cranial cavity. The cerebrum includes the cerebral cortex, which is the outermost layer, and is responsible for controlling complex motor and mental activity. The cerebral cortex includes the left and right cerebral hemispheres, separated by the median longitudinal fissure, a large crevice that runs from front to rear. The cerebral cortex, which contains billions of neurons and multitudes of interconnections, is involved in higher order intelligence, sensory perception, movement, language, memory, consciousness, emotion, and personality. Although the left and right hemispheres appear to be physically similar, they control different types of processes and also are anatomically different.

The cerebral cortex has both gray and white matter. Gray matter is located on the surface of the cerebral cortex, while a large mass of white matter is located below the gray matter. The white matter contains axonal fibers that provide input to and output from the cortical matter. The fiber tracts are identified as follows: (1) association fibers, which link one area of the cortex to another area within the same hemisphere; (2) commissural fibers, which link the two hemispheres; and finally, (3) projection fibers that connect the cerebral cortex with the subcortical centers, the brain stem, and the spinal cord.

The cerebral cortex consists of four lobes: frontal, parietal, temporal, and occipital. The frontal lobes are located superior to the lateral sulcus and in front of the central sulcus (i.e., over the eyes), and contain the motor cortex, which coordinates voluntary motor activities. Specifically, activities of the voluntary muscles on the right side of the body are controlled by the left part of the motor cortex, while voluntary activities on the left side of the body are controlled by the right part of the motor cortex. Motor intention is regulated by the dorsolateral frontal lobe as increased activity is apparent when animals are about to make movements. Damage to this area is associated with motor or autonomic disturbances, including contralateral limb akinesia, or failure to use one limb in order to respond to a stimulus, not caused by inattention or weakness of the limb. The frontal lobe is also involved in important mental activities such as planning, association of ideas, emotion, and self-awareness. Finally, the frontal lobe is also concerned with personality, so lesions in the frontal lobe produce alterations in character and behavior.

The parietal lobes lie posterior to the central sulcus, but above the lateral sulcus on the lateral surface of the brain. The parietal lobe contains the somatosensory cortex, which is involved in body sensations such as pain, cold, heat, touch, pressure, and body movement. Damage to the posterior frontal or anterior parietal lobes can result in the loss of the ability to

express emotion by modulation of speech patterns resulting in aprosody or aprosodia. Individuals with aprosodia speak in a monotone regardless of the situation, but nonetheless experience normal emotional feelings. Lesions involving the parietal lobe may also result in a disturbance or loss of function in perception of size, shape, and texture (agnosia), as well as writing and memory difficulties.

The temporal lobes are located behind the ears and below the lateral sulcus. The functions of the temporal lobes are still being defined, but they are primarily involved in hearing, smell, and taste, with some involvement also occurring in vision and memory. Lesions involving the temporal lobe may produce disturbances in hearing and memory and in the regulation of emotional behavior. The occipital lobes are located at the extreme back of the head, and contain the visual cortex, which is involved in visual perception. Damage to the cortical visual areas of the occipital lobes may result in blindness.

The limbic system is a set of brain structures located at the top of the brainstem and buried under the cortex. The structures of the limbic system are highly influential in complex functions of emotional behavior such as stress, motivations, emotional responses, and memory. Structures of the limbic system include the following: amygdaloid complex (amygdala), hippocampal formation (hippocampus, dentate gyrus, subicular region), hypothalamus, thalamus, olfactory cortex, basal ganglia, and septum. The amygdala is located deep in the dorsomedial portion of the temporal lobe and is involved in emotional responses, the detection of threat, and sensory input about olfaction. Lesions in the amygdala can cause behavioural outbursts such as rage or docility. The hippocampus, located within the parahippocampal gyrus on the medial surface of the temporal lobe, is the major regulator of the limbic system. The hippocampus is involved in the formation and encoding of memory, including emotionally charged memories. Damage to the intrinsic structure of the hippocampus, such as occurs with individuals with Alzheimer's disease, results in impaired memory for the recall of facts and events (i.e., declarative or episodic memory). Emotional functioning is also associated with the cingulate gyrus, the septum, and areas in the hypothalamus. The cingulate gyrus, situated above the corpus collusum, is composed of a five-layered cortex as well as the neocortex. The hypothalamus is responsible for overseeing autonomic physiological and hormonal regulation. The olfactory cortex, responsible for our sense of smell, is located in the temporal lobe. The olfactory cortex is composed of the pyriform cortex, periamygdaloid area, and part of the entorhinal area. The olfactory cortex is concerned with conscious perception of olfactory stimuli.

Brainstem

The brainstem connects the spinal cord to the cerebral cortex and consists of three major parts: (1) the midbrain (or mesencephalon), (2) the pons (or metencephalon), and (3) the medulla oblongata (or myelencephalon). The brainstem has three main functions: (1) it is responsible for transmitting information between the spinal cord and cerebrum; (2) it controls consciousness as well as vital functions such as respiration and cardiovascular functioning through its reflex centers; and (3) it contains many cranial nerve nuclei, responsible for much of the movement in the face and neck.

The midbrain is the smallest part of the brainstem and is located directly inferior to (underneath) the diencephalon and superior to (above) the pons. The midbrain has two parts, the tectum and the tegmentum, which are separated by the aqueduct of Sylvius, or cerebral aqueduct. The tectum, located dorsal (toward the back) to the aqueduct of Sylvius, is comprised of four rounded protrusions termed the corpora quadrigemina. The corpora quadrigemina is further divided into two parts, the superior (upper) colliculi and the inferior (lower) colliculi. The corpora quadrigemina controls the position of the head and eyes in response to visual, auditory, and somatic stimuli as well as transmits auditory signals to the auditory center in the cerebral cortex. The tegmentum, located ventral (toward the front or belly) to the aqueduct of Sylvius, contains the red nucleus that controls motor function, the oculomotor nerve, and the trochlear nerve which are both involved in eye movement. Another important structure in the midbrain is the substantia nigra that is involved in reward seeking, addiction, and movement. Degeneration of the substantia nigra is implicated in Parkinson's disease. Finally, the cerebral peduncles, located in the tegmentum, are bundles of nerves that run from the cerebrum to the spinal cord and are responsible for motor control.

The pons is located between the midbrain and the medulla oblongata. It is ventral to (in front of) the cerebellum and is responsible for relaying information between the cerebellum and the cerebrum. Part of the reticular formation, which is responsible for maintaining an awake state, is housed within the pons. Lesions in the pons may cause a coma-like state called 'locked-in syndrome' which is characterized by weakness of the extremities and the face, with a limited level of consciousness.

The medulla oblongata is the lowest structure of the brain and connects to the spinal cord at the foramen magnum. Because of its location, the medulla is responsible for transmitting information from the spinal cord to the higher centers of the brain. The medulla oblongata contains the respiratory, cardiac, vomiting, and vasomotor centers. The medulla also contains part of the reticular formation and controls vital autonomic functions such as breathing, heart rate, and blood pressure. As such, any damage to this portion of the brain may result in respiratory failure and/or death.

Cerebellum

The cerebellum sits dorsal to the brainstem and directly posterior to (or toward the back of) the pons and the medulla oblongata and is connected to all three parts of the brainstem through large bundles of nerve fibers called peduncles. The peduncles connect the cerebellum to the rest of the nervous system. Similar to the cerebrum, the cerebellum has two hemispheres that are covered by a folded surface layer, called the cortex. Both white and gray matter comprise the cortex, which also houses deep nuclear structures. The cerebellum is primarily responsible for motor functions, such as coordination and stabilization of movement, and is involved with maintaining balance. The cerebellum is able to fine-tune movements using the extensive neural connections from the motor cortex of the cerebrum to the spinocerebellar tract (located in the spinal cord). These neural connections allow the cerebellum to gather information regarding intended and actual movement and

make adjustments as needed. Individuals with cerebellar disease may demonstrate slurred speech, poor coordination, and disrupted gait.

Spinal cord

The spinal cord is the lowermost part of the CNS and connects with the brain through the medulla oblongata at the foramen magnum. The spinal cord is shorter than the bony vertebral canal that surrounds it and runs from the foramen magnum to the second or third lumbar vertebra. The spinal cord consists of inner gray matter, containing the nerve cell bodies, and outer white matter, containing the axons of the nerves. In the center of the spinal cord is a space called the central canal, which is filled with cerebrospinal fluid.

The spinal cord has 31 segments of paired spinal nerves and ends with a thin, fibrous thread called *filum terminale*, in the coccyx. The 31 segments are divided into regions: (1) the top 8 segments comprise the cervical region such that C1–8 nerves exit the spinal cord in the cervical region or in the neck; (2) the next 12 segments are part of the thoracic region such that T1–12 nerves exit the spinal cord in the thoracic region or the chest; (3) the next 5 segments make up the sacral region such that L1–5 nerves exit the spinal cord in the lumbar region or the lower back; (4) the S1–5 nerves exit the spinal cord in the sacral region or near the pelvis; and finally, (5) the last segment consists of the coccygeal nerves which exit the spinal cord near the coccyx, or tailbone. The main purpose of the spinal cord is to transmit and receive information between the brain and the rest of the body (muscles and glands). The spinal cord also has some of its own neural circuits that are responsible for reflexes and rhythmic movements, such as locomotion and respiration.

Spinal cord injuries affect the whole body; however, impairments in sensation and/or motor ability typically occur below the site of the injury. For this reason, some persons have altered functioning in their legs and lower body only (paraplegic), while others have altered functioning involving all four limbs (tetraplegic). As such, spinal cord injuries are classified according to the affected individual's degree of loss of motor and/or sensory function.

Behavior

Sensation and Perception

All human contact with the outside world is contingent upon sensation and perception. Sensation is the process of receiving physical stimulation through specialized sensory organs. Perception is the process of becoming aware of, modulating, integrating, and interpreting sensory stimulation. Perception represents the modification and organization of incoming stimuli. Specialized receptors convert sensory stimuli (e.g., light waves) into neural activity in the form of either graded potentials or action potentials, which is a process called transduction. The sensory systems include vision, audition (hearing), taste, olfaction (smell), and somatic sensation (touch).

Visual system

The sensory organ of the visual system is the eye, which detects and focuses stimuli. Light enters the eye through a transparent

outer covering known as the cornea. Subsequently, light travels through the pupil, an adjustable opening in the iris (the colored part of the eye), is focused by the lens, and finally falls on the light-sensitive area of the eye, referred to as the retina. Within the retina are two visual receptor cells: rods and cones. Rods are visual receptors that are sensitive to low-intensity light and are involved in night and peripheral vision; cones are mainly found in the central region of the retina and permit color vision.

Once the rods and cones are stimulated, they carry visual impulses via the optic nerve, the large nerve that carries visual impulses from the retina to the visual processing areas of the brain, to the optic chiasm. At the optic chiasm, approximately one-half of the fibers from each eye's optic nerve cross to the other side of the brain. These fibers cross to the other side of the brain from the nasal portions of each retina. As a result, information from each eye reaches both sides of the brain, with signals from the left visual field terminating in the right hemisphere and signals from the right visual field being sent to the left hemisphere. Finally, these optic tracts travel to the thalamus and ultimately to the primary visual cortex of the occipital lobe.

Auditory system

The ear is the sensory organ of the auditory system. From the outer ear, sound waves enter the auditory canal and travel to the thin membrane known as the eardrum (tympanic membrane). Sound waves cause the eardrum to vibrate, which creates movement in the three ossicles (tiny bones) of the middle ear: the malleus, incus, and stapes. The ossicles amplify vibrations and then transmit these higher-pressure sound vibrations to the oval window, the membrane that leads from the middle to the inner ear. The oval window then sends the sound information in wave form through the fluid of the inner ear to the cochlea. Attached to the basilar membrane of the cochlea is the organ of Corti which contains auditory receptor cells known as hair cells. The hair cells are compressed between the basilar membrane and the tectorial membrane. Fluid sound waves in the cochlea move these two membranes in such a way that the hair cells are bent and distorted, thus transforming the fluid waves into neural impulses in the adjacent auditory nerve. The impulses follow pathways from the cochlea via a series of nuclei to the thalamus; finally, the signal ends in the primary auditory cortex, which is located in the temporal lobe. The auditory system is bilateral, meaning that each ear projects to both sides of the brain.

Taste and smell

Taste and smell (olfaction) are referred to as chemical senses because both transduce chemical signals into perception. The primary receptor cells for taste are located in the taste buds (gustatory calyculi), concentrated on the upper surface of the tongue. The taste buds are sensitive to five basic tastes: bitter, sweet, sour, salt, and umami (savory). Other tastes are considered to be a combination of these five qualities and/or a mixture of taste and smell. In humans, signals from the taste buds are conveyed to the brain through three different cranial nerves (facial, glossopharyngeal, vagus) that, combined, form the tractus solitarius in the medulla oblongata. From here, the signals cross the midline and continue, via the thalamus, to the

insula and the somatosensory cortex (tongue area), ultimately leading to the experience of taste. A second branch of the tractus solitarius projects to the lateral hypothalamus and the amygdala, areas that are involved in feeding.

In contrast to taste, there are hundreds of olfactory receptors, each of which binds to a particular molecular feature. The primary receptor cells for olfaction are located within the olfactory epithelium, the membrane that lines the roof of the nasal cavity. The axons of these olfactory receptor cells synapse in the olfactory bulb. From there, the olfactory nerve passes through the pyriform cortex and subsequently to the thalamus and the orbital frontal cortex. Olfactory receptor cells are not specific to single odors; instead, each odor molecule possesses a variety of features that excite specific receptors in varying degrees. In fact, it is believed that the combination of multiple signals from different receptors is processed in the olfactory system to form the experience of a particular smell.

Somatosensory system

The somatosensory system includes the following cutaneous or skin senses: pressure (touch), pain (nociception), vibration and temperature, position sense (proprioception), and body movement (kinesthesia). The somatosensory system reacts to diverse stimuli and skin sensations through the mechanical, chemical, and thermal properties of the tissue in which the sensory nerves terminate. The quality of sensation is also due to variations in temporal and spatial patterns of neural discharge in the sensory nerves. Axons that carry information from cutaneous receptors gather together in nerves that enter the spinal cord through the dorsal roots; these nerves are organized into two systems in the spinal cord, the posterior column–medial lemniscus pathway and the spinothalamic tract. Both systems ascend to the posteroventral nuclear complex of the thalamus, which, in turn, sends projections to the somatosensory cortex. The posterior column–medial lemniscus pathway is responsible for transmitting pressure and position senses; the spinothalamic tract mediates the sensation of pain and temperature. The arrangement of these projections in the postcentral gyrus generally represents the body parts topographically, with the legs at the top and the hand at the bottom of the gyrus.

Motor System

The motor system is the part of the CNS that is involved in movement. The motor system consists of a number of subsystems including the spinal cord, the brainstem, the cerebellum, the basal ganglia, and the neocortex. These structures are all closely interconnected and do not function in isolation. In fact, some of these connections are arranged in parallel and hierarchical systems exist within the motor system. The brainstem and cortex each influence the spinal cord autonomously for the purpose of invoking movements, but each system is also interconnected with the other system, thereby permitting them to influence each other. The cerebellum is a crucial coordinating center in the motor system; it directs balance and posture. Along with the basal ganglia and motor cortex, the cerebellum is essential to the performance of coordinated and refined motor movements. Damage to the cerebellum can result in ataxia, a lack of muscle coordination during voluntary

movements that can affect movement, speech, balance, and gait. The basal ganglia represent another level of the motor system. These substantial subcortical nuclei are important in the initiation and control of voluntary movements, particularly in the regulation of muscle tone. Damage to the basal ganglia and the regulation and initiation of motor commands can result in either decreased motor activity (e.g., akinesia) or generation of involuntary movements. These disruptions are most prominently observed in the tremors and rigidity of Parkinson's disease or the uncontrollable limb movements of Huntington's chorea.

The motor cortex follows two different major pathways to descend into the spinal cord; these are referred to as the lateral and ventromedial systems. These pathways allow each hemisphere to control the trunk on the corresponding side of the body and the arms and legs of the opposite side of the body. Ultimately, both pathways synapse with motor neurons located in the nuclei of the cranial nerves and in the ventral horns of the spinal cord. The motor neurons are the final link in the pathway, projecting directly into the muscles. The lateral system projects from both the cortex and the brainstem in one hemisphere to the spinal cord of the opposite side. The lateral system contains the axons of the cortical neurons that are responsible for the muscles and the extremities. Specifically, the lateral system includes the corticospinal and rubrospinal components. The corticospinal component connects directly with motor neurons and is involved in the movement of distal musculature (i.e., fingers and hands) on the contralateral side of the body. The rubrospinal component connects with interneurons and then with motor neurons that control the musculature of the shoulders, arms, and hands. The other major pathway, the ventromedial system, projects to interneurons of the spinal cord from the cortex and the brainstem. Unlike the lateral system, the ventromedial system does not change sides when it enters the spinal cord. This system descends directly into the ventral and medial part of the spinal cord, where it innervates motor neurons that control the musculature of the trunk.

For both motor and sensory cortex, a topographical relationship exists between body parts and locations within the neocortex. This relationship is often demonstrated schematically in texts by cartoon men or homunculi drawn over the motor and sensory areas to represent this type of organization. The face and the hands of the homunculi are larger than other body parts, as they are capable of finer perceptions and movements. Thus, relative to other body areas, they require proportionately more neocortex to be represented accurately.

Cerebral Lateralization

While both hemispheres play a role in most behavior, cerebral lateralization refers to the preferential use of one hemisphere (i.e., left and right hemisphere) of the brain to perform certain cognitive functions. Although on initial examination the left and right cerebral hemispheres appear to be quite similar, a detailed examination reveals numerous anatomic differences that are believed to support functional asymmetries. For example, the superior temporal portion of the planum temporale, a cortical region posterior to the auditory cortex, is larger on the left side in the majority of

individuals and this difference in size is believed to reflect left-hemisphere specialization for language.

Information about hemispheric contributions to cognitive function and hemispheric specialization was initially obtained from studies of split-brain patients whose corpus callosa were severed as treatment for severe epilepsy. Additional evidence from studies of patients with lateralized brain lesions and normal individuals evaluated under specialized laboratory conditions also suggest differences. Specifically, for most people, the left cerebral hemisphere is dominant in the control of speech, language and analytic processing, and mathematics. In contrast, the right hemisphere appears to be specialized in spatial-relational processing, creativity, and facial recognition. Although the two hemispheres may be specialized for different types of stimuli, each hemisphere also might have a characteristic processing style that is best suited for analyzing those stimuli. For example, the left hemisphere may process information in a serial, sequential manner, which is conducive to the analysis of language. Alternatively, the right hemisphere has been described as a parallel, holistic processor, more appropriate for handling complex configurations.

Whereas the majority of individuals fit this functional model of lateralization, individual variability is clearly present and is generally related to factors such as handedness and gender. Neuroimaging techniques recently provided support for gender differences in language lateralization, with males utilizing only the left hemisphere and a majority of females activating both the right and left hemispheres on language-related tasks. However, a majority of research supports that some degree of functional asymmetry appears to be present from birth. For example, newborns can accurately discriminate speech from nonspeech sounds and demonstrate greater activation of the left hemisphere in response to human speech.

Language

Language is considered a function that is both lateralized and localized in the brain. The association between damage to the left hemisphere and language impairments is most widely credited to the discoveries of French neurologist Paul Broca and German neurologist Carl Wernicke. Broca found that lesions in the left frontal lobe in an area now known as 'Broca's area' affected speech production. Wernicke discovered that damage to the left temporal lobe results in different language impairment, specifically a difficulty in understanding language. Collectively, these are early descriptions of aphasia, or acquired language disorders that can be traced to damage of specific areas of the brain. Aphasias are classified by different patterns of impairment of language processes. Patients may exhibit disorders of comprehension of speech or written language, or they may exhibit deficits in the production of language. These disorders may affect speech fluency, speech repetition, syntax, grammar, word retrieval, or writing. For example, in all cases when comprehension remains intact,

Broca's aphasia (motor/expressive aphasia) is associated with repetitive speech, phonemic paraphasias (one sound is incorrectly substituted for another), and disrupted grammar and syntax. On the other hand, patients with Wernicke's aphasia (sensory/receptive aphasia) demonstrate fluent speech with adequate syntax and grammar but often include contrived or inappropriate words; thus, problems are largely associated with comprehension.

Studies of split-brain patients have assisted in the identification of the independent function of each hemisphere in language. Specifically, the right hemisphere is largely responsible for prosodic elements, or the emotional elements of language. The right hemisphere also plays a role in rudimentary speech and is largely responsible for spatial abilities. Research on individuals who are deaf, who use sign language, reveals that similar areas of the brain are involved in sign production. This line of research also indicates that damage to the left-hemisphere language area is more likely to produce signing aphasia than damage to the same area in the right hemisphere. As such, the lateralization of language is preserved in deaf individuals.

In addition to clinical investigation of patients with brain damage, the major brain regions involved in language have also been identified by using cortical stimulation during brain surgery and functional brain injury. Other areas associated with language include the primary sensory and motor regions of the face and the supplementary motor area.

See also: Aphasia; Glial Cells; Hippocampal Formation; Language Development; Memory; Motor Control; Sense of Smell; Touch; Visual Perception.

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Child Abuse

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Glossary

Attachment Developed by John Bowlby and Mary Ainsworth, it is an innate emotional and behavioral system of protection for children that includes a child's attachment system and a parent's protection system.

Child neglect It is the failure of a parent or caregiver to provide for a child's basic emotional, medical, educational, and physical needs. Forms of neglect include emotional, medical, educational, and physical.

Child sexual abuse Sexual abuse involves an adult engaging a child in sexually explicit conduct, including direct sexual contact, simulation of sexual contact, or visual representation of sexual contact. This may include rape, molestation, prostitution, child pornography, incest, or other forms of exploitation.

Emotional abuse Also called psychological abuse, it is a pattern of parenting or caregiving that degrades a child or impairs healthy development.

Human trafficking It is the recruitment, transportation, transfer, harboring, or receipt of persons by means of threat, or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or position of vulnerability, or the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation.

Physical abuse It is nonaccidental injury, inclusive of all levels from bruises to death, as a result of harm from a parent, caregiver, or adult responsible for a child's care.

Introduction

Throughout history, most cultures prohibited the abuse of children. Since the future of families, groups, and nations depends on the success of children to move forward and bear their own children to continue the species, most cultures have stated or implicit values about protecting children from harm. Children are generally valued for their representations of emotional connections between parents or others and serve as profound symbols of hope for the future as concrete protectors of traditions, caregivers of elders, and producers of new resources and subsequent generations. In addition, children are the rejuvenators of families and communities, renewing adults' senses of possibility.

Human children are altricial mammals, vulnerable at birth and unable to survive outside the care and support of a caregiving adult, usually a mother or parent. In this sense, there is no individual infant or young child independent of a dyad or family. On his or her own without a responsive and protective parent, caregiver, or community of caregivers, an infant or young child will not survive. Thus, millennia of evolution created complex and strong caregiving and protection systems for human children that are part of the fabric of all communities.

Nonetheless, child abuse remains a serious social problem, as children are some of the most vulnerable members of our societies and prone to victimization by those stronger than them or on whom they depend for care and protection – adults. While abuse against children is often perpetrated by nonfamily members, it is the exception rather than the rule. Outside areas of conflict such as war zones, children are more likely to be harmed, or put in harmful situations, by a family member or someone close to them in their community.

In this article, we provide an overview of child abuse as it pertains to intrafamilial child abuse or child maltreatment

perpetrated by a family member or a person close to a child. This includes four general types of child abuse: physical abuse, sexual abuse, neglect, and emotional abuse. However, we have also included information on human trafficking, which may be the result of intrafamilial or extrafamilial maltreatment, as it is an area of child exploitation, affecting children and mothers, that warrants further investigation and concern.

The theoretical framework used for this article is attachment and parent–child relationships with the view that child abuse is an extreme form of relationship-disruptions for children. As such, child abuse risk factors and protective factors for children, parents or caregivers, and community is reviewed with a particular focus on the role of relationships in contributing to maltreatment, ameliorating its traumatic impact, and preventing its occurrence. Child abuse treatment models reviewed here focus on interventions that repair a child's capacity, and a parent's or alternative caregiver's capacity, to enter into trusting and emotionally responsive relationships.

Attachment

Young children rely on their mothers or other caregivers for protection and guidance. Ideally, when a young child calls out for help or appears to need assistance, a mother or other caregiver will respond with support, nurturance, and protection. This emotional response is believed to be part of innate emotional and behavioral systems of protection – a child's attachment system and a parent's protection system.

Over time, the repeated expression of needs from a child and appropriate responses of emotional and physical support from a parent or other caregiver contribute to a child's feeling of a safe haven with that parent or caregiver. A parent's consistent signaling of emotional availability to a child affirms the stability of a child's safe haven. With a secure attachment

system between a child and a parent or caregiver, a child is able to use the relationship as a secure base from which he or she can explore the world and engage in other relationships based, in part, on the initial attachment system. A child is able to seek assurance and emotionally refuel as needed with a secure base, a responsive parent or caregiver.

In essence, a secure attachment system can create a template for future healthy and emotionally responsive relationships. It is believed that internal working models of relationships are based on early attachments systems between a child and a parent or caregiver. When those attachment systems are secure, derived from emotionally and physically responsive support from a parent or caregiver, a child can integrate a secure internal working model of attachment, encouraging his or her healthy development of autonomous emotional regulation and adept social skills.

If a parent or caregiver is not responsive, emotionally unavailable, abusive, or neglectful, a child is likely to develop an insecure attachment pattern and corresponding insecure internal working model of attachment. Child abuse and neglect can be the result of or contribute to insecure attachment systems. In the long term, children with insecure attachment systems are more likely to have social, cognitive, and mental health deficits.

Attachment Patterns

Four attachment patterns can be predicted from a child's attachment systems: secure, anxious, avoidant, and disorganized. Secure attachment usually emerges from a relatively normal functioning, nonabusive, child–parent relationship and attachment system. Additionally, secure attachment tends to correspond with stable physical, academic, and social development, and a general absence of anxiety and frustration.

Anxious attachments

Anxious, avoidant, and disorganized attachment patterns are classified as forms of insecure attachment and are associated with behavioral, relationship and mental health problems. Anxious attachment is usually produced from anxious, uncertain, and unreliable parenting from a caregiver who may have experienced similar anxious attachment patterns with his or her parents. The anxiety arises from a sense that a parent or caregiver is not reliably there to meet a child's needs. Such anxious attachments emerge from neglectful or inconsistent caregivers, resulting in a child doubting support from others and demanding more attention and reassurance.

Avoidant attachment

When a child's requests for comfort and nurturance are consistently met with insensitivity and unresponsiveness, he or she is likely to develop avoidant attachment patterns. A child with avoidant attachment patterns may exhibit uncertainty and anger resulting from a view of others as unhelpful, cold, or uninterested when a child needed help or support. Avoidant attachment patterns tend to be associated with people who do not trust others and may not be able to fully consider the needs of others.

Disorganized attachment

The most recently identified classification of attachment systems, disorganized attachment, arises from scenarios where a child's attachment figure or parent is observably frightened or frightening when a child needs comforting or reassurance. Disorganized attachment involves frightening and violent behaviors from parents or caregivers and is, therefore, more common with families suffering from combined or distinct problems of child abuse, domestic violence, and family instability. The severe long-term consequences for disorganized attachment systems include later dissociative disorders, anxiety disorders, and serious behavior problems.

Cultural Variations

Though there is general cultural pressure worldwide toward the selection of secure attachment systems, more cross-cultural and contextual attachment research is needed. Attachment theory and research focuses on Western culture models of parent–child relationships, but it continues to expand in consideration of other cultural and subcultural variations of child caregiving. Emerging models of social network support and plural caregiving referencing multiple attachment figures are in the process of being tested and will warrant further consideration in future reviews on attachment.

Types of Child Abuse

Most cultures recognize four major areas of child abuse: physical abuse, sexual abuse, neglect, and emotional abuse. These categories are not fully inclusive of all harm perpetrated on children, and most maltreated children are abused in various forms and not exclusively in one type or another.

Physical Abuse

Physical abuse is nonaccidental injury, inclusive of all levels from bruises to death, as a result of harm from a parent, caregiver, or adult who is responsible for a child's care. The exact detail of what constitutes physical abuse varies by jurisdiction or culture, but usually hinges on the intent of injury to be classified as abuse. Physical discipline is not considered abuse as long as it is culturally and physically reasonable and does not cause bodily injury to a child. However, infants are an exception, and physical discipline of an infant is usually viewed as abuse.

Sexual Abuse

Sexual abuse involves an adult engaging a child in sexually explicit conduct, including direct sexual contact, simulation of sexual contact, or visual representation of sexual contact. The acts of sexual abuse may include rape, molestation, prostitution, child pornography, incest, or other forms of exploitation of a child for the sexual gratification of an adult. Though there are varying legal definitions for child sexual abuse across cultures and jurisdictions, sexual abuse of a child can lead to trauma and stigma for a child and his or her family. Long-term health of a

sexually abused child usually depends on the support of the family or community and protection from further harm.

Child Neglect

The usual hallmark of child neglect is the omission of care rather than the commission of any particular act of maltreatment. Neglect is the failure of a parent or caregiver to provide for a child's basic emotional, medical, educational, and physical needs. Interpretation of child neglect depends on community standards and cultural values, as well as prevailing resources within a community. For example, lack of indoor plumbing or safe housing may be viewed as substandard living arrangement in many communities, leading to a potential assessment of neglect of children living in such conditions. However, in a community that lacks resources and standard housing does not always include indoor plumbing, child neglect may not be an appropriate assessment based on these particular elements.

Emotional neglect

Emotional neglect involves inattentiveness to a child's emotional and development needs. This may take various forms, including allowing independence inappropriate for a child's development needs. For example, permitting a child to use drugs or alcohol could be considered neglectful of a child's emotional and physical development. Interpretations of emotional neglect must also include cultural contexts, as plural or collective caregiving in some cultures and communities may allow for greater variation in emotional responsiveness based on shared caregiving practices. More specifically, a parent's potential lack of attentiveness to a child may be balanced by caregiving and attachment systems with other caregivers, such as grandparents, who are able to respond adequately to a child's needs.

Physical neglect

Physical neglect means a parent or caregiver fails to provide necessary shelter, food, or supervision. In these situations, resources and poverty are important considerations, as a parent or caregiver doing his or her best with meager resources to care for children is not physical neglect. In fact, poverty itself should never be considered physical neglect. Rather, physical neglect involves a risk to a child's health and safety and may involve parents failing to use the resources available to them to support children's needs.

Examples of physical neglect include

- *Unsanitary living conditions:* Home is unsafe or set near unhealthy or unsanitary conditions, which may cause sickness or harm to a child, and a parent or caregiver does not respond to a child's needs.
- *Unstable living arrangements:* A parent or caregiver does not have a stable home (e.g., homeless), and the instability presents a danger to the health and well-being of a child.
- *Abandonment:* A child is left without adequate care and supervision or without a plan for the child's care, leaving a child at risk of harm.
- *Exposure to drugs and alcohol:* Parents' or caregivers' addiction to drugs and alcohol presents a host of risk factors for children. Children exposed to drugs or alcohol prenatally

have special medical needs that require ongoing attention, and parents or caregivers who continue to use drugs and alcohol may be very challenged to fully address an infant's needs.

Medical neglect

Not providing for a child's medical or mental health needs may be considered medical neglect. Of special sensitivity are those situations where a child has a life-threatening condition that requires medical intervention and a parent or caregiver does not or will not attain professional services. The contextual considerations for these matters include parental or caregiver resources and the capacity to care for a medically fragile child and religious beliefs that may be counter to recommended courses of action. In the latter case, court intervention may be needed to obtain the right balance between community and familial standards in consideration of the best interest of the child.

Examples of medical neglect include

- *Inadequate or delayed health care:* A parent or caregiver is not able to care for a child's acute or chronic medical condition, physical, or mental disability that if left untreated causes harm or danger to a child.
- *Inadequate nutrition:* A parent or caregiver is unable to provide for a child's basic nutritional needs or purposefully withholds food and water.
- *Lack of treatment for mental health:* A parent or caregiver does not provide for necessary mental health concerns causing potential health and emotional impairment for a child.

Educational neglect

Inattention to a child's educational needs or failing to attend to a child's special education needs may be viewed as educational neglect. Considering community standards and resources as well as the mandatory education requirements of a culture, educational neglect involves deliberate lack of attention to a child's educational needs even when a parent or caregiver has been fully informed of his or her responsibility for that child's education and services have been made available. In these instances, a parent or caregiver may lack the physical or mental capacity to help a child with educational needs so efforts may be necessary to ameliorate both a child's and parent's or caregiver's needs.

Examples of educational neglect include

- *Unmet special education needs:* A parent or caregiver is unable or unwilling to have a child participate in special learning or remedial education programs, contributing to a child's learning disabilities.
- *Chronic truancy:* A parent or caregiver does not provide for a child's learning needs by not enrolling a child in school or not supporting a child's attendance.

Emotional Abuse

Emotional abuse, or psychological abuse, is a pattern of parenting or caregiving behavior that degrades a child or impairs healthy emotional development. This may involve constant demeaning or belittling comments and criticisms that impede a child's capacity to function and causes emotional strain for a

child. Withholding of parental or caregiver love, support, and guidance may also be considered emotional abuse if it causes undue strain and anxiety for an involved child.

Examples of emotional abuse include

- *Isolation*: A parent or caregiver does not allow a child to interact with peers or others causing undue dependency and potential harm to a child's physical and emotional development.
- *Ridiculing and degrading*: A parent or caregiver constantly belittles, degrades, and ridicules a child causing emotional harm and shame.
- *Witnessing violence*: A parent or caregiver allows a child to repeatedly witness criminal activities between caregivers and others.

Human Trafficking and Exploitation

Human trafficking is a modern-day form of slavery and is increasingly recognized as an emerging type of child abuse. It is estimated that 600 000–800 000 people worldwide are trafficked annually. No country in the world has been exempted from human trafficking. The Palermo Protocol adopted by the United Nations provides the most commonly recognized definition of human trafficking described as

the recruitment, transportation, transfer, harboring, or receipt of persons by means of threat, or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability, or the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labor or services, slavery or practices similar to slavery, servitude, or the removal of organs.

The primary forms of human trafficking are sex trafficking, sex trafficking of minors, and labor trafficking. Other forms of human trafficking include the trafficking of children for adoption and trafficking of organs. Women and children are the most vulnerable groups of individuals trafficked, with ~50% of all persons trafficked being children under the age of 18 years.

Causes and Contributing Factors

The underlying causes of human trafficking are issues of poverty that have been compounded by the rapid growth of communication technology and globalization. Victims are trafficked within countries of origin and transported across international borders. Collapses of economic systems in some governments and regions have left large segments of the population desperate for money for survival. Women and children have been hit particularly hard by poverty. It is estimated that internationally 70% of all persons who are living in poverty are women. Desperate for work and a way to support their families, many women have been lured into slavery through employment agencies and false advertisements that promise work abroad. Many women who have responded to these false advertisements have disappeared and are assumed

to have been trafficked. In poor countries, children are left alone to parent themselves and younger siblings. The issue of families without an adult parent or caregiver is so relatively common in some parts of the developing world (e.g., areas of extreme poverty) that the term 'child-led families' is used to describe parent-less families. Children, left to fend for themselves, have become victims of traffickers and have also disappeared without a parent, family, or community to protect them or seek assistance when they disappear.

In the United States, many children who have run away from child welfare services (e.g., foster care) have become victims of traffickers and prostituted. Adolescents have been found to have been blackmailed into prostitution by gangs who first provide them with drugs, and when addicted require payment to support the addiction. Some traffickers take pornographic photos of victims, then threaten to expose them to their parents unless they cooperate, causing some adolescents to be secretly forced into prostitution while still living at home.

Psychological and Health Issues

Human trafficking has consequences that interfere with the developmental milestones expected during childhood and adolescence. Captivity interferes with the development of one's identity and the establishment of societal or cultural morals and values. They experience psychological distress that includes depression and posttraumatic stress disorder. The psychological stress is so great that many captive women and children commit suicide. The overall psychological impact of the abuses of human trafficking can profoundly change the development of one's character and personality.

During captivity, victims are exposed to sexually transmitted diseases and other health problems that worsen due to a lack of appropriate medical care. Women become pregnant and experience lasting health problems as a result of poorly performed or botched abortions, the lack of adequate medical care, and poorly met nutritional needs. As a result, those who are released from bondage are often seriously incapacitated or terminally ill.

Long-Term Consequences

Children born into captivity are exposed from birth to inconsistent care. From the earliest period of awareness, babies experience deeply traumatized and despairing mothers creating insecure attachment systems and poor internal working models of relationships. They experience their mothers as powerless and unable to protect them from their abusers. Born into captivity, these psychological conditions leave many children to identify with a detached and emotionally absent mother.

Many women who give birth during captivity are minor children and unable to parent. For these women, their children are a reminder of the rape and abuse they experienced while in captivity and the men who abused them. These issues interfere with the emotions of giving and receiving love as well as a capacity to establish secure attachment systems for self or others.

There are long-term consequences for children born into captivity. If a captive mother is unable to psychologically

nurture a child, that child is at risk of becoming detached, limiting the emotional capacity for giving and receiving love. Some captive mothers are able to give and receive love from their children. When this happens, a child's need for safety may cause a mother to risk the consequences of an attempt to escape captivity. In other, more desperate situations, the love returned by a child may keep a mother from committing suicide. The loss of psychologically healthy women able to nurture the next generation of children will have long-term consequences on society. Consequently, emerging research and information about human trafficking is worthy of additional consideration in future reviews of child abuse both as a distinct type of child abuse and as a consequence of other forms of child maltreatment.

Risk Factors and Protective Factors

While child abuse is found in all cultures and all socioeconomic strata, social science data and research, mostly from Western countries, reveal some general risk and protective factors relative to child abuse. Risk factors are the individual and familial variables that appear associated with children, individuals, and families for whom child abuse has been a problem. Protective factors represent the variables that seem to thwart occurrences of child abuse for individuals and within families or communities. These factors should be considered global indicators, as the presence of, or lack of, any factors does not predict, or counteract, child maltreatment. Rather, risk and protective factors can guide assessment of child abuse and planning for programs to ameliorate its effects on children and families.

Some suggest that risk and protective factors are additive features that can be simply balanced out as needed. Specifically, an increase in protective factors and a reduction in risk factors would theoretically reduce the chances of harm to a child. This may be true in some cases but it has yet to be determined across all aspects of child abuse. Instead, risk factors should be viewed as signals of concern and protective factors as areas of strength. The following review of risk factors and protective factors summarizes some of these factors in the contexts of parents or caregivers, children, and community.

Risk Factors

Parents or caregivers

For parents or caregivers, risk factors generally correspond to a lack of resources, materially, emotionally, and socially. Many parents or caregivers who abused their children were themselves victims of abuse or had insecure attachments with their parents or primary caregivers. Relatedly, abusive parents have less knowledge or understanding about the emotional or developmental needs of their children, expecting more than what might be appropriate for their children's age or attributing negative attitudes of feelings to their children. These mismatches of developmental expectations may be exacerbated by a parent's own poor romantic relationships or high conflict within the home with other adults or other children.

Mental health issues are clear risk factors for a parent or caregiver, especially depression and anxiety. Coupled with

social isolation, single parenthood, and poor social support, compromised mental health can contribute to elevated stress that can manifest in child abuse. Moreover, a parent or caregiver with a history of being abused or neglected is more likely to repeat that approach with his or her own children when there is an accumulation of other risk factors.

Alcohol and drug addiction is a major risk factor that seems increasingly correlated with numerous other social problems in addition to child abuse and neglect. It is difficult to disentangle other risk factors from drug and alcohol addiction, but it is the one risk factor most associated with child abuse, possibly because it is both an outcome and a contributor to other child abuse risk factors. Additionally, it creates a social scenario and lifestyle for a parent or caregiver that contains risk for the adults involved, let alone for the dependent children living with them and relying on their good judgment.

Children

Risk factors for children begin in utero where a forming child may be exposed to toxins from a mother's use of drugs or alcohol. The effects of these toxins can have profound impacts on a child's lifetime capacity to regulate intellectually and emotionally. Fetal Alcohol Spectrum Disorder, for example, can seriously alter a child's ability to read social cues, including verbal and nonverbal, contributing to challenging social interactions with family and others.

Children with difficult temperaments are prone to abuse and neglect because they tend to be more challenging behaviorally than other children. In fact, behavior problems or externalizing behavior (acting-out behavior) from children are often cited by nonabusing parents as well as abusing parents as the most challenging part of parenting. Also at greater risk of abuse are children with developmental, intellectual, and physical disabilities as they can be less responsive to caregivers and may cause additional stress given their special needs. Further, children who have experienced trauma, including those maltreated by a parent or caregiver, respond to caregivers in ways that appear to reject affection and care creating new risks of maltreatment for those children with histories of being abused.

Community

Stressful environments or neighborhoods can contribute to disruptions in parent-child relationships and create contexts for maltreatment of a child. Parental unemployment and other stressful family life events, including uncertain housing and homelessness, can be environmental risk factors for child abuse. Racial, economic, or cultural discrimination also form a broad context of systemic risk for children and families that may potentially elevate risks for child abuse.

Protective Factors

Parents and caregivers

In contrast to risk factors, protective factors for parents and caregivers correlate with material, emotional, and social resources. Strong, early parent-child relationships defined by secure attachment systems can help inoculate a child against maltreatment from a parent or caregiver. This protective factor depends on a parent's or caregiver's own attachment systems

with his or her own parents or significant others. In fact, marriage or parenting with another supportive caregiver can be a protective factor. Networks of supportive friends and family who can serve as substitute caregivers and with whom a child can develop independent, secure attachment relationship help protect a child from incidents of abuse. Further, parental, familial, or community knowledge of child development and associated parenting skills connected to a child's varying needs at different periods of life can help protect a child against episodes of maltreatment.

Children

Healthy development including a stress-free prenatal period helps protect a child against child abuse as well as a range of other health, cognitive, and social challenges. Meeting or exceeding developmental milestones supports a child's capacity for normative emotional skills and his or her ability to form a secure attachment system with a parent or caregiver. An agreeable temperament and adequate cognitive abilities can also help a child with a range of social tasks with peers and adults, potentially reducing stress and conflict with a parent or caregiver.

Community

Supportive extended family and neighborhoods can help form protective environments for children and families. Formal and informal community networks, especially those that offer judgment-free support for parents or caregivers, can help alleviate stress at home and help potentiate healthy relationships between children and their parents or caregivers. Additionally, positive peer relationships for children and adequate educational and extracurricular resources are essential components of a healthy community.

Treatment and Support

Safety

The first step in treating issues of child abuse is child safety. This may take the form of removing a perpetrator of child abuse from a home or placing a child temporarily in alternative care with a safe kin or nonkin foster family. In most cultures, these initial moves are viewed as temporary to allow for additional planning to assess the core issues underlying the history of maltreatment. Viewed in the context of relationship-disruptions and potential insecure attachment systems, child abuse interventions reviewed here will be those targeting young children and their parents or alternative caregivers (e.g., kin or nonkin foster parents, adoptive parents).

In advance of relationship-enhancing interventions, specialized treatment may be needed for a maltreating family, especially the perpetrator as the source of continuing danger, relative to reabuse. For example, child sexual abuse requires specialized treatment for perpetrators, usually addressing sexual deviancy with a combination of cognitive-behavioral and medical methods. Similarly, families and perpetrators of physical abuse need ongoing treatment addressing cycles of rage and assault. In these instances, it is likely and necessary that court or criminal jurisdiction will be applied to a child abuse matter, creating additional external accountability.

Interventions

Abused children need individual support and interventions to address issues of trauma associated with abuse and the potential familial disruptions associated with it. While stability of a safe home and a secure relationship with a caregiver who will protect him or her are paramount to the emotional needs of a child, attention must also be paid to the individual traumatic events of abuse. Mental health professionals skilled in trauma counseling should be engaged to support a child's needs as soon as possible following interventions due to maltreatment.

Maltreatment has dire effects on a child's health and well-being. Children who are abused are at far greater risk for developmental, health, and educational problems than the general population of children. Abused children have more behavioral and mental health problems than nonabused children and are more likely to use mental health services. Attention to the unique mental health needs of these children is a critical component of their long-term health.

Using an attachment framework, the following interventions have been demonstrated to be effective with maltreated children and their parents or caregivers in repairing or improving parent-child relationships. These interventions are described here as representations of potential models for professionals treating abused children and their families. The categories of parental internal working models, parental behavior, and parent-intervener relationship reflect the general approach of the interventions.

Parental internal working models

Child-parent psychotherapy (CPP) is a dyadic intervention for young children and their parents. It is intended to help parents come to grips with their own compromised childhood attachment systems to help prevent child maltreatment and improve current parent-child relationships. In general, CPP helps address insecure attachment issues that undermine parental capacity and contribute to risks of maltreatment.

Attachment and Bio-behavioral Catch-up is a brief home visiting program for foster parents and young foster children. Paying close attention to a foster parent's own attachment history, home visitors help address a foster child's need for security and help foster parents understand behavior from a child in their care that may appear to be rejecting the foster parents. It helps address problematic internal working models for the foster parent, redirecting attention to the emotional needs of a foster child.

A group-based educational approach, circle of security, helps parents or caregivers better understand a child's relationships needs. Using guided reviews of parent-child interactions, parents or caregivers learn to better read a child's cues for security and exploration. Initial studies with families who experienced the trauma of child abuse indicate that insecure attachment patterns were significantly reduced following interventions.

Parental behavior

Parent-child interaction therapy is designed for families with children who are behaviorally disruptive or have mental health concerns. Using in vivo coaching, parents learn new techniques to address a child's externalizing behavior. Treatment

concludes once parents or other caregivers master the techniques for managing a child's behavior.

Triple P – Positive Parenting Program promotes positive parenting approaches through a variety of sources: multimedia, professional consultations, and self-directed modules. Triple P originated in Australia, and its multilevel program is intended to prevent severe emotional and behavioral problems in children by helping parents or other caregivers manage difficult behaviors. Triple P has been successful in reducing parent-reported child behavior problems and parenting problems.

In the Netherlands, models of short-term intense home visiting have helped mothers of irritable infants and young children with externalizing behavior problems. After learning sensitive disciplinary practices and reviewing cues about their children's behaviors, mothers appeared to be more securely attached to their children than those who did not participate, and the effects of the interventions persisted over time. These models may have broader application across cultures as they are short term and simple for both the involved parent or caregiver and home visitors.

Parent–intervener relationship

Two similar interventions with at-risk mothers and their babies, the UCLA family development project and Minding the Baby, use the relationship of the intervener with a mother to establish secure attachment with a baby or expected baby. Through an established secure base with an intervener, a participating mother was able to build reflective capacity to address the emotional needs of her child. With both approaches, early interventions in support of expectant mothers' emotional and relational needs helped prevent development of risk factors for abuse by strengthening protective factors of secure attachments.

Summary

Child abuse is a global social problem defined broadly as physical abuse, sexual abuse, neglect, and emotional abuse of children by adults who are usually family or community

members. Human trafficking involves exploitation of children who are vulnerable due to extreme poverty, child abuse, and other difficult social pressures. Maltreatment by parents and caregivers contributes to insecure attachment systems for children, potentially leading to unhealthy internal working models of relationships that may be transmitted to maltreated children's subsequent relationships, including those with a new generation of children. Risk factors relative to child abuse can help intervening professionals identify those children who may potentially be harmed, while protective factors can help families and communities build personal and environmental strengths toward preventing child maltreatment. Evidence-based treatment programs aimed at enhancing relationship capacity for children and parents or caregivers are available to help maltreated children and their families address severe relationship-disruptions characteristic of child abuse.

See also: Family Systems; Parenting; Parent–Offspring Conflict.

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Childhood Mental Disorders

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Glossary

Child psychopathology The study of psychological and behavioral disorders in children and adolescents, taking into account developmental processes and milestones.

Comorbidity The diagnosis of more than one mental disorder in any given individual.

Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) A manual published by the American Psychiatric Association that provides a common

language and criteria for the diagnosis of mental disorders.

Prevalence The proportion of individuals in a population diagnosed with a specific disorder.

Prognosis The likely outcome associated with a diagnosis or disorder.

Somatic complaints Unexplained medical symptoms.

Taxonomy The science of classifying plants, animals, and microorganisms into increasingly broader categories based on shared features.

Introduction

The current field of study for childhood mental disorders is often referred to as child psychopathology, which involves the study of psychological and behavioral disorders in children and adolescents. In order to be considered as meeting the definition of a mental disorder, there must be a pattern of symptoms that leads to some level of distress, disability or interference with daily functioning, and an increase in risk for pain, suffering, or loss of freedom (e.g., institutionalization). In addition, the symptoms are not consistent with the norms of the culture, though they may appear to be exaggerations of normal behavior or can occur in adaptation to some unusual circumstance (e.g., chronic illness, maltreatment).

The Diagnostic and Statistical Manual of Mental Disorders (DSM) was originally developed as a taxonomy to categorize these patterns of behaviors into distinct mental disorders. Currently, the DSM is in its fourth edition (DSM-IV) and a fifth edition is expected to be released in 2013. The DSM-IV lists numerous disorders as 'usually first diagnosed in infancy, childhood, or adolescence,' and these disorders will be discussed in the current article. Mood disorders and anxiety disorders are also common in children and adolescents, though in some instances they may not be diagnosed until adulthood. This review will focus on childhood mental disorders that are commonly seen in clinic populations, including the mood and anxiety disorders, attention-deficit and disruptive behavior disorders, and pervasive developmental disorders (PDDs).

Recent estimates suggest that 10–20% of youth meet criteria for a specific psychological disorder. Unfortunately, the majority of children with mental health problems do not receive services. About 20% of children with mental health problems will have significant difficulty throughout their lives, suggesting that childhood psychological disorders are long-lasting and continue into adulthood.

Anxiety Disorders

Anxiety in children is often an unrecognized and undiagnosed problem because some symptoms of anxiety are normal in

development (e.g., stranger anxiety in toddlerhood), many symptoms are not easily visible (e.g., increased heart rate), and the effects are not as damaging as those arising from disruptive behavior disorders (e.g., fighting, property destruction). While not easily identified, anxiety disorders in young people do exist and can be chronic.

Anxiety is a mood state that is often viewed as having three interrelated components – physical, cognitive, and behavioral. The physical component is mediated by the sympathetic nervous system and the endocrine system, and essentially involves the chemical and stress reactions that mobilize the body for action. This response is sometimes referred to as the fight/flight response, and prepares us to either flee or defend ourselves in dangerous situations. The cognitive component includes mental processes that allow us to search for potential sources of threat. This component can lead to worry or nervous apprehension. Finally, the behavioral component includes acts associated with anxiety, particularly aggression, avoidance or escape of the situation, and other nervous behaviors (e.g., finger tapping). Therefore, anxiety is characterized by a strong negative emotion accompanied with bodily fight/flight symptoms, apprehension of future danger, and a desire to avoid the feared situation.

In general, anxiety is thought to have some evolutionary survival value by preparing individuals physically and psychologically to cope with potentially dangerous situations. Some anxiety, therefore, is necessary for normal adjustment and coping. When anxiety becomes excessive and disabling, however, the child may have an anxiety disorder. Multiple anxiety disorders are specified in the DSM-IV and they will be reviewed here.

In general, the onset of anxiety disorders has been attributed to biological, behavioral, and social influences that lead to the dysregulation of the normal anxiety response. This disruption then results in undifferentiated anxiety, and ultimately distress and impairment. For example, being bitten by a dog may result in an animal phobia, being teased by classmates at school may result in social anxiety, and biological vulnerability may result in panic disorder. More specifically, the biological mechanisms associated with the onset of anxiety include an overactive behavioral inhibition system, overactive amygdala, increased cortisol levels, increased heart rate, blood pressure and electrodermal responding, as well as genetic influences

(i.e., 33% of the variance in anxiety is believed to be genetic). Family influences include excessive parental control, rejection, overprotection, or modeling. In terms of temperament, children who are born with a low threshold for novelty and unexpected stimuli are at greater risk for anxiety disorders. Countless influences have been identified as playing a role in the onset of anxiety disorders in children and a few of these mechanisms have been reviewed here.

Separation Anxiety Disorder

Separation anxiety disorder (SAD) is the only anxiety disorder in the DSM-IV that is specified as usually the first diagnosed in infancy or early childhood. SAD involves age-inappropriate, excessive, disabling anxiety about being away from home or from those individuals to whom the child is attached. According to the diagnostic criteria in the DSM-IV, the disturbance must last at least 4 weeks and begin before the child is 18 years old.

Separation anxiety is typical in toddlerhood, and so this disorder may be difficult to distinguish from anxiety that is developmentally normal. SAD occurs in about 4–10% of children and is equally common in boys and girls. Children with SAD may experience excessive distress when separated from their major attachment figures. They often need to know the location of their attachment figures and need to stay in frequent contact with them. They may become very ‘homesick’ when away from home and may become worried that something tragic will happen to their attachment figures while they are separated. Because of these fears, the children may avoid traveling independently away from home. For example, they may refuse to attend school, camp, or a sleepover at a friend’s house. Children with SAD may also refuse to engage in activities where they are alone, such as sleeping in their room. These children may sometimes have nightmares about their separation fears (e.g., being kidnapped), and they may also have physical complaints such as stomachaches and headaches.

Of all the anxiety disorders, SAD has the earliest onset. It often occurs after the child has experienced a stressful event (e.g., the hospitalization of a parent). SAD generally has a good prognosis, although it persists into adulthood for about one-third of children and adolescents. Friendships and academics may suffer as the child avoids school or other typical social events where they may be separated from their parent. In addition, children with SAD are at risk for developing other anxiety disorders or a secondary depression in reaction to their distress.

Generalized Anxiety Disorder

Generalized anxiety disorder (GAD) is excessive, uncontrollable anxiety and worry about numerous aspects of the child’s day-to-day life. According to the DSM-IV, it must occur on more days than not for more than 6 months. The onset of GAD is often around 10–14 years of age. Many people with GAD report having felt this way all their lives. It occurs in 3–6% of children, with equal rates in boys and girls, and is one of the most common anxiety disorders in children.

Children with GAD often find it difficult to control their worry, which is far out of proportion to the actual likelihood or

negative impact of the feared event. While adults with GAD tend to worry about everyday matters, children with GAD tend to worry about their own competence (e.g., grades). They may have excessive concerns about being punctual and about catastrophes, such as earthquakes. Children with GAD may also be overly conforming, perfectionistic, and uncertain of themselves, thus often requiring approval and excessive reassurance. In addition to this apprehension, the disorder is accompanied by at least one additional symptom, such as restlessness, fatigue, difficulty concentrating, irritability, muscle tension, and disturbed sleep (three of these symptoms are required in adults). It is commonly accompanied by physical symptoms such as headaches, twitching, shakiness, or muscle tension. GAD has a high comorbidity with other anxiety disorders, mood disorders, and substance related disorders. The course is chronic, but appears to fluctuate and worsen in times of stress.

Specific Phobia

Specific phobia is the extreme, disabling fear of specific objects (e.g., a dog) or situations (e.g., flying) that pose little or no danger. For example, if a child’s fear of costume characters impedes their ability to attend a friend’s birthday party, it may be considered clinically impairing. According to the DSM-IV, for individuals under 18 years old, the marked and persistent fear must occur for more than 6 months. Exposure to the feared stimulus is typically accompanied by an immediate anxiety response, which in children may be expressed as a temper tantrum or clinging to an attachment figure. In adults, DSM-IV criteria require that the individual recognizes that the fear is excessive or unreasonable; however, this characteristic is often absent in children and is not required for diagnosis. The onset of specific phobias can occur at any age, but the highest prevalence of specific phobias in children occurs between the ages of 10 and 13. Specific phobias occur in 2–4% of children, however only a small number of children are referred for treatment. Specific phobias are more common in girls than in boys, and the symptoms tend to occur at younger ages in girls than in boys.

Social Phobia

Social phobia is the marked, persistent fear of and desire to avoid being the focus of attention or scrutiny, or doing something humiliating in front of others. Subsequently, individuals with social phobia avoid situations where they may experience embarrassment or be perceived as stupid, including eating in public or speaking in front of the class. In children, the DSM-IV further specifies that there must be evidence of age-appropriate social interactions with familiar people (e.g., parents), but the child must become markedly anxious in peer social situations (e.g., school). Similar to the diagnosis of specific phobias, the DSM-IV specifies that, unlike adults, children frequently do not recognize that the fear is unreasonable, and for individuals under 18 years old, the fear must occur for more than 6 months. Social phobia in children may also take the form of selective mutism or the failure to speak in specific situations. The onset of social phobia typically occurs in early to mid-adolescence because of the greater emphasis on self-focus and -consciousness. It occurs in 1–3% of children, appears to

increase with age, and is slightly more common in girls than in boys. Younger children experience more somatic complaints, such as stomachaches, whereas adolescents report more concern about visible signs of anxiety, such as trembling or sweating.

Obsessive–Compulsive Disorder

Obsessive–compulsive disorder (OCD) is a disorder that is characterized by two types of symptoms: obsessions and compulsions. Specifically, individuals with OCD exhibit repeated, intrusive, irrational, and unwanted thoughts that cause anxiety (i.e., obsessions), which are often accompanied by ritualized behaviors or compulsions to relieve the anxiety (i.e., compulsions). For instance, experiencing irrational and repeated fears of germs (i.e., obsession) may lead a child to engage in hand washing (i.e., compulsion).

To be diagnosed with OCD, an individual must experience the symptoms for more than 1 h a day and the symptoms must cause marked distress or impairment in everyday life. In fact, OCD is typically associated with severe disruptions in health, social and family relations, and school performance. For instance, children with OCD frequently evidence declines in grades because of the secondary impairment in their concentration. Children diagnosed with OCD are extremely resistant to reason, even in instances where they recognize the irrational and obsessive nature of their fears and rituals.

The onset of OCD typically occurs between 9 and 12 years of age and tends to be gradual. The disorder is twice as common in boys than in girls during childhood, but the gender ratio equalizes by adolescence. Approximately 2–3% of children are diagnosed with OCD, the prognosis is poor, and there is a high rate of comorbidity with other anxiety disorders, depression and disruptive behavior problems. Fortunately, most children with OCD show some improvement in functioning following treatment.

Panic Disorder

Panic disorder is characterized by the presence of recurrent and unexpected panic attacks, as well as at least 1 month of persistent and marked worry about having another attack or worrying about the implications of having another attack. Panic attacks are sudden and overwhelming periods of intense fear or discomfort accompanied by the flight/fight response. Thus, panic disorder includes physical (e.g., elevated heart rate) and cognitive (e.g., fear of going crazy) elements of anxiety. Furthermore, situational avoidance may lead to agoraphobia, which is worry about being in situations where it would be difficult for one to escape or get help, if one were to have a panic attack. If agoraphobia is present in addition to panic disorder, then the diagnosis is coded as panic disorder with agoraphobia. Conversely, if the individual's symptoms do not meet DSM-IV criteria for panic disorder, then the symptoms are labeled as agoraphobia without history of panic disorder.

Panic attacks are fairly common in the population; however, panic disorder is relatively rare (i.e., 0.6%). The typical onset of panic disorder is 15–19 years old and is more common in girls. It is interesting that studies show that 95% of

adolescents with the disorder are postpubertal, supporting the importance of considering developmental milestones. Research suggests that panic disorder has the worst prognosis of all of the anxiety disorders, evidenced by the lowest rate of remission.

Posttraumatic and Acute Stress Disorders

Posttraumatic stress disorder (PTSD) is a disorder characterized by the development of symptomatology following direct exposure to a traumatic stressor during which an individual perceived a threat of death or serious injury, or after learning about the unexpected or violent death or serious injury of a close associate, such as a family member. Examples of traumatic stressors include natural disasters, car accidents, witnessing war, being kidnapped and experiencing sexual abuse. A diagnosis of PTSD involves three core features. First, individuals must report persistent reexperiencing of the event (e.g., flashbacks, nightmares). Second, PTSD is associated with the avoidance of associated stimuli and numbing of general responsiveness (e.g., dissociation). Third, individuals with PTSD experience extreme arousal, including increased autonomic reactivity. To meet DSM-IV criteria, the individual must experience symptoms for more than 1 month and the symptoms must cause significant distress or impairment.

PTSD in children may take a different form than the responses typically seen in adults. With regard to reexperiencing the event, children may engage in repetitive play involving themes from the trauma or they may report having nightmares without distinguishable content. Furthermore, PTSD in adults is associated with a response of fear, helplessness or horror following the trauma; however, children may exhibit disorganized or agitated behavior. This last criterion is being recommended for removal from future DSM editions, as it is difficult to operationalize in children.

Acute stress disorder is the development of symptoms within 1 month of being exposed to a traumatic stressor, during which the symptoms last for 2 days but no longer than 1 month. Thus, acute stress disorder is a short-lived stress response that involves many of the characteristics associated with PTSD.

PTSD occurs in ~3.7% of boys and 6.3% of girls in the United States. Furthermore, 75% of individuals diagnosed with PTSD also display comorbid depression and/or substance abuse. Prognosis following the diagnosis of PTSD is influenced by pretrauma child characteristics, exposure to additional traumatic stressors, features of the posttrauma environment, and specific PTSD symptomatology reported. For example, social support following exposure to a traumatic stressor is associated with better prognosis, whereas continued sexual abuse is typically associated with worse adjustment.

In sum, anxiety disorders in children are associated with cognitive disturbances, physical symptoms, social and emotional deficits, and high rates of comorbid mental disorders. These characteristics result in significant impairments in multiple areas of their lives, including academic difficulties, family conflict and peer problems. There are several therapeutic approaches that are used to address anxiety symptoms in children, such as behavior therapy, cognitive-behavioral therapy, medications, and family intervention.

Mood Disorders

Mood disorders, including depressive disorders and bipolar disorder (BD), are primarily categorized by a disturbance in mood and typically involve some form of depression. In the past, it was mistakenly believed that depression did not exist in children in a form comparable to adults; however, it is now known that children do in fact experience depression. Much of the confusion in the past occurred because childhood depression frequently co-occurs with more visible disorders and difficulties, such as aggression and attention-deficit/hyperactivity disorder (ADHD). Thus, the depression was typically masked under more observable symptoms. There is evidence now suggesting that depression is one of the most disabling childhood disorders. Furthermore, the prevalence of depression in children is increasing and the age of onset is decreasing. Although depression in children has many of the same features as the disorder seen in adulthood, the features and nature of the disorder change with age. For example, depressed preschoolers typically present as withdrawn and somber. Conversely, school-age children with depression tend to be argumentative and combative. Thus, it is important to take age into account when examining mood symptomatology.

Numerous causes of mood disorders have been identified. First, neurobiological influences have been implicated, such as a heightened stress reaction. Also, brain activity appears to be attenuated in areas associated with attention and sensory processes, but is more active in brain regions linked to recognizing and regulating emotions. Second, heritability estimates for depression range from 0.35 to 0.75, suggesting moderate genetic influences. In fact, if a parent has major depressive disorder (MDD) then their child is two to three times more likely to have depression. Family characteristics, such as more anger and conflict, poorer communication, parental over-involvement, less warmth and support, more disorganization, and higher levels of stress are also associated with mood disorders. Finally, stressful life events, including frequent moves, death of a parent, family illness, divorce, and violence may increase the likelihood that a child develops a mood disorder. In sum, no one influence has been linked to the onset of mood disorders, but several mechanisms have been identified that may increase the probability that a child develops a mood disorder, such as depression.

Depressive Disorders

The depressive disorders include MDD and dysthymic disorder (DD). MDD is a disorder that is characterized by one or more major depressive episode, which is a period of at least 2 weeks during which the individual experiences depressed mood or the loss of interest in almost all activities. To meet DSM-IV criteria, the individual must also report four additional symptoms, such as significant weight change, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue, feelings of worthlessness, diminished ability to concentrate, or recurrent thoughts of death. For diagnosis, it is also necessary to exclude the presence of prior manic episodes, organic causes, normal bereavement, and underlying thought disorders. In childhood MDD, it is common to see academic difficulties unrelated to intellectual deficits, few close friendships, and poor relations with parents and siblings. Evidence supports

suicidal ideations in most young people with depression, with between 16% and 30% attempting suicide.

Although the DSM-IV criteria for MDD are the same for all ages, children with depression often present differently than adults. For example, although children with depression may be sad, they typically cannot verbalize their emotions in the same way adults frequently do. Therefore, they may attempt to express their feelings through withdrawal or irritability. Depressed children are more likely to report somatic complaints than adults, such as headaches. Also, anhedonia, psychomotor retardation, psychosis, lethality of suicide attempts and impairment of functioning increase with age. Relative to adults, children also are more likely to be experiencing their first episode of depression, tend to recover faster, and are at increased risk of developing BD.

The average length of a depressive episode is 8 months, and almost all children recover from the episode, but recurrence is highly probable. Furthermore, even after recovery, children typically continue to exhibit adjustment and health problems, and appear to display mild symptoms of depression.

MDD occurs in ~2–8% of children between the ages of 4–18 years old. It is less common in preschool and school-age children (1–2%), but the prevalence increases to 8% by adolescence, which is the typical onset age of adult depression. The increase in prevalence of MDD from preschool to school-age has been attributed to the child's growing sense of self-awareness, cognitive capacity, verbal ability, and performance and social pressures. The subsequent drastic increase in prevalence that occurs during adolescence is likely due to biological maturation. There are no gender differences until puberty, after which girls are two to three times more likely to be diagnosed with MDD. The lifetime prevalence of MDD is between 10–25% in women and 5–12% in men. Comorbidity is very common, with as many as 70% of individuals with MDD reporting at least one other disorder, such as conduct problems or ADHD. Most co-occurring disorders precede MDD and persist after the child is longer depressed.

DD is similar to MDD, but is less severe and more chronic. Specifically, individuals with DD exhibit depressed mood more days than not for at least 1 year, have at least two additional symptoms of depression, and are never symptom-free for more than 2 months. This criterion is different than in adults, which requires a duration of at least 2 years. DD is also associated with less anhedonia, social withdrawal, impaired concentration, death thoughts, and physical complaints than MDD. Conversely, children with DD tend to display more constant sadness, self-depreciation, low self-esteem, anxiety, irritability, anger, and temper tantrums. Individuals that have both MDD and DD are said to have 'double depression,' which is associated with longer, more severe depressive episodes, higher rates of other mental disorders, more suicide attempts, and worse social impairment. DD is less common than MDD, with prevalence rates of ~1% in children and 5% in teenagers. The onset of DD is earlier than MDD (11–12 years old) and the average episode length is 2–5 years. Most children with DD recover, but they are then at greater risk of other disorders, particularly MDD.

Bipolar Disorders

The essential feature of BD is periods of depression alternating with or accompanied by abnormally and persistently elevated,

expansive, or irritable mood. During this time, individuals with BD may display symptoms of overexcitement, restlessness, agitation, sleeplessness, pressured speech, flight of ideas, sexual disinhibition, inflated self-esteem, and reckless behavior. Manic episodes in adolescents are more commonly associated with psychotic features, school truancy, school failure and substance abuse than MDD.

There are several subtypes of BD differentiated based on whether the child displays a manic (i.e., elevated or irritable mood lasting at least 1 week or requiring hospitalization), mixed (i.e., both manic and depressed episodes within a 1 week period), or hypomanic episode (i.e., manic for 4 days but with no deterioration of functioning). Bipolar I is having one or more depressive episodes alternating with one or more manic/mixed episodes. Bipolar II is having one or more depressive episodes alternating with one or more hypomanic episodes. Cyclothymia is at least 1 year of numerous hypomanic and depressive symptoms that do not meet full criteria for manic, mixed, or depressive episodes, no more than 2 months without symptoms, and significant distress or impairment.

The lifetime prevalence of BD is 0.4–1.2%, and is less common than MDD in children. BD is rare in young children, but the prevalence rate increases after puberty when it becomes comparable to adult rates. Research suggests that early signs of BD include irritability and anger difficulties, as well as fluctuations in energy levels. However, it is important to note that these symptoms are also associated with other psychiatric disorders. Typically, the first episode occurs during adolescence (15–19 years old) and depression normally appears first. In fact, ~50% of individuals experience depression first, 25% report mania and 25% report a mixed episode. In young people, it is common to exhibit milder Bipolar II and cyclothymia rather than Bipolar I. BD is equally common in males and females; however, early onset is more common in boys. Comorbidity is common with anxiety disorders, ADHD, conduct disorders (CDs) and substance abuse. BD is chronic and resistant to treatment, with poor long-term prognosis.

Pediatric BD is quite controversial and although it only appeared in the literature during the past decade, the rate of diagnosis has increased exponentially. In fact, prior to 1990, BD was not thought to exist in children. Specifically, in 1996, BD was the least frequently diagnosed psychiatric disorder among inpatient children; however, in 2004, it was the most frequently diagnosed disorder. This increase in the prevalence of pediatric BD is thought to be largely due to a shift in the definition of the disorder. That is, since DSM-IV, a milder form of mania (i.e., hypomanic) is recognized, which is referred to as Bipolar II. As previously noted, Bipolar II is more common in children. Prior to the aforementioned change, children who are now diagnosed with BD would likely have been diagnosed with CD or ADHD. This broadening of the symptomatology of BD has therefore resulted in a greater prevalence of BD, particularly in children, because Bipolar II is more common in this age range than Bipolar I.

Attention-Deficit and Disruptive Behavior Disorders

Attention-Deficit/Hyperactivity Disorder

ADHD is a persistent pattern of severe inattention and or hyperactivity-impulsivity that persists for at least 6 months.

Some of the symptoms need to have been present prior to 7 years of age. Moreover, impairment in functioning must occur in at least two settings (e.g., in school and at home). ADHD is estimated to occur in 4–8% of all school-aged children. It is three times more likely to occur in boys and is more prevalent in groups of lower socioeconomic status.

Difficulties with attention seem especially prominent during activities that are long, repetitive, and tedious. The child may fail to pay attention to details, make careless mistakes, produce messy work, appear as though they are not listening, frequently forget or misplace things, and have difficulty completing work. Children with ADHD tend to perform better on self-paced tasks that they have chosen, in novel settings, in one-to-one situations, and when the activity is especially engaging or offers immediate reward.

In the DSM-IV, hyperactivity and impulsivity are considered to be a single dimension and reflect a deficit in behavioral inhibition. This factor refers to behavior that is excessively energetic, intense, and not goal-directed. Hyperactivity or overactive motor behavior includes fidgeting, difficulty staying seated, moving, running, climbing about, excessive talking, and appearing as if driven by a motor. Impulsive behaviors include difficulty in stopping an ongoing behavior, inability to resist immediate gratification, responding too quickly or blurting out answers, interrupting others, and difficulty waiting for one's turn.

The DSM-IV specifies three subtypes of ADHD, depending upon the predominant symptoms in the last 6 months. The first subtype is the combined type, which accounts for most children with ADHD. The combined type is classified when six or more symptoms of inattention and six or more symptoms of hyperactivity-impulsivity have persisted for the last 6 months. The predominantly inattentive type (ADHD-PI), which occurs in about 1% of schoolchildren, is diagnosed if at least six symptoms for inattention have persisted, but the child displays fewer than six symptoms of hyperactivity-impulsivity. Finally, the predominantly hyperactive-impulsive types (ADHD-HI) is used when six or more symptoms of hyperactivity-impulsivity have persisted, but the child displays fewer than six symptoms of inattention. ADHD-PI is frequently associated with learning disorders, slow processing speed, difficulties with information retrieval, and anxiety/mood symptoms. The combined and ADHD-HI types are associated with aggressiveness, defiance, peer rejection, and placement in special education classrooms. Literature on the various subtypes is ongoing, and it is not yet clear if these subtypes are clearly distinct, or if they represent different stages in the developmental course of the disorder.

Although children with ADHD may have normal levels of intelligence, studies have indicated that IQ scores range about 5–9 points lower than children without ADHD. Lower IQ scores may be due to deficits in working memory, speed of processing, sustained attention, and test-taking behaviors. Many children with ADHD experience difficulties with school, including academic underachievement, being held back a grade level, placements in special education classrooms and increased school dropout. About 25% may have a diagnosable learning disorder and 30–60% may have speech and language impairments.

Many children with ADHD have difficulties with sleep, and may also experience motor clumsiness or repetitive motor movements (i.e., tics). Impulsivity may lead to accidents and

risk-taking behaviors, including more pedestrian and traffic accidents, unsafe sex practices and increased use of substances. Others may perceive the child as noncompliant or annoying, which can lead to high levels of conflict with family members and peers. It is also likely that children with ADHD will display symptoms of oppositional defiant disorder (ODD) (about 50%) or CD (about 30–50%), which further increases their social difficulties. They may also experience comorbid anxiety (about 25%) and depression (about 20–50%). Finally, many children with ADHD report a higher level of self-esteem than would be expected in light of their behavior. That is, they have an exaggerated perception of their own competence, and this has been referred to as a positive illusory bias.

Developmentally, hyperactive–impulsive symptoms tend to appear first, especially in the preschool years. In retrospect, parents may report that their child had a ‘difficult’ temperament. Although the disorder may be present at this early age, and possibly from birth, difficulties are usually not identified until the school-age years (around ages 5–7), when the child is faced with the demands of school and is required to engage in activities that are long, tedious, and repetitive. The prognosis is poorer for children with co-occurring behavioral problems. As the child matures into adolescence, about 25–50% of children outgrow the disorder or learn to cope with its symptoms. However, most children still exhibit the disorder into adolescence. In general, hyperactive–impulsive symptoms tend to decline with age, while inattention remains stable over time.

It is not clear what causes ADHD, though it is currently viewed as a neurobiologically based disorder. Genetic evidence suggests that ADHD runs in families, with a concordance rate of ~35%, and twin studies show heritability estimates as high as 80%. Pregnancy and birth complications, smoking and substance abuse during pregnancy, and minor physical anomalies have also been implicated, suggesting neural maldevelopment. In particular, the prefrontal cortex, basal ganglia and cerebellum appear to be involved, which are associated with attention, executive functions, delayed responding and response organization.

ADHD symptoms and associated impairments are often treated with stimulant medications. These medications are effective in about 80% of children with ADHD by increasing sustained attention, impulse control, and persistence of work effort, and by decreasing task-irrelevant activity and disruptive behavior. It is clear, however, that symptoms are never completely brought to normal levels, and they return as soon as the medication is stopped. Behavior therapy via parent management training and classroom management also have been found to be effective in making short-term behavioral gains and improving relationships with parents and teachers.

Oppositional Defiant and CDs

Oppositional defiant and CDs involve age-inappropriate actions and attitudes that violate family and societal rules and rights of others. Behaviors vary widely and may range from defiance and noncompliance to assault and murder. While general surveys indicate that antisocial acts are relatively common among youth (i.e., about 30–50% of children report some antisocial act), it is less common for children and adolescents to engage in persistent and serious rule breaking.

It is this small percentage of youth, ~3–5% of youngsters, which is of particular concern. Their antisocial behavior tends to remain stable over time and lead to a myriad of associated problems such as physical injury, academic underachievement, peer rejection, exacerbated family conflict, and psychopathology. Moreover, this small number of youth contributes to a disproportionately large number of antisocial acts.

In the DSM-IV, children with these sorts of persistent rule-breaking and antisocial behaviors fall under the categories of ODD and CD, which have prevalence rates ranging from 6% to 16% and are more likely to occur in males. In order to be diagnosed with ODD, the child must show four or more symptoms of age-inappropriate stubborn, irritable, and defiant behavior that persisted over 6 months. Symptoms include losing temper, arguing with adults, active defiance or noncompliance, deliberately annoying others, blaming others for mistakes or misbehavior, being touchy or easily annoyed, anger and resentfulness, and spitefulness or vindictiveness.

CD reflects a repetitive and persistent pattern of behavior in youth that violates the rights of others. Criteria for the disorder include aggression toward people and animals (i.e., bullying, threatening, intimidating others; initiating physical fights; using a weapon to cause harm; using physical cruelty; stealing while confronting the victim; and forcing someone into sexual activity), property destruction (i.e., deliberately setting a fire or destroying another's property with the intent to cause damage), deceitfulness or theft (i.e., breaking into another's house, building or car; lying or conning to avoid obligations or to get something; stealing without confronting the victim), and serious rule violations (i.e., repeatedly staying out past curfew beginning before age 13; running away from home at least twice or for a lengthy period; being truant from school beginning before age 13). Three or more symptoms must have been present for the last 12 months, with at least one in the last 6 months.

CD is further broken down into childhood-onset type and adolescent-onset type, based upon the age of onset. Childhood-onset represents those children for whom at least one symptom began prior to age ten. These children are usually male, display frequent physical aggression, have disturbed peer relationships, have had ODD in early childhood, and usually show full symptoms for CD before puberty. Adolescent-onset represents those for whom no symptoms were present prior to age 10. Relative to the childhood-onset type, these youth are less aggressive, have a lower male to female ratio, have more normative peer relationships, and are less likely to persist in their conduct symptoms. This typing is based upon work looking at the development of antisocial behavior, which suggests a better prognostic picture for the adolescent-onset type.

Children with ODD or CD tend to have normal levels of intelligence, but scores generally fall about eight points lower than their peers, with greater deficits in verbal intelligence. Some studies also indicate difficulties with executive cognitive functions, which may interfere with the ability to learn from consequences. Academic underachievement and learning disorders are also common, which can lead to grade retention and school dropout. These cognitive deficits are sometimes, but not always, accounted for by the presence of ADHD. Youth with conduct problems may also show inflated self-esteem (i.e., positive illusory bias) that is easily threatened. They may have

difficulty with peers due to their aggressive and threatening behavior. Other associated problems include family conflict, instability in the home, and harsh discipline or deficient parenting practices. Finally, these youth have a higher rate of premature death, risk of personal injury, early onset of sexual activity, substance abuse, and comorbidity with ADHD, depression and anxiety.

Studies on the course of conduct problems from childhood to adolescence suggest that ODD developmentally precede CD in the majority of cases. These children begin with minor behavior problems in early childhood that develop into more serious problems in later childhood and adolescence. These studies also indicate that typically, without intervention, conduct problems tend to remain stable or worsen over time. Of all children with ODD, ~25% desist from further antisocial behavior, ~50% maintain a diagnosis of ODD, and ~25% progress to a diagnosis of CD. The course of development may also differ between childhood-onset and adolescent-onset CD, with greater persistence and escalation of behavior occurring in childhood-onset type.

Antisocial behavior in youth is likely to have multiple causes, any combination of which may be acting in a given child. Biosocial models suggest that the interplay of biological, psychological, and social influences contribute to severe and persistent antisocial behavior problems. Twin and adoption studies support a genetic contribution, suggesting that traits such as impulsivity or difficult temperament may be inherited. Neurobiological studies have implicated frontal lobe deficits leading to executive cognitive dysfunction and the perseveration of inappropriate behavior. Psychophysiological studies have also implicated low heart rate in individuals who are aggressive, suggesting that low arousal may lead to sensation-seeking and risky behaviors such as aggression. Low arousal may also indicate a fearless attitude, in which the child does not become anxious at the thought of punishment or negative consequences for their behavior. Cognitive influences could include a biased way of processing social information, so that the child makes hostile interpretations of other's actions or views antisocial behavior as a means to a positive outcome. Family influences include coercive interaction patterns, in which parent-child dyads learn to use increasingly intense behavior to coerce the other person into submitting to their demands. Family instability and stress, harsh or abusive discipline, parental criminality, and parental psychopathology are also commonly associated risk factors for ODD and CD. Finally, societal influences include neighborhoods with criminal subcultures, community violence, poverty, or high social disorganization.

There are few effective interventions with empirical support. Parent management training is especially useful for younger children with ODD. This behavioral intervention teaches parents skills for managing their child's behavior through the use of ignoring, attention, reinforcement, and punishment. Cognitive problem-solving skills training also has some support. It is typically used in school settings and teaches children a specific strategy for finding nonaggressive solutions to problems. Finally, multisystemic treatment has support as a treatment for severely troubled youth. Based on a systems approach, this treatment is carried out with all individuals in all settings of the child's life to address shortcomings at multiple levels.

Pervasive Developmental Disorders

PDDs include an array of chronic and lifelong neurodevelopmental disorders that affect children's social interactions, language/communication, and behavior. In the DSM-IV, these disorders include autism, Asperger's disorder, Rett's disorder, childhood disintegrative disorder (CDD), and PDD-not otherwise specified (NOS). They affect whether children develop speech, form social relationships, and process sensory information.

Autism Spectrum Disorders

Together, autism, Asperger's disorder, and PDD-NOS are referred to as autism spectrum disorders (ASDs). They are considered spectrum disorders because children vary in the symptoms they display and the severity of the disorder. High functioning autism and Asperger's disorder are often similar in presentation and there is a controversy over whether they are truly distinct disorders. Autism is thought to be the fastest growing developmental disability in the country. Recent statistics from the Centers for Disease Control and Prevention indicate that as many as 1 in 110 children are affected with an ASD. As such, more children are being recognized and require services.

The diagnosis of autism requires impairments in three key areas – social functioning, communication, and repetitive behaviors, interests or activities – with onset prior to age three. The primary difference between the diagnosis of autism and Asperger's disorder is that Asperger's disorder does not require delays in communication. Also, in Asperger's disorder, there is no clinically significant delay in cognitive development, self-help skills, adaptive behavior, and curiosity about the environment. However, research has not clearly shown distinctions between Asperger's disorder and high functioning autism in outcome, course/outcome, etiology, neurocognitive profile, or treatment needs. As such, current recommendations are that Asperger's disorder be subsumed under the autism category in future editions of the DSM.

Impairments in social interaction include nonverbal behaviors (e.g., eye contact, gestures) to regulate social interaction, peer relationships, spontaneous sharing of enjoyment, and social or emotional reciprocity. Impairments in communication include delay or lack of spoken language, initiating or sustaining a conversation, stereotyped or repetitive language, make-believe or social imitative play. Impairments in behaviors include preoccupation with an interest that is abnormal in intensity or focus, inflexible adherence to routines or rituals, motor mannerisms (e.g., hand-flapping, twisting), and persistent preoccupation with parts of objects.

Children with ASDs often evidence skills that are scattered, meaning that they may have deficits in some areas and strengths in others. Up to 80% of children with autism fall in the mental retardation range of intellectual functioning, with particular weaknesses in verbal IQ (using traditional tests, which may not be appropriate). About 25% have splinter skills (above average skills in one area like math) and 5% have savant abilities (extraordinary or supernormal talent). Other cognitive deficits might include difficulty in understanding social situations, impairments in the ability to understand

others' and their own mental states (Theory of Mind), deficits in executive functions (orienting, shifting attention, organization, reasoning), and lack of drive for central coherence (do not filter out details). On the other hand, these individuals may be very good at sustained attention and memory for details. Some individuals experience sensory impairments including over- or under-sensitivities, and possibly both at the same time.

Raising a child with autism is stressful. For example, the child may be hyperactive, self-injurious, wandering, or may not sleep well. In addition, parents may be socially ostracized by friends and strangers and may experience frustration and delays before receiving help. Co-occurring symptoms include hyperactivity, learning disabilities, anxieties/fears, mood problems, sleep difficulties, and self-injurious behavior. Epilepsy is also a common co-occurring medical condition.

ASD occurs from birth or early in childhood, although deficits are often not noticed until around age two when the lack of language and other skills become especially evident. At 12–18 months, children with ASD may show a lack of pointing, showing, orienting to their spoken name, and looking at the face of another person. Often, there are gradual improvements with age, though they are likely to continue to experience many difficulties. Hyperactivity, self-injury, and compulsions appear to worsen in about a one-third of adolescents with ASD. Typically, this is a chronic and lifelong condition; however, variability in outcome depends on language abilities and IQ.

There is no known cause for ASD. Sometimes, problems have been noted during pregnancy or birth, such as premature birth, bleeding in pregnancy, toxemia, and viral infections. Family and twin studies suggest that the heritability of an underlying liability to autism is above 90%, and studies of family members suggest that there may be a Broader Autism Phenotype in which less severe symptoms are inherited. Neurobiological studies have implicated the frontal lobes, cerebellum, medial temporal lobe, and limbic system structures, which can reflect a brain system specialized for social cognition. The amygdala, in particular, may be implicated in deficits of orienting to social stimuli, motor imitation, empathy, and joint attention.

There are currently no empirically validated treatments for ASD, though there is a great deal of empirical support for early intensive behavioral interventions. These comprehensive treatment programs are recommended to begin before 5 years of age, occur in the home or preschool, actively involve family members and peers, and involve one-to-one work with the child for 15–40 h per week. The interventions use behavioral principles to address the core deficits and excesses in behavior that are commonly seen in ASD. Some evidence supports cognitive-behavioral treatments for children with Asperger's disorder and higher functioning autism. These treatments teach children that thoughts and knowledge can affect feelings and behavior. They often use a skill-building approach to teach social skills, affective education, and management of comorbid disorders like depression or anxiety.

Rett's Disorder and CDD

Other PDDs in the DSM-IV include Rett's disorder and CDD. Rett's disorder is a severe neurobiological disorder characterized by deceleration of head growth between 5 and 48 months

of age, loss of previously acquired hand skills and subsequent development of stereotyped hand movements (e.g., hand-wringing), loss of social engagement that may reappear later, appearance of poorly coordinated gait or trunk movements, severely impaired language development, and psychomotor retardation. It is a disorder that occurs primarily in females and is thought to be caused by a specific X-linked gene mutation. The prevalence rate is ~1–4 per 10 000 females. The long-term prognosis is poor. Rett's disorders is associated with mental retardation, epileptic seizures, motor handicaps, and difficulties with communication. Some studies have indicated that the brain sizes of children with Rett's syndrome are about 12–34% smaller than the brains of other children. The inclusion of Rett's syndrome in the PDD category has been questioned and this disorder may be removed entirely in future editions of the DSM. The primary rationale for removal of the disorder is that these children often have PDD symptoms for only a brief period during early childhood, and social interactions often reemerge later in childhood, so inclusion in the autism spectrum may not be appropriate for most individuals. Moreover, since Rett's disorder has a specific etiology, it can be specified as a known medical or genetic condition associated with PDD, rather than its own category as a mental disorder.

CDD is characterized by a significant loss of previously acquired language, social skills, and adaptive behavior prior to age 10, following a period of apparently normal development in at least the first 2 years of life. Recent estimates suggest that CDD is rare, occurring in about 2 per 100 000 children. This diagnosis was included in the DSM-IV primarily to encourage research on the disorder, though little research still exists. It has been recommended that CDD be subsumed under the autism diagnosis in future editions of the DSM because there is no evidence that this disorder is different from Autism with a regressive course. Also, some case studies indicate that lost skills reemerged following treatment, suggesting the possibility that the symptoms were instead due to some treatable neurological condition.

See also: Anxiety Disorders; Attention; Attention Deficit Hyperactivity Disorder; Autism and Pervasive Developmental Disorders.

Further Reading

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Relevant Websites

- <http://www.aacap.org/> – American Academy of Child and Adolescent Psychiatry.
- <http://www.cdc.gov/> – Centers for Disease Control and Prevention.
- <http://www.apa.org/> – Home Page for American Psychological Association.
- <http://www.dsm5.org/Pages/Default.aspx> – Home Page for American Psychiatric Association DSM 5 Development.
- <http://www.aboutourkids.org/> – New York University Child Study Center.

Chunking

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Glossary

Adopted chunk method A method of measuring the number of chunks adopted by participants in free recall by examining whether the order of recalled information matches its initial presentation order; each series recalled in order is considered a chunk adopted by the participant.

Chunk A unit of storage in memory containing multiple items that are grouped or bound together to form a unified whole.

Chunk access measure An estimate of the number of chunks in working memory; based on the assumption that if at least one item from a presented group is recalled, working memory has accessed a unit corresponding to that group.

Chunk completion measure An estimate of the integrity of a presented group of items or interassociation between the items; based on the assumption that if the group was stored

as a well-integrated chunk and the chunk was accessed (i.e., at least one item recalled from it), then recall of the group should be nearly complete, including most or all of the items presented in that group.

Chunking A process or strategy that increases the amount of information that can be stored in memory by meaningfully grouping information together.

Immediate memory Portion of memory that is currently in our conscious awareness and is easily reportable; also known as *short-term memory*.

Transitional error probabilities (TEPs) method A method of measuring number and size of chunks in serial recall by examining the probability in making an error during recall of items; the proportion of errors in transition from one item to the next in recall, or TEP, should be smaller within a chunk and larger between chunks.

Introduction

Chunking is a strategy or process by which one can efficiently increase the amount of information that can be stored in short-term memory by reorganizing information in a meaningful way, or by finding patterns within a set of items to be remembered. Chunking may also involve grouping stimuli together on the basis of perceptual principles such as the similarity or proximity of certain items to be remembered. However, this form of chunking does not typically involve strategic effort in forming chunks. For present purposes, the more strategic method of chunking, in which long-term knowledge must be accessed or constructed to form larger groups of items, will be of particular interest. For a simple demonstration of chunking, consider the following scenario. You are presented with a string of letters, MAIBIFBCL. Most likely, you will not remember all nine letters. If the string is rearranged to FBICIAIBM, you will probably remember all of the letters. Why? The letters can be grouped into three familiar acronyms; the number of separate items to be recalled is now much smaller. As a result of this grouping, the amount of information that can be stored has effectively been increased. This is a very simple illustration of one way in which people can use chunking to remember more items than they would (or could) otherwise.

Chunking is arguably one of the most powerful ways to increase the amount of information that can be stored in memory. In this article, we will discuss what is currently known about chunking. First, we will review a seminal work on chunking and capacity limits in memory, George Miller's 'The Magical Number Seven, Plus or Minus Two.' Following this we discuss the purpose of chunking and its role in the capacity-limited immediate memory (which is sometimes also known as working memory or short-term memory), as well as a theoretical model of how chunking operates. We then raise

the issue of measuring chunks, discussing several different ways to do so. Finally, we will close the article with questions about chunking that are worth examining in future research.

What Is Chunking?

Published in 1956, George Miller's article "*The magical number seven, plus or minus two: Some limits on our capacity for processing information*" has fundamentally shaped our understanding of capacity limits in immediate memory and how these limitations may be circumvented through the use of chunking. In this review, Miller noted that seemingly unrelated tasks had a puzzling commonality: an upper limit in the number of items (approximately between 5 and 9) that could be processed or stored at any given time.

Miller reviewed capacity limits for tasks that tested immediate recall of stimuli. In these tasks, participants are presented with a list of items (e.g., words, letters); following the presentation of the list, participants are to recall as many items from the list as possible. Across various types of immediate recall tasks, it was found that memory span was consistently between five and nine items, regardless of stimulus type. Similar capacity limits can be found for tasks that examine the absolute judgment of stimuli that vary in more than one dimension, such as lines that differ in length and angular orientation. Though these tasks differ somewhat in terms of methodology, in both cases, stimuli in these tasks involve multiple features that are bound together to form a single, unified item. Because of these similarities, the limits on how many multifeature objects can be held in mind theoretically could be the same, regardless of task type.

Although the consistency of capacity limits across various immediate memory tasks was the primary emphasis of the

review, Miller closed his paper with a discussion of recoding (by which he meant the same thing that was later termed chunking) and its implications for immediate memory performance. Recoding was defined by Miller as a process of grouping or organizing input information into meaningful units, or chunks. Because information in immediate memory is limited to approximately seven items, grouping items together in a way that allows them to be more easily remembered can effectively increase the amount of information that can be stored and, eventually, recalled.

To illustrate the phenomenon of chunking, Miller reviewed a prior study where participants were to immediately recall sequences of binary (e.g., 101000100) and octal digits. In general, persons can correctly recall approximately nine of these digits when presented with one of these sequences. It was possible, however, that the number of binary or octal digits that were correctly recalled from memory could be increased by recoding the digit information in a more meaningful way. For example, consider the binary sequence of nine digits that was presented above. Miller suggested that more digits from the list could be recalled if the digits within the sequence were reorganized into a series of groups (e.g., 101, 000, and 100). These items might be even better recalled, however, if one knows how to convert binary digits into digits with a different base (e.g., decimal digits, which are based on a base of 10). If one groups the binary digit list in the manner above, 101 equals 5, 000 equals 0, and 100 equals 4 – grouping digits into larger chunks reduces demand on memory, as does converting the digits into a more meaningful form. Initially, participants only recalled about nine binary digits and seven octal digits; however, once they learned the recoding schemes similar to the one described above, span for these digits increased.

This illustration of recoding and chunking of items that is described above has little ecological validity outside of a laboratory setting; persons are rarely required to convert digits from one base to another in their everyday lives. However, Miller himself noted that using chunking or some means of recoding as a strategy to increase the amount of information that could be stored in memory was quite possible in an everyday setting. In particular, Miller suggested that the most common uses of these sorts of strategies were for the translation or grouping of verbal materials, though chunking is advantageous in memorizing nonverbal stimuli as well.

For example, much of what we know about chunking of nonverbal stimuli originates from studies that have examined immediate memory for various positions in chess. In a series of experiments, William Chase and Herbert Simon presented both chess masters and novice players with different configurations of chess pieces on a playing board. Participants were shown these configurations for 5 s, which were later covered up so that participants could not see them. In a critical manipulation, these configurations were either possible chess positions or were entirely random. Once the configuration was hidden from view, participants were to recreate the configuration from memory. When configurations were actually permissible within the context of a chess match, masters were more likely than novices to remember the configurations accurately. However, for random configurations, the memory performance of masters was no greater than performance for novices. When

Chase and Simon examined how various chess pieces were chunked, they found that masters were more likely to group chess pieces based on prior knowledge about chess – for example, they might classify a subset of pieces as an attacking or defensive position. This is starkly contrasted to the grouping strategy of novices, who were more likely to group subsets of pieces based on more shallow aspects (e.g., noting that a group of pieces form a candlestick). The findings from this study clearly demonstrated the role that prior knowledge can have in terms of what is retrieved from memory and how chunks are organized.

The Purpose of Chunking

One of the most important conclusions in Miller's seminal paper was that immediate memory, where we are able to hold information in mind briefly, is capacity-limited. It may be unclear to some why Miller closed his paper with a discussion of chunking; however, we forward the idea that chunking cannot be understood without a discussion of capacity limits in memory. Chunking is a way to circumvent capacity limits in memory to an extent. To illustrate this point, it is important to discuss any potential limitations on the amount of information that can be attended at any given point in time. As chunking can only be understood in the context of memory capacity limits, we discuss evidence supporting a four-item limit in immediate memory below; we follow this with a discussion of the implications of capacity limits upon chunking.

Evidence for a Four-Item Limit in Immediate Memory

Why is there a great deal of evidence for a memory capacity of four items when Miller initially proposed that immediate memory was limited to approximately seven items? It is possible that in these prior studies that Miller reviewed, small chunks could have been formed during item presentation, allowing participants to recall a higher number of items. Interestingly, when items are either too numerous or are presented too quickly for chunking to occur, participants typically recall no more than 3–4 items. This even occurs for items with which we are very familiar. For example, in a 1975 paper Donald Broadbent described a study where participants were asked to recall familiar lists of seven items, such as the Seven Wonders of the World or the names of the Seven Dwarves from 'Snow White.' Participants were typically able to recall all of the items; however, Broadbent noted that long pauses during retrieval of items tended to occur between the third and fourth items being recalled; these pauses suggested that additional retrieval of remaining items had occurred. Here, seven digits could not be grouped together to form a single chunk. Instead of memory being capacity-limited to no more than seven items, our immediate memory may only be able to maintain up to four items before our memory performance declines and retrieving items takes increasingly greater time.

Early cognitive research that examined capacity limits and chunking in immediate memory corroborated Broadbent's view. Many of these early studies involved the presentation and later recall of phonological or linguistic materials. In many of these studies, materials that were presented to

participants in these studies varied in terms of how meaningful they were. For an example, consider a study by Glanzer and Razel that examined immediate recall and chunking, where participants were presented with various types of verbal stimuli, including words, sentences, and familiar proverbs. As one moves from words, to multiword sentences, to proverbs that can incorporate multiple familiar sentences, it is clear that the intraitem associations become increasingly stronger as the presented information becomes more meaningful. It becomes considerably easier to group words together when they form a sentence; likewise, it becomes easier to group sentences together when they form a very familiar passage. Regardless of how meaningful stimuli were in the context of these various prior studies, researchers consistently found capacity limits of approximately 3–4 chunks for each verbal stimulus type. Herbert Simon, in a similar discussion regarding the role of meaning in the formation of chunks, obtained similar results. Though a greater number of words might be recalled from a familiar nursery rhyme than a novel prose passage, one typically does not recall more than four chunks across various linguistic stimuli. This is not to say, however, that increasing the meaningfulness of verbal stimuli in the manner described above has no effect upon chunking. As we will discuss in a later section, the amount of information that is contained within a single chunk (i.e., chunk size), though not the number of chunks maintained in memory, may vary as presented stimuli become increasingly (or decreasingly) meaningful.

More recent research has examined memory capacity limits when higher-order strategies are precluded. In a 2009 study, participants were initially presented with various lists of words that were learned to a 100% criterion. These lists were composed of either word pairs or singletons. In addition to varying the size of chunks, the number of pairs or singletons within a list was varied. By varying both of these factors, the influence of item limits or length limits upon recall could be examined. Consider an example of three trials in which a participant might see a list of four singletons, a list of four learned word pairs, and a list of eight singletons. Assuming that each learned word pair is grouped into a single two-word chunk, the list of four word pairs is comparable to the list of four singletons in terms of the number of chunks that are present within a list; however, the list of pairs has a longer overall length (i.e., a larger number of total words) than a list of four singletons. In contrast, when overall length is considered, the list of four word pairs is equivalent to the list of eight singletons; however, the list of pairs contains a smaller number of chunks. If a chunk capacity limit is the sole reason why recall is limited, the prediction is that individuals should recall the same number of chunks regardless of the list length, and regardless of whether the chunks are singletons or learned pairs.

Following this training phase, participants were presented with lists of word pairs that were to be immediately recalled in correct serial order. To preclude any additional rehearsal of items, participants were to engage in articulatory suppression by repeatedly voicing the word *the* during list presentation. Ordinarily in serial recall, the list length matters a lot. Under these suppression conditions, though, when the order of responses was ignored, a remarkably precise, core capacity limit of approximately three chunks was consistently observed across all list types and lengths. For example, in lists with as few

as 4 singletons or as many as 12 singletons, about 3 singletons were recalled from the list on average; and in lists with 4 or 6 learned pairs, about 3 of the pairs were recalled on average. This constant number of chunks recalled across many conditions provides strong support for fixed capacity limits in immediate memory. The results of other conditions also suggest, though, that using strategies like chunking or additional rehearsal can supplement memory performance a great deal beyond this core limit.

Chunking Overcomes Capacity Limits

As we have shown above, the number of items that can be stored in immediate memory is greatly limited; typically, no more than four items or chunks can be attended simultaneously. Because this number is so small, one might expect that this places a severe limit on the information that we can attend at any point. This is probably true for many instances in our everyday lives, as retaining every piece of information that entered our awareness would cost us the ability to process information quickly and efficiently. Luckily, our attention is able to rapidly shift to adapt to new information that enters our environment, if doing so is needed. However, there are certainly times when we need to maintain more information than our limited memory capacity will permit, such as when one receives a long, verbal list of groceries to buy at the store. In these cases, chunking is an easy, powerful way to ensure that as much information as possible is stored. For example, if one is able to group grocery list items together by their respective grocery departments (e.g., tomatoes, cucumbers, and grapes belong in produce; bread, cookies, and apple pie can be found in the bakery), more information can be stored beyond the 3–4 items one would recall if no chunking took place.

Various findings from research support the notion that chunking helps us to exceed severe capacity limits in immediate memory. The role of chunking is especially exemplified when linguistic materials are manipulated in some way. Consider, for example, when sentences vary in terms of their coherence (i.e., whether they make sense or are completely nonsensical). This is known as order of approximation, which corresponds to how many words in a row make sense. A sentence that has a low order of approximation (e.g., first-order) typically makes little sense, often sounding like a list of random words: *telephone call over easy cheese and then he*. Sentences that have higher-orders of approximation (e.g., fifth-order) sound increasingly like grammatically correct text: *when we saw the cat attacked by using claws*. If you read both of these sentences out loud and tried to recall each of them immediately, you probably will find that you recall a greater number of words from the sentence with a higher order of approximation. In coherent language, there are numerous semantic and syntactic associations that exist between words; as one moves from nonsensical language to a more coherent form, the various associations between words increase and a more coherent whole can be apprehended. The more that words are associated with each other, the easier chunking words together becomes. As a result, sentences with a higher order of approximation, like the example above, are more likely to be encoded as a single chunk. Thus, we see more words recalled from these sentences than from nonsensical sentences where interword associations are considerably fewer.

The notion that increasing associations will lead to a greater amount of recalled information is also apparent when standard, grammatical sentences are considered. In cases where the order of approximation for two sentences is equivalent, more information will generally be recalled from the sentence that makes greater use of interword associations. Thus, a greater number of words will be recalled from a sentence that is a compound of two smaller sentences (e.g., *Grandmother warmed the oven and she baked a fudge cake*) than would be recalled from two unrelated sentences.

Dramatic cases of chunking overcoming capacity limits are found in research that examines effects of deliberate practice and expert performance. You might be familiar with the digit span task, an immediate memory test that was mentioned above. Here, participants are presented with a list of digits that they are to recall immediately after presentation of the list, in the presented order. The length of the digit list increases until a participant makes an error or fails to recall a digit for several lists in a row. As Miller noted, the average person can accurately recall between five and nine digits in this task. This is typically considered a measure of one's basic memory capacity; however, as we argued above, a small amount of chunking is still possible in this task.

What would happen to one's digit span if a participant practiced this task for a few hours each day over the period of a year? Given findings from a previous study that did just that, it is very likely that your digit span could be over 80 digits! In this study, a single participant repeatedly practiced the digit span task for several months; by the end of the training period, he was able to report back up to 82 digits in the span task, well beyond the 5–9 digits that the average person recalls. The ability to chunk various digits together played a considerable role in the participant's remarkable span increase. Specifically, the participant himself noted that he used prior long-term knowledge of long-distance running times to group digits together to form multidigit chunks. For example, the digits 4, 5, and 2 could be grouped together to form 4.52, a very fast time to finish a mile run. This sort of recoding, where meaningless stimuli are grouped in a way that connects to one's long-term knowledge, is reported by many expert mnemonists to be a typical way that they encode stimuli that exceed capacity limits. The role of chunking should not be downplayed in this case, as it is unlikely that such a high number of digits could be recalled without some sort of organizational strategy developing over time.

We should note that chunking only circumvents the capacity limits in memory in the sense that more information can be recalled. In the grocery example we mentioned above, chunking allows us to remember a greater number of items on our shopping list. Although chunking increases the amount of information that is able to be stored, the chunks that are formed are still subject to the four-item capacity limit. A greater amount of information is being stored within a single chunk (i.e., the size of the chunk becomes larger). The number of chunks that can be stored in immediate memory, however, never exceeds four. This result has been found even in cases where the number of items that can be stored or recalled is exceptionally large, including the participant who recalled 82 random digits in the digit span task. As we noted above, the amount of digits that were accurately recalled is far beyond what would normally be recalled in an

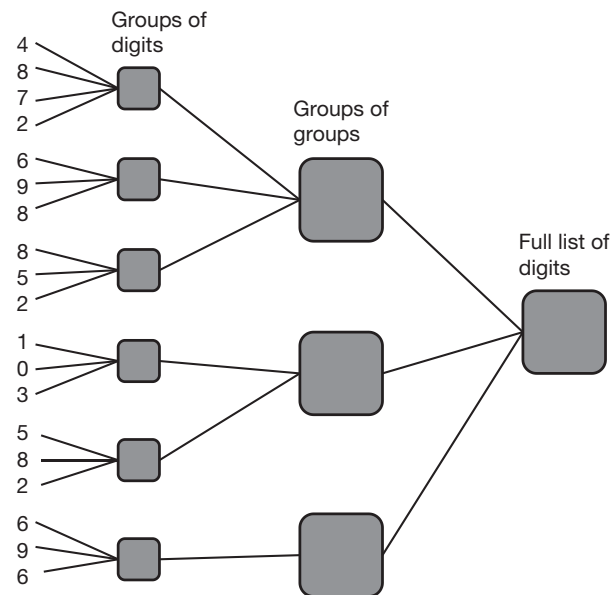


Figure 1 A hierarchical structure exemplifying the type of performance observed by Ericsson, et al. (1980) in a participant who learned to use athletic records and other memorized groups of digits to form multidigit chunks. The recalled list of digits was chunked into groups of 3–5 items (seen on the left), which were in turn spatially organized to form even larger groups, as shown on the right side of the figure. Although the total digit recall in the figure would greatly exceed what is considered the limit of immediate memory capacity if each digit were retained as a separate chunk, the number of larger groups on the right of the figure fall within this capacity (i.e., 3–5 chunks).

immediate memory task. However, it was found that he had chunked these digits into a hierarchical structure of four large supergroups (which were made up of various, smaller groups of digits), as is shown in [Figure 1](#).

It might be theorized that attention can ‘zoom’ up and down to different levels in the structure shown in the figure. When the mnemonist was thinking at the level of a single chunk that was just created, the number of digits in the chunk would be limited to about four. When the mnemonist zooms up to think on the superchunk level, however, he is limited to about four chunks per superchunk and at the list level, there should be only about four superchunks. In this way, the presumption is that the basic capacity limit does not change in an expert, but the way in which it can be used improves dramatically with expertise and practice.

Clearly, chunking does not entirely overcome the capacity limits inherent in the immediate memory system. Despite this, we suggest that chunking allows one to remember a greater amount of information than would be possible if no strategy were used at all. It is for this reason that chunking is regarded as such a powerful mnemonic strategy.

How Chunking Works

Chunking can help us increase the amount of information that can be stored and later recalled. This ability is important, as it can help us exceed a severely-limited immediate memory

capacity. If we understand the definition of chunking, as well as its necessity for the immediate memory system, a question that follows is how the process of chunking works. Above, we have suggested that items or chunks in immediate memory are stored in a capacity-limited region, where no more than four items may be consciously attended at any given time. Based on what we have previously learned about this region, we proceed with a discussion of how chunking may work in the context of this theory.

For chunking to occur, some degree of selective attention is often necessary. This is because items held in immediate memory receive attention; likewise, forming chunks from these attended items will also require attention and presence in conscious awareness. As an example of how this process might work, consider an instance where a person is provided with a seven-digit telephone number, 6847083. Assuming that there are no potential aides to record this number, one will have to store the series of digits in immediate memory. How might this proceed? Suppose that the first four digits of the phone number, 6847, enter into the capacity-limited region of immediate memory through selective attention. Because four items are currently being stored within this region, no other items receive attention or any form of processing. At this point, if more digits are to be stored, chunking must occur. Specifically, items within the capacity-limited region can easily be

chunked or associated with each other, as all of them are available and accessible in memory. As illustrated in [Figure 2](#), one could bind the digits 6, 8, and 4 into a single chunk – doing so reduces the number of items stored in immediate memory from 4 to 2. This allows room for two more digits (e.g., 0 and 8) to receive attention, and thus, enter the limited-capacity region. Further chunking can occur (e.g., 70 are formed into a single chunk); this again will reduce the number of chunks occupying the limited-capacity region, allowing the final digit to receive attention and storage. Through this process, the phone number is eventually memorized. The process of forming chunks in the capacity-limited region can be as recursive as needed – chunks can be grouped into even larger chunks, which is certainly beneficial for stimuli that are more complex or numerous than the example listed here.

In general, research supports the idea that chunking can occur through at least three possible ways. First, we can chunk or group items together by forming associations between items that are located in the capacity-limited region of immediate memory, in the manner described above. Second, in a similar vein to the first method, we can take advantage of perceptual cues present within a given set of stimuli (e.g., pauses in auditory lists, items in close spatial proximity) to form groups once items enter the capacity-limited region. Unlike the first case, where groups can be formed in any sort of fashion, the cues provide clear chunk boundaries. For example, a pause in between the third and fourth digit in a phone number (e.g., 684 7083) allows us to form two chunks – one containing the first three digits, and another containing the final four digits. Finally, we can also form an association between items that are in the capacity-limited region with prior knowledge that is stored in long-term memory. In general, long-term knowledge cannot be in conscious awareness unless it has been activated and brought into the capacity-limited region. Once long-term knowledge receives selective attention, forming a chunk or an association between this knowledge and other items in this region proceeds similarly to the first chunking process we described above.

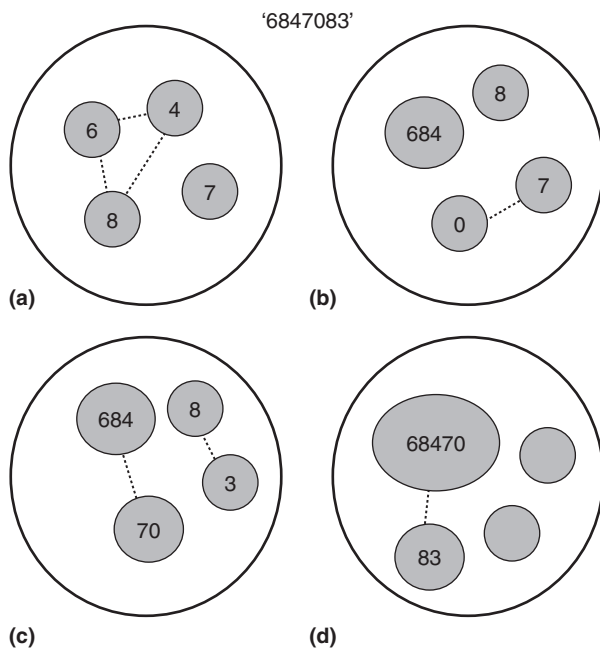


Figure 2 A model of how chunking may occur in the capacity-limited region of immediate memory. Digits in a phone number enter the region and form associations (indicated by dashed lines) to create larger chunks. Note, however, that the number of chunks that can be stored never changes. Encoding the phone number occurs in phases, as in this example: (a) Digits 6, 8, and 4 are first bound into a single chunk; (b) then 7 and 0 are bound into a chunk, and the second 8 enters the capacity-limited region; (c) chunks 684 and 70 are bound into a larger chunk, and 8 is chunked with 3, which has just entered the region; and (d) The two chunks that comprise the number are chunked, which will allow the entire phone number to occupy a single chunk and will free up several other chunks that can be used to accomplish something else (such as keying in the number or holding a conversation).

How Chunks Are Measured

Above, we discussed the notion of the boundaries of chunks, places where individuated chunks end and begin. In some cases, such as when stimuli contain perceptual cues that encourage chunk formation, the boundaries are relatively clear; we can tell how many chunks there are (the number of chunks), as well as how large each chunk is (chunk size). In a majority of cases, however, stimuli are considerably more complex (e.g., prose passages), and it may be unclear where these boundaries occur. This is particularly so when encoding of information is considered, as internal cognitive processes are occurring. How can we measure both the number and size of chunks in these cases?

One of the earliest ways proposed to examine chunk boundaries was done by measuring adopted chunks. Initially theorized by Endel Tulving and Jeanette Patkau, an adopted chunk is defined as recalled items that match the manner in which the stimuli were actually presented (i.e., order information must be preserved in recall). For example, a participant

is presented with the sentence “The quick brown fox jumped over the lazy dog.” If the participant recalls “The quick brown fox lazy dog,” two adopted chunks have been recalled. This is because the participant has recalled two phrases in correct order, but the whole sentence was not recalled verbatim (if this were the case, one adopted chunk would have been formed). Many early studies that measured adopted chunks in recall of unstructured materials found that across stimulus types that varied in terms of subjective meaningfulness; in the case of Tulving and Patkau, participants were presented with sentences that varied in terms of order of approximation to text, which was discussed previously. Findings from these various studies show that the number of adopted chunks that are recalled is constant, regardless of how meaningful the stimulus is. However, as we mentioned above, the size of these adopted chunks increases as stimuli become more meaningful. These studies concluded that there is a constant limit in terms of the number of chunks that can be maintained in memory; however, a greater amount of information (e.g., words within a sentence) can be grouped into a single chunk as stimuli become more meaningful and familiar to us.

Another way to measure chunks capitalizes on an important assumed property of chunks: the association between items contained within a single chunk should be considerably stronger than the association between items from two different chunks. Theoretically, this means that if one item that is part of a given chunk is recalled, other items within that chunk will likely be recalled as well (i.e., a positive relationship). In contrast, there is practically no relationship between recall of items that come from separate chunks; recall of one does not lead to recall of the other. In fact, as items from separate chunks are not bound to each other, we might expect that errors in recall will increase as one traverses a boundary between chunks. One way to measure chunk boundaries using these assumptions is to calculate the transitional error probability of recalled items. Using a mathematical formula, the probability of erroneously recalling a presented stimulus is calculated, conditional on the recall of the item presented immediately prior. In general, researchers have proposed that items within the same chunk will have low transitional error probabilities; when a boundary between two separate chunks occurs, the error probability should increase considerably.

A third means has similar assumptions to those of transitional error probabilities. As was stated above, items that are part of the same multi-item chunk are strongly bound together; in contrast, items separated by a chunk boundary (i.e., the items belong to two separate chunks) are not as strongly bound. It follows, then, that recalling items that are bound together within the same chunk should be faster than when items from two different chunks are recalled. This is because, in the latter case, two separate chunks which have little to no association to each other must both be retrieved. For example, Chase and Simon used this logic to measure chunk boundaries in their series of chess studies that was mentioned previously. In a chess board reproduction task, chess masters and novice players viewed a configuration of pieces, and were asked to copy the configuration onto a blank board; Chase and Simon were interested in how long it took participants to place successive pieces on the reconstruction board. When response times were examined, both for the immediate memory task

and the reconstruction task, it was found that a chunk boundary was defined at 2 s. If successive pieces were placed on the board in less than 2 s, those pieces belonged to the same chunk; if the placing down of two pieces had an interval of more than 2 s between them, the pieces belonged to different chunks. In general, it has been found in this and other studies that training increases the size of chunks; regardless of training level, the number of chunks that recalled remains the same.

A final method to measure chunks involves a posteriori assumption regarding how many chunks (and the size of those chunks) are stored in the capacity-limited region of immediate memory. Researchers have used two types of measures to examine chunk boundaries: chunk access and chunk completion. Chunk access is typically taken as a measure of the number of independent groups or units that are successfully retrieved at the time of recall. This is based on the assumption that items recalled from the same presented group (e.g., word pair, sentence) are part of the same chunk in immediate memory. For an example of how this might work, suppose that a participant were presented with the following word pairs in an experiment: pop-cube, apple-light, key-fish, and shoe-pill. The participant recalls the following items: pop, cube, apple, pill. Here, three separate chunks have been accessed, assuming that a pair functions as a single chunk – pop-cube, apple-light, and shoe-pill. The second measure, chunk completion, is taken as a measure of chunk size. This can be measured as the proportion of words recalled from the same chunk, provided that it has been accessed. Completion measures allow us to examine the coherence of chunks in immediate memory. Using the example above, the participant’s average completion for the list of pairs is 0.67 (0.5 for apple-light, 0.5 for shoe-pill, and 1 for pop-cube). Here, we see that chunking of the pairs is not perfect (there are instances where the entire pair is not recalled), but the size of chunks suggests that chunking of items is occurring somewhat.

Unresolved Issues

Throughout this article, we have described the phenomenon of chunking to the best of our ability, given what has been found in previous studies. That said, there is still much to learn about chunking. Below, we list some questions that, as of now, remain unresolved; by working to answer these questions, cognitive researchers will gain a better understanding of how chunks are formed and processed in immediate memory.

How Many Chunks Can Be Kept in Mind at Once?

Above, we proposed that chunking is necessary to overcome limitations in the capacity-limited region residing in immediate memory. In particular, we noted that this region can hold no more than four items or multi-item chunks at any given point in time; these items receive selective attention, and are in our conscious awareness at that time. There are, however, other views that report slightly different capacity limits. For example, recent studies by Klaus Oberauer and colleagues suggest that the capacity-limited region in immediate memory can only hold a single item at a time. Furthermore, if multiple items are present in conscious awareness, this is because they are

bound into a single chunk. Further research that examines chunk capacity limits is necessary to determine if any resolution between these conflicting views is possible.

Are Chunks Simple or Complex in Their Structure?

As chunking is often an internally generated process, it can be difficult for researchers to determine how chunks are organized in memory. A critical question worth examining in future research pertains to the organization of chunks in memory: when chunks are formed, are they separately stored and undifferentiated from each other, or are chunks connected to each other through some organizational structure? We argue, based on prior findings, that chunks in immediate memory may be organized by a hierarchical retrieval structure. For example, consider the study where a participant spent over a year practicing the digit span task to the point of accurately recalling 82 digits in the task. Based on retrospective reports, near the end of the training period, the participant was not only using his previously-reported strategy of encoding in terms of running time, but was also using other ways to give digits meaning. Furthermore, he reported deliberately organizing digit groups spatially, allowing larger groups (termed supergroups) to be formed; this nested organizational structure allowed digits to function as retrieval cues for remaining digits in a group or supergroup.

Similar organizational structures are presumed to operate in the comprehension of discourse or text, where the amount of information to be stored in memory typically exceeds immediate memory capacity limits. In a text retrieval structure, a linguistic representation contains several different organizational levels, allowing surface, semantic, and syntactic features to coexist in parallel and be chunked together. In general, only elements that have recently occurred or are central to passage comprehension are accessible in immediate memory. These various representations can serve as retrieval cues for what has previously been read, as recall of what has occurred earlier in a text passage is necessary for good comprehension.

From these examples, it is clear that chunks in immediate memory are most likely part of a larger, more complex organizational structure. People often need to know not only which elements belong together, but also the order in which they occur (as in a telephone number) or the way in which the elements are related to one another (as in the understanding of the slightly different chess configurations that are about equally good, and those that are not good at all). However, many studies that have examined organizational structures of chunks in memory focus upon exceptional domain-specific performance; even language comprehension can be considered a type of expertise. It is uncertain how chunks are organized in cases where expert performance is not required, or where task performance does not involve long periods of training.

Is Chunking Based on All-or-None Associative Strength, or Can Associations Be Continuous?

In our discussion of chunk access and chunk completion above, we noted in our example that word pairs were not perfectly chunked. Specifically, in the word pair example that we discussed above, completion rates were 0.67 overall.

Although items were presented in word pair form, there were instances where only one word in the pair was recalled. This potentially suggests that the associative strength between items within the pair was not sufficient to form two-item chunk. However, a thorny issue regarding completion rates as a measure of chunk size involves how we are to interpret associative strength between items. If two-thirds of the word pairs that are presented are successfully completed, as they were in our example, is it because one is only able to recall two-thirds of all of the pairs, with all pairs perfectly chunked together (i.e., associative strength equaling 1)? Or, alternatively, is it because one actually had some information about all of the pairs that were presented, but some pairs were so weakly associated or chunked that participants were unable to recall them accurately on every trial? Unfortunately, completion is not able to measure associative strength between items that make up larger chunks, and it is unclear whether associative strength is dichotomous (i.e., items are either chunked or are not) or is subject to a continuum of potential values. Future measures of chunking should be sensitive enough to be able to measure the strength of associations between items.

How Does Chunking Change with Age?

When immediate memory performance across the lifespan is examined, both children and older adults have worse performance than young adults. Two different views have tried to account for these differences. First, older adults and children may have a reduced memory capacity, meaning that they hold a smaller number of chunks in mind. Second, older adults and children may form smaller chunks. In two recent studies by Gilchrist and colleagues, participants ranging in age from the early elementary school years to young adults and older adults heard lists of unrelated English sentences. Each list of sentences varied in terms of how many sentences were present, as well as the length of each sentence. Chunk boundaries were measured by adapting chunk access and completion measures, discussed above, to sentence stimuli. The results suggested that both young children and older adults hold fewer chunks in mind than did young adults, but that chunk size did not change across the lifespan. Specifically, for these materials the completion rate for simple sentences remained at about 0.80 in all age groups, but the number of sentences accessed was smaller in children or older adults than in young adults.

Additionally, there is the question of how well young children and older adults are able to take advantage of chunking as an encoding strategy. Although completion rates for simple sentences were comparable across age groups, the ability to combine simple clauses to form compound sentences was not quite as good in the children and older adults. Previous research suggests that spontaneous use of strategies develops in later childhood, and then declines with adult aging. More research is needed to determine how the quality of chunking changes with age, and why these changes occur.

Concluding Remarks

Chunking is a process that allows us to meaningfully group items together to increase the amount of information we can

store and later recall. This process underlies much of how we learn information. Furthermore, chunking allows us to circumvent the capacity limits inherent in the immediate memory system; though chunks are still subject to capacity limits, we are able to store more information than if chunking were not possible, by fitting more information into each of a severely limited number of chunks that one can hold in mind concurrently. In this article, we have discussed chunking in depth, noting its purpose and a theorized view of how the process of chunking occurs. Chunking is one of the most powerful strategies to increase the information we hold in mind, yet there are many unresolved debates that should be examined in future research.

See also: [Attention](#); [Memory](#).

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Classical Conditioning

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Glossary

Acquisition and extinction With a number of pairings of a conditioned stimulus (CS) and unconditioned stimulus (US), conditioning will occur (i.e., acquisition of an association). Conditioning is evidenced if the CS elicits a conditioned response (CR) that it did not elicit before the CS–US pairings. (The US elicits an unconditioned response, UR, regardless of conditioning.) If, after acquisition has occurred, the CS is then presented without the US, the CS loses its power to elicit a CR. This phenomenon is referred to as extinction. Extinction is not simply undoing or forgetting an acquired association but it is better conceptualized as learning something new, that is, learning that the CS is not a predictor of the US anymore as it was before extinction.

Compensatory conditioned response and learned drug tolerance The compensatory CR is a special form of a CR, especially in classical conditioning with pharmacological USs. Its effect is opposite to the effect of the UR. It is thought that this is a learned response, dependent on the CS's predictive strength that is activated in anticipation of a disturbance of an animal's (including humans') homeostasis. For example, if a CS predicts a US such as morphine, which lowers the heart and respiration rate, the compensatory CR elicited by the CS is an increase in heart and respiration rate. This compensatory CR is thought to be the basis for learned drug tolerance because the compensatory CR counteracts the UR, thus making the drug less effective.

Conditioned stimulus (CS), unconditioned stimulus (US), conditioned response (CR), and unconditioned response (UR) An unconditioned stimulus (US) elicits a response without any previous learning. This response (in the absence of learning) is known as an unconditioned response (UR). A conditioned stimulus (CS) elicits a response only if learning has occurred after the CS has been paired with a US. Without previous learning, the stimulus to serve as the CS is neutral and elicits no response. The response elicited by a CS is known as a conditioned response (CR). Pavlov discovered that when, for example, a sound (CS) was followed reliably by food (US), a dog would salivate in response to the sound (CR) just as it had salivated in response to the food (UR), even though the sound did not elicit any reaction prior to conditioning (i.e., CS–US pairing).

Contingency and contiguity Contingency refers to an if-then relationship. For example, *if* the CS occurs, *then* it will be followed by the US with a certain probability. Contiguity

refers to the separation between two events. For example, the US may follow the CS immediately or after a few seconds (high contiguity) or after a few hours (low contiguity). In contrast to Pavlov's original thinking, contiguity is neither necessary nor sufficient for conditioning to occur. For example, in taste aversion learning where the US reliably follows the CS but perhaps only after hours, there is a strong contingency with low contiguity, yet conditioning is likely to occur.

Excitatory and inhibitory conditioning A CS that predicts the *occurrence* of a US is an *excitatory* CS (CS+). A CS that predicts the *omission* of a US is an *inhibitory* CS (CS−). Note that the plus or minus designations do not correspond to 'good' or 'bad' outcomes. A CS+ can predict the occurrence of an aversive or unpleasant US (which would make the CS+ undesirable). A CS− can predict the omission of an aversive or unpleasant US (which would make the CS− desirable).

Little Albert and John B. Watson's attempt to develop a behavioral therapy for phobias John B. Watson was driven by a laudable desire to develop a behavioral therapy to help people to get rid of their phobias (intense, irrational fear); he was successful in laying the groundwork for this. In order to study the elimination of fear scientifically, he sought to create a fear response in a person such that he would know its etiology and be able to develop a therapy based on learning principles. Thus, he exposed Little Albert to a rat (CS) and then immediately followed this experience by a loud, fear-inducing noise (US). After a few of such trials, Little Albert showed a fear response (CR) when just seeing the rat, similar to the response (UR) he exhibited when initially hearing the noise without the rat. Watson has been maligned often because of his work. According to modern standards, he clearly violated ethical conduct in research, however, contrary to popular belief, there is no evidence that Little Albert was permanently or severely traumatized. Many young children experience aversive events such as loud noises in their lives, yet they will not be marred for life.

The Rescorla–Wagner model of classical conditioning The Rescorla–Wagner model is a mathematical model that attempts to describe phenomena underlying classical conditioning. Learning is predicted to be a function of the discrepancy between the maximum amount that can be learned and the amount that has been learned thus far. The rate of closing this discrepancy is determined by the salience ('noticeability') of the CS that is involved on a given conditioning trial.

Introduction

Classical conditioning is also known as respondent conditioning or Pavlovian conditioning. The latter name was given for obvious reasons, that is, to honor the man who discovered it,

Ivan Petrovich Pavlov. Pavlov was a physiologist, not a psychologist, who discovered this natural phenomenon of reflexive learning serendipitously while investigating the digestive system. Thus, he became one of the most influential figures in psychology. Pavlov studied the digestive system using dogs as

subjects (which also conveniently served as producers of gastric juices, sold as a digestive aid for people to supplement Pavlov's underfunded laboratory). The story goes that one day it struck him that, just before they were fed, his dogs salivated to the sound of the caretakers' footsteps. Initially, Pavlov labeled this form of salivation *psychic secretion* because it was not obvious how the dogs were capable of anticipating a stimulus (food) before it actually made contact with the dog's tongue or palate. Sometimes Pavlov is credited with having invented classical conditioning, which is simply an incorrect assertion. Classical conditioning can be assumed to have existed ever since the evolution of animals capable of learning about their environment, long before Pavlov. It is also an incorrect assumption that classical conditioning is a somewhat primitive form of learning. Classical conditioning operates in a wide variety of situations (examples below), including complex human behavior such as emotions, language, and cognition. It is also critically involved in many other forms of learning and conditioning.

Pavlov's great contribution to psychology was to *discover* the existence of classical conditioning, and to develop (and in this case truly invent) scientific methods amenable to its systematic investigation. Thus, he introduced experimental control (i.e., exclusion of confounding variables and ability to produce classical conditioning on demand), which allowed him to manipulate factors such as stimulus duration, intensity, modality, timing, and degree of relationship between two or more stimuli in order to establish causality (the overarching goal of all sciences) as related to behavior (the realm of scientific psychology). By doing so, he contributed tremendously to the application of the natural sciences to psychology – a discipline that was thought of as not being easily amenable to scientific investigations because of its assumed mental nature. Pavlov's contributions to the sciences can still be appreciated when considering that in 2000, Eric Kandel was awarded the Nobel Prize in Physiology/Medicine for having identified in the giant sea slug, *aplysia*, the neural circuitry underlying classical conditioning, which plays a critical role in the physiological mechanisms of memory. (Ironically, Pavlov received the Nobel Prize in Physiology/Medicine in 1904 for his investigations of the digestive system, but not for his discovery of classical conditioning.)

Generally, classical conditioning can explain learning about situations where events occur in a typical sequence, regardless of what the specific events are and what a person (or animal) does. This way, a prior event in the sequence becomes a predictor for the subsequent event.

Terminology

Classical conditioning can be conceptualized as follows (Figure 1): on the first trial, a conditioned stimulus (CS; red), which at this point has no power to elicit a relevant response, is followed by an unconditioned stimulus (US; blue), which – without prior learning – has the power to elicit an unconditioned response (UR; tics on the UR trace). After several such pairings or trials, the CS acquires the power to elicit a conditioned response (CR; tics on the CR trace).

In one of Pavlov's first experiments, the sound of a metronome served as the CS, meat powder placed in the dog's mouth

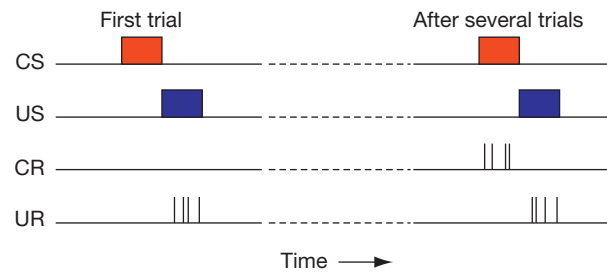


Figure 1 Schematic representation of classical conditioning involving conditioned stimulus (CS), unconditioned stimulus (US), conditioned response (CR), and unconditioned response (UR). Note that CRs only occur after several conditioning trials.

served as the US, and the salivation response (reflex) constituted the CR and UR. As can be seen in Figure 1, the metronome (CS) initially does not elicit any salivation (no tics depicted at the time when the CS is presented first), but the meat powder (US) does. After several trials (the sufficient number depends on several factors such as type of CS and US, their timing, salience, and relationship to each other), CRs (tics on the CR trace) can be observed when the CS is presented before the US. The US continues to elicit salivation (UR).

Apparently, the terms conditioned/unconditioned were an unfortunate inaccuracy when Pavlov's initial work was translated into English. Perhaps a better choice would have been the terms conditional and unconditional, because these indicate the different conditions under which a response does or does not occur. An unconditional response, for example, is a response that occurs unconditionally, that is, regardless of what was learned before, and a conditional response only occurs if certain conditions were previously met. The controversy regarding terminology, however, is by no means settled as there is an ongoing debate in the field of animal learning whether Pavlov, regardless of the issue of proper translation, indeed referred to conditionality (-al terminology) or to conditioning (-ed terminology) – the latter reflecting the notion that through conditioning a stimulus and response are changed (i.e., conditioned). For consistency in the literature, most writers nowadays have settled for the -ed, not -al, terminology.

Forms of Classical Conditioning

Delayed, Trace, Backward, and Temporal Conditioning

Figure 1 depicts what has become known as delayed conditioning. In delayed conditioning, the CS onset precedes the US onset, but there is no temporal gap between the CS offset and US onset. The CS and US may even overlap. The stimulus-stimulus interval, that is, the time between CS onset and US onset can be relatively short (i.e., seconds, short-delay conditioning) or long (i.e., hours, long-delay conditioning). This form of conditioning is considered quite effective because, as will be elaborated below, this arrangement makes the CS a clear predictor of the US.

Other forms of conditioning include trace conditioning, which is similar to delayed conditioning in that the CS onset

precedes the US onset. However, the CS offset occurs before the US onset such that there is a temporal gap between CS and US, when neither stimulus is present. This form of conditioning has been considered less effective than delayed conditioning, probably because of the weakened predictive power of the CS (depending on the temporal gap between CS and US). However, more recent research has shown that this does not have to be so. Whether or not one observes conditioning with the trace procedure depends critically on which CR is selected for observation. For example, when a pigeon is presented with a keylight (CS) followed by response-independent food (US) with a period of a dark key between the CS and US (i.e., trace conditioning), very few if any pecks at the lit key will be observed, implying that the procedure is ineffective and that little conditioning has taken place. However, if the pigeon's proximity to food is recorded, the pigeon's position with respect to the location of food delivery is an orderly function of how much time has elapsed during the trace. In other words, positioning becomes a learned response, and with this behavior in mind, the trace conditioning procedure is very effective in bringing about conditioning.

A third form of conditioning is backward conditioning. In this procedure, the US precedes the CS, and therefore the CS cannot predict the occurrence of the US. Unsurprisingly, little if any excitatory conditioning of the CS will occur. However, careful analysis reveals that the CS becomes a predictor for the US-free period to follow, because the CS explicitly indicates that there will be no US immediately after the CS. The CS becomes a so-called inhibitory stimulus (CS-; see below). As in trace conditioning, judgment of the effectiveness of the procedure depends critically on what response is being measured as the CR.

Finally, there is temporal conditioning – a procedure in which a US is presented repeatedly after a fixed-time interval has elapsed, without explicit CS. The sensation of passing time presumably serves as the CS.

Autoshaping: A Special Form of Classical Conditioning?

If a hungry pigeon is exposed to a situation where a keylight is followed by food regardless of the pigeon's behavior (defining the autoshaping procedure), the pigeon is likely to peck at the key after a few trials. Furthermore, if one keylight is followed by food and another keylight by water, the pigeon pecks at each of the two keylights reminiscent of the way it would peck during actual consumption of food or water: for food, one observes distinct peck movements toward the key, with beak open, whereas for water, one observes small, rapid beak movements, while the pigeon keeps its head close to the key. The keylight functions as the CS and food/water as the US; the peck at the keylight is the CR and actually eating or drinking (consummatory response) is the UR. One human example may be when people standing in an elevator stare at the floor indicator. Just as in classical conditioning, this behavior has no bearing on the outcome (e.g., whether people are staring or not, the elevator does not move faster or in a different direction). Autoshaping is of interest because it serves as a convenient model of classical conditioning with relevance to nonhumans and humans. For example, it can be shown that the ratio of the interval between trials (intertrial interval, ITI)

and duration of the CS is critical for learning rates. In general, under classical conditioning, the larger the ITI:CS ratio, the faster acquisition will occur.

Human Examples

The Case of Little Albert

One of the most famous case studies in psychology is the case of Little Albert. John B. Watson had designed a method to condition a child to be fearful, so he could develop, in a controlled manner, an effective treatment to subsequently eliminate fear. To accomplish this, he presented a pet such as a rat, rabbit, or other animal (CS) to Albert. Immediately after Albert saw the animal, a metal bar was struck to produce a loud noise (US). First, Albert did not cry when he saw the pet animal, but after repeatedly experiencing CS_{Pet}–US_{Noise} pairings, he began to cry (CR) as soon as he would see the pet, just as he would cry (UR) in reaction to the loud noise. The claims of Watson's putative cruelty and unethical conduct are probably vastly exaggerated. First, as sketched out in his book, *Behaviorism*, first published in 1924, Watson was driven by a genuine and admirable desire to develop an effective treatment of irrational fear (phobias) in people, regardless of how misguided and insensitive his approach may have been. Second, many babies or young children hear loud noises such as popping balloons at a children's party or suffer pain from falling, for example, and then cry because of it. They may even become afraid of balloons and stairs, which is actually a healthy and adaptive response. Yet one generally does not worry about these children being traumatized for the rest of their lives.

Language and Verbal Behavior

One of the most uniquely human behaviors is language, and classical conditioning (in linguistics sometimes referred to as statistical learning) is involved in language learning, as B.F. Skinner already recognized in the 1950s. Classical conditioning is particularly important for children to become effective listeners. Consider the following situation: A mother might say "Here's some milk!" or "Have a cookie!" The probability of occurrence of the actual items, milk and cookie, is much higher after the vocalizations 'milk' and 'cookie', respectively, than after the vocalizations of 'juice' and 'sandwich' for example. Since the sound of 'milk' (CS) often precedes the actual item milk (US), the CS becomes a predictor for the US. (In colloquial terms, the 'meaning' of the utterances 'milk' and 'cookie' is thus established.) Another example of verbal behavior is memorizing text (e.g., the word 'pledge' precedes the word 'allegiance').

'Cognitive Maps' and Memory

The learning of so-called cognitive maps is based in part on classical conditioning as well. Imagine that each day, on your way to work riding the bus, you drive by the convenience store with its bright-green awning immediately before arriving at the north-east corner of main street where the bus turns right. To be able to picture your way to work in your mind when, for example, giving directions to a friend ("Turn right immediately

after the convenience store with the green awning!'), you do not have to be actively driving to work. It is sufficient to be passively driven and to observe a series of landmarks in order to learn about specific localities. One landmark becomes the predictor for the next.

Classical conditioning is critical for some forms of memory (e.g., implicit memory, which is learning and remembering past events without explicit awareness). In order for a CS to remain a CS for a while after conditioning has occurred, memory – presumably encoded in altered neural connectivity – is essential. In the example above, learning about landmarks is only possible if stimulus-stimulus pairs are being remembered.

Embarrassment

Imagine a man finding himself attracted to a woman who rides the same bus he takes to work every morning. One day, he musters up all his courage to approach the woman and ask her if she might like to join him for a cup of coffee. The woman reacts by saying loudly (so everyone on the bus can hear it) 'You creep! Get lost!' The man blushes and feels embarrassed. The next day, as soon as the man sees the woman, he blushes and feels embarrassed all over again. In the framework of classical conditioning, the sight of the woman serves as the CS, the woman's initial verbal and embarrassing reaction as the US. Blushing and the feeling of embarrassment are the CR (when triggered by the mere sight or thought of the woman) or UR (when triggered by the woman's original reproach). This example illustrates that the association was established in one trial (initial situation) between two stimuli, that is, the sight of the woman (CS) and the embarrassing words (US).

Acquired Taste Aversion

Joe went to a restaurant where he shared a novelty pizza (duck meat and feta cheese topping) with his friends. In the middle of the night, he got violently ill with stomach cramps and nausea caused by a stomach virus. The next day, after talking to his friends who did not get sick, he realized that his illness was not caused by food poisoning. From this day on, even though he realized that his experience had nothing to do with the pizza itself, he immediately felt ill just smelling feta cheese or duck. In the framework of classical conditioning, the smell and taste of feta cheese and duck represent the CS, the toxin produced by the virus represents the US, feeling queasy in response to the smell of feta cheese and duck represents the CR, and feeling ill in response to the virus's toxin represents the UR. This example illustrates several additional aspects of classical conditioning. First, classical conditioning can occur with just one CS-US pairing. Pavlov's original demonstration required multiple CS-US pairings. Second, the temporal separation (referred to as contiguity) between CS and US can be quite long. Pavlov's original demonstration required rather close contiguity between metronome and meat powder. (If the metronome were presented hours before the meat powder, the dogs would not salivate to the sound of the metronome.) Third, classical conditioning occurred without awareness and contrary to what Joe deduced from his talk to his friends. Joe realized that the nausea after his restaurant visit had nothing to do with feta cheese and duck meat, yet these specific foods

continue to produce aversive reactions. Fourth, conditioning is more likely when novel stimuli with no or little prior history are involved. Joe had never experienced the combination of feta cheese and duck before. If it had been a standard pizza with tomato sauce and mozzarella, which he had eaten many times before in his life, it would have been unlikely that he develop an aversion to tomatoes and mozzarella cheese. This point will be elaborated in a subsequent section in the discussion of the so-called Rescorla-Wagner model (RWM) of classical conditioning, which in this article will serve as an example of one of several competing theories of classical conditioning. Fifth, some CS-US associations occur more easily than others, depending on what species is being considered. This phenomenon is referred to as species-specificity and underscores biological constraints on learning. Specifically, in humans, an association between a smell/taste CS and a nausea-inducing US occurs easily, but not an association between a visual CS and a nausea-inducing US. (The relationship might be opposite for another species, e.g., quail.) Note that Joe did not develop an aversion to the sight of the restaurant or of his bedroom even though these provided stimuli that were more contiguous than the smell/taste stimuli provided by the food in the restaurant. This point will be elaborated in the next example.

Fear-Conditioning

Here is another example of fear conditioning (compare with the case of Little Albert above) that involves pain without an experimenter's responsibility. Jane went to a restaurant where she shared the infamous novelty pizza (duck meat and feta cheese topping) with Joe and her other friends. After they finished and left the restaurant, she got hit by a car and experienced excruciating pain. After recovery, she got invited by her friends to go out for dinner again. She still liked novelty pizzas but to her own surprise, when she approached the restaurant, she broke out in cold sweat, her heart started racing, and she felt very fearful about being in another accident. In this example, the sight of the restaurant serves as a CS, the pain inflicted by the accident serves as a US, feeling fearful, breaking out in cold sweat, and her heart racing in reaction to the sight of the location where the accident had occurred represents the CR, and experiencing pain, fear, and dread because of the injuries she suffered from the accident when it happened represent the URs. This example, again, illustrates the species-specificity and biological constraints in classical conditioning (Jane developed an emotional response to the place where she ate, not to the food; the US was pain, not nausea). The mechanisms just described probably represent at least a partial explanation of the posttraumatic stress syndrome, where cues that have become associated with stress, pain, and injury can elicit extreme fear-responses even many years after the original situation that first established the association between the cues and the actual event. A second point is of importance: The CR and UR are not identical. Even though Pavlov hypothesized what he called stimulus substitution (i.e., the CS takes the place of the US) and thus tried to explain the similarities between CR and UR (both salivation), he recognized that the CR and UR were not identical (the saliva differed in chemical composition). The following example illustrates a situation where the CR and UR can even be opposite in their effect.

Learned Drug Tolerance

Bob and Serena had been using heroin for years, which they originally used recreationally under very specific circumstances, with their own routine and ritual. Because they had become increasingly more concerned about their health, they decided to quit and clean up. They stayed clean for 18 months, proudly overcoming the battle with initial physical withdrawal. They had not even been thinking of their past habit anymore, when one day they were invited to a party where old friends were shooting up heroin. As soon as Bob and Serena saw the familiar paraphernalia of syringe, spoon, lighter, and tourniquet, both experienced sensations that they immediately recognized as withdrawal symptoms. Whereas they always felt warm, happy, and relaxed when using heroin, they now, after months of abstinence, felt cold, irritated, and tense. This experience caught them completely by surprise because they had not used heroin for months and thought they had completely overcome withdrawal from heroin. An analysis of this situation within the framework of classical conditioning, somewhat simplified, is as follows: The paraphernalia function as CSs (cues that predict the imminent injection of heroin), the injected heroin functions as US, and the sensations and physical reactions resulting directly from the injected heroin are the URs. (A proper analysis is somewhat complicated by the fact that physical reactions themselves provide so-called proprioceptive stimuli.) What are the CRs? The analysis is in terms of so-called compensatory CRs. Considering that biological systems typically strive for homeostasis, CSs are assumed to be cues to allow the body to prepare and compensate for the impending physiological disturbances caused by heroin (US). With initial heroin use, these CRs are assumed to be nonexistent or weak but with repeated use, the CSs become increasingly strong as predictors (i.e., classical conditioning has occurred), and accordingly the elicited CRs become stronger as well. With drug use, the CSs are always followed by the US, but the URs are counteracted with increasing force by the CRs. The net effect of the drug thus becomes diminished. The user counteracts this in turn by increasing the dose of heroin to increase the net drug effect. The strength of the CR increases in turn, and thus the cycle continues. So, when Bob and Serena encountered the familiar CSs (paraphernalia) at the party, compensatory CRs were elicited (and experienced as withdrawal) that were not attenuated by the primary effects of heroin (because they were not using any). These unexpected withdrawal symptoms can contribute to relapse. Similar analyses can be applied to tolerance and withdrawal involving nicotine, caffeine, and alcohol, but also to less obvious situations involving the diminishing effects of thrill-seeking behavior (e.g., bungee jumping and skydiving), changing romantic attachment in short- and long-term relationships, and depressive reactions to retirement after a long work life.

In the example of learned tolerance, the effect of the CR and UR are in opposite directions. For example, if the UR is a decrease in heart rate, respiratory rate, pain sensitivity, and muscle tension, the CR is an increase in these measures. Note that this form of classical conditioning describes a phenomenon sometimes called psychological dependence. It occurs independently of systemic changes in opioid receptors or drug residuals, as can be logically verified as follows: After months of abstinence, putative opioid-receptor sensitivity

and drug residuals are identical moments before and after encountering the CSs, yet withdrawal occurs immediately upon encountering the CSs (environmental cues). Based on this analysis, a very effective therapy for drug dependence has been developed as will be presented in a subsequent section.

The Acquisition of Associative Strength in Classical Conditioning

Predictiveness: Contingencies and the RWM

The CS can be conceptualized as a signal that allows a person's (or animal's) physiology to prepare for events that happen with a certain probability: In the above examples, the metronome served as a cue for Pavlov's dogs' palates to be wet before the anticipated arrival of dry food; the mother's utterance 'cookie' was a signal that a cookie was on its way; the sight or thought of the person who inflicted embarrassment was a cue for more embarrassment; the smell of feta cheese was indicative of food that was likely to cause sickness (regardless of whether the food was the actual cause or not); the rat was a warning signal for Little Albert that a loud noise was about to happen; and the syringe for the heroin user was a cue for imminent disruption of physiological homeostasis. The critical point is that in these examples the CS becomes an effective predictor (more precisely an excitatory CS or CS+) for the occurrence of the US, if it signals a greater probability of the US in its presence than in its absence: $p(\text{US}|\text{CS}) > p(\text{US}|\text{no-CS})$. It is also possible that the CS becomes a predictor for the absence of the US. For example, a person might walk in a badly lit alley and worry about getting mugged. But as soon as the person sees a police station, the person might feel relief. The police station, CS, functions as a signal for the decreased likelihood of getting mugged and injured (US) because $p(\text{US}|\text{CS}) < p(\text{US}|\text{no-CS})$. In this case, the CS is inhibitory or CS-.

Perhaps it is helpful to think about how different types of CSs (CS+ and CS-) may elicit a range of human emotions with respect to different types of USs (desirable and aversive). Here are four examples: a person playing a slot machine who sees three cherries lined up (CS+ predicting the occurrence of a desirable US, money) probably feels happiness and excitement. A smoker who sees the 'No Smoking' sign (CS- predicting the omission of a desirable US, nicotine) probably feels unhappy and disappointed (perhaps even experiences withdrawal). A pilot seeing the warning light of engine failure (CS+ predicting the occurrence of an aversive US, danger) probably experiences fear. And finally, the Homeland Security Department's Code Green (Low Risk of Attacks; a CS- predicting the absence of the US, danger) probably elicits a feeling of relief and safety in people. It is important to realize that the signs in CS+ and CS- are not notations of the desirability of the CS or US. Instead, the sign signifies the type of contingency, a positive or negative contingency, which refers to 'if CS, then US' (positive contingency) and 'if CS, then no US' (negative contingency) – simply the degree of dependency between the CS and US. The desirability of the CS depends on the contingency and the type of US. Thus, a CS+ with respect to the occurrence of danger elicits the unpleasant emotion fear, whereas a CS- with respect to the omission of danger elicits the pleasant feeling of relief.

Several models of classical conditioning that see the CS as a signal for presentation or omission of a US have been proposed. One of them, the RWM, will be introduced as the most representative of these models, even though it has been shown that it cannot account accurately for all phenomena in classical conditioning. The RWM is also an example of an early model that proposed a mathematical equation that successfully predicted human behavior (even though it has been tested primarily in nonhumans). Here is a simplified version of this model: $\Delta V = s(A - V_{\text{sum}})$ where ΔV is the change in associative strength of a given CS (i.e., how much more or less conditioning has taken place after an additional CS-US pairing), s is the salience or noticeability of a CS (its value ranging from 0 to 1.0), A is an asymptote denoting the maximum amount of conditioning that a given US can support (sometimes conveniently expressed as percentage; it can be a desirable or undesirable US), and V_{sum} is the total of associative strengths of all stimuli that are involved in all previous conditioning trials. For example, if for a metronome $s = 0.50$, for a morsel of food $A = 100$ drops of saliva, and for all stimuli (metronome only, for simplicity) $V_{\text{sum}} = 0$ (before the first trial, before any conditioning has taken place), then $\Delta V = 0.50 (100 - 0) = 50$ after completion of the first trial. Thus, by completion of Trial 1, the metronome is predicted to have gained associative strength and can elicit 50 drops of saliva. After the second CS-US pairing, $\Delta V = 0.50 (100 - 50) = 25$; after the third and fourth pairing, $\Delta V = 12.5$ and $\Delta V = 6.25$, respectively. The cumulative associative strengths of the CS (V_{sum}) after Trials 1, 2, 3, and 4 are 50, 75, 87.5, and 93.75, respectively. Figure 2 depicts the acquisition curve of a CS over ten trials. ΔV in Trial 1 is added to V_{sum} in Trial 1 (amount learned prior to Trial 1) to produce a new sum (amount learned after Trial 1). This new V_{sum} is then inserted into the formula to determine ΔV for Trial 2, and so on. ($A - V_{\text{sum}}$) represents the amount of associative strength that still can be acquired after a given

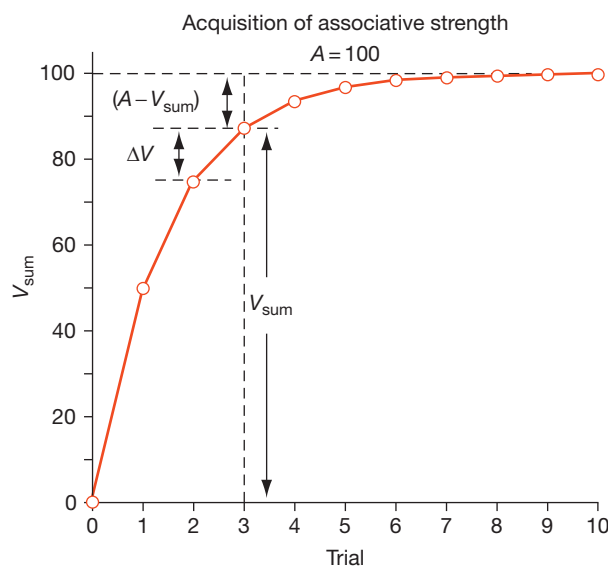


Figure 2 Hypothetical example of an acquisition curve (in red) as conceptualized by the Rescorla-Wagner model. Refer to text for explanation.

trial (i.e., the difference between the maximum of learning and how much has been learned already). How much of this difference will actually be added by the next conditioning trial is proportional to the salience of the CS and the number of previous CS-US pairings. It should be clear that the equation describes an increasing, monotonic function of diminishing returns with an asymptote at A , which is a classic learning curve similar to the one that Hermann Ebbinghaus described over 100 years ago in his memory research. (Each opportunity to study a list of nonsense syllables constitutes one trial, and each trial results in learning additional words, but the length of the list sets the asymptote because one cannot recall more words than are on the list.) In the beginning, much can be learned on one trial; after many trials, very little can be learned on an additional trial even though performance is ever improving.

The RWM can also account for the phenomenon of extinction by assuming that $A = 0$. Extinction refers to a situation where after several CS-US pairings, the CS is presented by itself, that is, not being followed by the US anymore. This results in a decline of associative strength. The resulting curve looks like a forgetting curve (a horizontal mirror image of the learning curve in Figure 2.) However, the notion that extinction is similar to forgetting has not been substantiated. Extinction is better conceptualized as learning a new contingency involving the same CS. (Evidence against forgetting as an explanation comes from so-called re-acquisition tests, for example, in which after complete extinction, the original CS-US pairings are reintroduced. Reacquisition is typically faster than the original acquisition, despite the fact that both start at levels where the CS appears to have zero associative strength.)

The RWM is a powerful model that has been tested empirically many times. For example, one can change the value of A (e.g., increase or decrease US magnitude or introduce extinction with $A = 0$) and change the salience (e.g., make the CS, a light, brighter, or dimmer). Decreasing US magnitude, for example, results in lowering the asymptote of the obtained learning curve. Increasing or decreasing the brightness of the CS results in a higher or lower rate of acquisition, respectively. Generally, these predictions have been validated empirically.

Contiguity

Contiguity in classical conditioning refers to the closeness of two stimuli (mostly temporal closeness of two CSs, or between a CS and US). This was one of Greek philosopher Aristotle's (384–322 BC) Principles of Association. For example, if one happens to observe a shooting star (CS) and then immediately thereafter hears a loud bang (US), many would be tempted to see a causal relationship between these two events (even if there is none). Pavlov also recognized this principle and empirically tested it by varying the time between the metronome (CS) and food (US). The more closely together the CS and US occurred (however, not simultaneously), the more quickly conditioning took place. When the temporal separation was too large, no conditioning occurred. (Even if there was a contingency between metronome and food, that is, US-food always followed CS-metronome, if there was only negligible contiguity – for example, presentation of the metronome was followed by food 8 h later – no conditioning would occur.)

Thus, it came as a surprise when acquired taste aversion was discovered (see example above). Here, a long gap (e.g., hours) between CS-taste and US-sickness was possible and still allowed for fast conditioning (sometimes even in just one trial). Thus, contiguity is not necessary for conditioning to occur. In fact, even in situations with contiguity but without contingency (i.e., the CS is not predictive; the US is equally likely to occur with or without being preceded by the CS), no conditioning occurs. (Robert A. Rescorla introduced this no-contingency test as the truly random control group.) Thus, contiguity is not sufficient for conditioning to occur.

Stimulus Overshadowing and Stimulus Blocking

The failure of conditioning despite contiguity is further illustrated by two phenomena, stimulus overshadowing and stimulus blocking. Stimulus overshadowing might occur when two CSs – one salient, the other not – are competing for associative strength. The outcome is that the more salient CS accrues most of the available associative strength whereas the less salient CS, despite equal contiguity, fails to accrue much associative strength. A human example is as follows: most elevators are equipped with a visual signal (up or down arrow) and an auditory signal (one or two chimes) for the vision impaired to be informed about the direction of the elevator. In general, for people visual stimuli are more salient than auditory stimuli. Therefore, we learn more about the direction of the arrows (CSs) as predictors for the actual movement of the elevator (US, to move in the intended direction) than about the signal value of one versus two chimes. When asked, most people cannot tell whether one chime indicates up or down movement of the elevator.

Stimulus blocking refers to a situation where one of two (or more) CSs has a prior predictive (or associative) history with respect to the US, and as a result blocks a second predictive CS that is added later. Thus, despite the fact that the second CS is contiguous with the US, its acquisition of associative strength is drastically reduced. (According to RWM, $A - V_{\text{sum}}$, the potential of subsequent learning, is small if one CS had already accrued most of the associative strength. Thus, little associative strength is left to be accrued by the added CS.) A real-life human example of blocking involving classical conditioning alone is difficult to identify. However, it can be argued that a discriminative stimulus, S^D , in operant conditioning acquires its value or cue function through classical conditioning (i.e., given an appropriate response, the S^D is followed by a reinforcing stimulus, S^R). This $S^D - S^R$ pairing is one of the three binary associations that has been experimentally identified in the so-called three-term contingency of operant conditioning, $S^D::R - S^R$ (if S^D , and if R , then S^R), and, for the current analysis, is equivalent to the CS-US association in classical conditioning. The blocking rationale may then apply to a variety of human situations.

What follows is an experimental demonstration of blocking in humans (even though similar paradigms have been used to study blocking in other species): initially, a light (CS_{Light}) is presented and followed by a puff of air (US) aimed at one of the participant's eyes. Conditioning has occurred when CS_{Light} elicits an eye-blink response (CR), similar to the eye-blink response (UR) elicited by the US. Then a tone (CS_{Tone}) is added to CS_{Light} ,

forming a $CS_{\text{Light}} + CS_{\text{Tone}}$ compound. Blocking is demonstrated when even after many presentations of the $CS_{\text{Light}} + CS_{\text{Tone}}$ compound CS_{Tone} alone fails to elicit a CR. It is said that CS_{Light} blocked CS_{Tone} in its acquisition of associative strength.

Novelty

One last point in this section deals with novelty of the stimuli involved. To follow through with the example of learned taste aversion, as mentioned above, consider that a person may have eaten regular tomato and mozzarella cheese pizza many times before. In effect, there were many $CS_{\text{Taste}} - US_{\text{Wellness}}$ pairings in the past. If it so happens that one day the person gets sick after having eaten a tomato-mozzarella pizza, not much learned taste aversion with respect to the taste of tomato and mozzarella cheese would occur because the CS_{Taste} would have accrued a lot of associative strength already. In other words, there were many CS-US pairings in the past that established the food as safe, so that one bad experience will not have a large impact on the firmly established CS. However, if the person gets sick the first time a novel CS_{Taste} is experienced, the one CS-US pairing will have a proportionally great impact. Recall that according to the RWM, early training trials with a new CS have a relatively large effect: much can be learned on the first few trials, whereas relatively little new information is learned on late trials.

Therapies Based on Classical Conditioning

The final section of this entry addresses the role of classical conditioning in a number of therapies for clinical disorders. Four examples will be offered as a representative selection of treatments based on classical conditioning.

Treatment of Phobias

A phobia is an irrational fear that is intense enough to render a person dysfunctional and distressed. As discussed above, the case of Little Albert was John Watson's attempt to develop a model of fear (with known history) in order to develop a treatment to take fear away from a person. His student Mary Cover Jones continued his work and developed one of the earliest behavioral therapies based on what she called unconditioning. The approach was to introduce the established fear stimulus (white rat or rabbit) gradually, while keeping the child relaxed and distracted by allowing him to eat a favorite food (and the loud noise was omitted). Years later, in 1958, Joseph Wolpe used this as the basis for his so-called systematic desensitization through reciprocal inhibition or counterconditioning. Research over the following years revealed that the clinically relevant component of unconditioning, systematic desensitization, or reciprocal inhibition was extinction (though changing the value of the CS from being a predictor of something unpleasant to a predictor of something pleasant may contribute to a successful treatment as well). In this and other treatments such as flooding and implosive therapy, based on extinction, the client is exposed to the fear CS without being exposed to the fear US (and without being allowed to avoid the CS by withdrawal, for example). As a result, the CS loses its fear-eliciting properties.

Treatment of Drug Tolerance

In the previous example of learned drug tolerance, the paraphernalia elicited withdrawal because of their association with heroin use. The experience of withdrawal is thought of being one of the reasons why former addicts relapse, even after months or years of abstinence because the former addict is very likely to reduce the unpleasant withdrawal by giving in and using the drug again. Thus, one aspect of treatment of drug dependence should focus on eliminating the experience of this type of withdrawal. In order to do so, the former addict is intentionally exposed to the drug-cues (CSs) but is not allowed to actually administer the actual drug (US). For example, an addict may be allowed to cook up saline solution (an inert substance) and inject it but is not allowed to do so with actual heroin. Initially, the addict will go through severe withdrawal all over again. Each presentation of the drug-cues without actually administering the drug, however, serves as an extinction trial. With extinction, once again, the association of the drug-cue-CS with the actual drug-US is changed such that the CSs lose their power to elicit the compensatory CRs, which decreases the experience of withdrawal.

Treatment of Alcoholism

Even though a similar extinction technique, as described above, can also be applied to alcoholism or any other form of dependence, so-called aversion therapy, based on classical conditioning, has also been used for the treatment of alcoholism. The idea is based on the principle of taste aversion learning. The alcoholic ingests a drug (e.g., Antabuse), which has no effect until alcohol is ingested. If alcohol is ingested while being treated with Antabuse, the person gets violently ill. The idea is that the taste of the alcoholic beverage serves as the CS, and that the nausea induced by antabuse+alcohol serves as the US. After a few CS-US pairings, the taste and smell of alcohol becomes aversive. This therapy by itself has not proved to be very successful for reasons that are beyond the scope of this article.

Treatment of Nocturnal Enuresis

Nocturnal enuresis refers to bedwetting in children who are considered to be too old developmentally for bedwetting. One treatment approach is based on classical conditioning, which is applied after organic or medical conditions have been excluded as a possible cause for enuresis. For this, a pad (constructed like a sandwich of two sheets of mesh wire, separated by a cotton sheet) is placed under the sleeping child. When the child urinates on the pad (and, urine being a good conductor, thus closing the electrical circuit), a battery-operated alarm goes off and wakes up the child. The sensation of a full bladder is thought to be the CS, the alarm the US, waking up to the alarm the UR, and waking up to the sensation of a full bladder the CR. (When the CR occurs, enuresis is eliminated.) Note that the sensation of a full bladder always precedes the sound

of the alarm. Thus, the sensation of a full bladder becomes an effective CS eliciting a waking up response. Note that no awareness of learning is required for classical conditioning to be effective (i.e., the conditioning can take place even though the child is sleeping). Note also that there is an alternative explanation in terms of operant conditioning, which is beyond the scope of this article.

Conclusion

The present article on classical conditioning was an attempt to give a flavor of the richness and complexity of this form of associative learning. There is a vast literature on the different models of classical conditioning; for the sake of brevity, only the RWM was introduced as one example of the many quite successful models. Other aspects of classical conditioning were given only a cursory treatment: the application of classical conditioning to neural networking and cognitive models, the complexity of recent findings relevant for extinction, and an appreciation of the fact that in most conditioning situations, many stimuli are involved, which compete and interact in their involvement with associations that are being formed. The interested reader is referred to the list of suggested readings.

See also: Alcohol: Psychosocial Effects; Drugs, the Brain, and Behavior; Operant Conditioning.

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The Clinical and Cognitive Psychology of Conflict

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Glossary

Cognitive factors Higher-order psychological factors relating to intellect, reasoning, belief, and construct systems which may have an influence on lower-order events such as learning, perception, and conflict resolution.

Cognitive unconscious Information presented at a speed too rapid for conscious recognition nevertheless establishes some kind of memory trace. This information is subsequently learned more quickly than nonpresented information. The designation 'cognitive' is added to emphasize that the effect is in the area of learning and perception and is more limited in its motivational or an emotional influence than alleged to occur with the Freudian or dynamic unconscious.

Conflict A perceptual state involving the executive function of the organism where the immediate choices in the organism's repertoire, together with the outcome of these choices, are seen to involve incompatible motives and needs.

Constructs A term promoted by the American psychologist George Kelly to describe the belief systems which individuals use to divide persons (and the world in general) into specific categories such as pleasant–unpleasant, attractive–repulsive, and honest–dishonest. Constructs are usually bipolar and characteristic of the individual.

Coping skills The skills, including those known as defense mechanisms, for dealing with the demands (especially those that are psychologically threatening) of the environment.

Defense mechanism The description of the various ways in which consciousness is said to defend itself against potential anxiety by distorting the perception of the situation to become a less or nonthreatening one. The usual defense mechanisms are denial, projection, displacement, sublimation, and rationalization.

Emotional unconscious The evoking of activity in the deeper structures of the brain (the limbic system) which border on the cortex of the brain and communicate with bodily organs. While these brain structures mediate potential emotional experience, the experiences themselves may take the form of gut feelings or more generally, so-called somatic markers. They may unconsciously influence decision making and may be a part of what is experienced as intuition.

Gestalt psychology Literally, the study of how the whole is greater than the sum of its parts. An approach within psychology, which emphasizes a basic principle in facilitating

learning, perception, and even psychotherapeutic change, is to create a whole and meaningful image from its components. Conflictual aspects are resolved by combining their inherent polarizations or promoting a dialog between them.

Mindfulness The focusing of attention on the *flow* of immediate experience in the here and now alongwith enabling the attitude of openness, acceptance, and curiosity as to the content of experience. It derives from the practice of Zen meditation.

Mindfulness-based cognitive therapy This is aimed at breaking habitual thought and reaction patterns and expanding awareness to include feelings and bodily reactions that would not otherwise be attended to: in short, access to otherwise nonconscious processes.

Positive psychology A movement rather than a school, which derives from humanistic psychology, which aims to be a counterbalance to psychiatry by providing psychology with a positive and scientific base in cognitive psychology. It places an emphasis on the expression of higher motives and positive emotions involved in the search for meaningfulness, wisdom, and happiness in life. It is associated with the works and concepts of Philip Zimbardo, Mihaly Csikszentmihalyi, Martin Seligman, and Albert Bandura.

Psychoneuroimmunology The study of the way psychological factors interact via neural and chemical messengers (hormones) with the body's immune system, thereby providing a pathway for psychological factors to have determining effects on illness.

Social identity theory Social identity is composed of several different identities corresponding to the social groups of which we are a member. The more positive the images of these groups, the more positive is our self-esteem, and we strive to increase the status of our group membership by creating a series of ingroups and outgroups. This becomes a basis for social prejudice and group conflict.

State-specific memory This concerns memory that is specific to a particular state of consciousness and is not retrievable or only partially retrievable in other states. For example, events which a person recalls in a drug-induced state may not be recalled in the normal waking state and vice versa.

Stroop effect A technique for studying the effect of perceptual bias on recognition time and learning by using words for colors written in colors which are incongruous with their meaning: the word *red*, for instance, written in blue.

Conflict is an integral part of all human behavior, and its attempted resolution can be seen as a major part of the effort toward mastery of the environment. Unresolved and chronic conflicts are probably the most central problems that clinical psychology deals with.

A conflict can be defined as a motivational and emotional state that challenges the cognitive resources of the organism and which can result in mental and bodily stress. The motivational aspect is due to the perceived nature of our goals to which we attribute polarized negative and positive loadings.

This often means that there is an increase in emotions such as anxiety associated with nearing the goals and their associated loadings or with the threat of loss of the reward associated with goal. Conflicts, when they are experienced consciously, also involve a cognitive and executive aspect in terms of applying experience and eliciting skills which can lead to their resolution.

Knowledge concerning conflicts and their effects can accordingly be organized under the aforementioned headings of motivational aspects and emotional aspects relating to their unconscious and dynamic significance, and the cognitive and executive aspects concerning how they are consciously conceptualized and resolved. Since conflicts inevitably produce bodily stress, this is also an important component.

Axiomatic to the understanding of conflict behavior is the view first put forward by the philosopher of science John Dewey: "the brain is primarily the organ of a certain type of behavior, not an organ of knowing the world." This is to acknowledge that with respect to evolutionary demands, the human psyche would seem to be best equipped for handling straight decision making in the face of practical conflicts and then carrying out these choices. The brain may not be designed to give any simple resolution of abstract philosophical and ontological problems such as the meaning of life. This apparent truism may explain not only why existential conflicts are the most intractable but also why behavioral conflicts appear to be the most readily amenable to psychological intervention.

In this vein, it is true that early psychologists chose to study simple paradigms of conflict situations, often attempting to determine the variables governing their resolution or persistence in the form of symptoms. The approach known as behavioral psychology emerged from this with its foundations in the study of how rat behavior is determined by simple laws relating to the contingency and frequency of noxious and rewarding reinforcers. In contrast, the early psychoanalytic approach focused on the dynamic forces and defenses governing emotional conflict. Historically (with the exception of Gestalt psychology and a few partisan approaches such as Jungian psychology), it was much later that therapies and theories developed to take into account the unique nature of the human species: man's ability to conceptualize the environment and enter into existential conflicts. Recent developments are, however, giving this aspect a central role in illness. Unresolved psychological conflict with its resulting long-term stress appears to be an important and sometimes a crucial determining factor not only in psychological disturbance but also in the genesis of a wide range of illnesses. However, rather than continuing to focus on diagnosis and disturbance, there is a contemporary focus, known as *positive psychology*, on the enormous human potential for change and on the importance of existential questions and conflicts.

The Motivational Aspects of Conflicts

It was because of its simplicity that the behavioral approach made rapid progress in the study of learning; whenever it was applied to the study of conflict, it had to adapt to a more holistic approach, that of Gestalt psychology. One of the most influential gestalt psychologists, Edward C. Tolman, introduced concepts such as expectancies, signs, and cognitions as so-called 'intervening variables' placed in the middle of the simple

stimulus-response analysis of behavioral psychology. For Tolman, even rats were cognizant of the salient features of their environment. Another gestalt psychologist, Kurt Lewin, proposed what is now regarded as the classic analysis of conflict in terms of conflicting goals. This was of the trilogy of approach-approach, approach-avoidance, and avoidance-avoidance goal conflict.

In *approach-approach conflict*, both goals are accredited equal positive values and a choice naturally entails loss of one. Analogies are easy to find in the human situation, for example, when one is faced with a choice between equally attractive job offers or equally attractive roles, such as in career fulfillment and in parenthood.

Approach-avoidance conflict involves by definition an aspect of punishment or loss in achieving the desired goal and evokes fear or anxiety. Challenges by their nature often entail fears and contemporary fears may not be only of physical harm but of psychological annihilation or humiliation, for instance as often experienced by the challenges and risks involved in the public performance of skills. Many life crises, from the first step the child makes to his or her first date, can be seen as conflicts of overcoming anxiety. Their attempted resolution creates the learning experience for future skills and confidence in dealing with the demands of the environment.

Avoidance-avoidance conflict is often regarded as the most deleterious of conflict paradigms, since behaviorally, the organism cannot avoid punishment. Some conflicts can be of relatively minor significance: hard work or the prospect of exam failure. Other conflicts of this type can, however, have serious effects: a monotonous yet stressful work situation against the demeaning prospect of being out of work. (The situation is not helped by accumulating evidence of a rising incidence of myocardial disorders with this type of job.) The conflict can be one between physical harm and psychological damage. Consider the anxiety evoked by and the consequences involved in the choice between risking death and physical harm in war or alternatively refusing to take arms in war and undergoing group rejection and imprisonment.

Nonresolution of all types of conflict in terms of an outcome in making behavioral choice (or at least some form of behavioral action) necessarily implies stress. Stress, independent of whether or not it is of a chronic nature, can produce a variety of behavioral and, as will be discussed later, physiological symptoms.

Whereas the aforementioned conflict analysis can be regarded as a contribution from Gestalt psychology, the behavioral approach using animals resulted in some exact lawful relationships. For instance, in observations of animal behavior, whether in the laboratory or in a natural setting, one may speak of conflict between two incompatible types of behavior if tendencies for these two behaviors are simultaneously present.

An approach-approach conflict involves two tendencies in conflict approaching two different objects some distance apart, which implies that the incompatibility is a physical one. Here, the animal may reach a point in between where there exists a balance between the tendencies to be drawn to each object. The position of this point will be unstable as the tendency to approach either goal increases with its proximity. Any departure from the point of balance toward one goal increases the

tendency to approach the other goal with a concomitant decreased tendency to approach the other.

In avoidance-avoidance conflict, an animal is confronted by two objects it attempts to avoid. The tendency to avoid either goal is likely to increase with its proximity. Therefore, any movement toward either object is then likely to result in a return to the point of balance.

While behavioral psychologists initially studied these situations in terms of animal behavior, they eagerly sought parallels in humans. The Russian psychologist I.P. Pavlov described the behavior of his dogs when they were unable to discriminate between competing but similar stimuli as a basis for choosing one of them. He coined the term *experimental neurosis* to describe how they yelped, bit aggressively, or lay down and gave up the task. Many years later, the American psychologist, Martin Seligman, focused on behavior in the avoidance-avoidance paradigm and described a condition he termed *learned helplessness*. Seligman's dogs, on successively receiving electric shocks at whatever end of the cage they chose to move to, finally gave up in their efforts to avoid the shocks and became passive and behaved as if they were resigned to their fate. This passivity continued even when the experimental paradigm changed and the active behavior of the animal would have removed it from the noxious stimulus. Theoretically, the learned helplessness condition assumes altered responding in at least three major categories of behavior: emotional, motivational, and cognitive. Seligman and his coworkers assume parallels here with the kind of reactive depression in humans that results from the carminative effects of negative life events. By this account, one develops the strategy of giving up in the face of apparently irresolvable conflict, becomes depressed, and loses the belief that own actions can change outcomes. This simple observation has become the cornerstone of a group of therapeutic approaches known as cognitive therapy. The underlying principle here is to teach the human patient alternative ways of viewing his environment, create new choice situations, and thereby encourage certain activities that may lead to positive reinforcement, either in purely behavioral or in conceptual (cognitive) terms.

Another motivational behavior concerns fear and anxiety as a learned drive or secondary drive in which the first stage is shock fear and the second concerns the signs of fear. Fear or avoidance behavior becomes an acquired drive in its own right. In a classic experiment by Dollard and Miller, rats learned to work hard at pedal pressing for the 'reward' of being released from a cage they associated with electric shocks. Dollard and Miller regarded the dependency effects of drugs such as barbiturates as due to their reinforcement of drug using behavior via fear reduction. The behavioral psychologist, Hans Eysenck, emphasized that the persistence of neurotic behavior is due to avoidance of the feared object – by always running away at the first possible opportunity. For Eysenck, it is the first physiological signs of anxiety – increased pulsation of the heart or increased rate of breathing – that induce this behavior rather than fear as a learned drive.

'Conscience' for behavioral psychologists can be, to some extent, explained in terms of conditioning which occurred according to the reinforcement and contingency laws of learning or else through imitation as a basic form of social

learning. In these terms, neurosis is seen then as an internal conflict between conscience and drives.

Motivation was until recent years studied either as a largely conscious process in terms of behavioral psychology or as largely unconscious process in terms of the psychodynamic psychology of Freud and his followers. However in recent years, there has been some rapprochement between these previously opposed views. Nowadays, cognitive behavioral psychology views defense mechanism as forms of copying (or noncopying) skills. Even the concept of *nonintentional motivated behavior* is used to describe motives that influence behavior but which cannot easily be consciously expressed or integrated into the self-concept or role. For instance, a person may deny what is seen by others as obvious flirtatious behavior by maintaining it was only innocent friendliness because this is not part of the person's self-concept.

The Unconscious and Emotional Aspects of Conflicts

Conflicts involve emotion, especially anxiety, which is disturbing to the psychological function and efficacy. There is little doubt that the major contribution of the psychoanalysis, and in particular that of Freud, is in having provided a rich catalog of the means of dealing with anxiety from conflicts between drives and the demands of reality and social learning (the superego). These are the classical *defense mechanisms* originated by the ego as strategies to defend it against the ensuing anxiety. Their common feature is that they result in an initial amelioration of the conflict by distorting the perception of reality to fit in with the needs of the individual. However, some defense mechanisms such as intellectualization can also be seen as adaptive *coping strategies*.

As such, defense mechanisms may be regarded as the strategies an individual learns to enable personality to function in the face of conflict from the environment. Regression, for instance, often operates in situations where efforts at problem solving or conflict resolution, based on current learning, are blocked and frustration results. The individual then regresses to a behavior repertoire, which may have earlier given successful solutions.

In the case of other defense mechanisms such as the denial of the conflict or its projection onto others, the price for their operation is a distortion of reality, and this is often in the long run rather maladaptive. An accurate perception of reality – and one which includes the individual's own motives and behavior – is important from the point of view of successful conflict resolution and ultimately for the harmonious functioning of personality.

Nevertheless, the primary function of defense mechanisms, as the term implies, is to protect the executive function of personality from threat and breakdown. Experimentally, there are techniques which demonstrate how defenses operate. Many years ago, the term *perceptual defense* was coined to describe the higher recognition threshold required for the identification of emotionally loaded words that were rapidly flashed (tachistoscopically presented) on a screen.

To demonstrate this convincingly, one needs techniques that circumvent the problem of response bias. It might be that individuals recognize the emotionally taboo words but

refuse to say them or even admit that they see them. One of the techniques that can demonstrate that genuine subliminal conflicts do occur makes use of the *Stroop effect*. In the Stroop effect, subjects are asked to read the names of various colors that are printed in colors that conflict with the meaning of the word, for instance, the word RED is printed in green. Normally, this interferes with the naming of the colors by delaying the naming response. The Stroop effect can be shown to operate even subliminally, that is below the threshold for conscious recognition. Subjects report they are unaware of when a clinically loaded word is being presented, but its interference on their performance can nevertheless be demonstrated if they were required to say the meaning of color words. Such experiments have led many authorities to reject the notion that perception is unitary and accept that degrees of perceptual processing or at least perceptual registration of events can occur without full conscious awareness.

While some aspects of this approach may be intuitively appealing, the notion of the dynamic manipulation of the contents of consciousness by an all-powerful Unconscious lurking beneath its surface has never been accepted by mainstream psychology. Nevertheless, a concept known as the *cognitive unconscious* has come into vogue on the basis of experimental findings from the study of memory and perception. This notion describes how perceptions and learning can occur without the individual being cognizant of the information involved but nevertheless showing evidence of its acquisition in his or her behavior. There appears to be some form of unconscious monitoring and correctional activity present in routine decision making. The originator of the term the cognitive unconscious, John Kihlstrom, is a coauthor of a recent paper where he has expressed his contemporary view that "the unconscious is not just an oxymoron" but that nonconscious vigilance occurs for nonconsciously occurring biases and automatic compensatory processes can be unconsciously activated. It is well known that the skepticism toward this area owes its origin to the ill-founded claims for the subliminal effects on coca cola selling. Nevertheless, a current review of the literature by Ran Hassin, James Uleman, and John Bargh concludes that the outright dismissal of the claims was unwarranted.

There appears now to be a consensus that information can be cognitively registered in this way as *subliminal perception*. It is often said that there is no evidence for subliminal perception effecting behavior or decision-making processes. Nevertheless, the rapid exposure (at nonrecognition threshold) of emotionally loaded words such as those relating to hostility, rudeness, or politeness and also of concepts relating to behavioral stereotypes such as 'professor' and 'secretary' or 'soccer hooligan' has been shown to have an effect on later behavior. When tested in staged ambiguous situations, it was found that, depending on the nature of the exposure, participants behave more politely or rudely, intelligently or aggressively, etc. than control groups.

Another contemporary reconceptualization of unconscious processes is found in the work of Antoni Damasio. Damasio downplays the role of conscious processes in decision making and maintains that emotions often steer what we believe are our logical decisions. An important concept here concerns *somatic markers*, which means that emotions arise through the influence of bodily processes and the limbic system or deep

structures in the brain and exert subtle effects on us without our knowledge.

Nowadays, the term *dynamic unconscious* is restricted to the older Freudian use, while the terms *cognitive* and the *emotional unconscious* are generally reserved for the contemporary use of the unconscious. Some authorities prefer the more limited term *learning without awareness*. Damasio's concept, often termed the *emotional unconscious*, is seen, at least in a limited sense, to be a neurobiological concession to Freud.

The Bodily Effects of Stressful Conflicts

As has been described earlier, defenses are not just a liability but can also serve, at least in a limited way, a positive function in enabling the individual to cope with conflicts that would otherwise be overwhelming. It is then not surprising that several styles of coping have been identified which show differing relationships to mental and physical health. What are the 'healthy' ways of coping with stress and conflict? There are findings suggesting that both a *goal-oriented* and an *emotionally reactive* way of dealing with threats may be effective strategies. Both these strategies of handling threat show a positive relationship to indices of a healthy immune system. A fourth means of handling conflict is described as *defensive hostility*, which involves projection outward of hostility, related only negatively to psychosomatic health. Indeed, it appears likely that this means of defense, involving as it does the projection of threat and hostility, can hardly be considered to be adaptive as its effect would be most likely self-reinforcing, thereby leading to only more stress and conflict.

The earlier-mentioned studies of the use of various defense mechanisms in handling threat and conflict indicate that stress is not just a mental and behavioral event but also has, in some cases, a profound and lasting physiological impact. Indeed, *stress* can be defined in terms of this threat (where the stimulus can be of an internal or external origin) to the psychophysiological integrity or well-being of the organism. Generally, chronic stress has profound deleterious effects on psychophysiology through increased release of corticosteroid hormones and catecholamines. Under normal conditions, the body is programmed to provide short-term muscular responses to stress situations. The short-term effect of the aforementioned hormones is vasoconstriction, and the increased mobilization of fat and protein provides energy to the tissues in order to meet the demands of conflict. However, these same mechanisms, through the action of the hormones, lead to hypertension and vascular disorders in the long term. In addition, a significant reduction in lymphocyte number and activity occurs, an effect which may explain the now well-established finding that chronic stress leads to increased susceptibility to a wide range of illnesses.

The immune system is almost certainly phylogenetically older than the central nervous system and therefore is accredited as having the primary role of defending the organism against, as well as adapting it to, the environment. Like the nervous system, the immune system is also capable of learning, so much so that the term *psychoneuroimmunology* is now used to describe the study of how various components of the immune system learn to respond to conditioned stimuli. Stimuli

that are consistently and associatively paired with those that previously induced a stress response come also to have a stress-inducing effect when presented alone. The significance of this can hardly be overstated since it implies a direct link between illness, hormones, and psychological factors. Already, two adaptive systems have been described. Allergic reactions can be seen as overreactions analogous to the nervous system's anxiety states, and autoimmune diseases can be regarded as an analogy with depressive states in that the response becomes internalized and self-destructive. To quote the actor-cum-director Woody Allen: "I don't get depressed, I develop a tumor."

The Cognitive and Executive Aspects of Conflict

A concept from cognitive psychology that has been frequently applied to the study of conflict is called *attribution*. The notion of attribution concerns the type of rationalizations that are given by individuals as explanatory hypotheses for their behavior. If the explanation for one's behavior is said to be attributed to environmental causes and therefore beyond the control of the individual, then it is said to be externally determined. This contrasts with the attribution of personal responsibility for behavior whence the individual is said to be internally determined. Research indicates that the type of attributions individuals make predicts behavior. The positive loading of the events that are being attributed are of course crucial. For instance, patients who externally attribute positive events to others (external attribution) and negative events to themselves (internal attribution) are reported to score higher on scales of depression and hopelessness. By contrast, those who persistently attribute positive events to themselves and negative ones to others and to external forces, are more likely to score high on paranoia.

The growth of attribution theory has been a major factor in leading to what is sometimes called the cognitive revolution. This is a mark of progress in psychology which to some extent stands in contrast to the other revolution taking place, that of reducing behavior to neurobiology. The pivotal question is of course 'is the individual a victim of his neurology' or can major changes in our concepts of ourselves and the world lead to changes in behavior and even in our neurological processes. Some leading authorities in the area of emotion, such as clinical psychologist Arne Öhman, are impressed by the findings that argue that the brain appears to respond about a half second before consciousness reports making the decision (SEE LIBET EFFECT) and conclude therefore that the role of consciousness is merely to tidy-up afterward by creating meaning out of what has in fact already been decided by the brain.

Yet, it cannot be denied that the recent history of psychology supports the cognitive revolution by the upsurge of interest in 'consciousness' as an object for scientific study. Max Velmans and Susan Schneider, the editors of a recent volume on *Consciousness Studies*, note how the field, during its 15 years of existence, has increased to 600 000 books and articles. *Consciousness Studies* gives organizing structures such as 'the self' and state of consciousness the individual is in, as having a determining influence on behavior.

The issue, which naturally arises here concerning so-called nonconscious roots of behavior, is the supposition that not

all the contents of experience and perception are represented in the self-concept. Perceptions, which are in conflict with how the person has been taught to view himself and behave, are either reinterpreted in accordance with this or denied and therefore not given verbal identification. They are nevertheless present in the form of so-called nonverbal feelings.

While the principles involved in this process appear similar to those postulated by the psychoanalytic and psychodynamic theories of Freud, the descriptive language is clearly different in terms of being a more humanistic and existential one. Defenses are thus seen as styles for handling perceptual data and arise in order to enable the self, as the organizing principle in consciousness, to cope with the demands of the environment. Defenses arise when the more biological side of personality (temperament) is in conflict with the 'conditions of worth,' that is the conditional demands from the environment governing the expression of love and care toward the individual. These demands lead naturally to the learning of self-concepts, social skills, and roles but, in doing so, lead also to the dissociation of the incongruous, nonaccepted self-experiences that are in conflict with the learned role.

How can this approach deal with the problem that has beset psychoanalysis: the dubious ontological status of the unconscious? If one follows the phenomenology-cum-functionalism of William James and Carl Rogers, the solution may be to simply accept that consciousness exists in many different forms. Some of these are dissociated from one and another, and the various forms may utilize different languages of symbolic representation for memories and ranges of experiences. Supporting this conceptualization are the now well-established findings relating to state-specific memories. The study of altered states of consciousness and dissociated states sometimes reveals that these memories are organized as distinct and conflictual self-representations.

According to this view, conflict and anxiety can then have a positive function since there is assumed to be a force for growth existing as a biological principle. This drive operates during the opportunity for change – in a crisis or in a therapeutic context – and strives after creating the reintegration of experiences and split-off parts of the self. Indeed, dissociated and altered states of consciousness have often been claimed to be associated with creative problem solving and therapeutic change.

For many years, a medicopsychiatric view dominated clinical psychology, and the findings from behavioral research had an explanatory input limited to anxiety and phobic states. Even psychoanalytic categorizations were based on an essentially nineteenth century Kraepelinian system of medical classification. During the 1980s, although retaining the spirit of the Kraepelinian system of category thinking, there has been an attempt to produce a theory-free system known as DSM-IV. While the scientific validity of DSM-IV has been severely criticized, it is nevertheless generally agreed that the system has incorporated a more sophisticated view of how predispositional and situational factors interact. The consensus view among psychologists appears to be that long-term conflicts in the form of stress-related events – so-called *life events* – interact with biological (predispositional) factors to produce a variety of psychotic and neurotic disorders.

In dealing with conflicts and ensuing stress, research has identified that there are some basic coping skills. Being

successful at skilled performance, however, means not only learning from one's own experience and gaining positive feedback from successes, but also being inspired and learning from others and then becoming fully involved in meeting the challenge. It is this combination of factors which Albert Bandura calls *self-efficacy beliefs* and enables people to overcome obstacles and reach goals. Bandura was one of the first to emphasize that the most effective source of learning in mammals and humans is not that of the classical conditioning but that of *imitation and observational learning*.

Positive Psychology

A refreshingly new approach which incorporates much of the aforementioned points has enabled clinical and health psychology to build an alternative model to the medical one for the study of mental disturbance. This is known as *positive psychology*. Positive psychology approach combines the behavioral work on cognitive functioning with approaches that were more phenomenological in using terms like self-concept and self-esteem. Some of the research findings challenge the traditional ways of seeing mental illness. For instance, those of the English psychologist Richard Bentall and his coworkers give us good reason to question the unity and homogeneity of such disorders as schizophrenia and neurotic disorders. Their findings provide an alternative way of viewing these disorders to that of illness, in terms of degrees of cognitive dysfunction arising from biological predispositions and life events. By having a knowledge of biological factors such as temperament and important life events from early attachment onward, one can then see how certain patterns of dysfunction in beliefs, thought processes, and emotional expression – what one sees as ‘symptoms’ – can come to develop.

Self-esteem and self-concepts are clearly part of the executive functioning of the organism and can be seen as closely connected to the process of attribution. As mentioned earlier, by using these concepts, it has been shown that patients with depressive ‘symptoms’ have excessive *internal attributions* in the form of being fixated on negative events relating to themselves and will tend to interpret events to conform to their preconceived self-concepts. In contrast, deluded and paranoid patients have been found to make excessive *external attributions* in the form of persecutory ideas, perhaps as a defense against impending depression and low self-esteem, by blaming others for negative events. Generally speaking, these types of attributions become the foundation for an optimistic versus a pessimistic lifestyle. A pessimistic lifestyle is an important predictor of later illness.

Positive psychology is, however, not so much about illness per se but about our higher and healthy motives: the need for meaningfulness, happiness, and wisdom. In looking at what seems to be a healthy functioning style, a series of such relationships has recently been found by Trevor Archer and his colleagues at Gothenburg University. They discovered that an optimistic lifestyle and so-called *intrinsic motivation* which is the enjoyment of activities for their own sake rather than for external reward, together with the expression of positive emotions, were all closely related and formed a personality pattern of healthy functioning.

The recent history of clinical psychology can be said to follow the career of one of its most esteemed leaders, Martin Seligman, who began his work as a behavioral psychologist contributing to the concept of learned helplessness. Seligman moved on to become one of the founders of cognitive psychology focusing on attributional styles and now finally is the major proponent of ‘positive psychology’ with its emphasis on existential problems and authentic happiness in life. This reflects how the old divisions between behavioral, psychoanalytic, and humanistic psychology have begun to fade away. Behavioral psychology used to have the dictum: change behavior and you change the way of seeing things. For psychoanalysis, it was first insight and then change. While the aphorism for today's cognitive psychology is change the person's constructs and you can change his behavior, it is probably true to say that in practice, most psychologists use all the three means where and when appropriate.

The research behind this change has led to tangible effects and the current interest in Europe in *cognitive behavior therapy (CBT)* is one outcome of this. Following the recent evaluation of antidepressive medication, showing this to be a costly and largely ineffective treatment, there is now government-empowered support for providing the public with cost-effective evidence-based treatment. CBT tends to be the most favored among the various therapies, although there is no decisive evidence for its superiority over the more personal and dynamic forms of therapy. Nevertheless according to leading psychologist and governmental advisor, David Clark, the UK government plans during the next 3 years to educate 3600 psychological therapists under the supervision of clinical psychologists with the aim of providing a treatment for the 900 000 citizens who are estimated to need it for the treatment of anxiety and depression.

The enormous interest in consciousness and its role in cognitive processes mentioned earlier may be the reason why there is now an otherwise unlikely allegiance between Zen Buddhism and behavioral psychology teaching ‘mindfulness’ meditation. *Mindfulness* is the focusing of attention on the flow of immediate experience in the here and now along with openness, acceptance, and curiosity to its content. *Mindfulness-Based Cognitive Therapy* is aimed at breaking habitual thought and reaction patterns and expanding awareness to include feelings and bodily reactions that would not otherwise be attended to: in short, access to otherwise nonconscious processes. Clearly, the current focus of psychology gives us reason to modify Dewey's axiom, which we began with, as being a simplification. Humans may not be very effective as achieving it, but they do seek meaningfulness.

Resolving Social Conflict

While it is a long way from the study of rat behavior and the psychoanalytic couch to the resolution of internal and group conflict, already during the 1960s psychologists were becoming interested in the application of theories about group identity to social behavior. This will be covered more fully in other articles, but some landmarks are worth noting.

Muzafer Sherif and his coworkers carried out what is now regarded as a classic experiment in the resolutions of group

conflict. Working with boys at a summer camp, the researchers followed the process of how group identity and rivalry arose. Different codes of behavior evolved and with it conflict and opposition. Open hostility developed between the groups. At this stage, various techniques for intervention and conflict resolution proved successful. One of these was the formation of superordinate goals that required the cooperation of both groups in order to resolve an externally imposed threat. Another was the introduction of methods to promote interaction and contact between the groups.

There are a few examples of psychological intervention in real group conflict. One well-known example, albeit almost on an anecdotal scale, was the successful involvement of Carl Rogers in facilitating openness and communication between members of a small group of Catholics and Protestants in Northern Ireland. Rogers relied on creating a therapeutic atmosphere of empathy, acceptance, and warmth.

For many years, practical solutions to racial and group conflict were influenced by Gordon Allport and his suggestions for reducing conflict by increasing contact between groups and focusing on similarities between individuals. However, with the recent development of the approach known as *Social Identity Theory*, the emphasis has now shifted away from the individual toward dealing with intergroup differences and promoting an understanding of the need to maintain these in the face of threat and discrimination.

Another major contribution came from social psychologist Irving Janis who described how group decisions often make systematic errors of judgment which he called *groupthink* and *mindguarding*. Groupthink refers to the pressures in the group to maintain an illusion of unanimity, and mindguarding refers to the efforts to maintain solidarity and protect the leader from stress and contradicting viewpoints. Irving recommended the use of a 'devil's advocate' as a counter to groupthink.

Other psychologists such as Max Bazerman have extended their expertise to the area of negotiations. Bazerman describes the common mistakes that negotiators make such as being locked in and committed to one perspective, seeing the others' gains as their losses, and being overconfident of success. Although a strong case can be made for the involvement of a psychologist in international conflict, this seems to rarely occur. However, one psychologist who has made an important contribution in the global context is Albert Bandura who was mentioned earlier in the context of self-efficacy and observational learning. Bandura now works with the film media in the entertainment-education area, producing films in order to encourage social change. These are films intended primarily for third-world countries addressing major issues such as overpopulation, genital mutilation, the education of women, and

literacy. Role models, in the form of highly admired actresses and actors, and plot-lines are used to debunk false beliefs and encourage people's beliefs about their own efficacy.

There is a classical quotation from the days of behaviorism by the well-known psychobiologist, Frank Beach: "Psychology is the study of the white rat and the college sophomore." Clearly, the aforementioned research shows that today's psychology has come a long way and now is a dynamic and reality-relevant subject.

See also: Attribution; Cognitive Behavior Therapy; Gestalt Psychology and the Development of Perceptual Organization; Positive Psychology; Subliminal Perception.

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Relevant Websites

- <http://crinfo.org/> – The Conflict Resolution Information Source.
- <http://www.ppc.sas.upenn.edu/> – Positive Psychology Center.
- <http://www1.eur.nl/fsw/happiness/> – World Database of Happiness.
- <http://mbct.co.uk/about-mbct/> – Mindfulness-Based Cognitive Therapy.
- http://www.ted.com/talks/martin_seligman_on_the_state_of_psychology.html – Martin Seligman on positive psychology.

Clinical Assessment

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Glossary

Antecedents Events that immediately precede behavior and influence its frequency.

Behavior Any measurable or observable act or response. Behavior is defined broadly in some perspectives to include cognitions, feelings, and physiological reactions which, although they are not directly observable, are defined so that they can be measured.

Behavioral Approaches to understanding and altering behavior in which learning histories and current environmental contingencies of reinforcement and behavior repertoires are considered. These approaches differ in the degree of attention devoted to thoughts (e.g., cognitive-behavioral compared to applied-behavior analysis).

Clinical inferences Assumptions about causes and remedies regarding problems.

Cognitions Beliefs, schemas, self-statements, attributions.

Cognitive approach Attention is devoted to thoughts.

Cognitive-behavioral approach Attention is devoted to thoughts as well as behavior.

Consequences Events that follow behavior and influence its frequency.

Contextual (ecological) assessment Attention is devoted to individual and environmental factors. This is an integrated appeal.

Contingencies Relationships between behaviors and the events that follow (consequences) and precede (antecedents) them.

Evidence-based practice A process and philosophy designed to forward effective integration of clinical, evidentiary and ethical concerns.

Interpersonal approach There is a focus on interpersonal relationships.

Psychodynamic Approaches to understanding behavior in which unconscious mental and emotional processes (e.g., motives, defenses, conflicts) related to past and current experiences are emphasized for example in discussing moral conflicts.

Reliability The extent to which a measure is stable over time (stability). There are other kinds of reliability such as interitem reliability.

Transdiagnostic approaches Approaches emphasizing similarities across 'disorders.'

Validity The extent to which a measure measures what it was designed to assess. There are different kinds of validity (e.g., predictive, content, concurrent, construct).

Clinical assessment involves the clarification of presenting concerns and related factors including identification of outcomes that will be focused on. It should offer guidelines for selection of intervention methods. Assessment lays the groundwork for selecting plans and should indicate how likely it is that hoped-for outcomes can be attained. The likelihood may be slim when needed resources are not available or when problem-related circumstances cannot be rearranged. Assessment should indicate what factors influence clients' options. It should suggest 'leverage points' for pursuing valued outcomes. Interrelated goals (sometimes referred to as case formulation or case conceptualization) include: identifying and clarifying presenting concerns, detecting characteristics of clients and their environments that influence those concerns, interpreting and integrating data collected, and, in collaboration with the client, selecting outcomes to focus on. Assessment should offer clients more helpful views of problems and a useful vocabulary for describing concerns and options. Decisions must be made about what data to collect, how to gather this, and how to organize it. This phase is an ongoing process in which assumptions are altered as needed in response to new information, such as degree of progress.

The assessment methods used differ because of differences in theoretical perspectives which influence the kind of data

collected, how it is gathered and the uses and functions of these data. Carrying out an assessment is like locating the pieces of the puzzle. Certain pieces of the puzzle are sought rather than others depending on the clinician's theoretical orientation and knowledge, and puzzle completion may be declared at diverse points. Related decisions and inferences differ in how closely they attend to related empirical findings. Issues of practicality may limit evidence available. Data are sought that are useful, reliable, and valid. Specialized knowledge may be required and critical thinking skills are needed to weigh the value of evidence and examine the soundness of assumptions. Although decisions must typically be made on the basis of incomplete data, without a sound assessment framework, opportunities to gather useful data may be lost and ineffective or harmful plans suggested. Collecting irrelevant data wastes time and money and increases the likelihood of incorrect decisions. Assessment methods can be harmful as well as helpful. Limitations of and related potential adverse consequences of assessment/diagnostic methods, such as anxiety and worry because of a high rate of false positives, are often *not* candidly acknowledged. Even when the decision to use a test is well argued, there may be risks which should be clearly described to clients. Hiding potential harm and inaccuracy of assessment methods are common in the helping professions.

There is general agreement that an individualized assessment which considers cultural differences should be conducted. This does not mean that this is indeed done and practice perspectives differ in what is focused on. Individualized assessment avoids the client uniformity myth in which clients (or families, or groups) are mistakenly assumed to be similar. Behavior consists of different response systems, which may or may not be related depending on each individual's unique history (1) overt behavior (e.g., avoidance of crowds) and verbal reports (verbal descriptions of anxiety); (2) cognitions (thoughts about crowds); (3) physiological reactions (e.g., increased heart rate when in crowds). Each person may have a different pattern of responses in a situation. Only through an individualized assessment can these unique patterns and related situations be discovered. Suicidal potential should be assessed as relevant. Recognizing the signs of pathology is important anytime. This would be helpful in understanding what can be accomplished and how it can be accomplished. A clear mutual agreement between clinicians and clients about the focus of helping increases the likelihood of client engagement.

Forming a conceptualization of concerns, one that is shared by both the clinician and the client that will be helpful in attaining hoped-for outcomes, is an integral aspect of assessment. The kind of conceptualization suggested will depend on the theoretical orientation of the clinician. It is important to arrive at a common view of hoped-for-outcomes and how to attain them. This common view is a motivating factor in that, if clients accept it and if it makes sense to them, there will be a greater willingness to try out interventions that flow from this account. Mutually agreed-on views are fostered in a variety of ways, including questions asked, assessment methods used, and rationales offered. Focused summaries help to put material together within a new conceptualization. Identifying similar themes among seemingly disparate events can be used to suggest new views. High levels of facilitating relationship skills are associated with success and thus vital to develop and use.

The Guiding Role of Practice Theories

How presenting concerns are structured is a key part of clinical decision-making. Assessment frameworks differ in what is focused on, the kinds of assessment methods used, and how closely assessment is tied to selection of intervention methods. Preferred practice theories influence what clinicians look for and what they notice as well as how they process and organize the data collected. Theories favored influence beliefs about what can be and is known about behavior and how related knowledge can be developed. Theories differ along the following dimensions:

- Unit of concern (individual, family, community, society).
- Goals pursued (e.g., explanation and interpretation alone or understanding based on prediction and influence).
- Clarity of goals pursued.
- Criteria used to evaluate the accuracy of explanations (e.g., consensus, authority, scientific).
- Range of problems addressed with success.

- Causal importance attributed to feelings, thoughts, and/or environmental factors.
- Range of environmental characteristics considered (family, community, society).
- Causal importance attributed to biochemical causes.
- Attention devoted to past experiences.
- Degree of optimism about how much change is possible.
- Degree to which a perspective lends itself to and encourages empirical inquiry (finding out whether it is accurate).
- Degree of empirical support (evidence for and against a theory).
- Attention given to documenting degree of progress.
- Ease with which practice guidelines can be developed.
- Degree of parsimony.

Frameworks differ in the attention given to observation of interactions in real-life settings, in whether significant others (those who interact with and influence clients) are involved, and how directive clinicians are. They differ in the degree of attention paid to cognitions (thoughts), feelings, environmental characteristics (such as reactions of significant others), and biomedical factors. Different frameworks are based on different beliefs about the causes of behavior. Beliefs about behavior, thoughts, and feelings, and how they are maintained and can be changed influence what data are gathered and how data are weighted and organized. Presenting concerns can be viewed from a perspective of deficiencies (e.g., psychiatric labels) or from a contextual view in which both personal and environmental factors are attended to. For example, a key point of feminist counseling is helping clients to understand the effects of the political on the personal, both past and present. Frameworks that focus on psychological characteristics of individuals are based on the view that behaviors are influenced mainly by such characteristics. There is a focus on interiors – on understanding private phenomena believed to cause overt behavior such as mental schemas and dispositions. In interactional perspectives, attention is given not only to the individual but to people with whom he or she interacts. Interactional views differ in how reciprocal the relationship between the individual and the environment is believed to be and in the range of environmental events considered.

In contextual, ecological perspectives, individual, family, community, and societal characteristics (political, social, and economic) are considered as they may relate to desired outcomes. A contextual framework decreases the likelihood of focusing on individual pathology (blaming the victim), and neglecting environmental causes and resources. Practice perspectives that focus on individual causes of personal problems may result in 'psychologizing' rather than helping clients. The *Diagnostic and Statistical Manual of Mental Disorders* (2000) (DSM) published by the American Psychiatric Association encourages a focus on individual pathology, listing hundreds of behaviors as potential indicators of mental disorders (illnesses). The fifth edition will include even more. Transdiagnostic approaches focus on what is common across a variety of disorders. Assessment frameworks differ in the extent to which they take advantage of empirical information about behavior including factors related to client concerns, and the accuracy of different sources of data.

Sign and Sample Approaches: Diagnosis and Assessment

In a sign approach to assessment, observed behaviors are viewed as indicators of more important underlying (and unobserved) personality dispositions (typically of a pathological nature) or traits. Traits can be defined as a general tendency to react in consistent and stable ways. Examples are 'aggression' and 'extraversion.' Inherent in sign approaches, is the assumption that observable behaviors are the outward signs of some underlying process which must be altered to bring about any lasting change. For example, a clinician may conclude that a child who has difficulty concentrating on his school work and sitting in his seat is hyperactive. A focus of change efforts on the behavior itself, according to this model, would not succeed, because no change has supposedly been brought about in underlying causes. The underlying hypothetical constructs are viewed as of major importance in understanding and predicting behavior. Such dispositional attributions shift attention away from observing what people *do* in specific situations to speculating about what they *have* or are. In the DSM, behaviors are assumed to equate with mental disorders. This classification system has come under increased criticism for example for ignoring contextual factors related to client concerns and pathologizing every day problems in living such as common (mis)behaviors on the part of children.

The interactions between wishes, anticipated threats if wishes are expressed, and the processes used to cope with or defend against conflictual situations, are of interest in psychodynamic frameworks. Important elements in such processes are believed to be beyond conscious recognition of the individual experiencing them even when they may be recognized or inferred by others. The concepts of developmental stages and 'mechanisms' (psychological processes such as defense mechanisms) are central concepts. There is a focus on interiors. Defensive aims, processes, and outcomes are of interest. Defense mechanisms include suppression, undoing, repression, role reversal, projection, and regression. The defenses are believed to be heightened under conditions of high emotion, stress, and conflict. Motives include the wish to avoid unpleasant, overwhelming, or out-of-control states. Some unconscious processes anticipate such outcomes. Other aspects of psychoanalytic approaches include an emphasis on verbal reports concerning early histories and efforts to alter inner processes by verbal means. Compared to behavioral assessment, less attention is devoted to environmental variables that may influence behavior because of the assumed core relevance and stability of underlying dispositions. There are different kinds of psychodynamic assessment frameworks. For example, there are variants of object relations theory, each of which may have a somewhat different approach to assessment. In object relations theory, the concepts of mirroring and self objects are key ones. Attention is given to internal mental representations of the self and significant others. The term 'object relations' refers to the interplay between the images of self and others. Ego psychology emphasizes identification and support of strengths and working within the 'defenses' rather than breaking them down. Proponents consider resistance to change natural and work with and support adaptive strengths.

Defense mechanisms, such as rationalization of actions and projection of feelings onto others are identified but not necessarily discussed.

Behavioral assessment involves a sample approach. In a sample approach, direct observation of behavior in real-life settings or, if this is not possible, in situations that resemble these, is valued. Labels are used as summarizing categories rather than as terms indicating some underlying mental disorder. Unlike in sign approaches where the cause of behavior is assumed to be underlying dispositions, the cause of behavior is assumed to lie largely in environmental contingencies. Behavioral frameworks differ in the attention devoted to thoughts and environmental contingencies. Differences in focus are so marked that they have resulted in the formation of different journals, societies, and names (e.g., 'cognitive,' 'cognitive-behavioral,' 'applied behavior analysis'). Differences in emphasis are related to the role attributed to thoughts in influencing behavior. This role varies from a causal to a mediating role. In the former, reflected in cognitive and cognitive-behavioral frameworks, thoughts are presumed to play a key role in creating feelings and behaviors. In the latter, reflected in applied behavior analysis, thoughts are assumed to influence feelings and behavior in a mediating (not causal) manner. It is assumed that one must look to past and present environmental contingencies to account for both thoughts and feelings. It is assumed that feelings and thoughts are (covert) behaviors which themselves require explanation.

In cognitive-behavioral methods, attention is devoted to thoughts as well as behaviors. Thoughts of interest include attributions for behavior, feelings, and outcomes, negative and positive self-statements, expectations, and cognitive distortions. Attention is devoted to identifying the particular kinds of thoughts that occur in problem-related situations including related 'schema.' Cognitive-behavioral approaches differ in their assumptions about the kinds of thoughts that underlie behavior. However, all share certain assumptions such as the belief that individuals respond to cognitive representations of environmental events rather than to the events per se. It is assumed that learning is cognitively mediated and that cognition mediates emotional and behavioral dysfunction. In applied behavior analysis, environmental contingencies are focused on. A contingency analysis requires identification of the environmental events and occasion that maintain behavior. There is an interest in describing the relationships between behavior and what happens right before and after as well as 'met contingencies' – the relationships between cultural practices and the outcomes of these practices. There is an emphasis on current contingencies. Attention is directed toward the change of 'deviant' environments rather than the change of 'deviant' client behaviors. There is an interest in identifying functional relationships. A behavioral analysis includes a description of behaviors of concern as well as evidence that specific antecedents and consequences influence these behaviors; it requires a functional as well as a descriptive analysis.

Although there are differences, all behavioral approaches share many characteristics that distinguish them from sign approaches. Assessment is an ongoing process in behavioral assessment. This contrasts with some traditional approaches in which assessment is used to 'diagnose' a client in order to

decide on treatment methods. What a person does is of interest in behavioral approaches rather than what she has. Behavior is of great interest, especially the behaviors of individuals in real-life contexts and those with whom they interact. Identifying variables that influence the frequency of behaviors of interest including positive alternatives to behaviors to be decreased is a key assessment goal. Behavior is assumed to vary in different contexts because of different learning histories and different current contingencies as well, for example, different levels of deprivation and fatigue.

The focus on behavior has a number of implications for assessment. One is the importance of observing people in real-life contexts whenever feasible, ethical, and necessary to acquire helpful data. A range of assessment methods is used including observation in real-life settings as well as role plays. Multiple assessment methods are also called for because of the lack of synchrony in overt behavior, physiological reactions, cognitions (thoughts), and feelings. Assessment and treatment are closely related in a behavioral model. It is assumed that assessment should have treatment utility. There is an emphasis on the use of valid assessment methods. The principles of behavior are relied on to guide assessment and intervention. There is a preference for limited inference and a focus on constructing repertoires (on helping clients to acquire additional knowledge and skills that will increase opportunities for reinforcement). Clients are viewed in terms of their assets rather than their deficiencies. The preference for enhancement of knowledge and skills requires a focus on behaviors that are effective in real-life contexts. In a task analysis, the specific behaviors that are required to achieve an outcome are identified. For each step, performance is clearly described as well as the conditions in which it is expected to occur.

Some Important Distinctions

The form of a behavior (its topography) does not necessarily indicate its function (why the behavior occurs). Identical forms of behavior may be maintained by very different contingencies. Just as the same behavior may have different functions, different behaviors may have identical functions. The distinction between motivational and behavioral deficits is also important. If a desired behavior does not occur, this may indicate either that the behavior exists but is not reinforced on an effective schedule or is punished (a motivational deficit) or that the behavior is not present in the client's repertoire (a behavior deficit). Motivational deficits are often mistaken for behavioral deficits. Motivational and behavioral deficits can be distinguished by arranging conditions for performance of a behavior. For example, clients could be requested to role play behaviors and asked whether similar or identical behaviors occur in other situations. Behavior surfeits are often related to behavior deficits. For example, aggression on the part of a child may be related to a lack of friendship skills. It is also important to distinguish response inhibitions from behavior deficits. Emotional reactions such as anxiety may interfere with desired behavior.

Past History

Although the past is viewed as important in influencing current behavior in just about all perspectives, assessment frameworks

differ in how much attention is devoted to the past and what is focused on. Past experiences are a major focus in psychodynamic frameworks. Knowledge about past circumstances may be of value when it is difficult to identify current maintaining factors. Information about a client's past may provide valuable information about unusual histories related to concerns. An understanding of how problems began can be useful in clarifying the origins of what seem to be puzzling reactions. New ways of viewing past events may be helpful to clients. Information about a client's past may help clients to understand the source of current reactions. Demographic indicators about a client's past behavior in certain contexts may be better predictors of future behavior than personality tests or clinical judgments.

Information about the past offers a view of current events in a more comprehensive context. Major areas include medical history, educational and work history, significant relationships, family history, and developmental history. Helpful coping skills may be discovered by finding out what clients have tried in the past to attain valued outcomes. Research concerning autobiographical memory suggests that memories change over time, making it difficult to know whether reports are accurate. From a psychodynamic perspective, accuracy would not be an issue. Rather, the client's memories of events, whether accurate or not, are the substance of import. It is assumed in fact that memories may be distorted by unconscious motives/conflicts and so on. Excessive attention to past troubles may create pessimism about the future and encourage rationalizations and excuses that interfere with change, especially if this is not fruitful in selecting effective intervention plans.

What About Labels?

The term *diagnosis* refers to accurately identifying the cause(s) of symptoms of an individual. The term *diagnosis* was borrowed from medicine, in which a physician makes a diagnosis of a patient's condition and then recommends a treatment based on this diagnosis. Diagnoses are used as a guide to selection of interventions. Evidence-based diagnosis can be defined as the use of certain symptoms and signs (feeling hot and having a fever as determined by a thermometer) to identify an underlying condition (a bacterial infection). Such a diagnosis is evidence-based in two senses (1) the signs and symptoms accurately indicate the underlying condition and (2) accurate identification of the underlying condition points to an effective remedy (e.g., antibiotics). Thus in medicine, we often have both signs (an X-ray) and symptoms (a cough). Is this true of psychological concerns such as depression and anxiety? The answer from psychiatry is yes. It is assumed that symptoms (e.g., anxiety in social situations) reflect an underlying disorder (or dysfunction). But what signs do they use? Here, signs are observed by the examiner. Diagnosis and assessment are not either/or endeavors. Providing a diagnosis for clients is a requirement for third-party payment. This does not mean that clinicians cannot or should not carry out an evidence-informed contextual assessment describing, for example, personal and environmental factors that create risks and contribute to resilience.

Labels are used in assessment in two main ways. One is as a shorthand term to refer to specific behaviors. The term unmanageable may refer to the fact that a student often gets

out of his seat and talks out of turn in class. A teacher may use the label 'hyperactive' as a summary term to refer to these behaviors. With psychiatric labels, the label connotes more than a cluster of (mis)behaviors. It involves additional assumptions about the person so labeled. The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) includes hundreds of labels. Methodological and conceptual problems connected with the use of psychiatric labels include lack of agreement about what label to assign clients and lack of association between a label and indications of etiology or what intervention will be effective. Indicators on which psychiatric labels are based are vague, say little about positive attributes, potential for change, and change that does occur. Both trait and diagnostic labels offer little detail about what people do in specific situations and what specific circumstances influence behavior. Some behaviors may appear 'trait-like' in that they are similar over time and situations because of similar contingencies of reinforcement. Degree of consistency should be empirically explored for particular clients and behavior rather than assumed.

Labels are classifications and are thus subject to all the ways in which classifications are wrong (e.g., under or over inclusion). The classification system may be faulty in not accurately distinguishing between different 'syndromes,' that is, there may be 'boundary' problems. Clients may be given an incorrect label (it does not really describe them) or a label that does accurately describe them may not be used and valuable services may be withheld. Labels can obscure important individual variations among people and thus encourage the 'patient uniformity myth.' Use of labels may overlook cultural differences and encourage 'the psychopathologist's fallacy – the belief that because a child has been brought in as a patient, there must be something wrong with him or her.' We may start to think of a person as the label he or she is given. We may think our work is over when we give a person a diagnostic label rather than realizing it is just beginning in relation to carrying out a contextual assessment. Having a label may result in seeking out characteristics that complement the label.

Acceptance of a psychiatric label may prematurely close off consideration of promising options. The tendency to use a binary classification system (people are labeled as either having or not having something, e.g., as being an alcoholic or not), obscures the varied individual patterns referred to by a term. Psychiatric labels have been applied to an ever-increasing variety of behaviors viewed as 'mental illnesses.' Critics of the DSM highlight the consensual nature of what is included (reliance on agreement rather than empirical criteria) and the role of political and economic influences in its creation. Some writers argue that psychiatric classification systems trivialize human problems in living and encourage blaming victims for their plights rather than examining and altering the social circumstances that are often responsible. For example, they argue that they direct attention away from political, social, and economic conditions related to expected gender roles and focus on individual deficiencies. Many scholars argue that labels, such as 'mental illness,' are used for social control purposes and often result in harming rather than helping people. The American Psychiatric Association claims that its classification system is based on scientific evidence. However critiques raise doubts about these claims and discuss the role of political and

economic considerations in the creation and 'selling' of the DSM and document reliability and validity problems with this system. These include the consensual nature of what is included (agreement among individuals is relied on rather than empirical criteria), lack of agreement about what label to assign clients (poor reliability) and lack of association between a diagnosis and indications of what plans will be effective.

Although they may sound sophisticated, too often labels offer few if any guidelines about what to do to resolve problems. In the introduction to the DSM, it states that diagnostic labels say nothing about etiology nor offer guidelines for selection of service. Neither trait nor diagnostic labels offer enough detail about what people do in specific situations and what personal and environmental events influence their behaviors to be of value in clarifying problems and related factors. The individual variability of behavior is overlooked, resulting in lost opportunities to discover unique relationships between a client's behavior and his or her environments. Dispositional attributions shift attention away from observing what people do in specific situations to speculating about what they might do or have done.

Labels that are instrumental (they point to effective interventions) are helpful. Failure to use labels that are informative may prevent clients from receiving appropriate intervention. Labels can normalize client concerns. Parents who have been struggling to understand why their child is developmentally slow may view themselves as failures. Recognition that their child has a specific kind of developmental disability that accounts for this can be a relief.

A Contextual Evidence-Informed Assessment

A contextual assessment includes a clear description of hoped-for-outcomes and related factors and description of what a person can do and cannot do, what he or she can learn to do, and what is expected of him or her, as well as environmental factors that influence problem-related behaviors and positive alternatives. It is assumed that only if complaints are clearly described can they be translated into specific changes that would result in their removal. The emphasis on behavior and the influence of environmental contingencies call for the translation of problems into observable behaviors and the discovery of ways in which the environment can be rearranged. Clients are encouraged to recognize and alter the role they play in maintaining problems. For example, teachers and parents often reinforce behaviors they complain about. Assessment is individualized; each person, group, family, organization or community is viewed as unique. Data about group differences do not offer precise information about what an individual does in specific situations and what cues and consequences influence their behavior.

Practice-related research regarding concerns and possible causes and ways to discover them are drawn on. This kind of assessment often reveals that environmental deficiencies contribute to problems such as a low frequency of positive social interactions, lack of recreational opportunities or day care, and low wages. A contextual assessment encourages the description of *processes* rather than the study of *conditions*.

The characteristics of contextual, evidence-based assessment include the following:

1. Individually tailored as needed.
2. Use of assessment frameworks and methods that have been critically tested and found to be of value.
3. A preference for testing inferences.
4. A focus on clients' assets rather than their deficiencies.
5. A focus on the present.
6. Attention to current contingencies in interrelated system levels.
7. A clear description of concerns and related hoped-for outcomes.
8. A preference for observation of important interactions (as ethical, practical) are needed.
9. A clear description of assessment methods.
10. A close relationship between assessment and intervention.
11. Offering high level relationships skills.

A contextual framework decreases the likelihood of errors, such as emphasizing people's deficiencies.

A contingency analysis involves describing the context in which problems occur (i.e., the relationships between behavior in *real-life settings* and what happens right before and after), including alternative behaviors that, if increased, would compete successfully with undesired behavior. Considerable advances have been made in some areas in identifying problem-related contingencies. For example, assessment protocols have been developed to identify the cues and consequences related to self-injurious behavior of children. A *descriptive analysis* involves identification of problem-related behaviors and associated setting, events, antecedents, and consequences. A functional analysis includes altering events identified in a descriptive analysis to determine their actual influence. Implications for assessment of a focus on contingencies include observing people in real-life contexts when feasible, ethical and necessary to clarify problems and their causes. A second is an emphasis on collecting information about individuals. A focus on vague problems may prevent the discovery of related factors. If hoped-for outcomes are not clearly described, it will be difficult to determine the frequency of behaviors of interest or to assess progress. The specific referents to which clients refer when using vague terms (such as *uncooperative*, *immature*, or *aggressive*) may differ.

Sources of Influence

Influences on behavior include other people's actions, the physical environment, tasks and materials, physiological changes, thoughts, genetic differences, and developmental factors. Material and community resources and related political, economic, and social conditions influence options. It is important to obtain an overview of the client's current life as this may relate to problems, including relationships with significant others, employment, physical health, recreational activities, and community and material resources available. Antecedents of behavior, like consequences, have a variety of sources. In addition to proximal antecedents (those that occur right before a behavior), distal antecedents may influence current behavior. Past or future events may be made current by thinking about these.

These thoughts may then influence what we do, feel, and think. *Setting events* are antecedents that are closely associated with a behavior but are not in the situation in which behaviors of concern occur. For example, an unpleasant exchange with a teacher may influence how a child responds to his parents at home. The earlier event alters the likelihood of given reactions in subsequent situations.

Preferred practice theories influence the attention given to various sources. Problems vary in the complexity of related factors. Problems may be complex because clients lack needed skills, have interfering beliefs, or are threatened by proposed changes. Distinguishing between problems and efforts to resolve these will avoid confusion between the results of attempted solutions and effects of the original concern. Expected role behaviors in a certain culture may limit options. Ongoing discrimination against a group may limit opportunities. Clients may lack needed information or skills. A behavior deficit may exist (the client may not know how to perform a given behavior).

Other People/The Nature of the Client's Social Relationships

The influence of significant others in the maintenance of a troubled or troubling behavior should be explored. Behavior occurs in a context. How significant others respond makes up an important part of our environment. Significant others are those who interact with clients and influence their behavior. Examples include family members and staff in residential settings. Significant others are often involved in assessment. For example, in family therapy, family members participate in assessment and understanding relationships among family members is a key part of assessment. Interactions between couples is closely examined in relationship counseling. It is important to assess the nature and quality of the client's social network and social support system. Clients may lack social support such as opportunities for intimacy and companionship or the opportunity to provide support to others. Social interactions may be a source of stress rather than of pleasure and joy.

The Physical Environment

The influence of the physical environment should also be examined. Physical arrangements in residential and day care settings influence behavior. Unwanted behaviors may be encouraged by available materials. For example, toys that are visible to children may distract them from educational tasks. Temperature changes affect behavior as do degree of crowding and noise level. Characteristics of the community in which clients live that may influence complaints and possible intervention options should be assessed. Neighborhood quality influences well-being. For example, children who live in lower quality environments (e.g., there is little play space, housing is in industrial neighborhoods, upkeep of streets is poor) are less satisfied with their lives, experience more negative emotions, and have more restricted and less positive friendship patterns. There is a relationship between the number of nonaccidental injuries to children and the physical conditions of the home which is related to socioeconomic status.

Tasks and Activities

The kind of task confronting an individual may influence the rate of problem behavior. Particular tasks or activities may be high-risk situations for unwanted behavior. Many studies have found a relationship between the kind of task and behavior such as self-injury. Problems may occur because a task is too tedious or difficult or because an individual is uncomfortable or bored, or is told to do something in an unpleasant manner. In these instances, altering antecedents may correct the problem.

Biophysiological Factors

Presenting problems may be related to neurological or biochemical factors. Such factors may place boundaries on how much change is possible. Malnutrition may contribute to behaviors complained of. Discovering biochemical abnormalities only establishes that they are present, not that they cause certain behaviors. Premature acceptance of biophysical explanations will interfere with discovering alternative explanations that yield knowledge about interventions. Biochemical changes may be a result of stress related to social conditions such as limited opportunities due to discrimination. Certain kinds of illness are associated with particular kinds of psychological changes. Drugs, whether prescribed or not, alcohol, environmental pollutants, and nutritional deficiencies may influence health and behavior. Behavior changes may be due to brain tumors. Hormonal changes/imbances may result in mood changes which may be misattributed to psychological causes. On the other hand psychological changes may be misattributed to hormonal changes. People differ in return of diffuse physiological arousal (DPA) to baseline levels. Whenever physiological factors may be related to a problem as, for example, with seizures, depression, fatigue, or headaches, a physical examination should be required. Overlooking physical causes including nutritional deficiencies and coffee, alcohol, or drug intake may result in incorrect inferences. Reviewing use of prescribed medication is ever more important in our overmedicated society.

Cognitive-Intellectual Characteristics

People differ in their intellectual abilities which may influence problems and potential for attaining hoped-for outcomes. Genetic differences have been found in intelligence as well as in temperament and conditioning susceptibility. The importance of assessing what people say to themselves in relevant situations is emphasized in many assessment frameworks. For example, in cognitive-behavioral approaches, clients' internal dialogs (what they say to themselves) and the way this relates to complaints and desired outcomes is explored and altered as necessary. Certain thoughts may occur too much, too seldom, or at the wrong time. A depressed client may have a high frequency of negative self-statements and a low frequency of positive self-statements. In a radical behavioral perspective, thoughts are viewed as covert behaviors to be explained, not as explanations for other behaviors, although it is assumed they can serve a mediating function and influence both feelings and behaviors. The thoughts and feelings in a situation are assumed

to be a function of the contingencies experienced in a particular situation or in situations that are similar or associated in some way. A causal role may be misattributed to thoughts because the histories related to the development of thoughts is overlooked. The role of thoughts can be examined by varying certain thoughts and determining the effects on behavior.

Feelings

When feelings are presented as a problem or are related to a problem, associated personal and environmental factors should be identified. Assessment frameworks differ in the role attributed to feelings and in factors sought to account for them. Some emphasize the role of thoughts in creating feelings. Others emphasize the role of unconscious conflicts and motives related to early childhood experiences. Other frameworks focus on the role of environmental contingencies in influencing emotional reactions. For example, in a radical behavioral approach, feelings are viewed as by-products of the relationships between behavior and environmental events. Feelings can be used as clues to contingencies (relationships between behavior and environmental events). Changing feelings will not make up for a lack of required skills, or rearrange contingencies required to attain desired outcomes.

Cultural Differences

Cultural differences may affect both the concern that clients experience as well as the communication styles and assessment and intervention methods that will be successful. An individualized assessment requires attention to cultural differences that may be related to problems and potential resolutions. Culturally sensitive practice requires knowledge of the values of different groups and their historical experience and how these differences may influence behavior, motivation and view of the helping process. Different groups may prefer different problem-solving styles and have different beliefs about the causes of problems. The norms for behavior vary in different groups. It is important to be knowledgeable about cultural differences that may be mistakenly viewed as pathology. The degree of acculturation (the process of adaptation to a new or different culture) is important to assess. This may influence drop-out rate, level of stress, attitude toward clinicians, and the process and goals that are appropriate. Knowledge of challenges faced and preferred communication styles of people in different generations will be useful.

Developmental Considerations

Information about required behaviors at different ages and life transitions can be helpful in assessment. Knowledge of typical behavior at different times (developmental norms) can be useful in 'normalizing' behavior – helping clients to realize that reactions they view as unusual or 'abnormal' are in fact common. Knowledge about typical changes in different phases of life (e.g., adolescence, parenthood, retirement) allows preventative planning. The following kinds of information will be helpful (1) norms for behavior in specific contexts; (2) tasks associated with certain life situations such as parenthood and retirement; (3) the hierarchical nature of some developmental

tasks (some behaviors must be learned before others can be acquired). Different kinds of norms may be used in the selection of outcomes. Criterion referenced norms rely on what has been found to be required to attain a certain outcome through empirical analysis. Another kind of norm is what is usual in a situation. However, what is usual may not be what is desirable. For example, although it may be typical for teachers to offer low rates of positive feedback to students in their classroom, it is not optimal. The similarities of contingencies for many people at a given age in a society may lead one to assume incorrectly that biological development is responsible. The role of similar contingencies may be overlooked. Acceptance of a stage theory of development may get in the way of identifying environmental factors that can be rearranged.

Resources and Obstacles

Assessment involves identification of personal assets and environmental resources that can be used to help clients attain desired outcomes, as well as personal and environmental obstacles. Personal resources and/or obstacles include cognitive-intellectual abilities and deficiencies, physical abilities and handicaps, social skills and social-skill deficits, vocational and recreational skills, financial assets, and social support systems. Clients differ in their 'reinforcer profile' and in degree of motivation to alter problematic circumstances. Environments differ in opportunities for certain kinds of experiences (see section 'Physical Environment'). Resources such as money, housing, vocational education programs, medical care, or recreational facilities may be unavailable. Limited community resources (such as day care programs, high-quality educational programs, parent training programs) and limited influence over environmental circumstances may pose an obstacle. Child maltreatment is related to poverty. Unemployment is related to substance abuse and spouse violence. Agency policies and practices influence options. Lack of coordination of services may limit access to resources; clients may receive fragmentary, overlapping, or incompatible services.

Sources of Information

Sources of data include interviews, reports on standardized measures, data gathered by clients and significant others (self-monitoring), observation in the interview as well as in role play or in real-life settings, and physiological indicators. A variety of electromechanical aids are available for collecting data such as wrist counters, timers, biofeedback devices, and audio- and videotape recorders. Preferred theories influence selection of assessment methods. In approaches that focus on interiors (e.g., thoughts), self-report within the interview may be the main source of data used. The broader the scope of change efforts, for example school (or district)-wide positive behavior support systems, the wider the range of sources and kinds of assessment data needed.

In behavioral approaches, self-report is supplemented whenever possible by other sources of data such as observation in real-life settings, role play, and/or self-monitoring. (Clients keep track of some behaviors, thoughts, or feelings and surrounding circumstances and consequences in real life.) Some

sources, such as self-report in the interview, are easy to use and are flexible in the range of content provided. However, accuracy varies considerably. The question is: What methods will offer an accurate description of reactions or conditions of concern and related events? Individual differences will influence a client's willingness to participate in a given manner. Accuracy of decisions can be improved by using multiple methods, drawing especially on those most likely to offer accurate relevant data.

Self-report is the most widely used source of information. There are many different types of self-report including verbal reports during interviews and answers on written inventories. Interviews also provide an opportunity to observe clients. Advantages of self-report include ease of collecting material and flexibility in the range of material that may be gathered. Structured interviews have been developed for both children and adults in a number of areas. The accuracy of self-report depends on a number of factors including the situation in which data are collected and the kinds and sequence of questions asked. Helpful questions in assessing the accuracy of self-reports include the following (1) Does the situation encourage an honest answer? (2) Does the client have access to the information? (3) Can the client comprehend the question? (4) Does the client have the verbal skills required to answer questions? Special knowledge and skills may be required when interviewing children. Play materials and storytelling may be used to gather data about children's feelings and experiences.

Measures that have uniform procedures for administration and scoring and that are accompanied by certain kinds of information, such as norms for different groups, are referred to as *standardized measures*. Thousands of standardized questionnaires have been developed related to hundreds of different personal and/or environmental characteristics. Standardized measures are used for a variety of purposes including (1) describing populations or clients, (2) screening clients (e.g., making a decision about the need for further assessment or finding out if a client is eligible for or likely to require a service), (3) assessing clients (a more detailed review resulting in decisions about diagnosis or selection of intervention methods), (4) monitoring (evaluating progress), and (5) making predictions about the likely futures of clients (e.g., in relation to use of a particular intervention method). As always, a key concern is validity. Does a measure assess what it is presumed to assess? Reliability should also be considered. How stable are responses on a measure given a lack of real change? Unstable measures are not likely to be valid. How sensitive will a measure be to change?

Personality tests may be used to collect assessment data. *Objective tests* include specific questions, statements, or concepts. Clients respond with direct answers, choices, or ratings. *Projective tests* such as the Thematic Apperception Test, incomplete sentences test, and the Rorschach Inkblot Test are purposefully vague and ambiguous. It is assumed that each person will impose on this unstructured stimulus presentation unique meanings that reflect his or her perceptions of the world and responses to it. Psychoanalytic concepts underlie the use of most projective tests. These tests focus on assessing general personality characteristics and uncovering unconscious processes. Tests are used not as samples of the content domain (as in behavioral approaches), but as signs of important

underlying constructs. Whereas content validity is of great concern in a behavioral perspective, this is not so within a traditional approach. In fact, items may be made deliberately obscure and vague.

Valuable information can be obtained from data clients collect (self-monitoring). As with any other source of data, not all clients will be able or willing to participate. Observation of relevant interactions in real-life settings offers a valuable source of information. This is routinely used in applied behavior analysis. If observation in real-life settings is not possible, observation in role plays may provide a useful alternative. Physiological measures have been used with a broad array of presenting problems. Measures include heart rate, blood pressure, respiration rate, skin conductance, muscle tension, and urine analysis. Physiological measures are useful when verbal reports may be inaccurate. Certain kinds of desynchronies between verbal reports of fear and physiological measures may provide useful assessment data. Whenever presenting problems may be related to physical causes, a physical examination should be obtained. Failure to do so may result in overlooking physical causes.

Assessing the Value of Data

Assessment methods differ in their accuracy. For example, self-report of clients or significant others may not accurately reflect what occurs in real life. Observers may be biased and offer inaccurate data. General predictions about a person based on tiny samples of behavior in one context are not likely to be accurate, especially when behaviors of interest occur in quite different situations. Measurement inevitably involves error. One cause of systematic error is social desirability; people present themselves in a good light. Important criteria to consider in judging the value of data include (1) reliability, (2) validity, (3) sensitivity, (4) utility, (5) feasibility, and (6) relevance. *Reliability* refers to the consistency of results (in the absence of real change) provided by the same person at different times (time-based reliability), by two different raters of the same events as in interrater reliability, or by parallel forms or split-halves of a measure (item-bound reliability). Reliability places an upward boundary on validity. For example, if responses on a questionnaire vary from time to time (in the absence of real change), it will not be possible to use results of a measure to predict what a person will do in the future.

Validity concerns the question: Does the measure reflect the characteristic it is supposed to measure? For example, does behavior in a role play correspond to what a client does in similar real-life situations? Assessment is more likely to be informative if valid methods are used (methods that have been found to offer accurate information). *Direct* (e.g., observing teacher student interaction) in contrast to *indirect* measures (e.g., asking a student to complete a questionnaire assumed to offer information about classroom behavior) are typically more valid. Validity (accuracy) is a concern in all assessment frameworks; however, the nature of the concern is different in sign and sample approaches. In a sign approach, behavior is used as a sign of some entity (such as a personality trait) that is at a different level. The concern is with *vertical validity*. Is the

sign an accurate indicator of the underlying trait? *Horizontal validity* is of concern in a sample approach. Different levels (e.g., behavior and personality dispositions) are not involved. Examples include (1) Does self-report provide an accurate account of behavior and related circumstances? (2) Does behavior in role play reflect what occurs in real life? Different responses (overt, cognitive, and physiological) may or may not be related to an event. For example, clients may report anxiety but show no physiological signs of anxiety. This does not mean that their reports are not accurate. For those individuals, the experience of anxiety may be cognitive rather than physical.

The *sensitivity* of measures is important to consider; will a measure reflect changes that occur? The *utility* of a measure is determined by its cost (time, effort, expense) balanced against information provided. *Feasibility* is related to utility. Some measures are not feasible to gather. Utility may be compromised by the absence of empirically derived norms for a measure. *Norms* offer information about the typical (or average) performance of a group of individuals and allow comparison of data obtained from a client with similar clients. The more representative the sample is to the client, the greater the utility of a measure in relation to a client. *Relevance* should also be considered. Is a measure relevant to presenting problems and related outcomes? Do clients and significant others perceive it as relevant?

The Social Context of Assessment

Clinical assessment takes place in the context of a helper–client relationship. The nature of this relationship (the alliance) is considered important in all practice frameworks, including providing new conceptualizations and support that decreases demoralization and avoiding negative reactions that damage this relationship, such as excessive negativity (e.g., criticism). Influence of the clinician on the client has been found even in very nondirective approaches. The interpersonal skills of the clinician are viewed as essential for facilitating a collaborative working relationship, validating and supporting the client, and encouraging clients to participate in intervention programs. Great attention is given to the diagnostic value of transference and counter transference effects in psychodynamic therapies and the relationship itself is viewed as the primary vehicle of change. Traditionally, transference has been viewed as a reenactment between the client and the counselor of the client's relationship with significant others in the past, especially parents. Counter transference effects refer to feelings on the part of helpers toward their clients. Transferences are distinguished from therapeutic or working alliances within psychodynamic perspectives.

There is a continuing need throughout assessment to explain the roles and requirements of the client and the counselor, the process that will occur, and the rationale for this. Introductory explanations include an overview of mutual responsibilities and of the framework that will be employed. Because different client behaviors may be required during different phases of assessment and intervention, this 'socialization' is an ongoing task. Behavioral clinicians tend to be more directive than psychoanalytically oriented clinicians. They more frequently give instructions, provide information, and

direct conversation. Clinicians may err by being too directive or too nondirective. Overly directive clinicians may not recognize the need to help clients to explore and to understand their behavior. In contrast, nondirective counselors may err by assuming that self-understanding is sufficient to achieve desired outcomes (when it is not).

Common Assessment Errors and Their Sources

Errors in clinical reasoning account for many errors in clinical practice. Errors may occur in any phase of assessment: (1) detection of characteristics of the client and his or her life situation that are related to problems and desired outcomes; (2) integration and interpretation of data gathered; and (3) selection of outcomes to pursue in order to remove complaints. Errors made in the first two steps will result in errors in the third step. Examples of common errors are noted below. They result in incomplete or misleading assessment. Unexamined speculation may result in misleading accounts. Indoctrination into a certain culture of helping (e.g., biomedical) may contribute to failure to search for well-argued alternative accounts and over reliance on one form of data collection. Not keeping up to date with research regarding options and controversies maintains questionable beliefs. Some errors involve or result in inappropriate speculation – assuming that what is – can be discovered simply by thinking about the topic. Failure to keep up to date with research describing the evidentiary status of different kinds and sources of data as well as factors related to different presenting concerns is a key source of error in clinical assessment (see prior discussion of evidence-informed assessment). Here are examples of common errors:

- Selecting vague outcomes.
- Premature closure – Hasty assumptions about causes (failure to search for alternative accounts).
- Speculating when data collection is called for.
- Searching only for data that confirms a preferred view (confirmation biases).
- Confusing the form and function of behavior.
- Illusory correlation (confusing correlation and causation).
- Using misleading and/or uninformative labels (confusing naming and explaining).
- Confusing motivational and behavior deficits.
- Ignoring base rate data.
- Focusing on pathology and overlooking assets.
- Misuse of resemblance criteria.
- Collecting irrelevant material.
- Relying on inaccurate sources (e.g., anecdotal experience).
- Being misled by superficial resemblances of a client to other clients in the past or to a stereotype.
- The fundamental attribution error (attributing behavior to personality characteristics of individuals and overlooking environmental causes).

Errors in detection of relevant events include an overly narrow focus (e.g., confining attention to the client's thoughts), overly narrow use of data collection methods (e.g., reliance on the interview alone), and errors during data collection (e.g., observer bias). Inaccurate or incomplete accounts of client concerns and related factors often occur because

attention is narrowly focused on one source of informant (e.g., thoughts or feelings). There may be no contextual assessment in which environmental factors related to desired outcomes are identified. Sources of error in integrating and interpreting data include focusing on consistency rather than informativeness of data, hasty generalization based on limited samples, and inadequate conceptualization of problems due to theoretical biases (e.g., focus only on environmental factors) or inaccurate or superficial knowledge of a practice framework. Another source of error at this stage is the use of vague language and psychological jargon that is not informative. Errors in selection of outcomes focused on may occur because of errors in the first two phases. Client ethnicity, race, and characteristics (such as obesity) influence helper's views of concerns.

Studies of clinical decision-making indicate that decisions are made on the basis of quite limited data. Even though a great deal of data are gathered, only a small subset is used. Clinicians tend to gather more data than are needed and, as the amount of data gathered increases, so does confidence in its usefulness, even though accuracy may not increase. Clinicians have a tendency to confuse consistency of data with informative value. Irrelevant as well as relevant data may be influential. Clinicians, like other individuals, are affected by limited information-processing capacities and motivational factors. As a consequence, they do not see all there is to see. Because of preconceptions and biases, things that are not actually present may be reported and events that do occur may be overlooked. Confirmation biases are common. That is, data are sought that are consistent with preferred theories and preconceptions, and contradictory data tend to be disregarded.

Many factors that are not correlated with the true frequency of an event influence estimates of its frequency and how important it seems (such as how visible it is, and how vivid it is). It is easy to recall bizarre behavior and pay excessive attention to this, ignoring less vivid appropriate behavior. The frequency of data that are available is overestimated. Clinicians in a given settings are exposed to particular kinds of clients, which may predispose them to make certain assumptions. For example, a psychologist who sees many severely depressed individuals may be primed to attend to signs of depression. Base rate data that are abstract tend to be ignored, which increases the probability of inaccurate inferences. A lack of concern for sample size and sample bias can lead to incorrect judgments. General predictions about a person that are based on tiny samples of behavior in one context are not likely to be accurate, especially when behaviors of interest occur in quite different situations. Not distinguishing between description and inference may result in incorrect assumptions. Use of multiple sources of data within a contextual practice framework provides the greatest opportunity for sound clinical assessment.

Ethical Issues and Future Directions

Evidence-informed assessment encourages use of frameworks and methods that have survived critical appraisal in relation to their accuracy. Taking advantage of the steps involved in evidence-based practice, for example, consulting practice-related research, should contribute to making well-informed decisions regarding questions that arise. Lack of up-to-date

knowledge and related skills regarding valid assessment methods may result in the selection of ineffective and/or harmful interventions. It is thus incumbent on clinicians to draw on empirically sound methods that are useful in discovering the potential to attain valued outcomes and in selecting effective plans. Helpers and clients have preferred views about behavior and how it develops, is maintained, and can be altered. These views differ in the extent to which they have been critically appraised regarding their accuracy and usefulness in providing guidelines about how to attain valued outcomes or if they can be attained.

There are great stakes in how problems are framed and considerable resources are devoted to influencing how people think about personal and social problems. Many problems once viewed as sins were then seen as crimes and are now considered to be 'mental illnesses.' Beliefs about the causes of behavior influence how people are viewed. In past years, pathology was often attributed to housewives who wanted to work. Knowledge about social, political, and economic factors that influence the very definition of personal and social problems (their social construction) is vital so that clinicians consider concerns in their social context. This also decreases the likelihood of pathologizing clients (medicalizing problems in living). Honoring ethical obligations to clients requires selection of assessment frameworks and related methods that are compatible with empirical data regarding behavior. Accurate descriptions of different assessment perspectives increases the

likelihood that points of convergence and differences among varied views are correctly identified. Continuing research efforts are needed to identify valid methods and indicate assessment frameworks that are most likely to help clients achieve hoped-for outcomes. Increased interest in clinical reasoning and related errors and how to avoid them bodes well for enhanced quality of clinical decisions regarding assessment.

See also: [Cognitive Behavior Therapy](#); [Defense Mechanisms](#); [Social Support](#).

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Clinical Psychology: An Information Processing Approach

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Glossary

Attentional bias Differential allocation of attention to self-relevant threatening stimuli relative to neutral stimuli.

Automatic processing Although no absolute consensus exists on the meaning of automatic processing, it generally refers to a cognitive process that operates unintentionally, without conscious awareness, is effortless, and requires no resources.

Cognitive architecture The organization of mental subsystems involved in the performance of information processing tasks.

Metacognition Cognition about cognition; any knowledge or cognitive process that is involved in guiding, monitoring, controlling, or appraising cognition.

Strategic processing In contrast to automatic processing, strategic or controlled processing is a conscious, effortful, volitional process which requires cognitive resources.

Introduction

Over a century ago, Lightner Witmer established the first psychological clinic and formally proposed and outlined a structure of clinical psychology. Subsequently, clinical psychology has blossomed as a discipline and undergone many paradigmatic transitions; but all have deigned to improve our understanding of human behavior and to improve the efficacy of psychological interventions. The information processing (IP) approach has become one of preeminent frameworks in clinical psychology, particularly in the United Kingdom and the United States, in the twenty-first century. The IP approach has been extensively utilized in an attempt to account for the core features of a broad range of clinical disorders in all subdivisions of clinical psychology. More importantly, IP models have moved beyond descriptive phenomenology and are illustrating how particular types of attentional, interpretative, and memory biases are involved in the etiology and maintenance of psychological disorders, ranging from anxiety disorders in children and adults to IP models of autism. This development has raised the usefulness of the IP approach to a new level, namely that theoretical expositions are translated into psychological interventions, either in an additive fashion to existing treatments or as innovative and novel approaches.

This article begins with a brief overview of the nature and development of the IP paradigm within cognitive psychology. It should be noted that within the rubric of cognitive psychology, IP can be considered from many perspectives, which accounts for the continued enthusiastic exploration of the IP approach from both theoretical and practical positions. IP can be studied from multiple perspectives including neurobiological and neuropsychological perspective. For example, understanding how lesions in specific brain regions map onto difficulties in learning or how specific neuropsychological deficits are associated with theory of mind difficulties in autism highlights the wide applicability of the approach. In this article, we will focus on how IP approach applies to emotional disorders. Following the overview of the IP paradigm, the value of the IP paradigm to clinical psychology is then presented, coupled with a discussion of the factors leading to the paradigmatic shift from behaviorism to cognitivism. The next section

discusses some of the experimental methods, research findings, and clinical developments within the IP paradigm using attentional biases in anxiety as the main exemplar. The final section of this article focuses on two innovative clinical developments for anxiety disorders: cognitive bias modification procedures and metacognitive therapy. Both are grounded within the IP framework, but theoretically are very distinct.

Overview of the Information Processing Paradigm

Empirical investigation within cognitive psychology includes, but is not limited to, the study of memory, attention, language, perception, higher level thought, reasoning consciousness, and cognitive development. The IP approach was developed as a framework within cognitive psychology to explain human behavior by reference to a cognitive system that mediates between incoming stimuli and behavior. The most familiar metaphor to explain the IP approach is the individual as a computer, and indeed the development of the IP approach is partially attributable to developments in computer technology during and following World War II. Specific guiding principles of the IP approach in cognitive psychology were outlined in the late 1970s. The first assumption was that people are autonomous individuals who intentionally engage with the other people and the environment. Next was the idea that the cognitive processor is a general-purpose, symbol-processing system involving both process, such as the allocation of attention, and content, such as an image in memory. Of central importance to the IP paradigm is the assumption that the cognitive system has a limited capacity. This proposition is crucial as it means there will be competition for resources leading to selective attention. For example, every day we are bombarded with stimuli and only a finite proportion can be selected and processed; how does this occur? Selective attention has engaged cognitive psychologists for over three decades and debate has centered on the extent to which selective attention is an automatic or strategic process. Although, a general agreement now exists that attentional bias is a combination of automatic and controlled processing, considerable theoretical disagreement continues as to the relative importance of each component in

psychopathology. More importantly, the adopted theoretical positions on automaticity have had a profound influence on research directions and clinical practice. This issue will be discussed in more detail later.

A further fundamental assumption of the IP paradigm is that IP takes time and that the time taken for a particular IP task can be specified. This allows predictions and testable hypotheses to be derived. For, example, attentional bias is inferred from differential response times to competing stimuli in a range of experimental tasks. The IP paradigm also specifies that cognitive processes are dependent upon, and constrained by, neuroanatomy and neurochemistry. Exploration of the interface between neuroscience and IP is an emerging field, which is providing valuable insights for the practice of clinical psychology. For example, neuroimaging assessment before and after psychological interventions is generating important data on the neurobiological mediators of change.

Evolution of the IP Paradigm Within Clinical Psychology

Clinical psychologists working in adult mental health embraced the IP paradigm during the 1970s for two main reasons. First, there was growing dissatisfaction with the prevailing clinical paradigm of behaviorism. Although behavioral therapy was, and continues to be, an effective treatment for many clinical problems, the underpinning theory had insufficient explanatory power. Classical and operant conditioning processes were unable to explain fundamental aspects of specific disorders or the psychological mechanisms effecting clinical change. Interestingly, contemporary theories of the mechanisms of change in behavior therapy explicitly focus on cognitive constructs and processes, rather than on the two-factor model that had dominated theorizing from the 1950s to the 1970s.

The second key influence was the development of schema theory proposed by Aaron Beck. This clinical theory placed schemas at the heart of emotional disorders. The construct of schemas was appropriated from work conducted on early research on memory processes. Schemas were defined as relatively stable and enduring cognitive structures that influence how an individual perceives and interprets information. The content of the schemata is thought to be of paramount importance and differentiates between anxiety and depressive disorders. Specifically, depression or anxiety will occur when a matching life event activates congruent knowledge stored in the long-term memory. Typically, depressogenic schemas incorporate negative beliefs about the world, the future, and themselves as being inadequate or worthless. In anxiety disorders, the content of schemas concerns personal vulnerability, uncertainty, and danger. It is hypothesized that schema activation results in biased IP, most readily seen by an increased presence of negative automatic thoughts and interpretative biases, more commonly referred to as cognitive distortions. Examples of cognitive distortions include selectively attending to one component of an event and ignoring other relevant aspects, or thinking in all or nothing terms.

The original exposition of schema theory was not explicitly developed within the IP paradigm; the theory clearly implicates many cognitive processes including memory, attention, and perception. Furthermore, the theory states that schemas

guide processing of incoming stimuli and influence perception and understanding, which in turn is translated in how people behave. However, neither the original exposition nor subsequent IP accounts of schema theory have provided a cogent model of how schemas guide IP and result in persistent emotional distress. It remains to be explained why a declarative belief such as 'the world is a threatening place' should result in heightened levels of anxiety and persistent worry. Schema theory remains a hugely influential and useful clinical theory, but has a number of conceptual limitations when considered from an explicit IP perspective. Notwithstanding this issue, the undoubted success of cognitive therapy continues to stimulate considerable research interest in the cognitive processes involved in the etiology and maintenance of clinical disorders. Cognitive behavior therapy (CBT) has become the predominant psychological treatment approach of the twenty-first century, having been extensively evaluated in over 400 randomized controlled trials and the breadth of application continues to grow. It is widely recognized that improvement in the efficacy of CBT approaches for specific disorders, such as social phobia, is a direct result of integrating schema and IP theories. Therefore, the IP paradigm will continue to flourish as it is assumed that further unraveling of cognitive processes, such as attentional biases in anxiety disorders, will enable increasingly effective interventions to be developed.

Significance of the IP Paradigm to Clinical Psychology

The value of any paradigm resides in its ability to generate theories and well-specified models; the IP paradigm has excelled in this regard. There are a multitude of theories and associated models derived from the core assumptions of the IP paradigm across all subspecialties of clinical psychology. Within adult mental health, a multitude of generic and disorder-specific models exist, some drawing very specifically on the IP paradigm and others integrating components drawn from the IP paradigm with other schools of thought. Once models have been developed and empirically evaluated, the next step is to translate the models into effective psychological interventions and again work conducted under the IP paradigm has been extremely successful and has produced many highly differentiated treatments. Both of these core strengths of the IP paradigm can be illustrated with reference to post-traumatic stress disorder (PTSD). The central premise of many models of PTSD is that memory processes operate differently to normal memories as a consequence of the traumatic conditions in which the memories were encoded. For example, the dual representation theory proposes that different components of trauma memories are stored in different memory systems. Specifically, features of the traumatic experiences that are attended to consciously are stored in the verbally accessible memory (VAM) system and can be recalled easily. The nature of the beliefs in this system is hypothesized to be dysfunctional and represents common beliefs expressed by trauma patients, such as 'I am to blame, it was my fault.' In contrast, there are other aspects of the traumatic experience which were not consciously attended to, but were encoded in a situationally accessible memory (SAM). These memories are only recalled when triggered by a trauma cue and result in increased

physiological reactivity, and reexperiencing symptoms. The model proposes that psychological treatment must correct information stored in both memory systems; therefore, cognitive restructuring methods are used to correct maladaptive beliefs, whereas exposure strategies are required to modify the physiological components of PTSD.

In contrast to the models of PTSD, which specify a critical role for memory disorganization, the metacognitive model of PTSD proposes that metacognitive beliefs and processes are more important in maintaining PTSD than specific aspects of memory such as encoding and retrieval. Indeed, the metacognitive model argues that maintaining factors in PTSD relates to a particular processing style called the cognitive attentional syndrome (CAS). The CAS consists of high levels of perseverative thinking, threat monitoring, and coping behaviors that are guided by metacognitive beliefs and proceduralized knowledge that become active following the trauma experience and subsequent symptoms. Patients engage in high levels of worry because they hold positive metacognitive beliefs about the usefulness of worry as a coping strategy and also because they have negative metacognitive beliefs about the uncontrollable nature of worry. In relation to memory, an example of positive metacognitive belief would be 'I must be remember all aspects of the trauma in order to move on,' whereas negative metacognitive beliefs focus on the dangers and consequences of not being able to recall every aspect of the event. These two categories of metacognitive belief combine to keep the person focused on the threat and engage in continued processing of the trauma experience.

Treatment would focus on the modification of positive and negative metacognitive beliefs about the CAS and would not involve cognitive restructuring of beliefs in the cognitive domain or use exposure exercises. These two examples illustrate the development and diversity of disorder-specific models that have been developed under the broad framework of the IP paradigm. Moreover, the two models highlight that the resultant treatments are distinct in how individuals with PTSD are assessed, conceptualized, and treated.

The development of models within an IP framework has directly influenced diagnostic classificatory systems such as the International Classification of Disease (ICD) and Diagnostic and Statistical Manual (DSM). Since generalized anxiety disorder (GAD) entered the diagnostic taxonomy in 1980, it has undergone substantive changes. Originally, GAD was conceptualized primarily as a disorder of anxiety but with very limited reference to cognitive processes. In the latest incarnation of the Diagnostic and Statistical Manual (DSM-IV), the cardinal diagnostic feature of GAD is a cognitive process, namely excessive worry, which a person finds difficult to control. Such diagnostic changes are very significant as they provide both an impetus and direction for research. In the case of GAD, research is ever more focused on understanding the psychological processes which underpin worry. Panic disorder represents another clear illustration of how diagnoses for anxiety disorders have been shaped by research conducted under the IP rubric. Panic disorder is defined according to the psychological mechanisms responsible for the maintenance of the disorder. Patients with panic disorder catastrophically misinterpret symptoms of anxiety which is both the primary target for intervention and the cardinal feature of the disorder.

Evidently, clinical psychology has benefited from research conducted within the IP paradigm in many ways. In addition to the taxonomic, treatment, and model development, the IP framework continues to broaden its horizons as it is being applied to an increasing number of clinical problems. Furthermore, the IP approach is contributing to our understanding of vulnerability to relapse following treatment or indeed the genesis of clinical disorders as can be seen in the child psychopathology literature where research is providing illuminating data on potential pathways to emotional difficulties. Finally, evidence is steadily being accumulated that models and treatments located within an IP paradigm are producing increasingly more effective and time-efficient psychological treatments.

Emotional Disorders and Information Processing Biases

A wealth of studies using a range of experimental tasks have demonstrated that people with elevated levels of anxiety demonstrate an attentional bias toward threatening stimuli compared to neutral stimuli. Such results are in accord with clinical accounts in which patients describe focusing their attention on signs of threats, for example internal sources such as unwanted thoughts and feelings or external signs of possible threat, typified by hypervigilance for signs of danger in PTSD patients. However, there may be both qualitative and quantitative difference in attentional allocation in the natural environment compared to laboratory experiments; this conundrum remains to be resolved. Nevertheless, research into biased IP in emotional disorders has made substantial advances over the past two decades. Early work in this area took a rather dichotomized approach to explain the IP biases observed in emotional disorders. For example, the majority of research found that anxiety disorders were characterized by selective attention toward threatening stimuli whereas affective disorders did not show this bias. Alternatively, depression and not anxiety was characterized by explicit memory biases toward self-relevant negative information. However, as the experimental paradigms and theorizing increased in sophistication, it has become evident that both anxiety and depression are characterized by a range of IP biases. Recent studies on depressed adolescents and on adults experiencing suicidal ideation have shown preferential attentional bias for self-relevant stimuli. A general finding is that the degree to which threatening stimuli are perceived as self-relevant is correlated with the magnitude of attentional bias. In PTSD, the interference effect observed on the emotional Stroop task is greater when the stimuli are most self-relevant; so, in combat veterans with PTSD, the interference effect will be greater for military stimuli than general trauma stimuli. A similar picture is seen in obsessive compulsive disorder, whereby biases are only observed when the stimuli are relevant to the individual specific obsessional concerns.

Components of Attentional Bias

Attentional bias in anxiety comprise at least three components, which change according to the stage of IP. The first stage is facilitated attention, in which threatening stimuli are detected

more rapidly than neutral or less threatening stimuli. The next stage is difficulty in disengaging from threat; in other words, anxious people find it difficult to shift their attention away from threatening stimuli; and the final stage is attentional avoidance, where people allocate their attention away from threatening stimuli. A broad range of experimental tasks (described below) have repeatedly demonstrated attentional bias at each stage of processing; however, the mediating mechanism(s) underpinning each component remains a source of controversy. Understanding the mechanisms responsible for attentional bias would facilitate the development of theoretically cogent and defined interventions.

Experimental Paradigms

The emotional Stroop was the first task used extensively to measure attentional bias in anxiety. In this task, participants are presented with a series of threatening and neutral words printed in different colors and the objective is to name the color that each word is printed in as quickly as possible whilst ignoring the semantic content of the word. Response times are measured and differences in latencies of color-naming between threat words and neutral words are indicative of attentional bias. Across a range of anxiety disorders, studies using the emotional Stroop have found increased latencies of color-naming of threat words. The most frequent conclusion is that slower color naming is attributable to an automatic processing bias in anxiety which directs attention toward threatening material. However, the emotional Stroop has been the center of considerable debate for many years as numerous authors have argued that the mediating mechanism underpinning is not rapid orientation or engagement with threatening stimuli but instead primarily reflects a later stage of processing, namely difficulty engaging with threatening material. Researchers have also suggested that attempts by participants to suspend further processing of the threat cues slow color-naming. Other explanations for the interference effect on the emotional Stroop relate to the other cognitive and emotional processes involved in undertaking the task as it is not a pure measure of attention. It may be that participants process neutral and emotional stimuli to the same extent; however, the negative stimuli produce an increase in emotion which inhibits reaction time performance. This brief account of the emotional Stroop highlights that interpretation of the observed interference effect is highly problematic. Overall, evidence suggests that the interference effect is not attributable to just one component of attentional bias, and that the component which explains most of the effect appears to be difficulty disengaging from threat, rather than facilitated attention.

An alternative task that has also been widely employed in assessing attentional bias toward threat and overcomes some of the limitations of the emotional Stroop is the dot probe task. This task is also thought to have greater ecological validity as it does not rely on words as stimuli and tends to use pictures that have personal meaning for the particular problem being investigated. For example, if a spider phobic was completing this task, then the neutral stimuli might be a range of everyday objects or animals that do not provoke distress, whereas the threatening picture would be relevant to the phobia. In this task, two pictures are presented simultaneously on a computer

screen. The pictures then disappear and a probe replaces one of the pictures. Participants are asked to indicate as rapidly as possible (by a button press) which stimulus has been replaced by the probe. Attentional bias is inferred through faster responses to the probes that replace threatening stimuli relative to the neutral stimuli. A major advantage of the dot probe task is that the interval between stimulus presentation and the probe can be varied, enabling assessment of the time course of the attentional bias. Studies which have examined the effects of facilitated attention and difficulties in disengagement overwhelmingly find that the attentional bias effect is accounted for by delayed disengagement. This does not mean that a fast automatic orienting bias does not occur, but it does imply that the rapid orienting response is not contributing as significantly to the maintenance of anxiety disorders as early research indicated.

Two other experimental tasks are frequently used to measure attentional biases. The visual search task allows assessment of spatial allocation of attention and speed of responding. Participants are asked to search for the target word amongst distractor words (as in a word search puzzle). A single threat word might be embedded in a matrix of neutral words and the reverse condition would ask participants to search for the neutral word amongst a set of self-relevant emotional words. Attentional bias is inferred from faster detection of threat words embedded in neutral words relative to detecting a neutral word embedded amongst other neutral words. The alternative condition is where participants are slower to detect neutral words in a matrix of threat words compared to detection of a neutral target word in a matrix of neutral stimuli. The final task that has been used frequently in attentional bias research is the spatial cueing task. In this task, the participant is asked to rapidly identify a target stimulus but they are cued (either by a neutral or threatening cue) to a spatial location on the computer screen before the target appears. The cue may be valid, in that the target appears in the same spatial location as the cue; alternatively, it may be invalid, in which case the target stimulus appears in a different spatial location to the cue. Attentional bias is inferred by faster response times for threatening cues in the correct spatial location or by slower response times on invalid trials. Both the visual search task and the spatial cueing task have produced robust results demonstrating attentional bias for threatening stimuli in a range of anxiety disorders, accounted for by difficulties in disengaging from threat.

As experimental tasks have increased in sophistication and ability to measure the different components of attentional bias, the most robust finding is that people with elevated levels of anxiety have difficulty in disengaging from threatening stimuli. In other words, anxiety disorders are characterized by a lack of flexibility of allocation of attention. In the next section, the issue of whether attention is primarily an automatic or controlled process is discussed in more detail.

Automatic and Controlled Processing

One of the most enduring theoretical disputes within IP accounts of emotional disorders and particularly in relation to attentional biases in anxiety is whether the observed bias is attributable to automatic or controlled processing. Automatic

processing has been defined as uncontrollable, unintentional, unconscious, capacity free, and effortless, whereas controlled or strategic processing is an intentional, volitional process, which requires conscious awareness, effort and is constrained by capacity limitations. As IP accounts of anxiety were proposed during the course of the 1980s and 1990s, the distinction between controlled and automatic processing became highly significant because it determined how psychological treatments for anxiety were developed. If attentional and interpretative biases are automatic processes, then this implies that psychological therapies should focus on enabling patients to cope and manage with anxiety or possibly through extended retraining, attentional biases could be alleviated. The alternative view that attentional bias is primarily a product of controlled processing will result in a very different psychological intervention, as the focus would be on modifying processing configurations, guided by beliefs/knowledge which is stored in long-term memory structures.

Examination of the automaticity of attentional biases in anxiety has moved away from a simple all-or-nothing dichotomy to exploring whether the different stages of processing are related primarily to automatic or controlled processing. The predominant view was, and continues to be, that facilitated attention represents an automatic process whereas the later stages of attentional bias (delayed disengagement and avoidance of threat) come increasingly under strategic control. However, research thus far has not unequivocally demonstrated that any stage of processing is either completely strategic or completely automatic. This is despite many studies concluding that attentional bias is an automatic process but this conclusion is unwarranted as these studies have generalized from an experimental task that has only manipulated one component of automaticity. For example, studies using the emotional Stroop have tried to determine whether the interference effect is attributable to an automatic process by using masked presentations. This task involves very brief presentation of the stimuli (<20 ms) and then the stimulus is masked for up to 480 ms before the next stimulus is presented. The idea behind this is that such rapid presentation prevents conscious awareness and therefore the observed interference effect reflects an automatic process. However, only degree of awareness has been manipulated and there is a question mark over the extent to which subliminal presentations with backward masking actually preclude conscious awareness. Therefore at best, studies have demonstrated that attentional biases are partially automatic, as no studies have successfully manipulated all facets of automaticity. This raises an important question, which is whether research focusing on differentiating automatic from controlled processing is meaningful or clinically useful as the majority of cognitive processes appear to be a combination of automatic and controlled processing. The more clinically useful question is determining whether strategic processing can exert an influence over the more automatic components of attentional bias.

Theories differ in the importance placed on each stage of processing. Some theories emphasize that anxious people exhibit an enhanced automatic bias for threat during the early stages of processing and avoidance of threat in the later stages of processing, often labeled as the vigilance-avoidance model. Others have argued that the early stages of processing

and the automatic or rapid orienting response have little impact on anxiety, instead arguing that anxiety is maintained by a difficulty in disengaging from threat. As reviewed earlier in the article, the evidence from various analyses of experimental tasks would indicate that early components of attention are less important than later stage of processing in the maintenance of anxiety disorders.

Clinical Applicability of Information Processing Models and Treatments

The ultimate test of the value of the IP approach is whether it has resulted in improved treatment efficacy as a result of translating theoretical advances into clinical treatments. The answer to this question depends on the treatment and disorder being investigated. Cognitive therapy for depression remains virtually unchanged in terms of treatment delivery and treatment efficacy over the past 30 years. Findings from empirical work on memory biases and attentional processes in depression have not been incorporated into cognitive therapy. The opposite is true for psychological treatments of anxiety disorders, where there are clear developments in the focus and nature of interventions for almost all anxiety disorders.

Cognitive Bias Modification

Following on from research demonstrating that individuals with anxiety disorders show a preferential attention for threatening stimuli, it was argued that attentional bias was an integral component of anxiety disorders. Prospective studies found that facilitated attention bias was predictive of greater emotional reactivity to a stressful event. Furthermore, that when nonanxious people were trained to either direct their attention toward or away from threat, those individuals who were trained to orient toward threat showed significantly higher emotional responses to a stressor task. As a result of such studies, it was hypothesized that people suffering from an anxiety disorder could be trained to reduce their attentional bias toward threat. Therefore, cognitive bias modification (CBM) procedures, designed to decrease attentional bias in anxiety disorders, have been developed. It has been argued that CBM procedures may have an important role in the treatment of anxiety disorders, especially as the current level of efficacy of psychological treatments for many anxiety disorders is somewhat limited. CBM procedures typically involve a modification of the dot probe task and train people to orient rapidly away from threatening stimuli. Recent applications of CBM procedures in clinical samples have shown promising results including significant reductions in anxiety and depression in a GAD sample, after a 4-week training program. However, a number of issues require resolution. First, these procedures are predicated on the assumption that the early stage of attentional bias, facilitated attention toward threat, is being modified. However, it appears that the CBM procedures are operating at the later stages of attentive processing of threat, namely avoidance of threat. In other words, CBM techniques are modifying strategic rather than automatic processing. A related issue is that if people are being trained to look away from threat, then this has important clinical

implications. Patients use avoidance to modulate anxiety, but with an important consequence, they do not learn more effective methods of responding to threat. A further issue with the CBM results is that although GAD patients showed reductions in overall levels of anxiety and depression, the cardinal feature of GAD, namely worry, remained comparatively unchanged. Studies such as these highlight that modifying attentional processes may result in reductions of anxiety, but anxiety disorders are not only characterized by attentional biases and other important aspects of the disorder remain unchanged. Further research is required to delineate the mechanism of action, especially as it is possible that these training procedures are actually counterproductive in the long run. Despite the need to clarify these issues, the recent studies on CBM raise a number of fascinating possibilities including whether the strategies can be successfully incorporated in existing CBT protocols with a resultant increase in treatment efficacy.

The Self-Regulatory Model of Executive Dysfunction in Emotional Disorders

One model that has been developed within an IP framework to explain the persistence of emotional disorders is the Self-Regulatory Executive Function model (S-REF). This model was proposed by Adrian Wells and Gerald Matthews as a transdiagnostic understanding of the factors involved in the maintenance of psychological disorder. The model attempted to overcome some of the limitations of schema theory and develop a model of psychopathology that was explicitly developed within the IP framework. The model specifies that psychological disorders should be conceptualized as predominantly top-down or conscious processes, with a set of self-regulatory strategies. According to the model, a particular style of thinking and coping with negative thoughts and feelings results in the exacerbation and maintenance of emotional distress. This particular style of thinking has been termed the CAS and consists of perseverative thinking, threat monitoring, and counterproductive coping strategies. In developing the model, the authors returned to earlier work on attention, which specified that there were different levels of control in the form of automatic and controlled processing. The S-REF model proposes that emotional distress is linked primarily to biases in the selection and execution of controlled processes for appraising and coping with intrusive cognitive and emotional events. More specifically, an individual's strategy for thinking and self-regulation in response to unwanted thoughts and feelings can either intensify and maintain negative emotions or result in brief emotional reactions. Emotional disorders such as anxiety and depression occur when the style of thinking and coping inadvertently leads to persistence and strengthening of emotional responses. The CAS is guided by metacognitive beliefs concerning (a) the benefits of engaging in each aspect of the CAS, for example 'worry helps me cope' and (b) the uncontrollable nature of the CAS, for example 'my worry is out of my control, I cannot stop myself from worrying.' In MCT, the CAS and the supporting metacognitive beliefs are the psychological processes that are targeted in therapy.

In contrast to cognitive therapy and CBM approaches, metacognitive theory does not link psychological problems to automatic processing biases or the content of schemas. Instead, metacognitive theory specifies that psychological problems are attributable to conscious and volitional strategies. In relation to the experimental paradigms used to assess attentional bias earlier in the article, metacognitive theory does not link the observed effects to activation of schemas or automatic processing but attributes them to strategy selection. In anxiety disorders, patients have a strategy of maintaining attention on sources of threat and engaging in worry-based processing as a means of coping.

The S-REF model is based on three basic levels of cognition: a level of reflexive and automatic processes that run with minimal or no conscious involvement. These processes may generate intrusions into consciousness that capture attention. The next level is an online form of processing which is conscious and capacity-limited, responsible for regulating and implementing appraisal and action. The final level is stored knowledge in long-term memory. The immediate activities of the online processing require access to stored knowledge in order to run. Online processing is guided by knowledge or beliefs that are metacognitive in nature. In line with one of the core values of the IP approach, the S-REF theory has generated many disorder-specific models, including models of depression, GAD, PTSD, social phobia, and obsessive compulsive disorder. Current research is evaluating the applicability of the S-REF model in an even broader range of issues such as alcoholism, psychosis, and persistent distress in survivors of cancer and myocardial infarctions. Evaluation of treatment efficacy of metacognitive therapy is in the early stages, but it is producing very high recovery rates across a range of clinical disorders.

Conclusions

IP models proliferate in clinical psychology, but the disparate nature of the underpinning theories leads to very different treatment approaches. This is a strength of the IP approach as it provides clinical psychology with a rich theoretical basis, from which further advancements can be achieved. The generation of novel interventions in the form of CBM strategies and metacognitive approaches are exciting innovations that hold considerable promise for the continually evolving practice of clinical psychology. In summary, the IP paradigm has resulted in a wealth of research and clinical developments that ultimately result in significant therapeutic benefits.

See also: Anxiety and Fear; Anxiety Disorders; Attention; Cognitive Behavior Therapy; Cognitive Bias.

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Cognition and Personality

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Glossary

Attentional resources A general-purpose reservoir of 'energy' or 'fuel' for processing that may be flexibly allocated to support effective attention.

Cognitive patterning A detailed description of the tasks or cognitive functions that are facilitated or impaired by a personality trait or stressor.

Executive functioning A set of control operations used to regulate attention and memory.

Extraversion A personality trait associated with sociability, assertiveness, and positive affect.

Idiographic approach The assumption that all aspects of personality are fundamentally unique and idiosyncratic to each individual.

Neuroticism A personality trait associated with a predisposition to experience negative affect.

Nomothetic approach The assumption that personality may be understood using universal concepts and principles that apply to all people.

Self-regulation The motivational and cognitive processes controlling goal-directed personal adaptation to the external environment.

Self-schema A structured set of beliefs about the self (which may not be fully accessible to consciousness).

Trait A personal disposition or characteristic showing long-term stability and influencing behavior in a range of situations.

Working memory A memory system used for information processing including both a central executive and short-term storage components.

Introduction and Historical Context

The essence of the cognitive psychological perspective on personality is that individuals differ in their understanding of the outside world and their own place in it. Thus, theories of individual differences in cognitive processes and structures should be central to the psychology of personality. Historically, the route to a cognitive understanding of personality has been surprisingly circuitous. In psychoanalysis, for example, the rationality of the ego often appears subservient to the basic drives of the id. Later theorists including George Kelly and Carl Rogers placed cognitive processes at the center of personality research, through emphasizing the person's active efforts at making sense of the world and of the self. However, these clinically oriented approaches lacked the benefits of the formal models of information processing provided by cognitive psychology.

At the dawn of the 'cognitive revolution' in the 1960s, we could discern three trends that continue to shape models of personality. The first comes from H.J. Eysenck's biological personality theory. Eysenck followed the behaviorist tradition of seeing cognition as secondary to more basic neural processes, but he pioneered the use of performance tasks as a means for testing personality theory. Tasks requiring memory and attention were used as a means of testing predictions from the arousal theory of personality traits. The failure of these attempts encouraged attempts to use cognitive psychological models as a basis for predicting personality effects.

The second trend was the development of social learning theories of personality by Walter Mischel and Albert Bandura. Such theories emphasized that social learning builds internalized cognitive structures, such as representations of self-efficacy, that provide both a coherent style of behavioral interaction with others, and a coherent sense of self. By contrast with trait

theory, social learning theories focus on the cognitive representations of the individual.

A third trend was for clinical psychologists to link emotional disturbance to broad individual differences in cognitive functioning, an approach more compatible with the notions of general personality traits. A.T. Beck's landmark schema theory elaborated the role of cognitive knowledge structures as a basis for personality, in relation to dysfunctional negative self-beliefs and styles of reasoning that are associated with clinical depression.

Contemporary personality research remains infused with a variety of cognitive constructs. However, personality researchers have adopted cognitive psychological methods and concepts in order to pursue rather different, although complementary, research aims. Next, three research directions are distinguished, relating to experimental studies of performance, the contents of self-representations in the 'cognitive self,' and long-term personality development.

Individual Differences in Performance

Personality traits relate to individual differences in performance of a variety of tasks. The conceptual model is that the trait is seen as a fixed quality of the person, which is associated with a range of biases that feed forward into observed behavior. Studies of human performance seek to relate personality to information-processing models that specify individual differences in components of memory, attention, decision making, and so forth. An important area of this research concerns cognitive bias in processing emotional stimuli, which has been related to anxiety and other traits linked to emotionality. Theory is then concerned with specifying the cognitive processes that mediate the behavioral expressions of the trait. For example, recent anxiety research has explored how anxiety

effects may be mediated by individual differences in executive processes. Because information processing can typically be related to neural systems, work of this kind also lends itself to cognitive neuroscience theory. Research of this kind is closest to 'standard' cognitive psychology in using experimental methods to investigate information-processing mechanisms in detail.

Experimental studies have also been used to investigate effects of personality on mood and emotion. It is commonplace (although perhaps simplistic) to identify neuroticism and extraversion traits with negative and positive emotionality, respectively. Although the dominant theoretical approach has been to relate these traits to brain systems for emotion and motivation, researchers are increasingly studying cognitive processes that may influence emotion, including biases in appraisal and styles of emotion regulation.

The Cognitive Self

In the classic experimental paradigm, the personality trait is a 'given' that influences cognitive processes and behavior over a short time interval. However, cognitive theory can also be applied to understanding the underlying nature of traits, given that the stability of personality implies that personal characteristics are represented in long-term memory (LTM). Variation in traits may correspond to variation in stable cognitive structures. Building on A.T. Beck's (1967) schema theory, researchers have explored how traits correspond to stable representations of self-knowledge, which in turn shape individual differences in social behavior. Traits may also correspond to 'implicit' procedural knowledge, such as well-learned scripts for interpersonal interaction, as well as to 'explicit' declarative knowledge.

Research on the cognitive self divides sharply into two separate camps. Following Mischel and Bandura, one line of research is concerned with 'idiographic' personality coherence at the individual level, and the role of the individual's cognitive-affective structures in producing consistency of behavior within specific situations. The alternative perspective assumes that features of the self such as dysfunctional negative beliefs may be assessed nomothetically, that is, as an attribute of all individuals, contributing to general traits. Typical methods include experimental studies, such as investigating speed of processing self-referent information, but may also employ other techniques, including subjective reports of self-beliefs. Recent research has increasingly focused on 'implicit' aspects of the self, for example, using techniques based on A.G. Greenwald's Implicit Association Test. For example, someone whose implicit self-esteem was low might respond more slowly if required to respond on the basis of an association between the self and positive qualities.

Personality Development

Temperamental qualities such as emotionality and self-control are expressed in early childhood, and form the precursors to adult personality. While temperament is often seen as essentially biologically based, there is increasing interest in how brain maturation and self-development are interrelated. For example, attachment theory is concerned with how the

innate neural programs for managing social interaction are shaped by experience to regulate the child's attachment to the caregiver. The development of (cognitive) working models of self and others plays a critical role in intimate relationships into adulthood. Research on personality and individual differences in cognitive development uses a variety of methods, including experimental studies and self-report. Studies of younger children obtain reports of behavior from parents or trained observers. Longitudinal studies that may run from infancy to adulthood are also important.

The developmental perspective helps us to understand how the cognitive self is acquired, as the child internalizes an increasingly sophisticated set of self-beliefs and strategies for self-regulation. Again, traditional social learning theory has often emphasized self-development as a process best understood at the level of the individual. However, normative traits may relate to consistent developmental trajectories and styles of person-environment interaction. For example, aggressiveness may relate to beliefs in the hostility of others, the acquisition of confrontive interpersonal strategies for self-defense, and willingness to engage with environments in which confrontation is likely.

Structure of this Article

The introductory overview of research on personality and cognition indicates the scope and diversity of this work. The remainder of this article is organized as three major sections. The first is concerned with work that is closest to the central goal of cognitive psychology, that is, to construct and test detailed models of the information processing that supports major psychological functions such as attention and memory. In personality research, the aim is to specify how personality traits correspond to individual differences in the parameters of information-processing models. The next section reviews integrative theoretical accounts of empirical findings, focusing on attentional resources, control processes, and the adaptive functions of cognition. The third section reviews applications of cognitive psychological research to other research topics which are concerned not only with individual differences in cognition, but also affective, motivational, and social functioning. These topics are self-regulation and emotion, the cognitive self and social functioning, and abnormal personality and clinical disorder.

Personality is itself a diffuse field of study, and some comment on its treatment in this article is needed. The research covered is primarily concerned with nomothetic trait models, which assume that the major features of personality can be described in relation to a psychometrically defined standard set of traits that are meaningful for all individuals. Coverage of idiographic personality models that emphasize the uniqueness of the individual will be brief.

The five factor model (FFM) is the dominant trait model at the present time. It includes extraversion-introversion, neuroticism (or emotional instability), conscientiousness, agreeableness, and openness as major traits. Traditionally, most cognitive research has been directed toward extraversion and neuroticism, and related traits such as anxiety. Work on the personality 'superfactors' is supplemented by studies of more narrowly defined traits, sometimes described as primary or

midlevel traits. Studies of clinical disorder have referred to the roles of both traits considered normal, such as neuroticism, and traits labeled as abnormal, such as schizoid and schizotypal personalities which may be associated with clinical schizophrenia. Recent work suggests that both types of trait may be treated as continuous dimensions, rather than discrete categories. That is, rather than an individual being rigidly categorized as either schizophrenic or nonschizophrenic, people vary in a continuous, graded fashion on the traits that capture core qualities of schizophrenia, such as experiencing delusions. In fact, there is quite good convergence between dimensional models for normal and abnormal domains. This article will focus primarily on constructs within the normal domain, but make some reference to abnormal traits.

Personality Traits, Information Processing, and Performance

The historical impetus for performance studies came from H.J. Eysenck's (1967) attempts to validate the arousal theory of personality from studies of various performance tasks. Interactions between extraversion and various stressful agents might be explained on the basis that extraverts were vulnerable to under-arousal whereas introverts were prone to over-arousal. Similarly, neurotic and anxious individuals were seen as liable to become over-aroused in emotive or stressful circumstances.

This research was valuable in showing that the impact of traits on performance is frequently moderated by environmental factors. However, it has failed to provide an adequate account of the performance data, for several reasons. First, evidence suggests that extraversion and neuroticism effects on personality may be found even with arousal controlled. Personality effects are not always (or even frequently) mediated by arousal. Second, the anxiety research of Charles Spielberger and Irwin Sarason highlighted the primacy of cognitive mechanisms over emotional physiological arousal in determining anxiety effects. Anxiety is harmful to performance because it is accompanied by worries that interfere with attentional processes. This perspective has been especially influential in studies of test anxiety. Third, personality effects vary substantially with the information-processing demands of the task. Performance is not a unitary construct, and traits are differentially related to different types of task. Fourth, the emerging cognitive neuroscience of personality, further discussed below, points toward brain mechanisms more specific than general cortical arousal as critical to personality.

Cognitive psychologists faced similar issues in seeking to understand effects of stressors such as noise and heat on performance. An influential critique set out by G.R.J. Hockey offered an alternative to arousal theory. He argued that the diversity of stressor effects across different tasks suggested a *cognitive patterning* of effects. The typical stressor appears to impair only certain components of information processing, while leaving others intact, or even improving processing. Hockey also pointed out that stressors may affect strategy as well as basic processing efficiency. Individuals under stress may appraise tasks and the priorities for applying effort differently.

The cognitive patterning approach provides a means for better understanding personality effects on performance. The assumption is that traits typically correspond to multiple, often small, biases in information processing. (Typically, cognitive ability is a stronger influence on processing and performance). There remains a need for a systematic investigation of the processing correlates of traits, but published studies allow at least an outline of the multiple influences of major traits, especially extraversion and anxiety/neuroticism.

Cognitive Patterning: Extraversion–Introversion

Table 1 shows an outline patterning for extraversion–introversion. Discussion of the individual entries in the table is beyond the scope of this article, but two general themes may be identified. First, the temporal characteristics of tasks may be critical. Extraverts appear to have the advantage over introverts where speed is emphasized, as evidenced by more risky speed–accuracy tradeoff in reaction time tasks, and faster motor response execution. Extraverts also tend to do somewhat better on short-term memory (STM) tasks, whereas LTM may favor introverts. Tasks in which stimuli are presented infrequently, including vigilance and reflective problem solving, tend to be better performed by introverts. Second, the coding or representation of task stimuli may be critical. Although extraversion is largely unrelated to verbal ability, extraverts show greater verbal facility in tasks including fluent speech production and retrieval from semantic memory. Indeed,

Table 1 Outline cognitive patterning for extraversion–introversion

<i>Cognitive function</i>	<i>Sample task</i>	<i>Result</i>
<i>Extravert superiority</i>		
Divided attention	Memory search for single or multiple targets	Extraverts faster in dual-task versions conditions
Short-term memory	Free recall of word lists	Extraverts better at immediate recall
Speed of motor response	Choice reaction time	Extraverts show faster response execution
Speech production	Conversation in a second language	Extraverts more fluent in speech production
<i>Introvert superiority</i>		
Visual vigilance	Detecting line signal	Introverts show higher detection rate
Long-term memory	Paired-associate learning	Introverts better at long-term recall
Problem-solving	Problem-solving tasks requiring insight	Introverts faster and more accurate: extraverts finish impulsively
<i>Qualitative performance differences</i>		
Vigilance	Detection of brighter target stimulus	Extraverts adopt a lower response criterion
Response to stress and arousal	Serial choice reaction time	Extraverts are faster when high in arousal; introverts are faster when low in arousal (also depends on time of day)

studies of divided attention suggest that extraverts may have an advantage in processing multiple symbolic (alphanumeric) stimuli. Note also that several of these effects are moderated by the arousal or stress level of the experimental setting. For example, extraverts may find it especially hard to sustain attention and vigilance when the surrounding environment is unstimulating and deactivating.

Cognitive Patterning: Anxiety and Neuroticism

A cognitive patterning for anxiety (or neuroticism) is shown in Table 2. Again, some general themes are evident. Individuals high in trait anxiety are vulnerable to overload, especially on tasks making high demands on attention and/or working memory. Neuroticism is also associated with difficulties in managing transitions in workload. Second, anxiety may also be related to compensatory effort as the person tries to cope with the distraction associated with their own worries. Indeed, anxiety may sometimes relate to enhanced performance on easy tasks. Third, anxiety relates to enhanced sensitivity to threat stimuli, as shown most directly in studies of selective attention. The emotional Stroop test requires participants to name the ink colors of threatening or other emotive words. A. Mathews and C. MacLeod pioneered research showing that

anxious individuals tend to respond relatively slowly on this task, especially when the threat words match their current concerns, implying a cognitive bias.

Other traits have been studied less extensively, so that no detailed cognitive patterning may be presented, but there are several promising research areas. Within the FFM, there is accumulating evidence, often from an organizational perspective, suggesting that *conscientiousness* tends to relate to enhanced performance of a variety of tasks. The information-processing basis for these findings is unclear, but conscientiousness has been linked to effort and goal setting. *Openness* relates modestly to cognitive ability, especially crystallized ability, and other tests with some intellectual content, including creativity tests. These relationships may be mediated by motivational factors, including 'typical intelligence engagement'; that is, more open individuals have a greater interest in intellectual activities, supporting skill acquisition.

Cognitive Neuroscience Perspectives

The psychobiological roots of research on personality and performance ensured that the introduction of cognitive models to the field was accompanied by continued interest in psychophysiological correlates of information processing. One of the more productive lines of research relates to evoked potential (EP) responses derived from the electroencephalogram (EEG). Differences between extraverts and introverts have been found in the amplitude of the P3 (or P300) wave that may reflect updating of working memory. These differences may be associated with performance differences on working memory task.

In recent years, the cognitive neuroscience of personality has been boosted by studies of brain imaging, using techniques including functional magnetic resonance imaging (fMRI). Such studies may indicate the individual differences in neurological functioning that correspond to performance variation. There are several promising lines of research. As already described, traits including extraversion and anxiety relate to attentional functioning. The cortical brain circuits that control different attentional processes are increasingly well-understood, and evidence from fMRI may be integrated with behavioral studies in order to elucidate the nature of personality effects.

Traditional biological theories of personality situated traits in subcortical systems such as arousal circuits and reward and punishment systems. In contemporary cognitive neuroscience, such circuits are relevant because their activity may modulate the cortical systems that more directly control information processing. For example, dopaminergic afferents may influence the areas of prefrontal cortex that support executive processing in attention and working memory. Extraversion may be related to reward areas of the brain and increased dopaminergic activity. Research is exploring whether this hypothesis explains the greater efficiency of working memory in extraverts, relative to introverts (in some task paradigms).

Similarly, structures including amygdala and anterior cingulate cortex may relate to individual differences in processing emotional information. Circuits including these structures may mediate effects of traits on cognitive bias in attending to emotional stimuli, shown by studies of the emotional Stroop test. Finally, research is also addressing the molecular genetics of

Table 2 Outline cognitive patterning for anxiety/neuroticism

<i>Cognitive function</i>	<i>Sample task</i>	<i>Result</i>
<i>Processing efficiency effects</i>		
Divided attention	Concurrent math and verbal memory	Anxiety leads to impairment in dual-task performance (especially on secondary tasks)
Working memory	Mental transformation of letter sequences	Anxiety-related impairment increases with memory load
Resisting distraction	Comprehending text with background speech	Anxiety relates to distraction by irrelevant speech
<i>Cognitive bias effects</i>		
Selective attention (single channel)	Emotional Stroop	Anxiety subjects are slow to name ink colors of threat words
Selective attention (multiple channel)	'Dot-probe' visual attention task	Anxious subjects respond more quickly to probe presented at location of threat
Semantic processing	Interpreting spoken homophones: for example, 'die' versus 'dye'	Anxious subjects biased toward selecting threatening interpretation
<i>Qualitative performance differences</i>		
Response to evaluative stress	Performance with evaluative instructions	Anxiety relates to performance impairment when evaluated
Memory strategies	Free recall of word lists	Anxiety relates to reduced strategic reorganization of words

the relevant neurotransmitters; future studies may identify polymorphisms that correspond to individual differences in cognitive functioning and performance.

Toward Cognitive Theories of Personality Effects

The delineation of the cognitive patterning of a trait is essentially a descriptive exercise, which provides the fine-grained account of trait effects necessary for subsequent theory building. Typically, cognitive psychological theories of trait effects reflect a progression of increasing specificity in relating traits to information-processing mechanisms. Early studies suggest an association with some broad cognitive function such as 'attention' or 'short-term memory,' without isolating any specific information-processing mechanism. Further work differentiates possible mechanisms and seeks to isolate those that are responsible for trait effects. For example, the cognitive bias associated with anxiety might be produced by either an early 'preattentive' bias in threat encoding, or by later strategic processes. Ideally, the end-point of theory development should be a computational model that identifies traits with quantitative model parameters. Extant research has rarely attained this goal, although promising work has been done from a connectionist perspective, especially in modeling the effects of traits linked to negative affect.

The cognitive patterning approach emphasizes that trait effects are *distributed* across multiple component processes. By contrast with traditional biological theories of personality, there is no single key process for trait action. Thus, we may arrive at a series of 'cognitive mini-theories' that describe the effect of a given trait on a given class of tasks (e.g., effects of extraversion on vigilance), but do not provide any general synthesis of the relationship between the trait and information processing.

Some researchers have attempted to provide general accounts of personality effects, which will be reviewed next. These theories relate to processing resources as a key mediating construct to the role of executive control functions in mediating anxiety effects and to the adaptive functions of cognitive biases associated with personality.

A Processing Resource Model

Processing resources are metaphorical reservoirs of energy that may be required for processing that remains under voluntary control. The concept has been influential especially in research on divided and sustained attention. There has been debate over whether resources are unitary, or whether multiple resource pools energize qualitatively different types of processing.

M.S. Humphreys and W. Revelle proposed that variation in resource availability may mediate the effects of both transient arousal states and a range of personality and motivational traits. Their multiple resource model incorporates resources for 'sustained information transfer' (SIT), required for a variety of demanding attentional tasks, and resources for STM. High arousal tends to increase the availability of SIT resources, consistent with evidence that stimulant drugs tend to enhance vigilance and other attentional tasks. Arousal also reduces

STM resources. The theory distinguishes on-task effort from arousal as an energetic construct. On-task effort increases functional availability of both types of resources.

The theory has inspired work in a variety of areas. The authors' own research focused primarily on effects of extraversion and impulsivity and their interaction with arousal manipulations including time of day and caffeine. They investigated tasks including cognitive ability tests and more basic information-processing tasks. They were able to show that interactions between personality and caffeine were consistent with the theory. A key assumption derived from the model was that complex tasks, requiring both SIT and STM resources, showed the inverted-U curve relating arousal to performance assumed by traditional arousal theory. A criticism of the model was that tasks most sensitive to interactive effects of extraversion and arousal appear to require routine, somewhat automatic stimulus encoding, and may not be highly resource-limited. Researchers are continuing to elaborate the theory.

The resource model has also been applied to understanding individual differences in vigilance. The state factor of task engagement (combining energy, motivation, and concentration) reliably predicts performance of a range of demanding vigilance and visual search tasks. The association between high engagement and attention is reliable only under high levels of task demand, as resource theory predicts, assuming task engagement can be identified with arousal. The hypothesis that arousal impairs STM has been less successful. Indeed, high task engagement may facilitate working memory. The multiple resource model also links STM deficits to reduced on-task effort, a hypothesis that is compatible with other cognitive models of anxiety.

Attentional Control Theory

Attentional control theory, developed by M.W. Eysenck and his colleagues, aims to explain anxiety effects on a range of tasks requiring attention and working memory in terms of specific executive control processes. It integrates several themes of existing anxiety research within the understanding of executive function provided by contemporary cognitive neuroscience. The first theme is the generally detrimental effects of anxiety and worry on various cognitive tasks. The initial cognitive mechanisms to which these effects were attributed were broadly described in terms such as cognitive interference and working memory impairment. However, attention and working memory may be regulated via multiple executive control processes, as shown by recent psychometric work in the area. Inhibition of conflicting responses, shifting between mental operations, and updating working memory are three separate control processes. Evidence reviewed by Eysenck and colleagues suggests anxiety reliably disrupts inhibition and possibly shifting, but not updating.

A second theme is that anxiety relates to selective attentional bias, in the form of enhanced attention to threatening stimuli. The bias effect can be demonstrated with 'subliminal' stimuli that are masked to the point where they cannot be consciously recognized, implying that anxiety influences early, preattentive processes. Attentional control theory assumes that attention is both stimulus-driven and goal-driven. Anxiety relates to enhanced sensitivity of the stimulus-driven system

to threat. A third theme is that attentional bias is controlled by expectancy and strategy choice as well as unconscious preattentive processes. Attentional control theory proposes that weakness of executive control, especially in relation to inhibition, accentuates the tendency of anxious individuals to be distracted by the threat stimuli prioritized by stimulus-driven attention. A fourth theme, articulated in M.W. Eysenck's earlier work, is that anxious individuals may compensate for disruption of attention via increased effort; an assumption that is also incorporated into the theory. It successfully integrates much existing anxiety research, although it has been developed too recently to be tested explicitly, other than in the ongoing work of Eysenck and his colleagues. These authors – consistent with a cognitive patterning perspective – also point out that the theory is directed specifically toward the effects of anxiety on attention and working memory. Other performance correlates of anxiety, such as effects on retrieval from LTM, are beyond its scope.

Cognitive-Adaptive Theory

Cognitive-adaptive theory, developed by G. Matthews, is an attempt to interrelate the multiple cognitive correlates of traits such as extraversion and neuroticism. It asks how the cognitive correlates of the trait support adaption to the individual's life circumstances. A key assumption is that there is a correspondence between personality traits and environments. A high level of a given trait equips the person to thrive in certain environments (with corresponding disadvantages in others). The cognitive correlates of a trait typically have an indirect rather than a direct effect on adaptation by facilitating the development of acquired skills congruent with the trait.

Extraversion-introversion effects illustrate this perspective. Extraverts are adapted to function well in cognitively demanding social environments. Cognitive correlates of extraversion (see [Table 1](#)) such as good verbal STM, and fluent speech production support acquisition of the relevant social skills. Neurologically based attributes of extraversion such as tolerance of high arousal and stimulation, and reward-sensitivity, facilitate adaptation in parallel with cognitive skills. Conversely, introverts are adapted to solitary environments in which task stimuli and positive reinforcement may be infrequent. The cognitive-adaptive perspective on anxiety and neuroticism suggests that anxious individuals are adapted to environments in which threats are disguised or ambiguous, requiring high threat sensitivity and subsequent threat avoidance. Individuals low in anxiety are more geared to direct confrontation of threat after it becomes salient.

Cognitive-adaptive theory explains the distributed nature of the cognitive correlates of traits. It is also compatible with theories that specify information-processing mechanisms in detail. The theory also goes farther than standard cognitive accounts in describing the dynamic nature of interaction between personality and cognition. The 'adaptive triangle' refers to the interplay between (1) the stable cognitive structures and biases that provide the basis for personality effects, (2) self-regulative processes that evaluate performance competence and coping potential, and (3) outcomes of behavior that may provide feedback both to influence further skill acquisition, and the person's beliefs about his or her own competence.

Further Research Directions

The research topics reviewed thus far are those that address the relationship between personality and cognition most directly, by collecting objective data on individual differences in performance from controlled experiments. However, the relationship between personality and cognition has also been explored using other methodologies such as analysis of self-reports of cognitive processes and clinical observations. This section briefly surveys the contribution of cognitive research to three further major areas of personality research: self-regulation and emotion, social behavior, and clinical disorder.

Self-Regulation and Emotion

There are many theories of emotion, but one influential approach is to see emotion as a concomitant of self-regulation. C.S. Carver and M.F. Scheier have suggested that avoidance and approach behaviors are controlled by feedback loops that aim to reduce discrepancy with some standard value. Personal and social standards may be represented as part of the self. Discrepancy generates negative emotion, whereas an acceptable rate of progress toward meeting the standard produces positive affect. The later work of these authors also describes discrepancy-enlarging feedback loops in which the system operates to increase distance from a reference value (e.g., avoiding ridicule). They also discuss the role of nonlinear dynamics. Personality may impinge on several features of feedback control systems, including the individual's personal standards, the availability of corrective actions, and dynamic properties of the system such as speed of response to feedback. Recent personality research has sometimes equated extraversion and positive emotionality with approach tendencies, and neuroticism and negative emotionality with avoidance.

Self-regulation models complement traditional neurological models of personality. At a more fine-grained level, research has identified several potential mediating processes. Traits may bias cognitive appraisal of stimuli and events. Neurotic individuals are more likely to appraise events as threatening, whereas extraversion relates to challenge, elevating negative and positive affect, respectively. In addition, as the transactional theory of stress and emotion describes, individuals manage demanding events dynamically, by implementing coping strategies, and processing feedback on outcomes of coping. Traits may influence how these cognitive regulatory processes operate. Neuroticism has been linked to emotion-focused coping, whereas extraversion is associated with greater use of task- or problem-focused coping. These associations may be demonstrated in both controlled laboratory settings and in real-life contexts.

Personality also relates to style of mood regulation. Individuals high in neuroticism and other traits linked to negative emotion tend to ruminate perseveratively on negative events and thoughts, perpetuating negative affect and worry. Conversely, extraverts may be better than introverts at repairing a bad mood or maintaining positive affect. Emotions may also be regulated through choice of activities and exposure to situations that are mood-uplifting or depressing. High neuroticism

individuals are more prone to become involved in disagreements with others that may elicit negative emotion, whereas extraversion is linked to mood-enhancing social participation.

A new perspective on personality, self-regulation, and emotion derives from research on the new construct of emotional intelligence (EI). Although conceptualization and assessment of EI remains controversial, emotionally intelligent individuals may possess personality characteristics that support more effective mood regulation. Attention to emotion, clarity of emotions, and mood repair are aspects of trait EI that may support mood regulation. Individuals high in EI may be better able to use and express their emotions constructively, even in difficult, potentially stressful circumstance.

Personality and Social Behavior

As previously indicated, traits may relate to the content of self-knowledge. For example, self-esteem may relate low neuroticism and high extraversion. Because of the social nature of the self, much of this knowledge refers to social relationships, such as the extent to which the self is generally liked or disliked by others. The person's typical social behaviors may be influenced by this knowledge. In addition, traits may relate to specific self-regulative processes such as self-verification (seeking confirmation for self-beliefs) and self-enhancement.

These principles have informed experimental studies of agreeableness. The trait relates to self-reported attributes including empathy, cooperativeness, and liking for others. There is indeed evidence that agreeableness relates to higher quality of social interaction, more satisfying close relationships and fewer conflicts with others. Controlled observational studies confirm that agreeableness relates to behaviors that may promote interpersonal relationships such as greater visual attention and more 'open' body positions. The effects of agreeableness may be controlled by cognitive processes including more positive perceptions of others and greater attention to prosocial stimuli. Agreeableness also relates to the social motivations that may be represented within the cognitive self, including motives to accommodate to the needs of others, and to resolve conflicts through collaboration. Conversely, aggressiveness as a personality trait relates to distorted perceptions of others that lead to false attributions of hostility, and to motives to cope with hostility via confrontation and aggressive behaviors. At the extreme, such cognitive distortions may contribute to externalizing disorders and antisocial personality.

Vulnerability to Clinical Disorders

Although causal relationships between traits and episodes of acute mental disorder may be bidirectional, it is accepted that certain traits may elevate vulnerability to disorder. Vulnerability may relate to cognitive as well as to biological factors. A.T. Beck's identification of the encoding of dysfunctional negative self-beliefs in the self-schema as a risk factor for depression has already been indicated. Abnormality in information processing as well as in the content of self-knowledge may also be important. For example, a bias toward attending to threat may lead to a chronic overestimation of the prevalence and severity of threat. Indeed, recent experimental studies

conducted by C. MacLeod and colleagues show that training participants to respond to positive or negative stimuli may influence anxiety congruently. Memory biases also contribute to the initiation and maintenance of disorder.

The self-referent executive function (S-REF) theory of A. Wells and G. Matthews aims to provide a comprehensive account of the various cognitive factors that may shape vulnerability to anxiety and mood disorders and their perpetuation. A key assumption is that multiple cognitive processes contribute to vulnerability. Cognitive content, information-processing, and dynamic person-situation interaction are all important. Critical to the symptoms of emotional disorder are cycles of perseverative worry or rumination that reflect misdirected executive processing. Several cognitive factors increase the likelihood of such self-referent processing including dysfunctional declarative and procedural self-knowledge, and excessive attention to threat and to the self. Metacognitions that worry is effective for problem-solving are also harmful. Emotion-regulation strategies intended to reduce awareness of disturbing thoughts and images may, paradoxically, strengthen dysfunctional self-knowledge. Avoidance of feared situations may produce a similar, harmful outcome, by preventing opportunities for disconfirming irrational negative self-beliefs. Both neuroticism and more narrowly defined personality traits related to metacognitive style may tend to enhance these maladaptive styles of interaction with the external environment. These insights have supported cognitive-behavioral therapies directed toward the person's style of attention and metacognition.

Abnormal personality traits may relate to attentional impairments that contribute to additional mental disorders. The strongest body of research surrounds the schizotypy trait. Schizotypy refers to traits such as unusual and disorganized patterns of thinking, together with interpersonal difficulties, that may raise vulnerability to schizophrenia. Several studies show that schizotypy is associated with impairments in selective attention, associated with weaknesses in inhibition of task-irrelevant stimuli. P. Venables proposed that the selective attention deficit tended to flood the person's consciousness with confusing and sometimes bizarre ideas and images, similar to the positive symptoms of schizophrenia. Additional traits that have been linked to maladaptive attention include sensation-seeking, impulsivity, and tendencies to cognitive failures.

An Integrative Perspective on Personality and Cognition

One of the difficulties of cognitive personality research is that of seeing the forest for the trees. Personality appears to be associated with often small-magnitude biases in a wide variety of cognitive processes. G. Matthews has suggested that it is useful to place cognitive expressions of personality within the trilevel explanatory framework for cognitive psychology advanced by Z. Pylyshyn. Personality effects on behavior may variously be attributed to individual differences in

- (1) parameters of the physical, neural architecture for information processing (biological level),

- (2) parameters of the virtual processing architecture associated with constructs such as attentional resources and working memory (symbol-processing level), and
- (3) self-knowledge, personal goals, and beliefs about strategies for goal attainment (semantic level).

Thus, different problems in personality call for different types of cognitive explanation. Cognitive-adaptive theory is an attempt to show how the information-processing correlates of personality traits may cohere around individual differences in adaptation. At the most basic level, traits may represent different styles of adaptation to human social environments, adaptations that call for different cognitive strengths.

See also: Anxiety and Fear; Attention; Clinical Psychology: An Information Processing Approach; Cognitive Bias; Extraversion–Introversion; Personality, Structure.

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- http://dev2.affinitynewmedia.com/uea_psyc/links-to-other-personality-labs-pg82.html – Philip Corr, of the University of East Anglia, maintains this list of personality labs.
- <http://ipip.ori.org/ipip/index.htm> – The International Personality Item Pool (IPIP) is a useful open-source resource for obtaining scales for numerous personality traits. IPIP scales may not be validated as extensively as the personality questionnaires developed by test publishers.
- <http://www.personality-project.org/personality.html> – The Personality Project, directed by William Revelle of Northwestern University, provides information on numerous aspects of contemporary personality research, including cognitive models.

Cognitive Behavior Therapy

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Glossary

Behavioral experiments Planned experimental activities based on experimentation or observation, which are undertaken between patients between therapy sessions. The primary purpose is to help patients to test the validity of their maladaptive beliefs, in order to obtain new information about themselves and the world.

Cognitive restructuring A technique used in cognitive-behavioral therapy to identify and correct negative thinking patterns, by replacing them with more rational beliefs.

Exposure A technique used in cognitive-behavioral therapy which involves presenting a patient with anxiety-provoking stimuli for a long enough time to decrease the intensity of his or her emotional reaction.

Metacognitions The knowledge you have of your own thoughts and the factors that influence your thinking.

Mindfulness A kind of nonelaborative, nonjudgmental, present-centered awareness in which each thought, feeling, or sensation that arises in the mind is acknowledged and accepted as it is.

Introduction

The development of cognitive behavior therapy could be divided into three generations. Behavior therapy (BT) could be considered as the first wave, where behavioral principles developed in the laboratory were used in a clinical setting in treating psychological problems (e.g., phobias). The second wave was cognitive therapy (CT) developed by A.T. Beck in the early 1970s, which initially was developed to treat depression, but later expanded to the treatment of other psychiatric disorders as, for example, anxiety and personality disorders. From the late 1980s to early 1990s, we could notice a synthesis between behavior therapy and cognitive therapy, into cognitive behavior therapy, which today has a large evidence base related to its treatment efficacy. During the two last decades, a number of new treatments have evolved from the cognitive therapy foundation, which many have classified as the 'third wave' of cognitive behavior therapy. This article describes the theory behind and therapeutic techniques used in traditional cognitive behavioral therapy (CBT) and newer developments in the third wave of cognitive therapy. In addition to treatment principles and cognitive theory, the efficacy of cognitive behavioral therapy is also discussed.

What Is CBT?

CBT has rapidly grown as a therapy approach in the last 20 years. It acknowledges that the processes between cognitions, emotions, and behaviors are influenced by complex interactions between biological processes and environmental and interpersonal influences. The relation between cognitions, emotions, and behavior is accentuated in this approach and particularly how change in cognitions could influence alterations in emotions and behavior. Departing from psychoanalytic concepts, several post-Freudian theorists like Adler, Sullivan, and Horney have influenced the development of CBT. Core beliefs and self-schemas from Kelly's personal construct, and the rational-emotive therapy from Ellis contributed to the theory and methods used in CBT. Beck and others extended

CBT to a wide array of conditions like depression, anxiety disorders, eating disorders, schizophrenia, bipolar disorder, chronic pain, personality disorder, and substance abuse. More than 300 controlled studies of CBT have been completed for a variety of psychiatric disorders.

CBT integrates two originally separate theoretical understandings and treatment approaches, namely, the behavioral and the cognitive approach. The most stringent behavioral approach exclusively focuses on observable and measurable behavior and does not take into account the mental processes. The cognitive approach, according to Beck, asserts that emotional disorders are maintained by a 'thinking disorder' where cognitions are viewed as antecedents and determinants of feelings and behaviors. Negative automatic thoughts are essential in CBT and manifest themselves as rapid content-specific thoughts. For example, in depression, these thoughts have a content that reflects negative ideas about the self, the world, and the future, while for anxiety, they usually reflect the theme of danger and an underestimation of coping. The cognitive theory further states that negative automatic thoughts are rooted in early negative experiences that may facilitate the formation of more permanent negative beliefs (core beliefs). Particular situations relevant to a negative belief may activate it. Once the negative belief has been activated, negative automatic thoughts will occur in the stream of consciousness. Beck therefore proposed a cognitively based therapy aiming to reverse dysfunctional cognitions and related behaviors. Panic disorder is one particular example where cognitive and behavior theories come together. According to Clark's cognitive model of panic disorder, patients suffering from panic attacks typically have cognitive symptoms like catastrophic fears of physical calamities or loss of control combined with behavioral impulse to escape or avoid. Altering dysfunctional cognitions and encouraging the reversal of maladaptive behavioral coping like avoidance would therefore be a focus in CBT.

The principal element of CBT is that cognitive processing is given a prominent role, because humans continually appraise the significance of the events they observe and take part in. Depending on the appraisal, emotional and physical reactions often form the basis for behavioral responses. According to the

Heimberg's cognitive model of social phobia, patients with this disorder may have the following thoughts related to an invitation to a social event: "I don't know what to say . . . Everyone can see that I am nervous . . . Others will think I'm stupid . . . It is best if I don't go at all . . ." These thoughts that are typical in social phobia could give emotional and physiological responses like severe anxiety, physical tension, and autonomic arousal like dry mouth, increased heart rate, and increased sweating. Avoidance of a feared situation strengthens the relation between negative thinking and avoidance, primarily because the avoidance gives an immediate reduction of stressful emotional and physical reactions. However, the avoidance also limits or eliminates alternative learning experiences because an individual avoids situations that may contribute to new information, and therefore strengthens his or her dysfunctional assumptions.

Basic concepts

In CBT, it is not the event in itself that affects our behavior and emotion, but it is how the event is appraised that influences our responses. CBT has identified three levels of cognitive processing, namely (1) conscious processing, (2) automatic thoughts, and (3) schemas (core beliefs). The first process allows us to monitor and assess our interaction with the environment, integrate past memories with present experiences, and plan and control the future. The two latter concepts are parts of automatic information processing and thus not part of a controlled and voluntary information process. In this article, the concept of automatic thoughts and schemas will be described.

Automatic thoughts

Automatic thoughts are cognitions that flow rapidly through our minds while we are remembering a situation or are in the midst of one. These thoughts are typically subliminal and not subjected to careful rational analysis, but they do influence how we evaluate the significance of particular events. All humans have automatic thoughts, but it is only when the situation triggers negative automatic thoughts that these thoughts form the basis for psychological disorders. Research has shown that individuals with psychological disorders often experience a flood of maladaptive automatic thoughts that contribute to generate stressful emotional reactions and dysfunctional behaviors. For depression, the negative automatic thoughts often spin around themes like failure, hopelessness, and low self-esteem. For anxiety disorders, such thoughts often focus on the prediction of danger, harm, uncontrollability, and inability to manage threats. In CBT, increased awareness of primarily negative automatic thoughts and subsequently the emotions and behaviors they contribute to create is among the initial steps of the treatment.

Cognitive errors

Initially, in CBT, it was theorized that there would be characteristic errors of logic in the automatic thoughts typical for individuals with emotional disorders. Research has later confirmed that there are pathological styles of information processing where characteristic cognitive errors are typical. Beck and colleagues have identified six main categories of cognitive

errors: arbitrary inferences, selective abstraction, dichotomous or all-or-nothing thinking, magnification and minimization, overgeneralization, and personalization. The CBT therapist typically educates the patients about these cognitive errors which thereby increase the patients' ability to identify when they make such cognitive errors, and make new evaluations less influenced by them.

Schemas and core beliefs

In CBT theory, schemas are core beliefs that underlie or govern information processing, and underlie the more superficial layer of automatic thoughts. These core beliefs are enduring principles of thinking that are typically shaped in early childhood. A multitude of life experiences influence the development of these schemas, like parental modeling and teaching, educational activities along with peer experiences and traumas. It is theorized that these schemas develop in order to facilitate the processing of the multitude of information that individuals face in their everyday life. It is thought that they serve as a screening, filtering, or coding function in assigning meaning to information for the individual. Some researchers differentiate between nuances of the levels of schemas; however, it has been found that most patients benefit from recognizing the general concepts of maladaptive schemas and that these have a strong influence on self-esteem and behaviors. The goal in CBT is to identify and develop adaptive schemas and simultaneously modify and reduce the influence of the maladaptive schemas.

Overview of CBT Therapy Approach

There are some fundamental principles for administering CBT treatment. The cognitive processes involved in appraisal of information described earlier are equally relevant for clinical and nonclinical individuals and as such relevant for all humans. The CBT is at present, problem- and content-oriented. In addition to a thorough diagnostics, it is very important to develop an individualized case formulation at the beginning of therapy, as this will serve as a guideline throughout the therapy and direct therapist interventions. An early identification of a shared goal of therapy is important and can facilitate the therapeutic alliance. The CBT sessions follow a particular pattern for each session, starting with establishing an agenda, establishing the main themes of therapy are discussed, designing content appropriate homework tasks, and at the end of the session, letting clients summarize the session and learning points.

The general approach is founded on scientific principles, and the therapist aims to view the client's assumptions, automatic thoughts, and schemas as testable scientific hypothesis that ideally can generate behavioral experiments in order to check out the validity of the patient's thoughts. This is often labeled collaborative-empirical therapeutic relationship. One particular often used technique called Socratic questioning involves formulating questions in order to stimulate curiosity and inquisitiveness and aiming to get the patient involved in a learning process. This technique has been shown to facilitate guided discovery, where the therapist leads the patient to discover the dysfunctional patterns and behaviors and thereby generate alternative cognitions or operationalize their assumptions to make them testable in behavioral experiments. Psychoeducation is also an important part of CBT in

normalization of symptoms, also in addition to deepening the understanding of the relation between cognition, emotion, and behavior.

Particular techniques

Identifying negative automatic thoughts and subsequently the underlying core beliefs is a primary objective of CBT. Once the content of the negative automatic thoughts and schemas is identified, these assumptions are later challenged. This is often labeled cognitive restructuring, which basically involves identifying cognitive errors, examining the evidence (pro-con analyses), reattribution, exploring alternative explanations or ways of understanding situations, and listing rational alternatives and cognitive rehearsal and behavioral experiments to test hypothesis based on either negative automatic thoughts or schemas. One example of a particular technique in CBT is the ABC technique. Listing Antecedents (situations), Beliefs, and (emotional) Consequences, in three columns, familiarizes the clients with how particular situations may activate different automatic beliefs, which again elicits emotional reactions. Proposing and exploring alternative beliefs may alter the emotional reaction.

Behavioral techniques are primarily designed to help clients break patterns of avoidance and helplessness, gradually face feared situations, build adaptive coping skills, and reduce maladaptive emotional and autonomic arousal. A behavioral experiment is designed to explore the validity of the patient's existing beliefs about themselves, others, and the world, and to construct and test new more adaptive beliefs. Behavioral experiments take a scientific approach and tests whether a particular automatic thought or a core belief could predict what happens in the real world. It is therefore important to generate one or more precisely operationalized predictions based on the theory the client and therapist want to test. If the theory of a patient suffering from social phobia is 'I blush when I talk in social situation and therefore others think I am stupid,' then it should be possible to observe the blushing on a video, and further we should check if others really think someone is stupid for blushing. Behavioral consequences of particular sets of cognitive errors may lead to behavioral avoidance and safety-seeking behaviors, which in itself contributes to maintain the psychological disorder. Following each behavioral test, it is important to evaluate the outcome, and explore if the predictions were true and if there is reason to maintain or abandon previous behavior and negative automatic thoughts and schemas.

Efficacy of CBT

CBT has played a very important role in establishing the evidence-based approach within psychotherapy, by using meticulous scientific methods to explore the validity of theory and therapy. Initially a treatment for depression, CBT has become a treatment approach to very many different psychiatric disorders. With time, many studies have evaluated the efficacy of CBT, so meta-studies are rather common. One such study undertaken in 2006 by Butler and colleagues summarized 16 methodologically rigorous meta-analyses. Large effect sizes were found for CBT for unipolar depression, generalized anxiety disorder, panic disorder with and without agoraphobia, social

phobia, posttraumatic stress disorder, and childhood depressive and anxiety disorders. Moderate effect sizes were found for marital distress, anger, childhood somatic disorder, and chronic pain. CBT and behavioral therapy was equally effective for adult depression and obsessive-compulsive disorder. For bulimia nervosa and schizophrenia, there were found large uncontrolled effect sizes. Another meta-analysis of 108 treatment trials across anxiety disorders in 2007 by Norton and colleagues found that treatment was superior to no treatment and expectancy control treatments.

In summary, there are many randomized controlled treatment trials for CBT with large numbers of participants that collectively support the efficacy of CBT across a wide variety of diagnoses. Collectively, these studies suggest that CBT could be considered the treatment of choice for anxiety and depressive disorders. Despite extensive evidence, the scientific and hypotheses-driven approach of CBT has resulted in the development of newer cognitive treatment approaches, which we describe next.

The Third Wave of Cognitive Behavior Therapy

The third wave represents a new approach to CBT, and examples of such so-called third wave CBT therapies include Acceptance and Commitment Therapy (ACT), Dialectical Behavior Therapy (DBT), Metacognitive Therapy (MCT), Mindfulness-Based Cognitive Therapy (MBST), Cognitive Behavioral Analysis System of Psychotherapy (CBASP), Functional Analytic Psychotherapy (FAP), and Integrative Behavioral Couple Therapy (IBCT).

Compared to traditional CBT, the aforementioned types of third wave cognitive behavior therapies have important differences between them and some shared features. While traditional CBT is primarily engaged in working with the content of thoughts (disputing, change and restructuring content of the person's thoughts), these new forms of cognitive behavioral therapies try to work to change the relationship between the person and his or her thoughts and feelings. The therapeutic methods used for change have also a more experiential character than the didactic approach which is well known in traditional cognitive behavior therapy. In many of the third wave therapies developing mindfulness and acceptance of your thoughts play a leading role, while disputing the content in the thoughts is emphasized in traditional CBT. It would be impossible to give a full description of all the third wave cognitive behavioral therapies in this article. As ACT, DBT, and MCT are treatment approaches developed to treat a broad variety of psychological problems and also have been tested out empirically, these treatments are described in some detail in relation to their theoretical basis, treatment principles, and treatment efficacy.

Acceptance and Commitment Therapy

ACT described their theoretical basis for understanding psychopathology, and their model for psychological treatment is embedded in what is called Relational Frame Theory (RFT). The details of RFT go beyond the scope of this article, so just a very short version of the theory is given here. From a RFT

perspective, psychopathology develops mainly because individuals have problems in separating the process of thinking from the products of thinking. This cognitive fusion between the process and products of thinking leads to an excessive or improper regulation of behavior by verbal processes. The behaviors of individuals will then be guided more by their inflexible verbal networks than by contingencies of reinforcement in their environment. The process of cognitive fusion leads to other processes in developing psychopathology. As individuals have problems in separating the content of thoughts from the process of thinking (thinking the thought), many people start to fear and avoid their own thoughts, feelings, and bodily sensations as a way to cope with and regulate their negative emotions. This process of escaping thoughts and emotions is destructive, because it leads to what is called 'experiential avoidance.' It will trigger people to think that certain emotions, thoughts, and bodily sensations are dangerous to experience and therefore must be avoided. All in all, these psychological processes will cause people to miss out of their experiences of their present moment. They will disappear in what Stephen Hayes describes as "a cacophony of human thinking and its reasons, explanations and justifications for behavior." In accordance with RFT, it would therefore be of importance to down-regulate these negative processes so that people could start clarifying their personal values and goals and let them guide their behavior instead.

In ACT, psychological suffering is seen as being caused by experiential avoidance and cognitive fusion. This would result in psychological inflexibility that leads to a failure in taking the needed behavioral steps into acting according to a person's core values of life. If people's actions are directed by their personal values, it would bring more vitality and meaning into their lives. Making people clarify their values and act according to these goals would increase their psychological flexibility and make them less vulnerable to psychological problems.

ACT's principles of treatment is focused around six core treatment principles, where all of them are aimed at helping the client to develop an increased psychological flexibility, making the client experience the present moment more fully, and trying to let the clients' behavior be guided by their personal values and goals. A short description of these six treatment processes in ACT is given in the following paragraphs.

- *Cognitive defusion*: Cognitive defusion techniques try to make the client to change the way one interacts with or relates to one's thoughts. Instead of trying to alter the form of the thoughts and their frequency, the client is taught to perceive thoughts and emotions as they are, not as what they appear to be.
- *Acceptance*: Acceptance of the thoughts and emotions is taught as an alternative to experiential avoidance. Instead of trying to avoid specific thoughts and emotions, the client is taught to allow emotions and thoughts to come and go, without struggling to suppress and avoid them.
- *Contact with the present moment*: ACT tries to increase the client's skill of having a nonjudgmental contact with his or her private events and events in the environment as they occur. In order to make this happen, the client is trained in developing skills to develop a better awareness of the 'here

and now.' If the experience of the 'here and now' is guided by interest and openness instead of an experiential avoidance, it would increase psychological flexibility in the individual.

- *Observing the self*: Since human language leads to a sense of self as a locus of perspective, the self cannot be contacted consciously since it is at the core of consciousness itself. It is therefore essential that the client gets access to his or her transcendent sense of the self. A transcendent sense of the self instead of having a picture of the self as a fixed entity, would help the client to experience his or her thoughts and feelings as ideas of themselves, instead of permanent and predetermined characteristics.
- *Values*: Early in treatment, the client is asked to list values in different life domains, in order to make them discover what is important to oneself and life. When the client chooses directions in life which are based on their personal values instead of choices based on avoidance or cognitive fusion, it could help the client to develop a more vital and meaningful life.
- *Committed action*: While personal values never really can be fully achieved, committed actions involving these values must be broken down to make concrete short- and long-term goals. Based on these goals, committed actions to achieve their values are carried out by clients.

These core treatment processes in ACT are overlapping and interrelated, and could be chunked into two groups of interventions according to ACT. Mindfulness and acceptance processes involve acceptance and cognitive defusion which will result in a better contact with the present moment, and the development of the client's ability to see their personal self in a context. The processes of commitment and behavior change involve contact with the present moment, where the clients could see themselves in a context, and make their values explicit and committed actions in accordance with these values. All of these treatment processes use different exercises, homework, and metaphors in order to work and change the client's psychological problems.

There are a substantial number of controlled trials investigating the efficacy of ACT on a diversity of psychiatric disorders. A meta-analysis by Öst done in 2008 showed that ACT compared to waiting list conditions reported a large effect size both at treatment and follow-up. Powers followed up with a new meta-analysis in 2009 where further new ACT studies were included. The meta-analysis from Powers showed that ACT outperformed control conditions as waiting list, treatment as usual (TAU), and psychological placebo both at posttreatment and follow-up with a medium effect size. However, when ACT was compared to established active treatments as for example CBT, ACT showed no distinct advantage over these treatments.

Dialectical Behavior Therapy

DBT is a psychotherapeutic intervention originally developed to treat persons with borderline personality disorder (BPD). Although it was originally developed for chronically suicidal individuals with BPD, DBT has since then been adapted for other psychiatric disorders characterized by emotional dysregulation problems. These disorders include substance

dependence, binge-eating disorders, and depression in elderly and suicidal adolescents.

DBT came into being mostly because traditional cognitive behavior treatment showed important shortcomings in the treatment of BPD, and combines the basic strategies for behavior therapy with eastern mindfulness practices. DBT tries to integrate both the concepts of acceptance and change in their treatment philosophy. The therapist is focused on accepting and validating people's feelings, thoughts, and behaviors as reactions of patients' suffering and problems, but at the same time trying to educate patients that some of these feelings and behaviors are maladaptive and in need of change. The DBT treatment could be broken down in phases where in the first phase self-injurious and suicidal behavior takes the main concern and needs to be taken under control, which is then followed by a focus on therapy-interfering behaviors. The next phase is directed on how to enhance the quality of life and make the clients feel better, to resolve problems in living and residual disorders, and finally to find joy and meaning in their lives. Acceptance procedures in DBT include mindfulness and a variety of other validation and acceptance-based strategies. Change strategies in DBT include behavioral analysis of maladaptive behaviors and the introduction of new problem-solving techniques, including skills training, contingency management, cognitive modification, and exposure-based strategies. The goal of the treatment is to help the patient to engage in functional life-enhancing behavior even when intense emotions are present. The therapy could be split into several components. Among the components is the use of highly structured individual or group skill training, individual psychotherapy, and telephone contact between the patient and the individual therapist. In both group and individual therapy, learning and improvement of skills is emphasized. These specific skills are divided into four modules: mindfulness skills, interpersonal skills, emotional regulation skills, and distress tolerance skills. In addition to all these aforementioned techniques, a team regularly meets the therapists to keep them motivated and supervise them in order to provide effective treatment for their patients. For a further in-depth description on the treatment principles of BPD, the books listed in the Further Reading section is recommended.

Since DBT is developed for the treatment of BPD, it is understandable that most of the studies done on the efficacy of DBT are focused on BPD, although there are a few studies related to the use of DBT in treating eating disorders and on depression. The original DBT treatment lasts for 1 year, but studies with shorter treatment duration have been published. Öst's meta-analysis from 2008, showed an overall effect-size of a mean of 0.58 the DBT studies included in this meta-analysis. In line with the results of ACT, DBT showed large effect sizes compared to a waiting list condition, but in comparison to treatment as usual and other active treatment, the effect size was moderate.

Metacognitive Therapy

Metacognition refers to the cognition applied to cognition and may be defined as any knowledge or cognitive processes that is involved in the appraisal, control, and monitoring of thinking. According to metacognitive theory, there is a distinction

between metacognitive knowledge, which is information that individuals have about their own thinking and about the strategies that affect it, and metacognitive regulation, which comprises the strategies used to change the status of thinking. As many people experience negative thoughts but do not develop psychological disorders, MCT proposes that thought content is not so important as suggested in CBT, but it is the reactions to the thoughts which play a prominent role in the development and maintenance of psychological disorders. MCT is focused on the core question: Why do people have problems regulating their preservative and fixative style of thinking?

The theoretical grounding of MCT is the Self-Regulatory Executive Function (S-REF) model, which emphasizes the similarities in maladaptive cognitive processing across psychological disorders. The S-REF model postulates a thinking style called the Cognitive Attentional Syndrome (CAS). The CAS is a universal feature of psychiatric disorder and is responsible for prolonging and intensifying distressing emotions within the individual. The CAS consists of inflexible self-focused attention, preservative thinking style in the form of worry and rumination, and threat monitoring and coping behaviors that backfire and fail to modify erroneous beliefs about your thinking and the world around you. The CAS is considered to be a problem for psychological well-being because it focuses appraisal on threat, it fails to provide information that can modify erroneous appraisals and beliefs, it drains attentional resources for more adaptive responses, it also biases perception and automatic processing in a negative and skewed manner, and consequently it maintains the psychological problems. Threat monitoring is a particular process of the CAS where a person focuses his or her attention to external and internal threats as a way to cope. This way of coping causes the individual to become hypervigilant and aware of potential internal and external threats. Such a focus often leads to negative thoughts, worry, and rumination, causing the person to become depressed and anxious. Avoidance and thought suppression is the last template of the CAS. Such cognitive processes block new information processing and thus preserve erroneous beliefs about themselves, others, the world, the past, and the future. There is a large evidence-base to prove that the CAS is associated with the vulnerability and serves as preserving factor of emotional disorders.

The CAS is driven by metacognitive beliefs and knowledge stored in long-term memory, and exists as programs for guiding cognitive information processing and coping behaviors. MCT implies that all disorders could be linked to a higher level of metacognitive beliefs about thinking and that these fall into either positive or negative categories. Positive metabeliefs concern the advantages of worrying, ruminating, threat monitoring, and controlling of cognition. An example of such positive metabeliefs could be 'Worrying about the future helps me to be prepared for forthcoming negative events.' Negative metabeliefs are linked to the uncontrollability of worries and rumination or the dangerous consequences of such thinking processes. An example of such negative metabeliefs could be 'Worrying too much could make me lose control, and make me go mad.' MCT suggests that positive metabeliefs make a person vulnerable to develop emotional disorders and that negative metabeliefs serve as a maintaining factor for distress. The problem is that the metabeliefs lock the individual into a

processing style filled with worry and rumination which prolongs anxiety and depressive symptoms, because the person focuses on metabeliefs and cognitive processes that strengthen dysfunctional patterns. CAS occurs in response to initial negative thoughts or intrusions and the persons use worry and rumination as a way to cope with these thoughts.

A metacognitive therapy normally starts on building a case conceptualization that is grounded in a disorder-specific model. When doing metacognitive therapy, the therapist needs to work at the metacognitive level. In order to do this, the MCT therapist focuses on detecting and modifying the aspects of the CAS; preservative thinking, maladaptive attentional strategies, and unhelpful coping strategies. Clients are helped to see that problems are not the occurrence of negative thoughts, but that their problems lie in how they react to the thoughts themselves. It is essential that the client shifts from a content focus to a metacognitive way of processing. This will facilitate the development of a new awareness to their cognitive processes.

Techniques from the standard CBT, such as Socratic questioning and behavioral experiments, could be used, but in MCT, these techniques are aimed at the metacognitive level rather than at the cognitive level. Metacognitive beliefs are restructured through experiencing new types of relationships with cognitions, so the CAS could be modified. The MCT therapist incorporates techniques such as detached mindfulness, attentional training, and situational attentional refocusing in order to manipulate and change metacognitive beliefs and the CAS. It is essential for the client to develop new plans for processing by challenging the patient's negative and positive metabeliefs. Such changes are typically changed through new corrective experiences of their thoughts and thinking, with very little focus on the actual content of thoughts.

There is a large evidence base supporting the role of the CAS and the importance of metacognitions in psychological disorders. Some studies on the effectiveness of MCT have been completed, and other studies are ongoing. Several open trials indicate that MCT is an effective treatment for generalized anxiety disorders, social phobia, posttraumatic disorder, obsessive compulsive disorder, and major depressive disorders. However, there is a lack of large randomized controlled trials comparing MCT to established evidence-based treatments, which implicates a need for such studies before conclusions regarding the efficacy of metacognitive therapy could be drawn.

Conclusions

This article has described what characterizes different forms of cognitive behavioral therapies. While traditional CBT is primarily engaged in working with the content of thoughts, the third wave of cognitive behavioral therapies tries to work to change the relationship between people and their thoughts and feelings, and with less focus on the content of thoughts. In the last four decades, CBT has shown that it is an effective

psychotherapeutic treatment approach for mostly all of the psychiatric disorders listed in the diagnostic manuals. Although the results from clinical trials are promising, third wave cognitive behavioral therapies need to be compared to already evidence-based treatment for different psychiatric disorders in larger controlled trials, to prove if this is a more effective treatment than traditional CBT. Although there are few clinical studies related to the effect of these new cognitive behavioral approaches, it is important to acknowledge that the results are promising based on the fact that these types of therapeutic interventions are rather new.

See also: Anxiety Disorders; Cognition and Personality; Depression; Psychotherapy; Social Anxiety Disorder; Social Cognition.

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- <http://www.academyofct.org/> – Cognitive Behavioral Therapy.
- <http://behavioraltech.org/> – Dialectical Behavior Therapy.
- <http://www.mct-institute.com/> – Metacognitive Therapy.

Cognitive Bias

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Glossary

Bounded rationality The principle that organisms have limited resources, such as time, information, and cognitive capacity, with which to find solutions to the problems they face.

Cognitive bias Systematic error in judgment and decision-making common to all human beings which can be due to cognitive limitations, motivational factors, and/or adaptations to natural environments.

Ecological rationality The principle that there is a match between the structure of information in the environment and the judgment and decision-making strategies of humans and other organisms.

Heuristic Judgment or decision-making mechanism or cognitive shortcut that relies on little information and modest cognitive resources.

Heuristics and Biases: A Short History of Cognitive Bias

In the early 1970s, Amos Tversky and Daniel Kahneman introduced the term ‘cognitive bias’ to describe people’s systematic but purportedly flawed patterns of responses to judgment and decision problems. A term search for ‘cognitive bias’ in the Social Sciences Database of ISI Web of Knowledge reveals close to 4000 hits covering the past 35-year period and an exponential increase in the usage over time, suggesting that the term ‘cognitive bias’ has since gained significant influence in the psychological and social science literatures.

Tversky and Kahneman’s research program – the heuristics and biases program – addressed the question of how people make decisions given their limited resources. The program was inspired by Herbert Simon’s principle of bounded rationality. In the late 1950s, Simon attempted to oppose the idea of classical rationality, which was concerned mostly with the formalization of normative solutions to judgment and decision-making problems through probability theory and statistics, with the idea of bounded rationality, which addressed the specific constraints faced by agents in their environments. For example, humans have only limited time, information, and cognitive capacity to decide which mate to choose, food to eat, or house to buy, and so may have to rely on simple decision strategies or heuristics to make their decisions. The heuristics and biases program followed the bounded rationality principle by attempting to identify the specific constraints or biases associated with human judgment and decision-making.

The heuristics and biases program was inspired by research on perceptual biases, and proposed that the human cognitive system like the perceptual system was designed to make inferences about the external world based on imperfect cues that could lead to errors in some situations. The program thus generated a straightforward and productive research paradigm, which can be described as follows. First, participants were presented with a reasoning problem to which corresponded a normative answer from probability theory or statistics. Next, participants’ responses were compared with the solution entailed by these norms, and the systematic deviations (biases) found between the responses and the normative solutions were

listed. Finally, the biases were explained as the consequence of the use of heuristics or simple cognitive principles. Using this strategy, researchers in the heuristics and biases program have produced an extensive catalog of norm violations. We present a partial list in [Table 1](#) that spans the judgment and decision-making, social, and memory research domains. Naturally, the goal was to provide explanations of these violations due to reliance on a small set of cognitive principles, the most popular judgment and decision mechanisms proposed being *representativeness* (a judgment is based on how much the hypothesis resembles available data), *availability* (a judgment is based on how easily an example can be brought to mind), and *anchoring-and-adjustment* (a judgment is based on a specific value or anchor and then adjusted to account for other factors).

The heuristics and biases program represents the most influential psychological research program to emerge in the last 40 years, and its merit lies in showing the shortcomings of classical economic approaches and the value of a bounded rationality perspective on understanding human judgment. The heuristics and biases program has, however, been criticized. First, researchers have argued that there are no unequivocal norms for defining rational judgments and decisions. For example, there are different concepts of probability espoused by statisticians and philosophers that imply different norms, which makes deviations from one hard to interpret as error or bias. Second, the program has been criticized for presenting only vague models of human reasoning. For example, the representativeness, availability, and anchoring-and-adjustment heuristics proposed by Tversky and Kahneman do not provide quantitative predictions of people’s judgments and it is often unclear which heuristic is applied under which condition. Third, the heuristics and biases program has been criticized for focusing on people’s initial responses to judgment problems rather than providing opportunity for learning from experience. For example, some anomalies to classical decision theory are eliminated if people have substantial experience with a decision problem. Similarly, many classic paradigms in this tradition involve participants’ responses to situations described in word vignettes, which are not ecologically valid and thus may offer inadequate insights about everyday decision-making.

Table 1 Examples of common cognitive biases

<i>Cognitive bias</i>	<i>Short description</i>
Confirmation bias	The tendency to selectively search for or interpret information in a way that confirms one's preconceptions or hypotheses
Conjunction fallacy	The tendency to assume that specific conditions are more probable than a single general one
Endowment effect	The tendency that people often demand more to give up on an object than they would be willing to pay to acquire it
Fundamental attribution error	The tendency to overemphasize personal factors and underestimate situational factors when explaining other people's behavior
Gambler's fallacy	The tendency to think that future probabilities are changed by past events, when in reality they are unchanged (e.g., series of roulette wheel spins)
Halo effect	The tendency for a person's positive or negative traits to extend from one area of their personality to another in others' perceptions of them
Hindsight bias*	A memory distortion phenomenon by which with the benefit of feedback about the outcome of an event, people's recalled judgments of the likelihood of that event are typically closer to the actual outcome than their original judgments were
Hot-hand fallacy*	The expectation of streaks in sequences of hits and misses whose probabilities are, in fact, independent (e.g., coin tosses, basketball shots)
Illusory correlation	The tendency to identify a correlation between a certain type of action and effect when no such correlation exists
In-group bias	The tendency for people to give preferential treatment to others they perceive to be members of their own group
Mere exposure effect	The tendency by which people develop a preference for things merely because they are familiar with them

Asterisks refer to examples that are discussed in the main text.

This view echoes well Egon Brunswik's argument for the study of the mind by relying on the informational cues present in natural environments.

Ecological Rationality: Putting Cognitive Biases in an Environmental Context

One fundamental criticism of the heuristics and biases program is that it has severely neglected the ecology of judgment and decision processes. The principle of bounded rationality is deeply associated with the idea that cognitive systems are fundamentally adapted to their environments – either through individual learning or by design through natural selection. Simon illustrated this with a metaphor: mind and environment as blades of a pair of scissors. Similar thoughts have been espoused by a number of other theorists. For example, Roger Shepard saw human vision as reflecting regularities of the physical world. John Anderson advanced the idea that memory is structured so as to mimic the probability of information occurring in the world and thus being needed by the organism.

In the late 1990s, Gerd Gigerenzer, Peter Todd, and the ABC Research Group presented a research program – the fast and frugal heuristics program – that extended the principle of bounded rationality and gave new breadth to the idea of cognitive bias. The fast and frugal heuristics program emphasized the principle of ecological rationality, that is, how the success of reasoning strategies depends on the structure of the environment. A good example of this principle is demonstrated by the United Parcel Service (UPS) Right Turn Policy: UPS, an international shipping company, delivers millions of packages every year in numerous delivery trucks. The right turn policy involves carefully mapping out routes for all deliveries to reduce the number of left-hand turns each truck makes, which helps reduce accidents as well as save fuel, thus maximizing overall profits. Naturally, this strategy works well in the United States and other countries where traffic keeps to the right. One would predict, however, that the right turn policy

would have the opposite results in countries, such as England, India, or Hong Kong, where people drive on the left.

The fast and frugal heuristics program has proposed an alternative research paradigm to the heuristics and biases' one. The program starts by analyzing the statistical structure of a specific task environment people face and then – based on the analysis – derives attributes of the cognitive models of reasoning that perform well in that environment. In sum, this program holds that exploring the characteristics of the environment will contribute to our understanding of what reasoning processes people follow and when and why these processes work well.

According to the fast and frugal heuristics program, a cognitive bias is the tendency to solve problems using a particular cognitive tool or heuristic. Crucially, it sees the selection of a particular heuristic not necessarily as the product of cognitive limitations but rather as a bet on the part of the organism about the structure of the environment in which it finds itself. One metaphor that guides the fast and frugal heuristics program is that of the mind as an adaptive toolbox of simple decision mechanisms, a repertoire of strategies, with each strategy tuned to a particular environment. A model of mind based on an adaptive toolbox is, therefore, boundedly rational in the sense of relying on few cognitive resources, and ecologically rational in the sense of being tuned to characteristics of natural environments.

Some have suggested that the differences between the Heuristics and Biases and the Fast and Frugal Heuristics programs are not substantive, boiling down to a disagreement between those that stress that the human mind is fallible and those who claim that it is often accurate. One clear contribution of the Fast and Frugal Heuristics program has been, however, to emphasize the role of environment and specify the statistical properties of environments that make particular cognitive biases or heuristics successful. In addition, the focus on ecological rationality has spurred new approaches that emphasize the role of environment and sampling in determining adaptive behavior. Specifically, recent approaches are devoted to understanding the role of sampling in generating

bias with less focus on the cognitive apparatus and more on environmental stimuli. For example, people's risk judgments of low probability events are often inflated. One possibility is that such bias is due to selective memory retrieval. However, an unbiased memory may also produce inflated judgments of risk due to biased media coverage of natural catastrophes and accidents. Current and future work on cognitive bias is concerned with the role of biased sampling in both the external environment and the internal cognitive apparatus.

Evolutionary Rationality: Understanding Why Cognitive Biases Occur

The concept of ecological rationality describes the match between structure and representation of information in the environment on one side, and the simple decision-making algorithms such as heuristics on the other. Whenever this match exists, heuristics can perform well. Evolutionary rationality holds, however, that it is important to consider the match between mind and the *past* environments in which the mind evolved. In other words, evolutionary rationality attempts to sketch the evolutionary origins of cognitive bias.

Some evolutionary scientists have followed the Heuristics and Biases program approach of using errors to study cognitive bias. The underlying principle behind such research strategy is that while people can make rapid adaptive decisions using simple and reliable cues, they are still at risk of making errors. However, these researchers have tried to introduce the role of costs to theories of cognitive biases. The argument goes that eliminating errors altogether is rare, if ever possible, but the costs associated with certain errors may lead organisms to systematically commit one type of error over another. This principle is at the heart of error management theory – a theory that applies evolutionary logic to signal detection theory. Imagine the problem of reliably identifying a recurrent danger in the environment such as poisonous snakes. For any given relevant percept (e.g., a long slender object on the ground), one must make a decision: snake present or snake absent. Because of the dire consequences of being bitten by a venomous snake, it is better to have a low evidentiary threshold for inferring that long slithering objects are snakes so as to identify every snake you encounter, than to require too much evidence and occasionally incur a costly surprise. Because both types of errors cannot be minimized at the same time, asymmetries in the costs of two types of errors (false positives and false negatives) should lead systems to be biased in the direction of the least costly error.

Examples of such biases can be found in auditory perception. For example, listeners perceive tones with rising intensity to change faster than equivalent tones falling in intensity – an effect termed auditory looming. Auditory looming has also been found to occur in nonhuman primates and is well explained in an error management theory framework. The enhanced saliency of rising intensities associated with approaching objects causes listeners to reliably underestimate object arrival time. The bias occurs with tones but not broadband noise showing some specificity for sound that provides reliable single-source information and made almost exclusively by biological organisms. Of course, any time a bias affects

perception of the physical environment, there are risks of misapplying it to irrelevant objects that could lead to any variety of costly errors. The degree to which this is true will largely determine how advantageous the bias will be, and thus its impact over evolutionary time. In the case of auditory looming, the costs of false alarms (e.g., wasting time by being ready too early) are relatively low compared to the costs of misses (i.e., not being prepared for an approaching object). The difference in these costs allows for the selection of a bias that causes people to systematically overestimate a reliable auditory cue of movement toward a listener.

Examples of Research on Cognitive Biases

In this section, we introduce two examples of research on cognitive bias. The first example focuses on search in the external world and how people's perceptions of events or their co-occurrence may be biased toward frequent, natural distributions. In this example, cognitive bias arises from experimenters observing an organism's behavior or judgments in environments that are very atypical compared to those experienced across phylogenetic and/or ontogenetic time. The second example focuses on biases in internal search from memory and emphasizes that cognitive bias may occur both due to cognitive limitations and motivational factors. For example, an individual's inaccurate recall of poor past performance may be due to poor memory and/or a motivation to preserve a positive view of the self.

Foraging, Hot Hands, and the Structure of the Environment

The work of Andreas Wilke and colleagues on human foraging behavior in patchy environments, illustrates that an awareness of ancestral conditions can be key to understanding human decision-making strategies. When resources are distributed in patches (i.e., areas with a high density of the resource surrounded by areas with low density), animals are required not only to make decisions on where to forage, but also on how long they should forage in a particular patch as resources diminish. Biologists have studied simple decision mechanisms that solve this problem of patch time allocation and identified resource environments where these mechanisms work well. Different patch-leaving strategies are necessary because resource environments differ in how resources are distributed across patches. The number of resource items within a patch can either be similar (evenly dispersed distributions), completely random (Poisson distributions), or some patches may only contain a few items while others will be very resource rich (aggregated distributions). Wilke and colleagues tested how well humans can adapt their patch-leaving behavior when faced with such resource distributions in a computerized foraging game. The results showed that participants applied patch-leaving rules that were particularly appropriate for aggregated environments also in other types of environments (e.g., those with evenly dispersed and Poisson distributions). Were research participants ecologically *irrational*?

This finding is less puzzling once one considers that aggregation in space and time, rather than dispersion, is likely to have been the norm for most of the natural resources humans

encountered over evolutionary time. Species of plants and animals rarely, if ever, distribute themselves in a purely random manner in their natural environment, because individual organisms are not independent of one another: Whereas mutual attraction leads to aggregation for some species, mutual repulsion leads to regularity (dispersed environments) in others. Most often, these deviations from randomness are in the direction of aggregation, because aggregation offers considerable benefits such as a common habitat, mating and parenting, or the benefits of group foraging. Since humans have been hunters and gatherers for a very long part of their history, it could well be that our evolved psychology is adapted to assume such aggregated resource distributions as the default. Thus, participants in the foraging experiment might have behaved *evolutionarily rationally*.

The idea that humans expect aggregation in space and time also helps to explain why apparent misconceptions of probability, such as the hot-hand fallacy, may not reflect fundamental shortcomings of the human mind but rather adaptation to the statistical structure of natural environments. The hot-hand fallacy occurs when research subjects expect lucky streaks in hits and misses in everything from basketball to coin tosses when in fact the probabilities of events are independent. When a basketball player hits many shots in a row, for instance, the natural expectation is that he has a 'hot hand' and will shoot another successfully. People are often surprised to discover that this strong intuition does not square with the reality that the success of the next shot is determined independently from the shot before it.

The foraging example presented above hints at an explanation for the hot-hand phenomenon based on limited experience with evolutionarily novel events like coin tosses, and gambling that involve random events. Instead, one can ask about the structure of objects and events surrounding important adaptive problems faced by our ancestors, and what kinds of adaptations might have been shaped by selection. Evolutionary behavioral scientists would argue that many of these – plants, animals, human settlements, and even weather – would have been organized in an aggregated, clumpy fashion – not perfectly at random (independent) like those in Las Vegas. Thus, the default human expectation is aggregation, clumpiness, and nonindependence. To explore this hypothesis, Wilke devised additional computer tasks in which the subject could forage for fruits, coin tosses, and several other kinds of resources, and present them to American undergraduates and a South American indigenous population of hunter-horticulturalists (the Shuar). In each population, subjects exhibited the hot-hand phenomenon for all resource types, despite the fact that the resources were distributed randomly by the computer. The one exception found was for coin tosses for the American students only for which the hot-hand expectation was reduced though not altogether eliminated. This suggests that the expectation of aggregation in space and time may be the psychological default that is overcome only through extensive experience with truly independent random phenomena like coin tosses. This runs in contrast to the original explanation offered for the hot-hand phenomenon – that it is attributable to biased sampling by the mind – and instead suggests it is a consequence of the minds' adaptation to the distribution of resources in the natural environment.

Memory Biases: Cognitive and Motivational Determinants

Would humans be better off if we had been blessed with superior cognitive abilities, such as unfailing memories? One view on the rather limited cognitive capacities of the human mind is that limitations, such as forgetting, have functional significance. Some researchers, like John Anderson, have suggested that the function of memory is not simply to store information, but rather provide relevant information in specific situations. According to this view, the human memory system is organized such that it facilitates the retrieval of information that is recent, frequent, and relevant to the current context. In other words, memory is designed to provide the information we are most likely to need. Many man-made information systems are built in such way. For example, computer applications usually incorporate a timesaving feature as follows: When a user tries to open a document file, the applications presents a 'file buffer,' a list of recently opened files from which the user can select. Whenever the desired file is included on the list, the user is spared the effort of searching through the file hierarchy. For this device to work efficiently, the application must provide the user with the desired file. It does so by 'forgetting' files that are considered unlikely to be needed on the basis of the assumption that the time since a file was last opened is negatively correlated with its likelihood of being needed now. In other words, such a system has a bias toward information that is likely to be needed.

Although memory systems are very often efficient, they can sometimes fail because forgetting and sensitivity to contextual knowledge may lead to systematic error. The hindsight bias is one of the most frequently cited and researched cognitive biases in the psychological literature. Hindsight bias is a type of memory distortion in which, with the benefit of feedback about the outcome of an event, people's recalled judgments are typically closer to the outcome of the event than their original judgments were. Research on hindsight bias is particularly important because it is a ubiquitous phenomenon and one with potentially detrimental consequences in applied settings, such as law and medicine.

In the 1970s, Baruch Fischhoff was concerned with professionals such as clinicians' or politicians exaggerated feeling of having known all along how patients' recovery or elections were going to turn out. To study this issue empirically, Fischhoff asked participants to assess the probabilities of various possible outcomes concerning upcoming events, for example, President Nixon's historic trips to China and the Soviet Union (e.g., Pres. Nixon will meet Chairman Mao; Pres. Nixon will announce that the trip was a success). After the trips, participants were asked to recall their predictions. Results showed that participants tended to exaggerate what they had known in foresight.

There are two common experimental designs that have been used in the psychological literature. In the *memory* design, participants first make judgments concerning some stimuli, then receive feedback on some or all of the items, and are finally asked to recall the original judgments. In the *hypothetical* design, participants first receive feedback concerning some or all of the items and are then asked to say what they would have estimated had they not been given feedback. Empirical results using either design have shown that recalled or hypothetical estimates are commonly biased toward the feedback information.

At present, there is no single theory that can explain all patterns of data and moderator variables that have been studied in laboratory or real-world settings (e.g., expertise, experimental materials). One potential reason for this is that multiple processes are involved in producing the effect. In fact, there is largely consensus that the bias is multiply determined, and involves both cognitive and motivational factors.

Regarding cognitive factors, the prevalent idea is that both processes of retrieval and reconstruction play a role. For example, when reporting the original judgment participants are likely to both try to retrieve the specific memory of the event as well as reconstruct the original judgment process. Accordingly, the hindsight bias effect can occur by new information (feedback) biasing (1) the retrieval cues used to query memory for the original judgment, (2) the reconstruction of the judgment process, (3) or both. This view also suggests a prominent role for inhibition processes. Accordingly, research shows that individuals with strong inhibitory deficits have more difficulties inhibiting feedback about the outcome of an event from entering working memory and thus show increased hindsight bias. As expected, this is particularly the case when the correct response is either in sight or accessible in working memory at the time of the attempt to recall one's original response.

In addition, there is evidence that hindsight bias may serve motivational goals. For example, people seem to change the perceived probabilities of events so that negative events appear inevitable as a way to mitigate disappointment and personal blame. However, this seems to occur mostly in situations people can control and in situations that are unexpected, suggesting that such phenomena should be interpreted in the light of people's attempts at preparing for future events. In other words, these forms of hindsight bias can be seen as arising from the use of a sense-making process, whereby people integrate all they know about a topic into a coherent mental model. In this light, human memory is not so much designed

to accurately reconstruct the past as it is to make sense of it to better deal with the future.

See also: [Cognition and Personality](#); [Defense Mechanisms](#); [Judgment](#).

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Cognitive Disorders

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Glossary

Cognitive disorders Illnesses in which the primary symptoms are related to thought, attention, and perception.

Consciousness Awareness of surroundings.

Disorder Root cause of a syndrome.

Disoriented person Someone who is unable to report where he or she is, why he or she is there, and/or what time it is.

Syndrome Cluster of commonly co-occurring symptoms.

What Are Cognitive Disorders?

Although we never fully know someone else's experience, in general, people agree on many aspects of the world around us. In other words, where you are, what day it is, who you are, and so on are questions that participants in a conversation can typically agree on. In contrast, when consciousness and thought processes themselves – problem solving, attention, perception, and language – are disrupted, patients are said to have cognitive disorders. Patients with these disorders may be disoriented, inattentive, have memory and language disturbances, and sensory irregularities including hallucinations. The cognitive disorders, delirium, amnesia, and dementia, are some of the most devastating diagnoses for at least two reasons. First, these disorders separate patients from his or her normal conscious states. This makes communication very challenging and it can make it difficult for caregivers to know if the patient's symptoms have been alleviated. Second, diagnoses such as dementia are progressive and unrelenting indicating that the patient will not return to his or her former state. In the paragraphs below, we detail aspects of each of the primary cognitive disorders, delirium, amnesic disorders, and dementia. These descriptions delineate the criteria set forth in the diagnostic and statistical manual (DSM-IV-TR), which mental health clinicians use to assess psychiatric illness.

How Do We Recognize and Treat Delirium?

Delirium

Delirium is a group of conditions characterized by disturbances of consciousness and changes in cognition that occur over short periods of time, on the order of hours or days. Delirium can have a rapid-onset and resolve itself so that the person returns to normal rather quickly. However, because delirium is secondary to an underlying cause it requires immediate medical attention. To more precisely distinguish between delirium brought on by different causes, there are several different classifications: delirium due to a general medical condition (disease basis such as inflammation, fever, or infection, malnutrition, dehydration, major stress), substance-induced delirium (drug withdrawal), delirium due to multiple etiologies (disease and substance basis), or delirium not otherwise specified (where the underlying cause cannot be determined). In delirium, these subclassifications are important in determining the appropriate course of treatment.

Symptoms

There is no laboratory test for delirium. This makes diagnosis challenging and attention to the symptomology is critical. The classic symptoms of delirium include a disturbance of consciousness accompanied by a change in cognition. In other words, the patient may be confused, and unable to respond to simple questions. These symptoms develop over a short period of time, usually hours to days. Delirium symptoms may fluctuate during the course of the day. If medical attention is quickly sought, delirium is a temporary condition that will last up to a few weeks in duration. Patients with delirium must be monitored for noncompliance with medical directives, such as removing intravenous tubing. During the delirious episode, a patient may have moments of lucidity, in which he or she is aware of what is happening around him or her. Disorientation is often the first symptom to appear in cases of mild delirium, and is exhibited by an individual being unable to report time or place. For example, the patient may not know the day, the month, or even the year. In addition, attention, and particularly sustained attention, is abnormal in delirium patients. Irrelevant objects easily distract individuals with delirium. For example, they may stare at the flowers in the room rather than look at the person speaking to them. Cognition also changes in delirium. In particular, new memory formation is impaired. A simple test for memory impairment is to ask the individual to remember several unrelated objects (e.g., apple, clock, turtle) and then to ask him or her to report the objects after several minutes of conversation. Communication through speech and language may be disrupted for a variety of reasons. An individual may have a difficulty articulating words (dysarthria), a deficit in naming objects (dysnomia), an impaired ability to write (dysgraphia), or even language production or comprehension deficits (aphasia). Symptoms affecting attention, memory, and orientation may be compounded by sensory abnormalities including hallucinations. For example, delirium patients may perceive imaginary people in the room with them. Hallucinations may be in any sensory domain.

Delirium is also associated with disturbances in the sleep-wake cycle. Sleep-wake cycle disturbances mean that the regular pattern of daytime alertness and nighttime rest is abnormal. Symptoms may include daytime sleepiness, nighttime agitation, and difficulty in falling asleep. Patients may sleep during much of the day and be awake or agitated during the night to the point where a complete reversal of the night-day sleep-wake cycle occurs. Patients often report experiencing nightmares.

Psychomotor abnormalities are often associated with delirium such that diagnosed individuals are hyperactive or hypoactive. It is more common to observe hyperactivity in delirium patients but decreased activity including sluggishness and lethargy associated with hypoactivity may also be witnessed. In the same individual, psychomotor activity may even shift from one extreme to the other over the course of a day. The hyperactive state is more likely to prompt symptoms such as hallucinations. Finally, emotional states may be disturbed in delirious states. Individuals diagnosed with delirium may display intense emotional disturbances associated with anxiety or fear. Other emotional states include depression, irritability, anger, euphoria, and apathy. There can be rapid and unpredictable shifts from one emotional state to another. Threatening hallucinations or paranoid delusions often induce a strong fearful response in the patient and such individuals may attack those who are falsely perceived as threatening. Alterations of emotional state are most common at night or in the dark because of the lack of other environmental cues.

When delirium is suspected, electroencephalogram (EEG) may be used as a confirmatory tool. The EEG signal in delirium patients reveals slowed processing to sensory inputs (e.g., lights, sounds). EEG can also be used to follow recovery over time. As the patient improves, the EEG signal should return to normal.

Prevalence

As with all of the cognitive disorders, the prevalence of delirium is not consistent across the population. Indeed, the prevalence of delirium in the general population is normally very low, less than 1% of young adults over 18 years of age and rising slightly in those over the age of 55. Although rare, certain populations including the elderly and hospitalized individuals have a much higher incidence of delirium. In hospitalized individuals the prevalence of delirium ranges from 10% to 40%, with the elderly being the most likely to be affected. Disease can also increase the likelihood of delirium. In hospitalized cancer patients, as many as one-quarter may be affected. The numbers are even higher for those with AIDS (30–40%). Populations with the highest prevalence of delirium are residents of nursing homes (60%) and individuals diagnosed with a terminal illness (up to 80%). It is important to note that the prevalence of delirium depends on many aspects of their overall health.

Time Course

Delirium usually develops quickly over hours to days. The disorder usually presents with symptoms such as restlessness, anxiety, irritability, disorientation, and disturbed sleep. An individual's delirium may resolve in a few hours to days, or symptoms may persist for weeks. Elderly individuals who also are diagnosed with dementia are especially susceptible to longer lasting delirium and they are less likely to fully recover. However, treatment is important and failure to treat the underlying cause of the delirium (e.g., withdrawal, nutritional problems, or disease) may lead to more severe conditions including coma, seizures, and even death. Delirium can also prompt additional medical complications in elderly

individuals. Complications due to delirium may include pneumonia and bedsores. These types of complications can lengthen hospital stays. Patients who develop delirium during a hospitalization also have a high mortality rate in the months following discharge.

Treatment

Most individuals diagnosed with delirium achieve a full recovery. However, successful treatment ultimately depends on the appropriate diagnosis and amelioration of the underlying cause. Treatment most often involves pharmacological treatment in conjunction with appropriate interventions to relieve symptoms. Neuroleptics (antipsychotic medications) are the most common medication used to treat delirium when the patient is agitated and possibly aggressive. Benzodiazepines (sleep-inducing, antianxiety medications) are used to combat withdrawal symptoms. In addition to medications, supportive therapy involves environmental modifications such as ensuring balanced nutrition, hydration, and creating a controlled and supportive environment for the patient. Finally, support from health care professionals and family members are necessary in achieving treatment goals and ensuring patient health.

Current Research Directions

Current research in delirium treatment focuses on two fronts: the prevalence and consequences of delirium in hospitalized patients, and new treatments. Recently, a multicenter investigation including over one hundred intensive care units revealed that delirium was associated with increased mortality rates and longer hospital stays. The large scale of this study provided an important step toward assessing the widespread effects of delirium. Future research focused on delirium as an independent risk factor may provide health care professionals with additional diagnosis criteria and will also substantiate delirium as a critical health concern.

Progress is being made in therapeutic treatments to improve outcomes following delirium. The use of cognitively stimulating activities (e.g., reading, writing, word games, puzzles, etc.) in the attempt to reduce delirium severity, duration, and functional loss was studied in postacute care settings. Their promising results suggest that cognitive stimulation may promote faster recovery and improve physical function and mental status. This type of research will help improve our understanding of a disorder whose cause and long-term effects are not yet fully understood.

How Do We Recognize and Treat Amnesic Disorders?

Symptoms

A second group of cognitive disorders are called amnesic disorders. These disorders are all associated with impaired memory processes. Symptoms of amnesic disorders include specific types of memory impairment, which can be serious enough to dramatically impair a person's quality of life. Specifically, certain amnesic disorders prevent patients from explicitly learning any new information. This symptom is referred to as anterograde amnesia. Other patients may have trouble

remembering information from their own past. This deficit is called retrograde amnesia. Additionally, both types of amnesic impairments may occur simultaneously. In some instances, people will spontaneously create stories to fill in missing details from their memory. This process of adding supporting details, which never occurred, to memory is known as confabulation. The person does not intend to mislead; he or she is genuinely not aware that the information is not true. Serious cases of these disorders can involve impairments in maintaining knowledge of time and space. People suffering from these disorders may forget where they are or exhibit confusion of time. In amnesic disorders, however, confusion of time extends beyond momentary lapses of memory for matters like the current day of the week to more severe impairments such as failing to know the current calendar year. Other characteristics of the amnesic disorders may include an apparent lack of caring about anything, limited emotion when communicating with others, and general confusion.

Furthermore, in order to be categorized as an amnesic disorder, social or work-related problems must occur alongside memory deficits. The manner of measuring the impact these disorders have on a person's life involves comparing their current state with their functioning prior to onset of the amnesic disorder. Another important requirement for reaching a diagnosis of amnesic disorder exists. The amnesic symptoms must continue beyond a single episode. This distinguishes the disorder from delirium. The amnesic disorders do not include disruptions of other cognitive functions, which are related to dementia. It is also important to note that cultural differences that place emphasis on memories for certain types of events should be taken into account. Types of information that a person ought to know in one culture may have little meaning for people from a different culture. As such, lack of memories for culture-specific information outside an individual's cultural background should not be taken as an indication of the presence of an amnesic disorder. Finally, in spite of the serious memory deficits in these patients, other cognitive processes remain intact. In other words, symptoms are restricted to the mnemonic realm.

Causes

As with delirium, there are multiple underlying causes of amnesic disorders, but all causes result in permanent brain damage. Specifically, amnesic disorders can result from a variety of physical events affecting the integrity of the brain itself. Physical causes typically result from three types of circumstances. The first of these is related to medical conditions often resulting from, but not limited to, physical trauma to the brain. For example, the person may have been involved in an accident that caused damage to specific parts of the brain. Vascular problems can also cause brain damage. An example is stroke, which is caused by insults to blood vessels in the brain. A second cause of amnesic disorder is due to metabolic damage to the brain. In these cases, severe vitamin deficiency can lead to brain damage. This phenomenon is associated with substance-induced amnesic disorders (see below). A third cause is disease. Medical conditions causing amnesic disorders include temporary lack of oxygen (hypoxia), virus (herpes simplex encephalitis), or bacterial infection (bacterial meningitis).

The characteristics of the amnesic disorder depend on the parts of the brain that are affected and how severely they are damaged. One of the best known cases of an amnesic disorder is that of the neuropsychological patient H.M. This patient suffered from a seizure disorder presumably brought on by a head injury. To minimize the detrimental effects of this condition on the brain, the portions thought to be triggering seizures were surgically removed. The excised structures were located in regions on the lower left and right sides of the brain known as the medial temporal lobes. The medial temporal lobes and related structures include the hippocampi, parahippocampal gyrus, entorhinal cortex, mammillary bodies, and fornix. Some of these structures, particularly the hippocampi, are necessary for the formation of long-term memories. On removal of portions of the medial temporal lobe, H.M. experienced dramatic, but specific memory deficits. He could no longer form new long-term memories, although short-term and procedural memory remained intact. In other words, he could remember his childhood, he could remember the question you just asked him, and he could remember how to do things like riding a bicycle, but he could not remember what happened that morning or a few moments ago. The case of H.M. established that damage to the medial temporal lobe and surrounding regions can cause an amnesic disorder as he lost the ability to form new long-term memories.

Substance-Induced Amnesic Disorders

As noted, amnesic disorders can be caused by substance abuse and either recreational or prescription medications. Excessive consumption of alcohol over many years can cause permanent brain damage. One well-known example is Korsakoff's syndrome, in which severe thiamine deficiency develops because the patient's calories come primarily from alcohol. Alcohol does not contain necessary vitamins. This chronic thiamine deficiency leads to cell death in the mammillary bodies, and results in permanent memory deficits. People with Korsakoff's syndrome will confabulate their personal histories in part because they are unable to remember the past and they cannot form new memories. These patients have both anterograde and retrograde amnesia.

Some other substances such as medications (e.g., anticonvulsants) may produce side effects that can create amnesic deficits. Additionally, exposure to environmental toxins such as industrial solvents, lead, mercury, and carbon monoxide may alter the typical functioning of the brain in a manner consistent with amnesic symptoms. In substance-related types of amnesic disorder, it is essential to prevent reexposure to the substances.

Time Course

Depending on the cause of the amnesic disorder, the time course of symptom onset can vary. If the cause is a traumatic head injury, for example a car accident, the onset of amnesic symptoms may be instantaneous. In these cases, symptoms observed after the acute stage immediately after trauma are generally permanent. In some cases, some symptoms may subside. On the other hand, the time course of amnesic disorders caused by substances is more variable. In some cases,

the memory symptoms may be temporary, although if the brain has been permanently damaged, the amnesic disorder is also permanent. In the case of Korsakoff's syndrome, it may take many years to develop and only with prolonged alcohol abuse. Disease processes such as meningitis and encephalitis can progress very rapidly – over the course of hours and days, and with early intervention they can be treated with some success. If treatment is sought early, greater chance of recovery is possible. If treatment is delayed, these rapidly developing diseases may quickly lead to permanent amnesic symptoms.

Treatment

Prevention is the best treatment for amnesic disorders. Traumatic injuries can be prevented by use of helmets and taking extra safety precautions. Brain damage due to substance exposure can be entirely avoided. Once a person has experienced brain damage, the prognosis is very poor for alleviating amnesic disorders. If the amnesia is caused by a substance (e.g., alcohol or drug), it is important to prevent continued exposure. In some cases, treatment in the form of teaching people suffering from amnesic disorders memory strategies for improving their day to day functioning may help. Essentially, this type of treatment is designed to establish coping strategies to maintain function and independence in these individuals. These may include making lists and altering their environment to provide external memory cues. For example, labels placed around the house may help remind the patient where commonly used objects are found and how to use them. Additionally, counseling may help people diagnosed with amnesic disorders to regain a sense of purpose and focus on existing positive aspects of their life. Substance-induced amnesics may benefit from drug treatments typically used to reduce irritability or confusion associated with memory deficits.

Current Research Directions

While no effective treatment currently exists to cure amnesic disorders, recent research has examined various prospective treatments. A series of recent endeavors have used animal models, mainly mice, to investigate the efficacy of newly identified chemical compounds. Some of these compounds lead to improved memory performance in animals including methylene blue (a diaminophenothiazine drug) and others that are found in nature, including neferine (from *Nelumbo nucifera* seeds), Marapuama extract (from a type of wood in the Amazon), *Ficus religiosa* Linn (from a fig tree), *Murraya koenigii* leaves, *Asparagus recemosus*, and *Bacopa monniera* (a perennial herb). These compounds now require extensive testing before any drugs will be appropriate for humans with amnesic disorders.

There are advances in improving the independence of those with amnesic disorders as well. Recent approaches include the use of technology and external cues to improve memory function. The SenseCam[®] (Microsoft) automatically takes digital pictures after designated intervals (e.g., every 2 min). The amnesic user can therefore review the sequence of images as a reminder of recent events. Similarly, the implementation of SmartPhone technology allows people with amnesic symptoms support for managing everyday tasks. These tasks can be

accomplished by creating reminders of frequent upcoming events (via alert messages) and memo options available within most SmartPhone technologies. For example, a person with amnesia could enable an auditory alert system on his or her phone signaling him or her to take a dosage of an important medicine or of an upcoming appointment such as a visit to the doctor. Another external cue approach involves the Memory Support System, a calendar and organizational system shown to help people with memory impairments to be more self-sufficient.

How Do We Recognize and Treat Dementia?

The third member in the cognitive disorder grouping is dementia. Dementia consists of memory impairments accompanied by at least one additional cognitive problem. The second cognitive deficit may include dysfunction of language (aphasia), the loss of motor planning (apraxia), or loss of the ability to recognize certain objects (agnosia). The cognitive deficits resulting from dementia must be severe enough to cause impairment in social or occupational ability. Dementia is generally a progressive condition, but it may also be static and rarely in remittance. Dementia also disrupts cognitive and social functioning in patients.

Prevalence

The overall prevalence of dementia in the adult population increases with age. The estimates are in the range of <2% for adults 65–69 years of age. The incidence of dementia increases rapidly after the age of 85 to somewhere between 16 and 25%. A diagnosis of dementia in children is rare and difficult because multiple cognitive deficits must demonstrate documented deterioration.

Time Course

The DSM-IV criterion for a diagnosis of dementia is on the basis of a pattern of cognitive deficits beginning with absentmindedness that becomes more notable over time. As previously discussed, dementia can be progressive, static, or in remittance. The degree of disability may depend largely on the amount of social support available to the patient. This support allows the patient greater independence for longer periods of time. An additional factor is the type of cognitive deficits observed in the patient. Finally, in demented individuals, severe infections and accidents can be fatal. Dementia is typically associated with progressive incapacitation, which requires fulltime monitoring. Individuals with advanced dementia are typically in residential nursing homes.

Differential Diagnosis

To some extent, dementia treatment depends on the appropriate diagnosis of the underlying cause of symptoms. However, as there is no cure for dementia, knowledge of the cause provides for better management of symptoms. The minimal state exam (MMSE) is a commonly used neuropsychological test that can be used at the patient's bedside to quickly identify the possibility of dementia. The MMSE asks common

knowledge questions everyone should be able to answer easily. For example, 'Where are you?' Individuals are scored on a 30-point scale; scores of 25 or higher are considered to be in the normal range and lower scores are strongly correlated with dementia. The most important aspect of diagnosis is to ensure that the patient is actually demented and not suffering from another cognitive disorder with similar symptoms.

Dementia Arising from Alzheimer's Disease

The difficulty in diagnosing dementia in patients with Alzheimer's disease (AD) arises from the gradual onset and continual cognitive decline characteristic of AD. AD is assumed if no other cause can be found, and when it is clear that the patient is not suffering from delirium. Other causes such as central nervous system conditions (e.g., Parkinson's and Huntington's disease), systemic conditions (e.g., HIV), and other causes such as head trauma must be ruled out first to receive this diagnosis. Thus, the majority of dementia cases are of the AD type. AD patients have great difficulty with explicit memory tasks, for example repeating a story or remembering a picture. Visuomotor skills are less affected. The course of AD is progressive; those with the diagnosis generally lose 3–4 points (out of 30-points) on the MMSE per year. The prevalence of AD increases substantially after the age of 65. The rates increase rapidly after the age of 65, from ~11%, to more than 26% by the age of 85. There are also genetic factors related to AD. Relatives of AD patients are more likely to develop AD than the general population. In postmortem analysis, AD patients have neurofibrillary tangles (tangled protein masses) and senile plaques (protein and cell deposits). These signs of AD are found throughout the brain, especially in the hippocampus. In addition, neuronal cell loss is particularly noted in the temporal and parietal lobes of the brain. Patients with AD are likely to die within ten years of diagnosis.

Dementia Due to Frontal Lobe Dementia

In frontal lobe dementia, the frontal lobes show atrophy and cell loss within portions of the brain as in AD. Instead of dominant memory symptoms, these patients present with symptoms typical of frontal lobe dysfunction such as problem solving and planning. Frontal lobe dementia is thought to have many causes and several variants, including Pick's disease. Pick's disease is a degenerative disease that affects the frontal and temporal lobes. Difficulties with memory, motor function, and other features of dementia materialize later in the course of the disease. Pick's disease typically begins with personality changes before memory loss. Individuals may become more distractible, socially inappropriate, and impulsive. At autopsy, Pick's disease is confirmed by the presence of Pick bodies (characteristic protein bundles found inside neurons). Frontal lobe dementias account for an estimated 10% of disease-based dementia cases. Patients are diagnosed at an earlier age, generally in the mid-50s and people live for ~10 years following diagnosis.

Vascular Dementia

Vascular dementia is the second most common form of dementia after AD. Vascular dementia results from interrupted blood flow to the brain. Commonly, vascular dementia occurs

after a stroke. Strokes that cause a blockage in arteries within the brain are called infarctions. Multi-infarct dementia (MID) is caused by a large number of small strokes, which often go unnoticed. MID develops gradually because of the cumulative effects of multiple mini-strokes. A major stroke can lead to rapid-onset vascular dementia. When vascular dementia is diagnosed in conjunction with AD, it is referred to as mixed dementia. Symptoms of delirium and depressed mood can occur simultaneously in vascular dementia.

Dementia from Other Medical Conditions

A wide range of other conditions can cause dementia. Dementia can result from medical conditions such as HIV, Parkinson's disease, Huntington's disease, Pick's disease, Creutzfeldt-Jakob disease (colloquially known as 'mad cow disease'), traumatic brain injuries, hypothyroidism, brain tumors, or vitamin B12 deficiency. For example, in HIV-related dementia, the virus destroys the myelinated white matter pathways throughout the brain. Myelinated white matter tracts enable faster connectivity between regions of the brain and damage to these tracts disrupts proper intercortical communication. Behavioral changes resulting from HIV-related dementia include apathy, social withdrawal, delirium, delusions, forgetfulness, imbalance, slowness, poor concentration, and difficulties with problem solving. Within AIDS patient populations, more than a third develop HIV-related dementia by the time of their death. In these patients, the cerebral cortex is generally intact but deeper brain structures including the basal ganglia and white matter tracts show damage.

Dementia commonly follows from Parkinson's disease. Parkinson's related dementia is characterized by reduced cognitive abilities, executive dysfunction, and impaired memory. Parkinson's disease is a result of a progressive deterioration of certain cells in the nervous system as dopamine producing cells in the substantia nigra die. Additionally, dementia can result from the genetic disorder Huntington's disease. Creutzfeldt-Jakob disease is caused by a viral infection that causes the misfolding of proteins. These patients typically develop symptoms of dementia as well as involuntary movements. The virus is transmissible, and can be exchanged between people and even humans and animals.

Finally, head trauma is a growing public health concern. The severity of head trauma is correlated with the severity of the subsequent dementia. Generally speaking, in traumatic brain injuries there is memory loss. Dementia resulting from a single head injury is usually not progressive; instead, after the acute stages of treatment, the dementia symptoms remain constant. Dementia resulting from multiple head traumas (e.g., in the sports of boxing or football) leads to more notable progressive dementias. Repeated traumatic brain injury has cumulative detrimental effects on the brain and often causes memory loss and depression.

Treatment

Dementia cannot be reversed as it results from tissue damage in the brain. The primary treatment is to improve the quality of life of patients by making life more simple and comfortable. Medical treatments are aimed at improving symptoms

Table 1 Comparison between the cognitive disorders: delirium, amnestic disorders, and dementia

	<i>Delirium</i>	<i>Amnestic disorders</i>	<i>Dementia</i>
Symptoms	<ul style="list-style-type: none"> ● Disturbed consciousness ● Disorientation ● Speech and language disturbances ● Memory impairment for recent events 	<ul style="list-style-type: none"> ● Impaired memory ● Failure to remember old or new information 	<ul style="list-style-type: none"> ● Memory impairments and other symptoms ● Agnosia ● Apraxia ● Aphasia
Age of onset	<ul style="list-style-type: none"> ● All ages 	<ul style="list-style-type: none"> ● Trauma: all ages ● Substance abuse: older middle age 	<ul style="list-style-type: none"> ● Elderly, especially over 85 years old
Time course	<ul style="list-style-type: none"> ● Rapid-onset ● Resolution after hours or days 	<ul style="list-style-type: none"> ● Following head trauma ● Prolonged onset when due to substance abuse ● Permanent 	<ul style="list-style-type: none"> ● Progressive over decades ● Permanent
Causes	<ul style="list-style-type: none"> ● Medical condition ● Substance induced (e.g., toxin exposure) 	<ul style="list-style-type: none"> ● Physiological general medical condition (e.g., head trauma) ● Substance induced (e.g., toxin exposure) 	<ul style="list-style-type: none"> ● Disease process ● Reduced blood flow ● Vitamin B12 deficiency ● Hypothyroidism
Treatment	<ul style="list-style-type: none"> ● Supportive therapy ● Pharmacological 	<ul style="list-style-type: none"> ● Technology (e.g., smartphones, SenseCam[®]) ● Memory strategies ● Pharmacological 	<ul style="list-style-type: none"> ● Treat symptoms ● Supportive therapy

in dementia patients. Recently, several cholinesterase inhibitor drugs have been approved for AD treatment and are used in other dementia populations. This class of drugs prevents the decomposition of the neurotransmitter acetylcholine and shows evidence of slowing the memory decline in AD. In vascular dementia, prevention of further vascular problems is a priority. Treatment targets conditions such as high blood pressure, diabetes, and high cholesterol. Antidepressants are often prescribed for those who also have depressive episodes; sedatives are prescribed to treat agitation. Education of family members or caregivers toward strategies that make life more comfortable for those with dementia is beneficial.

Current Research Directions

Dementia is a topic of considerable research, in particular because as our population ages, the number of individuals diagnosed with dementia will also increase. Currently, five approved drugs inhibit acetylcholinesterase to elevate the level of acetylcholine in the synapse. However, a recent review of these drugs reveals that the effectiveness of these drugs is questionable. Patients on these drugs improve only marginally. Selegiline, a drug that is used to treat Parkinson's, is often used as a treatment for dementia although studies have found no long-term benefit. Several new compounds, including soybean-derived phosphatidylserine, show some improvement in those with mild cognitive impairments. The improvements were seen mostly in tests of delayed verbal recall, which may be effective at improving the quality of life of elderly dementia patients. Recent findings suggest that alternative treatments may also be beneficial in treating dementia. In one study, elderly patients suffering from dementia were incorporated in everyday Montessori classes with preschool-aged children. Dementia patients were involved in teaching the normal lessons and playing along with the children. Taking part in the activities was positively correlated with positive engagement. Music therapy seems to

help treat some symptoms of dementia, although statistically significant approaches have not yet been confirmed.

Differential Diagnoses of Cognitive Disorders

It can often be difficult to distinguish between the cognitive disorders (see Table 1). All of them include disorientation and confusion. Yet, proper diagnosis is essential for appropriate treatment. There are important guidelines that can improve diagnostic accuracy. For example, if the patient does not have disturbed consciousness, the patient does not have delirium. The diagnosis of delirium follows when a patient has a rapid-onset and episodes of disturbed consciousness and fluctuating cognitive symptoms. Although symptoms of delirium fluctuate regularly, symptoms of dementia and amnestic disorder are more stable. If the patient is conscious, and only has memory problems, the diagnosis is amnestic disorder. Amnestic disorder involves severe memory impairment, which can be seen in dementia but does not involve cognitive deficits such as apraxia, agnosia, aphasia, or other executive function deficits. Finally, if the patient is conscious, shows evidence of memory problems, and has other cognitive disruptions, the diagnosis is dementia. Symptoms of dementia may persist for months unlike those seen in delirium. Unfortunately, there are no magic cures for the cognitive disorders. Future research is needed to treat these burgeoning public health problems and to improve the quality of life for patients and their families.

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Cognitive Dissonance Theory

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Glossary

Action-based model A theoretical reinterpretation of the original theory of cognitive dissonance that posits that the cognitions most likely to cause dissonance are those cognitions with opposing action implications. Inconsistent cognitions that have no likelihood of influencing the individual's behavior should not arouse dissonance.

Effort justification According to dissonance theory, individuals should experience dissonance whenever they engage in an effortful activity to obtain an outcome. Dissonance occurs because the cognition that the activity is unpleasantly effortful is inconsistent with engaging in the activity. Dissonance can be reduced by exaggerating the desirability of the outcome, which would add consonant cognitions.

Induced compliance paradigm Experimental paradigm used by psychological researchers interested in studying cognitive dissonance processes. This paradigm has been used to test the hypothesis that dissonance should be aroused when a person acts in a way that is contrary to his or her attitudes. The amount of dissonance experienced will be inversely related to the amount of external pressure or justification for behaving in that manner. For example, an individual who is forced by an authority figure to behave contrary to his/her attitude should experience less dissonance than an individual who was subtly coerced into behaving contrary to the attitude. If the external pressure is low, individuals may change their attitudes to be more consistent with the counter-attitudinal behavior.

Misattribution paradigm An experimental paradigm used by cognitive dissonance researchers to test whether dissonance-related attitude change was indeed motivated by negative emotional feelings, as the theory proposed. In this paradigm, dissonance is created in standard ways but some subjects are led to believe that their negative emotional

feelings created by dissonance are actually caused by another source, such as the bright lights in the room or a pill they had just consumed. When individuals believe that their dissonance-created negative feelings are caused by another source, they do not show the typical attitude change that occurs as a result of dissonance.

New look A theoretical reinterpretation of the original theory of cognitive dissonance that posited that cognitive inconsistency was not the cause of dissonance but that feeling personally responsible for producing a foreseeable negative consequence was the cause. This reinterpretation was applied primarily to the induced compliance paradigm, which is the main experimental paradigm used to test dissonance theory.

Self-affirmation A theoretical reinterpretation of the original theory of cognitive dissonance. This reinterpretation posits that dissonance is not the result of cognitive inconsistency or self-inconsistency, but is instead the result of a threat to one's self image.

Self-consistency A theoretical reinterpretation of the original theory of cognitive dissonance. Instead of positing that any type of cognition can be involved in creating dissonance, this reinterpretation posits that only cognitions involving the self-concept will arouse dissonance. According to this view, dissonance only occurs when one behaves contrary to his/her self-view.

Spreading of alternatives According to research derived from cognitive dissonance theory, after individuals make difficult decisions, they often perceive their chosen option as more positive and their rejected option as more negative than they perceived these options prior to the decision, when the options were perceived as similar in value. In other words, the individuals spread apart their attitudes toward the decision options from predecision to postdecision.

Cognitive dissonance theory and research dominated social psychology from the 1950s until the 1970s. The theory revolutionized thinking about psychological processes, particularly regarding how rewards influence attitudes and behavior, and how behavior and motivation influence perception and cognition. In the 1990s, research on the theory was revived and it has since been gaining in interest. In addition to the explicit, renewed interest in the dissonance theory itself, the theory has had implicit influence on much of contemporary theorizing.

The Original Version of the Theory

Leon Festinger formulated the original theory of cognitive dissonance in the mid-1950s, and the first formal and complete

presentation of the theory appeared in 1957. The theory was presented in abstract terms and, consequently, it has been used to understand a variety of phenomena, as is shown below. Festinger theorized that when an individual holds two or more elements of knowledge that are relevant to each other but inconsistent with one another, a state of discomfort is created.

He called this unpleasant state 'dissonance.' Festinger theorized that the degree of dissonance in relation to a cognition = $D/(D + C)$, where D is the sum of cognitions dissonant with a particular cognition and C is the sum of cognitions consonant with that same particular cognition, with each cognition weighted for importance. Several theorists have proposed that the dissonance between cognitions could be determined by assessing whether a person expects one event to follow from another.

Festinger theorized that persons are motivated by the unpleasant state of dissonance and that they may engage in 'psychological work' to reduce the inconsistency. This work will typically be oriented around supporting the cognition most resistant to change. To reduce the dissonance, individuals could add consonant cognitions, subtract dissonant cognitions, increase the importance of consonant cognitions, or decrease the importance of dissonant cognitions. One of the most often assessed ways of reducing dissonance is change in attitudes. Attitude change is expected to be in the direction of the cognition that is most resistant to change. In tests of the theory, it is often assumed that the knowledge about recent behavior is usually most resistant to change, because if a person behaved in a certain way, it is often very difficult to undo that behavior. Thus, attitude change would be consistent with the recent behavior.

Festinger presented dissonance theory during the heyday of cognitive consistency theories, and he discussed dissonance as a cognitive consistency theory. However, as several subsequent theorists noted, dissonance theory contained an important element not present in other consistency theories. That is, dissonant and consonant cognitions are defined in relation to a particular focal or generative cognition. Moreover, this focal cognition is usually related to a behavior, a point to which we return later.

Experimental Paradigms Used to Test the Theory

Free Choice

In 1956, Jack Brehm examined dissonance theory's predictions for postdecision processing. According to the theory, after a decision, all of the cognitions that favor the chosen alternative are consonant with the decision, whereas all the cognitions that favor the rejected alternative are dissonant. The greater the number and importance of dissonant cognitions and the lesser the number and importance of consonant cognitions, the greater is the degree of dissonance experienced by the individual. In a decision situation, dissonance is typically greater the closer the alternatives are in attractiveness, as long as each alternative has several distinguishing characteristics. Dissonance caused by a decision can be reduced by viewing the chosen alternative as more attractive and/or viewing the rejected alternative as less attractive; this particular pattern of attitude change has been referred to as spreading of alternatives.

Brehm conducted an experiment in which participants made either an easy or a difficult decision between two alternatives. The difficult decision was one in which the alternatives were close in attractiveness, whereas the easy decision was one in which one alternative was much more attractive than the other. Participants were asked to evaluate the decision options before and after the decision. Brehm found that, after persons made a difficult decision, they changed their attitudes to become more negative toward the rejected alternative (and slightly more positive toward the chosen alternative). After an easy decision, participants did not change their attitudes. Some scientists have questioned whether this paradigm actually provides support for a dissonance theory interpretation. However, research has dealt with these challenges and provided evidence that difficult decisions cause spreading of alternatives for the reasons outlined by dissonance theory.

Induced Compliance

In 1959, Leon Festinger and Merrill Carlsmith reported an experiment to test the hypothesis that dissonance should be aroused when a person acts in a way that is contrary to his or her attitudes. To test this prediction, they brought participants into the laboratory and asked them to perform a boring task. Then, participants were paid either \$1 or \$20 to tell 'another participant' that the task was interesting. According to dissonance theory, lying for a payment of \$20 should not arouse much dissonance, because \$20 provides sufficient justification for the counter-attitudinal behavior (i.e., it adds 20 cognitions consonant with the behavior). However, being paid \$1 for performing the same behavior should arouse much dissonance, because \$1 provides just enough justification for the behavior (i.e., it adds only one consonant cognition). As expected, participants in the \$1 (low-justification) condition changed their attitudes to be more positive toward the task, whereas participants in the \$20 (high-justification) condition did not change their attitudes.

Effort Justification

Dissonance is aroused whenever a person engages in an unpleasant activity to obtain some desirable outcome. From the cognition that the activity is unpleasant, it follows that one would not engage in the activity; the cognition that the activity is unpleasant is dissonant with engaging in the activity. Dissonance should be greater, the greater the unpleasant effort required to obtain the outcome. Dissonance can be reduced by exaggerating the desirability of the outcome, which would add consonant cognitions.

In the first experiment designed to test these ideas, in 1959, Aronson and Mills had women undergo a severe or mild 'initiation' to become a member of a group. In the severe initiation condition, the women engaged in an embarrassing activity to join the group, whereas in the mild initiation condition, the women engaged in an activity that was not very embarrassing to join the group. The group turned out to be dull and boring. The women in the severe initiation condition evaluated the group more favorably than the women in the mild initiation condition. This paradigm continues to be used fruitfully in research, and it has been usefully applied in psychotherapy.

Other experimental paradigms have been used to test the theory but they are used less frequently and because of space limitations are not described here.

Challenges to the Research and Original Theory

After these and other dissonance results appeared in the literature, some theorists began to question whether the results were due to motivation. Some theorists hypothesized that the effects were due to nonmotivational, cognitive processes or impression management concerns. However, subsequent research confirmed that dissonance is a motivated process. That is, research revealed that during the state of dissonance, individuals evidence heightened electrodermal activity (which is associated with activation of the sympathetic nervous system) and report increased negative affect. After discrepancy is

reduced (attitude change occurs), self-reported negative affect is reduced. However, electrodermal activity does not decrease at this point unless individuals are distracted from the cognitive discrepancy. It is possible that the arousal following attitude change is the result of a motivation to follow through with the commitment.

Moreover, research using the misattribution paradigm has revealed that discrepancy reduction is motivated by the need to reduce negative affect. In the misattribution paradigm, participants are provided a stimulus (e.g., a placebo) that is said to cause specific side effects. It is assumed, following Schachter and Singer's two-factor theory of emotion, that individuals may mistakenly attribute their dissonance arousal to this other source, but only when the expected side effects of the other source are similar to the state produced by dissonance. The nature of the internal state can then be inferred indirectly by determining the type of stimuli to which individuals misattribute the state aroused by dissonance. In this paradigm, participants are exposed to treatments that will or will not arouse dissonance, and then they are either provided or not provided a possible external cause for their experienced state. Research has indicated that participants in the dissonance arousing conditions will misattribute their arousal to stimuli that are said to cause negative affective side effects and that once this misattribution is made, dissonance reduction (attitude change) does not occur.

Beginning in the late 1960s, researchers began to propose motivational explanations for dissonance effects that differed from Festinger's originally proposed theory. Three revisions of dissonance theory have been proposed, and their originators have provided evidence to support these conceptions. These include Aronson's self-consistency theory, Steele's self-affirmation theory, and Cooper and Fazio's new look at dissonance.

Self-Consistency

In his self-consistency theory, Elliot Aronson proposed that dissonance is due not merely to an inconsistency between cognitions. Instead, he posited that dissonance occurs when a person acts in a way that violates his or her self-concept, that is, when a person performs a behavior inconsistent with his or her sense of self. Because most persons have a positive self-concept, dissonance is most often experienced when a person behaves negatively, behaving in an incompetent, irrational, or immoral manner. One of the primary predictions derived from this revision is that low and high self-esteem individuals should respond with less and more dissonance reduction (e.g., attitude change), respectively, because in dissonance experiments high self-esteem individuals are induced to act in ways that are more discrepant from their positive self-views. Experiments testing this prediction have produced mixed results. Also, Beauvois and Joule obtained results that are difficult to explain with this revision.

Self-Affirmation

Claude Steele proposed a different alternative to Festinger's dissonance theory. He proposed that persons possess a motive to maintain an overall self-image of moral and adaptive adequacy. He stated that dissonance-induced attitude change occurs because dissonance threatens this positive self-image.

Whereas Festinger's dissonance theory posited that individuals are motivated to reconcile inconsistent cognitions, Steele proposed that, instead, individuals are merely motivated to affirm the integrity of the self. In support of this idea, Steele presented experiments, where, following a dissonance induction, participants either were, or were not, presented with an opportunity to affirm an important value. When participants were allowed to affirm an important value, dissonance-related attitude change did not occur.

However, Simon, Greenberg, and Brehm presented evidence supporting an alternative explanation for Steele's findings that was in line with the original theory of dissonance. Festinger's original theory proposed that the degree of dissonance experienced depended upon the importance of the dissonant and consonant cognitions. Simon et al. hypothesized that making an important value salient could reduce dissonance by reducing the individual's perception of the importance of the dissonant act. They conducted an experiment in which participants who opposed a tuition increase were given a high choice to write essays in support of a tuition increase (a counter-attitudinal statement). After writing the essay, participants were either given an opportunity to affirm an important value (self-affirmation condition), or asked to write about a value that was not important to them personally but was of general importance (value salient condition, e.g., world hunger), or neither (control condition). Participants were then asked to rate the degree to which they supported a tuition increase. Participants in the control condition changed their attitudes to be more favorable toward a tuition increase, as expected. Participants in both the self-affirmation and value-salient conditions did not change their attitudes. They had trivialized, or reduced the importance of, the tuition increase issue by thinking about other important values, even when these values were not personally important and thus not self-affirming. Other evidence has been presented that is difficult to interpret in self-affirmation theory terms.

In more recent work testing his self-standards model of dissonance, Jeff Stone has found that individuals with low self-esteem show less attitude change following induced compliance if their personal self-standards were primed (by rating their personal ideal for themselves on untrustworthy, precise, and ethical traits) immediately after the writing of the counter-attitudinal essay. When normative standards (by rating what their peers thought they ought to be on untrustworthy, precise, and ethical traits) or no particular standards were primed, participants with low self-esteem showed the same amount of attitude change as participants with high self-esteem. Stone suggested that "for self-consistency to operate in dissonance, something in the context must make idiosyncratic self-knowledge accessible. Otherwise, dissonance processes are not necessarily moderated by individual differences in the structure and content of self-knowledge" (2003: 852). Stone suggested that these results cast doubt on both self-affirmation and self-consistency theories, and he proposed that both the self-affirmation and self-consistency models are correct, but under different conditions.

New Look

Joel Cooper and Russell Fazio proposed the idea that the discomfort experienced in dissonance experiments was not

due to an inconsistency between the individual's cognitions, but rather to feeling personally responsible for producing an aversive consequence. They stated, "Dissonance has precious little to do with the inconsistency among cognitions per se, but rather with the production of a consequence that is unwanted." In support of this idea, in 1970, Cooper and Worchel replicated and extended Festinger and Carlsmith's classic experiment. In addition to the conditions of the original experiment, Cooper and Worchel added conditions in which, when the participant tells the confederate that the boring task is interesting, the confederate is not convinced by the lie. They found that attitude change occurred only in the low-justification condition where the confederate believed the lie. This result and others have been interpreted as indicating that dissonance-related attitude change occurs only when individuals feel personally responsible for producing an aversive consequence. The new look, or aversive consequences, revision of cognitive dissonance theory was widely accepted.

However, the results obtained in paradigms other than the counter-attitudinal action paradigm are not consistent with the aversive consequences model. Dissonance research using a selective-exposure paradigm has demonstrated that persons are more willing to examine materials that confirm their beliefs than materials that dispute their beliefs. Research using a belief disconfirmation paradigm has shown that, when persons are exposed to information that challenges their beliefs, they often strengthen their original belief. Research using a hypocrisy paradigm has shown that persons change their behavior to be more in line with their beliefs when they are reminded of times when they did not live up to their beliefs. It is difficult to reconcile any of these lines of dissonance research with a conception of dissonance theory in which the production of an aversive consequence is the only motivator of dissonance-related attitude change.

According to the original theory of cognitive dissonance, the production of aversive consequences would be expected to increase the amount of dissonance produced because an aversive consequence may be an important dissonant cognition. However, the original theory would deny that an aversive consequence is necessary to produce dissonance. In the induced-compliance experiments testing the necessity of aversive consequences, attitude change may have occurred only when participants caused aversive consequences for a number of reasons. First, the lack of attitude change in the no-aversive consequences conditions is a null effect. Null effects are difficult to explain and subject to multiple alternatives. Second, attitude change may have been produced, but may have been too slight to be detected with the small sample size of these experiments. Third, not enough dissonance may have been aroused in these experiments to produce attitude change without the additional help of an aversive consequence. For example, too much justification for the counter-attitudinal behavior may have been provided. Fourth, in these experiments, dissonance may have been produced in the no-aversive consequences conditions, but may have been reduced by a route other than attitude change.

To examine whether attitude change could occur in an induced compliance setting in which aversive consequences were not produced, Harmon-Jones and colleagues conducted several experiments. Under the pretext of participating in an

experiment on memory, participants were exposed to an attitudinal object. They were assured of privacy and anonymity, and then given high or low choice to write a counter-attitudinal statement about the object (to manipulate justification). They were asked to discard the statement in the trash after writing it so that there was no chance of the statement causing an aversive consequence. This manipulation was on the basis of Cooper and Fazio's statement, "making a statement contrary to one's attitude while in solitude does not have the potential for bringing about an aversive event" (1984: 232). Other experiments revealed that dissonance produced in this experimental paradigm caused more nonspecific skin conductance responses and greater self-reported negative affect.

These results demonstrate that dissonance affect and dissonance-related attitude change can occur in situations in which a cognitive inconsistency is present but the production of aversive consequences is not present. They also demonstrate that the experience of cognitive dissonance evokes an unpleasant motivational state that motivates dissonance reduction. These experiments have supported the original conception of dissonance theory over the revisions. But why does dissonance evoke this negative motivational state? Why is inconsistency aversive? Festinger simply proposed that inconsistency was aversive but never thoroughly explained or tested why inconsistency was aversive.

Action-Based Model of Dissonance

To address these questions, Harmon-Jones proposed an action-based model of dissonance. The model concurs with other areas of psychological research in proposing that perceptions and cognitions can serve as action tendencies. The model further proposes that dissonance between 'cognitions' evokes an aversive state because it has the potential to interfere with effective and unconflicted action. Dissonance reduction, by bringing 'cognitions' into consonance, serves the function of facilitating the execution of effective and unconflicted action. The action-based model uses the term 'cognitions' to be consistent with the language of the original theory. However, for the model, the more accurate term for the psychological construct involved in dissonance is action tendency. That is, it is the inconsistency between important action tendencies that causes dissonance. This line of thinking is consistent with the thinking of past dissonance theorists who emphasized behavior as the focal or generative cognition. The action-based model extends these past views by suggesting that the other (nongenerative) cognitions most likely to arouse dissonance are those that have action tendencies inconsistent with the generative cognition.

The action-based model proposes that inconsistency between cognitions makes persons uncomfortable because inconsistency has the potential to interfere with effective action. From the viewpoint of the action-based model, cognitions are important because they guide the actions of an organism. When an individual holds two relatively important cognitions that are inconsistent, the potential to act in accord with them is undermined. To reduce the inconsistency and resulting negative affect, individuals engage in a variety of cognitive strategies.

For example, dissonance results when one 'freely chooses' to engage in behavior that is inconsistent with an attitude or

belief. The 'free choice' is subtly induced by the experimenter in experimental research. Experiments have shown that when individuals engage in such behavior, they often change their attitudes to be consistent with their recent behavior, as discussed previously. After making difficult decisions, individuals value the chosen alternative and devalue the rejected alternative more than they did prior to the decision. In both of these dissonance-evoking situations, dissonance occurs because there are cognitions that are inconsistent with a chosen course of action. That is, in the former situation, the past attitude is inconsistent with the current behavior. In the latter situation, the positive aspects of the rejected alternative and the negative aspects of the chosen alternative are inconsistent with the decision. The dissonance thus has the potential of interfering with the translation of the decision into effective action. According to the action-based model, attitude change produced by dissonance is the result of following through with the commitment to the behavior. The attitude change is posited to be one of a number of processes that would assist with the translation of the commitment into effective and unconflicted action. Thus, according to the action-based model, dissonance evokes a negative affective state that signals the organism that something is wrong and motivates the organism to engage in behavior to correct the problem. The correction of the problem often involves following through with the commitment to the behavior or decision. This view of dissonance is consistent with past as well as present theorizing on the function of dissonance and dissonance reduction.

Other scientists have advanced similar but not identical conceptions. For instance, in 1951, Lewin discussed the organism's capacity to 'freeze' upon an action tendency following a decision. In 1967, Jones and Gerard discussed the concept of an unequivocal behavior orientation that was described as an adaptive strategy that forced the individuals to bring their relevant cognitions into harmony with each other. Another perspective consistent with the present model is Julius Kuhl's theory of action control. He proposed that to insure that the intended action rather than a competing action tendency will be executed, the intended action tendency has to be selectively strengthened and protected against interference until the action is executed. The postdecisional spreading of decision alternatives may serve the function of putting the decision into action. When one considers that dissonance is primarily a theory about postdecisional processing, it is easy to see how these theories fit with the present conception of the function of the dissonance process.

Experimental Tests of the Action-Based Model

Action-Orientations

An action-oriented state is a state that often occurs following a decision. When a person is in an action-oriented state, implementation of decisions is enhanced. In 2002, Harmon-Jones and Harmon-Jones integrated these ideas with dissonance theory to propose that this action-oriented state that follows decision-making is equivalent to the state in which dissonance motivation operates and dissonance reduction occurs. They hypothesized that experimentally manipulating the degree of action-orientation experienced following a decision should affect the degree of dissonance reduction.

Harmon-Jones and Harmon-Jones conducted an experiment to test these ideas. Participants were asked to make either an easy decision or a difficult decision, choosing to perform one of two physical exercises that the participant rated attractive and unattractive or rated as very similar in attractiveness. Participants were asked to fill out a mindset questionnaire after the decision. The neutral mindset questionnaire asked participants to list seven things they did in a typical day, while the action-oriented mindset questionnaire asked participants to list seven things they could do to perform well on the exercise they had chosen. Participants were then asked to re-evaluate the exercises. Results indicated that participants in the high-choice, action-oriented condition changed their attitudes to prefer the chosen exercise more than participants in the other conditions.

In a second experiment testing the action-based model, Harmon-Jones and Harmon-Jones replicated the results of the first experiment using a different manipulation of action-orientation. In this experiment, action-orientation was induced by asking participants to think of an important decision that they had made and to list the steps they intended to use to successfully follow through with their decision. The participants in the action-orientation condition engaged in more attitude change following a difficult decision than did participants in the comparable conditions. This study replicated the results of the previous study, but provided stronger support for the model because it used an action-orientation induction unrelated to the decision at hand.

Neural Processes Involved in Dissonance

To assist in translating the behavioral commitment or intention into effective action, approach-motivational processes should be activated, as the individual works to successfully implement the new commitment. Thus, the increase in approach motivation should activate the left frontal cortex, as much past research has found this cortical region to be involved in approach-motivational processes.

Other research has suggested that activity in the anterior cingulate cortex is involved in monitoring the occurrence of errors or the presence of response conflict. Importantly, research has found increased anterior cingulate cortex activity, as measured by the event-related potential known as the error-related negativity, when behavior conflicts with the self-concept. This finding suggests that even higher level conflicts, the type with which dissonance theory has been most concerned, also activate the anterior cingulate cortex. More recently, Vincent van Veen and colleagues found increased anterior cingulate cortex activation in the induced compliance paradigm.

Based on this past research, dissonance (or potential response conflict) first activates the anterior cingulate cortex, and then activates the left dorsolateral prefrontal cortex, which assists in resolving the conflict. To test the prediction that dissonance is associated with increased left frontal cortical activity, university students who were opposed to a tuition increase participated in a study ostensibly concerned with attitudes and personality. They were randomly assigned to one of two choice conditions. In the low-choice condition, participants were told they were to write an essay supporting a 10% tuition increase at their university. In the high-choice

condition, participants were told that writing the essay in favor of the tuition increase was their choice and completely voluntary. However, the instructions subtly encouraged them to write such an essay. EEG was assessed for 1 min following the beginning of the writing of the counter-attitudinal essay, as past research has revealed that dissonance is greatest at this point in time. Moreover, the commitment alone (and not the complete essay writing) is sufficient to evoke dissonance. Then, participants completed an attitude measure. Replicating past research, results revealed that high-choice participants changed their attitudes more than low-choice participants. Supporting the primary prediction, results also revealed that high-choice participants evidenced greater relative left frontal activity than low-choice participants.

Another experiment extended the above research by testing the hypothesis that an action-oriented mindset would not only facilitate discrepancy reduction following a decision, but would also increase relative left frontal cortical activity. Replicating past results, the current experiment demonstrated that the action-oriented mindset caused greater spreading of alternatives than the neutral mindset condition. Moreover, the action-oriented mindset caused greater relative left frontal activation than the other condition. These results supported our predictions and suggest that the dissonance reduction involves activation of the left frontal cortex and approach-motivational processes.

In the previous experiment, the psychological process (action-orientation) was manipulated and the proposed physiological substrate was measured (left frontal cortical activation). Studies of this type are limited in the causal inferences that can be drawn. Because the measured physiological activation may be only one of a number of physiological activations that occur in response to the psychological manipulation, it is possible that one of the other unmeasured physiological activations is more responsible for the psychological process. To provide stronger causal inferences regarding the role of a particular neural structure's involvement in a particular psychological process, it is important to reverse the direction and manipulate the physiology and measure the psychology. Such measurement also provides stronger causal evidence than simply correlating the proposed mediator with the outcome. Thus, an experiment used neurofeedback to manipulate left frontal cortical activity. After neurofeedback training, participants were given a difficult decision and following the decision their attitudinal spreading of alternatives was measured. The manipulated decrease in relative left frontal activity led to a decrease in spreading of alternatives.

Individual and Cultural Differences

Research has suggested that individual and cultural differences may moderate dissonance processes. For instance, individuals with greater preferences for consistency show greater attitude change after being given high choice in an induced compliance situation, and individuals from Eastern cultures show greater dissonance-related attitude change as compared to individuals from Western cultures when interdependence is salient. As noted by Wicklund and Brehm, individual (or cultural) differences in dissonance-related attitude change could emerge because of differences in the initial perception of discrepant

cognitions, the awareness of dissonance, the tolerance of dissonance, and/or the mode of dissonance reduction. If attitude change is the only measure in a standard dissonance experiment examining individual differences, it is impossible to determine why a particular individual difference may be related to a pattern of attitude change. In order to determine why a particular individual, or cultural, difference relates to a pattern of attitude change, it would be necessary to measure the relationship of this difference to factors influencing dissonance.

Heine and Lehman found that North Americans and East Asians differ in their attitudinal responses to difficult decisions. While North Americans showed the typical spreading of alternatives following the difficult decision (regarding choice over popular compact disk music selections), East Asians did not. This observed effect was not consistent with earlier observations by Haruki Sakai and colleagues who had found dissonance-related attitude change following public but not private induced compliance.

However, Hoshino-Browne and colleagues noted this discrepancy between results and suggested that the experiments by Sakai and colleagues may have produced dissonance-related attitude change because participants were concerned about the interpersonal consequences of their actions. That is, the participants, who were typically motivated to be interdependent with others and avoidant of interpersonal conflict, experienced dissonance because they had acted inconsistently with those cultural ideals. To address these issues and others, Hoshino-Browne and colleagues conducted four studies in which European Canadians and Asian Canadians made difficult decisions for themselves or for a friend. Results indicated that whereas European Canadians spread alternatives more for self than friend decisions, Asian Canadians spread alternatives more for friend than self decisions. These results serve as a reminder that the importance of the cognitions was one of the factors affecting the magnitude of dissonance in Festinger's original theory. Cultural values would be expected to relate to the importance of cognitions, and thus, to the amount of dissonance these behaviors would evoke.

Conclusion

Several experiments have challenged the revisions of dissonance theory and have provided support for Festinger's original conception of dissonance. Clearly, dissonance has much to do with inconsistency and is not due to such limiting conditions as a self-threat or the production of an aversive consequence. As Aronson noted, a number of social psychological theories, such as self-affirmation theory, could be thought of as dissonance in other guises. In addition to the theories noted by Aronson, much research and theory concerned with guilt and self-regulation over prejudiced and other impulses may be understood from the perspective of dissonance. Incorporation of the key variables and past research of dissonance theory into these and other research enterprises will likely benefit those enterprises and lead to a more cumulative psychological theory.

Festinger did not propose why cognitive inconsistency produces discomfort and motivates perceptual, cognitive, and

behavioral changes. However, the action-based model of dissonance does propose an underlying motivation. Research on the action-based model suggests that dissonance reduction may serve the function of assisting in the successful execution of a commitment, which may facilitate effective and unconflicted action. Incorporation of these ideas derived from action control thinking may assist in stimulating new research on dissonance theory and assist in connecting the large body of dissonance theory evidence with other research literatures concerned with action orientation, behavioral regulation, emotion regulation, and the neural processes that underlie these important psychological processes.

As dissonance theory goes on to its sixth decade, it clearly has weathered many challenges but still provides much explanatory, integrative, and generative power.

See also: [Attitude Change](#); [Attitude Formation](#); [Motivation](#); [Self-Esteem](#).

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Comparative Primate Psychology

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Glossary

Adaptation A genetically controlled trait that has evolved by natural selection.

Analogous traits Similar traits that evolved independently in different species in response to similar environmental pressures.

Comparative psychology The study of mind and behavior in nonhuman animals.

Convergent evolution The process by which natural selection produces similar adaptations in different species that live in similar environments.

Homologous traits Similar traits possessed by different species as a result of inheritance from a common ancestor.

Phylogeny The evolutionary development and history of a species or higher taxonomic grouping of organisms.

Primates The discipline that studies nonhuman primates.

Trait A morphological, physiological, or behavioral characteristic of an organism.

Evolutionary Foundations of Comparative Primate Psychology

Psychology is the discipline that studies mind and behavior. Within psychology, there are many subfields including, among others, biological, clinical, cognitive, comparative, developmental, educational, evolutionary, industrial/organizational, personality and individual differences, and social psychology. Some of these subfields are often recognized as independent disciplines. Comparative psychology, which involves the study of mental processes and behavior in other animals, is also known as ethology or behavioral biology. Within comparative psychology, there are subfields specializing in the study of particular groups of animals. For example, the comparative psychology of nonhuman primates is sometimes called behavioral primatology, or simply primatology.

All of these multilevel disciplinary subdivisions have resulted from the growth of psychological research, its expansion in many different directions, and the increasing specialization of researchers addressing different types of questions about mind and behavior. Although specialization is both welcome and inevitable, the risk involved in these sub-fields turning into independent disciplines is that they may become conceptually disconnected from psychology and from each other. With regard to the study of mental and behavioral processes in non-human primates, it is important to discuss how this area of research is conceptually linked both to comparative psychology and to psychology in general.

A frequently used rationale for conducting comparative psychological research is the 'animal model' argument. This argument is that similarities in brain structure and function, or physiological processes, or learning abilities in animals and humans allow researchers to use animals as models for a specific aspect of human behavior, or cognitive process, or its underlying neurobiological or physiological regulation. For example, according to Gottlieb and Lickliter, the 'animal model' approach entails finding "nonhuman species with behavioral and psychological repertoires that are similar to humans so that the results of experiments with the model may throw light on seemingly

related behavior in human beings" (pp. 311–312). Evolutionary arguments do not figure prominently in comparative research conducted with the animal model approach. Particular organisms are selected mainly on the basis of practical criteria, such as they are small and cheap to maintain in the laboratory, they reproduce frequently, and it is easier to conduct experimental studies that may require highly invasive procedures. The most common organisms that fit these criteria and are used in comparative psychological research include fruit flies, cockroaches, some frogs and reptiles, pigeons and some other birds, and of course, rats, mice, and other rodents. Although comparative research with these 'model organisms' can make some beneficial contributions to psychology, there are risks involved in selecting organisms based solely on practical criteria. One of these risks is that the extrapolation of findings or conclusions from animal to human research may be inappropriate.

Comparative psychologists who use the 'animal model' argument as rationale for their research not only recognize the limitations of this approach but, surprisingly, also minimize the contributions comparative research can make to psychology. This position is exemplified by Gottlieb and Lickliter, who argued that "the certainty that animal models are faithfully mimicking their presumed human counterparts in the arena of psychological, social, and behavioral function is always open to even greater question" (p. 312). As a result, they conclude that the main contribution of comparative research to psychology is to provide food for thought, that is, hypotheses but not data, general principles but not facts.

In a critique of Gottlieb & Lickliter's article, I argued that a logical corollary of their position is that the rationale for doing comparative animal research in general is very weak. Computer simulations can be a good source of testable hypotheses about human behavior. Studying human behavior can be an excellent source of testable hypotheses about human behavior. Why bother with animals? Given the economic costs, the logistic difficulties, and the ethical issues associated with animal research, such research would no longer be warranted if its contribution were only to provide hypotheses or food for thought. Even animal studies with highly invasive

experimental procedures that are impossible in humans would be difficult to justify if their main contribution were only to provide hypotheses. I argued instead that animal studies provide much more than food for thought, and discussed many cases in which animal data have clear cross-species validity and direct extrapolability to the human condition. To give just one example, in his 1969 formulation of attachment theory, British psychoanalyst John Bowlby did not use information from nonhuman primate research just to develop the hypothesis that there they might be an attachment system in humans or some general principles about its functioning. He showed that there were 'formal similarities' in the infant response to separation, the development of fear of strangers, and the use of the mother as a secure base in monkeys and in humans. Based on these and other similarities, he argued that the development, regulation, and adaptive function of the attachment system are very similar in humans and some other primates, and that this similarity is probably due to common descent, that is, humans and closely related primates inherited the infant attachment system from their common ancestors. Thus, Bowlby provided a clear example of how data from nonhuman animals, and not just hypotheses or general principles, can be directly extrapolated to humans and how one can develop a theory of behavior that has a strong evolutionary foundation and cross-species validity.

Evolutionary biologist Theodosius Dobzhansky once said "Nothing in biology makes sense except in light of evolution." Many evolutionary and comparative psychologists believe that the same should be said about psychology as well. Comparative psychological research can be strongly justified on evolutionary grounds, and evolutionary arguments can also help select the best study organisms and the research questions that can be best addressed from a comparative perspective. One evolutionary rationale for conducting comparative research is that similarities in behavior between animals and humans are the result of common phylogenetic history. In this view, certain traits are similar in animals and humans because they were inherited from a common ancestor, that is, they are 'homologous.' Studying these traits in animals helps one elucidate the phylogenetic history of human behavior. In general, the probability that two species have homologous traits is higher the closer the phylogenetic relationship between the species. Thus, human behavior is more likely to be homologous to the behavior of other primates than to the behavior of nonprimate animals. This provides a strong evolutionary rationale for using nonhuman primates, especially primates that are closely related to humans, in comparative psychological research.

Another evolutionary rationale for conducting comparative research is that similarities in behavior between animals and humans may be the result of convergent evolution. This means that similar traits in animals and humans evolved by natural selection in response to similar pressures from the environment, but independently in different species. These traits are considered 'analogous' and studying them can help one understand how the environment has shaped human behavior through the action of natural selection. Similar adaptations to the environment can occur in species that are distantly related and, therefore, in theory, to investigate the adaptive aspects of human behavior from a comparative perspective,

honeybees can be as good as models as chimpanzees are. In reality, however, there are many constraints on the type of adaptations to the environment that organisms can evolve through natural selection. Therefore, similarities in genetic, anatomical, physiological, and cognitive constraints increase the probability that organisms will evolve similar adaptations to the environment. Thus, human behavior is generally more likely to be analogous to the behavior of other primates than to the behavior of nonprimate species. This provides another strong evolutionary rationale for using nonhuman primates in comparative psychological research.

Studying the mind and behavior of nonhuman primates that are closely related to man can potentially enhance the understanding of many human mental and behavioral processes for clear evolutionary reasons. Although primatology and psychology are sometimes considered different disciplines, there is no conceptual reason why this should be the case. In fact, the history of research on primate minds and behavior illustrates that, from the very beginning, studies of primate and human minds and behavior were closely interwoven.

History of Comparative Primate Psychology

The implications of primate behavior research for understanding human behavior were first explicitly recognized by Darwin, who in his 1872 book on *'The Expression of Emotions in Animals and Man'* drew several parallels between the facial expressions of nonhuman primates and those of human beings. However, it was psychologists rather than evolutionary biologists who began the systematic study of primate behavior and cognition at the beginning of the twentieth century.

One of the first psychologists to conduct systematic primate behavioral research was Wolfgang Köhler. As a Gestalt psychologist, Köhler was interested in cognitive processes other than learning and was curious to see if apes could use 'insight' to solve novel cognitive tasks. In a research station established at Tenerife on the Canary Islands, Köhler conducted many elegant experiments with chimpanzees during the period 1913–1917. Many of these experiments involved the manipulation of the environment to obtain food rewards and the use of previously familiar objects in novel and instrumental ways. Köhler's research questions and some of its procedures were very innovative and some of its findings are still highly cited in contemporary research. He can certainly be considered one of the founders of modern research on primate cognition.

In the United States, the systematic study of primate behavior was pioneered by Robert Yerkes, a Harvard-trained psychologist who established a primate research facility in Orange Park, Florida, with the goal of making primates available to many different kinds of scientific inquiry, most notably, psychological research. Yerkes felt that research on the behavior and cognitive abilities of primates, and in particular the great apes, would help answer some questions in psychology that had historically been very difficult to address. His contributions to primate behavior research were many and ranged from studies of spatial cognition and problem-solving to research on social and maternal behavior.

In addition to the pioneer efforts by Köhler and Yerkes, other early attempts to study primate behavior and cognition

were made in Russia, France, Cuba, and other parts of the world. The 1920s and 1930s also saw the beginning of attempts to teach language to chimpanzees. The first of such attempts was made in 1930 by Kellogg and Kellogg who raised a young chimpanzee named Gua along with their son Donald. The Kelloggs' experiment turned out to be a failure but it was followed by many others, using similar or different strategies.

Along with the growing recognition that primate behavior could be useful to understand human behavior, the years before World War II were characterized by increasing interest in studying primates in their natural habitat and understanding the basic principles regulating their social organization. With World War II, research on primate behavior was interrupted for almost a decade, but in the early 1950s and especially in the 1960s, there was renewed interest in studies of primate behavior all around the world. Japanese primatologists' intensive and long-term studies of social behavior led to the discovery of kinship systems and cultural traditions in macaque societies. Primate behavior research in Japan, however, was originally conducted within the tradition of anthropology, and it is only later that such research established a strong connection with psychological science. The 1950s also witnessed the resumption of research with rhesus macaques on the island of Cayo Santiago, in Puerto Rico, where an American zoologist, Clarence Ray Carpenter, had established a colony of these monkeys prior to the War. The availability of genealogical information on the animals and the long-term observations of their behavior contributed, along with the work of Japanese primatologists, to the identification of the matrilineal structure of macaque society and the mechanisms underlying the acquisition of dominance.

As more information on primate social behavior became available, Harvard anthropologist Sherwood Washburn developed the conviction that extant primate species could provide important information on human origins and social evolution. He and his graduate students pioneered field studies of primate behavior in Africa and Asia, placing particular emphasis on aggressive and maternal behavior. These two topics dominated much of primate behavior research through the 1960s and 1970s. Interest in anthropology and human origins also motivated paleontologist Robert Leakey to begin long-term studies of chimpanzees, gorillas, and orangutans, which were led by Jane Goodall, Diane Fossey, and Birute Galdikas, respectively.

Psychologists' interest in primate behavior rose dramatically with the resumption of research in captivity after World War II. Harry Harlow's research at the University of Wisconsin played a pivotal role in this process. After making important contributions to the study of primate learning, Harlow concentrated his efforts on elucidating the nature of infant attachment and social development in rhesus monkeys. Harlow's well-known experiments with surrogate mothers demonstrated that the mother's ability to provide contact comfort is a more important determinant of infant attachment than her ability to provide milk, thus providing a fatal blow to secondary-drive theories of attachment. Because Harlow's work touched upon many areas of research that were very important to psychologists at that time (e.g., learning and motivation, attachment, normal and abnormal social development, the social origin of affective disorders), and because Harlow's academic career took place within psychology, during the years in which most

of his work was conducted and published, primate behavior research was very well known among psychologists.

Although Harlow was very effective in promoting the importance of primate behavior research in the scientific community and the general public, the person who made the most systematic effort to conceptually integrate primatology and psychology was probably the British ethologist Robert Hinde. Hinde's interest in primate research was sparked by John Bowlby, who encouraged him to set up a colony of rhesus monkeys in Cambridge and investigate mother-infant attachment processes. From the study of social influences on the mother-infant relationship, the scope of Hinde's research was gradually broadened and elaborated into a conceptual framework for the study of social processes, which distinguished three main levels of complexity: interactions, relationships, and social structure. Hinde made important conceptual contributions to the science of social relationships, and for decades was one of the most articulate proponents of the conceptual integration between biological and psychological approaches to the study of behavior.

Thanks to the efforts of talented and charismatic scientists such as Harlow and Hinde and the success of field studies of primate behavior begun in the 1960s, primatology reached a peak in popularity in the 1960s and early 1970s. In the mid- to late 1960s, in particular, behavioral research in the United States thrived at the newly established Regional Primate Research Centers, and most research proposals to study primate behavior were readily funded by federal and private agencies. In the 1960s and 1970s, a large number of articles and books on primate behavior were published, and primate behavior research was probably well represented in all branches of scientific psychology, including developmental, social, cognitive, and clinical. The heyday of primatology, however, did not last long. In the early 1970s, that is, only ten years after the establishment of the NIH-funded Regional Primate Research Centers, there were already significant cuts to research funding.

The realization that evolutionary theory could be effectively applied to the study of social behavior in the 1960s and 1970s gave a great boost to primate research in the field. Although anthropology and psychology had been the disciplines dominating primate behavior research up to the 1970s, ecology and evolutionary biology acquired a leading role in most subsequent research. The fact that behavioral ecologists were mostly interested in questions of adaptive function whereas psychologists were mostly interested in questions of proximate causation or development of behavior was one of the several factors that contributed to the growing separation between primate behavior research and psychological science that occurred in the 1980s and early 1990s. Another important factor was the rapid progress of biological disciplines such as genetics, molecular biology, and neuroscience and the growing popularity of scientific reductionism. In particular, the success of neuroscience led to the optimistic view that many important questions about behavior would eventually be answered by studies of brain anatomy and function, thus rendering behavioral research unnecessary. One corollary of this view was the belief that comparative research with primates may not be as useful as research with other species, given the difficulty of conducting molecular work with primates.

Despite the current weakness of primatological research, in the last decade, some favorable conditions have emerged for renewed cross-fertilization between primatology and psychology. The cognitive revolution that occurred in psychology in the middle of the century was followed, a few decades later, by a similar cognitive revolution in the field of animal behavior, and primate behavior in particular. Thanks to the efforts of pioneers such as Donald Griffin and Gordon Gallup, once it became scientifically acceptable to ask whether animals have a sense of self and understand other individuals as having a mental life of their own, the field of primate cognition boomed. It became apparent that many of the questions traditionally addressed by cognitive psychologists could also be addressed, with similar or new experimental procedures, in primates as well. Therefore, research on primate cognition shifted from the study of learned behavior to the study of mental representations of the self and of the physical and social environment. Today, cognition is the branch of scientific psychology in which primate behavior research is best known and represented. Interestingly, and in line with the notion that comparative psychological research should have strong evolutionary foundations, a further impetus for research on primate cognition has been provided by the framing of cognitive investigations within ecology and evolutionary biology, which has led to a new understanding of primate cognitive adaptations, their ecological significance, and evolutionary origins.

Comparative Primate Cognition

Primate cognitive adaptations can be conceptualized as complex "behavioral adaptations in which perceptual and behavioral processes are (1) organized flexibly, with the individual organism making decisions among possible courses of action based on an assessment of the current situation in relation to its current goal; and (2) involve some kind of mental representation that goes beyond the information given to direct perception." Cognitive adaptations, and their underlying neural substrates, evolve by natural selection in response to recurrent problems posed by the physical, ecological, or social environment. Within this framework, the question can be raised as to whether the primate order as a whole exhibits cognitive adaptations that are different from those of other animals, and whether primates that are phylogenetically closest to humans show evidence of cognitive specializations similar to those of the human species.

The study of primate cognitive adaptations has involved many aspects of physical and social cognition. Primate research in the domain of *physical cognition* has addressed how monkeys and apes acquire information about the physical space in which they live and the inanimate objects in it, how information is mentally represented and processed, and how it is retrieved and used to make decisions. Free-ranging primates form spatial maps that represent the environment in which they live and use them to make travel decisions as they search for food within their home range. In the laboratory, primates exhibit knowledge of movements of objects through space and understanding of object permanence, that is, the notion that objects continue to exist and maintain their features and properties if they have been moved or hidden from view.

For example, primates search for hidden objects and can solve tasks that require mental rotation of object orientation. Though primates are proficient at these tasks, there is no evidence that primates have greater understanding of space and objects relative to other mammals, nor is there evidence of significant differences among primate species (e.g., between monkeys and apes).

Other research in the domain of physical cognition has involved object manipulation tasks, in which objects are used in relation to other objects, and which require an understanding of causality (e.g., the relation between the use of the tool and the goal to be accomplished with it). Many species of primates, and especially capuchin monkeys and the great apes, are proficient tool users and also show some evidence of understanding of causality. However, primates' tool using skills have been matched or even surpassed by those of some corvid birds. Discrimination learning studies have addressed whether primates learn to discriminate particular features of objects and assign these objects to categories on the basis of similarities and differences in these features. These studies have shown that primates can not only discriminate and categorize objects but also understand complex rules underlying categorization, for example, the notion that categories of objects can be formed on rules such as identity, oddity, sameness, or difference. Similar to birds and other mammals (e.g., laboratory rats), primates also possess the ability to make accurate estimates of small quantities of items as well as the ability to solve simple tasks involving quantity conservation or summation. The exact perceptual or conceptual mechanisms underlying these skills remain unclear.

Taken together, studies of primate physical cognition have shown that monkeys and apes possess the ability to form mental representations of their space and objects, including hidden ones, but show little evidence of greater learning skills or greater understanding of the physical world and its properties than other vertebrate animals do. The strongest evidence for a potentially unique primate cognitive specialization in the realm of physical cognition involves the use of tools and the understanding of relational properties of objects including causality. This is particularly strong in large-brained primate species that face strong ecological pressures for complex food processing such as capuchin monkeys, and for all species of great apes.

In the domain of *social cognition*, early studies of primates' ability to recognize themselves in a mirror were driven by the hypotheses that mirror self-recognition indicates self-awareness and that knowledge of the self forms the basis for theory of mind. On the mark test of self-recognition, primates as a whole perform better than other animals, and apes perform better than monkeys. However, the notion that learning how to use a mirror to inspect inaccessible aspects of one's body necessarily entails possessing a concept of self has been questioned. Experimental evidence for theory of mind skills including intentionality or attribution of knowledge or ignorance to others is scarce but stronger for chimpanzees and other apes than for monkeys. Theory of mind is clearly a unique primate cognitive specialization but could be limited to the human species, and possibly the great apes. Complex forms of social learning involving emulation, imitation, or teaching have also been documented mainly in great apes,

where they are believed to form the basis for the origin and spread of behavioral traditions that may approximate elementary forms of human culture. The question of whether or not culture can be considered a cognitive specialization unique to humans or shared by other primates rests on how culture is defined and what operational criteria are used for its identification across species.

While the question of whether nonhuman primates have the ability to think about other individuals' mental states remains unanswered, it is well recognized that they excel at the task of observing other individuals' behavior, remembering past interactions, and making predictions about the future. Primates form complex social relationships with others and have knowledge and memory not only of their own relationships, but also of relationships between other individuals. Studies investigating this aspect of social cognition have assessed primates' ability to recognize kinship, dominance rank relationships, or friendships between individuals that reside in their social group. Knowledge of social relationships is used in complex cooperative and competitive strategies involving exchange of favors, alliance formation, opportunistic exploitation of social situations, and manipulation of other individuals with deceitful tactics.

Complex social strategies in group-living monkeys and apes invariably entail the exchange of vocal or visual signals between individuals. *Communication* can therefore provide a window into the primate social mind. Specifically, many aspects of communication can provide insights into social cognition, including the role of social learning in the developmental acquisition of signal production, comprehension, and usage; the extent to which signals are under volitional control and can be used flexibly; the complexity in the structure of signals; the information content or meaning of signals; the extent to which signals are combined with other signals within the same modality or across different modalities to accomplish different functions; the extent to which combinations of signals exhibit properties of human languages such as grammar or syntax; and the extent to which the production of signals is modified in relation to the presence of particular individuals (audience effects), their attentional states or current behavior, and possibly also their mental states.

The search for cognitive complexity in primate communication has often focused on vocalizations, in part because of possible direct parallels between monkey vocalizations and human speech. For example, great emphasis has been placed on the finding that vervet monkeys and other primates possess different alarm calls for aerial and terrestrial predators, and are therefore capable of semantic communication. It is now recognized, however, that this ability is shared by a number of birds and other mammals. Food calls have also been given as examples of referential signals, as according to some researchers, they convey information about the type, quantity, and location of food to other conspecifics. It is unlikely, however, that primate vocalizations about predators or food require a higher degree of cognitive complexity than similar vocalizations used by other mammals, birds, and other animals. This is because the problems faced by most primates during foraging or escaping predators are simply no different in complexity from those faced by most other animal species. Therefore, it is difficult to argue that these activities posed a special pressure to evolve higher cognitive or communicative abilities in primates.

The agonistic screams of macaques appear to elicit different responses from other group members in relation to characteristics of opponents such as their dominance rank, and representational signaling in the context of recruitment of agonistic support is an ability that might have been strongly selected for in the social environment of group-living primates. Vocalizations that are emitted in order to coordinate the behavior of group members during travel or to facilitate affiliative and bonding interactions are an even more promising area of investigation because, unlike antipredator calls and recruitment screams, these signals are not obviously associated with states of high arousal. Contact vocalizations that facilitate coordination of group movements and close-range interactions are particularly well developed in arboreal species such as New World monkeys. The complexity of vocal structure and vocal sequences in New World monkeys, however, is likely to be the result of the pressures of arboreal life rather than those of social variables. Moreover, the referential nature of agonistic screams, grunts, or other short-range contact calls has been called into question even for the Old World monkeys and apes.

Regardless of how primate calls are interpreted, there is little or no evidence that primates as a whole show complex cognitive specializations in their vocal communication abilities relative to other animals. Moreover, there is no trend toward increasing complexity in the structure, function, and use of vocal signals from the prosimians to the New World monkeys, the Old World monkeys, and the great apes, suggesting that the evolutionary increase in brain size that occurred in the Cercopithecoids and the ape lineage was not associated with increasing complexity in vocal exchanges or their cognitive substrates. Such an evolutionary trend, however, is observable in the use of nonvocal signals. In the Old World monkeys and in the great apes, there is a clear increase in the role played by facial expressions (associated with the development of complex facial musculature) relative to vocalizations. Moreover, in the great apes, there is an involvement of the arms and hands in making social gestures to a degree that is not observed in other nonhuman primates or other animals.

Although there is no good evidence that manual gestures are socially learned from others, the flexibility with which great apes use gestures in different contexts likely requires considerable developmental learning and experience. If gestures develop through a process of ontogenetic ritualization, it would require many exposures to and opportunities to perform a particular action before it becomes a gesture. If the forms of gestures are largely innate, then a period of learning when different gestures are likely to be effective (e.g., visual only when visible) would be required. Thus, it is possible that primates, and especially great apes, have evolved cognitive specializations to attend to and learn to use social variables (such as identity, visual attention, and dominance) during communication, and particularly during gesture.

The importance of development in shaping primate communication has been investigated in only a limited number of studies, and almost all of them have focused on vocal communication. Additionally, little is known about the relationships between cognitive abilities such as understanding visual attention, gaze following, and individual recognition and the structure and use of communication systems in nonhuman primates. In humans, language develops alongside a whole

range of cognitive abilities – building upon some and providing the foundation for others. The relationship between the emergence of language and other cognitive abilities is well studied in humans: similar work is needed in nonhuman primates. Comparative developmental studies are needed to understand whether and how development of one ability (e.g., understanding social hierarchies) affects or is affected by the development of communicative behaviors (e.g., using different strategies when communicating with a dominant vs. a subordinate individual). Within this framework of research, developmental studies of gesture acquisition and experimental studies of gesture use have the potential to shed new light on the social-cognitive specializations of great apes and, more generally, provide a window into the nonhuman primate mind.

See also: [Evolutionary Psychology](#); [Primate Cognition](#).

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Competition

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Glossary

Basal levels Baseline or resting state levels of hormones.

Behavioral economics A field of research interested in economic decision making with an emphasis on whether to cooperate for collective gain or defect for individual gain.

Cortisol A steroid hormone that is part of the physiological stress response that can also act as a behavioral inhibitor.

Dominance An aspect of personality characterized by a drive for attaining and maintaining high social status.

Moderator A variable that controls the nature of the effect that an independent variable has on a dependent variable.

Status An individual's position in a social hierarchy relative to other members of the hierarchy.

Testosterone A steroid hormone that has masculinizing effects on an individual that can also influence behavior.

Competition

Whether it is for a significant other, a promotion, or the admiration of peers, social competition dictates a large amount of human behavior. This article will provide a review of the scientific research on social competition in humans. We will discuss the social function of competition, dispositional dominance, and the underlying physiology that drives dominance behaviors, focusing on testosterone. To that end, we will discuss the dynamic relationship between testosterone, personality traits, situational forces, and cortisol. We will also discuss sex differences in competitive behaviors, and conclude with a discussion of the field of behavioral economics with an eye toward how this research has informed our understanding of competitive behaviors.

The Social Function of Competition

Across all species, individuals must compete for access to limited resources. Yet, rarely do individuals compete over every uneaten apple or available mate. Rather, competitions are used to establish a social hierarchy, and this hierarchy is the primary means by which limited resources are allocated throughout the group. High status, though risky to pursue, grants the individual increased access to limited group resources.

High status within the hierarchy gives an individual numerous benefits. For humans, high status grants the possessor the power to direct groups (i.e., leadership), control inner-group functioning, influence lower status group members, and gain privileged access to group resources. From an evolutionary perspective, competition exists to facilitate the perpetuation of those genetic lines that are most fit to reproduce. By competing for high status, the most able individuals are most likely to reproduce. By virtue of having high status, individuals who win social competitions are healthier, have better diets, less stress, are more likely to copulate, and their offspring are more likely to live to a reproductively viable age. In short, high status yields a life style that is generally more pleasant, healthier, and more productive, and thus is generally more desirable than a life of low status.

A large body of research has examined both human and nonhuman competition. Among many nonhuman species, competition takes the form of physical aggression between individuals or groups. This aggression is used to establish who is granted access to what resources, including food, territory, or mates. Even among humans, competition may take a violent and physically aggressive form. The establishment of territory, access to coveted resources, or religious conflict between countries and/or groups may lead to large scale conflict, such as war. Smaller scale interpersonal violence, such as physical beatings or homicides, may be born out of interpersonal competition over a highly coveted resource, for example two men fighting over the same woman. Across a number of species, including humans, males tend to be the primary perpetrators of aggressive competition. This may be due to patriarchal social structures, evolution disproportionately benefiting aggressive males, or the underlying biological mechanisms driving behavior. As discussed below, research suggests that it is a combination of all three.

Unlike nonhuman animal species in which physical aggression is the primary form of competition, human competitions do not always involve violence or physical aggression. Instead, humans have multiple routes to obtain resources and establish status. These alternate, nonaggressive routes include eminence (i.e., status given as a result of high levels of achievement), birthright, knowledge or ability, prosocial behaviors, and social manipulation or coercion. Some of the more explicitly competitive, but nonaggressive, means to pursue and obtain high status include academic achievement, work promotions, elections, or athletic competitions.

Research has shown that social competition develops at a young age, even during prepubescence. Children learn at an early age that there are both coercive and prosocial means for gaining status, and they learn to utilize both effectively. Even children who do not actively pursue high status clearly learn to recognize the behavioral strategies being utilized by their peers. Research shows that not only do children recognize different strategies, but they respond to them in different ways. Even amongst prepubescent children, coercive strategies tend to lead to less stable, more transient forms of high status, whereas

prosocial strategies tend to lead to more long lasting and stable forms of status. As an example, a bully may use coercion to establish his/her dominance, but that is very tenuous. A more friendly and prosocial strategy, alternatively, is more likely to yield higher numbers of friends, increased popularity among peers, and thus a stable coalition of social support.

Dominance and Competition

The drive to engage in social competition to move up the social hierarchy characterizes much interpersonal human behavior. 'Dominance' refers to this striving for attaining and maintaining high status. Within the realm of personality and social psychology, dominance is often conceptualized as a trait-like feature of a person's personality (i.e., it is an inherent, enduring, and relatively static aspect of an individual's social behavior). Dominance, as with other personality traits, varies between individuals, with some individuals exhibiting higher levels of dispositional dominance than others. Competition is a common behavioral outcome of a dispositionally dominant individual's striving for high status, and individuals high in dominance tend to succeed in achieving the high status positions they desire.

Dominance can be expressed interpersonally in a number of ways. Postural expansion, or carrying oneself to maximize one's perceived size, maintaining eye contact while speaking to another individual (whereas maintaining eye contact while listening to another individual is perceived to be nondominant), and lower rates of smiling among women (but not men) are some behavioral expressions of dominance. Dominant individuals also respond to perceived status threats with anger and aggression. High dominance has been characterized by actions such as spontaneously and eagerly engaging in interpersonal competition, establishing oneself as being in charge of a group, projecting competence regardless of actual ability, behaving assertive, and controlling the actions of others.

Dominance and Testosterone

A great deal of social endocrinology work has explored the role of hormones in human social behaviors, and no hormone has been given greater attention than testosterone. Testosterone is an androgen, meaning it is a steroid hormone derived from cholesterol that has masculinizing effects on an individual. Testosterone is produced in both men and women by the gonads, adrenal glands, and within the brain, though due to the fact that the testes produce testosterone in much larger quantities than any other source, men tend to have roughly seven times as much testosterone as women. Despite the great difference in testosterone levels between men and women, relative testosterone levels within sex can have similar influences on social behaviors in both sexes. For instance, a woman high in testosterone relative to other women will behave similarly to a man high in testosterone relative to other men, even though the high testosterone woman's testosterone levels will be much lower than the high testosterone man's. Although all hormone levels are subject to fluctuations caused by a number of factors, basal (i.e., resting or baseline) steroid hormone levels have been found to stay relatively static over extended

periods of time, leading many researchers to treat basal testosterone as a trait-like factor. It is worth noting that the majority of research on testosterone and competitive behaviors has focused on males. The findings and effects discussed below are based primarily on research on males, but sex differences and effects among females are discussed in section '[Sex Differences in Competition](#).'

In nonhuman animal species, testosterone has been associated with rank in the social hierarchy in a variety of species (e.g., baboons, deer, mandrills, chimpanzees, ducks, possums, mice, rats, grouse, finches), although only when the social hierarchy is unstable (justification for this is provided below in our discussion of the challenge hypothesis). Testosterone has also been found to be positively correlated with dominance-related behaviors, such as aggression. Just as with nonhuman animals, research on humans has established that there is a positive correlation between basal testosterone levels and dominance. Research shows that testosterone correlates positively with many behavioral aspects of dominance, such as high self-regard, scores on personality questionnaires, reactions to competitive outcomes, and social dominance. Basal testosterone also correlates with increased sensitivity to status-relevant information, even when that information is presented outside of conscious awareness, and reacts by rising or falling as a result of engaging in socially competitive behaviors.

The link between testosterone and aggression deserves special mention. Popularly, testosterone is believed to cause increases in aggressive behavior, but this is not entirely true. Research suggests that testosterone promotes dominance behaviors, which can be manifested behaviorally in a number of ways. In terms of aggression, though, dominance will only manifest itself as physical aggression in social groups in which physical force is an acceptable and efficient means by which to compete for status (e.g., prison populations). Social norms dictate that physical aggression in the pursuit of status is a potentially costly behavioral strategy, with the possibility of incurring punishment for violating those norms (e.g., arrests for violent crimes). Even in those instances when testosterone leads to aggressive behavior, research has found that the effect tends to be moderated by neurobiological mechanisms related to low levels of impulse control (e.g., low frontal lobe activity, low levels of serotonin).

Although the human literature supports the idea that testosterone is linked to dominance, it is not the case that testosterone influences behavior in every situation. The challenge hypothesis postulates that testosterone will influence behavior only during critical periods to facilitate behavior during moments of high competition, such as mating seasons or during times of hierarchy instability. Although originally developed to explain the mating behaviors of birds, the challenge hypothesis has since been expanded to explain a wide range of testosterone-behavior relationships in a variety of species. Researchers have confirmed that humans' physiology and psychology interact in ways that are consistent with the challenge hypothesis.

The critical role of the situation, according to the challenge hypothesis, is that testosterone will not have an effect on behavior if the situation does not contain a status threat or an opportunity to increase status. Put another way,

if testosterone is the underlying biological force driving dominance-related behaviors, testosterone will not influence behavior if there are no dominance-related gains to be had. If the social hierarchy is firmly established, there is nothing to be gained; then any influence testosterone might have on behavior will disappear. It is when the hierarchy is unstable, and thus high status positions are available, that testosterone's influence over behavior will become apparent. This is in contrast to the 'mouse model' which portends a direct cause and effect relationship between testosterone and behavior across all situations.

In summary, research has established that basal testosterone strongly influences dominance behaviors in humans. Further, both humans' and nonhuman animals' behavior will only be influenced by testosterone in social environments in which it is possible for an individual to increase his/her status. This means that competition is generally only engaged in when there is something to be gained from competing. It is also the case that testosterone and dominance strongly interact with the outcome of those social interactions in which status is gained or denied. The successful attainment or denial of high status and overt threats to one's status has been found to carry powerful psychological and physiological consequences.

Testosterone and Status Mismatches

The psychological motivations that drive an individual's desire for competition are deeply rooted in physiology, namely the testosterone circulating through their bloodstream. Given that this motivation is so deeply rooted, you would expect that successful attainment or the denial of high status would have dramatic consequences for a highly dominant individual. Research has found that success or failure when competing does elicit strong psychological and physiological reactions.

Researchers have found that when an individual engages in social competition, basal testosterone predicts a number of reactions to the successful attainment of high status or relegation to low status. If an individual is high in testosterone and experiences a victory, he/she will be content, indifferent to status-relevant information, report lower levels of negative emotional affect, and perform well on complex cognitive tasks. The opposite effect has been shown for high testosterone individuals who experience a loss. These high testosterone individuals show increased levels of negative affect, cognitive impairment, and an increased focus on status cues when relegated to low status positions.

Notably, this research has found opposite patterns of effects for those low in testosterone. Low testosterone individuals who experience a victory become unhappy, report high levels of distress, show cognitive impairment, and experience physiological arousal, such as increased heart rate. Those low testosterone individuals who lose a competition, though, report being quite content, perform very well on complex cognitive tasks, experience a drop in heart rate, and show a lack of interest in status-related information.

Termed the 'mismatch effect,' this illustrates the role of basal testosterone in social competition. Individuals high in basal testosterone have a strong desire for high status, whereas those with low basal testosterone levels actively avoid high status. When an individual is placed in a position of high or

low status that is incongruent with his/her desired status (i.e., a high testosterone individual in a low status position or a low testosterone individual in a high status position), they experience a number of negative consequences. A mismatch between actual status and desired status causes emotional distress, hypervigilance toward status-related information, physiological arousal, and a decline in complex cognitive processing. This mismatch effect also illustrates individual differences in dominance by demonstrating that not everyone is striving for positions of high status, that there are some who would prefer to avoid high status if at all possible. The adverse effects of status mismatches can also extend from the individual to the group level. If status mismatches exist among individuals within a given group, those mismatches are associated with greater pessimism among group members as to the likelihood of the group's success on a task. Also, as the correlation between individuals' testosterone and their status within a group becomes more negative (i.e., mismatches increase), the group as a whole functions more poorly.

It is clear that testosterone is intimately linked with dominance, and the successful attainment or denial of high status elicits strong reactions in dominant individuals. Winning or losing status competitions causes psychological and physiological reactions, and can lead to maladaptive behaviors. One strong reaction caused by the interaction of dominance and competitive outcomes is the short-term fluctuations in hormone levels that can further influence behavior.

Dynamic Testosterone Fluctuations in Competition

Although basal testosterone levels remain static over time and can be treated essentially as personality traits, testosterone levels are also subject to dynamic fluctuations in reaction to changes in the social environment. If basal testosterone is a biomarker of trait dominance, changes in testosterone levels are akin to a transient dominance mood state. A temporary rise in testosterone can lead to a temporary elevation in one's social competitive drive. Similarly, a temporary drop in testosterone can temporarily suppress one's natural competitive motivation. The reciprocal model of social endocrinology tackles the dynamic relationship between basal hormone levels, the environment, and transient hormone fluctuations. Specifically, hormones influence behavior, behavior influences the environment, changes in the environment cause temporary fluctuations in circulating hormone levels, and these temporary fluctuations in turn further influence behavior and the environment. Hormones, and certainly testosterone, act not only as partial causes of behavior, but also experience the effects of behavior.

Research on testosterone and competition has found that testosterone rises in response to competitive environments. Many athletes experience a rise in testosterone prior to engaging in athletic competition to facilitate dominance behaviors in the competitive environment. Athletes' testosterone rises significantly more before a competition played at home than away, presumably because more status is on the line when a team plays at home, and that the rise tends to be the strongest when a team is competing against a serious rival. This suggests that not only does testosterone rise in anticipation of a competitive event, but that the degree of status threat moderates the magnitude of testosterone increase.

A number of studies have also found that not only does testosterone increase in reaction to a competitive environment, but that it fluctuates in predictable ways in response to the outcome of a competition; specifically, testosterone increases following a victory and decreases following defeat. In fact, an individual does not even need to actually engage in competition to elicit these effects. An individual's testosterone follows this same pattern even when they experience a vicarious victory or defeat, such as an imagined victory, watching their political candidate win an election, or watching their sports team win a game.

These temporary fluctuations are an important signaling mechanism that prompts an appropriate behavioral response (i.e., rising levels prompting further engagement in competition, falling levels prompting withdrawal from competition). The temporary changes in testosterone following a loss influence how individuals choose to behaviorally react to that loss. They are either motivated to attempt to regain high status when testosterone increases or withdraw from the possible further loss of status when testosterone decreases.

Even though many researchers have found that testosterone levels change in reaction to the outcome of a competition, some research has failed to find this effect. Instead they found that testosterone changes following a competition were moderated by a number of psychological factors. For instance, in some group competitions, increases in testosterone are positively correlated with how much an individual contributes to his/her team's victory, such that the more a given individual was responsible for his/her team's victory, the more his/her testosterone will increase. It has also been found that changes in testosterone levels are negatively correlated among winners who attributed their victory to external factors (e.g., luck), and were positively correlated amongst losers who made the same external attributions. This suggests that simply engaging in competition is not enough, but that psychological factors, such as motivation and cognitive appraisals of the competitive situation, are what drive reactions to competitive outcomes.

Nonconscious motivational drives can also moderate the effect of competition on testosterone fluctuations. Namely, those who are high in implicit (i.e., nonconscious) power motivation show the expected hormonal reactions to winning or losing a contest. In this case, the competition–testosterone–change link is dependent on personality factors related to an unconscious desire for power and high status, not merely the experience of winning or losing. Some research has also found that some personality factors not even directly related to status and power can also influence the relationship between competition and testosterone change, such as social anxiety.

Even though previous research has clearly linked testosterone to status-seeking, there have been striking inconsistencies across studies. Although much of the research summarized above did indeed show effects of testosterone on behavior, other studies have found weak or null effects. One explanation is that testosterone's effect on behavior is moderated not only by psychological factors, but also by the hormone cortisol.

The Moderating Role of Cortisol

Cortisol, like testosterone, is a steroid hormone. Cortisol is known primarily for its role in the physiological stress response

via activation of the hypothalamic–pituitary–adrenal axis (HPA-axis). The HPA-axis consists of the series of communications between the hypothalamus and the pituitary and adrenal glands. When the hypothalamus receives information that there is a threat in the environment, it relays a signal via the pituitary gland to the adrenal gland, which releases cortisol, as well as other hormones such as epinephrine and norepinephrine. The resulting stress response causes physiological changes which include increased respiration, heart rate, blood pressure, and blood glucose levels. These changes are all intended to prime the organism to physically respond to the threat by facilitating fight or flight behaviors. Unlike the catecholamines (i.e., epinephrine and norepinephrine), cortisol is able to pass through the blood–brain barrier, making it the primary behavioral influence during active stress responses. As such, cortisol has been shown to have not only physiological effects, but psychological and behavioral effects as well.

Not only is cortisol linked to the experience of stress, but it has been linked to approach and avoidance behaviors as well. Approach motivation is conceptualized as a broad system motivating behavior toward desirable and rewarding outcomes. Avoidance motivation, on the other hand, is a parallel system that motivates an individual to behave in ways that facilitate moving away from undesirable outcomes. Essentially, high approach motivation is characterized by appetitive behaviors and sensitivity to reward, whereas avoidance motivation is characterized by avoidant behaviors and sensitivity to punishment. High levels of cortisol have been found to correspond to behavioral inhibition, shyness, and introverted behavior, all avoidance motivation behaviors. Low levels of cortisol, on the other hand, have been found to correspond to extraverted and disinhibited behaviors, more approach-motivated behaviors.

Cortisol has been shown to play a moderating role between testosterone and behavior. Namely, high cortisol levels can suppress the action of testosterone. Given what we know about the relationship between testosterone and dominance behaviors, combined with the moderating role of status-relevant situational cues, the impact of cortisol provides yet another important factor underlying the manifestation of social competition. Testosterone is the underlying force driving social competition, but certain psychological (e.g., need for power) and situational (e.g., status threat) conditions must be met for testosterone to be manifested behaviorally. In addition to these conditions, testosterone's behavioral manifestation also depends on low levels of basal cortisol.

For instance, research shows that basal cortisol and basal testosterone interact to significantly predict individual differences in overt aggression among adolescent males, such that testosterone and aggression are related only when the individual also has low levels of cortisol. When cortisol is high, testosterone and aggression are unrelated. Furthermore, the effects of testosterone on competition and leadership behaviors are also only expressed when basal cortisol is low. For instance, when cortisol is low, basal testosterone predicts whether or not an individual will continue competing or will withdraw from competition after having been defeated once. Specifically, high basal testosterone motivates an individual to re compete after a loss, while low basal testosterone motivates withdrawal to avoid further losses, but this effect is only observed if basal cortisol is low. When cortisol is high the

effects of testosterone following a defeat are suppressed. This cortisol–testosterone interaction effect can even be extended to other dominance-relevant situations, such as leadership. Once again, basal cortisol moderates the effect of testosterone on behavior, such that when cortisol is low, the higher an individual's basal testosterone, the more dominant their behavior will appear to others. This behavioral effect of testosterone completely disappears among those leaders who have high levels of basal cortisol.

This moderation suggests that the biological underpinnings of social competition are more complex than a univariate relationship between testosterone and competition. It is not enough to have a testosterone-fueled desire to attain and maintain high status, but one also needs to have an approach motivated social style to act on that desire. Or at the very least, to not have a socially fearful, avoidance motivated behavioral style.

Research on the physiological interaction of testosterone and cortisol suggests a number of possible mechanisms for how cortisol is able to moderate the relationship between testosterone and behavior. Just as cortisol is tied to the HPA-axis, testosterone is tied to the hypothalamic–pituitary–gonadal axis (HPG-axis). The HPG-axis cues the release of testosterone in preparation for reproductive behaviors. These two axes have an antagonistic relationship, that is, when one axis is activated, the other is suppressed. Thus, when the stress response is activated, reproductive behaviors will be suppressed until an organism's physiology has returned to baseline. Cortisol, as well as other glucocorticoids, can also have an impact on the expression of androgen receptors. High levels of glucocorticoids downregulate the expression of androgen receptors. Thus, high levels of cortisol might not affect testosterone levels, but rather affect the degree to which testosterone could influence behavior by regulating the number of available receptor sites for testosterone to bind to.

Sex Differences in Competition

As stated above, the majority of research on social competition has focused disproportionately on male behavior. There is a relative dearth of research on competitive behaviors among women, but the existing research does suggest that there are sex differences in how men and women engage with and react to competition. Some evolutionary psychologists have theorized that there should be clear sex differences in competitive behavior. Namely, men are more motivated by competition, both as individuals and as a group, whereas women are motivated by social needs. For instance, some behavioral research has found that women tend to cooperate more than men across situations, whereas men tend to cooperate with one another primarily as a means to compete as a group against another group. These theories suggest that, evolutionarily, women are more interested in protecting offspring and promoting social cohesion for the purposes of maintaining social stability and security. As is outlined below, there are mixed findings on how women's competitive tendencies match or differ from those of men.

A number of research studies have found that females (both women and young girls) tend to be less competitive than their

male counterparts. There are a number of possible explanations for why men and women differ in their competitive tendencies. As mentioned above, some evolutionary theorists have suggested that although it is beneficial for men to engage in competitions to establish status, women benefit more from prosocial engagement to establish social stability. Research on stress and threat response behaviors seems to support this view, by exploring the possibility that the traditional 'fight or flight' response may be specific to male behavior, and that females may respond to threat by engaging with friendly conspecifics to establish safety and security in numbers. These theories suggest an inherent behavioral tendency away from competition and toward friendly social engagements among females.

On the other hand, anthropological research suggests that these sex differences in competitive behavior may result from strong socializing forces. When comparing patriarchal societies to matrilineal societies, women raised in a matrilineal society tend to be more behaviorally competitive than the men in that society, whereas in patriarchal societies, men tend to be the more competitive sex. These findings are conceptually in line with evolutionary theories in a broad sense, namely that different behavioral orientations (i.e., competitive vs. cooperative) yield different social benefits. The clear difference between these views is whether these differences are innate or learned. It appears that it is some combination of both. Although research in anthropology has shown that socialization determines whether competitive behaviors are more prevalent among men or women, research in social endocrinology suggests that there are underlying physiological systems tied to sex differences in competitive behaviors.

As stated previously, women's levels of circulating testosterone are much lower than men's, due to differences in the sources of testosterone. The testes produce the vast majority of testosterone in men, whereas women's testosterone is produced primarily by the adrenal glands, and to a lesser extent the ovaries. Ultimately, women have roughly a seventh of the amount of circulating testosterone as men. It is worth noting that although women's testosterone levels are significantly lower than men's, their basal testosterone is equally stable over time.

Research examining the relationship between testosterone and dominance in women has yielded mixed results in terms of whether testosterone's effects are the same across sexes. Women's basal testosterone predicts aggression and dominance, social status, performance in individual versus group competitions, and cognitive impairments associated with status mismatches. In fact, the research on the effects of status mismatches has been conducted primarily with mixed-sex samples, and has found similar patterns of results for both men and women. Some research, though, do not replicate the testosterone effects found in men among a female sample. Research on the anticipatory changes in testosterone prior to an athletic competition has found that some female athletes do not experience an elevation in testosterone leading up to a competition, but other findings support this relationship. Other research has also found that some female athletes do not experience the postcompetition fluctuations in testosterone (i.e., a win or lose dependent increase or decrease in testosterone), but other findings have found this postcompetition fluctuation.

Although the replicability of testosterone–dominance findings among women is mixed, preliminary research has begun to examine the possibility of a female-specific endocrine-dependent form of dominance. Some researchers have found that certain hormones, for instance the estrogen estradiol, are better predictors of dominance behaviors in women than testosterone. This research suggests that women possess a similar endocrine–dominance relationship, simply one that is not necessarily testosterone specific. The research to date examining dominance in women indicates that further understanding of the potential sex differences in the physiological underpinnings of dominance behavior is an important and rich avenue for future research.

Although there appear to be sex differences in competitive behaviors, research is mixed as to what those differences are and what is underlying those differences. Behavioral research suggests that women are not as competitive as men, possibly due to socialization or due to the different evolutionary goals associated with competition versus cooperation. Social endocrinology research has also produced mixed results in terms of sex differences and dominance. Some research, such as reactions to status mismatches, show limited sex differences, yet other research, such as athletic competitions, show clear differences between men and women. These mixed results may be due to erroneously applying theories and approaches derived from male-specific research to females.

Competition and Behavioral Economics

A rich field of research that has looked at human competitive behaviors is the field of behavioral economics. The study of behavioral economics relies on the basic premise that in most instances there are limited resources available to a group, thus creating an inherent conflict between the interests of the group and any one individual within that group. For instance, by focusing solely on one's own interests, the individual may utilize more of a given resource than his or her equitable portion. This overuse of a resource creates shortages for the rest of the group, which in turn leads to increased and potentially costly competition within the group. Behavioral economics utilizes interpersonal economic 'games' that rely on pitting an individual's self-interest against that of a cohort. In most instances, an individual can obtain a modest gain by cooperating with his/her partner, but could potentially obtain a larger gain by defecting from his/her partner. High levels of dispositional competitiveness have been linked to an increased propensity to betray one's partner to obtain more resources, but a number of situational and social factors influence behavior as well.

Research shows that the behavior of an individual's partner exerts a powerful influence over how that individual will behave. If a partner is viewed as acting unfairly, the other individual will respond by rejecting any kind of cooperation, even if that rejection knowingly causes all of the resources to be lost for both players. This retaliatory behavior serves to reinforce social cooperation and maintain a certain level of parity within the dyad regarding the distribution of resources. Aggressive and competitive behavior on the part of one's partner increases the likelihood that an individual will respond with

an equally aggressive and competitive behavioral style. The opposite effect has also been found to be true. Individuals are more likely to behave cooperatively and noncompetitively if they are interacting with a cooperative partner.

Two important situational factors moderate this reciprocal effect. First, reciprocity is particularly pronounced if individuals are interacting repeatedly over a series of trials. Repeated cooperative interactions lead to developing a sense of trust. Because individual success is tied to the behavior of the individual's partner, individuals recognize that punishing an aggressive partner and trusting a cooperative partner is the best strategy for maximizing one's gains. Second, physical distance and anonymity both decrease reciprocal behaviors. If an individual is physically isolated from his/her partner and is able to behave anonymously, it increases the likelihood that that individual will behave aggressively and competitively, regardless of the partners' behaviors. Anonymity appears to nullify the social motivation to reciprocate.

The threat of retaliation is also affected by the magnitude of the resources at stake. When individuals are engaging with one another during an economic decision making game, the higher the stakes, the more likely individuals are to act fair and cooperate with one another. If there is relatively little to be gained or lost, individuals will act more competitively, because the potential to gain an extra amount is offset by the potential to lose an equally small amount. On the other hand, when the stakes are higher, not only is there a potentially larger gain to be had, but there is also the threat of potentially larger losses. Humans have a well established aversion to losses, so as the stakes increase, the threat of a large loss exerts a greater influence over behavior than the potential for a large gain, meaning that as the stakes increase, competitive behaviors decrease.

In addition to situational and social forces, individual differences also influence whether one acts aggressively or cooperatively toward his/her partner. Research has shown that dispositional dominance is a power factor in determining whether an individual tends toward a competitive or cooperative orientation. The effect of dominance is moderated by situational forces, in some instances driving an individual to treat their partner as a competitor and attempt to secure as many resources for him/herself as possible, and actually facilitate cooperative behavior between individuals in other instances.

In some interactions, an individual high in dispositional dominance may view cooperation as an acknowledgment that both individuals are equal, and may opt to act aggressively to establish his/her higher social status. Research has supported this theory, showing that high dominance individuals view these situations as moments of potential status instability. If the pair is even, at the outset, high dominance individuals will engage with their partner with a competitive motivation, attempting to acquire more resources than the partner in order to elevate their own status. If the pair is asymmetrical in some way (e.g., one individual has more resources than the other), high dominance individuals will respond to this asymmetry as a status challenge, and respond with aggression and/or retaliation in order to obtain or preserve their status. On the other hand, research has also shown that in certain circumstances high levels of dominance may actually increase the likelihood of cooperative behavior. Recall that there are a

number of strategies for obtaining high status, one of which is to behave prosocially toward one's peers. In the context of economic games, by acting prosocially toward one's partner, it minimizes the likelihood that the partner will retaliate or punish the individual, and increases the likelihood that the partner will reciprocate the cooperative behavior. It has been suggested that a key circumstantial factor in determining which behavioral strategy will be adopted is whether or not an individual feels a continued dependence on one's partner to succeed. Individuals dependent on their partners are more likely to adopt a prosocial strategy, thus maximizing their benefit in the long term.

Conclusions and Current Research Trends

Competition among social animals takes many forms, including physical aggression between individuals over a specific resource and social competition for high status positions within a hierarchy. High status positions offer a much more efficient and less costly means to distribute limited resources. Just as is the case among rats, mice, chimpanzees, baboons, and countless other social animals, it is also the case among humans.

The primary biological fuel driving social competition is testosterone, which manifests itself behaviorally as dominance. Dominance behaviors are meant to facilitate one's ascension up the social hierarchy by besting other individuals within the same hierarchy. The effect that testosterone has on dominance behaviors is moderated by two important factors. One is the hormone cortisol, which acts as a behavioral inhibitor, such that when cortisol is high, testosterone's influence on behavior is suppressed. The other important factor is the presence/absence of appropriate social circumstances; namely, conditions under which competition will yield actual social rewards.

Recent research has begun to explore more complex neurobiological and genetic factors that may be influencing competitive behaviors. Neuroscience research is examining the potential role of brain structures related to emotion regulation and impulse control on behaviors such as aggression and economic decision making. Behavioral genetics research has been studying how genetic variations on neurotransmitter and neurochemical promoter genes potentially influence complex social behaviors, such as how the underexpression of certain neurotransmitters may reduce impulse control or blunt threat responses. These approaches are being combined with continued research on situational, environmental, and cultural

influences over competitive behavior to further elucidate the dynamic and interactional relationship between the environment and biology that gives rise to complex social behaviors. Ultimately, the merging of multiple disciplines has led to a highly nuanced examination of the biological, social, and environmental forces influencing social competitive behaviors.

See also: [Aggression](#); [Violence](#).

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Confabulation and Reality Filtering

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Glossary

Confabulation The emergence of memories of events and experiences which never took place.

Frontal-subcortical loops Anatomically defined, separate loops connecting specific parts of the prefrontal lobes with the striatum, globus pallidus, substantia nigra (reticular part), and the thalamic nucleus having connections with the loop's originating part of the prefrontal cortex.

H₂[15]O-PET Positron emission tomography using radioactively labeled water to study the distribution of metabolic activity in the brain.

Orbitofrontal cortex Area at the inferior aspect of the frontal lobes. Its posterior medial part has limbic connections and projects to the ventral striatum.

Substantia nigra Anatomical structure in the midbrain with two components: (1) the reticular part participates in the frontal-subcortical loops; (2) the pars compacta has the dopaminergic neurons, which have multiple functions. They are part of the brain's reward system; their degeneration contributes to the symptoms of Parkinson's disease.

Definition

Confabulation derives from the Latin word 'confabulari' whose original meaning was to gossip, to chat, or to discuss something with somebody. The word 'fabula,' contained in confabulation, primarily meant a chat, dialog or tattle with people, but it also meant the saga, fairy tale, and fiction.

Confabulation made its first appearance in the medical literature around 1900, when Carl Wernicke used the term in his textbook on psychiatry and defined it as 'the emergence of memories of events and experiences which never took place.' The term replaced the previous denominator, which Sergei Korsakoff had used in his writings on confabulation around 1890: pseudoreminiscences. Korsakoff had defined them as 'a situation in which a patient conceived of an event that he had not really experienced, but that had only come to his mind, as if it had really happened to him.'

Thus, since its first appearance in the medical literature, confabulation denoted a failure of memory, a mnestic phenomenon. Later authors introduced diverse refinements to the definition, claiming that confabulations had to be unintentional; that they might have fantastic features, or not; could only occur in organic brain damage, or also in psychiatric disease; only concerned autobiographical memory, or might extend to semantic memory, etc. None of these limitations is unequivocally accepted.

The term confabulation was eventually also used to describe false statements emanating from incorrect perceptions of bodily states or of the outer world. These confabulations may be classified as nonmnestic confabulations. For example, the term was used to describe the false idea of patients who have half of their body paralyzed but believe that they can move it normally, a situation called anosognosia. Likewise, patients with psychosis or organic brain damage may believe they are in another place than the real one (reduplicative paramnesia) or pretend to know unfamiliar people or not to know familiar people (Capgras syndrome; misidentification syndromes). These nonmnestic confabulations often occur independently of mnestic confabulations and normally have different anatomical bases. Their

association with mnestic confabulations will be discussed below. In the following, confabulation denotes mnestic confabulations unless otherwise stated.

Forms of Confabulation

From the beginning of the twentieth century, many authors distinguished different types of mnestic confabulations. The most common distinction proposed the following dichotomy:

1. Momentary confabulations (other terms: out-of-embarrassment, classic compensatory, or plausible confabulations): in most definitions, these confabulations were considered a consequence of memory loss resented by the patient who would invent answers to questions in order to avoid embarrassment.
2. Fantastic (or productive) confabulations: these would be produced spontaneously and resemble delirious, dreamlike states, as seen in psychosis.

Another distinction, initially used to separate different degrees of confabulation, is the following one:

1. Provoked confabulations: these confabulations occur in memory tests and may also occur in healthy subjects. They were also considered a normal response to a faulty memory.
2. Spontaneous confabulations: these were considered a pathological phenomenon, possibly reflecting an incoherent and context-free retrieval of memories. Another definition requires patients to act in agreement with the confabulations as the proof of their spontaneous generation.

The precise definitions proposed by different authors often seemed to be influenced by, and limited to, the precise types of brain damage that they had studied. Although the two classifications are widely accepted, the precise meaning of the terms varies considerably between studies. Numerous authors used these classifications to describe different degrees, rather than different forms, of confabulation. However, some

dissociations have been proven. For example, the tendency of patients to make intrusions in memory tests, that is, to produce words that were not originally in the test (provoked confabulations) doubly dissociates from the tendency to act according to spontaneously produced confabulations. Also, the severity of confabulations does not predict an association with behavior: patients producing the most intense fantastic confabulations, reported at times when antipsychotic medications were not available yet, showed no tendency to act on the basis of these confabulations.

Thus, the proposed classifications described above, which entail a dichotomy, do not account for the known dissociations between confabulations. I suggested the following classification that accounts for the currently known forms of confabulations:

1. Simple provoked confabulations encompassing intrusions or occasional distortions in memory tests. These confabulations may also occur in healthy subjects. Thus, when recalling the words from a previously learned word list, subjects may produce items that were not in the list.
2. Momentary confabulations, which consist of false verbal statements produced upon some form of incitement, be this questioning or the circumstances of a discussion. False statements can range from a slightly distorted response to a question – and then appear to be provoked – to elaborate, apparently spontaneous confabulations in a discussion. Momentary confabulations may occur in diverse brain diseases, may be present initially or appear in the course after brain damage, and are probably not a unitary disorder. For example, a hospitalized patient may falsely believe to have been at work in the morning (autobiographical confabulation), pretend to know what he ate for lunch on January 5th 2003 (autobiographical) or invent elements when recounting a fairy tale (semantic confabulation).
3. Fantastic confabulations, which have no basis in reality and are intrinsically nonsensical and illogical. These confabulations are very rare and may occur in severe psychosis, delirium or advanced dementia. For example, patients have been described who believed that they were the richest kings on earth, had been Adam in paradise or had already landed on Mars.
4. Behaviorally spontaneous confabulations in which patients recount invented recent experiences and describe plans for the future that are incompatible with their current situation. At least occasionally, they also act according to such false ideas. Mostly, they enact former habits: they think they have business meetings or that they are expected at home. This form is always accompanied by amnesia (as measured by free recall) and disorientation: the patients do not know the time, place or their current role. For example, a 58-year old mother, who had suffered rupture of an aneurysm of the anterior communicating artery, left the examination in the conviction that she had to feed her baby, who was 35 years old at the time.

Until now, only the dissociation between forms 1 and 4 has been proven. Patients may have a combination of momentary and behaviorally spontaneous confabulation, possibly also fantastic confabulations.

Simple provoked confabulations – according to the above definition – require focused memory testing and will then become evident as intrusions. The other forms are normally easily detected in a discussion, when patients talk about events or experiences that have not really taken place. Questionnaires containing questions that cannot normally be answered have been proposed to quantify momentary confabulations. Fantastic confabulations are often produced spontaneously by confused patients but may be spurred by questions. Behaviorally spontaneous confabulation normally requires clinical observation: while the confabulations come out in discussions, in which patients recount experiences and actions that have not truly taken place, the spontaneous behavior betraying the spontaneity of the false ideas may only be revealed by behavioral observation. The combination of amnesia with disorientation increases the likelihood that a patient has behaviorally spontaneous confabulation; the absence of disorientation makes the presence of behaviorally spontaneous confabulation unlikely.

Disorders Associated with Confabulation

Initial descriptions of confabulations emphasized their association with anterograde amnesia and disorientation. Later observations suggested an association with false recognition as well as behavioral particularities, namely, anosognosia and misidentification syndromes. The following paragraphs summarise the evidence.

Simple provoked confabulation will not be particularly considered in the following; as they also occur in healthy subjects, these associations are obviously not mandatory for provoked confabulations to occur. Overall, simple provoked confabulations (intrusions) are more common in brain damaged subjects, but their intensity correlates neither with the severity of amnesia nor of executive failures. Most notably, simple provoked confabulations are not associated with false recognition: among comparably severe amnesic subjects, the number of intrusions produced in a recall paradigm does not correlate with the number of items falsely recognized in a recognition paradigm.

In the other forms of confabulation, the associations are more complex.

Amnesia

Relevant momentary, fantastic, and behaviorally spontaneous confabulations are always associated with moderate-to-severe amnesia as measured with tests of delayed free recall, that is, when subjects have to reproduce information from memory with no external help. By contrast, if a memory task is relatively free of strategic demands and just requires recognition of previously presented material, amnesia is not always present. This may be tested, for example, with a continuous recognition task, in which subjects see a long list of items (typically pictures) and are requested to recognize item repetitions within the series. Under such conditions, occasional behaviorally spontaneous, and presumably also momentary and fantastic confabulators, may demonstrate intact learning and recognition. Thus, in

terms of simple information storage, confabulation and amnesia may dissociate; confabulation need not be associated with a gap in memory.

Disorientation

Disorientation describes the inability to correctly acknowledge the current time, place, one's role, and personal identity. These dimensions are called orientation to time, space, situation, and person, respectively. Personal orientation is rapidly restored after most types of brain damage. While fantastic confabulations, as described in the early literature, are often characterized by absurd misinterpretation of one's own identity, momentary and behaviorally spontaneous confabulation were mostly described in patients with intact personal orientation. Most patients with momentary confabulations, especially if they also have severe amnesia, are also disoriented. But the association is not mandatory. This is different with behaviorally spontaneous confabulation which is characterized by a confusion of reality that is practically always measurable as a disorder of orientation. Although disorientation can result from severe amnesia alone, most instances of disorientation have the same mechanism as behaviorally spontaneous confabulation, namely a failure of memory filtration and extinction capacity that will be described below.

False Recognition

False recognition describes the erroneous familiarity with items in memory tasks; test subjects believe they have encountered a piece of information in a specified previous context (e.g., a word in a previously presented word list) when, in fact, the information has not been presented. Although false recognition may occasionally be observed in memory impaired patients, there is no confirmed association with any form of confabulation; indeed, the two phenomena doubly dissociate.

Paramnesic Misidentification

Paramnesic misidentification describes erroneous interpretations regarding places, people, or the current situation. Some patients with behaviorally spontaneous confabulation, possibly also other confabulations, are convinced that they are not at a hospital but rather at a familiar place, typically their home or their work place. This false identification of one's current whereabouts is called reduplicative paramnesia. Similarly, patients may falsely recognize strangers as friends or colleagues, or deny familiarity with people they correctly perceive (Capgras syndrome). Although these misidentifications of places or people can sometimes be observed in behaviorally spontaneous confabulators, the association is not stable: many patients do not have such misidentification problems. Conversely, these misidentifications may occur without any other form of confabulation and are then not accompanied by corresponding acts. The same is true for another form of paramnesic misidentification: *déjà-vu*, the strange feeling that one has already lived the present situation in precisely the same way. *Déjà-vu* has no confirmed association with mnemonic confabulation.

Anosognosia

This term was originally introduced to describe the unawareness of unilateral hemiplegia, but is nowadays used to describe unawareness of disease in general. The false statements that the patients make about their paralysed side have been called confabulations (classified as nonmnestic confabulations in this article). Conversely, diverse authors suggested that anosognosia of memory failure was a common feature of and a prerequisite for the occurrence of confabulation. Whereas fantastic confabulators, as they have been described in the old literature, have mostly no sense for the absurdity of their thoughts, momentary confabulations may also be produced by patients who are fully aware of, and suffer from amnesia. In behaviorally spontaneous confabulation, the association is more complex: although patients are normally unaware of the falseness of their perceived reality, occasional patients may be aware of having a memory problem.

Normal False Memories

Normal false memory denotes false products emanating from normal memory processing by healthy subjects. Apart from occasional provoked confabulations, which may also occur in healthy subjects, the confabulations discussed in this article occur in the context of pathological brain dysfunction or damage and are, therefore, by definition distinct from normal false memory. Nonetheless, a brief review may be warranted, all the more so because some mechanisms hypothesized to explain confabulation were meant to cover normal false memories, too.

Memory storage and retrieval is thought to rely on associative processes that do not necessarily produce a precise record of an experience. Even personally very engaging memories – so-called flash-bulb memories – may undergo significant distortion over time, even if they are normally relatively resistant to alterations. The fact that the healthy brain processes the meaning, rather than just perceptual features of information renders memory vulnerable to associative errors. This weakness, resulting from the associative power of memory, is exploited in the DRM-paradigm (Deese-Roediger-McDermott-paradigm) in which subjects learn a list of words (e.g., door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze, sash, scream, shutter) which together associatively encircle a target word not present in the list (e.g., window). When healthy subjects learn such a list and later recall it, they are likely to produce the target word, which is also falsely recognized as having been present in the list. Amnesia seems to have a protective effect against this type of susceptibility. In the standard DRM-paradigm, confabulating amnesics did not differ from nonconfabulating amnesics as regards susceptibility to the DRM-effect.

Errors of normal memory have had the most dramatic impact in eyewitness testimony. Indeed, innumerable studies have shown that the precision of memory storage and retrieval may be heavily influenced by cognitive and mood states at the time of an event (e.g., ethnical biases), information received after an event (e.g., confirmatory feedback) and the phrasing of questions. Manipulative procedures are most efficacious if

the memory of an event is relatively weak and manipulative information or questions are plausible. Under certain circumstances, it is possible to plant completely invented memories that may be held with similar conviction as true memories.

The relationship between normal false memories and confabulation has never been formally explored. However, it appears that normal false memories are created during the normal processing (retrieval, reconsolidation) of memories and may be augmented or induced by manipulation at storage or just before retrieval of information. There is no evidence that pathological confabulations have to be planted first or require suggestive questioning. They are very often composed of fragments of memories of real events experienced before the occurrence of brain damage. It is therefore likely that normal false memories and pathological confabulations have independent mechanisms effective at different stages of memory processing.

Etiologies and Anatomy of Confabulations

Not all confabulations require brain damage. Provoked confabulations can also be induced in healthy subjects, although their frequency markedly increases after brain damage. In the following, the causes and the anatomy of behaviorally more relevant confabulations will be reviewed: momentary, fantastic, and behaviorally spontaneous confabulation.

The distribution of brain diseases provoking confabulations has evolved over the last century. The sequels of malnutrition and alcohol can nowadays be limited with vitamin B1 supplementation; syphilis of the nervous system can be treated with antibiotics. Conversely, previously deadly diseases such as herpes encephalitis and aneurysm bleeding are nowadays more often survived; unfortunately, some survivors are left with severe cognitive deficits including confabulation.

Since the early descriptions, a multitude of causes of confabulations were recognized: paralytic dementia (syphilis), alcoholism and malnutrition, infections, hypoxia, traumatic brain injury, diverse types of poisoning, etc. With many of these causes, confabulations occurred during an acute confusional state (delirium), that is, a state of incoherent thinking, hallucinations, and fluctuating attention.

Momentary Confabulations

Momentary confabulations have been recognized in many brain diseases. In the early literature, malnutrition, especially in the context of chronic alcohol abuse, was the most frequently reported cause of confabulation, nowadays known to be caused by a deficit of thiamine (vitamin B1). The Wernicke-Korsakoff syndrome – according to the original descriptions – encompasses amnesia, a strong tendency to confabulation, disorientation, plus physical impairments: oculomotor disturbances and ataxia. The precise cause of the amnesia itself is still a matter of debate: destruction of the mamillary bodies or the dorsomedial thalamic nucleus, or frontal and medial temporal lobe dysfunction have been invoked. In what way confabulatory amnesia in this syndrome anatomically differs from nonconfabulatory amnesia, is unknown.

Nowadays, the most quoted cause of relevant momentary confabulation is rupture of an anterior communicating artery

aneurysm with destruction of the basal forebrain and orbitofrontal cortex. However, confabulatory amnesia is very rare with modern neurosurgical and neuroradiological treatment and may concern a maximum of 3–5% of affected people.

Many other causes of momentary confabulation are known, ranging from traumatic brain injury and tumors to ischemic stroke, encephalitis, or hydrocephalus. Many of these diseases do not induce circumscribed brain lesions and do, therefore, not contribute to the understanding of the anatomical basis of momentary confabulation. In those diseases that cause circumscribed brain lesion (tumors, stroke, etc.), confabulations appear to be more common when a lesion involves the anterior ventral part of the brain including the orbitofrontal cortex, basal forebrain, and hypothalamus. But the association is not strict: occasional patients with posterior lesions involving the medial temporal lobe or even the parietal lobe, who confabulated significantly, have been described.

Fantastic Confabulations

The most striking examples of fantastic confabulation, completely nonsensical and illogical, were described in the early literature in patients having advanced syphilis of the nervous system (paralytic dementia) or schizophrenia. Both diseases are nowadays causally or symptomatically treatable. Neither has a circumscribed anatomical basis. In the more recent literature, fantastic confabulations, typically less absurd than those following the above causes, were reported in the early phase after acute brain damage of diverse etiologies, including, for example, aneurysm rupture, encephalitis, or multiple sclerosis. In addition, they have been described in advanced dementia, which differs from a confusional state by more stable basic attention.

Behaviorally Spontaneous Confabulation

Behaviorally spontaneous confabulations share many causes with momentary confabulations: rupture of an anterior communicating artery aneurysm, traumatic brain injury, herpes encephalitis, etc. Indeed, behaviorally spontaneous confabulators sometimes go on to produce only momentary confabulations: they no longer act according to their confabulations and orientation improves. The anatomical basis of behaviorally spontaneous confabulation has become clearer over the last years. **Figure 1** shows an overlap of focal brain lesions of patients presenting behaviorally spontaneous confabulation (with disorientation) in comparison with nonconfabulating patients having similarly severe amnesia, as determined with measures of free recall. As **Figure 1** shows, the confabulating patients had a strong lesion overlap in the area of the posterior medial orbitofrontal cortex. Additional lesion sites have been described: a lesion of the knee of the right internal capsule; stroke of bilateral paramedian thalamus; amygdala damage on the right side combined with perirhinal damage on the left side; or lesions (sarcoidosis, tumor) of the anterior hypothalamus. In summary then, all hitherto reported cases presenting with behavioral spontaneous confabulation, which persisted beyond a confusional state (delirium), had lesions that involved the posterior medial orbitofrontal cortex, in particular area 13, or brain areas having a direct connection with it.

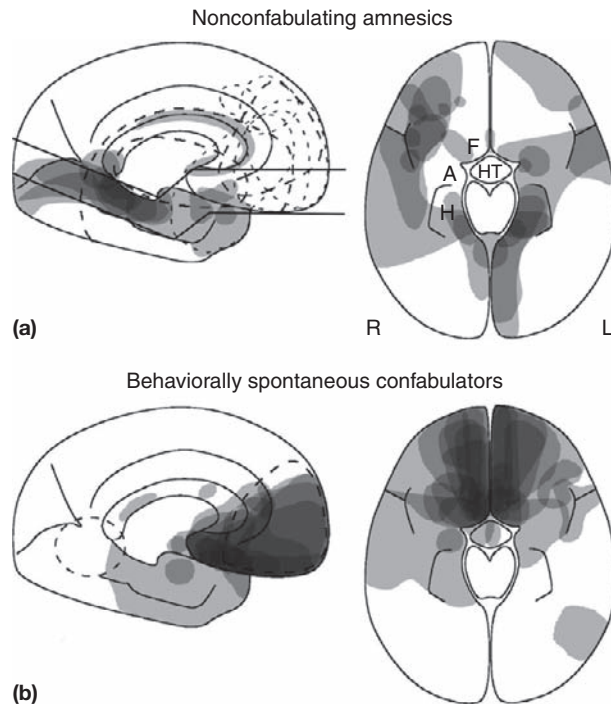


Figure 1 Anatomy of behaviorally spontaneous confabulation. (a) Lesion overlap of nonconfabulating amnesics. (b) Lesion overlap of behaviorally spontaneous confabulators. Shaded areas indicate lesions of the paramedian cortex (left template) or inferior surface (right template). Dashed lines are used to indicate lesion of the lateral convexity (left template). A, amygdala; F, basal forebrain; H, medial temporal lobe including hippocampus; HT, hypothalamus. Reproduced from Schnider A (2008) *The Confabulating Mind. How the Brain Creates Reality*. Oxford: Oxford University Press, with permission from Oxford University Press.

Area 13 was also activated – as measured with $H_2[15]O$ positron emission tomography – in healthy subjects, who successfully performed a task of memory selection on which behaviorally spontaneous confabulators had failed.

A continuing mystery is that only a small minority of patients having a type of brain damage that normally accounts for significant momentary or behaviorally spontaneous confabulation will actually confabulate beyond the confusional state. This is true for ruptured aneurysms, diencephalic tumors, traumatic brain injury, and alcoholic Korsakoff syndrome. Amazingly, only a few percent of these patients subsequently present with behaviorally spontaneous confabulation. Also, most patients with this syndrome eventually stop confabulating and regain a correct sense for reality. It seems that the structures essential for reality adaptation in thinking, whose failure accounts for behaviorally spontaneous confabulation, are redundantly organized.

Clinical Course

There are very few studies describing the clinical course of confabulation, and most of these are case reports. In degenerative

disorders, confabulatory tendency may increase over time, although no specific pattern has been described. If confabulation is due to acute brain damage, it normally decreases over time and transitions between different forms of confabulation may occur. Patients who produce fantastic confabulations in an acute confusional state (delirium) may subsequently cease to confabulate, produce momentary confabulations, or suffer the reality confusion characterizing behaviorally spontaneous confabulation. The latter transition has only been described in patients having damage to the posterior medial orbitofrontal area or structures directly connected with it. Patients having behaviorally spontaneous confabulation may simply stop to confuse reality and to confabulate; others may stop to produce inappropriate acts but still produce momentary confabulations in response to questions. Momentary confabulations may occur in the course of a memory disorder with no transition to other forms of confabulation. These observations indicate that the different forms of confabulation are at least partly independent disorders rather than different degrees of a common disorder. Confabulatory behavior of any kind often ceases despite continuing amnesia.

The course of behavioral spontaneous confabulation has been studied more specifically. Virtually all patients eventually stop to confuse reality. They stop confabulating and regain correct orientation about time, place, and their current role. The duration of the confabulatory phase seems to depend on the lesion site. If a patient has behaviorally spontaneous confabulation beyond termination of the initial confusional state and has a lesion that involves the posterior medial orbitofrontal area, the confabulatory phase may last many months. In a notable case, the transition from the state of reality confusion to appropriate behavior occurred within one week after 18 months. If the lesion does not directly involve the posterior medial orbitofrontal area, there is a high chance that the confabulatory phase lasts less than 3–6 months. Very rare cases with permanent reality confusion over several years have been described. Clinical improvement is not reliably associated with the recovery of amnesia or of executive dysfunction (although these functions, in groups of patients, tend to improve). The improvement is, however, associated with recovery of the capacity to distinguish between memories that pertain to ongoing reality and memories that do not. The evaluation of this capacity will be described below.

There is no specific treatment with proven efficacy for behaviorally spontaneous confabulation. Single patients were trained to use diaries and notebooks with the goal of teaching them to respect a schedule. Another goal was to have them take notes whose belated study would provide evidence to the patients that their thoughts were false. In severe reality confusion, this approach – while worth a trial – is not efficacious. Some patients may profit from neuroleptic treatment, whose effect can be estimated within a few days. In our experience, patients should not permanently be confronted with the fact that their ideas are false. It is more useful to provide an environment of protected freedom where patients can express their (false) ideas about reality and freely move around without putting themselves in danger, for example, by stepping into the street while they still have attentional deficits. Hospitalization in a specialized unit with the possibility to prevent the patients from leaving may be necessary.

Mechanisms of Confabulation

Since the early descriptions of confabulation, at the end of the nineteenth century, investigators have speculated about its mechanisms. Common themes have been that confabulators fill gaps in memory (gap-filling hypothesis), may do so to obtain satisfaction (motivational hypothesis), have the combination of amnesia with a mental control disorder (executive hypothesis), have a problem in the association of elements constituting a memory (reconstructive hypothesis), fail to verify whether a memory refers to a real event in the past or not (monitoring hypotheses), or confuse information from distinct periods (temporal order hypothesis). Most hypotheses were derived from observation alone; controlled evidence has remained extremely scarce. In addition, many theoreticians made no difference between the diverse forms of confabulation and suggested that their theory was valid not only for all forms of mnestic confabulations, but also for nonmnestic confabulations and false recognition. The following is a brief summary of the prevalent hypotheses and their empirical bases.

Gap-Filling

One of the earliest interpretations of confabulation, especially momentary confabulations, was that the patients fill gaps in memory to avoid embarrassment. Arnold Pick proposed a special version of the gap-filling account in which he interpreted gap-filling as a physiological process similar to the filling of the blind spot in vision. This process would serve the coherence of memories. Gap-filling is still proposed in present-day textbooks.

As far as empirical data exist, they do not support the gap-filling account. Diverse studies have shown that provoked confabulations, momentary confabulations, or behaviorally spontaneous confabulations do not correlate with the tendency to respond to questions about items that do not exist or which the patients cannot reasonably answer. Their tendency to respond to such questions does not differ from nonconfabulating amnesics. Thus, confabulators do not have an indiscriminate tendency to fill gaps in memory. In addition, as described above, even severe confabulators may not necessarily have a 'gap in memory' if their encoding and retrieval capacity is tested with a conceptually simple recognition task. Thus, while gap-filling may be a reasonable explanation for certain instances of confabulation, it is definitely not a generally valid account of any type of confabulation.

Motivational Hypothesis

An early variation of the gap-filling idea held that elaborate confabulations (intense momentary or fantastic confabulations) may provide satisfaction to the patient. The idea has also been applied to nonmnestic confabulations, in particular falsely favorable accounts of one's hemiplegia (anosognosia) or patients' beliefs that they were near their home rather than at hospital (reduplicative paramnesia). These nonmnestic confabulations were interpreted as embellishment of the true situation, motivated by the wish to be in a better state than the real one.

The motivational hypothesis has recently been revived. Indeed, patients with apparently elaborate momentary

confabulations after lesions in the orbitofrontal area tended to produce more positive accounts of their past and present than healthy subjects asked to invent responses to similar questions. The idea was again that the wish to embellish reality might be an inducer or modifier of confabulations. It is unclear whether the comparison with intentionally invented ideas by healthy subjects is valid. Also, the account does not explain why false memories come up in the first place. Finally, the positive emotional bias of confabulations may also depend on sociocultural circumstances: Korsakoff noted that confabulations in his patients mostly referred to deaths and funerals.

Executive Hypothesis

A very early observation was that confabulation was not explained by memory failure alone but required additional mental impairments, nowadays called executive dysfunctions. Single cases have been described in whom fantastic or momentary confabulations decreased with improvement of executive functions. Such findings are, of course, not specific. Diverse group studies showed that brain-damaged subjects who confabulated had overall worse executive functions than patients who did not confabulate. In the absence of an appropriate matching criterion, this observation just shows that more severe brain damage is likely to produce more severe deficits, without any specific conclusion about confabulation. Also, executive dysfunction is such a broad class of failure that the specificity of the account is unclear. Importantly, diverse studies showed that behaviorally spontaneous confabulators do not differ from nonconfabulating patients with similarly severe amnesia on a select series of executive functions. Thus, momentary and behaviorally spontaneous confabulations are not explained by general executive dysfunction. Fantastic confabulations have only been described in disease states characterized by severe and multifaceted executive dysfunction (delirium, severe dementia, severe schizophrenia), but the association has never been formally explored.

Provoked confabulations appear to require some form of cognitive flexibility: among similarly severe amnesics, the number of intrusions in memory tests was positively correlated with measures of mental drive and relatively better retrieval success in memory testing. It appears that provoked confabulations at least partly constitute the pay-off for a particularly broad search in an imperfect memory.

Monitoring Hypotheses

Korsakoff suspected that confabulations were based on some defect in the association of memories, a defect that would nowadays be called a disorder of reconstructive processes. Where precisely the defect lies, has never been specified. Many authors, including early ones, thought that confabulations resulted from an inability to verify whether an upcoming memory relates to a real event (reality monitoring) or to verify the memories' provenance (source memory). Although this interpretation is phenomenologically hardly contestable, empirical evidence is lacking. While confabulating patients who failed in reality and source monitoring have been described, nonconfabulating amnesics often appear to have the same difficulty. Thus, the knowledge about when and

from what source a memory was acquired in the past is not critical for the occurrence of confabulation. Hitherto, no experimental paradigm able to separate between patients having any form of confabulation and an appropriately matched nonconfabulating brain-damaged control group has been demonstrated. Nonetheless, as will be shown further down, behaviorally spontaneous confabulation can indeed be interpreted as a defect of preconscious filtering of upcoming memories, a defect that might be conceived as a failure of a preconscious, real time or on-line monitoring process.

A particularly elaborate version of a monitoring hypothesis is the strategic retrieval hypothesis by Moscovitch and coworkers. It describes a chain of processes, subserved by specific medial temporal and frontal structures, that leads up to correct, or incorrect, memory retrieval. A critical structure is the ventromedial prefrontal cortex, which together with the frontal pole would convey the feeling for the rightness of memories. The hypothesis was tested by comparing groups of confabulating and nonconfabulating patients who were asked to recall personal events upon a cue or to recount in detail fairy tales or bible parts. Confabulating patients indeed produced more erroneous recollections. Although the authors suggested that these findings explained behaviorally spontaneous confabulation, the limitation to a singular pathology (rupture of an anterior communicating artery aneurysm in one study) leaves open the possibility that the findings simply reflect the severity of cognitive failures in general. In an earlier study, confabulating patients had indeed had more severe executive dysfunction. More importantly, semantic memory need not be affected in behaviorally spontaneous confabulation. Thus, this hypothesis pertains particularly to momentary confabulation. It suggests that – at least in the explored etiologies – the severity of momentary confabulation is also measurable by the number of confabulations in semantic memory. However, it does not clarify the precise mechanism or stage of processing whose defect is responsible for confabulation. Of note, other authors used similar experimental evidence (errors in fairy tale recall) to support the temporal order hypothesis of confabulation, which will be discussed next.

Temporal Order Hypotheses

An observation already made by early clinicians was that confabulations very often consist of bits and pieces from real events in the patients' past, but assembled with incorrect temporal order. This element, by the way, relates to most instances of all forms of confabulation, possibly with the exception of intense fantastic confabulations that defy any concept of logic. An early suggestion was, therefore, that elaborate confabulations reflected a loss of the temporal order in memory. Single case observations supported this view. However, an inability to know in what temporal sequence information was previously seen also occurs in nonconfabulating amnesic patients and in patients having prefrontal lesion with otherwise intact memory. Thus, the simple knowledge about when in the past an event happened is not relevant for the occurrence of confabulation.

A more recent refined version of the temporal order hypothesis holds that confabulating patients have lost the temporal frame in consciousness – they have a pathological

awareness of personal temporality. Similar to the monitoring hypotheses, the temporal order hypothesis formulated this way can hardly be contested, but the authors did not limit the theory to any specific form of confabulation and provided no experimental paradigm to separate confabulating from nonconfabulating amnesics or to explore the mechanisms behind the shift in personal temporality.

Nonetheless, in conceptual agreement with monitoring and temporal order hypotheses, experimental evidence on behaviorally spontaneous confabulation has indeed shown an inability to refer memories to ongoing reality, and in that sense a defect of monitoring or loss of the temporal frame in thinking. The mechanism, which will be discussed in the next paragraph, is specific for behaviorally spontaneous confabulation; no evidence exists that it applies to other forms of confabulation.

Confabulation and Reality

Confabulations are – first of all – verbal descriptions of false memories about events and experiences which never took place. In most instances, these false verbal statements relate to past events and do not necessarily influence the way in which patients perceive ongoing reality. This is different with behaviorally spontaneous confabulations: the patients not only recount recent experiences which have not taken place in reality, but also falsely interpret ongoing reality. This confusion of reality is manifested by measurable disorientation about time, place, and current role, and in the fact that the patients act according to their falsely perceived reality. In most instances, they enact previous habits, such as, going to work. Thus, behaviorally spontaneous confabulation constitutes more than a false verbal account of recent experiences: it is a disorder of reality perception. Its study may help us understand how the brain recognizes that a memory refers to ongoing reality, or not. Given its anatomical specificity, it also represents a natural human lesion model for the orbitofrontal influence on reality perception.

Confabulation and Memory Suppression (Filtration)

We found that behaviorally spontaneous confabulators fail to suppress the interference of memories that do not pertain to the 'now.' We arrived at this conclusion using the following experimental task: patients performed repeated runs of a continuous recognition task in which they saw a long series of pictures among which they had to recognize repetitions. Most importantly, all runs were composed of exactly the same picture series. In this way, the first run demands learning and recognition of new information. From the second run on, subjects are familiar with the pictures; now, the task demands the ability to realize that a picture – although it appears familiar – comes up for the first or a repeated time within the ongoing run.

We found that the performance of healthy subjects and nonconfabulating amnesics remained constant over the different runs. Behaviorally spontaneous confabulators, in contrast, had a specific increase of false positive responses, that is, they indicated more and more frequently that they thought they had just seen a picture in the ongoing run, when indeed they

had seen it in a previous run, up to 45 min earlier. Thus, they failed to suppress the interference of their currently irrelevant memory of an item's appearance in a previous run. This failure also very highly correlated with the degree of orientation, measured with 20 questions about orientation to time, place, current situation, and personal information. In addition, this failure individually paralleled the clinical course of the reality perception of the patients, irrespective of the persistence of amnesia. Translated to normal thinking, the results meant that the ability to realize what day it is, where we are, and what our current role is, depends much more on the ability to filter out ideas that do not pertain to ongoing reality than on the ability to learn new information.

Normal Reality Filtration

The same experimental paradigm was used in adapted form to study reality filtration in healthy subjects. In agreement with the anatomical data in patients, who had lesions of the posterior medial orbitofrontal cortex or directly connected structures, we found that healthy subjects performing a similar task while their brain activation was monitored using $H_2[15]O$ -PET, activated the medial temporal lobe as they learned the new pictures in the first run. In subsequent runs, however, the posterior medial orbitofrontal cortex, in particular area 13, started to activate, reflecting the need to select, rather than acquire, currently relevant memories. A subsequent study using an even more difficult task showed that this selection process not only activated orbitofrontal area 13, but also subcortical structures involving the head of the caudate nucleus, the substantia nigra, and the medial thalamus. These structures participate in frontal-subcortical loops; some of them are part of the dopaminergic reward system. A study using evoked potentials showed that this selection or filtering process occurs at an early stage of processing, between 200 and 300 ms. Refined analysis suggested that filtering of memories that do not pertain to ongoing reality are possibly conveyed by transient inhibition of synchronization in temporo-parietal association cortex between 200 and 300 ms. In contrast to this early response, the distinction between new and repeated information in the first run, reflecting learning and recognition, was expressed in amplitude modulation at about 400–600 ms. These findings indicated that the filtering of memories according to their relation with ongoing reality (200–300 ms) occurs before the recognition, and presumably the re-encoding, of information, which occurs at 400–600 ms. In other words, before we even know what we think, the brain (orbitofrontal cortex) has already decided whether an upcoming memory relates to ongoing reality or constitutes a fantasy.

Reality and Extinction Capacity

What might be the mechanism behind this filtering capacity? The hypotheses on confabulation described in the last paragraph would probably suggest prefrontal high-level monitoring processes. This appeared unlikely to this author. Indeed, the 'invention' of memory in evolution would appear to be a dangerous step if an organism were not endowed at the same time with a mechanism allowing it to immediately sense whether a memory relates to ongoing reality, and might therefore guide behavior, or

whether it constitutes a mental association having no current behavioral relevance, a fantasy. We, therefore, suspected that the filtering of currently relevant memories depends on a phylogenetically ancient faculty. One striking characteristic of behaviorally spontaneous confabulation is the incorrigibility of inappropriate action plans. Although patients may be constantly at odds with the hospital environment which should normally convince them that they are not at a business meeting or at home, they continue to act according to their false reality. Thus, the patients continue to act on the basis of ideas (anticipations) which may have been valid in the past but which do not refer to current reality. This behavior is reminiscent of the behavior of animals that continue to act upon a previously reward-predicting cue although it has stopped to be followed by reward. In technical terms, we suspected that behaviorally spontaneous confabulation reflects deficient extinction capacity. Primate experiments showed that the only prefrontal area whose damage induces a specific deficit of extinction is orbitofrontal area 13. Single cell recordings showed that this area, which is constantly damaged or disconnected in our patients, contains a particularly high density of neurons that specifically fire in response to the nonoccurrence of expected reward.

In agreement with this interpretation, we recently found that disorientation and behaviorally spontaneous confabulation are very strongly associated with a deficit of extinction capacity, as measured by a simple, explicit anticipation task. A similar task performed by healthy subjects induced strong activation of the orbitofrontal cortex (pole and area 13) and induced specific electrocortical potential variations at 200–300 ms. These findings suggest that, rather than invoking high level monitoring processes, the brain uses an ancient biological faculty – extinction – to keep thinking and behavior in phase with reality.

Conclusion

Confabulation is not a unitary phenomenon. Both functional and anatomical dissociations can be recognized. At the current stage of knowledge, four forms of memory-related confabulations with distinct mechanisms can be distinguished:

Provoked confabulations, manifested as intrusions in memory tests, appear to reflect a normal response to a faulty memory. They are more frequent in brain-damaged subjects but also occur in healthy subjects. They have no specific anatomical basis.

Momentary confabulations evoked by the context of a discussion or by questions are the most common form of confabulation and may relate to autobiographical or semantic memory. No specific mechanism or anatomical basis has been described, although they seem to be more frequent after ventromedial prefrontal lesions, similar to behaviorally spontaneous confabulation. Momentary confabulations are probably a group of different disorders with different mechanisms and different clinical courses, but these subtypes have yet to be determined.

Fantastic confabulations are a rare phenomenon occurring in a delirium (confusional state), advanced dementia or psychosis. Their mechanism or mechanisms have never been specifically explored.

Behaviorally spontaneous confabulation constitutes a confusion of reality as reflected in inappropriate acts according to the confabulation and in disorientation. They seem to emanate from the defect of an orbitofrontal filtering mechanism, which probably relies on extinction capacity, that filters upcoming memories according to their relation with ongoing reality at an early stage of memory evocation, before the precise content is recognized.

Future studies should specify the type of confabulation under investigation and substantiate claims about mechanisms by controlled, empirical data.

See also: [Agnosia \(including Prosopagnosia and Anosognosia\); Amnesia and the Brain; Memory.](#)

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Conflict Communication

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Glossary

Aggressive conflict communication Conflict communication consisting of name calling, swearing, put downs, verbal threats, and menacing/controlling/painful physical behaviors.

Communication process Senders and receivers arrive at similar meanings through the exchange of messages (symbols and signs).

Conflict A difference or incompatibility between people, which becomes significant when it has adverse effects on their relationship and/or escalates to verbal abuse and physical violence.

Conflict communication behavior Conflict management; observable interaction that occurs when people are in a conflict situation.

Mediation Action in which a neutral third party intervenes in a dispute to facilitate communication between the conflicting parties.

Personal relationships Friends, colleagues, neighbors, romantic partners, spouses, and family members.

Strategy A cognition; a mental or psychological state; a disposition; a preference for a way of responding to other people during a conflict.

Conflict may be defined as a difference of opinion or incompatibility between people. However, it becomes significant when it has adverse effects on their relationship and/or escalates into aggressive conflict communication.

Conflict communication may be viewed as a process that includes antecedents and consequences. Antecedents occur at an early stage of *potential* conflict communication wherever a difference of opinion or incompatibility exists. Conflict communication becomes an *actuality* when one or more parties are aware of the existence of this difference or incompatibility or believe that the incompatibility exists. Consequences occur at the final stage of development when the conflict *threatens the relationship* because each of the partners perceives that significant, undesired sacrifices must be made to satisfy the other or the conflict communication escalates into verbal abuse and physical violence.

According to researchers, there are at least three ways in which conflicts may escalate and do harm to a relationship. First, the more excited and heated the conflict (in terms of physiological arousal, especially for men), the more likely the partners are to disengage from their relationship during the next few years. Second, some patterns of conflict are more disastrous to the relationship in the long run even if they appear more desirable at the beginning. Third, certain nonverbal behaviors during conflict (e.g., woman's disgust, man's miserable smile, etc.) predict relationship breakups later. The fact that certain communication behaviors and ways of dealing with conflict are associated with relationship dissatisfaction and breakups necessitate a better understanding of conflict communication.

A better understanding of the subject is achieved by placing relevant theory and research within a particular research perspective or tradition. This is no easy task for two reasons. First, when attempting to put together empirical findings on the subject of conflict communication, one discovers that the extensive research on conflict in personal relationships appears disorganized. Numerous empirical studies in several related disciplines, such as psychology, sociology, communication, and family, and published research reports appear to reflect

different orientations to doing research, use different types of measures, and reflect the jargon of their particular disciplines. The first step then is to identify the major perspectives on gathering data and to organize the relevant studies along the lines of these major research approaches.

A second problem is that more than one research perspective or approach appears to dominate the study of conflict in personal relationships. Scholars view the nature of conflict communication differently, depending on their particular research approach. Therefore, this article describes conflict communication and its role within the context of four different research approaches.

The System–Behavior–Interactionist Approach to the Study of Conflict Communication Behavior

According to the system–behavior–interactionist research approach, poorly managed conflicts increase in degree and complexity, and may go beyond differences regarding a specific problem, issue, or argument because of the emotional nature of many close relationships. In its most negative form, conflict is expressed as an emotionally charged communication behavior pattern that typically involves anger and hostility, escalates, and harms the personal relationship.

On the Nature of Conflict Communication

Conflict communication from this perspective may be viewed as verbal and nonverbal interactions between persons expressing opposing interests, concerns, or opinions. Partners' conflict communication is categorized as constructive or destructive according to whether it results in mutually satisfying outcomes, or escalates and harms the partners' emotional ties.

Research Question Asked in This Approach

Researchers who work within the system–behavior–interactionist paradigm have invested considerable time and effort, attempting

to answer the following question: How do partners resolve their differences without doing harm to their personal relationship?

Typical Case for Data Collection

Usually, researchers who adopt this approach to the study of conflict in personal relationships focus on dyadic interaction and typically recruit romantic partners, spouses, family members, or friends, create a conflict situation, audiotape or videotape their interaction, and compare the conflict communication patterns of those who are satisfied with their relationship with the patterns of those who are not. Recording the interactions between partners in conflict appears to be useful for subsequent examination of the interactions and for the identification of constructive and destructive dyadic communication patterns.

Relevant Theories and Key Concepts

Relevant theories view communication and conflict as *stochastic* processes in which the data for research take the form of a series of events that occur in a sequential pattern, preceding events constraining the probabilities of subsequent ones. Partners' conflict communication may be compared to a game in which the move of one partner constrains the alternatives available to the other, thereby reducing uncertainty in predicting subsequent moves or plays. Because of the interdependent nature of behaviors during conflict communication (where antecedent behaviors influence the probabilities of subsequent behaviors), the system-behavior-interactionist approach is particularly useful for examining communication behaviors that are linked to one another in an escalating process.

Sources of Dyadic Conflict

A partner's behavior is said to be problematic when it produces conflict communication. From the system-behavior-interactionist perspective, problematic behaviors are of interest because they fit the assumption that subsequent behaviors (i.e., conflict communication) are dependent on preceding behaviors (sources of conflict). Because one way to deal with conflict is to eliminate the behavior that leads to it, it is necessary to first identify the problematic behavior.

Efforts to identify problematic behaviors in personal relationships have produced lengthy lists. Moreover, the same behaviors are not always perceived as problems by both men and women, and different behaviors appear to be perceived as problems at different stages in the development of a relationship.

While some researchers describe a number of problematic behaviors that lead to conflict communication in personal relationships, others focus more on the escalation of conflict. Once the conflict is under way, behavioral interaction measures are useful for observing and recording the interrelated behaviors that occur during conflict and lead to escalation.

Measuring Instruments for Collecting Data in Dyads

A number of dyadic measures are available for observing the stochastic nature of conflict communication behavior. For example, the Couples' Interaction Scoring System (CISS)

developed by Gottman consists of eight verbal behaviors or content codes (disagreement, agreement, mind reading, communication talk, solution proposal, summarizing other, summarizing self, feeling, or problem information) and three nonverbal behaviors or affect codes (positive, negative, or neutral). Interestingly, with the exception of agreement, verbal behaviors (content codes) did not discriminate between dissatisfied and satisfied couples, although nonverbal behaviors (affect codes) did generally discriminate between the two types of couples.

By listing specific, concrete verbal, nonverbal, affect, dominance, and avoidance behaviors, measuring instruments like these provide a clear idea of what system-behavior-interactionists mean by conflict communication behavior and enable them to objectively observe the escalation of conflict in personal relationships.

Research Findings

Negative conflict communication is characterized by negative affect, coercive/controlling, escalating, rigid messages, and conflict avoidance.

Negative affect

When engaged in conflict, dissatisfied partners rely more on a type of communication called negative affect (or punishing, aversive) messages. The measuring instruments described earlier have revealed the following negative characteristics of conflict communication:

- Dissatisfied partners display higher rates of aversive behaviors, express more criticism/blame/accusations, are less responsive, and display fewer problem-solving behaviors and reinforcers than satisfied partners.
- Dissatisfied partners are more likely than satisfied partners to use cross-complaints and counter-complaints, and less likely to engage in validation sequences.
- Compared to satisfied partners, dissatisfied partners are more likely to begin a conflict by directly attacking each other with criticism and negatively loaded statements, followed by attempts by each to justify himself/herself and blame the other.

Coercive/controlling behaviors

Researchers have revealed that coercive and controlling behavior during conflict interaction (as well as at other times) is associated with dissatisfying marital relationships. However, there appear to be sex differences in the use of controlling messages. In conflict interactions that were behaviorally coded, men assumed a more coercive stance, while women took an affiliative or accommodating position.

Escalation: negative reciprocity

Once hostility is expressed by either partner, it is likely to escalate in frequency over the course of the interaction. In both dissatisfied and satisfied partners, negative communication behavior is more likely to be reciprocated than positive. Of course, dissatisfied partners demonstrate stronger negative reciprocity than happy ones.

Early research findings indicate that reciprocity of negative affect is symmetrical. However, researchers detail different types of negative affect messages and reveal that most of the husband's negative affect consists of anger and contempt, while only a little of the wife's negative affect is anger and contempt. Most of her negative affect is whining, sadness, and fear. While a husband may reciprocate his wife's anger, she does not reciprocate his. Instead, the wife responds with fear to her husband's anger, suggesting that their relationship is not symmetrical or fairly balanced.

According to Gottman, dissatisfied partners begin a conflict verbally with complaints and criticism follow nonverbally with hostile behavior and end without agreement on a solution.

Rigidity

Research shows that interactions between dissatisfied partners show a higher degree of structure and more predictability of one spouse's behaviors from those of the other than is found in the interactions between satisfied partners.

Conflict avoidance

One way of managing a conflict is the use of indirect methods such as teasing and humor for expressing unacceptable emotions on threatening or embarrassing topics. Because these methods serve to remind partners of their bonding, they can promote solidarity, reestablish intimacy, and excuse a slight. Not all jokes are equal, however. Benign humor consists of jokes about the self, about the relationship, or about the partner in a gentle manner. Hostile humor includes jokes about the partner in a negative way, particularly with sarcasm. Researchers report that more satisfied couples use humor not to resolve sources of conflict, but to bring a verbal disagreement to an end on a playful note.

Other avoidance behaviors include denial of conflict, change of topic, contradictory statements about the presence of conflict, statements that direct the focus of conversation away from the conflict issues, and abstract, noncommittal, and indirect statements. Researchers have observed a strong reciprocity tendency in partners' interaction in that avoidance behaviors were typically followed by other avoidance behaviors. They have also found that less satisfied couples engaged in fewer avoidance behaviors than more satisfied partners. At least one researcher reports that conflict avoidance in marriage is a complex topic in that different types of married couples use conflict avoidance to different degrees and in different ways, ranging from hostile to friendly.

There may be a difference in the way men and women engage in conflict avoidance behavior. According to Gottman, men show a larger autonomic nervous system (ANS) response to stress, respond more readily, and recover more slowly than do women. If extreme ANS response is viewed as harmful, unpleasant, and undesirable, then men might be more inclined than women to avoid situations that would be associated with repeated ANS activation. Thus, men may become more conciliatory and are likely to avoid conflict or terminate it by withdrawing.

Other researchers have observed that both husbands and wives are more likely to be demanding when arguing over a change one wants in the other, and as likely to be withdrawing

when arguing over a change their partner wants them to make. Although neither sex indicated that it would be more demanding than the other sex, data revealed that, overall, men withdraw more than women.

Conflict Training: Helping Couples Resolve Issues and Improve Their Intimate Relationships

Some behaviors lead to more positive outcomes than others, that is, some behaviors de-escalate emotional outbursts. For example, discussion that focuses on resolving a problem is less emotionally upsetting than name calling and partner blaming.

How can one learn or be taught de-escalation behavior in a conflict? Behavior modification may be used to reinforce positive behaviors but not negative behaviors. In addition to behavioral modification, training in conflict communication skills is directed toward enhancing emotional ties within the personal relationship. By observing their own concrete verbal and nonverbal behaviors on videotape, partners learn how they convey interest or disinterest, and warmth or coldness, as well as attraction or repulsion.

The system-behavior-interactionist approach accounts for many empirical research studies of conflict in personal relationships. In addition to its productiveness as a research paradigm, it has also generated many useful techniques for helping partners improve their personal relationship by encouraging positive, constructive, and integrative conflict communication.

The Rules-Interventionist Approach to Mediated Conflict Communication Rules

The notion of mediation as conflict communication may at first appear novel. Although opportunities for interaction seem limited by the presence of an outsider (a mediator), disputing partners may exchange information, influence one another, and develop mutual agreements. However, mediation may not be appropriate for every dispute. Where effective, mediation facilitates communication between partners, is future oriented, and often includes renegotiation of the personal relationship. Thus, mediation is a unique form of conflict communication in which partners may participate in a more formal conflict resolution process than they normally encounter in their everyday lives.

On the Nature of Conflict Communication

A dispute is defined as conflict communication when people are unable to resolve the issue by themselves, and normal relations are unlikely until the dispute is resolved. The rules-interventionist approach views conflict communication as mediation in which a neutral third party creates and enforces certain rules that enable partners to resolve their dispute. Mediators strive for the development of reasonable outcomes for all concerned. Mediation is normally seen as an alternative to adjudication, in which a judge imposes a decision upon the disputing parties.

Research Question Asked by Rules–Interventionists

The rules–interventionist approach to the study of mediated conflict has generated studies designed to answer the question: What role does a third party play in helping partners learn how to resolve issues? This research approach is useful for incorporating the actions of an impartial third party or mediator along with those of the conflicting partners to determine the effects of the role of the mediator and the partners on the outcome of the mediation process.

Typical Case for Data Collection

Understanding helps personal relationships and interaction over time. For one or both partners, however, understanding may no longer hold, resulting in a breakdown in communication between them. Researchers who take a rules–interventionist approach to the study of conflict communication call attention to the role of a third party in helping partners communicate, resolve disputes, and restore or redefine their relationship as the typical case involving partners in personal relationships. For example, mediators may help divorcing spouses legally dissolve the marriage, restructure the family, and create new relationships in which former spouses can cooperate with each other (on matters such as custody and visitation) long after the divorce.

Relevant Theories and Key Concepts

Because mediated conflict presents a context or type of relationship entirely different from that of dyadic conflict communication as discussed earlier, the study of mediation appears to need a different research approach. The rules–interventionist approach is particularly useful because it is designed for three interacting roles – two partners and a mediator – and the effect on the outcome of each person's role.

Unlike the system–behavior–interactionist approach, in which stochastic probability governs the outcome of interaction, in the rules–interventionist approach, the mediator intervenes to place interaction under the control of *rules* designed to limit emotional conflict, reduce uncertainty and surprises, and encourage open communication, cooperative problem solving, and equitable treatment.

Successful mediators begin mediation by announcing communication rules. These rules go beyond explanation of the process and legality of mediation, and place limits on the agenda and the tone of the discussion. Ruled out are common negative verbal tactics such as name calling, verbal abuse, and introduction of irrelevant issues and nonverbal tactics such as screaming, threatening gestures, standing up, or refusing to look at each other.

Mediation theorists view personal relationships as complex, private systems and as delicate entities that must be respected. They assume that partners are in the best position to decide mutually acceptable outcomes with minimal intervention by others. However, while partners determine issues and make decisions for themselves, the mediator enforces the communication rules.

Sources of Mediated Conflict

There is a difference between the sources of conflict that give rise to particular behavioral dyadic interaction patterns and those that give rise to mediation. Compared to private conflicts

that tend to occur in the privacy of the home or involve only the partners themselves, mediated conflict is seen more as a social or public event because of the presence of the third party as mediator. In the case of divorce mediation, the sources of conflict may be reduced to five types.

- *Control over resources*: money, property, space, children, and so forth that may be viewed as not sharable.
- *Preferences and nuisances*: activities of one person impinging on another's sensibilities, preferences, or sensitivities.
- *Values*: concerning what should be, for example, religious and ideological issues.
- *Beliefs*: concerning what is, for example, fact and reality.
- *The nature of the relationship*: repair and redefinition of personal relationships.

Mediation may be rated and evaluated by using triadic interaction measures to observe and record conflict communication. One such measure was created by Donohue.

Measuring Instruments for Collecting Data in Triads

Donohue and his colleagues developed a measure for coding partners' and mediators' verbal acts. They distinguished between two types of verbal acts: cues to subsequent utterances and responses to prior utterances. In addition, the partners' verbal acts were identified according to the following categories:

- *Attacking*: personal accusations; negative evaluations.
- *Defending*: presenting proposals, providing information, requesting information or clarification, or providing a rationale for one's position.
- *Integrating*: any utterance that agreed with the prior utterance, demonstrated support for a proposal or position.

Finally, Donohue and his colleagues added the following categories to code the mediator's interventions.

- *Structuring*: identifying and enforcing interaction rules.
- *Reframing*: helping to restructure disputants' own proposals; pointing out areas of agreement.
- *Expanding/requesting*: requesting proposals; requesting clarification of proposals; requesting reaction to proposals.

By applying both the coding schemes of Donohue to recorded mediation, one might better understand the role of the mediator and how her or his actions help to settle disputes.

Research Findings

Researchers have applied different interventionist measures to essentially overlapping data derived from 80 audiotapes of divorce mediation. Using these tapes for coding triadic interaction, researchers found that successful mediators were more likely than unsuccessful mediators to use more intense structuring and reframing interventions in response to attacks. The more successful mediators were also more likely to rephrase negative comments and turn them into more positive ones. Researchers have shown that successful mediators were more in control of the mediation, used more interventions to involve the divorcing partners in finding the information necessary for agreement, and distributed more of these interventions fairly and consistently between the disputants.

Other researchers report that the most important difference between cases that were settled successfully and those that were not was the amount of time disputants expected mediators to spend discussing the final settlement. In the successful cases, mediators not only felt obligated to spend more time discussing the terms of the final agreement, but were also expected to spend more time discussing possible solutions in general. They were not expected to spend much time explaining the mediation process to the spouses, requesting disclosure of feelings, and making statements about the parties' attitudes.

In all, researchers discovered that the following patterns of actions implied that rules were operating:

- Speaker time was fairly evenly distributed among the two spouses and the mediator.
- Mediators tended to address both spouses, whereas husbands and wives usually directed their remarks to the mediator.
- Mediators tended to ask more questions than did either of the parties.
- Mediators expressed statements on procedural issues three times more than did the parties.
- Mediators conveyed more information on what mediation is and made more statements regarding the process itself than did the parties.
- Mediators made the most statements summarizing the spouses' comments. Spouses made more emotionally toned statements than did the mediator.
- One-third of the statements made by both spouses were self-disclosures. A number of statements were about the attitudes, motives, and actions of others, usually the other spouse.
- Perhaps in an effort to establish rapport and encourage the spouses to share their feelings, mediators made statements that showed more empathy than did those uttered by the spouses.
- Mediators attempted to balance proposals by specifying how both parties could be involved, while each spouse tended to specify what he or she could do.
- Very few statements were classified as interruptions (where the thought was not resumed).

Divorce mediation sessions that ended in agreement appeared to progress from differentiation to integration through three phases: information exchange, problem solving, and finally resolution actions.

Structured Mediation: Helping Partners Settle Disputes

To help both parties emphasize cooperation and gain something from mediation, third-party interventionists need a thorough understanding of mediator goals and tactics that include structuring the process of mediation, reframing the disputants' positions, and expanding the information resource.

The Cognitive Approach to the Study of Conflict Communication Strategies

When thinking about the topic of conflict communication in personal relationships, one probably envisions partners engaged in a verbal disagreement. Cognitive researchers view conflict communication in an entirely different perspective – as

mental (cognitive) strategies that range from preferences for direct confrontation to the desire to avoid conflict. As these strategies are mental or psychological in nature, the process of conflict communication is not observable. From the cognitive perspective, to view conflict communication as a process means that one must ask partners to give their own retrospective reports on the selection of conflict communication strategies.

On the Nature of Conflict Communication

The cognitive approach views conflict communication as strategies that are internal responses to perceived sources of conflict. Because some conflict communication strategies involve intention to avoid open confrontation, conflict communication may exist even when partners are not overtly disagreeing.

Research Questions Asked in This Approach

Questions of interest asked by cognitive researchers include the following: What antecedent conditions influence one's choice of a conflict communication strategy? What alternative strategies are best for dealing with different sources of conflict? What beliefs underlie one's predisposition to engage in aggressive conflict communication? This research approach is useful for examining the role played by predispositions in the form of conflict communication strategies in a broad, general model of relationship development and the effects of these strategies on the outcome of the conflict.

Typical Case for Data Collection

Cognitive research focuses on developing relationships (including romantic partners, friends, coworkers, and roommates and also offspring) as the typical case for data collection.

Relevant Theories and Concepts

Some researchers take the position that a great deal of conflict can be explained in terms of attribution processes and efficacy expectations. Attribution refers to the process of assigning reasons or motivations for particular behaviors, while an efficacy expectation refers to the belief that a problem can be solved by confronting it. These researchers argue that attributions of blame or intent give rise to hostile behavior, such as retaliation. However, they go on to argue that regardless of one's attributions of cause, responsibility, and blame, given low efficacy expectations, a partner is unlikely to want to resolve the conflict and will prefer to avoid it or withdraw from it. Given high efficacy expectations, however, the person is likely to undertake such efforts and confront the problem. In such cases, resolution attempts are directed toward that which is perceived as most easily changed and likely to produce satisfactory results.

Sources of Conflict in Developing Relationships

Perceived imbalance in the resources of exchange, perceived inequity, and perceived unequal distribution of power in a relationship likely lead to feelings of relationship

dissatisfaction which itself may be a source of conflict. While studying relationship dissatisfaction in general as a source of conflict, researchers use self-report techniques to assess the degree of dissatisfaction in the relationship. In this approach, cognitive variables like relationship dissatisfaction are believed to be capable of producing other effects. Thus, self-reported relationship dissatisfaction may be seen as a cognition that influences the preference for particular confrontation and conflict avoidance strategies.

Measuring Instruments for Collecting Data in Developing Relationships

One of the most well-known lines of research on alternative strategies for managing conflict in intimate relationships actually grew out of business administration/management research. Rahim proposed a typology for the management of organizational conflict, consisting of the following five strategies: dominating (forcing, competing), integrating (confronting, collaborating), obliging (smoothing, accommodating), avoiding, and compromising (give and take) styles that reflected either a high or low degree of concern for oneself and concern for the other (e.g., partner).

Other researchers view aggressive conflict communication as a self-reported potential for verbal abuse. A few researchers have determined the propensity toward aggressive conflict communication on the basis of scores achieved on the Dysfunctional Beliefs Assessment and on the Child Abuse Inventory. Scores on these measures operationally defined potential verbally abusive parents.

Research Findings

There appear to be important *male-female differences* that affect partners' perceptions of rewards and costs and their role in conflict. Men appear to differ from women in the way they perceive conflict that in turn affects their relationship satisfaction. At least one researcher has asked dating partners to keep daily observation records of conflicts over a 2-week period. Such research reveals that the perception of many unresolved conflicts is most salient to women's perceived relationship satisfaction, whereas the perception of a large number and the stability of conflicts (i.e., the same issues coming up again and again) are most salient to men's relationship satisfaction.

Other male-female differences in perceptual processes have been found to have an impact on conflict in intimate relationships by distorting the intent of the message sent. For instance, the behavior of dissatisfied spouses compared to that of satisfied spouses is perceived more negatively by partners than intended. This confirms an earlier finding that dissatisfied husbands are more inclined to attribute 'negative connotations' to their wives' attempts to communicate affection, happiness, and playfulness than satisfied husbands.

There is evidence that partners may tend to prefer the strategy of avoidance – a tendency for partners in personal relationships like marriage to avoid dealing with conflicts. Yet, a number of research findings support open confrontation as a constructive conflict communication strategy. For example, at least one study reports that black couples and white couples who believe in avoiding conflicts reported lower marital

happiness in the first year of marriage and again 2 years later than those couples who believe in confronting conflicts.

A number of factors that contribute to preferences for open confrontation or conflict avoidance strategies have been observed. People are more likely to prefer to confront when they are committed, equal in power, prepared for confrontation, and the issue is important. Men are more likely than women to blame their mates for problems, avoid emotional involvement, and prefer coercive conflict communication as their way of dealing with conflict. Some personality types are more prone to open confrontation and others to avoidance. Culture and immediate social context are also influencing factors. For example, there is a tendency among male and female managers to prefer more competitive strategies of conflict resolution when dealing with workers and more accommodating strategies with their partners at home.

More recently, researchers found patterns of attributions about a child's behavior that result in dysfunctional child-rearing beliefs, automatically producing in mothers verbally abusive responses to their child's (mis)behavior. Later, researchers related mothers' child abuse potential with the mother and child's play behavior and found that children of high-risk mothers (for aggressive conflict communication behavior) displayed higher levels of involvement combined with lower levels of cooperation compared to children of lower-risk mothers.

Educating Partners on How to Manage Conflicts

Some of the sources of conflict result from faulty perceptions or inferences. Training in cognitive restructuring helps partners deal with the sources of conflicts and improve their relationship. Essentially, cognitive restructuring is a means of increasing relationship satisfaction by relabeling faulty cognition, that is, misperception and unwarranted inference. Of particular interest are perceptions of undesirable behavior and inferences made from them. Cognitive restructuring includes helping partners see the connection between their behavior and a partner's feelings, identifying myths and accepting reality, emphasizing the positive aspects of their relationship, and training in empathy.

The Qualitative Research Approach to the Study of Conflict Communication Perceptual and Evaluative Processes

The qualitative approach can help researchers better understand the sense-making processes parties use to legitimize their conflict communication behavior. To do this, the qualitative research approach relies more on interpretive means of collecting data. By using methods such as participant observation and unstructured interviews, the qualitative approach applies interpretative techniques to narratives (personal stories) and open-ended interviews of people who are in conflict situations. In their search for multiple interpretations, qualitative researchers are known to consider 'alternative voices,' especially the victims of domestic abuse. To increase real-world relevance, qualitative researchers seek to make the research experience a part of the subjects' natural habitat, such as the home environment. It is argued that the understanding

of conflicting parties can assist practitioners, social workers, family, and psychotherapists working with conflicting parties, especially in violence-prone premarital, marital, and parent-child relationships.

On the Nature of Conflict Communication

Conflict communication from this perspective is redefined as each party's subjective perception or assessment of the quality (or the impression) of their own and the other's conflict communication behavior. Implications of this approach are (1) What might seem appropriate verbal and nonverbal behavior to one person may not seem so to the other, and (2) What might be appropriate verbal and nonverbal behavior in one situation may not be appropriate in another.

Research Question Asked in This Approach

Researchers who work within the qualitative research paradigm attempt to answer the following question: How do conflicting parties perceive their own and the other's communication behavior in a conflict situation? This includes the attempt to understand how they legitimize their own behavior as well as how they evaluate their own and the other's conflict communication behavior.

Typical Case for Data Collection

Researchers who adopt this approach can either observe as participants in the conflict situation or interview one or both parties in conflict. In cases of potentially aggressive conflict communication, parties may be interviewed separately; in less threatening situations, however, the parties may be interviewed together. In some studies, people may watch videotapes of their conflicts and provide insight into why they did what they did, how they felt, and what they were hoping to accomplish. The parties involved may be in a premarital, marital, or parent-child (including elderly parent-adult and parent-adolescent) relationship. Recording the interactions of partners in conflict appears to be useful for interpretation later.

Relevant Theories and Key Concepts

According to this approach, conflict communication is the product of people sharing and creating meaning in a conflict situation. *Social construction theory* attempts to gain access to the phenomenology of people's lives. The ways in which people think and use categories to structure their experience and analyze the world are constituted in their communication. Because people learn from the society and times in which they live, conflict communication behavior is said to be socially prescribed.

Ethnography provides descriptions of behavior in cultural groups: behavior that conforms to rules, roles, rites, and rituals. This type of study might take the form of a field study or a case report. As participant observers, ethnographers usually spend time in another society or cultural subgroup, living with the local people and learning about their way of life to better understand their social behavior and thinking processes. They may also apply their methods to families, groups, or couples. Ethnographers focus on relationships and social structure, verbal and

nonverbal language codes, practices, rites, and rituals. Ethnography is useful in identifying rules that govern conflict communication in specific communities, groups, or couples.

Grounded theory is inductive in nature, suggesting that theory emerges from the data. While quantitative research takes a deductive approach (one begins with a theory and then tests or examines it by collecting data), grounded theorists begin by collecting data (observe video taped conflicts). Next they identify a series of codes from the text. Using what they call the constant comparison method, they group these codes into similar categories that may serve as a basis for the creation of a theory.

Story telling and narratives have developed into a theory and study of narrative and narrative structure, and the ways they affect people's perception of events. By collecting individual stories from particular couples/families and other groups, organizations, and cultures; by listening to and comparing different accounts; by examining how narratives are constructed around specific events; by learning which events in a culture, subculture, or group's history generate stories and which ones do not, quantitative researchers gain a deeper understanding of the subjects' realities, which are closely linked to their social experiences. By doing so, they discover the group's political, social, and cultural dynamics.

Sources of Dyadic Conflict

Dialectical tensions are said to lie at the heart of conflict between partners in a personal relationship. The relationship is supported or threatened by the way people manage the dialectical tensions of autonomy versus connection (cohesion) and stability versus change (adaptability) in their everyday lives. People who experience difficulty managing their conflicts are viewed as less balanced in their management of the dialectical tensions than other people, who have more resources, such as communication skills. Those less skilled are also more likely to repeat old patterns rather than learn new ones.

Measuring Instruments for Collecting Data in Dyads

Purely qualitative researchers do not use measures beyond nominal categories, such as those classifications used in content analysis. For example, they may interview couples (living together) and victims in shelters for battered women. In this case, the narratives of people in dysfunctional relationships may be compared with those in more 'normal' relationships. However, other qualitative researchers use measurement at the ordinal, ratio, and interval levels when they incorporate various existing measures of relationship satisfaction, commitment, or trust to identify target groups, whose members they are interested in interviewing. While they may or may not use higher level measurement tools for the independent variables, both groups of qualitative researchers are not inclined to use measures and statistical methods for analyzing the dependent variables.

Research Findings

A researcher reported that an aggressive communication encounter is a process of 'escalating antagonism' between person A and person B: A's action upsets B; B orders A to cease the action; A fails to comply; B and A verbally abuse each other,

making way for physical violence. An implication of this observation is that the conflict communication may increase in intensity until aggressive conflict communication and even physical violence appear justified to at least one of the parties.

In a study of ten couples with a history of abuse and ten couples without, cohesive and adaptability dialectical tensions consisted more specifically of vague versus precise language, opposition versus collaboration, relational versus content talk, despair versus optimism, interfering versus facilitating interdependence, complaints versus compliments, and effective versus ineffective change. The greater the tension on these seven dimensions, the less cohesive and less able they were to adapt to the other.

Other researchers interviewed 15 abusive male spouses to better understand how they perceive themselves and their spouses, and to account for their abusive behavior. The men provided accounts for their abuse in the form of justifications, excuses, denials, or efforts to minimize the significance of their acts, and blamed their wives for their abusive behavior. Meanwhile, another researcher revealed that abused women also provide accounts of their mates' behavior, but they dissociate the 'real him' from his abusive acts – that is, he was not being himself. In both cases, accounts provided by the partners revealed that abusers and their victims perceive the abusive acts differently but in ways that attempted to excuse the abuser.

By interviewing 31 people, another researcher attempted to better understand the sense-making process couples use to legitimize use of aggression. She found that many of the participants assessed their use of verbal and physical aggression according to social customs, finding it inappropriate and ineffective generally. However, many noted their aggression was appropriate and effective, given the circumstances of their relationship. These findings suggest a unique relational culture where verbal and physical aggression are perceived as appropriate, even though such acts deviated from the social norm.

Researchers report that interpersonal violence is more likely when there is verbally aggressive conflict communication. One study found that the first episode of adolescent-to-parent abuse experienced by parents consisted of verbally aggressive conflict communication. Later, these adolescents progressed to more severe types of emotional or physical abuse.

Family researchers found that mothers' patterns of attributions about their child's behavior resulted in dysfunctional child-rearing beliefs and aggressive conflict communication. This cognitive approach has identified factors such as beliefs and attributions, recognized abusers' violence-prone predispositions, and described the mental beliefs and attributions needed to enable one to avoid aggressive communication behavior in conflict situations.

Educating Partners to Better Manage Conflicts

Findings from qualitative research help to resolve existing social problems. They may or may not contribute to the development of theory. Qualitative research lends some support to the effectiveness of treatment programs for those who abuse others with aggressive conflict communication. Results from

these studies provide some evidence that a change in how an abuser perceives his or her responsibility and thinks about the other may persist into the future, if reinforced by his or her relationships.

Although the perspective view conflict in personal relationships, each perspective has its own definition of conflict, theories, and research methods:

- **system-behavior-interactionists** define conflict as a stochastic process relying on behavioral interaction theory using dyadic behavioral research methods;
- **rules-interventionists** define conflict as rule-governed activity relying on rules theory using recorded triadic interaction research methods;
- **cognitive theorists** define conflict as a predisposition to behave relying on social exchange, network, and perception theories using subjective self-report research methods;
- **qualitative researchers** define conflict as a subjective perception/assessment of the quality of one's own and other's conflict communication behavior relying on social construction theory, ethnography, and grounded theory using subjective interviews and narratives as data.

Although researchers tend to adopt one of these views of conflict, they should realize that each perspective adds to a better understanding of the antecedents and consequences of conflict communication behavior.

See also: The Clinical and Cognitive Psychology of Conflict; Divorce; Equity Theory; Family Systems; Marital Dysfunction; Parent-Offspring Conflict; Sex Differences; Social Exchange.

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Conformity and Obedience

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Glossary

Conformity Typically defined as occurring when perceived or actual social pressure from others causes a person to alter their opinions, feelings, or behavior. These changes may be public, private, or both.

Descriptive norms Modal patterns in how people (usually in specific groups or contexts) actually think, feel, and behave.

Dissent Nonconformity expressed or exhibited with the intention of changing a norm.

Informational influence A psychological mechanism underlying conformity in which people rely on others for information about the world. Is motivated by a desire for accuracy and efficacy.

Injunctive norms Widely held conceptions regarding how people (again, usually within specific groups or contexts) should think, feel, and behave.

Normative conflict A state of disagreement with group norms, descriptive or injunctive.

Normative influence A psychological mechanism underlying conformity that results from a desire to meet the expectations of others. Is motivated primarily by the need for approval.

Obedience Occurs when a person acquiesces to the request or instruction of someone in authority, changing their opinions, feelings, or behavior.

Social identification A psychological mechanism underlying conformity that involves adopting a normative group prototype as a guide for thought, feeling and action. Is motivated by a desire to express a collective identity, and by solidarity and certainty goals. Under certain circumstances, social identification can also motivate dissent.

Investigations of conformity and obedience are foundational to social psychology. Indeed, early studies examining these phenomena conducted by Solomon Asch (conformity) and Stanley Milgram (obedience) rank among the most famous psychology experiments ever conducted. Both sets of studies are still taught to thousands of college students each year, and policy makers and media commentators routinely draw ostensible lessons from each. This article reviews the literature on conformity and obedience, with particular attention to their underlying psychological mechanisms. Whereas a great deal of research attention has been paid to conformity and there is vast post-Asch empirical literature, the same is not the case for obedience. For a variety of reasons (including the impossibility of ethically replicating his work, at least exactly), our understanding of obedience has not advanced a great deal since Milgram's day.

Conformity

Nineteenth century social scientists were highly attuned to the influence that social pressures could exert on opinions, beliefs, and actions. In his book, *Extraordinary Popular Delusions, and the Madness of Crowds*, journalist Charles Mackay described a series of movements in which popular opinion widely, if sometimes only briefly, swayed in strange and foolish directions. In a variety of crazes, people showed sudden and mass passions for, among other things, investing in tulips, for alchemy, and for peculiar shapes of beard. Beliefs regarding sensible economic decisions, natural and supernatural phenomena, and masculine ideals appeared to be highly flexible and contagious, spreading in waves among a malleable populace. Thus, writing in 1903, Tarde stated that 'society is imitation' and 'social man is a veritable somnambulist.'

The advent of modern psychology in the twentieth century saw the application of scientific methodology to the investigation of the psychological processes that underlie conformity. Muzar Sherif conducted a series of studies in the 1930s that took advantage of a visual phenomenon known as the autokinetic effect. When people are seated in a darkened room and a stationary point of light is directed at the opposite wall, the light appears to move about in arbitrary directions. Employing this ambiguous stimulus, Sherif asked participants to estimate how far the light had moved and found that their distance estimates were influenced by the estimates of others. Experimental stooges giving prespecified answers were able to shift participants' estimates by several inches. There were limits, however, to how far estimates could be pushed around, suggesting that social influence was subject to reality constraints, and that participants' responses reflected a combination of both their own impressions and the ostensible observations of others. Subsequent research showed that the responses of experimental confederates established a type of cultural norm that persisted after all original group members had gradually been replaced by new participants. However, because participants in each generation combined their own impressions with the impressions of others, over successive generations the influence of the norm was steadily attenuated. Still, the experimentally manipulated norm did exert significant power over responses, and this research gave credence to notions of human relations as inherently conformist.

The history of psychological research on conformity can itself be described in terms of normative trends, punctuated by occasional reactions against them. Solomon Asch led the first such reaction. Asch recognized that groups and societies could not expect to function healthily if driven only by conformist processes, and that nonconformity was essential to

creativity, innovation, and social change. Nonconformity by this formulation is a group-oriented and cooperative act, and given its utility, is a behavior that ought to occur with some frequency in human interaction. Asch noted that the autokinetic and related investigations of conformity employed ambiguous stimuli, which put individuals in the awkward position of having no firm ground to stand on when disagreeing with the responses of others. In a classic series of studies, Asch gave participants a less ambiguous task to perform, which he posited would reveal significantly higher rates of disagreement. Naïve participants were placed in a group with a number of confederates and were asked to make a series of visual judgments, matching the length of a line to one of three possibilities. These judgments were exceedingly simple, such that control participants not privy to the responses of others responded with over 99% accuracy. Experimental participants, however, were exposed to others' decisions that were manipulated to be uniformly incorrect on critical trials prior to making their own response. In the face of unanimity from the rest of the group, participants made significantly more errors, indicating a degree of conformity to an incorrect social norm. Critically, however, rates of conformity on critical trials in these and subsequent studies hovered around 30–40% and, consistent with Asch's contention, the modal response was clearly nonconformity.

Given Asch's intentions, it is an historical irony that his work is now most often used to make the opposite point and invoked as an illustration of the extraordinary power of social influence on decision making. Whereas what Asch and his immediate contemporaries found most compelling was strong evidence for disagreement in the face of social pressure, the majority of contemporary references to these experiments focus on conformity as the important finding. As such, the bulk of subsequent research has focused on (a) identifying domains in which conformity accounts for important patterns of behavior and (b) understanding the psychological mechanisms underlying conformity. Both enterprises have been highly successful. In the former case, conformity has been identified as an influential force in almost every conceivable realm of human behavior, including eating, consumer choice, sexual behavior, prejudice, humor and fashion. A variety of contributing mechanisms, which will be reviewed below, have also been identified. In contrast, less attention has been paid to processes underlying nonconformity (although we do know quite a lot about its effects).

Mechanisms Underlying Conformity

Normative Influence

Several classes of mechanism have been proposed to account for conformity to social norms. Normative influence refers to conformity that results from a desire to meet the expectations of others. The motivation underlying conformity in this case is a need for approval. There is a substantial evidence for normative influence processes, such that conformity increases in situations where others are likely to notice and disapprove of deviant behavior, and decreases in the absence of these factors. When participants are able give anonymous responses in the Asch paradigm, for instance, rates of conformity show a

significant decline, although conformity does not disappear entirely. Similarly, individuals are more likely to conform to collective norms when they value the group in which they are situated or when they believe that the group values them. The influence of Asch's work is nowhere more apparent than in the fact that his conformity paradigm has been replicated in countries and cultures around the globe. A meta-analysis of these studies examined national rates of conformity as a function of each country's level of individualism/collectivism. Whereas in individualist cultures, it is considered socially desirable for decisions to be driven by personal opinions and goals, in collectivist cultures it is socially preferable to place collective opinions and goals ahead of one's own. Consistent with normative influence, participants in countries with higher levels of collectivism were found to display greater conformity than participants in individualist nations.

Punishment of Deviance

The type of norms that underlie normative influence have been termed injunctive norms, which refer to widely held conceptions of how people should think, feel, and behave. These are collectively held standards regarding what is appropriate and inappropriate. Normative influence derives part of its force from the fact that people have a striking willingness to enforce these sorts of norms. There is a great deal of evidence, both anecdotal and experimental, that groups react negatively to deviants, punishing norm violations by imposing social costs (e.g., ridicule, rejection), as well as physical and economic hardships. Real-world examples of punishment for deviance abound, particularly in religious and political contexts. In these domains, dissension from official doctrine earns the dissenter a variety of pejorative labels, including heretic and traitor. These are dangerous names to bear, and those who incur them have a distressing tendency to come to sticky ends: condemned in show trials, burned at the stake, assassinated, etc.

Early psychological research found that individuals who expressed divergent opinions in small groups were liked less and received greater attention (e.g., were the targets of more persuasive attempts) than individuals whose opinions matched the group norm, and this was particularly the case in cohesive and valued groups. Generally speaking, the more strongly identified members are with a group, the more likely they are to punish deviance. The propensity to impose heavy costs on deviance in political and religious contexts may reflect the fact that these tend to be particularly cohesive and valued groups. However, it is also likely due to the fact that these sorts of groups are, at least in part, defined by the possession of common beliefs. In groups that are defined by sharing a particular set of beliefs (e.g., regarding the role of the state, abortion or the meaning of the sacraments), anyone who challenges a core belief poses a threat not only to that particular norm, but also to the meaning and viability of the group as a whole.

A related phenomenon known as the black sheep effect illustrates the group-based nature of punishment for deviance. This line of research finds that identical negative acts are regarded more negatively and result in greater rejection when they are committed by an ingroup member as opposed to an outgroup member. As such, it is not the behavior per se that

people are responding to, but rather behavior by members of their own group. There are two potential reasons for this. First, although certain types of injunctive norm (expectations for appropriate behavior) may be applied to everyone regardless of group membership, other norms are regarded as group specific, and punishment is confined to those to whom the norm is perceived to apply. Second, the bad behavior of ingroup members reflects poorly on the group, and other members are motivated to punish and prevent these sorts of acts in order to maintain a positive group image and reputation. As in the research described above, strongly identified group members exhibit the black sheep effect more strongly.

The mechanisms by which cooperation among members of a species evolves has been a persistent puzzle in evolutionary psychology. Although cooperation often bestows collective benefits (e.g., we all benefit if everyone pays their taxes and we can afford safe roads and fire departments), it is, all else being equal, in any individual's interest to avoid cooperating (i.e., to defect). If I do not pay my taxes but everyone else does, I keep a higher proportion of my income and also benefit from safe roads and fire service. Critically, however, if it is in everyone's individual interest to avoid cooperation in this fashion, rates of cooperation will rapidly decay. Anyone who does cooperate will be exploited by others and will suffer reduced fitness; thus, orientations toward selfish behavior are more likely to be selected for than orientations toward cooperation. Recent research has shown, however, that cooperation can be sustained by sanctions for noncooperation, and particularly by third-party punishment in which people who are personally unaffected by noncooperation nevertheless punish defectors. If others reliably punish individuals who attempt to cheat the system, it can change the cost-benefit ratio (and fitness levels) in favor of cooperation. Individuals appear to be willing to punish noncooperators even at some cost to themselves and when there are no costs to not punishing. This behavior has been observed across a wide variety of societies and cultures, although rates of punishment vary quite substantially. It appears that a propensity to punish noncooperation may be partially a genetic predisposition that is itself shaped by local norms and can thus serve as at least a partial solution to the cooperation problem. All things considered, punishment of those perceived to act against the collective interest seems to be a deeply ingrained reaction.

There are, however, boundary conditions to the punishment of deviance. Recognizing that some degree of divergence and dissent is often functional for groups (as will be discussed in further detail below), researchers have recently suggested that groups may not be as allergic to deviance as is often assumed. The intergroup sensitivity model focuses specifically on group criticism and suggests that criticism of an ingroup is likely to be well received and even persuasive to the extent that it is perceived to be constructive. Critically, whether or not criticism is perceived to be constructive is dependent on the person who expresses it; in particular, their standing in the group. Members who are believed to have the interests of the group at heart because, for instance, they have been part of the group for a long time, are given the benefit of the doubt and are responded to positively when they express concern regarding the group and its norms. Similarly, high-status group members have greater latitude in the extent to which they can deviate from group

norms before incurring disapproval and sanction. In contrast, relatively recent or low status group members, as well as the members of outgroups, elicit negative reactions when they direct criticism toward a group.

Informational Influence

Another mechanism underlying conformity is known as informational influence, and reflects a reliance on others for information about the world. Many situations are more ambiguous than the Asch paradigm, and it often makes sense to compare one's own impressions or opinions with those of others in order to better understand the nature of reality. The central motive underlying informational influence is a desire for accuracy. Under many circumstances it is reasonable to assume that although individuals are subject to errors and biases, aggregating information from across individuals is likely to yield a more accurate representation or understanding of what is correct. The type of norms that often underlie informational influence have been termed descriptive norms, and these reflect modal patterns in how people actually think, feel and behave. The notion is, quite simply, that individuals use information from others in combination with their own impressions, preferences or beliefs when rendering judgments and making decisions. The fact that conformity does not disappear (although it is reduced) when participants in Asch-style paradigms can respond entirely anonymously provides evidence consistent with the informational influence mechanism. It has further been shown that as the difficulty or ambiguity of a task increases, conformity also increases, presumably because individuals are less confident in their own perspectives and turn to others for information. Importantly, this effect is stronger when the motivation for accuracy has been increased by providing participants with incentives for correct responding.

Informational influence processes have been incorporated into the economic literature, where theorists have modeled informational cascades. An informational cascade occurs in sequential decision-making situations when individuals possess information about others' prior decisions (e.g., whether they saw movie X or movie Y last night), but not necessarily the reasons for those decisions. A typical cascade model might assume that people weight their own opinions equally with the opinions implied by the actions of others. In this model, when there is disagreement between the two (e.g., I am leaning toward seeing movie X, but I know that you went to see movie Y) the rational response is to engage in a mental coin toss, weighting each option equally. If, as a result, I end up seeing movie Y, our mutual friend Bob can infer with a 0.75 probability that both you and I were of the opinion that movie Y is the superior choice. In this situation, even if Bob privately believes the opposite, it is rational for him to take his date to see movie Y the next night. Although it is unlikely that people engage in precisely these rational computations, the notion of informational cascades highlights the important point that conformity is not necessarily an irrational response; there are many situations in which it may be rational to weight others' information as heavily or perhaps even more heavily than one's own. Put differently, thinking rationally does not necessarily represent an antidote to conformity. These models show that rational computations can result in conformity and thus that conformity is not limited to the somnambulist.

Models of informational cascades further illustrate how once a pattern of behavior is established, it can become self-perpetuating, and they can thus account for why some things (e.g., movies, products, fashions, ideas) become wildly popular whereas others do not. Cascades can occur when there is little *a priori* reason to prefer one thing over another, or even when there are objective reasons to prefer the choice that does not become popular. Critically, these models can also account for the fragility and fluidity of popular trends. As cascades lengthen, the behavior of others carries less information about their personal beliefs and preferences. If Bob made his decision in the manner described above, Cindy can infer nothing about his personal preference from which movie he selected. As a result, the presence of even a single dissenter may be enough to break the cascade because the deviant's choice does provide information about their opinion; in fact, by diverging from the cascade, the dissenter may signal a particularly strong and well-formed point of view. If this happens to coincide with Cindy's own view, she is likely to continue the dissent. In this situation, even a long unbroken string of unanimous choices can be attributed to others 'just following the crowd.' Breaks in cascades and shifts to new ones may be particularly likely in contexts where there is a bias toward recent information or an assumption that newer is better.

Social Identification

An additional mechanism underlying conformity arises from social identification with groups. This mechanism highlights the critical importance of group memberships for conformity processes and stems from the social identity approach to group behavior. Social identity theory and its descendent, self-categorization theory, posit that when individuals enter a group context, they adopt the group membership as a component of their self-concept (i.e., as a social identity). Members will differ in the extent to which they self-categorize in terms of a particular group membership, but to the extent that they value a particular group, their sense of self shifts from an individual to a collective level. The theory posits that group members undergo a process of depersonalization in which idiosyncratic characteristics (e.g., traits and personal values) become less active and exert less influence on behavior, while shared characteristics representative of the group's prototype (e.g., norms and collective values) become more active and more influential. In this formulation, group norms provide information about what prototypic group members do, think, and feel, and to the extent an individual is motivated to be a good group member, he or she is likely to conform to these norms.

The key motive underlying the social identification mechanism thus does not reflect a simple desire to be approved of by others, but rather a desire to express an important aspect of one's identity – to instantiate the characteristics that define and uphold the image of the group in question. Other motives are also involved: identified group members may be interested in maintaining collective solidarity and cohesion because cohesive groups are capable of more efficacious action. Further, identified group members are interested in maintaining a clear set of group norms because consensus implies correctness and reduces uncertainty. Thus, the social identification

mechanism can account for the findings, outlined above, that individuals who value and identify with groups are more likely to conform to normative patterns of group behavior. This approach can also explain why identified members are more willing to derogate and punish other ingroup (but not out-group) members who violate group norms.

Cognitive Principles

Whether one is talking about normative influence, informational influence or social identification, norms are knowledge structures that operate within the cognitive system. In the case of the Asch paradigm, the normative response on each trial is presumably computed online as fellow group members verbalize their decisions, and the extent to which the norm is correctly interpreted and the degree to which it influences behavior is a function of attention. If the norm is not accurately perceived or is unnoticed, it is unlikely to drive behavior. Many norms, however, are more stable than this and reflect stored knowledge about descriptive or injunctive patterns of behavior (e.g., drivers in Paris often honk their horns, one should not wear white after labor day). The influence of this stored knowledge on behavior follows standard cognitive principles, such that it must be activated/accessible to exert effects. Accessibility maybe relatively chronic or may vary as a function of situational salience. A series of clever field studies conducted by Robert Cialdini and colleagues has shown that the behavior of another individual can direct attention to and make accessible both descriptive and injunctive norms. When an experimental confederate was observed to litter (vs. not) in a heavily littered environment, participants littered more frequently. However, participants who observed another person litter in a clean environment (and particularly in an environment where litter had been neatly swept up) were less likely to litter than if they had not observed anyone else litter. These findings indicate that individuals were not simply imitating the behavior of the other; rather others' actions made salient wider norms regarding littering as implied by the cleanliness of the overall environment. The importance of salience and accessibility are further highlighted by the social identification mechanism, in which different norms are active and influential in different group contexts.

Minority Influence

As noted above, the field of social influence itself can be characterized by long normative trends, interrupted by occasional notes of dissent. Despite Asch's original intent, his work inspired a great deal of interest in the processes and effects associated with conformity. This work proved enormously fruitful; however, by the 1970s it seemed to Serge Moscovici that the field was too focused on the influence exerted by majorities. Certainly majorities have powerful effects, but Moscovici believed that minorities also play an important role in collective life and can, under the right circumstances, influence others' opinions and decisions. Moscovici proposed that people expect to achieve consensus on most if not all issues, and believe that there is generally one correct perspective to hold. As such, when someone encounters a perspective that

differs from their own, it generates conflict, which the individual is motivated to resolve. The manner in which this conflict is resolved differs depending on whether the discrepant perspective comes from a majority or a minority. If it comes from a majority, a normative influence mechanism similar to that described above kicks in, such that individuals conform in order to maintain cohesion and acceptance. In contrast, if the discrepant perspective comes from a minority, an informational influence type mechanism operates, such that individuals are motivated to critically evaluate and perhaps validate (if there is enough supporting evidence) the minority's position.

Critically, majority versus minority influence results in different types of opinion change. Because majorities exert influence via normative pressure, majority influence is more likely to affect public than privately held opinions. This response is termed compliance, and reflects the fact that people may publicly express agreement with majority perspectives while maintaining private doubts. Interestingly, however, to the extent that they exert influence, minorities are more likely to have the opposite effects: exerting less influence on public opinions because individuals are reluctant to associate themselves with a minority, but greater influence on private opinions because minorities trigger more rigorous consideration of available information. A change in private but not public responses is termed conversion. Generally speaking, there is good evidence for these hypotheses. Across studies, it is clear that minorities can exert influence and that they are particularly likely to exert indirect effects on opinion. For example, a minority opinion regarding a specific issue may not affect others' perspectives on exactly that issue, but it is likely to affect others' opinions on related issues. Further, minorities exert influence to the extent that they are perceived to be consistent; if one is going against the grain, it pays not to be wishy-washy.

Related lines of research have examined the effects of minorities and dissenters on group functioning more generally. Irving Janis' famous analysis of groupthink during the Cuban Missile Crisis and other events made salient the fact that extreme cohesion and unanimity in groups can lead to poor, even disastrous decisions. Although the groupthink construct itself remains controversial, what is now uncontroversial is the fact that diversity and divergence in group settings often leads to improved collective decisions and group outcomes. Researchers have found, for instance, that the presence of dissent and/or diversity increases creativity and innovation within groups, and reduces the extent to which groups become polarized – moving them away from rather than toward extreme positions. Interestingly, improvement in these sorts of outcomes does not depend on the dissenter or minority being correct. Consistent with Moscovici's model, minorities encourage others to think more divergently and to consider alternate perspectives; it is the consideration given to multiple possibilities that ultimately improves decisions. Although the expression of minority views is largely functional for collectives, it is important to note that there can be costs in terms of reduced cohesion. Recent research has shown that when a minority successfully converts a group to their position (and becomes a majority), the group suffers an overall loss of cohesion as former majority members reduce their level of identification with the group, which is not replaced by an equivalent increase in identification among the new

majority. Interestingly, these ill effects are not observed if the minority achieves its goals by increasing tolerance for their position but does not seek to convert other group members.

Mechanisms Underlying Nonconformity

Although the minority influence literature has illuminated the effects that deviance can have on groups, relatively little research has investigated the mechanisms or motives that might cause individuals to express minority opinions and make nonnormative decisions. Researchers and theorists have generally assumed (at least tacitly) that nonconformity can be accounted for by the absence of the mechanisms that underlie conformity. As such, nonconformity is predicted when individuals are not motivated to seek the approval of others, do not fear social sanctions, do not need or trust others' information and/or are weakly identified with relevant social groups. In each case, a motive that might trigger conformity is replaced by an orientation toward independence and autonomy from others. Although independence and autonomy are undoubtedly the cause of some nonconformity, they seem to miss a whole class of nonconformist behavior in which people act not out of a desire to separate or distinguish themselves from others but rather act on principle or out of concern for others – in particular for important groups. Interestingly, this was how Asch himself conceptualized nonconformity. Intuiting the importance of diversity and divergence for collective functioning (intuitions that, as we have seen, turned out to be correct), he did not believe that nonconformity was an individualistic act, but rather a cooperative, group-oriented one. In this conception, nonconformity is often motivated by a desire to see one's groups succeed, and individuals are likely to express dissent when they think that doing so can improve collective outcomes.

It is, however, difficult to account for this type of nonconformity simply in terms of the absence of mechanisms that underlie conformity, each of which implies social separation. This difficulty is further compounded by the fact that nonconformity often poses individuals with a social dilemma – specifically, a public goods dilemma. Public goods dilemmas of all types pit collective and personal interests against one another, such that by acting to benefit a group, individuals incur personal-level costs. We have already encountered an example of one such dilemma: paying taxes to afford roads and fire departments. We have further seen how social sanctions can be used to ensure cooperation; that is, to ensure that people resolve these dilemmas in favor of the collective interest. Somewhat ironically, however, the ubiquity with which sanctions are applied to deviance may give rise to an entirely new public goods dilemma when it comes to dissent. Dissent is often associated with positive collective outcomes – it is an act that, all things considered, is often beneficial to the collective. At the same time, however, dissent is often associated with significant social costs to the individual – individual dissenters risk their good name, social standing, sometimes even their livelihood and lives by deviating from widely held norms. As such, would-be dissenters must often be willing to sacrifice personal-level interests for potential collective benefits, which seems an unlikely contingency among autonomous individuals standing apart from others. For these reasons, conformity and

nonconformity are unlikely to be reciprocal, fully explainable by a common set of processes working in reverse.

Asch's notions regarding nonconformity have recently been revived, and researchers have started to attend more closely to mechanisms that underlie nonconformity. One such approach is the normative conflict model, which predicts how group members are likely to respond to norms under a variety of conditions. This model represents a refinement and extension of the social identification approach to conformity outlined above, and predicts the likelihood of several conforming and nonconforming responses as a function of three psychological factors:

- (a) social identification,
- (b) normative conflict (i.e., disagreement with group norms), and
- (c) estimates regarding the likely costs and benefits of conformity versus nonconformity.

A great deal of research in the social identity tradition has shown that when people adopt a group membership as an important component of their self-concept (i.e., identify with the group), it alters decision-making processes. When individuals make decisions outside of group contexts or in groups with which they are weakly identified, actions and outcomes are evaluated primarily in terms of their individualistic implications: how will this affect me? In contrast, when individuals make decisions in groups with which they are strongly identified, actions and outcomes are evaluated primarily in terms of their collective implications: How will this affect us? As a result, identified group members are frequently observed to resolve social dilemmas of all kinds by acting in the collective interest, even in the absence of sanctions.

The normative conflict model posits that identified group members may respond in the same way to the dilemma posed by dissent. The key assumption is that all group members are likely, at one time or another, to experience disagreement or conflict with group norms. For weakly identified members, this conflict may stem from a tension between personal and collective interests (e.g., what is good for me vs. good for us). In contrast, for strongly identified members, conflicts are more likely to arise when group norms are perceived to be harmful to the collective itself. This type of normative conflict can come from discrepancies between descriptive and injunctive norms, such that how the group is actually behaving is believed to be at odds with the group's own ideals or standards for behavior. However, normative conflict might also arise from the application of personally held standards (e.g., moral beliefs) to collective behavior or even the application of norms incorporated from other group memberships. Importantly, it is predicted that strongly identified members are often willing to express dissent if they perceive it to be in the collective interest, even if they are likely to incur personal costs for doing so. In contrast, weakly identified group members are not expected to dissent on behalf of the group, and are actually predicted to be more conformist than strong identifiers when dissent carries personal costs. A number of recent studies have provided evidence consistent with these hypotheses.

Types of Conformity and Nonconformity

Although it is possible to talk about conformity versus nonconformity in general terms, theorists and researchers have

often noted that there are various forms of both. We have already encountered the distinction between compliance and conversion, two forms of conformity arising from different psychological processes and with distinct behavioral consequences. The distinction between private and public beliefs forms the basis for a number of taxonomies of social response. The normative conflict model also provides a way of distinguishing between different forms of conformity and nonconformity; specifically, as a function of social identification (low vs. high), normative conflict (low vs. high), and estimates of the pros versus cons of conformity/nonconformity among individuals in each of these four cells (see [Figure 1](#)).

- Weakly identified group members experiencing low levels of normative conflict (i.e., little disagreement with group norms) exhibit either indifference or strategic conformity depending on what they believe to be in their personal self-interest. Generally speaking, these members are not motivated to conform to group norms (are indifferent), but they will conform if they expect to be rewarded for doing so or punished for not.
- Strongly identified members experiencing low normative conflict exhibit either loyal conformity or strategic nonconformity. Generally speaking, these members are happy to conform to group norms with which they agree, although under certain circumstances they may see the collective value of deviance even though they do not disagree with collective norms (e.g., playing devil's advocate).
- Weakly identified group members experiencing high levels of normative conflict (i.e., sharp disagreement with group norms) display either disengagement or personally oriented dissent. Personally oriented dissent reflects an attempt to change group norms in ways that would serve one's individual interests; this is a selfish type of dissent and may be relatively rare due to the fact that others are highly likely to punish dissent that is not perceived to be collectively constructive. Disengagement reflects a class of response in which individuals try to distance themselves from a group that they disagree with; rather than attempting to change the group, these behaviors set one apart from the collective.
- Finally, strongly identified members experiencing high normative conflict display either collectively oriented dissent or uneasy conformity. Collectively oriented dissent reflects attempts to change group norms in ways that are believed to benefit the collective. These group members are, however, not entirely blind to the personal costs associated with dissent, which at times may result in uneasy conformity to group norms – one would like to do something to change them but holds back, deterred by possible consequences.

General Relational Norms Versus Context-Specific Norms

It is important to distinguish between two additional types of norms: norms that apply generally within classes of relationships, and norms that develop as patterns of and prescriptions for behavior within specific relationships. It is, for instance, generally normative to conform in collective contexts – when one joins a group it is with the understanding that one will learn and adopt normative patterns of action

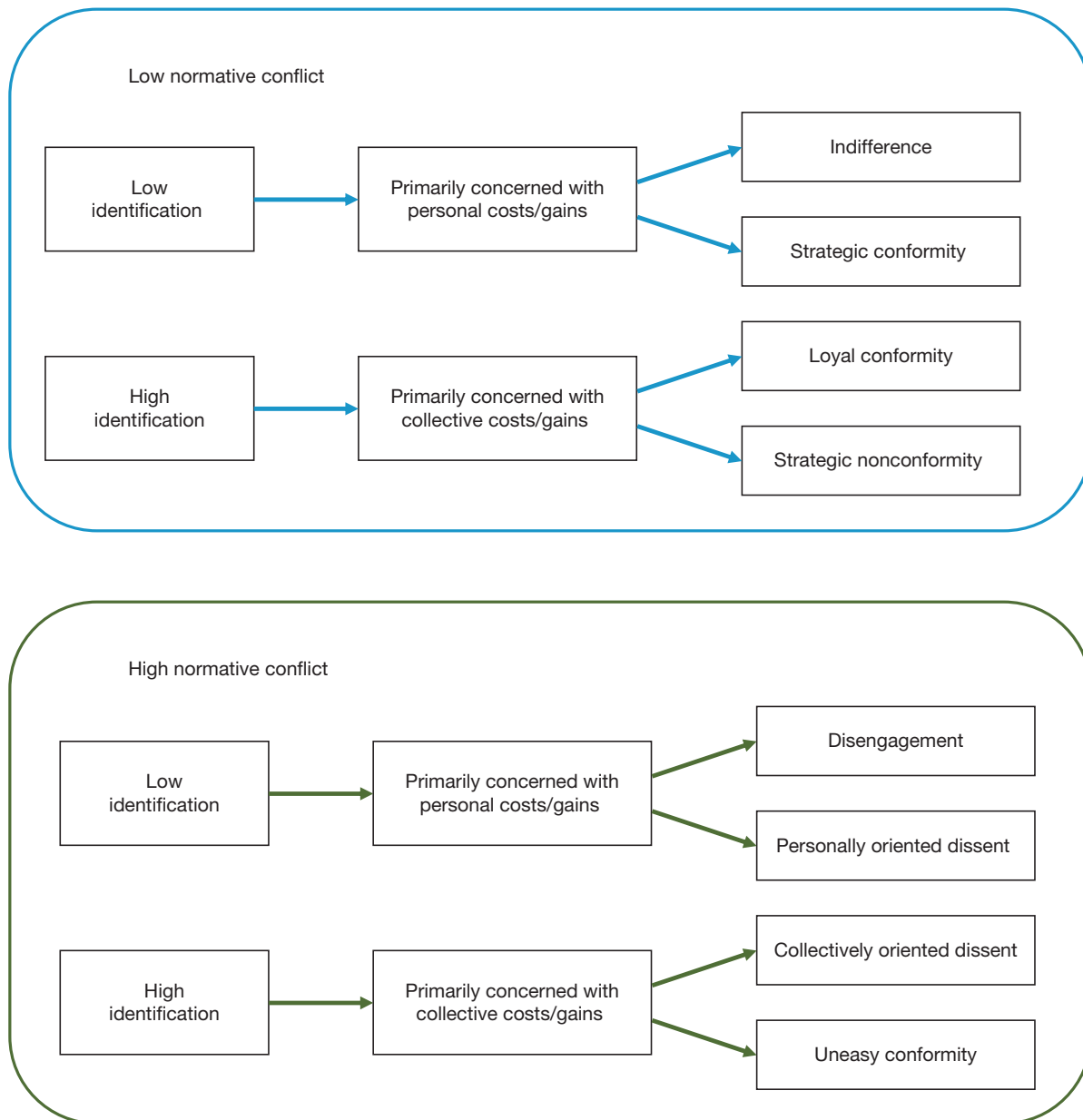


Figure 1 Types of conformity and nonconformity predicted by the normative conflict model.

(through socialization). Interestingly, however, this norm of conformity can itself be revised by group norms, such that in some groups it becomes normative not to conform. Recent research has shown evidence for this paradoxical state of affairs: there are groups in which it is normative to be distinct and where nonconformity represents conformity. Other types of relationships also have general norms associated with them. A particularly powerful general norm is known as the norm of reciprocity. This norm is most powerful in equality matching relationships, where the understanding is that all favors done by one party for another must be reciprocated, sometimes exactly, at a later point in time. The deeply embedded nature of this norm is often exploited by marketers and salespeople, who offer naïve victims a small gift, which triggers in them an

urge to reciprocate – by listening to a sales pitch or even shelling out hard cash. The manifestation of this general norm can also be shaped by local norms. For example, the range of others to whom one is obligated to reciprocate is normatively determined: the small gift trick seems to work well in North American society, but may be less effective in cultures where haggling with salespeople is normative and reciprocity is reserved for friends and family.

Obedience

Obedience to authority also often arises from a general relational norm. It is typically assumed that people should attend

and acquiesce to the requests or instructions of individuals in positions of authority. Obedience is, like conformity, ubiquitous in human life. When your dentist tells you to 'open wide,' you do it even though you know that what is about to ensue is likely to be unpleasant. Different types of authorities get their power to influence from different sources. Some obedience stems from the ability of authorities to affect others' outcomes. On the negative side, an authority may coerce obedience with explicit or implicit threats of punishment; on the positive side, they may reinforce obedience with rewards. However, authority can also arise from other factors, including the legitimacy of a role (e.g., kings, presidents, police officers), charisma and attraction (e.g., celebrities, some politicians), and expertise (e.g., dentists, doctors, professors).

It was at one point widely agreed upon by psychologists that obedience was a good thing – a virtue to be instilled in children from an early age. It was also often assumed that obedience was not a spontaneous behavior, but that it had to be learned and reinforced. The events of the twentieth century, however, changed these conceptions. Obedience to authority became widely recognized as a problem after the Second World War when social scientists tried to understand how vast numbers of seemingly ordinary people became involved in atrocities, culminating in the Holocaust. It became clear that whether obedience is a virtue or a vice depends on the morality or malevolence of the relevant authority figures, and authorities did not come off at all well throughout the last century.

Stanley Milgram initiated a program of research to better understand the psychological processes involved in destructive obedience. In a series of studies, participants were instructed by a lab-coated experimenter (the authority figure) to administer (ostensible) shocks in 15 V increments to a 'learner' whenever he made a mistake; these shocks started off mild (15 V) and rose steadily (to 450 V). As the voltage of ostensible shocks increased, the learner emitted a series of prescribed vocalizations, which included increasingly intense expressions of physical pain (beginning at 75 V), as well as verbal requests to be released (beginning at 150 V). By the middle, the learner was screaming in pain, and by the end, he had fallen silent. Remarkably, in many versions of the study, the majority of participants was fully obedient to the experimenter and continued the procedure to the very end, despite considerable personal discomfort. The original studies were conducted in the 1950s; however, recent partial replications of the paradigm reveal comparable rates of obedience even today.

The Milgram paradigm is complex, and the psychological mechanisms underlying the obedience he observed are multifaceted. A variety of mechanisms have been proposed, and although direct empirical evidence is often lacking, many are plausible contributors. It has been suggested, for instance, that obedience was facilitated by the sequential nature of decision making and the gradual manner in which the shocks increased. Each decision led to the next, and a foot-in-the-door type of process may have made it difficult to justify refusing to administer a shock having agreed to give the previous. Similarly, the gradual increase in severity may have desensitized participants to the learner's expressions of pain. Cognitive dissonance between participants' values and their behavior may have altered conceptions of the harm they were causing (e.g., 'it can't be as bad as all that'). Participants may also have engaged in what

Milgram called an agentic shift, giving up their sense of personal responsibility and allowing the experimenter to take charge. It is also possible that participants looked to the experimenter to define the reality of what was occurring. The experimenter was, after all, supposed to be an expert: if he did not see a problem with what was happening, perhaps there was no problem.

As with nonconformity, less attention has been paid to the opposite response: disobedience. In part, this is because rates of disobedience were relatively low in Milgram's studies, with only a few noncompliant participants to examine in any given study. However, a recent meta-analysis combined data across a series of comparable studies to examine disobedience among a larger sample. What emerged was a previously undocumented systematicity in disobedience, such that disobedience was most likely to occur at the point (150 V) when the learner made his first request to be released. A much higher proportion disobeyed at this point than at any other across studies, and this was the single most frequent point of disobedience within each study. Interestingly, there was no linear relationship between level of shock and obedience as would be expected if increasingly intense expressions of pain were reliably motivating non-compliance. These findings strongly suggest that disobedience to authority in this paradigm was not driven by an empathic response to the suffering of another, but rather may have been due to recognizing the learner's first request for release as a choice point. It appears that those participants who disobeyed the experimenter at this point may have had a different understanding of what was and was not a legitimate use of authority in the experimental situation. When push came to shove, these participants gave the learner authority over his own fate, and were obedient to his rather than the experimenter's request. However, despite these conjectures, much about Milgram's effects and about processes of obedience and disobedience more generally remains, for the moment, unclear.

See also: Attitude Change; Crowd Psychology; Group Dynamics; Individualism; Persuasion.

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Consumer Psychology

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Glossary

Advertising Paid communication in which a sponsor provides information about products, services, and/or ideas.

Behavioral decision theory The body of research that investigates how people make decisions.

Brand management Making strategic decisions regarding the marketing of products and services.

Consumer psychology The study of how individuals form judgments and make decisions related to the consumption of products and services, and how marketplace phenomena affect attitudes, choices, and personal and group identities.

Inference The act of forming beliefs about unknown attributes about a target based on attributes that are known.

Information processing Consumers' acquisition and use of information to help them form judgments of, and make choices regarding, products and services.

Persuasion The act of trying to influence others' beliefs and attitudes.

Sales promotion Providing an incentive aimed at stimulating purchase of products and services either by intermediaries (e.g., retailers) or the end consumer.

At its most general level, consumer psychology is the study of how individuals navigate myriad judgments and decisions related to the consumption of products and services. Researchers interested in consumer psychology study phenomena as diverse as the determinants of what attracts consumers' attention, how they process incoming information, and how they integrate it with existing knowledge. Moreover, consumer researchers consider what is remembered from consumption experiences, and how these memories guide future judgments and choices. Similar to social psychologists, constructs such as attitudes and motivation are extremely important for consumer psychologists. One key defining feature of consumer psychology is that it is both a basic and an applied science, and is typically taught and practiced in business schools with the ultimate goal of informing and improving marketing management decision-making, and hence organizational outcomes. Moreover, by understanding the psychological principles that govern consumption, researchers also hope to contribute to consumer welfare.

Although consumer psychologists study a diverse set of phenomena, one contribution of researchers in the field is that of a consistent picture of the human decision-maker. In contrast to the assumptions of economic standard value theory, individuals do not act as dispassionate, strictly rational, calculators of utility when they make consumer decisions. Instead, although consumers certainly tend to prefer more utility to less, they do not use all of the information available to them when they form judgments and make decisions, they are heavily influenced by normatively irrelevant aspects of the context in which consumption takes place, and they routinely respond in accordance with social pressure, whether actively imposed by others or imagined. Although consumers' choices are not often strictly rational as per economists' assumptions, consumers display a variety of consistent and predictable tendencies in how they acquire, aggregate, and use information in their decisions that facilitate adaptive navigation of a complicated world. Consumer psychologists endeavor to understand these

tendencies and processes that influence individuals' judgments and ultimately guide their choices.

An overview of core research areas and key findings that are central to consumer psychology follows. After the presentation of basic research, a summary of important implications of consumer psychology for managerial decisions is offered.

Core Principles of Consumer Psychology

Attention and Memory

Consumer researchers expend a great deal of effort researching how to best structure persuasive messages such as advertisements. A number of different models of communication have been proposed, but the first step in any model is capturing consumers' attention. This is not an easy task because consumers are exposed to hundreds, if not thousands, of persuasive messages every day. Some determinants of consumer attention include personal interest in, and knowledge about, a marketing stimulus (consumers attend when they have preexisting interest and are highly knowledgeable). Aspects of marketing stimuli themselves also determine if they will garner attention. Marketing stimuli that are novel, vivid, concrete (i.e., easy to visualize), and close versus distant in sensory, temporal, and spatial proximity are typically readily attended.

Of course, just because an individual has attended to a stimulus does not imply that it will be processed, transferred to memory, and brought to bear in future choice making. The study of memory is fundamental to all of human behavior and is of particular importance for consumer psychologists. Researchers have investigated what and how information is encoded, stored, and retrieved, the processes and likelihood of retrieval failure, and how remembering and forgetting influence behavior. Consumer psychologists have used, and contributed to, this literature in myriad ways. One important attribute of memory is that it is active and constructive, and often what consumers recall is a story that plausibly integrates

bits of retrieved information versus an exact and invariant recalling of experiences akin to watching and rewatching a DVD.

One of the most influential notions to arise from memory research is that memory is associative. That is, memories are created and stored in networks characterized by representations of concepts, or nodes, and links between nodes. The strength of association between nodes is determined by the frequency and recency of associations, as well as by the depth of processing. When one node is activated, either because it has been attended to in context or retrieved from memory, related nodes may also be activated through a process of spreading activation in which related nodes are activated to the extent that they are strongly linked to previously activated nodes. This basic property of memory has been used by consumer psychologists in understanding diverse phenomena, such as attitude formation, structure, change, and the likelihood of attitudes driving behavior, predicting which brands are given consideration prior to choice, how the priming of concepts affects subsequent judgment and decision-making, and how firms' investments in sponsorships may color brand perceptions.

Consumer Information Processing

Consumer psychologists devote a great deal of attention to understanding the processes that underlie the use of information to make judgments and decisions (attention, comprehension, encoding, retrieval, integration), the extent of processing (deep vs. shallow), and the direction of processing (one-sided or belief-consistent vs. two-sided or evenhanded). The nature of how consumers process information depends on their motivation and ability to deliberate. When the motivation and the ability to deliberate are high, the extent of processing increases (consumers are likely to consider more alternatives and more attributes), and the likelihood of two-sided processing, in which consumers consider information that is inconsistent as well as consistent with their beliefs, increases. When motivation or ability is low, fewer alternatives, fewer attributes, and simple heuristic cues that enable consumers to reach judgments and decisions quickly and easily are likely to be used. Furthermore, consumers are likely to focus on information that is readily accessible from memory or that is consistent with their beliefs. Accessibility depends on the recency, frequency, and intensity of information processing.

Consumers can attend to and think about only seven pieces of information at a time. More than about seven pieces overloads consumers and forces them to use heuristics or shortcuts to simplify information processing. Consequently, consumers rarely consider more than seven brands when they need to make a purchase decision, and frequently consider fewer brands. Pioneering brands (i.e., new brands that are the first entrant in a new category) and other salient or attention drawing brands are likely to be considered. Being considered early in a consumer's decision process lends tremendous competitive advantage for a given brand, because brands that receive selective consideration often benefit from a brand positivity effect, in which a focal brand comes to be perceived as superior. As motivation or knowledge increases, the number of brands considered increases. Generally, as the number of brands considered increases, consumers make better decisions.

Information that is easy to process is weighed heavily in judgment, even if other more relevant but more difficult to process information is available. Information is easy to process if it is easy to pronounce, easy to read, attention drawing, encountered frequently, accessible from memory, or if it has straightforward implications for judgment and decision-making. Information that is easy to process seems more familiar, more valid, more relevant, and more esthetically pleasing, and such information leads to more confidently held judgments.

Availability refers to whether information is stored in memory, and accessibility refers to the 'activation potential' of the available information. Accessibility depends on the strength of the association between stored knowledge and situational cues, the recency with which information has been acquired or last activated, the frequency of prior activation, and the intensity with which information has been processed. Rather than using all relevant information stored in memory, consumers frequently use the subset that has been primed by the environment. A wide variety of marketing communications have been shown to serve as priming stimuli (e.g., ads, internet messages, salesperson interactions, retail environments, consumer magazines), and these priming stimuli have been shown to influence a wide variety of judgments (e.g., expensiveness, evaluative, and likelihood judgments) and mindsets (e.g., comparing brands in one product category can increase purchase intentions in a different product category). Consumers often overestimate the likelihood of occupations (e.g., doctors, lawyers), objects (e.g., luxury cars, swimming pools), and behaviors (e.g., having wine with dinner, incidence of crime) shown frequently on television. This is particularly the case for heavy viewers, despite the fact that most consumers do not believe that television reflects reality. Priming can result in either assimilation (a shift in judgment of a target toward the priming stimulus) or contrast (a shift in judgment of a target away from the priming stimulus), depending on the degree of overlap between the priming stimulus and the target. Assimilation occurs when overlap is high, and contrast occurs when overlap is low.

Attitudes

The concept of attitudes, or evaluations of objects, is tremendously important for consumer psychologists. Consumers can hold attitudes toward a variety of very different targets, including products, product categories, firms, advertisements, spokespeople, and so on. To the extent that consumers hold favorable attitudes toward a target, they are likely to engage in approach behaviors such as attending to advertisements for favored products and purchasing them, and remaining loyal to liked brands over time. Negative attitudes, in contrast, drive avoidance behaviors. Measuring attitudes allows consumer psychologists to predict consumers' behavior, and behavior can be influenced if attitudes are changed (e.g., when a consumer is exposed to a persuasive message, or has a good or bad experience after trying a product).

Consumers' attitudes may be formed based on three fundamental processes. First, attitudes can be formed as a result of classical conditioning, in which originally neutral targets come to be evaluated in accordance with other stimuli to which

repeated associations are made. Attitudes can also arise from processes of operant conditioning. The rewards and punishments that drive consumer attitudes are diverse, and include inputs such as direct experience with a product, and the social consequences, or anticipated consequences, of making certain consumer choices. To the extent that consumers feel rewarded after engaging in a given behavior, the behavior is likely to recur, whereas behaviors that evoke punishments, or fail to provide rewards, are unlikely to be repeated. A third, more cognitively intensive, attitude formation process involves breaking a target object down into its attributes, considering how valuable each attribute is, and the likelihood of each outcome occurring. Then, the products of the values and likelihoods are summed to create an overall expected value of the object, which is then compared against other objects. Calculating attitudes in this fashion is central to the Theory of Planned Behavior, a very influential and enduring model of behavior that proposes that the expected value of options, which considered along with social norms, drives behavior.

A critical concern for consumer psychologists is the extent to which attitudes and choices are strongly associated. To the extent that attitudes are strong, they are likely to guide behavioral decision-making, whereas weak attitudes are less likely to play a role in behavior. Measures of attitude strength include extremity (how positive or negative the evaluation is), accessibility (how easily an evaluation of an object is recalled from memory), and certainty (confidence that an attitude held is correct). Attitudes characterized by ambivalence, that is, both positive and negative evaluations, tend to be less likely to guide behavior. Overall, though, as long as the correct attitude is measured, attitudes are of enormous utility in predicting consumers' behavior.

Consumer psychologists are devoting increasing attention to understanding the implications of the distinction between explicit and implicit attitudes. Explicit attitudes are deliberative, and are based on consumers introspecting on, and subsequently self-reporting, their evaluations. Implicit attitudes, in contrast, are much more automatic, and are based on associations in memory that do not necessarily reside in conscious awareness. Explicit and implicit attitudes toward different targets vary in terms of how strongly related they are, and can be manipulated independent of each other. Moreover, explicit and implicit attitudes differ in terms of how they are influenced and how they guide behavioral decision-making.

Persuasion and Attitude Change

The importance of attitudes in determining consumers' choices has driven a long-standing interest in understanding how, and under what circumstances, consumers' attitudes change. Of particular focus is persuasion, the attempt to change another's attitude. The earliest paradigm of attitude change research has been termed the Message Learning approach, and has revealed insights into how attributes of the source of a communication, and the message itself, affect whether a persuasive attempt is successful or not. More persuasion from a message occurs when the source is credible (e.g., trustworthy, has high expertise) and attractive (both socially and physically). Persuasion is also facilitated when the message is constructed to match elements of the argument and the intended audience. Specific

considerations include when a one versus two-sided argument should be used, where to position the strongest evidence in a message, the optimal number of message exposures the audience should receive, whether conclusions should be specified, and how to best use fear as a motivator.

A next paradigm includes dual-process models of persuasion, which have been enormously useful both in understanding persuasion and in stimulating research. Both the Elaboration Likelihood Model and the Heuristic-Systematic Model posit that attitude change may occur along one of the two paths. When consumers have both the motivation and the ability (i.e., there are no time constraints and no distracters) to carefully consider a persuasive communication, the extent of persuasion is determined by their judgments of the quality of the arguments in the message. In contrast, when either motivation or ability is absent, persuasion is driven by peripheral cues in the communication context (i.e., the number of arguments offered to support the communication, aspects of the source of the communication such as expertise, attractiveness, and similarity). Although persuasion may result from either path, when consumers evaluate the merits of the message, more persuasion results, it is more enduring over time, and it is less likely to decay than if persuasion is driven by peripheral cues.

In addition to research on the processes of persuasion, researchers have identified six fundamental influences that contribute to persuasion. First, to the extent that one likes someone, one is likely to be persuaded by that person. Liking often arises when consumers perceive that another is similar to them, when the other offers compliments, and is attractive. A second influence is reciprocity, or the social norm that favors should be repaid. When someone feels indebted, even from an unsolicited favor, they are likely to try to repay the favor. Third, consumers like to be seen by others as well as by themselves as being consistent. Once consumers are committed to an attitude or a course of action, they tend to stick to their commitments. A fourth influence is social proof, or the tendency to follow the lead of similar others. Authority refers to consumers' proclivity to defer to experts. Communications that appeal to expertise often succeed because consumers infer that experts' opinions are valid. A sixth influence is scarcity; to the extent that something is in demand, it seems more valuable. Marketers use these persuasive influences in creative ways in the attempt to convince consumers of the merit of their offerings.

Inference

A challenge that consumers often face is that they do not have complete information about products and services that they are considering purchasing. Consumers are likely to go beyond the given information and draw inferences about missing information when they are sensitive to the omission of important information, and when they have accessible implicit theories or assumptions that link evidence to conclusions in a subjectively logical fashion. For example, most consumers have an implicit theory that links price and quality; as price increases, perceived quality increases. Typically, the relationship between price and quality in consumers' implicit theories is much stronger than the actual relationship between price and quality in the marketplace. Consumers also have implicit

theories about products made in different countries. In the United States, many consumers believe that Japanese electronics, German cars, and French wine are of high quality. Other countries, such as China, Korea, and Mexico, are often associated with low-quality products. Consumers also have implicit theories about product popularity and quality. Highly popular products are often perceived as higher in quality than less popular products. Consequently, consumers like bestselling books, popular restaurants, and products that everyone else seems to use or to like. Consumers have many different implicit theories relevant to persuasion. For example, experts are trustworthy, length implies strength (long messages are more persuasive than short messages), and consensus cues (millions of satisfied customers cannot be wrong) can have a profound impact on persuasion. Unfortunately for marketers, consumers also have an implicit theory that marketers are untrustworthy and that one should not believe everything one sees or hears in marketing communications, which produces resistance to persuasion.

In addition to drawing inferences about global quality, persuasiveness, and trustworthiness, consumers also attempt to draw inferences about specific missing attributes when they realize that information is missing. However, consumers are frequently insensitive to omissions and this can lead to strong judgments (extreme and confidently held judgments) based on weak evidence. High levels of prior knowledge or involvement can increase sensitivity to omissions and lead to more moderate judgments. Comparing products described in terms of different attribute dimensions can also increase sensitivity to omissions. Reading a relatively large amount of information about one product can increase sensitivity to omissions concerning another product described by a relatively small amount of information, even when the two products belong to completely different categories.

Categorical knowledge also helps consumers to fill in missing details. Once a product has been categorized, consumers assume that the product has all of the properties and characteristics that are typically associated with the category. Even if a consumer has never tasted panna cotta, he or she is likely to assume that panna cotta is sweet when they learn that it is a dessert. Prior knowledge and experience is organized into knowledge structures called schemata that are also useful for filling in gaps in knowledge. For example, the linear ordering schema suggests that if A is better than B and B is better than C, then A must be better than C. Similarly, the syllogism schema suggests that if A implies B and B implies C, then A implies C.

Behavioral Decision Theory

Behavioral Decision Theory refers to the research paradigm that explores consumers' decision tendencies. For example, research on the framing effect shows that the manner in which choice alternatives are framed or described has a profound effect on choice, even though consumers typically believe that their preferences are stable. This occurs because consumers think differently about outcomes described in terms of gains (above a reference point) versus losses (below a reference point). Loss aversion, or the tendency to weigh losses more heavily than equivalent gains, can explain the framing effect, the compromise effect, the endowment effect,

the status quo bias, and the sunk cost fallacy. For example, when outcomes are framed in terms of gains, consumers are risk-averse. When outcomes are framed in terms of losses, consumers are risk seeking. Consequently, when asked to choose between a program that would save 200 out of 600 lives for sure and a program that would save 600 with $p = 0.33$ or 0 with $p = 0.67$, most people prefer the former safe option. When asked to choose between a program in which 400 out of 600 would die for sure and a program in which 0 would die with $p = 0.33$ or 600 would die with $p = 0.67$, most people prefer the latter risky option. Of course, the two safe options are identical and the two risky options are identical too.

Consumers often prefer a compromise brand that is average on two equally important attributes over brands that are excellent on one attribute but poor on the other. Poor performance on an attribute is often interpreted as a big loss and loss aversion leads consumers to avoid extreme brands.

Research on the endowment effect shows that owning an object leads consumers to value that object more. This occurs because buying a new object is interpreted as a gain and selling an object one currently owns is interpreted as a loss. Loss aversion makes consumers reluctant to sell objects they currently own. Consequently, selling prices are often much higher than buying prices.

People often prefer the status quo to change (the status quo bias). This occurs because change often involves gains on some dimensions and losses on others, and loss aversion can make people reluctant to accept change. Consequently, when consumers are told that a pharmaceutical product is currently on the market, they recommend keeping it on the market. When they are told that the same product is currently not on the market, they recommend keeping it off the market. People also prefer to keep their current jobs, automobile color, financial investments, and medical insurance policies.

As the amount of time, money, or effort invested in a project increases, the reluctance to abandon the project increases even if people would be better off doing so (the sunk cost fallacy). After spending millions of dollars on a dam, building, or construction project, people are reluctant to abandon the project even when it would be less expensive to do so. After spending millions of dollars on old mixing technologies, many steel companies went out of business because they refused to invest in new superior technologies. Loss aversion makes people reluctant to give up what they have already invested, even when the investment is unlikely to ever pay off.

Motivation

Motivation refers to tension that results from the discrepancy between a current state and needs or wants that consumers are driven to ameliorate. Consumers feel motivation to address both biological (e.g., thirst, hunger, safety) and learned (e.g., prestige) needs, and needs may be utilitarian and practical, or hedonic and emotional. Many classic psychological concepts and theories have been adopted by marketers, including Drive Theory and the motive to maintain homeostasis, motivational conflicts (i.e., approach–approach, approach–avoidance, avoidance–avoidance, and double approach–avoidance), and Maslow's Hierarchy of Needs.

One of the most influential motivational theories in consumer psychology is regulatory focus. Research has explored how individuals' motivation to seek positive outcomes while avoiding negative outcomes affects a host of behaviors. Two self-regulation systems help individuals pursue these motives. The promotion system seeks advancement and growth, and approach strategies are employed in the pursuit of positive outcomes. The prevention system, in contrast, derives from security needs such as safety and protection, and employs avoidance strategies to preclude negative outcomes. Although these systems are independent, one's overall regulatory focus at a given time may vary, and is determined both by individual differences in socialization and by contextual factors such as the framing of behavioral decision problems. Regulatory focus has been shown to play an important role in numerous consumer behavior phenomena, including the evaluation of products, response to advertising, perceptions of the importance of different product attributes, and the propensity to adopt new products.

Although regulatory focus considers general motivation, consumers often behave to address more concrete goals. Goals are representations of desired and undesired states, and proximally activate behavior. In some cases, goals may conflict, in which case the goal associated with more importance (i.e., stronger activation as a function of internal associations and external context) is likely to dominate. Goals may be actively set by consumers and are hierarchical in nature, that is, they vary according to how specific they are. Goal pursuit refers to the actions consumers take to achieve their goals. The goal concept is important for consumer psychologists conceptually because understanding goal-directed activity helps to unravel the complexities of consumer behavior. Marketing practitioners make use of goals in myriad ways; if consumers' goals are known, firms can better address consumers' needs in marketing communications, product development, pricing, and so on.

Individual Differences in Consumer Psychology

A variety of traits that vary across individuals relate to what information they consider, and how they process it, as well as what values and preferences are brought to bear in the consumer choice context. Consumer psychologists care about individual differences for two reasons. When one observes a given consumer behavior, that behavior is influenced both by the context in which the behavior occurs and by variables internal to the consumer. Thus, studying individual differences helps us to better understand the nature of the consumer as a decision-maker. Moreover, studying how consumers who vary on some theoretically relevant dimension respond differentially in a given consumption context can help us to understand the processes that underlie the behavior.

Researchers have considered a wide range of individual differences. Although exhaustive cataloging is beyond the scope of this article, several individual differences that have proved to be of extraordinary utility are discussed. The Need for Cognition, for example, refers to the extent to which consumers like to engage in careful, effortful thinking, and to understand and make sense of the world. Consumers who are high versus low in Need for Cognition engage in more

exhaustive information search and more effortful processing of persuasive communications, are more open-minded, have more persistent attitudes, consider a wider range of prices when making a purchase, and prefer verbal versus visual information.

Conceptually related yet distinct from Need for Cognition is the Need for Closure, which refers to the desire to come to a decision, any decision, quickly versus engage in exhaustive deliberation before making a choice. Other individual differences relevant for consumer psychologists include the Need for Uniqueness, which refers to the pursuit of differentiating oneself from others through the acquisition and use of consumer goods, Romanticism (inspirational, imaginative, intuitive, and creative people for whom feelings come first) versus Classicism (unemotional, straightforward, economical, facts come first types), and, as noted earlier, regulatory focus considered as a trait.

Consumer Neuropsychology

A next generation of consumer decision research involves understanding how brain function guides consumer behavior, often by localizing parts of the brain responsible for different types of information processing. Researchers have used methodologies such as functional magnetic resonance imaging (fMRI) scans, which enable researchers to determine which brain areas are most active when consumers engage in particular tasks, and lesion studies, in which the behavioral decision-making of patients with injuries to specific neural structures is compared to individuals with injuries in other regions, as well as to those without any injury. This is an emerging science, but it has already produced a number of provocative findings regarding the role of particular brain structures, as well as the functions (e.g., emotion) governed by those structures, in decision-making.

Consumer Welfare

Consumer psychologists study a number of behaviors with the goal of enhancing consumer welfare. For example, researchers have explored the harm done by the advertising of unhealthy products such as sugar-laden food and smoking materials. Other research discusses how marketing can propagate racial stereotypes or unrealistic standards of female attractiveness. Social marketing research investigates how to persuade consumers to adopt healthy or prosocial behaviors. Finally, researchers have considered the effects of marketing on disadvantaged and at-risk populations. Overall, although the primary focus in consumer psychology is on understanding consumer behavior to facilitate organizational performance, a great deal of attention is also given to facilitating consumers' well-being.

Managerial Applications of Consumer Psychology

Research in consumer psychology is often applied in industrial settings, most typically in marketing. By understanding how consumers form judgments and make decisions regarding products, services, and marketing communications, marketers hope to be better able to offer products that match consumers'

preferences, price and promote products optimally, and offer products to consumers via distribution channels (e.g., retail, online) that best facilitate sales. Consumer psychology has generated an enormous body of knowledge that can enhance organizational performance. Some examples of how consumer psychology has helped marketers to be more effective follow.

'Brand management,' or 'branding,' refers to a set of key decisions that marketers make in the aim of creating a product that meets consumers' needs, including both tangible needs (e.g., food relieves hunger) and intangible needs (e.g., the prestige of owning a luxury car), and that is associated with favorable attitudes and is likely to be purchased. Understanding consumers' motives as well as the social influences on them is essential. Some examples of marketers' considerations when trying to build brands include creating marketing communications and product packaging that conveys an attractive, clear, consistent, meaning that facilitates awareness of the product, and signals what the product does, and why it is different, and better, than competitors. The 'differentiators' can be on a number of dimensions, including quality, reliability, price, and/or image. Consumers choose products that best meet their needs on these dimensions. The relationships consumers have with brands are dynamic, and in many ways approximate human-to-human relationships.

Consumer psychologists know a great deal about why consumers choose particular products, and this knowledge is very useful in making a variety of brand management decisions. One such set of decisions regards creating and managing brand elements, such as brand name, logos, symbols, slogans, and packaging. Marketers' decisions are made in light of the constructs discussed earlier; brand elements should be attention grabbing, memorable, and contribute to brand salience so that the brand receives consideration. Elements should be likable and correspondingly facilitate likeability of the brand, so that strong, favorable, attitudes that guide choice are developed and maintained. Moreover, brand elements should be meaningful, so that brand associations in memory are forged, facilitating consumers' esteem for, and choice likelihood of, the product.

Marketers also have to set strategies regarding marketing communications that facilitate high purchase likelihood of their brands. Ideally, tools, such as advertising, sales promotion, public relations, publicity, and new media (i.e., social networking Web sites), should be integrated so that consumers can easily attend to and process information about the brand, perceive the product in a way that the marketer wants, and hold consistent, strong attitudes toward the brand. An example of a common persuasion tool studied extensively by consumer psychologists is comparative advertising, in which a comparison is made between the advertised brand and one or more competitors. Researchers have shown that such ads may be very effective in persuading consumers because they are very good at garnering attention, but that in some circumstances they may be ineffective or even harmful to the firm that uses them. In general, when making a comparison in an advertisement, it is more persuasive to make a positive comparison (e.g., their brand is good, our brand is better) than a negative comparison (e.g., their brand is poor, our brand is good) because consumers often infer that a negative comparison is biased and unfair. The exception to this rule is that firms that

are well known and trusted can make negative comparisons without provoking an inference of bias from consumers.

Inference research has been invaluable in helping marketers weigh the potential benefits and risks of sales promotion, a commonly used set of tools that offers some extra value to consumers if they make a purchase. Common sales promotions include coupons, rebates, and free gifts if consumers purchase a given product. Although it is unsurprising that offering such sales inducements often lead to increased sales, consumer psychologists have helped marketers understand how promoting a product can erode consumers' evaluations of it. Specifically, because consumers perceive a strong relationship between price and quality, when a product is offered with a price discount, consumers may infer that it is a bad product. Research has shown when such an inferential process is a threat and how to ameliorate the risk (e.g., one strategy is to advertise when one offers a price promotion to bolster brand attitudes).

A ubiquitous problem in managing brands is how and when to offer brand extensions, that is, launch a new product using an existing brand name (e.g., the parent brand). Businesses often favor this strategy because consumers are often more likely to try a new product if it is associated with a brand name that they know and trust. Moreover, consumers perceive the new product in light of the associations that they have with the existing brand in memory, and thus businesses often can spend less on marketing support for a brand extension versus a new product with a new brand name. Consumer psychologists have devoted extensive study to determining influences on two key criteria for the success of a brand extension: whether consumers will purchase the new product in sufficient frequency for the manufacturing firm to turn a profit, and, importantly, what implications the launch of the new product will have for the existing brand. In general, brand extensions are likely to be successful when there is a strong match between the associations that consumers have in memory regarding the parent brand and the associations that will lead to favorable attitudes for products in the category of the proposed extension, and when associations about the parent brand are strong enough to carry over to the brand extension. Launching a brand extension can have harmful consequences for the parent brand when new associations with the parent brand are developed that undermine consumers' attitudes toward the parent brand. Such a process is likely to occur, for example, when a low-quality brand extension shares the name of a high-quality parent brand, even if objective features of the parent brand do not change.

Although brand extensions are a useful strategy for driving profits, new products are firms' lifeblood and the future. Indeed, one of the most vexing problems faced by business managers today is the successful creation and introduction of new products. Despite the vast resources expended by practitioners and an impressive amount of research on new product introductions, the failure rate of new products is still extremely high; it is estimated that between 60% and 90% of all new products fail. Recently, the focus has shifted from refining the process of new product development from the companies' perspective toward understanding the role of consumer psychology with respect to the precursors and motivations to adopt new products. At a global level, consumer researchers

investigate how core psychological theories (i.e., approach/avoidance, regulatory focus, goals) impact how consumers learn about, evaluate, and ultimately, adopt new products. Some of the topics that are currently being investigated include understanding how consumers evaluate the importance of new benefits (and perceptions of learning costs that are associated with obtaining these new benefits), how consumers integrate multiple sources of information to both learn about and evaluate new products, and how the adoption and use of new products act as core elements of consumers' identities.

Many psychological factors come into play when consumers predict how useful new products will be. For example, there are common biases in the estimation of the benefits provided by new products, whereby consumers overweigh the importance of existing benefits that they know well while underappreciating the value of novel benefits with which they are unfamiliar. Consumers' perceptions of the amount of learning required to extract novel benefits have a huge impact on the adoption of new products. Another important question is associated with understanding the role of multiple sources of information (i.e., company sponsored versus consumer recommendations) on adoption intentions for new products. For example, the emergence of the social media has increased the ability of potential consumers to read reviews and engage in conversations with fellow consumers who are early adopters of new products. How these interactions will shape the adoption pattern for new products has yet to be determined. Finally, the role of new product adoption in presenting oneself to others is an important factor in adoption decisions that is not particularly well understood. Although understanding the connections between consumers and brands has been extremely helpful in the branding domain, defining the connections between new products and multiple levels of the self (i.e., actual, ideal) could be a fruitful avenue for incorporating the core principles of consumer psychology toward furthering one's understanding of the adoption of new products.

See also: Associative Learning; Attention; Decision Making (Individuals); Media Influence on Behavior; Memory; Motivation; Neurotechnologies; Organizational Behavior; Persuasion; Social Cognition.

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Relevant Websites

- <http://www.marketingpower.com/> – American Marketing Association.
- <http://www.acrwebsite.org/> – Association for Consumer Research.
- <http://www.myscp.org/> – Society for Consumer Psychology.

Coping

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Glossary

Coping Behavioral, cognitive, and emotional attempts to mitigate or manage stressful or threatening circumstances; the continual process of interpreting and responding to life's demands.

Emotion-focused coping Coping efforts aimed at managing negative feelings related to a stressor with the goal of reducing the impact of those feelings.

Primary appraisal Initial recognition of a potential threat or source of stress and then consideration of its potential negative impact.

Problem-focused coping Coping efforts aimed directly at changing or managing the stressor itself.

Secondary appraisal Evaluation of coping resources and options available to remove the stressor or mitigate its impact.

Stress/stressor Any change (internal or external) to life patterns and habits typically construed as a threat to life or comfort; also, the physical and psychological manifestations resulting from exposure to these threats.

Introduction

All life seeks a sense of constancy or stability, yet the greatest constant in life is change. As changes occur in the human body, the autonomic nervous system works to restore everything to a state of balance, called homeostasis. This process requires no conscious thought or action by the individual to respond to that change. The external world, that is, daily life, also is filled with new situations and changing circumstances that challenge stability, from everyday irritants such as a bad night's sleep or heavy traffic to acute conditions like flu or a disagreement with a loved one, and ongoing strains such as chronic disability or the death of a spouse. Because these changes are a part of the normal course of life, people must fairly consistently monitor and adjust – themselves, the change factor (stressor), or the environment – in order to regain that sense of stability. Thus, the healthy human body may take care of itself internally. What about changes that require adaptation? Do they 'stress us out'?

Endocrinologist Hans Selye introduced the terms stress and stressor while studying the biological responses of rats to external stimuli. He defined stress as any change to an organism that requires or elicits adjustment from that organism in order to return to homeostasis. Selye did not characterize the factor (stressor) triggering the need to adjust as positive or negative, only that it exists and can result from both pleasant and unpleasant events. So, while studies have shown strong associations between negative life events and symptoms of psychological distress, psychiatric disorders, and even mortality, the stressor itself is not necessarily the culprit. Stress is not inherently bad. Rather, it can provide the impetus for people to learn and grow (see *eustress* [eu = good] also coined by Selye in the mid-1970s). Because it opposes simple stagnation in life, a certain degree of stress is healthy for humans. Selye's biological framework was seminal to the field of human coping because he was the first scholar to conclude that a key determinant in the stress–health relationship is neither the type (good/bad) nor level (a little/a lot) of the stressor itself, but how one reacts to, that is, copes with, that stressor.

Coping is the ongoing behavioral, cognitive, and emotional processes people use to manage those life circumstances that threaten feelings of stability. Coping can also occur proactively in order to limit the threat to future homeostasis. Its goal is to avoid, minimize, master, or manage life's situations in such a way as to decrease any potential negative impact or outcome. In the social sciences, the study of stress and coping encompasses many factors that relate to life changes and how people manage those changes, so scholarly discourse on these topics is both immense and diverse. The goal of this article is to provide a general overview of coping in psychosocial research. First, two historically predominant theoretical frames – coping as a personality disposition and coping as a person–situation process – are reviewed and the current direction of these perspectives is summarized. Next, major coping strategies and coping resources are listed, and finally, a few additional factors that influence the coping process are offered. The material herein relates to adult coping and does not include issues specific to children and chronic psychopathology. It is our hope that this brief discussion will provide readers with general information about the coping literature (i.e., research), as well as help them gain an understanding of their own coping processes.

Theories of Coping

Numerous terms and expressions have been used to convey scholars' beliefs about the origin, or basis, of coping. Nearly all of these conceptualizations can be viewed within a theoretical framework of coping as either part of one's personality, an active process, or most recently, the combination of these two. The following are some main points from each of these theoretical perspectives.

The Personality Framework

The foundation for coping as a part of personality began with the work of Sigmund Freud. According to early psychodynamic/psychoanalytic theory, conflicts between the id and superego create anxiety, and the ego responds by employing

defense mechanisms to repress these negative feelings. Though additions have been made to this list over time, the original Freudian defense mechanisms are denial (refuse to believe despite evidence to the contrary), displacement (act out on someone else rather than the actual target), intellectualization (pay little attention to emotions), projection (place own negative thoughts or feelings on another), rationalization (replace the real reason with a logical one), reaction formation (believe/feel the opposite of the real, unwanted belief/feeling), regression (return to a child-like state/behavior), repression (keep the unwanted in the unconscious), sublimation (act out unacceptable impulses in a socially acceptable way), and suppression (try to put the unwanted into the unconscious).

Though it remained popular for many years, Freud's view of coping was sharply criticized for defining all defense mechanisms as existing completely within the unconscious and as pathological in nature. Personality was considered to be inflexible and driven solely by sexual or aggressive urges of the id. Other scholars defined defense mechanisms in a less negative fashion and held that personality formed the basis for coping in both the conscious and the unconscious. Instead of being pathological in nature, coping and the desire for control are seen as normal, and indeed, healthy, functioning. As part of the individual's conscious world, this frame for coping relates personality to the likelihood of exposure to certain types or numbers of stressful events (e.g., choosing to become a firefighter or emergency room physician), perception and interpretation of the stressor (e.g., an unwanted threat or exciting challenge), responses to the stressor (e.g., learn more about the situation, pray, make a plan), and the availability of resources (e.g., a strong group of friends, sufficient income, health). This definition of coping as being more than an unconscious course of action undeniably advanced our knowledge of coping and personality. Early research on personality, however, was hindered by a lack of consensus on descriptors and other research procedures, which made it difficult for scholars to share results, duplicate one another's work, and establish verifiable results.

To address this issue, researchers systematically created a list of five specific personality traits. Called the Big Five and sometimes known by the acronym OCEAN, those traits are openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (alternately called emotional stability for its opposing trait on the continuum). Popular among researchers, the Big Five framework provides the solid, common foundation necessary to properly explore relationships between personality and coping. Studies indicate that people are relatively consistent in their choice of coping responses across different situations, and traits are related to the types of coping strategies an individual is likely to use, as well as the order in which the person will try given strategies. The most frequently studied trait has been neuroticism. People high in neuroticism tend to interpret common situations as threatening, emphasize the negative features of a situation (i.e., negative processing bias), and are more likely to recall stimuli associated with failure. Neuroticism also is related to the less effective, passive, or possibly harmful ways of coping: denial, wishful thinking, self-blame, avoidance, hostility, distancing, and distraction. In contrast, extraversion, conscientiousness, agreeableness, and openness to experience are related to more positive appraisals of potentially threatening situations,

interpreting negative events as a challenge, and emphasizing the positive aspects of a situation (i.e., positive processing bias). Extraversion predicts low use of avoidance, denial, or disengagement from goals. Conscientiousness is related to planning and seeking help. Conscientiousness and agreeableness are related to lower substance abuse, and openness to experience is related to planful problem-solving.

Although the Big Five personality traits have received a great deal of scholarly attention, much of the research has examined the associations between a single trait, a particular outcome (e.g., substance abuse, depression), and coping responses. However, individuals possess a combination of these five traits, which may interact to influence the types of experiences they select for themselves and how they respond to the potential stress associated with these experiences. For example, a person who is high in extraversion and neuroticism but low in conscientiousness may be impulsive, pleasure seeking, and have low control over his/her emotions, which may lead to quitting his/her job impulsively. This decision may lead to great stress if another job cannot be found. In addition, these same traits that led to the stress of job loss may also influence subsequent coping strategies selected. In this case, this combination of traits may lead the individual to seek out an entirely new field of employment.

Coping as a Process

The post-World War II social and academic zeitgeist of the 1950s and 1960s saw a shift in focus away from behaviorism, views that reduce human motivation to expectations about rewards and punishments, and toward Richard Lazarus' transactional theory of coping with stress. Lazarus's process model of coping emphasizes an active interplay between the individual and the environment, and accentuates the role of the person's cognitive appraisal of a given stressor and how best to act upon that stressor.

Lazarus' transactional theory is a cyclical process of appraisal and feedback, and the way a person copes with a stressor is largely determined by the meaning that the person attributes to the event in his/her life. Primary appraisal occurs when the individual senses a change in the environment (stress), then determines whether this change is good, has no impact, or poses some sort of threat. If the change is perceived as good or neutral, the process ends. If the change is perceived to be a threat, then secondary appraisal occurs. During secondary appraisal, the individual takes an inventory of available resources (types and amounts), assesses possible courses of action and constraints to these actions, and determines what may provide the greatest likelihood of managing or mitigating the situation. These appraisals result in the use of certain strategies to address (i.e., cope with) the given stressor. Feedback from the evolving situation then triggers a reappraisal of the stressor and available resources. The individual adjusts behaviors, cognitions, and emotions as necessary, and if the situation resolves, the cycle ends. If the situation continues, the cycle repeats. Note that the coping process may involve the individual focusing on (and perhaps adapting) himself or herself, the external environment, or a combination of the two.

Process theory classifies the various behavioral, cognitive, and emotional strategies people use. Lazarus and Susan Folkman

categorized coping strategies as either problem-focused or emotion-focused. Problem-focused coping strategies seek to reduce stress by dealing directly with the stressor to decrease its impact. These strategies tend to be action-oriented with the goal of eliminating or changing the stressor. For example, a woman who lacks reliable transportation to her job can directly resolve her situation by replacing her old car. Problem-focused coping also may involve changing oneself in relation to the stressor, such as a hiker moving to the other side of a trail to avoid a snake while on a nature walk. In comparison, the goal of emotion-focused coping is to reduce the impact of distressing feelings. This method is more effective than problem-focused coping for circumstances over which the individual has no control, such as a severely disabling condition or death of a loved one. It also often occurs when problem-focused coping fails to resolve the situation or when the stressor is so great that problem-focused coping has no real likelihood of helping. For example, a soldier who loses two buddies in an attack cannot control this reality, but he may tell funny stories about his friends to decrease feelings of grief. Emotion-focused coping need not be linked to the specific event. The grieving soldier may increase his workouts to counteract the negative effects of his war experiences, of which death is only one part.

A third category for coping strategies is known as meaning-focused coping, wherein people attempt to understand their stressful experiences in a broader context. Also called cognitive reframing, meaning-focused coping helps people align negative experiences with their belief systems (spiritual or otherwise) or worldviews, attempting to make sense of the stressor by finding a purpose or something good from it. An excellent example is the young woman dying of breast cancer who made her sister promise to educate others about the disease. That promise became Susan G. Komen for the Cure, the world's largest charity for breast cancer that has raised \$1.5 billion since its inception in 1982. Meaning-focused coping is linked primarily to traumatic events; the ability to find meaning in negative events is associated with more positive mental and physical health outcomes. Finding meaning may be a catalyst not only for decreasing distress levels but can also result in cognitive and emotional growth (see, e.g., Richard Tedeschi and Lawrence Calhoun's concept of posttraumatic growth). At the same time, not every person who searches for meaning in a traumatic event is able to make sense of that event in such a way as to make it meaningful. Some events may be perceived as so contrary to one's normal experience that they challenge strong beliefs about the way the world is supposed to be. Events that are uncontrollable, sudden, and violent, such as a random homicide, can have these qualities, as can rape or the sudden death of an infant. These types of events are often perceived as gravely unfair, and the attempt to find meaning without being able to do so has been found to be a stressor in itself.

Current Directions in Coping Theory

In the last decade, powerful statistical software programs have made possible the rapid analyses of very complex sets of data. Similarly, the full-text availability of the majority of coping research (both historic and current) via the World Wide Web has enabled scholars to integrate this information and test

theories in a manner that previously was quite difficult. Current research shows that the situation (e.g., being a single parent, a medical diagnosis), individual differences (e.g., extravert or introvert, life experiences), and environmental factors (e.g., physical safety, cultural standards) are all associated with a person's coping response. Thus, the current refinement of coping theory focuses on the integration of these factors, as well as determining whether certain combinations predict certain coping responses or outcomes.

Coping Strategies

Coping strategies are as numerous and varied as the stressors that precede them. From Folkman and Lazarus' *Ways of Coping Questionnaire* and Charles Carver and colleagues' *Coping Orientation of Problem Experience* (COPE), some common strategies or categories for coping responses are accepting the situation or one's role in it, active/confrontive coping to remove the stressor or oneself from the stressor, anticipatory coping aimed toward an expected but uncontrollable event, avoiding/escaping the stressor or associated feelings of distress, denying the problem or feelings, disengaging mentally or behaviorally (giving up), distancing/detaching from the situation or minimizing its significance, planning the steps to solve the problem, reinterpreting the stressor as a positive or growth-oriented experience, seeking social support (discussed later), controlling one's emotions or waiting for an appropriate time to act, using substances to dull feelings, suppressing competing activities until the problem subsides, turning to religion, using humor, and venting emotions.

Individuals also engage in proactive coping. These future- and action-oriented behaviors can prepare a person not only for specific stressors, but also for those that are likely to arise in the normal course of life. Proactive coping includes building and strengthening all resources (e.g., from practical and academic knowledge, experiences, and sufficient numbers and varied kinds of social contacts; see also direct effects hypothesis of social support). As well, proactive coping involves gaining skills and abilities to assess the changing environment more accurately, from signs of a possible stressor, to appropriate strategies and resource use, to feedback on a given situation. Though it is impossible to make causal claims, future-oriented coping tends to be associated with positive outcomes such as goal achievement and lower levels of distress. However, too great an emphasis on the future may be a sign of hypervigilance, which has been linked to negative outcomes such as anxiety and poor information processing.

As with the other components of coping, research classifies strategies by type, such as problem-focused coping or emotion-focused coping. One needs to bear in mind, however, that people's thoughts, feelings, and behaviors seldom fit into black-or-white categories such as those required for quantitative analytics. For example, a man responds to being laid off by networking with friends to learn of other job opportunities. Networking is active coping and planning, both of which are problem-focused. Networking with friends, however, likely adds the benefit of support from others to decrease his anxiety, which is emotion-focused. This illustration also shows that often the best method of coping is a combination of problem-focused and emotion-focused strategies. Whether it is a single strategy or

a few enacted together, this approach can both reduce the impact of the stressor and the negative emotions it may evoke. Yet, there is no one universal coping strategy that will be effective in all situations. Coping strategies that lessen distress in one situation may be ineffective or even detrimental to the individual in another.

Similarly, one must keep in mind that strict labeling of most strategies and other coping behaviors can result in erroneous interpretations. This is especially true when attempting to categorize responses as effective or ineffective. Seldom is a coping response all good or all bad, and one must well consider the many specifics of the situation and the goals of the individual prior to drawing firm conclusions. For example, considering the time frame during which the strategy is employed (e.g., the duration of the stressor) may be helpful in assessing its efficacy. Denial or substance use (not to be mistaken with abuse or use of illicit drugs) may be adaptive in the immediate aftermath of a traumatic event. However, these strategies rapidly deteriorate as wise choices for coping over time and should be replaced with responses that are more appropriate as time progresses. So, when the laid-off man goes home, he may have a few beers to wash down his sorrows, but continuing this behavior would no doubt exacerbate the problem.

Coping Resources

During secondary appraisal, people identify the types and amounts of resources they can call upon to help manage the stressor or buffer the intensity of their feelings. The presence and absence of resources directly influences the appraisal process because coping strategies may require specific resources in order to be an available option or for particular behaviors to be effective. This is true for both internal resources (e.g., self-esteem, knowledge, health) and external resources (e.g., money, friendships, shelter). Coping resources may be tangible or intangible, and the perceived value (intrinsic/extrinsic) of a given resource can be highly variable depending on the individual, the specific situation, and even the timing of the situation. For example, rapid access to a hospital may be essential immediately after an injury. During recovery, though, the need for emergency care declines while the value of a loved one's presence may increase. The more and varied types of coping resources a person has, the greater the likelihood of coping success. As well, those who lack resources or who are unskilled at identifying or using them are at greater risk for psychological distress and mental illness. Stevan Hobfoll suggests that it is the threat to one's resources, whether material goods or personal relationships, that is the major source of stress in the environment.

Like coping strategies, coping resources have been categorized in the literature. Some are appropriate for problem-focused coping, others are emotional-focused or meaning-focused, and like coping strategies, some can address more than one area. Scholars often use the terms resource and support interchangeably, for example, material support.

Material Resources

Many stressors can effectively be addressed or eliminated, often proactively, with material resources. Material resources typically are tangible, such as a house, vehicle, clothing, a computer, and

other items used in daily life. In modern society, however, the key material resource is money. Sufficient and consistent access to money and its equivalents helps individuals cope in a manner that no other material resource or coping strategy can match. An adequate supply of funds can provide proper shelter, healthy and sufficient food, medical care, and countless other goods and services that both proactively and concurrently address the stresses and strains that result when a person lacks necessities. Socioecological interpretations of deviation amplification illustrate the impact of money across multiple aspects of life. Studies clearly show that those with less money experience a disproportionately high level of exposure to stressors. Some of these consequences are generally apparent, such as the lack of adequate food, shelter, or medical care (preventive or otherwise). Other circumstances are less obvious, however, such as the positive relationship between poverty and living or working around environmental toxins.

Social Support

Research conducted over the last few decades has clearly demonstrated the importance of family and close others in times of stress. Meta-analyses indicate that the influence of social relationships on morbidity and mortality is equal to well-established risk factors such as smoking and obesity. Early humans evolved as social creatures, quickly recognizing the value of pooling resources to cope with harsh environmental demands. Hunter-gatherer societies were more successful when multiple hunters were available to secure food and ward off predators, and multiple females more easily tended to the needs of any offspring. Today, engaging one's social network during stressful times is recognized as one of the most productive coping strategies. Indeed, social support has been shown to be beneficial whether or not one is experiencing increased stress. Support from others can take many forms, including instrumental support (e.g., providing groceries or a ride to work), informational support (e.g., providing information about an illness), and emotional support (e.g., providing comfort and listening). Having the opportunity to talk about an emotional trauma – when one desires to do so – is associated with better health. Even the simple knowledge that family, friends, and others (e.g., counselors, clergy) are available when needed can buffer the physical and psychological effects of stress. Though the mechanisms by which social support works as a defense against the negative effects of stress continue to be examined, research consistently finds that individuals who have a supportive network are better able to cope with stress, and receiving effective social support plays a role in influencing health and well-being.

Whereas a growing body of work describes these significant benefits, a broad conclusion that all social interactions are good for coping would be incorrect. The presence of others is not always a resource for support and may sometimes be its own stressor. Seminal work by Karen Rook and others indicates that not all social interactions are perceived as helpful, and some may even lead to unintended negative outcomes that can be more impactful on the individual than positive outcomes. For instance, outsiders may have specific expectations about the process or coping behaviors that should occur in response to a stressor. A failure to show an expected level of

distress (e.g., length of time to grieve the death of a child), or not engaging in the expected behaviors, may lead others to believe that they are seeing signs of pathology. A loved one's advice may feel more judgmental than assistive, or too many visitors may exhaust a sick person and prolong the recovery period. Sometimes the level of support that is expected does not materialize, or providers offer well-intentioned but ultimately unhelpful comments that minimize the trauma or seem rejecting and alienating. Researchers have found that for social support to be effective, it must be matched both with the environmental demands triggering the distress and the specific needs of the distressed person.

Religiousness/Spirituality

Many people report a belief in God, though constructions of God and worship vary greatly, even within a single country. The study of Western religious philosophies and practices shows that religion serves two principal functions in coping. First, the act of believing in a higher power is associated with individuals finding both emotional comfort and personal meaning from painful events. This is especially true for situations involving loss and over which one has no control. For example, a belief in God may provide comfort upon the death of a loved one, such as through an image of heaven as beautiful, joyful, and believing that the loved one is waiting there for reunion. Similarly, belief in a higher power may help some individuals construct meaning for events that are dissonant to a worldview of justice and fairness. Second, regular attendance at religious services can provide or enhance an individual's social support network. Having others who share the same beliefs can also be comforting during difficult life periods. In this same manner, other religious behaviors, such as being involved in prayer groups or attending church-related functions, can support strategies such as positive reframing, and are negatively associated with typically less effective coping strategies. Religion as a deterrent to alcohol and drug abuse specifically is apparently achieved via two mechanisms. The first is a person's behavioral adherence to the belief held by most religions that the human body should not be misused (e.g., drinking to excess, drug abuse). The second deterrent relates to the person's focus of time and attention on healthy, positive social activities (e.g., a church's softball team) and away from possible negative influences.

Some Additional Factors

In addition to personality, other characteristics have been shown to influence the coping process. One such characteristic is gender. Human subjects research historically focused on the male gender, and conclusions from these studies (e.g., health and physiology) were assumed to apply equally to females. An example specific to stress and coping is Walter B. Cannon's proverbial fight-or-flight response, wherein a threat or challenge initiates a rapid sequence of neuroendocrine events to prepare the individual for maximum effort against danger. While fight-or-flight is a universal physiologic response, Cannon's model did not address the actualities that neither fight nor flight is a reasonable behavioral choice for females, especially when they are

tasked with protecting offspring. More recent studies show distinctively different hormonal responses in females. In particular, lower levels of testosterone and higher levels of oxytocin trigger females' behavioral responses to tend-and-befriend, as coined by Shelley Taylor and colleagues. Tending to the young and befriending others for mutual support offer females the greatest likelihood of success in coping with any threat, whether real or potential. Also to that end, neural (brain) differences in females better enable the development and maintenance of social networks, such as the ability to read body language more accurately and greater verbal skills relative to males. On the other hand, females are more likely to appraise situations in a negative light and tend to rely less on problem-focused strategies than their male counterparts. These differences are a few examples of how gender plays a role in the coping process.

Age is another characteristic that influences coping. Studies have revealed an interesting juxtaposition of generally age-related losses and gains that older adults have learned to manipulate to best maintain a sense of control. For example, older adults are less likely to engage in the active, problem-focused coping strategies; however, they are more likely to have a well-established social network on whom to call for assistance. Older people frequently face losses that hold greater significance than those faced by younger people, from personal independence to the deaths of loved ones and one's own declining health. At the same time, age is related to more positive appraisals of situations, as well as a philosophical acceptance of uncontrollable circumstances. Often related to age, a person's level of experience – both in life in general and with specific or similar events – can influence appraisals. Individuals may experience the same types of stressors several times over the life course. Whereas a novel experience requires a certain amount of energy and resources, repetition of the same or similar situations may be related to feelings of comfort and decreased stress, especially when one has gained wisdom and mastery over the stressor the first time around.

In addition to enduring characteristics such as gender and age range, temporal states, such as a person's mood, are associated with coping with stress. Appraisals of potentially stressful situations can be influenced by mood to the extent that the appraisal is, or becomes, consistent with the current mood state. For example, someone feeling happy may evaluate negative news in a more positive frame, or may pay less attention to signs of a potential threat. Conversely, sadness (and in the longer term, depression) is associated with greater sensitivity to change and people in negative emotional states tend to appraise neutral situations as more stressful or threatening than might be appropriate.

Conclusion

An integral factor in life, stress clearly is unavoidable. Stress, though, is not inherently bad or negative, and may serve as an impetus for personal growth. Of importance to human adaptation and health, then, is understanding the coping process as a whole, as opposed to focusing simply on the stressful circumstance. Two major theoretical perspectives were presented in this article: coping as a function of personality and

coping as a process. Research has demonstrated that both individual characteristics and the person–situation process significantly contribute, individually and in interaction with each other, to how a person adapts to change. Features of the personality influence the coping process by influencing appraisals, strategies, and resources. For nearly all of life's stressful circumstances, the most successful coping responses typically include both problem-focused and emotion-focused strategies. Together, these strategies provide a multifaceted response to stressors, which often tend to be multifaceted themselves. Aside from money, perhaps the most important external resource for coping is social support, which has been shown to decrease the negative effects of stress both from specific causes and in life in general. In the next few years, the field of coping will continue to discover and verify those factors in the individual, in resources, and in the characteristics of the stressor itself that predict better coping outcomes. This information, in turn, will help guide more effective programs or treatment for individuals who may be struggling to cope with a significant trauma or negative event.

See also: Big Five Model and Personality Disorders; Defense Mechanisms; Hope and Optimism; Id, Ego, and Superego; Learned Helplessness; Motivation; Perceived Control; Personality, Structure; Psychological Predictors of Heart Disease; Psychology and Religion; Stress and Blood Pressure Dysregulation; Stress and Illness.

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Creative and Imaginative Thinking

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Glossary

Convergent thinking Cognition that follows conventional pathways and is useful for finding correct answers to closed-ended problems and tasks.

Divergent thinking Cognition that goes in varied and unconventional directions and often leads to original ideas and remote associations.

Meta-cognition Tactical and controlled thinking; thinking about thinking that often contributes to effective creative problem solving.

Primary process Libidinal thought process, characteristic of the unconscious and uncensored by convention and mores.

Secondary process Reality-oriented thought that takes conventions into account.

Stage models Theories of creative cognition that break the processes down into phases or steps.

Introduction

Creative and imaginative thinking are related to one another but far from redundant. This article defines each of them and highlights exactly how they are related to but separate from one another. The emphasis here is on *thinking*, which means that the most relevant theories and research are found in the cognitive sciences. Still, definitions of creative and imaginative thinking are far from homogeneous; they are in fact notably diverse. Some of this is due to the fact that creative thinking often varies from domain to domain. The obvious example of this is that it can be more experiential and logical (in a traditional sense) in mathematics and the sciences and more intuitive and subjective in music and the arts.

Diversity is also indicated by the cognitive and extracognitive processes which have been associated with creative and imaginative thinking. Creative thinking is sometimes intentional, deliberate, tactical, and consciously controlled, but other times it is unintentional, unconscious, and seemingly chaotic. This article touches on each of these possibilities and reviews the range of perspectives on creative and imaginative thinking.

Defining Creativity and Imagination

Although there are variations among the domains in which creativity can be expressed, there is one commonality. Indeed, all definitions of creativity emphasize originality. Creative ideas and products must be original; if originality is lacking, there is no creativity. Most accurately put, originality is necessary but not sufficient for creativity. It is required, but there is always more than mere originality. Things which are merely original but not effective or somehow fitting are not creative. They may in fact be bizarre and useless, odd, weird, or even unrealistic to the point of psychosis. Psychotic individuals can be quite original due to their loose contact with shared reality; but this kind of originality does not constitute creativity since it is merely original and not effective.

Thus, there are two requirements for creativity: originality and effectiveness. The former is often operationalized in terms

of novelty or statistical infrequency. In other words, original things are unique or at least highly unusual. They are unconventional in a literal sense. The second requirement is more difficult because effectiveness can be objective, as in the case when an original idea solves a problem in a manner that is widely appreciated, or it can be fairly subjective, as is the case when one individual sees the esthetic appeal of an idea or work of art, but others do not see the same thing. A painting may convey meaning very effectively to some people, but not to others. Much the same can be said about all kinds of creative things; their effectiveness and appropriateness is often fairly subjective.

These two features of creativity go a long way toward distinguishing it from imagination. That is because imagination is that which allows an individual to explore ideas and options that are outside the boundaries of the objective world. It has been well described as *the capacity to transcend reality*. This can be very useful for creative thinking. Hence, the overlap of creativity and imagination. More specifically, the capacity to transcend reality can be used to find or invent original ideas or perspectives. These may be ineffective, precisely because they are not constrained by reality. That is how creativity and imagination differ. The former requires originality *and* effectiveness.

There is also a strand of research that defines creativity such that it always leads to a product of some sort (e.g., an invention, a work of art, a publication, or perhaps even just an idea), which makes some sense if you think about the word *create* (to bring something into existence). If this product perspective is held, another distinction is suggested: imagination differs from creativity in that it may not lead to a product. Imagination may only allow the transcendence of reality and not result in a product.

Stage Theories

The bipartite nature of creative thinking (originality and effectiveness) may explain why many theories of creative thinking look to stages or components. Simplifying, stage models usually allocate one or more stages specifically to the finding of

original ideas, and then later stages to their refinement or verification as effective.

Wallas presented a four-stage model of creative thinking that is still widely cited. It describes creative thinking as beginning with *preparation*, then moving to *incubation*, *illumination*, and finally *verification*. These four stages are also recognized in more recent theories of creative thinking, though the labels sometimes change.

Preparation is a surprisingly important part of the process. That may be implied by the fact that preparation assumes that experience is useful. After all, if preparation is influential, creativity can be enhanced by the right kind of experiences. Preparation actually takes many forms, depending on the level and domain of creativity. Preparation may involve learning and the collection of resources. This kind of preparation can eventually lead to *expertise*; and the highest levels of creativity (e.g., paradigm shifts) require expertise. Certainly expertise sometimes makes it difficult to think creatively, as is the case when it leads to routine and assumption. Both of these make information processing faster but also can keep the individual from seeing original ideas. Expertise is sometimes helpful for creative thinking, and sometimes detrimental.

Another kind of preparation involves the task or problem rather than the individual. Sometimes the task must be identified and defined such that creative solutions can be applied to it. This kind of preparation fits under the label *problem finding*, the idea being that problems must be found before they can be solved. Empirical work has confirmed that problem finding skills can be reliably assessed and are relatively independent of the skills used for problem *solving*. Problem finding and problem solving can work together, which is probably the ideal, but some people seem to be better at one than the other. What may be most important is the implication that creative thinking is not synonymous with problem solving. It is not just a special case of problem solving. After all, if creative thinking is related to problem finding, it can occur before (and independently of) problem *solving*.

There are other lines of thought that also support a separation of creative thinking from problem solving. Creative thinking may, for example, occur when there is no problem, as is the case when someone is proactively creative. Solutions to problems tend to be reactions to problems, so proactive efforts are independent of problem solving, at least in the sense that they precede and may not be dependent on it. Creativity which is playful or self-expressive rather than an attempt to solve a problem also support the distinctiveness of creativity from problem solving.

E. Paul Torrance and J. P. Guilford, two of the most influential scholars in this field, emphasized that problem finding plays a central role in creative activity. Torrance, for example, included problem *sensitivity* in his definition of creativity. For Guilford, problem finding was targeted in 'Seeing Problems.' This is a psychometric task that begins by informing an examinee, "In each problem of this test you will be given the name of a common object. You are to state problems that occur to you as you think about the object. You do not have to think about any solutions to the problems" (Merrifield and Guilford, 1969: 1). The object given as an illustration to examinees is 'Candle,' with examples such as how to light it, keeping it from falling over, keeping it burning steadily, how long it will burn, and what to do

with the drippings. The actual test includes tree, hammer, wind, envelope, rug, and sun as the objects for 'seeing problems.'

Guilford is well known for distinguishing *divergent thinking* from *convergent thinking*. The former allows ideation to move in different and potentially original directions. The latter characterized ideation moving toward the correct or conventional, and therefore unoriginal, solutions.

Mumford et al. presented a detailed stage model of creative thinking. They identified stages after an extensive review of the literature on creativity. The stages in their model are:

problem definition,
information gathering,
information organization,
conceptual combination,
idea generation,
idea evaluation,
implementation planning, and
solution appraisal.

Runco and Chand presented a stage model that included problem finding as the starting point. This is a unique model in that it acknowledges the impact of both motivation and knowledge. The two of these are on one tier of the model, with (1) problem finding, (2) ideation, and (3) evaluation and valuation on the primary tier. This model acknowledges that cognition does not work on its own. Many cognitive operations are only initiated if there is a reason to do so. These may be extrinsic or intrinsic. Similarly, knowledge can play a role, and it can be either conceptual, factual, and declarative, or procedural. The last of these is especially important for creativity that is intentional and tactical. Indeed, procedural knowledge often provides exactly that – a procedure for finding original ideas (e.g., 'change your perspective on the problem') or know-how.

A great deal of research has focused on one stage or another. Many influences on creative thinking, for example, may only have impact on one stage. Findings suggest that the impact of expected evaluation varies from stage to stage, which is interesting because evaluation is thought to undermine the intrinsic motivation which supports creativity. A second line of studies suggests that the relationship of mood and creative performance also varies from stage to stage. This is a significant finding because, too often, the impact of mood is presumed to apply across the board, but in fact elation or depression (and presumably the moods in between) may hinder or facilitate creative work, depending on the stage in which the individual is working. Just to name one example, it appears that creative thinking may suffer from elation or even mild happiness if this occurs specifically during the evaluation stage of the creative process. The elated individual may be happy about everything and his or her 'rose colored glasses' therefore preclude a detailed, careful examination of options. That individual may tend toward *satisficing*, which occurs during problem solving when one of the first options is accepted, and consideration of other alternatives terminated.

One of the newer models is called *geneplore* because it describes an interplay of generation ('gen') and exploration ('plore'). According to its authors, Ronald Finke, Thomas Ward, and Steve Smith, creative thinking occurs when the individual first generates a *preinventive form*. This is an unconstrained but ambiguous cognitive structure. It is subsequently

extended, elaborated, and evaluated during the exploratory stage of the process. Finke et al. reported impressive support for this model in their empirical work.

Uncontrolled Cognition and Creative Syntheses

The genealogy model is intriguing in part because it assumes that thinking is not entirely controlled, intentional, and directed. This is a very important idea for creative thinking because originality may result precisely from phases of the process which allow uncontrolled ideation. Recall here that Graham Wallas' stage model included incubation. This is by definition a time when the individual is either not thinking about the problem at hand, or, more likely, is working on the problem but not on a conscious and directed level. The illumination included in that same model (also known as the moment of insight or 'ah ha') occurs when the uncontrolled cognition hits something worthwhile and it is brought back to the level of consciousness.

The attractive alternative is that creative thinking reflects a synthesis of controlled and uncontrolled thought, a blend of conscious and unconscious, primary (libidinal, uncensored) and secondary (reality-oriented, censored) thought. This would allow the range of possibilities and motivations of the uncensored mind to work along with the direction, discipline, knowledge, and critical acumen of the logical mind. This seems to be what Arieti described as the *magic synthesis*, an idea later used by Klaus Hoppe to describe why commissurotomy ('split brain') patients have difficulty thinking in a creative fashion. They are unable to synthesize a freedom of thought with directed cognition.

Another kind of creative synthesis occurs on the level of individual ideas or solutions. Arthur Koestler described how different ideas can come together in what he called the *bisociative* process. More recently, Albert Rothenberg demonstrated how creative thinking may benefit from either *Janusian* or *homospatial thinking*. Janusian thinking was named after Janus, the Roman God of doorways; he could look in two directions at once. As is implied by the name, homospatial thinking allows an individual to bring two images together, in the mind's eye, to form a meaningful whole. Rothenberg identified a number of well-known discoveries and insights which could easily have depended on Janusian and homospatial thinking. The Heisenberg Uncertainty Principle, for example, recognizes that the speed and location of a particle cannot be known at the same time, while Existential Philosophy recognizes both the infinite and also the absurdity of mortality. Chaos theory also brings opposites together into 'an orderly disorder' (Glieck, 1987: 15). Most important may be the experimental support presented by Rothenberg demonstrating that many individuals do in fact produce creative ideas, solutions, and images when the synthesis of inputs is experimentally facilitated.

Extra- and Meta-Cognitive Processes

There are, then, a number of ways that creative and imaginative thinking may benefit from undirected, uncensored, uncontrolled thinking. There is at least as much evidence that creative

and imaginative thinking can benefit from controlled, directed, and deliberate processes. This makes a great deal of sense given the observation that high-level creative accomplishment requires work and effort. It can be work and depend on effort. This again is a reminder of the role of motivation. In fact, there are several extracognitive influences on creative performance. For this reason many studies of creativity examine personality and attitude. One view is that the cognitive capacity is by itself not sufficient but must be energized and maintained, which means that the person is motivated to invest the time and effort into thinking in a creative or imaginative fashion. Yet again there is a difference between creativity and imagination. The former is more easily tied to effort, perhaps because it is not enough to have an original idea. That idea must also be effective, and verifying or refining the idea may require the motivation. Imaging alternative realities or experiences, on the other hand, may require less verification and refinement. For the same reason it is easy to see the imaginative worlds and friends of children, even though they do not invest time into preparation, verification, and refinement.

For similar reasons it is clear that creative thinking can benefit from intentionally used tactics and strategies. Many of these have been reported in the literature, including 'work backward,' 'shift your perspective,' 'take time away from the task,' 'turn the situation on its head,' and 'break a large problem down into small ones.' Such tactics and strategies for creative thought are meta-cognitive in that they are intentional. The individual is thinking about and trying to guide his or her own thought. Many programs have been developed to best communicate tactics to persons interested in creative thinking and to allow practice with them. In fact, many organizations do much the same and bring facilitators in for training in creative thinking and practice with tactics. Organizations tend to be more interested in creativity than imagination, probably because the former is clearly connected with effectiveness, and businesses require effective originality. They often see the role of creative thinking in innovation. One view is that innovation is a result of creative thinking. Innovation does seem to require the same two things, originality and effectiveness, though it may be that there is more emphasis on the latter in innovation as compared to creativity.

Conclusions

Although stage theories of creative and imaginative thinking are common, care must be taken not to delineate them into entirely discrete stages, phases, or components. It is a bit like the trade-off of laboratory versus naturalistic research; with each there is a benefit but also a cost. Laboratory research offers control, but application to the natural environment is lost. Similarly, discrete stages may make the process more manageable and testable, but in reality creativity probably depends on a spontaneous flow among stages. No doubt there is recursion rather than a simple step-by-step progression toward a creative insight.

Recall also that cognitive processes do not operate in isolation. There are extra- and meta-cognitive influences. Motivation and affect can be quite influential. This is probably true in a general sense in that some of the directed and intentional

tactics for creative thinking will not be used unless the individual is motivated to expend the necessary effort. It is also true in more specific and idiosyncratic ways, such as when certain affective disorders provide troubled individuals with advantages for creative thinking.

This article suggested that creative and imaginative thinking may differ in that the former depends more heavily on effective thinking. This in turn explains why there are developmental differences (children having less reason to be effective, often think in an imaginative way as part of their play) and why creativity is more often targeted by organizations. They need to be effectively original, not just original, in order to adapt to market changes and to perform in an innovative fashion.

It will be interesting as neurophysiological technologies advance to see if the brain is structured such that there is in fact both overlap and distinctiveness between creativity and imagination.

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Creativity

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Glossary

Convergent thinking Analytical, usually deductive, thinking in which ideas are examined for their logical validity or in which a set of rules is followed.

Depression A psychiatric disorder characterized by an inability to concentrate, insomnia, loss of appetite, anhedonia, feelings of extreme sadness, guilt, helplessness and hopelessness, and thoughts of death.

Divergent thinking Thinking in an unusual way, for example, to generate several possible solutions to a problem.

Dopamine A monoamine neurotransmitter formed in the brain by the decarboxylation of dopa and essential to the normal functioning of the central nervous system.

Norepinephrine A hormone and neurotransmitter, secreted by the adrenal medulla and the nerve endings of the sympathetic nervous system to cause vasoconstriction and increases in heart rate, blood pressure, and the sugar level of the blood. Also called noradrenaline.

Definitions of Creativity

The construct of creativity has received a great deal of interest from a variety of disciplines such as psychology and neuroscience, but often there is not much coherence in the findings across these disciplines. The reason for these inconsistent findings may partially be due to the fact that creativity is a very complex mental process and thus difficult to study. Different researchers have not only defined creativity in different ways but have also approached the study of creativity using different paradigms and have provided different explanations for the mechanisms that might underlie creative thinking.

Investigators and experts who judge creativity have not even come to a consensus about the definition of creativity. When a person states that something is a creative product or someone is a creative person, what does that mean? Webster's II University Dictionary (1988) provides several definitions of creativity: having the power or ability to create, productive, marked by originality, new. While these definitions do contain elements of creativity, they are, however, incomplete. For example, there are many individuals who are musicians, artists, writers, and scientists who are very productive without being creative. A person can have technical expertise, work hard, and be productive but his or her work might not be new or original. Novelty alone does not make a creative product. For instance, a list of nonwords and/or colors randomly applied to a canvas may be novel or original but is not creative.

Another definition of creativity that is widely used in research is that of Bronowski: *Creativity is finding unity in what appears to be diversity*. Great art works have many colors, forms, as well as textures and great musical works have a large variety of melodies and rhythms, but creative artists and composers are able to develop a thread that unifies diverse elements and display order. Although this definition focuses on the crucial importance of a 'global approach' within the construct of creative thinking, it is lacking in concepts such as originality (novelty) as well as productivity and these concepts are considered to be essential to the creative process. The concept of novelty includes two aspects that may be separated: novelty for

a person versus novelty for the world. Researchers often find that their original or new ideas for future studies have already been conducted once they perform a review of the literature and they may learn that they are 'reinventing the wheel.' Are these instances of creativity, even though the idea was not new? The answer is 'yes' for that individual, but 'no' for the society; however, people who perform creative projects need to be aware of prior creative projects. Computer networks have been an important advance in allowing creative people to get to know what has been previously produced.

Many researchers who study creativity believe that, in addition to being novel, a product must also have some value in order to be considered creative. Thus, an invention must carry out the task for which it was designed, a scientific theory must help us understand the domain in question, a creative work of art must be appreciated by some audience beyond the artist, and a creative solution of a problem has to solve the problem.

Csikszentmihalyi and Csikszentmihalyi have presented a detailed analysis of how novelty and value are both relevant to creativity. A novel product becomes creative only after it has become part of the domain, that is, only after it has been positively valued by the field. In this view, if a product is rejected by the field, that product is not creative, whether or not it is novel.

Weisberg as well as Heilman, however, disagree with the concept that products must be valued to be considered creative. Often, a product is not valued at the time it is produced but then becomes valued by later generations, or vice versa. For example, the impressionist painters were criticized when they first painted using this style. Galileo Galilei was accused of being a heretic and confined in jail in 1633 when he first supported the heliocentric theory of Copernicus. It was not until 180 years later that the Catholic Church officially recognized the Copernican theory as compatible with the Christian faith. Further, in 1992 the cardinal Poupard finally wrote that the persecution of Galileo Galilei was a mistake.

For all of these reasons, it may be more useful to separate the creativity of a product from the value of the product and to consider a product as creative if it is novel and produced intentionally.

Another aspect of creativity that many believe is important is that the product must in some way be beneficial and available, such that people other than the creator should benefit from the creative process. Benefit, as used here, does not mean solely profit and can mean anything from healing (Fleming's penicillin) to enjoyment (Puccini's *Madame Butterfly*). For those who include 'beneficial' in the definition of creativity, innovative products would not be considered creative if they are not followed by objective verification, independently of the value of the idea itself. Thus, for those who believe that 'beneficial' should be a part of the definition of creativity, productivity is an essential element and if an idea remains solely in the mind of the researcher or the artist and never becomes a reality by being produced and judged to be beneficial then there will be no means of knowing if that idea was indeed creative.

Even to those who believe that ideas, even in the absence of production can be creative, having a creative idea without a product, such as a scientific paper, a piece of art, or music, is like leaving a treasure under the sea.

In this article, we define creativity as the ability to understand (see unity in what appear to be diversity), develop, construct, and express in a systematic fashion, novel orderly relationships.

Methods of Studying Creativity

Just as there are difficulties in defining creativity there are also difficulties in finding the right method to study creativity. Here we will describe some of the methods that have been used to study creativity, explaining the limitations and the strengths that apply to each method.

Autobiographical Self-Reports

The oldest method to study creativity consists of personal reports from individuals with extraordinary creative accomplishments, including detailed descriptions of how the individuals conducted their work. These reports come from a range of creative people across a spectrum of fields, and are in the form of letters, books, and articles, addresses before scientific societies or other groups, as well as responses to questionnaires or interviews. Although these autobiographical self-reports are produced by people who have been highly creative, these reports are uncontrolled, as well as being subjective, and they cannot be fully assessed for reliability or validity. Even when there is no intent to deceive, sometimes these reports are even factually inaccurate. Self-reports are based on introspection and while introspection can provide some hints as to brain function, neuropsychological studies, such as those with callosal disconnection, have revealed that introspection often does not elucidate the brain mechanisms underlying a behavior. Finally, self-reports provide us with only qualitative descriptions of the creative processes, and hence they cannot test a-priori hypotheses and they do not provide data that can be used for rigorous scientific analysis.

Biographical Studies

Another way to approach the study of creativity has been through biographical studies such as Gardner, who collected

data from the biography of many creative individuals such as Einstein, Picasso, Gandhi, etc. Biographies are based on verifiable historical records and provide a method of directly studying individuals with the highest level of creative accomplishment. One possible limitation of this method, however, is the quality of the data that is available. Incomplete or inaccurate records may severely restrict the findings and conclusions of these studies. Additionally, biographical studies have many of the same limitations as do the autobiographical self-reports discussed above.

Historical Case Studies

Historical case studies are often more focused on the products of the creator, as opposed to the personal characteristics and the brain mechanisms that allowed individuals to be creative. Thus, analysis of historical case studies makes it difficult to discover the neuropsychological basis of the creative process or how it can be generalized. Case studies also have the same limitations as do the autobiographical and biographical studies as discussed above.

Historiometry

Throughout history there were certain eras and geographic localities where there was more successful creative productivity than during other eras and in other locations. These eras and centers of creativity were often associated with creativity in certain domains. These observations suggest that environmental factors can influence creativity. A number of researchers have applied quantitative methods to historical data in order to formulate and test casual hypotheses concerning creativity, using what has been called historiometric analysis. The term historiometry means 'measuring history.' As an example of historiometric analysis, Simonton was interested about how war and other sources of social upheaval might influence creative productivity. For example, during World War II there was a flurry of creativity. In medicine, penicillin was first used and it was learned that it was healthy to mobilize patients shortly after their surgery. We also learned much about atomic physics. Simonton divided the last two millennia into 20-year 'epochs' and determined the frequency of creative accomplishments within each of these epochs and assessed the influence of environmental factors such as war. For example, the frequency of creative accomplishment was based on such measures as the number of years of active warfare within each epoch and the number of creative individuals who flourished during each epoch.

Using statistical methods, Simonton attempted to infer causal relationships from historical data and concluded that the occurrence of war involving a nation results in a decrease in creative accomplishments in that nation for the following epoch. The strength of the historiometric method is that it directly involves creative accomplishments at the highest level. However, this method is also limited by the availability of the data and although it might provide data about the influence of environmental factors on creative production it does not help elucidate the brain mechanisms underlying creativity.

Quantitative Case Studies

This method applies quantitative measurements to the analysis of individuals or groups of individuals over a period of time. Quantitative approaches to case reports sometimes result in discoveries that would not have been apparent from a more qualitative presentation of historical information. However, a potential problem of this approach consists of the serious threats to external validity that result from generalizing the results of a single case to a wider range of individuals and circumstances. Thus, it is of paramount importance for other researchers to replicate the findings from case studies using a range of creative domains, settings, fields, and individuals. Systematic replication will result in enhanced generalization and understanding of the creative process.

Empirical Investigations

Empirical investigations of creativity appear to be the premier means of learning why people are creative. Empirical studies require the development of an a-priori hypothesis, the development of the tests and methods to test the hypothesis, the analysis of the data, and the interpretation of results. These studies require the recruitment of participants as well as the apparatus and procedures that can test the a-priori hypothesis. These experimental investigations include attempts to directly manipulate creativity through random subject assignments and typically require subjects to perform various tests of creativity under a variety of conditions.

Experimental approaches have the advantage of exerting the highest level of control over potential confounds, thereby permitting investigators to draw cause and effect relationships. Although these are widely used methods to study creative thinking in normal individuals, there are limitations on the data that are derived from laboratory studies, as well as questions as to its ecological validity.

As we have discussed, each of the aforementioned methods have strengths and weaknesses. Thus, depending on the question that has been posed and the answer that is sought, researchers will use one method or another, while bearing in mind the potential strengths and limitations of the selected method.

Stages of Creativity

Socrates thought that 'inspired thinking' arrived from divinities, specifically the muses or the nine daughters of Zeus, each of whom was responsible for a separate domain. According to this belief savants are inspired instruments through which Nature shows humanity the secrets of underlying discoveries. Contemporary views, however, regard creative ideas as emanating from within the individual rather than from outside. Consistent with this more modern view, many studies have focused on identifying the brain mechanisms that underlie creativity. Helmholtz and Wallas suggested that creativity has four stages: preparation, incubation, illumination, and verification.

Preparation

In order to be creative an individual has to acquire the basic knowledge needed to develop creative ideas and skills

necessary to develop novel and creative products. Kuhn who wrote a very influential book on creativity noted that many important discoveries are initiated by the observation of an anomaly. An example would include a scientist perceiving significance in an accidental occurrence, such as Alexander Fleming's discovery of penicillin. Fleming left bacterial cultures (staphylococci) in his lab exposed to the air and did not close the windows in his laboratory. The fungus mold penicillin flew into his laboratory and landed on these cultures. When he looked at the cultures he noted that the penicillin mold had killed the adjacent bacteria. Although these types of discoveries are based on accidents, it is the 'prepared mind' that enables scientists, such as Fleming, to perceive the importance of the phenomenon they observed. Fleming was a well-trained bacteriologist who during World War I saw many men die of infection and found that antiseptics would not cure these infections. Creative imagination takes advantage of the ability of our brain to displace different life events in a new and original way, and the more rich and varied the experiences of a person, the more his or her imagination will have material from which to consider the problem.

Incubation and Illumination

When a person such as a scientist is confronted with a problem, the creative solution of this problem is often not immediately apparent. Then after a period of time the solution to the problem may enter this scientist's consciousness. Thus, it is highly probable that this creative scientist was incubating his or her ideas about the phenomena prior to becoming aware of the solution. This sudden awareness of a solution has been called the 'Aha!' experience and it is this 'Aha' experience or epiphany that Helmholtz and Wallas termed illumination. Whereas Fleming's 'Aha' experience was aided by observing an anomaly, many scientists and artists develop an illumination even without observing an anomaly. Henri Poincaré (1854–1912), a world-renowned mathematician and physicist, reported that he had several illuminations when describing his creative achievements. The occurrence of illuminations may then be considered evidence for unconscious processing. If 'Aha!' experiences do not originate from conscious thinking, then there has to be an unconscious incubation as an explanation for sudden illumination. Support for the concept that unconscious or subconscious incubation or thinking may lead to solutions come from more recent work by Strick et al., who demonstrated that following distraction from the problem for a period of time there was an improvement of some judgments. Weisberg, however, also noted that creativity does not always require great leaps following unconscious processing and the processes that lead to many great discoveries did not involve subconscious incubation, but rather a series of conscious steps.

Verification and Production

After illumination, creative people, such as scientists, perform experiments that attempt to test their new hypotheses, artists paint their pictures, writers write their books or poems, and composers write or play their music.

Intelligence and Creativity

There was a significant change in the direction of research on creativity around 1950 when Guilford, an expert on intelligence testing, surprised many people by proposing that psychology had not spent enough time examining thinking that went beyond the kind of cognitive processes and knowledge measured by intelligence or IQ test, namely, creative thinking.

Definition of Intelligence and Relationship to Creativity

There are many definitions of intelligence, but for most psychologists, intelligence is the measure of a person's ability to acquire and apply knowledge. Sternberg and O'Hara suggested four possible relationships between intelligence and creativity: (1) intelligence is the same as creativity; (2) creativity is a subset of intelligence; (3) intelligence and creativity are unrelated; (4) these are overlapping but independent constructs. If intelligence is considered a measure of a person's cognitive ability to adapt, then creativity is a gift that might enhance one's ability to use their cognitive resources to better adapt. Whereas this statement would hold for certain forms of creativity, such as medical science (i.e., discovery of penicillin) and engineering, this definition would not hold true for other forms of creativity, such as the arts, including music, dance, painting, writing of poetry and fiction, etc. If, however, the definition was expanded so that intelligence is both a measure of a person's ability to adapt and to enhance the quality of life, then the arts could also be included.

One of the founders of intelligence tests, Alfred Binet, must have initially thought that creativity and intelligence were the same or closely overlapping constructs because the first intelligence test he devised in 1896 used inkblots to explore the imagination of children. Later, according to Sternberg and O'Hara, he discontinued this inkblot test because he was unable to develop a reliable means of scoring it. This test, however, has been subsequently used as a measure of creativity.

Guilford and Christensen, who are among the first to study and help increase psychologists' interest in creativity, thought that creativity was a subset of intelligence and Guilford attempted to develop psychometric tests that could measure creativity. These tests are similar to those developed by Torrance. Most of these tests assess the ability to develop novel uses of common objects. For example, subjects would be asked to name in a fixed time interval the different ways in which they might be able to use a brick.

Another means of studying the relationship between creativity and intelligence is studying the intelligence of creative individuals. Barron and Harrington in their article 'Creativity, intelligence and personality' suggest that there is a curvilinear relationship between intelligence and creativity, with intelligence presumably becoming less and less influential as one moves to the higher levels of intelligence. This observation suggests that there might be an IQ threshold, such that a person needs to be above this threshold for him or her to have sufficient intelligence to acquire the knowledge about the domain of his or her creativity and to acquire the skills needed to be creative in that domain. Thus, intelligence is a necessary but not sufficient component of creativity.

Other investigators, such as Herr et al. and Simonton, have also studied populations of known creative people and

attempted to learn if there is a strong correlation between their estimated eminence as creators and their intelligence. They found that the correlation between intelligence and creativity is weak. This weak correlation, however, might be related to the tests that were used to measure intelligence.

Crystallized and Fluid Intelligence

Cattell posited that there are two types of intelligence, which he termed, 'crystallized' and 'fluid.' Crystallized intelligence is basically declarative memories, such as knowing that Rome is the capital of Italy or lexical-semantic knowledge, such as knowing the meaning of the word 'impale.' In contrast, fluid intelligence is defined as the ability to solve problems. Most intelligence tests, such as the Wechsler Adult Intelligence Scale (WAIS), assess both crystallized (e.g., vocabulary definitions), and fluid intelligence (e.g., similarities – How are a fly and a tree similar?). Cattell thought that while crystallized knowledge is important in creativity, it is fluid intelligence that primarily determines creativity. Although fluid intelligence may be the best predictor of creativity, we know of no formal studies that have studied this relationship and there may be different domains of fluid intelligence. In addition, there has been little written about the brain mechanisms of fluid intelligence and cognitive flexibility.

Divergent and Convergent Thinking in the Assessment of Creativity

Divergent Thinking

Guilford reasoned that an important step in the creative process must be a breaking away from the past, which is the function of what he called divergent thinking. Divergent thinking is the ability to take different directions from the prevailing modes of thought or expression. As the name implies, this type of thinking breaks away from established concepts and produces novel ideas, which can serve as the basis for the development of a creative product. Divergent thinking often produces multiple new ideas.

Convergent Thinking

In contrast to divergent thinking, convergent thinking involves seeing–recognizing the similarity or the commonality of phenomena that appear to be different or combining and joining two or more different observations or ideas together so that they provide additional information, for example, putting the pieces of a puzzle together so they make a complete picture. One of the best and classic examples of a paradigmatic shift using convergent reasoning is the Copernican heliocentric theory of planetary motion. Convergent reasoning or thinking is similar to that which has been termed deductive reasoning. Unlike divergent thinking with convergent thinking there is usually a correct answer. Almost all multiple choice tests that assess reasoning rather than knowledge require the person taking the test to use convergent reasoning.

Tests Assessing Components of Creativity

Guilford's work was the stimulus to the psychometric stream of creativity research, which has focused on measuring the

psychological characteristics of creative people (psychometric meaning 'measuring the mind'). Guilford and others have used their tests in attempting to measure the thought processes underlying creative thinking. Additionally, other investigators have developed other tests to conduct similar investigations.

As mentioned, creative endeavors require preparation, innovation, and production. Innovative thinking requires that a person first break away from prior solutions (disengagement), develop alternative solutions (divergent and associative thinking), and then learn which solution works best (convergent thinking). In this and the next section we will briefly describe some of the tests that have been used to study creative thinking, with the understanding that different tests explore different components of the creative process. The tests mentioned here represent only a portion of the tests that are widely used to investigate creativity and there may be many other tests.

The Wisconsin Card Sorting Test

The Wisconsin Card Sorting Test is a test of disengagement and divergent thinking. The task involves presenting a series of cards containing stimuli that vary along several dimensions, including shape, color, and form. The subjects are asked to sort the cards by matching the stimulus cards with a key card that has the same characteristic (e.g., shape). Once the subject demonstrates the ability to sort on one variable the examiner switches to a new sorting principle and the subject taking this test must find the new sorting principle (e.g., color). This process is repeated until all the cards are sorted. The score on this test represents the ability of subject to successfully disengage and switch sorting strategies. Patients with frontal lobe damage exhibit impaired performance on this test.

Alternative use of objects task

In this test the subjects are given three different objects (e.g., a brick) and are asked to name as many different uses for the object as possible in a specified time. The individuals are informed that their performance will be scored based on the number of uses as well as the degree of novelty-innovation for the uses they identify.

Each specified use is scored as a 1 for a common use (such as using the brick to build), 2 for a minimally innovative use (use the brick as a door stop or book end), and a 3 for moderately or highly innovative uses (grind the brick up and using it as a cleaning abrasive or as make-up.) The total score is the sum of the item scores.

When an area of brain is active and its neurons are firing, more blood is carried to that area. Carlsson et al. conducted a study looking at cerebral perfusion in low versus high creative individuals during the alternate use of object task. The results appear to indicate an increase in bilateral frontal activation in the highly creative individuals.

Alternative meanings test

Many words in English have multiple meanings. For example, the word pen can mean a writing instrument or it can be a place where animals (e.g., pigs) are kept. This test involves providing subjects with a series of words and having these subjects provide two sentences using each word, but in each sentence the word should have a different meaning. After the subject produces two sentences a new word is given. If the two sentences are not

given within 60s, the examiner provides the next word. The score is the time taken to successfully complete the test.

Tests Assessing Convergent Thinking

Verbal-word anagram task

Anagram tests involve providing individuals with words where the letters that comprise the words are arranged out of order. The task is then to recognize the word that would be spelled if the letters were in the correct order (such as LPSENID being identified as SPINDLE). This task has been used in several studies in our laboratories where we examined the effects of central norepinephrine blockade on creativity. The anagram test is often composed of 10 words and contains five 5-letter words, three 6-letter words, and two 7-letter words. Subjects are shown the scrambled letters of a word printed on a sheet of paper and asked to write down on an answer sheet the word that these letters spelled. The score for each word is the number of seconds required to identify the correct word. If the subject makes an error or does not write the correct word in 100s, a maximum score of 100 is given. The lower the score the better the ability to perform convergent reasoning.

Verbal-remote associates tests

The remote associates test (RAT) requires respondents to access the semantic representations for three presented words and find the one correct fourth word that is linked with the three presented words. The presented words may be related to the solution words in a number of ways, they can be semantically or associatively related, they may be two parts of a compound word, or they may be words used as synonyms. For example, the subject may be provided with the words 'falling,' 'famous,' and 'dust,' with the solution word of 'star.' 'Falling' and 'star' are associatively linked, 'famous' and 'star' are synonyms, and 'stardust' is a compound word. There are often 20 items in this task and the response to each item is scored for accuracy and time to respond.

Tests Assessing Both Divergent and Convergent Thinking

Insight problems

The concept of insight problems began with Gestalt psychology. Insight problems are problems which are simple to state but relatively difficult to solve, and require some sort of 'insight' (creative thinking) to solve them. Such problems initially seem overwhelming and without solution. However, insight may suddenly occur, giving a new perspective on the situation and an answer that clearly fits. There are different kinds of insight problems, some of them are verbal problems and others are more based on mathematical or spatial tasks.

An example of an insight problem is the 'Nine Dot Problem' or 'Thinking Out of the Box.' The subject is asked to connect nine dots in a 3×3 matrix with four connected straight lines without lifting the pen from the paper (see [Figure 1\(a\)](#)). The solution can be seen in [Figure 1\(b\)](#).

Revised Torrance Test of Creativity

The standard Abbreviated Torrance Test for Adults (ATTA) consists of three activities, one verbal and two visual. During the verbal activity the subject is asked the following question.

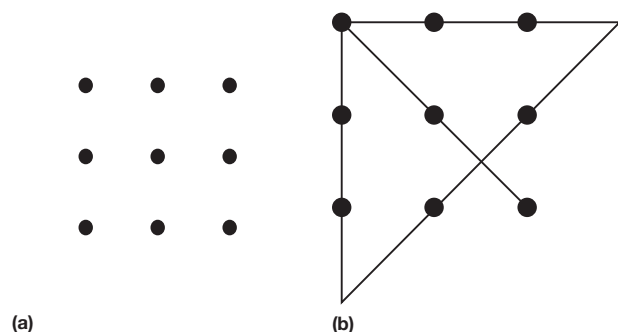


Figure 1 'Thinking out of the box.' The person performing this test is asked to connect all the dots in (a) with four straight lines, without removing the pen from the paper. The solution to this problem is show in (b). In order to correctly perform this test, a person must go 'outside the box' formed by the dots on the perimeter.

"Just suppose you could walk on air or fly without being in an airplane or similar vehicle. What problems might this create? List as many as you can."

The second activity consists of giving the subject a paper on which there are two incomplete drawings. The subjects are then asked to create meaningful drawings that incorporate these incomplete figures and to title their drawings. The third activity consists of giving the subjects a sheet of paper that contains nine isosceles triangles. The subjects are asked to make as many pictures as possible using these triangles or lines. The subjects are told that every picture should have a meaning and a title. Subjects are given three minutes to complete each activity.

Neurological Diseases, the Right Hemisphere, and Creativity

As mentioned in the introduction, through investigating the behavioral changes associated with brain dysfunction, scientists can understand the components that constitute complex cognitive functions and behaviors. We also mentioned the critical components of creative thinking including disengagement, divergent, associative, and convergent thinking with incubation and illumination (finding the thread that unites), as well as productivity. In the following section we will provide examples of the effects of neurological diseases on various cognitive mechanisms that are important in creative thinking.

Bruce Miller and his coworkers wrote a series of reports on the emergence of visual artistic talents in patients affected by frontotemporal lobar atrophy (FTLA). Two of the most common forms of degenerative dementia that are seen in clinics are Alzheimer's disease and FTLA. Most patients with Alzheimer's disease initially experience problems with episodic memory and then develop other cognitive deficits, such as problems with naming, route finding, constructional apraxia (drawing, copying), and even performing learned skilled movements (ideomotor apraxia). The signs and symptoms associated with frontotemporal or dysexecutive form of FTLA are different from those seen with Alzheimer's disease. In one form, patients lose their social skills and engage in socially inappropriate behaviors. Other patients may become abulic and sit around all day doing nothing useful. Still other patients with frontotemporal dementia might experience language deficits that

cause speech to become progressively less fluent (progressive nonfluent aphasia) or they might experience difficulty with naming and comprehension (semantic dementia). Additionally, unlike patients with Alzheimer's disease, patients with FTLA dementia may have relatively intact visual-spatial memory.

Brain imaging, such as magnetic resonance imaging (MRI), of patients with Alzheimer's disease usually demonstrate evidence of atrophy, primarily in the medial temporal lobes and in the parietal lobes. Conversely, patients with FTLA often evidence atrophy of the frontal lobes or the anterior temporal lobes or both. Further, FTLA might be asymmetric and primarily involve only one side of the brain. For example, patients with the semantic dementia form of FTLA most often have atrophy of the left anterior temporal lobe.

Microscopic examination of the brain in patients with Alzheimer's disease reveals the presence of amyloid depositions (plaques) and neurofibrillary tangles in the neurons. Patients with FTLA have a variety of different microscopic changes, including intraneuronal inclusions called Pick bodies (after the neurologist who first described this syndrome), ballooned neurons that stain poorly, or even no specific pathological markers.

Although it is often difficult to know, in retrospect, when a dementing disease has started several of the artists described by Miller and his coworkers (1998–2000) appeared to have started drawing or painting prior to the time they had the symptoms and signs of FTLA dementia or at the time when the disease was just beginning. What was remarkable about these patients is that in spite of their dementia they continued to paint and some even improved their artistic skills.

Whereas the left hemisphere, in right-handed individuals, is dominant for language and primarily mediates verbal activities, the right hemisphere appears to be more important for the type of spatial skills needed when painting. Miller and his coworkers noted that the brain atrophy of most of these artistic people was limited to the left frontotemporal lobes, sparing the right side of the brain, and their creative skills were nonverbal. Based on the reports by Miller et al. however, we cannot ascertain whether these patients' talents existed before the onset of the dementia.

Similar reports have been subsequently described from other authors. Finney and Heilman conducted a study with a patient with the progressive nonfluent aphasia form of FTLA by having independent judges score a variety of artistic qualities of seven of this patient's paintings completed before the onset of this disorder and seven paintings completed after the onset of the disease. The qualities scored included: (1) Novelty: 'How original is this painting?' (2) Aesthetics: 'How beautiful or attractive is this painting?' (3) Representation: 'How well is the subject of this painting rendered?' and (4) Closure: 'How complete is this painting?' The results of this assessment indicated that the patient's artistic ability neither diminished nor improved with the onset and progression of the disease, with the exception of novelty, which declined over time.

Drago et al. conducted a similar investigation by studying 40 paintings of an artist affected by the semantic dementia form of FTLD. Their findings showed an increase of some visual artistic skills over time. To help explain why brain dysfunction can result in the emergence of a new or improved skill, Kapur suggested that facilitation of a function might be

induced by a lesion that destroys an inhibitory circuit (i.e., a 'paradoxical functional facilitation'). Miller and his coworkers suggested that perhaps a similar phenomenon was occurring in their patients and the left anterior temporal lobe degeneration "contributed to the unexpected emergence of talent ...". This disinhibition hypothesis has also been used to explain creativity in individuals who are without dementia. For example, Einstein noted that he often used spatial reasoning to develop his creative theories. Einstein did not start speaking until the age of three, was probably dyslexic, and had abnormal development of his left parietal lobe. It is possible that these left hemisphere developmental abnormalities allowed his right hemisphere to develop exceptional spatial skills and talents. Although these aforementioned studies provide some important insights concerning visuospatial abilities, this right hemisphere disinhibition hypothesis has not been experimentally tested.

Some support for the hypothesis that the right hemisphere is important in creativity comes from a recent imaging study by Asari et al., who examined unique perception using functional MRI (fMRI). During the study 68 normal subjects were asked to look at ten ambiguous figures taken from the Rorschach inkblot test and state what the figures resembled. The responses were then classified as frequent, infrequent, or unique. The results indicated a greater activity in the right temporopolar region at the time of the unique response, as compared to the frequent responses. These results provide support for the idea that the right hemisphere is integrally involved in the visuospatial creative process.

Based on the hypothesis of a 'paradoxical functional facilitation,' Drago et al. studied an artist affected by Parkinson's disease (PD) who had a left deep brain stimulator (DBS) implanted. DBS can induce activation of one or both hemispheres. Thus the purpose of the study was to learn if DBS of the left hemisphere, presumably inducing left hemisphere activation, would alter the creativity of a professional artist as well as her ability to judge somebody else's art. The authors had the patient perform a test of creativity with the stimulator 'on' versus 'off.' The patient was also asked to judge the art of other individuals when the stimulator was both on and off. The results suggested that left ventral subthalamic nuclei/substantia nigra reticular deep brain stimulation (STN/SNr DBS) reduces creativity as well as appreciation of art. The reason for these alterations is not known, but might be related to enhanced activation of the left hemisphere and reciprocal deactivation of the right hemisphere. The right hemisphere is thought to mediate visuospatial skills and global attention, both of which might be important in artistic creativity and appreciation of art.

The hemispheric lateralization model grew in the 1970s. Researchers espousing this model postulated that the nondominant hemisphere was specialized for creative activities such as art and music. At the beginning of the article when creativity was defined we raised the concept of 'finding the thread that unites' and 'finding unity in what appears to be diversity.' The right hemisphere appears to be more important in global than local processing and a global approach may be important in finding the thread that unites. The right hemisphere is also important in mediating visual-spatial functions and as mentioned, many extremely creative people, such as Einstein, claim to have used visual-spatial strategies to help find creative solutions. Thus, the hemispheric lateralization model suggests

that the right hemisphere mediates functions that are crucial for creative processing.

An EEG study conducted by Jausovec and Jausovec recorded from 115 normal participants during resting, 'eyes open' and 'eyes closed' conditions. He found that when his subjects were stratified across measures of creativity and intelligence, EEG coherence (obtained during 'rest' with eyes open) was significantly related to creativity scores, particularly across the right hemisphere. Coherence provides information about the cooperation of different areas of the brain as well as the functional relations between brain regions. Finding 'the thread that unites' might require the cooperation of a variety of modular networks that are distributed in different anatomic areas and thus measures of coherence might provide evidence of modular coordination, ie associative thinking that is important in creativity.

The Role of the Frontal Lobes and the Influence of Dopamine on Creativity

According to Beals, Thomas Edison said that being a creative genius required "ninety-nine percent perspiration and one percent inspiration." Almost all creative people, independent of the domain in which they create, may be characterized by perseverance and persistence.

Goal-oriented behaviors or volition permeates almost all aspects of creativity, and the major organ of volition appears to be the frontal lobes. Clinically, patients with degeneration or injury of the frontal lobes present with a loss of initiative and drive, and this loss is called 'abulia.' Harlow, in 1868, reported the famous case of Phineas Gage, one of the best-known descriptions of a person who developed abulia from a brain injury. The ability to have long-term goals and to suppress biological drives when they interfere with long-term goals, as well as the ability to persist and not be distracted, is what Heilman calls 'frontal intelligence.' Frontal intelligence is one of the major factors underlying success in any profession, including those that require creativity. However, the frontal lobe networks have another function that appears to be important for creativity, namely, disengagement and divergent thinking. As we mentioned above, divergent thinking is the ability to take a different direction from the prevailing modes of thought or expression and as also mentioned, Zangwill and Milner suggested that frontal lobe damage or dysfunction would disrupt divergent thinking.

Electromagnetic studies demonstrate that frontal lobe activity appear to be important in creativity. Comparing subjects with high and low creativity has revealed that the highly creative individuals possess higher baseline frontal lobe activity and greater increases in frontal lobe activity while performing creative tasks. Further, there is preliminary evidence that transcranial magnetic stimulation applied over frontal lobes can increase frontal activation as well as creativity in normal subjects during both drawing and writing tasks. There are also case reports of patients whose creativity increased after receiving subcortical deep brain stimulation with the electrodes placed near the nucleus accumbens. The connections of the nucleus accumbens to the frontal and temporal lobes, and its role in limbic generation of drives and reward may help explain this effect. The dorsolateral prefrontal cortex supports

the planning and organization of artistic efforts, while the cingulate cortex modulates attention, drive, and emotion. Also, the motor and premotor frontal regions (along with the basal ganglia and cerebellum) carry out the precise movements needed for great art, dance, and playing of musical instruments. In addition, there is some evidence suggesting that creative drive may be controlled through interactions among the temporal lobes, the frontal lobes, and the limbic system. Particularly, creative drive increases with temporal lobe dysfunction and increasing dopaminergic activity. In contrast, reduced creativity (creative block) is associated with deficits in frontal lobe activity, or decreasing dopaminergic activity.

Creative people have also been shown to have higher baseline arousal and heightened responses to sensory stimulation. Dopamine decreases latent inhibition, a behavioral index of the ability to habituate to sensation and raises baseline arousal. Thus, the focused aspect of creative drive may be modulated by mesolimbic dopaminergic activity. Dopamine also mediates reward seeking activity, ranging from gambling and cocaine addiction to the appreciation of beautiful faces and music. Conversely, too much dopamine may cause excessively focused, highly complex motor stereotypes, such as repeatedly disassembling and reassembling one's motorcycle engine. Dopamine may also play a role in creative discovery through its effect on novelty seeking. An allele of the D4 receptors has been postulated, somewhat controversially, to be a novelty-seeking gene.

A recent study by Drago et al. examined patients affected by PD performance on a test of creativity. The patients were grouped based on side of onset, with the hypothesis that when compared to healthy controls, patients with a right hemibody onset would be more impaired in verbal creativity and patients with left hemibody onset would have more problems with visuospatial creativity. The results indicated when compared to control participants there was a decline in verbal creativity in the group of patients with right hemibody onset PD.

The neurobiology of creativity has also been addressed using single photon emission computerized tomography (SPECT), positron emission tomography (PET), and fMRI. Chávez-Eakle et al. used SPECT to study 12 highly creative subjects while performing figural and verbal creative tasks. These authors found a positive relationship between the creativity index and cerebral blood flow in the right post central gyrus, bilateral rectus gyri, right inferior parietal lobule, and right parahippocampal gyrus. These findings were interpreted as supporting a 'highly distributed brain system' underlying creativity. PET was used to study normal subjects as they performed verbal creativity tasks, with significant brain activation being observed in the left parietal-temporal brain regions (Brodmann's areas 39 and 40), which are considered to be 'crucial' to the creative process. An fMRI study attempted to localize creative story generation within the brains of a cohort of eight normal subjects. The results indicated that when creative story generation was contrasted to uncreative story generation, significant activations were observed within bilateral medial frontal gyri (Brodmann's areas 9 and 10) and the left anterior cingulate gyrus (BA 32). Across all studies, however, no clear consensus has emerged as to whether frontal or more posterior brain regions are more central to creative processes. There appears to be no single creativity node, but rather a complex of interactive modular networks.

The Role of White Matter Connectivity in Creativity

Creativity was defined in the beginning of this chapter as the ability to understand, develop, and express in a systematic fashion novel, orderly relationships. This ability might require intra- and interhemispheric communication between several brain modules. Works of scientific or artistic creativity often require the skills and knowledge mediated by both cerebral hemispheres. For example, the sculptor must imagine the rotation of spatial images mediated by the right hemisphere while he or she uses the motor skills mediated by the left hemisphere. Thus, intra and interhemispheric communication might be crucial for integrating the knowledge and skills that are important for creative innovation.

Corpus Callosum

The largest structure connecting independent modular systems is the corpus callosum. Lewis administered the Rorschach test to eight patients affected by medication-resistant epilepsy before and after they had undergone a cerebral commissurotomy and noted that disconnection of the two cerebral hemispheres tended to destroy creativity as measured by this test. Frederic Bremer suggested that the corpus callosum subserves the highest and most elaborate activities of the brain, in a word, creativity.

The corpus callosum is primarily comprised of myelinated axons whose cell bodies are in the pyramidal layers of the cerebral cortex. The cerebral connections important for creativity, however, might not only be interhemispheric, but also intrahemispheric.

Intrahemispheric Connectivity

In addition to the myelinated axons that carry information between the hemispheres, there are white matter connections between the thalamus, basal ganglia, brain stem, and the cortex. Myelinated axons also carry information between cortical regions in the same hemisphere. These intrahemispheric connections facilitate intrahemispheric communication, which also might be important for creative innovation because widespread connectivity allows creative people to combine the representations of ideas that have been previously isolated. In addition, these intrahemispheric white matter connections, that include connections between the frontal lobes and the posterior association areas in the temporal, parietal, and occipital lobes, might allow the selective activation or inhibition of cognitive modules.

Connectionist, or parallel distributed processing (PDP) models, suggest that there are processing units or nodes that are similar to the neurons found in the brain and PDP models strongly emulate the fundamental properties of neural networks. Information in PDP networks is stored in the strengths of connections between units (as in the brain). Concepts are represented as patterns of activity involving many units (i.e., as distributed representations) and large number of units linked by a set of connections define a domain of knowledge from which any one of a large number of concepts can be generated.

Psychological studies of priming effects on the latency of lexical decision tasks are a good demonstration of the ability of this model to account for empirical results. In a lexical decision task, words are flashed, one at a time, on a screen and the subject has to indicate, as rapidly as possible, if the word displayed is a real word or a pseudo word. In a priming paradigm, before the target word or a nonword appears on the screen, a prime word appears. If the prime is strongly related to the target (e.g., the prime is stripes and the target is tiger), the response time for word (e.g., tiger) is less than when the prime and target are unrelated (e.g., doctor-zebra). This reduction of reaction time to primed words is thought to occur because when a related prime appears it generates a distributed concept representation that involves activation of many of the units that define the distributed representation of the target. As much of the target's distributed representation is already activated when the target appears, response latency to the target is reduced.

Mednick suggested that in generating associative responses to a stimulus, creative individuals are characterized by a more flat associative hierarchy than are less creative individuals. Hence, creative people might have the ability to activate more highly distributed networks and this ability allows them to see 'the thread that unites.'

Relaxation, Depression, and Creativity

Sleep and Arousal

Several scientists reported being able to solve difficult scientific problems during sleep or when they were either falling asleep or awakening from sleep. One of the most famous examples of this phenomenon is August Kekulé, who in 1865, while attempting to understand the structure of benzene, had a vision, during a dreamy state, of a snake chasing its own tail. This vision provided Kekulé with the idea that benzene was a ring-like structure.

Before and after sleep, people who are actively working on a problem describe moments of insight when they were able to solve previously insoluble problems. Often the solution to difficult problems is aided by the ability to make remote associations and these moments of insight often come at time when the person is relaxed and at rest. Eysenck suggested that during conscious problem solving, cortical arousal is often high. This high level of cortical arousal narrows associative fields and suppresses the ability to make remote associations. A lowering of arousal, however, might allow these remote associations to emerge.

Support for the postulate that the level of arousal might determine the size of neural networks comes from some research performed by Contreras and Llinas. Using high-speed optical imaging, they performed electrical stimulation of subcortical white matters in slices of brain from a guinea pig and recorded the portions of the neocortex that were activated by this subcortical stimulation. They found that with low-frequency stimulation cortical activation was initially limited but then after few milliseconds the activation spreads into nearby areas. After high-frequency stimulation the excitation remained fixed to a small column of neurons that were directly above the stimulating electrode. Recordings from the neurons

around the excited column during rapid stimulation revealed increased inhibitory synaptic activity that probably inhibited the spread of activation.

Depression and Bipolar Disorder

Several researchers have investigated the relationship between depression and bipolar disorders in otherwise healthy creative individuals who were or are composers, scientists, artists, and writers and found a high incidence of affective disorders in this population and in their families.

To find a connection between all these different states that influence creativity, such as relaxation, depression, and resting, it has been hypothesized that alteration of the brain's neurotransmitter systems, primarily a reduction of the catecholamine norepinephrine might enhance creative thinking.

As mentioned above, the simultaneous and full activation of multiple modular networks appear to be important in creative innovation. Partial support for the postulate that catecholamines modulate the size of neuronal networks comes from the priming study of Kischka and coworkers who used a lexical priming task. As mentioned, either real words or pseudo words were flashed on a screen and the participants were asked to press a computer key as rapidly as possible when they determined that the word on the screen was a real word, but not to press the key if a pseudo word was seen. Sometimes these real words and pseudo words were preceded by another word that is called 'a prime.' If this preceding word is related to the real target word, the prime word will help the participants more rapidly recognize the real target word. The closer the prime and the target word are associated the more rapid will be the recognition of the real target word (direct priming). In contrast, if the words are weakly or distantly related the priming will be less robust (indirect priming) and the reaction will be only slightly reduced by these primes. When Kischka et al. administered levodopa to normal participants, the indirect priming effect decreased, suggesting that dopamine reduces the spread of semantic activation induced by the prime. Although Kischka et al. attributed this effect to the dopaminergic system, levodopa is also precursor of norepinephrine, and the administration of levodopa to these individuals may have also increased the level of norepinephrine.

To study the influence of norepinephrine on cognitive flexibility, Beversdorf et al. tested the ability of normal participants to solve anagrams when treated with placebo, ephedrine, or propranolol. Ephedrine increases the level of norepinephrine whereas propranolol is a beta-noradrenergic blocker and thus interferes with the influence of norepinephrine in the brain. They found that performance on the anagrams task was better after participants took propranolol than after they took ephedrine.

During stressful conditions, where normally there is an increase of catecholamines such as norepinephrine, the performance on the Remote Association Test declines. Further support for the postulate that high levels of catecholamine might reduce associative and convergent reasoning comes from a study where students with test anxiety improved their score on the Scholastic Aptitude Test when they took the beta-adrennergic blocker propranolol.

When performing the Controlled Oral Word Association Test subjects are asked to produce as many words as they can that begin with a certain letter in one minute. Foster et al. performed a study examining lexical-semantic activation in a population of Parkinson's patients. They sought to investigate the effects of PD, which is associated with dopamine and norepinephrine depletion, on spreading activation in the lexical-semantic networks. If these lexical-semantic networks are constricted, subjects would be more likely to use high-frequency words and if the network was expanded the subjects would be more likely to recall low-frequency words. Hence, Foster et al. examined the average word frequency on the words produced on the Controlled Oral Word Association Test in patients with PD and compared their performance to that of controls. These investigators found that the participants with PD exhibited a lower average word frequency than did control subjects, suggesting the subjects with PD had a more expansive activation of their lexical-semantic networks than did the control participants.

Ghacibeh et al. performed a study examining the effect of vagus nerve stimulation versus sham stimulation on creativity and cognitive flexibility in people affected by medically intractable partial epilepsy. Their hypothesis was that since vagus nerve stimulation activates the neurons in the locus coeruleus (LC), and results in increased release of brain norepinephrine, vagus nerve stimulation should reduce creativity and cognitive flexibility. These investigators had their patients perform tests of creativity such as the Torrance Test as well as cognitive control tests such as the Hopkins Verbal Learning Test. They found that when compared to sham stimulation, vagal stimulation reduced creativity but did not impair memory. These investigators concluded that the reason vagus nerve stimulation impairs cognitive flexibility and creative thinking is probably related to increased activity of the LC-central noradrenergic system that increases the signal-to-noise ratio and improves the brain's ability to attend to sensory input, but decreases its ability to recruit large-scaled networks. Depression is associated with a reduction of brain norepinephrine and based on this literature, it would be reasonable to think that depression with a decrease in norepinephrine would facilitate creative innovation; however, as we mentioned earlier, the verification and productivity portion of the creative process do need high level of arousal and thus it might be that depressed individuals have very creative ideas but have difficulty producing creative products until their depression remits.

Summary

Creativity is defined as the ability to understand, develop, construct, and express in a systematic fashion, novel orderly relationships. There are three or four major steps in the creative process, the first step is preparation, the second is innovation, including incubation and illumination, and the final is productivity. There are several means of studying how the brain allows humans to be creative and these include studies of creative people and patients with neurological diseases, as well as physiological studies (including functional imaging and electrophysiology (EEG and evoked potentials)), cognitive

psychological studies, and pharmacological studies. In regard to preparation, to be creative a person needs an adequate level of general intelligence as well as domain-specific knowledge and special skills that are dependent upon the domain of creativity. In the human brain knowledge is, for the most part, stored in the temporal, parietal, and occipital association cortex. In the human brain some forms of knowledge (language) are stored in the dominant left hemisphere whereas other forms of knowledge (visuospatial) are stored in the right hemisphere. There is some evidence that either faulty development or degeneration of one portion of one hemisphere might disinhibit other areas of the brain, particularly in the other hemisphere, and this disinhibition might enhance domain-specific creativity. Domain-specific knowledge and special skills alone are, however, are not sufficient for creativity. The ability to disengage from accepted solutions and develop alternative solutions or divergent thinking is an important aspect of creativity. Clinical as well as functional imaging studies suggest that the frontal lobes are critical for divergent thinking. The frontal lobes have strong connections with the posterior cortical association areas where concepts and various forms of knowledge are stored. White matter connects the right with the left hemisphere and white matter pathways connect the frontal lobes with the more posterior cortical association areas. These connections might allow the selective activation and inhibition of portions of posterior neocortex in both hemispheres and thus be important for developing alternative solutions. Although extensive knowledge and divergent thinking are critical for creative innovation they alone are insufficient for allowing a person to find 'the thread that unites.' Finding unity requires the binding of different forms of knowledge and these different forms of knowledge are often stored in separate cortical modules. Thus, creative innovation requires both the coactivation and communication between regions of the brain and thus is highly dependent on white matter pathways, both inter- and intrahemispheric. In addition, creative innovation most often occurs during levels of low arousal. High arousal is associated with high levels of brain norepinephrine produced by high rates of LC firing. This high rate of firing normally allows people to focus on external stimuli by restricting the breadth of activated concept representations. Low levels of norepinephrine shift the brain toward intrinsic neuronal activation with an increase in the size of distributed concept representations and coactivation across modular networks, a state that enhances creative innovation. Many people with depression are creative and this relationship may be related to the alterations of neurotransmitters such as norepinephrine that are associated with depression. In addition to being important in divergent thinking, the frontal lobes also help control the activity of the LC-norepinephrine system. Highly creative people may have brains that are capable of storing extensive specialized knowledge in their posterior association cortex, are capable of frontal mediated divergent thinking, and have an ability to modulate the frontal lobe-LC (norepinephrine) system allowing them to find the thread that unites.

See also: Creative and Imaginative Thinking; Depression; Human Intelligence.

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Crisis Management

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Glossary

Crisis Any negative event or situation that a person or organization perceives as such.

Crisis decision theory A framework developed by Kate Sweeny in which that describes the decision-making processes people undergo when faced with a crisis.

Crisis management The process a person or organization uses to deal with a crisis. The process includes preparation and prevention processes, detection of crisis, responding, and postcrisis responding.

Crisis signal detection The process through which people and organizations recognize or predict crises.

Damage containment The process through which people and organizations attempt to minimize the damage associated with a crisis.

Proactive coping A set of behaviors including acquiring resources, recognizing potential negative events, and taking action before an event occurs that prevents the negative event from happening or changes its course or outcome.

Introduction

Crises arise in many forms. For example, a company suffers a privacy breach in which their customers' financial information is accessed by outside parties. A woman realizes that her car is no longer in its parking space and wonders if someone stole or towed the car. A teacher overhears a student threatening to bring a gun to school. How do people manage crises such as these? This article focuses on the decision-making processes associated with managing crises in a variety of circumstances. Although much of the crisis management literature focuses on organizational behavior, this article also devotes substantial attention to the way individuals manage personal crises and draws connections between crisis management in individuals and organizations.

Definition of Crisis

The definition of a crisis depends in part on whether it is a crisis for an individual or an organization. The business and management literature typically defines a crisis as an event that damages a company's financial situation or reputation. In the case of medical research on crisis management, the definition of a crisis is any potentially life-threatening situation such as anaphylaxis or cardiac arrest. Further, education researchers define a crisis as any event that threatens the safety, and well-being of the students, or faculty, and staff or the students' ability to learn. However, when focusing on crises occurring at the individual or small group level, the definition becomes much broader and more subjective and includes any negative event or situation that a person perceives to be a crisis. The severity of individual crises can vary and do not necessarily threaten the person's life, safety, or well-being, or impact financial stability or social reputation. In other words, a crisis is, to a large extent, in the eye of the beholder.

A variety of crisis management models put forth in the past few decades address a wide range of factors associated with preparing for, preventing, and responding to crises. Despite the diverse research areas from which these models derive

(e.g., health, education, social psychology, and organizational behavior), they include many common and overlapping features. This article provides an overview of the full process of crisis management, including the detection of crises, the preparation for and prevention of crises, the decision-making processes engaged in crisis response, and recovery from crises. The goal of this article is to draw parallels between the various crisis management models and to merge previously disconnected areas in which crisis management has been studied.

Detection of Potential Crises

A significant segment of the crisis management literature comes from the fields of management and business and focuses on early detection of potential crises. Signal detection and issues management, two frequently used terms that refer to this stage of crisis management, involve information gathering, monitoring, and scanning of the environment in an attempt to predict potential crises. Additionally, Lisa Aspinwall and Shelley Taylor's proactive coping framework provides a social psychological conceptualization of how individuals acquire resources and attempt to recognize stressors that could potentially lead to a crisis.

Regardless of whether a crisis affects an individual or organization, four types of information can signal an impending crisis, according to frameworks described by Ian Mitroff and Gus Anagnos. Signals can be internal or external and derive from technological sources or from people. *Internal technological signals* monitor internal operations, such as virus scans on a computer. *External technological signals* can come from outside organizations such as government agencies or weather monitoring institutions, and they typically alert people to impending natural disasters or other external crises. *Internal people signals* involve information provided by personnel within an organization but may also refer to an individual's thoughts and emotions. For instance, a woman who finds a lump in her breast would likely respond to her awareness of the problem (i.e., internal information) by making an appointment to get a mammogram. Finally, *external people signals* come from

community members, customers, or friends and family. For example, a friend may communicate news of the death of a mutual friend, or community members may alert their city government about increased gang activity in a part of their city.

Even when signals exist to cue individuals or organizations to the potential for a crisis, the question remains as to whether they will seek out and acknowledge this information. In fact, research finds that although some people seek out information in the face of a potential crisis, many others prefer to avoid such information. At the individual level, information seeking in the face of a crisis involves activities like reading about symptoms, prognosis, and treatment for a medical illness or comparing home insurance policies to gain the best coverage. Businesses, too, can seek out information to aid in their prediction of potential crises. For instance, they may collect stock market trend data to foretell financial woes or examine employee satisfaction surveys to anticipate potential employee discontent.

Information avoidance, on the other hand, is a defensive strategy to avoid acquiring unwanted or aversive information. For example, a large percentage (up to 55%) of people tested for HIV do not return to the testing clinic to receive their results. In such cases, choosing to avoid information may postpone the onset of a potential crisis (e.g., facing a diagnosis of HIV). Although attending to information that potentially predicts an impending crisis is typically quite beneficial, individuals and organizations may ignore accessible information for a variety of reasons. That is, people are most likely to avoid information when it could lead to an unwanted or difficult change in their attitudes, beliefs, or actions, or when the information will induce aversive or negative emotions. Similarly, people also avoid crisis-provoking information if they perceive that they have little control over the outcomes of the information, if they lack sufficient coping resources to deal with the information, or if the information is difficult to access or hard to interpret.

As an illustration of the potential consequences of information avoidance, the crisis associated with the Space Shuttle Challenger disaster provides a prime example of crisis-predicting information avoidance. The conclusions of the investigating committee, the Rogers Commission, determined that there was a plethora of available information, namely indicators of defective parts on the shuttle and expert warnings against launching the shuttle, that NASA officials chose to ignore and that ultimately contributed to the occurrence of the tragedy. Although information avoidance may protect people from unpleasant feelings of anxiety and fear, the consequences in the context of crisis management can be dire.

Even if individuals or organizations are receptive to information that might indicate an impending crisis, they may face another barrier to crisis detection. Ian Mitroff notes that a psychological bias can occur in organizations such that they perceive an unrealistically low risk of experiencing a crisis. Organizations with this perspective tend to take fewer preparatory and preventative actions and thus, ironically, become more crisis prone. Similarly, individuals who are unrealistically optimistic about their likelihood of, for example, facing a health crisis also tend to engage in fewer preventative health actions. Thus, a critical aspect of crisis management is overcoming the biases that prevent individuals and organizations from realistically assessing their risk of experiencing a crisis.

Preparation and Prevention of Crises

Effective crisis management requires preparatory and preventative actions. A number of models include preparation and prevention as key components of crisis management, and many business and management scholars argue that the preparatory and prevention stage is the most critical for good crisis management. The goals of the preparation and prevention stage of crisis management are preparing oneself and others for a potential crisis and developing and implementing contingency plans for crisis responding.

Even when individuals and organizations recognize the necessity of preventative action, they often have limited resources to prepare for all possible crises. Mitroff and Anagnos' business frameworks of crisis management typically distinguish different categories of crises. The seven most frequently discussed crises are economic (e.g., labor strikes or market crashes), informational (e.g., loss of customer information or other confidential documentation), physical (e.g., loss of materials or facilities), human resource related (e.g., loss of staff or decrease in productivity), reputational (e.g., slander or gossip), psychopathic acts (e.g., violence, kidnapping, or terrorism), and natural disasters. The developers of such crisis frameworks recommend that organizations prepare for at least one crisis in each category.

Preparation for crises often entails simulation and training experiences. For example, in the case of hurricane preparation an organization might establish a meeting destination in case of evacuation, determine how members will communicate with each other, and post information about where emergency supplies are located. Similarly, schools conduct fire, earthquake, and tornado drills in order to prepare faculty, staff, and students to respond to natural disasters. Other preventive actions include implementing strong security systems, scheduling, planning and training workshops, engaging in mental health counseling, and encouraging activities that promote well-being, among others.

Unfortunately, individuals and organizations at times do not engage in preparatory or preventative actions even when they detect the possibility of a crisis. For example, women often fail to get recommended mammograms to proactively scan for breast cancer. Similarly, prior to the 2007 Virginia Tech campus shooting many college campuses failed to invest resources in preventative programs focusing on college student mental health and response plans for violence in the school. Similar to information avoidance, organizations engage in a number of defense mechanisms that hinder proper proactive responding. Mitroff and Anagnos point out several of the typically used defense mechanisms of crisis-prone organizations. For example, both individuals and organizations can fall victim to the 'just world' thinking by believing that good people/organizations do not face crises, or that all people/organizations in crisis must have done something to deserve their fate. Similarly, organizations often have a sense of perceived grandiosity, or the feeling that they are immune to crises. Both the 'just world' thinking and grandiosity can lead to denial in the face of crises, which undermines the motivation to prepare and respond effectively. Other defense mechanisms that can undermine the motivation to prepare for a crisis include disavowal

(i.e., thinking that a crisis will not significantly impact the organization), projection (i.e., thoughts about how evil people or organizations want to hurt the targeted organization), intellectualization (i.e., believing that the chances of a crisis are statistically small), and compartmentalization (i.e., thinking that a crisis can only affect a small part of the organization and not the entire company).

When a Crisis Happens

Despite the best efforts to detect and prepare for crises, they may nonetheless occur, and often unexpectedly. When a crisis occurs, people must then decide how best to respond. Kate Sweeny proposed the *crisis decision theory* to conceptualize the decision-making process that individuals and organizations use when dealing with a crisis. The following sections of this article explore how people make choices when responding to a crisis. Specifically, crisis decision theory proposes three stages of responding: assessment of severity, determination of response options, and evaluation of response options. Although crisis decision theory primarily describes individual's decision-making processes in the face of a crisis, the theory is broad enough to encompass the crisis response options that confront business, medical, and education organizations.

Assessment of Severity

As mentioned at the outset of this article, a crisis can be defined as any negative event that a person or organization perceives as a crisis. This broad definition can encompass such a wide variety of crises that the severity of crises also varies widely. Crisis decision theory describes that three types of information inform perceptions of a crisis's severity: information about the causes of a crisis, information about how the crisis compares to other outcomes, and information about the potential consequences of the crisis.

Crisis decision theory further proposes that the severity of a given crisis affects the extent to which people invest time and effort in responding to the crisis. According to the theory, responding occurs in an inverted U-shaped pattern such that nonsevere crises and extremely severe crises both result in low response effort. For example, one employee stealing a single pen from the office supply closet (a nonsevere event) is not likely to warrant a response from the management. At the other extreme, individuals or organizations can become paralyzed by very severe crises. A diagnosis of a severe and incurable disease may be so traumatic for the patient that s/he will not seek out ways to cope with or respond to the crisis. Similarly, an organization facing a financial crisis that could lead to the downfall of the entire organization may be unable to face the implications of the crisis, and thus unable to respond. Accordingly, moderately severe crises are most likely to prompt an effective response.

Determination of Response Options

Some crises may lack the severity necessary to prompt a response. However, when an individual or organization deems an event severe enough to warrant a response, they then turn to the second stage of crisis decision theory: determining available response

options. At this stage, people focus on two components of the crisis: the controllability of the consequences of the crisis and the feasibility of the available response options. Turning first to controllability, a crisis may have short- or long-term consequences that are controllable or uncontrollable. For example, the company responsible for the Gulf oil spill in 2010 faced some consequences that they could mitigate or control (e.g., the financial impact of the crisis on industries in the region) and other consequences over which they had little control (e.g., the effectiveness of various attempts to stop the oil from spilling into the Gulf). Crisis decision theory proposes that to the extent that individuals or organizations evaluate the consequences of a crisis as controllable, they will consider more active response options (i.e., responses that tackle the crisis itself). If the consequences of a crisis are primarily uncontrollable, individuals and organizations are left with few response options other than protecting themselves from the full impact of the crisis.

In addition, the extent of available resources limits crisis response options by making many options unfeasible. If individuals or organizations were effective at the preparation and prevention stage of crisis management, they are likely to have more response options available once a crisis occurs. For example, a school that employs security guards on campus has more response options in the face of a violent incident than does a school without extra security resources. Likewise, an elderly person who gathers a social support network in advance of the diagnosis of a terminal illness will have more options when facing the illness than will a person who is not prepared for the diagnosis.

Evaluation of Response Options

Having determined the available options for responding to a crisis, individuals and organizations must then evaluate the potential effectiveness of their various response options. This stage of crisis management is essentially a cost–benefit analysis of the resources required to engage in each response and the consequences associated with each response, including both direct and indirect consequences. All else being equal, people typically prefer the response option that requires the fewest resources (e.g., time, money, effort, etc.).

However, people must also consider the consequences of each response option. *Direct consequences* are outcomes of a response that affect the status of the crisis (i.e., make the crisis better or worse). Crisis decision theory describes three important aspects of direct consequences: the likelihood that the consequences of a response will be positive and avoid making the crisis worse, the magnitude of the potential consequences, and whether the consequences are reversible.

Indirect consequences of responses to a crisis are any outcomes of the response that do not affect the status of the crisis. Indirect consequences include public image consequences, consequences in other areas of life or infrastructure, and consequences for other people or organizations. Public image consequences are especially important to organizations facing public crises. It is at this stage in crisis management that businesses and other organizations must decide whether to communicate with the media about their current crisis. Even when the media is already aware of the crisis, organizations must determine how their response to the crisis will affect the media's

coverage of the crisis and ultimately their public image. Similarly, social psychology reveals that individuals constantly monitor the impressions they make on others, and these impression management concerns come into play when people evaluate their response options in the face of a crisis. People and organizations also evaluate how various responses to a crisis are likely to affect other aspects of their lives or other parts of their organization. For example, choosing to lay off a number of low-level employees may mean that senior-level employees work more hours, take on more responsibilities, and carry a heavier work burden. In addition, responses to a crisis can have far-reaching consequences for people other than the individual or organization facing the crisis. For example, an organization's response to a crisis could affect employees and their families, customers, suppliers, and stockholders.

Selection of a Response

Finally, individuals and organizations facing a crisis ultimately must choose a response. Although the chosen response typically reflects the cost-benefit evaluation just described, people may also prefer responses that they used in the past, regardless of their prior efficacy. Put simply, the known is often more comfortable than the unknown, even if the familiar response is imperfect from a rational, cost-benefit perspective.

In addition to selecting an appropriate response to the crisis, individuals and organizations may also benefit from engaging in *damage containment*. The goal of damage containment is to minimize the impact of the crisis and prevent the situation from negatively affecting other areas of an individual's life, or other departments, procedures, and individuals within an organization. For example, damage containment played an important role in the reaction of the company responsible for the 2010 Gulf oil spill, despite the fact that the company was heavily criticized for not engaging in sufficient damage containment at the onset of the crisis. In the months following the onset of the oil spill, the company engaged in damage containment by circulating press releases and producing television commercials that attempted to repair the company's reputation. In addition, they implemented a plan to provide monetary aid for people suffering financial loss due to the spill. Despite these efforts, critics still argued that the delayed response severely harmed the organization's reputation as well as the financial stability and well-being of individuals and businesses impacted by the oil spill. For instance, environmentalist groups accused the company of being responsible for withholding information regarding the severity of the oil spill that potentially slowed the response action to help save wildlife in the Gulf region. To reiterate, the goal of damage containment is to minimize the crisis's impact, and thus BP's efficacy in achieving that goal is perhaps debatable.

Postcrisis Responding

Fortunately, most crises eventually resolve and come to an end. However, crisis management may not cease with the end of the crisis. In fact, many crisis management models include the recovery period as an important phase in the experience of a crisis.

Recovering from a crisis involves numerous strategies including replenishing resources, attempts to recover losses, and revising crisis management programs. In addition, people must deal with the emotional consequences of experiencing a crisis. For example, after traumatic school shootings such as the Virginia Tech massacre or the Columbine shootings, schools typically hire counselors to talk with students and faculty about their reactions to the crisis.

Can individuals and organizations truly and fully recover from a crisis? Research from the health domain suggests that they can. Although cancer patients report lower quality of life during the acute phases of their illness, cancer patients in remission report similar quality of life as that of cancer-free individuals. Similarly, some schools and businesses report greater cohesion and a stronger sense of community between students, faculty, and/or employees following a crisis. This enhanced sense of well-being and connectedness can serve to replenish resources such as energy and mental health that may have been depleted during the crisis.

Reflecting on and learning from the crisis are critical processes to prepare for future crises. Although reflecting on a crisis may provoke anxiety, especially in the case of severe or traumatic crises, reflection may also promote renewed confidence and feelings of self-efficacy regarding the ability to handle future crises. Furthermore, people's perceptions of the causes and implications of a crisis may change once the crisis is over. It may be difficult to evaluate all aspects of a crisis while in the midst of it, so reevaluating the crisis once it ends can provide insight into the most effective ways to prevent future crises and to mitigate the consequences of crises that are unavoidable.

See also: Expectation; Leadership; Organizational Behavior; Perceived Control; Planning; Problem Solving; Uncertainty.

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Cross-Cultural Adaptation

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Glossary

Acculturation The process of acquiring a new culture's symbols and practices by an individual whose prior cultural learning has taken place elsewhere.

Adaptation The process of internal modification of individuals that enables them to attain a relatively stable, reciprocal, and functional relationship with a particular environment.

Assimilation The absorption process of foreign-born individuals into the native population by cultural, social, and economic mainstreaming.

Communication The process by which information is exchanged between individuals through the encoding and

decoding activities employing verbal and nonverbal symbols, signs, or behavior.

Culture shock Psychological and physiological stress responses to being placed in an unfamiliar cultural environment.

Deculturation The process by which individuals at least temporarily suspend, or unlearn over time, some of the symbols and habitual practices of one's native culture and replace them with new symbols and practices of the host culture.

Enculturation The primary socialization process whereby individuals learn and internalize their native culture.

Background

Millions of immigrants and refugees change homes each year seeking better hopes of safety, freedom, or economic betterment, or simply looking for a more desirable environment in which to live. Many others temporarily relocate in a foreign land to carry out religious activities, or to serve as diplomats, military personnel, and other governmental, intergovernmental, and nongovernmental agency employees on overseas assignments. Researchers, professors, and students visit and study at foreign academic institutions, along with the employees of multinational corporations. Increasingly, individual accountants, teachers, construction workers, athletes, artists, musicians, and writers seek employment in foreign lands on their own. Although varied in individual circumstances, all of these groups of people and many others share the common project called cross-cultural adaptation. They find themselves straddled between two worlds, the familiar milieu of the home culture and their new locus in the host society, and recognize that many of their previously held beliefs, taken-for-granted assumptions, and routinized behaviors no longer relevant or effectual.

Long-Term Adaptation

The process of cross-cultural adaptation among long-term settlers has been one of the most salient research issues across social science disciplines. Studies addressing this phenomenon have been continuous and extensive, particularly in the United States and more recently in European countries. In the 1930s, the Social Science Research Council appointed a Subcommittee on Acculturation and charged it with the task of analyzing and defining the parameters for this new field of inquiry within the domain of cultural anthropology. As a result, the concept, acculturation, was formally adopted as a new area of study dealing with those phenomena that result

when individuals and groups from one culture come into direct contact with another culture.

Subsequent academic inquiry into cross-cultural adaptation has evolved into a vast and diverse field. Such has been the case due to the application of concepts, definitions, and methodologies pertaining to differing disciplinary and individual perspectives and research foci. Many sociologists, for example, have approached immigrant adaptation focusing on macrolevel issues pertaining to the patterns and processes in which minority groups are integrated into the political, social, and economic structure of the new, or host, society. Studies in urban sociology and urban anthropology have added the dimension of ethnographic explorations into the issues related to political, social, and economic dynamics in immigrant or ethnic communities and neighborhoods.

In comparison, studies in social psychology, sociolinguistics, and communication have concentrated on the microlevel phenomenon of long-term adaptive change in individual immigrants. In this approach, emphases have been placed on the psychological, social, and cultural integration of individual newcomers into their host society. By and large, such studies have revealed that an individual's adaptive change is cumulative and progressive over time, thereby affirming the traditional 'melting-pot' perspective on the history of immigration in the United States.

The linear-progressive understanding of long-term adaptation, however, has been increasingly challenged since the 1960s and 1970s. With the rise of the ideology of pluralism in the United States and elsewhere, pluralistic conceptions of long-term adaptation have been proposed to reflect the viewpoint that assimilation into the dominant mainstream culture on the part of immigrants and ethnic minorities need not, or should not, take place. Instead, scholars upholding or sympathetic to this view have emphasized alternative choices for individuals or groups such as maintaining a distinct identity or seeking a dual identity with respect to their original culture and the host society.

Short-Term Adaptation

Studies of temporary sojourners have been largely exempt from the above-described ideological controversy over the phenomenon of assimilation. Since the 1960s, studies of sojourner adaptation have been motivated mainly by practical, problem-centered concerns of easing the temporary but often difficult transition into a new cultural environment. The problem-centered perspective is evident in the many studies that have addressed the phenomenon of culture shock. This concept, as well as related terms such as transition shock, cultural fatigue, and self-shock have been employed to investigate various stress reactions to cultural dislocation, from irritability, insomnia, and an acute sense of loss, to feelings of anxiety, insecurity, and impotence.

While focused on the problematic nature of life in a foreign land, sojourn research findings have shown discernible patterns of change in psychological states over time. A variety of studies have reported a 'U-curve' of psychological adaptation during a sojourn, depicting the general tendency for sojourners to experience initial optimism and elation, the subsequent emotional dip or trough, followed by a gradual recovery to higher adaptation levels. This U-curve description has been extended to the 'W-curve,' that includes the reentry phase during which the sojourner, once again, undergo a similar psychological adaptation process upon returning home. Despite their intuitive appeal, the U-curve and W-curve hypotheses have produced inconsistent findings when applied to different research contexts. Comprehensive reviews of pertinent research have concluded that evidence for the theories' claims are inconclusive and overgeneralized.

Sojourner adaptation studies have also highlighted some of the positive and beneficial aspects of crossing cultures. Arguments have been made that the cultural shock experience must be viewed in a broader context of profound learning and growth that leads to an increased self-awareness. Highlighting such positive aspects of sojourn, some studies have shown that the intensity and magnitude of initial culture shock is either unrelated to, or even positively related to, the level of subsequent psychological adjustment and social and professional effectiveness within the host environment.

The Process of Cross-Cultural Adaptation

Clearly, there are differences between long-term and short-term adaptation associated with the duration of the adaptation process itself. Unlike immigrants, most short-term sojourners are more likely to limit their contact with the new culture to mostly peripheral areas, such as to pursue a career, obtain a degree, or merely enhance one's prestige in the eyes of the folks at home. Compared to long-term settlers, their commitment to the host environment is likely to be weaker given their more specific and narrowly defined goals for sojourn.

Differences such as these, however, are largely a matter of degree, and not of kind. That is, immigrants and sojourners alike undergo at least some level of the common project of cross-cultural adaptation as they begin their life in the host society as strangers. As strangers, all newcomers embark on a cross-cultural journey as outsiders. They are challenged to

undergo at least some level of modifications in their original cultural habits, at least to the extent that is called for by the specific circumstance under which they have entered the host culture, so as to navigate their unfamiliar milieu and carry out their daily life activities.

This notion of strangers can be extended to include those who return home after a sojourn in a foreign culture or subculture. Generally, readapting to one's original culture is less demanding than adapting to a foreign culture. Yet, to the extent that the returnee has been changed by the sojourn experience, and to the extent that the original culture has changed during the sojourn, the returnee, once again, goes through essentially the same process of cross-cultural adaptation. Strangers further include those native-born individuals who cross subcultural or ethnic boundaries within a society and face significant adaptive pressures from the new subcultural environment. Such would be the case, for example, for American Indians leaving an Indian reservation to find employment in an urban environment. Also included in the domain of strangers are those individuals who find their local community rapidly changing in its demographic composition. For example, existing African American inner city residents may find themselves changing from being a majority group to becoming a minority group due to a significant influx of Asian immigrants.

The following discussion addresses the essential nature of the adaptation process that applies to all of the above-described categories of strangers who share the common challenge of the practical necessity to bridge the gap between their internalized cultural habits and those of the new environment.

Enculturation, Acculturation, Deculturation, Assimilation

The unwritten task of every culture is to organize, integrate, and maintain the home world of the individual primarily in the formative years of childhood. Children grow up in their native culture learning what they need to know to function acceptably in a given culture. Through continuous interaction with the various aspects of the environment, they are socialized to live in the company of others around them who share a similar image of reality and self. This process is commonly called enculturation.

In many ways, entering a new culture is like starting an enculturation process all over again. Only this time, strangers are faced with situations that deviate from the familiar and internalized original cultural script. They become more aware of the previously taken-for-granted habits of mind. Now, as strangers, they discover that they lack a sufficient level of understanding of the new communication system of the host society. They are challenged to suspend, or even abandon, some of the cultural patterns that have symbolized who they are and what they are. Such inner conflicts, in turn, make strangers susceptible to external influence and compel them to learn the new cultural system. This activity of new learning is the essence of the process known as acculturation, that is, the learning and acquisition of the new cultural patterns and practices, particularly in those areas of direct relevance to their everyday living.

Acculturation, however, is not a process in which new cultural elements are simply added to prior internal conditions. As new learning accumulates, some deculturation also

takes place, at least in the sense that new cultural responses are adopted in situations that previously would have evoked old ones. As the interplay of acculturation and deculturation continues for a prolonged period, strangers undergo an internal transformation, from visible changes in superficial areas such as overt role behavior to more intangible but more profound changes such as changes in previously held cultural beliefs, values, outlooks on life, and even cultural identity.

The ultimate directionality of the internal change driven by the continual processes of acculturation and deculturation is toward assimilation, a state of the maximum possible convergence of our internal and external conditions to those of the natives. Whether by choice or by circumstance, individual settlers vary in the distance that they travel in their own adaptation process. For most strangers, assimilation remains a lifetime goal than an obtainable outcome, one that often requires the efforts of multiple generations.

Stress, Adaptation, and Growth

Acculturation and deculturation processes inevitably produce in individual strangers stress, the experience of temporary internal disturbance and even breakdown in extreme cases. As parts of their internal organization undergo adaptive modifications, strangers are temporarily in a state of disequilibrium manifested in varying levels of confusion and anxiety. The state of internal flux is often met by the tendency to use various defense mechanisms such as denial, hostility, cynicism, avoidance, and withdrawal, all of which are particularly acute during the initial phase of sojourn or immigration, as indicated by the difficulties and disruptions documented in culture shock studies.

At the same time, however, stress experiences are the very force that drives strangers to adaptation. The interplay of stress and adaptation can be understood as a dialectic between integration and disintegration, between progression and regression, or between permanence and change. Each stress experience presents strangers with an opportunity to recreate themselves. It is through the impetus of stress that they are compelled to engage in activities of new learning that enables them to handle the transactions of daily living. Stress, in this regard, is intrinsic to complex open systems and essential in the adaptation process – one that allows for self-(re)organization and self-renewal. The state of misfit and a heightened awareness in the state of stress serve as the very forces that propel individuals to overcome the predicament and partake in the act of adaptation through active new learning.

Out of these activities, some aspects of the environment may be incorporated into an individual's internal structure, gradually increasing its overall fitness to the external realities. Over time, most strangers manage to achieve an increasing capacity to detect similarities and differences between the new surrounding and the home culture and are better able to manage their changed circumstances. What follows a successful, long-term, and cumulative management of the stress-adaptation disequilibrium is a subtle and often imperceptible psychological growth, a form of internal change in the direction of increased perceptual and intellectual complexity with respect to the host culture.

Together, stress, adaptation, and growth constitute a three-pronged conceptual representation of the psychological

underpinning of the cross-cultural adaptation process. As depicted in **Figure 1**, the stress-adaptation-growth process continues as long as there are new environmental challenges, with the overall forward and upward movement in the direction of greater adaptation and growth. The process does not unfold in a smooth, arrow-like linear progression, but in a cyclic and fluctuating pattern of drawback to leap: each stressful experience is responded to with a temporary setback, which, in turn, activates adaptive energy to reorganize and reengage in the activities of cultural learning and internal change, bringing about a new self-reintegration. Large and sudden changes occur during the initial phase when the severity of difficulties and disruptions are likely to be high. Over a prolonged period of undergoing internal change, the fluctuations of stress and adaptation are likely to become less intense, leading to an overall calming in the individual experiences of interacting with the host environment.

Factors Influencing the Process

We now turn to the question of differential adaptation rates, or speeds, at which cross-cultural adaptation occurs in individual cases. Although strangers, by and large, manage cross-cultural challenges successfully over time, the degree and pace of their individual adaptive change vary. Some may suffer more from hostility or indifference among the natives that makes it difficult to find ways to overcome the challenges they face in the host environment. Some may resist the idea of having to change their original cultural habits more, thereby raising psychological barriers to work against their own adaptive change. Others may be less capable of dealing with states of adaptive stress, leading to a more extreme withdrawal and alienation from the host society or a decision to return to their home country prematurely.

The fact that individual cases of cross-cultural adaptation vary in terms of the level of success begs the question, 'What factors facilitate or impede the adaptation process?'

This question is addressed below through an examination of the key factors of the communicative interface between the individual and the host environment, of the host environment, and of the individual's own background predisposition.

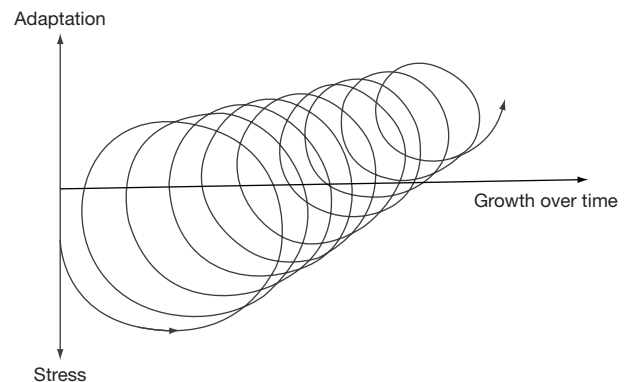


Figure 1 The stress-adaptation-growth dynamic. Reproduced from Kim YY (2001) *Becoming Intercultural: An Integrative Theory of Communication and Cross-Cultural Adaptation*, p. 59. Thousand Oaks, CA: Sage.

Communication Factors

Like all human-social activities, cross-cultural adaptation occurs in and through the communication interface between the stranger and the surrounding environment. Just as the natives acquire their capacity to function in their social world through communicative interactions throughout their lives, it is through communication that strangers come to learn and internalize the significant symbols and practices of the host culture. Through communicative engagement, nonnatives gain insights and skills that are necessary to achieving a level of success in their adaptive endeavor.

Communication activities comprise two basic, inseparable dimensions, personal communication and social communication. Through personal (or intrapersonal) communication, individuals organize themselves internally with respect to their surroundings, developing ways of engaging themselves in social communication activities. If the personal communication can be compared to the 'off-line functions' of computer systems, social communication carries out the 'on-line' functions of interfacing with the computer environment through input-output transactions of messages.

Personal communication

In the context of cross-cultural adaptation, personal communication can be best understood in terms of 'host communication competence,' that is, the overall internal capacity of a stranger to decode and encode information in accordance with the host cultural practices of communication. Host communication competence serves as the main engine that drives the adaptation process. Successful adaptation of strangers can be realized only when their internal communication systems sufficiently overlap with those of the natives. An individual's level of host communication competence at a given time reflects his or her overall capacity to participate in host social communication activities, whereas the lack of such competence manifests itself in various forms of miscommunication, social inadequacies, and, in some cases, marginalization.

Host communication competence comprise three interrelated subcategories: cognitive, affective, and operational. Cognitive competence refers to an individual's overall intellectual capacity to deal with the host culture, including the knowledge of the host culture, history, social institutions, and rules of interpersonal conduct. Knowledge of the host language, in particular, serves as the primary conduit for adaptation, one that enables strangers to access the accumulated records of the host culture and learn to think in the way the native speakers think. Knowledge of the local language means not just technical knowledge such as phonetics, syntax, and vocabulary. It also includes pragmatic knowledge about the everyday use of the language including the many subtleties in the way the language is spoken and interpreted in various formal and informal social contexts.

Affective competence refers to the emotional and motivational capacity to deal with the various challenges of living in the host environment. Specifically, it includes positive attitude (acceptance of the host culture) and adaptation motivation (the willingness to learn and participate in it). A positive, willing, and flexible self-other orientation helps engender greater openness and lessen unwarranted prejudicial cynicism

toward new cultural experiences. The affective competence also includes the development of a capacity to understand, and participate in, the local people's emotional and esthetic sensibilities, thereby making it possible for strangers to establish a deeper-level psychological connection with the natives. Although initially difficult, strangers become better able to participate in the surrounding landscape of art, food, music, sports, and other everyday experiences of fun, joy, humor, and happiness, and of anger, despair, and disappointment. In this visceral connection, strangers are on their way to being 'insiders' who are capable of forming close relationships with the natives.

The cognitive and affective capabilities work side by side the operational competence, the capacity to express outwardly by choosing a 'right' combination of verbal and nonverbal acts in specific social transactions of the host environment. As strangers become increasingly competent cognitively and affectively, they are better able to act in greater consonance with the natives' actions and display greater resourcefulness with which to negotiate and reconcile cultural differences and to form appropriate and effective action plans for accomplishing personal and social goals.

Social communication

Host communication competence is directly and reciprocally linked to participation in the social communication activities of the host society. An individual's host social communication activities are enabled or constrained by his or her capacity to communicate effectively and appropriately. Conversely, the individual's host communication competence cannot be developed without participating in the social communication processes.

Interpersonal communication activities with natives offer opportunities for learning the host cultural practices and for engaging in 'corrective exchanges' with respect to the use of the host communication system, including its verbal and nonverbal codes. Through experiences of direct engagement with native-born individuals, strangers obtain vital information and insight into the mindsets and behaviors of the local people. The natives' behaviors provide strangers with points of reference or a check and validation of their own communication behaviors. By conferring with the natives, strangers can confirm or reject presumed meanings and motives in natives' communication behaviors. They learn not only what to do but also some of the relevant cultural and personal values.

Notwithstanding cross-cultural barriers, strangers develop at least a limited number of interpersonal ties with host nationals over time. As their host communication competence improves, so does their self-confidence to participate in host interpersonal communication activities. Through active engagement in host interpersonal communication activities, strangers also begin the process of constructing a set of satisfying and supportive relationships with natives. Newly arrived immigrants and sojourners tend to be drawn to coethnics when they are available nearby. Over time, however, more ties with local people are likely to be incorporated into their personal networks, replacing some of the coethnic ties.

Cross-cultural adaptation is further facilitated by participation in mass communication activities of the host society. Through a wide range of mediated and public forms of

communication such as radio, television, newspaper, magazine, movie, art, literature, music, and drama, strangers interact with their host milieu without direct interpersonal involvements. Such mass communication activities help broaden the scope of cultural learning opportunities beyond the immediate social context with which a stranger routinely comes into contact. Compared to host interpersonal communication activities, host mass communication activities render less opportunity for direct feedback, serving as an important source of cultural and language learning, particularly during the early phases of the adaptation process.

In many societies and communities today, strangers' interpersonal and mass communication activities involve their coethnics or conationals and home cultural experiences, as well. Some form of ethnic mutual-aid or self-help organizations, including religious organizations, may be available to render assistance to those who need material, informational, emotional, and other forms of social support. In addition, ethnic mass media such as newspapers, radio stations, and television programs may be accessible via the Internet or in prerecorded audio- and videotapes and computer disks.

Findings from studies of long-term cross-cultural adaptation generally indicate that participation in ethnic interpersonal and mass communication activities can be helpful to the initial phase of the cross-cultural adaptation process when newly arrived strangers lack host communication competence and access to host interpersonal resources. Beyond the initial phase, however, heavy and prolonged reliance on coethnics have been found to be either an insignificant influence on, or impede, the long-term adaptation process with respect to the host society at large.

Environmental Factors

The adaptation function of the strangers' personal and social (interpersonal, mass) communication cannot be fully explained in isolation from the conditions of the host environment. Since different societies and communities present different environments for cross-cultural adaptation, a given stranger can be more successful in adapting to a certain environment than to another one.

Of various environmental characteristics, three key factors are discussed below as particularly important to individual strangers' adaptive efforts (1) host receptivity, (2) host conformity pressure, and (3) ethnic group strength. These three factors help define the relative degrees of 'push and pull' that a given host environment presents to strangers.

Host receptivity

Host receptivity refers to the degree to which the receiving environment welcomes and accepts strangers into its interpersonal networks and offer them various forms of informational, technical, material, and emotional support. A society or a community can be more receptive toward certain groups of strangers while unwelcoming toward certain others. For example, Canadian visitors arriving in a small town in the United States are likely to find a largely receptive environment. On the other hand, the same town may show less receptivity toward visitors from lesser known and vastly different cultures. Differences in host receptivity toward different groups of strangers

can be attributed to a number of plausible reasons such as the nature of the relationship, friendly or hostile, between the host country and the stranger's home country; cultural and ideological difference and incompatibility between the two cultures; and the racial/ethnic prejudice predominantly held by the society against strangers in general or the particular group.

Host conformity pressure

Along with receptivity, individuals face differing levels of conformity pressure from the host environment. Conformity pressure refers to the extent to which the society challenges strangers to adopt the normative patterns of the host culture. Different host environments show different levels of acceptance and appreciation of strangers and their ethnic characteristics. In general, people in heterogeneous and cosmopolitan societies such as the United States tend to hold more pluralistic and tolerant attitudes toward ethnic differences, thereby exerting less pressure on strangers to change their habitual ways. Even within a country, ethnically more heterogeneous metropolitan areas tend to display lower levels of host conformity pressure than do smaller, ethnically more homogeneous rural towns.

Ethnic group strength

The third environmental factor that influences strangers' cross-cultural adaptation is the strength of their ethnic group in the context of other groups in the host society or community. Depending on relative group size, status, or power, stronger ethnic groups are likely to provide their members with a more vibrant subculture and practical services to its members. In doing so, however, a strong ethnic community is likely to encourage the maintenance of ethnic culture and communication, and even exert a subtle or explicit pressure to conform to the ethnic cultural norms. A long-term consequence of such ethnic community influences is likely to be an impediment, intended or not, to individual community members' active participation in host social communication processes and long-term cross-cultural adaptation to the host culture at large.

Predisposition Factors

Each stranger begins the cross-cultural adaptation process with a different set of preexisting characteristics. The internal conditions with which they begin their life in the host society help set the parameters for the way they relate to the new environment and their own subsequent adaptive changes. The various predispositional differences in which strangers differ in their background conditions can be organized into three categories: (1) preparedness, (2) ethnic proximity/distance, and (3) personality predisposition. Together, these characteristics help define the degree of a stranger's 'adaptive potential.'

Preparedness for change

Strangers come to their new environment with differing levels of preparedness for dealing with that environment. Preparedness is directly linked to the level of readiness to develop host communication competence. Influencing the strangers' readiness are a wide range of formal and informal learning experiences they may have had prior to moving to the host society. Included in such activities are the schooling and training in,

and the media exposure to, the host language and culture, as well as their prior cross-cultural adaptation experiences, particularly contacts with members of the host society. In addition, the strangers' preparedness is often influenced by whether their move to the host society is voluntary or involuntary and for how long. Voluntary, long-term immigrants, for example, are likely to enter the host society with greater readiness and willingness for making necessary efforts to adapt, compared to the temporary visitors who unwillingly relocate for reasons other than their own volition.

Ethnic proximity/distance

The ethnicity of a stranger plays a role in the cross-cultural adaptation process by serving as a certain level of advantage or handicap. It does so by affecting the ease or difficulty with which the stranger is able to develop the communication competence in a given host society, and to participate in its social communication activities. For instance, many Japanese business executives in the United States face a greater amount of challenge in overcoming their language barrier than are their counterparts from the United Kingdom. The strangers' visual ethnic markers (such as height, skin color, and facial features) and audible ethnic markers (such as accents and other speech patterns) influence the degree to which the natives are psychologically prepared to welcome them into their interpersonal networks. Accordingly, ethnicity influences the cross-cultural adaptation process in at least two interrelated manners. First, each stranger faces a level of linguistic and cultural distance for the stranger to overcome in order to develop host communication competence and to participate in the host social communication activities. Second, each stranger creates a certain level of psychological distance (or affinity) in the minds of the natives, which, in turn, would affect the natives' receptivity toward the stranger.

Adaptive personality

Along with preparedness and ethnicity, strangers enter a host environment with a personality, or a set of more or less enduring traits of sensibilities. Their existing personality serves as the inner resource, based on which they pursue new cultural experiences with varying degrees of enthusiasm and success. Of particular interest are three interrelated personality resources that would help facilitate the strangers' adaptation by enabling them to endure stressful challenges and to maximize new learning: (1) openness, (2) strength, and (3) positivity. Openness is an internal posture that is receptive to new information. Openness enables strangers to minimize their resistance and to maximize their willingness to attend to the new and changed circumstances. It is a psychological orientation that allows for greater tolerance for ambiguity, intellectual flexibility, and cultural and interpersonal sensitivity. The strength of personality reflects the inner quality of resilience, hardiness, patience, and persistence. Individuals with high levels of personality strength tend to be stimulated by new challenges and remain confident. Openness and strength of personality is closely associated with positivity, an affirmative and optimistic outlook of mind, or the internal capacity to defy negative prediction. Strangers with a positive personality are better able to endure stressful events with a belief in the possibilities of life in general as opposed to being overcome by unwarranted defeatist cynicism.

Facets of Adaptive Change

Through the interactive workings of the above-described factors of the communication activities, of the environment, and of the background of an individual stranger, the process of cross-cultural adaptation unfolds. Emerging in the adaptation process, over time, are three interrelated facets of internal change in the stranger (1) increased functional fitness in carrying out daily transactions; (2) improved psychological health in dealing with the environment; and (3) emergence of an intercultural identity orientation. These three facets are interrelated developmental continua, in which individual strangers can be placed at different locations reflecting the different levels of adaptive change at a given point in time.

Functional Fitness

As previously noted, strangers conduct continuous experiments in the host environment. They instinctively strive to 'know their way around,' so that they may effectively control their own behavior and the behavior of others in the host environment. Through repeated activities resulting in new learning and internal reorganizing, strangers achieve an increasing functional fitness between their internal responses and the external demands of the host environment. Well adapted strangers would be those who have accomplished a desired level of appropriate and effective communication relationship to the host environment – particularly with those individuals with whom the strangers carry out their daily activities. As they achieve increased communication competence, they are also better able to meet their personal and social needs.

Psychological Health

Everyone requires the ongoing validation of his or her social experience. Being unable to meet this basic human need can lead to symptoms of mental, emotional, and physical disturbance. The shifting of the self-world relationship brings about heightened levels of inner conflict due to the gap between the internal and external reality. In the absence of adequate host communication competence, engagement in host social communication activities, and functional fitness, strangers are subject to frustration, leading to the symptoms of poor psychological health. The very meaning of the term culture shock employed in studies of temporary sojourners suggests lack of psychological health, stemming from the poor fit of a stranger's intrapsychic system to that of the natives. Most strangers, however, are able to achieve, over time, a higher level of psychological health and a subsiding level of disturbances in dealing with the host environment. They achieve an increased internal integration – a sense of inner cohesiveness and confidence.

Intercultural Identity

Long-term adaptive change also includes the gradual emergence of an intercultural identity, a psychological orientation toward self and others that is no longer clearly and rigidly defined by either the original cultural identity or the identity of the host culture. As the host cultural elements are

increasingly incorporated into their self-concept, the stranger's self-other orientation becomes more flexible. While rooted in the original cultural identity, the stranger's identity is broadened to incorporate new dimensions of perception and experience in which the original cultural identity begins to lose its distinctiveness and rigidity. More than likely, this kind of identity transformation is unlikely to be a matter of conscious decision but simply an aspect of the natural psychological evolution beyond the boundaries of childhood enculturation.

Terms close to intercultural identity include 'metaindentity,' 'cosmopolitan identity,' or 'transcultural identity,' all of which indicate an identity orientation that is less dualistic and more inclusive, less categorical and more individuated, less parochial and more universalized. The development of an intercultural identity does not come about without certain 'costs' that may be deemed too high by some. The process can be filled with ambivalence and internal conflict between one's loyalty to the original identity and a necessity to embrace a new one that is rooted in, embracing, and not discarding, the original cultural identity, just as acquiring knowledge and skill in the host language does not necessarily result in corresponding loss in the original language.

Conclusion

Cross-cultural adaptation is, in essence, a largely unconscious process of cultural learning and personal change that takes place over time. It is a dynamic unfolding of the natural human tendency to struggle for an internal equilibrium in the face of adversarial environmental conditions. It is a process in which, over a prolonged period, a newcomer can potentially become a fully functioning insider. The process unfolds in the fluctuating experiences of stress, adaptation, and growth, a process in which the newcomer advances toward achieving a higher level of personal and social efficacy with respect to the environment that was once new and unfamiliar. The pursuit of cross-cultural adaptation opens up a path of personal development, in which individuals stretch themselves out of the familiar and reach for a deepened and more inclusive understanding of human conditions, including their own.

Central to this process is the individual's ability to communicate in accordance to the norms and practices of the host culture and his active engagement in its social communication processes. Multiple forces are simultaneously at work surrounding the communicative interface between the individual and the host environment, from the conditions of the environment and the ethnic and personal predispositions of the individual. Like a locomotive engine, each unit operating in this process affects, and is affected by, the workings of all other units. Some of the factors may be more pertinent than others in specific cases of cross-cultural adaptation. In some cases, adaptive successes may be almost entirely due to the openness, strength, and positivity of the stranger's personality, which enable the stranger to overcome even the most severely unresponsive host environment. In other cases, very little adaptive change may take place in strangers whose ethnic community offers an almost complete insulation from having to face the host cultural challenges.

Should strangers choose to adapt successfully, they would benefit from being prepared and willing to face the stressful experiences that are part and parcel of the adaptation process. They would need to concentrate on acquiring new cultural communication practices and be willing to put aside some of the old ones, recognizing the critical importance of host communication competence as the fundamental mechanism that drives their own adaptation. They would also need to participate actively in the interpersonal and mass communication processes of the host environment. In addition, through cultivating the adaptive personality of openness, strength, and positivity, they are likely to be more successful in overcoming temporary setbacks and attaining greater success in pursuing their personal and social goals.

With the advent of globalization, we no longer have to leave home to experience new cultural learning and cross-cultural adaptation. For many people in the world, physical distance no longer dictates the extent of exposure to the images and sounds of once distant cultures. Many urban centers present their own contexts of cross-cultural adaptation, the natives are routinely coming in face-to-face contacts with nonnatives. Such encounters often compel everyone involved to put aside and even unlearn at least some of the original cultural patterns. The rapidly changing reality can be threatening to many people, provoking a keen sense of unsettling discontinuity, malaise, and nostalgia for the age of certainty, permanence, and a fixed and unitary cultural identity.

In the end, then, cross-cultural adaptation is a journey that compels individuals to make choices and to be accountable for the outcomes. Those who have successfully crossed cultural and subcultural boundaries are likely to be those who chose to adapt and to be changed by that choice. Although their tribulations can be staggering, they have worked through the setbacks and come out victorious with an increased capacity to see others, themselves, and situations in a new light. They are the ones who bear witness to the promise of the cross-cultural adaptation process. Their personal achievements are a tribute to the ever-present human capacity to adapt – the capacity to face challenges, learn from them, and evolve into a greater self-integration that defies the simplistic and conventional categorizations of people and reveals a new, intercultural way of being in the world.

See also: [Evolutionary Social Psychology](#); [Perceptual Development](#); [Social Support](#); [Stress and Illness](#).

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Crowd Psychology

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Glossary

Collective empowerment An increased sense that the group has the ability to do what it wishes, even against the opposition of outgroups.

Collective self-objectification The transformation of the group's idea of how society *should* be organized into the *actual* organization of society.

Contagion The notion that people automatically follow the ideas and emotions of those around them.

Crowd A large face-to-face assembly of people who consider themselves to be members of a common social group.

Deindividuation The idea that identity is lost in the group and that, as a consequence, people lose control over their behavior.

Elaborated social identity model of crowds (ESIM) A theory of how crowd identities and crowd action develop through the intergroup interaction between crowd members and outgroups.

Emergent norm theory A theory of how norms emerge in crowds through the interactions of members and the actions of prominent individuals or 'keynoters.'

Social identity One's sense of oneself as a member of a particular social group (e.g., 'I am an American') along with the significance attached to that membership.

Social identity model of crowds (SIM) A theory of how crowd behavior derives from the transition from individual to social identity and the process of defining identity-appropriate behavior in context.

Introduction

In his 1988 textbook on Group Processes, Rupert Brown notes that "there is a widespread view both in our society and in our discipline that groups are bad for you." If this is true of groups in general, it is particularly true of crowds. Indeed, the very language used to denote crowds – terms such as 'the mad mob,' 'the herd,' 'the rabble' – speaks in equal measure of fear and derision. This is entirely understandable if one considers the contexts in which a science of crowd psychology emerged.

Crowd psychology centers on the question of how people are transformed when they assemble together in large numbers. Although, as we shall see, when authors refer to crowds, they are generally referring not simply to large numbers of individuals but rather to assemblies of people who share some common sense of who they are and some common purpose: crowds of demonstrators, crowds of sports fans, revolutionary crowds. We shall also see that there are important psychological differences between masses who are merely copresent and copresent masses who perceive themselves as sharing a group membership.

Interest in crowds goes as far back as one cares to look – and the general consensus seems to be that whatever transformations are wrought by crowds, they are inevitably negative. Herodotus, sometimes styled 'the father of history,' declared that "there is nothing less understanding and more proud than the blind mass". He was but the first of a long line of eminent thinkers who made disparaging comments about crowds and crowd psychology. However, a distinctive crowd science developed only during the late nineteenth century.

This period was dominated by a crisis of social order. Industrialization had transformed a largely agrarian population into urban masses. New forms of social organization such as trade unions and new political movements, such as syndicalism, anarchism and, above all, socialism, were leading these masses to challenge gaping social inequalities. How, then, were

the elite to maintain their dominance? How were they to face down the challenge of the masses and even engage them in defense of the existing order? These were the dominant questions of the day.

But if the masses in general were seen as a potential threat to the status quo, the crowd was the radicalized mass in action. It was the potential catastrophe made actual. And so the crowd became a dense symbol which regrouped all the bourgeois fears and fantasies of chaos. If social discipline seemed under threat from alcoholism, the crowd was characterized as drunken, either metaphorically or literally. If the patriarchal order seemed under assault from independent women, the crowd was described metaphorically as feminine, while the worst of crowds were seen to be crowds of women – such as the 'petroleuses' of the 1871 Paris Commune.

Indeed, the Paris Commune has a particular prominence in the history of crowd psychology. For, to take progression one step further, where the masses were a potential threat and crowds in general an actual threat to the elite, the Commune crowds had, at least temporarily, overthrown the elite and created what has been described as the first socialist republic in history. Those of the elite who had experienced the Commune had witnessed a future they did not like and which they would do everything to prevent. A key part of this was to find ways of mitigating against crowd action. It is hardly surprising, then, that French theorists dominated early crowd science and that they presupposed that crowd psychology and crowd action are a purely negative phenomena.

I shall start by analyzing this early crowd science and showing how its social concerns are embedded deep within its core assumptions. I shall then outline alternative approaches which, rather than seeking to pathologize crowd psychology (and hence crowd action), pay attention to the perspectives of crowd participants, analyze the patterns of crowd action, and seek to understand the relationship between the two. Above all, I shall seek to demonstrate that the early crowd theorists

have done us a disservice by characterizing crowd members as mindless and crowds as irrelevant to the normal functioning of society. For crowds provide a particularly productive site in which to understand how people are constituted and act as social subjects. Crowds are critical to the formation of the social identities and social relationships which regulate everyday life.

Classic Crowd Science: A Tale of Loss

Early crowd science was a vibrant field. Many theorists such as Fournial, Tarde, Sighele, Rossi, and others debated crowd behavior, not only in academic texts but also in the society magazines of the day. But these names have largely disappeared. Only one remains, that of Gustave Le Bon. His book *The Crowd: A Study of the Popular Mind*, first published in 1895, is still cited in psychology journals, in official reports, and in the popular media. It has been described as the most influential psychology text of all time in that it not only analyzed mass behavior, but also that it helped create the mass politics of the twentieth and twenty-first centuries.

Le Bon – both the man himself and the basis for his enduring influence – exemplify the general themes of fear, hostility, and repression which frame the emergence of crowd science. Le Bon's first experience of crowds was as the head of ambulance services in the Paris Commune. That experience bred him in a deep hatred and contempt for the masses. The rest of his career was devoted to understanding how crowds could be tamed and engaged for – not against – the nation. Indeed, the text of which he was most proud was not 'The crowd' but a far more obscure book called 'La Psychologie Politique et la Defence Social' published in 1910.

What made Le Bon stand out from his fellow theorists was not so much his conceptual originality as his practicality. Where others documented the bestiality of crowds and did little more than throw their hands up in horror, Le Bon sought to show how leaders could take advantage of crowd psychology and use it to their own ends. His book was only in small part a theoretical analysis. The larger part reads like a primer for leaders who wish to exploit the power of crowds. And the leaders he sought to educate were the right wing leaders of his time – for whom he ran a regular weekly luncheon club. Moreover, these leaders reciprocated his enthusiasm. The list of those who praised Le Bon reads like a roll call of the autocrats of the early twentieth century. Mussolini, for instance, after praising Le Bon to the skies, declares that he built the principles of the (fascist) Italian state on the basis of 'The crowd.'

When it comes to Le Bon's actual crowd psychology, the predominant theme is one of loss. His starting point lies in the notion that, on entering the crowd, people become anonymous and lose their sense of personal identity. This first process submergence is termed *submergence*. Submergence, in turn, leads people in crowds to lose control over what they feel and do. Because they can no longer access the personal values and standards that allow them to judge what is and is not appropriate, crowd members simply follow passing ideas and emotions – particularly emotions, since the self as the seat of the intellect has been occluded. This second process is termed *contagion*.

Finally, submergence and contagion lead the crowd members to lose their civilized standards. Because people's conscious access to internal standards has been blocked, the emotions and ideas that govern action come predominantly from the 'racial unconscious' – an atavistic residue which people share in common from a distant past. And because this residue is ancient and primitive, so are the actions to which it leads. This third and last process is termed *suggestion*.

Altogether, the picture that emerges of crowd psychology and of crowd behavior is unrelentingly bleak. Crowds, says Le Bon, are only powerful for destruction. The crowd member, he declares, is a barbarian who descends several rungs on the ladder of civilization simply by virtue of becoming part of the crowd. Most revealingly, in a passage that reveals much of both Le Bon's 'science' and his politics, he remarks that

among the special characteristics of crowds there are several – such as impulsiveness, irritability, incapacity to reason, the absence of judgement and of the critical spirit, the exaggeration of the sentiments and others besides – which are almost always observed in beings belonging to inferior forms of evolution – in women children and savages for instance.

There is only one exception to this analytic negativity. Le Bon acknowledges that crowd members can be extraordinarily heroic at times. Moreover, this flows not only from the loss of self (and hence a loss of concern for self-preservation) but also from the one element of gain in Le Bon's account. That is, on becoming submerged in the mass, people might forget their individuality, but they become part of something much bigger and hence they evince a sense of immense power which allows them to do almost anything – thus making crowds the ultimate nightmare for those who have stakes in the social order: total power without any sense of responsibility.

Le Bon's work continues to be cited in contemporary texts. What is more, his work continues to have relevance through the development of deindividuation theory. This approach is derived directly from the idea of submergence and is most centrally concerned with the effects of anonymity (or 'perceptual immersion') in a group. There are a number of variants of the theory. One, most associated with Zimbardo, suggests that anonymity leads to a lowered concern with social standards and a lowered threshold for exhibiting antisocial behaviors. A second, associated with Diener, suggests that immersion in a group leads to a lowered awareness of internal standards and increased domination by external stimuli. In effect, people become uncontrolled and simply go along with whatever is suggested to them. A third variant effectively integrates the other two and argues that, in the group, people become less aware of both internal and social standards and hence both more uncontrolled and more willing to behave in antisocial ways. For all these differences, all the variants equate collective participation with the loss of self and of the loss of self with the loss of reasoned or socially responsible action.

Not surprisingly, Le Bon's approach evoked strong opposition from early on. Floyd Allport in particular strongly attacked the notion of a 'racial unconscious' or 'group mind' as an empty and meaningless concept. His 1924 book, often (mistakenly) seen as the first social psychology text, and certainly a seminal influence in the development of the discipline in North America, is written largely as a rebuttal of Le Bon's ideas.

However, paradoxically, it is arguable that Le Bon's influence was enhanced rather than diminished by those, like Allport, who challenged him. For, in challenging his explanation of crowd action, they accept his description of such action as mindless and destructive. What is more, the difference at the explanatory level is more a matter of displacing rather than discarding the Le Bonian narrative of loss.

To be more concrete, Allport – and the so-called 'convergence' approach to crowd action which derived from his work – suggests that crowd action reflects the preexisting individual characteristics of crowd members. If crowds are violent or destructive, it is because flawed individuals are drawn to such events. All that has happened here is that the locus of crowd pathology and loss has shifted from the group to the individual level. People become crowd members because they lack something already, they do not come to lack something because they have become crowd members.

For all the sharp debates that divided classic crowd science, then, the commonalities are ultimately more telling. Crowds either create a pathological psychology or else attract individuals with psychopathologies. As a result, crowds are pathological entities. There is no place here for understanding how social and cultural factors might shape the understandings and actions of people in collective settings. There is no basis for addressing, let alone understanding the socially meaningful nature of crowd action.

Crowd Patterns and Crowd Norms

There are many criticisms that can be made of Le Bon's work and classic crowd science more generally. But at their root lies yet another loss – the loss of context. In both Allport's and Le Bon's accounts, the focus is exclusively on the crowd. Although the crowds that they reference are drawn from important social groups – crowds of socialists or trades unionists or miners – they write as if mere physical assembly is enough to explain how crowd members behave. They make no reference to the broad social context of struggles between these groups and others for power and resources in society. Equally, they make no reference to the immediate context of struggles between these groups and others (the army, the police, private security forces) on the streets. And once the context is lost, we can no longer see how action might make sense as an attempt to challenge the other or as a reaction to the acts of the other. Instead, behavior can only be attributed as reflecting something inherent about crowd members or crowd process, something universal that holds for all time and all places. In short, decontextualization pathologizes and essentializes and eternalizes the results of specific social processes.

By the latter half of the twentieth century, however, things were changing. Academia was changing from an elite system to more of a mass system. Academics who experienced crowds were more likely to be positioned as engaged insiders as horrified outsiders, whether (in the United States) within the civil rights movement, the anti-Vietnam protests, or (in Europe) in the events of 1968 and its aftermath. And, from this perspective, crowds were to be welcomed rather than to be feared, they were healthy rather than pathological phenomena, and, above all, they were meaningful rather than meaningless.

This was true across the humanities and human sciences. A series of seminal historical studies demonstrated that crowd members are not those who stand at the margins or against society – in more pejorative parlance, 'riff-raff.' Rather, they characteristically come from more stable, integrated, and 'respectable' layers. They also showed that crowd action, far from being inchoate and universally destructive, is typically highly patterned and that the patterns are highly socially meaningful. Crowds act in ways that reflect shared social belief systems. Indeed for many historians, who face the problem of recovering the perspective of those groups in society who, in the past, did not leave written records, crowds provide a uniquely valuable resource.

Similar conclusions were drawn by those political scientists and sociologists studying contemporary events such as the wave of black urban riots across many US cities in the 1960s and 1970s. The massive report of the US Riot Commission in 1968, using a database of 1200 interviews from 20 cities, noted that the average rioter was more socially integrated and better educated than the average black person. The evidence also shows that, far from being random or impulsive, riots were articulate protests against specific grievances. Finally, and perhaps most importantly, a close examination of events showed that crowds were neither wild nor orgiastic. They were discriminating in their choice of targets, they only attacked those state officials they viewed as enemies (notably, the police), they only looted shops of outsiders against which they had concrete grievances. Fogelson sums up this evidence in a phrase that contrasts markedly and memorably with the prevalent image of mob madness: "Restraint and selectivity were among the most crucial features of the riots."

In sum, even the most violent of crowd events are subject to normative constraint, even if the norms (attacking particular people and property) are at odds with those that regulate everyday life. These conclusions, drawn from the field, have been corroborated by experimental evidence. Thus, a meta-analysis of deindividuation studies suggests that, far from acting in uncontrolled or antisocial ways, those made anonymous in groups tend to increase their adherence to situational norms.

How then are such norms created? The first answer was provided by Turner & Killian's aptly named 'emergent norm theory' (ENT) first published in 1957. This theory suggests that crowds do not become homogenous entities in an instant. Rather, there is an extended period where people mill about. They are addressed by many would-be influence agents, or 'keynoters.' Gradually, particular keynoters who are more striking than others begin to gain sway and norms begin to spread through the crowd. Homogeneity, like normativity, is therefore an emergent property of encounters among crowd members.

ENT provided a nuanced and compelling portrait of the micro interactions in the crowd out of which shared understandings emerge. This is its legacy from the symbolic interactionist tradition. However, it is less successful in explaining why particular keynoters become successful leaders and why some norms rather than others come to shape crowd action. This can be traced to Turner & Killian's reliance on a desocialized model of influence deriving from the small group psychology of the time. Such models root influence in the

personal qualities and interpersonal relations between individual crowd members. As a consequence, it is hard to see how group (and crowd) norms relate to broad cultural belief systems. Such a model can explain the patterned nature of crowd action; however, it cannot explain why such patterns should be socially meaningful and reflect broader conceptions of society. In effect, the micro is divorced from the macrosocial. Although ENT and other normative accounts mark a great step forward from classic crowd psychology, they, like Le Bon, still face the problem of relating crowd action to the larger social context in which it occurs.

The Social Identity Model and Intragroup Dynamics in Crowds

Over recent decades, the social identity has become the dominant psychological approach to group processes in general. This approach aims explicitly to understand how ideological and structural factors shape group action and it is formulated to be as relevant to large-scale social categories (such as nation, religion, or 'race') as to small groups of familiars. It is understandable, then, that social identity tenets have proved successful in addressing the specific issues of crowd psychology. Indeed, the social identity model (SIM) of crowd behavior has, by now, itself become the dominant contemporary approach to crowd psychology.

SIM contests the classic models of crowd psychology as lost through the very concept of social identity which lies at its heart. It will be recalled that Le Bon's analysis starts from the idea that selfhood is lost upon entering a crowd. This derives from a singular and individualistic notion of selfhood: people have a unique personal identity which is the sole basis of behavioral control. If this personal identity is compromised (as in the crowd), then control over behavior is lost. By contrast, social identity theorists view self as a rich and varied system which exists at different levels of abstraction. Sometimes, I think of myself in terms of how I, as an individual, differ from other individuals (personal identity: 'I' vs. 'you'). At other times, I may think of myself in terms of belonging to a social category – I am an American, a Catholic, a woman, a Mets fan . . . – and in terms of how my group differs from other groups (social identity – 'we' vs. 'they').

The foundational assumption of social identity research is that when people act as group members, they shift from acting in terms of personal identity to acting in terms of social identity. That is, the eclipse of one's sense of oneself as a unique individual is not a *loss* but a *refocusing* of identity. Hence, as intimated at the start, an important psychological distinction is implicitly made between a *physical* group – a set of people who happen to be copresent at the same place and time – and a *psychological* group – a set of people who share a sense of themselves as belonging to the same social category. The difference between the two can best be illustrated by a simple thought experiment: imagine you are on a crowded commuter train heading home. People are squeezed together in a carriage, but each remains psychologically an individual, seeking to avoid eye contact with others, reading the same paper as others but resenting anyone looking at theirs, and feeling discomfort or even disgust at any physical contact with others. Then, the

train stops. After a long delay, there is an insufficient excuse for what has happened. Now, people begin to think of themselves together as aggrieved commuters against the train company. And that shared identification transforms their behavior. They start turning toward one another, talking to one another, even sharing their sandwiches.

In a similar vein, SIM draws an explicit distinction between physical crowds based on copresence (aggregates) and psychological crowds based on social identification. These, as has been argued previously, are the types of assembly that all crowd psychologists have been concerned with (even if this is not made explicit in their models) and therefore, this is the type of assembly for which the term 'crowd' will henceforth be reserved. SIM proposes three transformations that occur when people join a crowd and these are detailed in the following section.

The Cognitive Transformation

Just as identity is not lost in crowds but refocused from the personal to the social level, so control is not lost but shifted from personal norms and values to those that define the relevant social category. This means that the behavior of crowds will vary as a function of what categories are involved. The norms and values – and hence the actions – of, say, a crowd of environmentalist protestors will be different from those of a crowd of soccer fans which, in turn will be different from those of a Catholic crowd welcoming the Pope. The process of conformity to group standards may be general, but the behaviors it leads to will always depend upon contextually relevant belief systems.

There are two important implications of this process which need to be stressed. The one is that, insofar as crowd members act in terms of their social identities and that social identities invoke category-based belief systems, here is a mechanism for understanding how the behaviors of specific crowds relate to broad conceptions of society – a key requirement for any adequate model of crowd action. The other is that this process is not mechanical or routinized. Crowd situations are typically either novel or uncertain – and made all the more so by the fact that they are interactions in which the behavior of the other side is unpredictable (a point developed in much more detail in the next section). Consequently, one cannot just apply preformed rules and norms of action. Rather, one has to determine what the general category means in the concrete situation.

The creation of situationally appropriate norms can happen through a process of induction. That is, people infer group norms from the behaviors of those who are unambiguously ingroup members – as long, that is, that these behaviors are consonant with the broad terms of group identity. So, for instance, in a British urban riot, when someone threw a stone at the police, it was followed by a hail of stones. However, when someone stoned a bus, not only did others not follow, but they actively intervened to prevent further stoning. Or, equally, when someone smashed the windows of a bank (one of the external institutions seen to keep the local community in penury) others joined in, but when the windows of a local shop were smashed, others spontaneously defended the shop from looting. This is very different from the process of contagion.

It also elaborates upon ENT, both by showing how norm creation can be rapid and responsive to events and by showing that, while there is space for variability in the interpretation of what is appropriate, there are clear limits set by social identity to the norms that form in crowd events.

This is not to say that the deliberative processes described by emergent norm theorists are irrelevant, merely that they are not always necessary. Where there is time – particularly at the start of events – people do mill around, listening to others and trying to determine what they should be doing. But even here, social identity is crucial in framing the emergence of norms. The keynoter who is influential (i.e., the leader) is the one who can best represent his or her proposals as instantiations of ‘who we are’ and ‘what we believe in’ – of group identity that is. Conversely, the basis on which members deliberate is not simply ‘what should we do here,’ but rather ‘what should we do here as *environmentalists*’ (or whatever the situationally relevant category might be). Altogether, the task of keynoters/leaders and group members is jointly to develop a situationally appropriate elaboration of a preexisting identity.

The Relational Transformation

In crowds, the relationships between individual members undergo a profound shift. This is not simply as a function of the fact that crowd members identify with a social category. It occurs to the extent that people share a common identity with others in the crowd and also that they are aware of this commonality. Under such conditions, fellow crowd members shift from being ‘other’ at the individual level to being part of a shared collective self. Hence, personal boundaries between people are dissolved and the boundary shifts to that between ingroup (‘us’) and outgroup (‘them’).

On the one hand, then, the sense of difference to others in the group is dissolved. We expect them to share similar norms, values, and beliefs with ourselves. ‘We’ will all see things the same way and strive for the same goals. As a consequence, we will both trust and respect our fellow ingroup members more and we will look for agreement rather than disagreement with them. We will also feel more confident and validated in our own beliefs. Unlike everyday life where venturing an opinion, especially a strong stance, may evoke the disagreement, disapproval, even rejection by the other, in crowds, we can express ourselves in the full expectation that others will support our views. More than that, for those in the midst of a crowd, they will be surrounded by others who chant the same chants as them, who look and dress like them, who even smell like them: their sensuous universe is one that affirms their identity.

On the other hand, our sense of ‘interest’ and of ‘fate’ is extended to encompass other group members. That is, our self being the collective self, then ‘self-interest’ becomes a matter of advancing the interest of the group as a whole, and a detriment to any group member becomes a detriment to our (collective) selves. Correspondingly, the act of ‘self-defense’ is a matter of defending not only one’s own body from injury but also that of any other group member from attack, especially where that comes from the outgroup. Often, in crowds, people will put themselves at considerable risk to help and support fellow group members who, for instance, are under threat of being attacked or seized by the police.

In combination, these various consequences of the relational transformation that occurs in crowds create the conditions where people can coordinate their actions. People are able to integrate their efforts, to support one another, and to initiate action in the confidence that they will be supported by others. Whereas, outside the crowd, people may feel isolated and unable to enact their beliefs due to the power of others, in the crowd they feel united and able to overcome any potential resistance of others. That is, they feel empowered as group members. In this sense, Le Bon provides an important insight about crowds. However, *contra* Le Bon, this empowerment is highly focussed. It is a power to translate the norms and values of the group into objective social practices. Accordingly, Drury and Reicher refer to this process as *collective self-objectification*. To paraphrase the historian of the French Revolution, Georges Lefebvre, perhaps it is only in crowds that people are able to become the subjects of history.

The Affective Transformation

One criticism of the early social identity approach to crowd psychology was that it was a very cold approach which emphasized the mindful and meaningful nature of crowd action but which neglected the emotional dimension. Empirically, this would be to leave out one of the most striking things about crowd events: they are often highly passionate affairs. People who watch sports at a stadium scream and shout and chant far more than at home or alone. Any model that leaves this out is necessarily deficient. Conceptually, this would be to buy into the Le Bonian duality between reason and emotion (one which is widespread within and beyond psychology) and simply reverse the polarity: from all emotion and no reason to all reason and no emotion.

There are many bases for the strength of emotional experience in crowds. Many of the relevant processes have been clarified by recent research in the area of collective emotions. That is, when people identify highly with a group, they can feel things not only because of what they have done or what was done to them as individuals, but because what their group has done or what was done to members of their group. Thus, for instance, acts by outgroups (such as the police) which are seen either to attack the group or else to deny the group its legitimate rights evoke strong feelings of anger. However, when talking about their feelings, crowd members lay particular stress on the importance of empowerment and collective self-objectification discussed previously. After living one’s life in a world made by others and having to trim one’s behavior to what is acceptable to others, at last, in crowds, people can shape the world in their own terms. This is not only an occasion for joy, it also leads to increased commitment to the group and even to increased individual well-being.

Once again, then, we can find value in Le Bon’s work – in this instance, his emphasis on passion in crowds. But the explanation of this passion is the precise opposite of Le Bon’s. It does not derive from a loss of mind, a loss of judgement, and a loss of individual agency. Rather it flows from the fact that, perhaps uniquely in our experience, ordinary people are able to make their own history. Insofar as we define ourselves in terms of our group membership and that, through joint action, our groups are able to impact on social reality,

then we feel ourselves to be agents. And because crowds make us agents, we are passionate about them.

The Elaborated Social Identity Model and Intergroup Dynamics in Crowds

The focus of the social identity model is predominantly upon intragroup relations in crowds: the model analyzes how individuals and interindividual relations are transformed within crowds and how this impacts on what they do and feel. And yet, throughout the analysis, there is an implicit recognition of the importance of the outgroup – whether it be a matter of the salient presence of an outgroup transforming a disparate set of people into a psychological crowd with shared identity (as in the example of the train carriage), of the perceived illegitimacy of outgroup action inspiring crowd solidarity and crowd reaction, or else of crowds empowering their members and hence transforming relations with the outgroup.

Nonetheless, there remains the danger that SIM, like preceding models of crowd behavior, will seek to analyze crowd action without (explicitly) recognizing that crowd events are typically interactions between at least two groups (one group of sports fans against another, the police against rioters, company security guards against strikers) and that it will be impossible to fully understand the behavior of any one party without looking at both and the ways each impacts on the other. To make the same point slightly differently, if the core problem with classic crowd psychology lies with decontextualizing crowd action, then it can be argued that SIM links crowd action to the broader context (by rooting crowd action in broad category-based beliefs, norms, and values) but that it neglects the immediate interactive context.

The elaborated SIM (ESIM) of crowd action extends SIM by explicitly analyzing the intergroup dynamics of crowd events and placing intragroup dynamics in this interactive context. Moreover, through its focus on intergroup dynamics, ESIM lays more stress on change processes in crowds than the earlier social identity work.

ESIM derives from a common pattern of action observed across a number of crowd events, including such different groups as students, environmental protesters, antitax protesters, and football fans. In each case, events started with heterogeneous crowds comprising multiple psychological groups, most of whom were opposed to conflict and violence. However, all those present were perceived as at least a potential threat by the police who then acted to contain the crowd and prevent them from progressing as they wished. This common experience of being denied what they perceived to be their legitimate rights led to the formation of a single psychological group united around opposition to the police. Moreover, this unified crowd felt thereby empowered to contest police actions, which in turn validated the police's original conception of the crowd as dangerous. In this way, a spiral of escalating conflict occurred, often resulting in overt violence.

In order to explain this pattern, ESIM conceptualizes social identity as a representation of the nature of social relations in our world and where we stand within them along with the behaviors that are proper and possible given that position. Many protestors, for instance, see themselves as living in a

liberal democratic society where the police are neutral arbiters who uphold the social order. They themselves may be opposed to certain other groups but they do not view the police as an outgroup. Most of the time, the different parties to a crowd event share the same representations of one another. Hence, their interactions serve to confirm and stabilize the views of participants.

However, under certain (rare) circumstances, there is an asymmetry, such as when protestors do not see the police as an outgroup but the police see all protestors as an outgroup (in part because of the continuing dominance of models which portray all crowd members as dangerous). What is more, when one of these parties (the police) has the power to act upon its perception (by erecting cordons and stopping crowd members from doing what they want), then the perception of one group becomes an experiential reality for the other. Protestors experience being positioned as 'oppositional.' And, from this experience, they begin to reconceptualize their relationship to the police and hence their own identity. That is, they begin to see themselves as oppositional.

This shift of identification sets in train a whole series of associated changes. First, new norms and values emerge. Those behaviors that make sense in a world where the police and state are neutral – persuasion and patience – no longer make sense where the police and state stand against one. Hence, those voices (leaders/keynoters) calling for conflict who were earlier shunned are listened to more, and there is greater potential for more than a small minority to become involved in conflict. In other words, outgroup actions alter the relative success of contending sources of influence in the ingroup. The irony, often, is that the police, fearing violence, act in ways that make those calling for violence more impactful.

Second, as crowd members redefine their own identities, their relations to others outside as well as inside the actual crowd may shift. Thus, in seeing themselves as oppositional, a common ingroup bond may be formed with other oppositional groups which, previously, had been rejected. For instance, in one antiroads campaign, an early division between local protestors who simply wanted to preserve their amenities and committed environmentalists who were opposed to the overall roads program was overcome after the police were equally hostile to all involved in trying to stop the tree on the town green being felled. But the 'locals' not only came to see themselves as part of a wider protest and hence included the environmentalists as ingroup, they also started to see groups like striking miners, black people, and feminists as part of a common cause against injustice.

Third, even the goals and the concept of success of crowd members can shift. To continue with the aforementioned example, locals originally conceptualized success as saving their green and its tree. But as they began to see the police and state as arraigned against them and in favor of the roads lobby, they looked at the act of simply standing up against the police and publicizing the nature of what they were up against as an end in itself. Even if the tree was cut down, in this latter sense, the protest had been a success, it was celebrated as such and it led to increased commitment to future protests.

Theoretically, the core message here is that crowd identities and hence crowd action are not simple givens but rather products of intergroup interaction. It is important to recognize this

in order to understand how identities are reproduced and come to be seen as stable or even natural and in understanding the conditions where rupture and change occur. Practically, the core message is that the interventions of the authorities, the police in particular, do not simply serve to contain collective violence. They are a critical part of the escalation or the de-escalation of violence. In recent years, ESIM has been applied practically to design forms of police intervention which distinguish between groups in the crowd and which seek to facilitate those with lawful intentions. In this way, the influence of those promoting violence can be reduced and the prospects of peaceful democratic protest maximized.

Conclusion

I began this piece by noting how crowds have long been seen as aberrant – a social aberration caused by psychological aberration – and by suggesting that this has prevented us from learning about both society and psychology from the study of crowds. By now, it should be clear that one cannot understand crowd action if one divorces it from its social context. Even if crowd action is occasionally extreme, this reflects long-standing patterns of social belief about what is acceptable and unacceptable. And crowd action does more than reflect existing social beliefs and social identities. Crowds play a critical role in forming the identities of participants and creating new unexpected identities in the crucible of collective interaction.

But even here, we are only beginning to appreciate the wider importance of crowds. There are two ways, at least, in which crowd psychology has much to contribute. First, at a theoretical level, crowds provide a particularly clear example of how intergroup dynamics frame intragroup relations. However, this is not because crowds are unique but rather because (a) in crowds, the intergroup dimension is particularly obvious since the police are physically present, whereas in everyday life, the impact of outgroups may be more subtle (enshrined, for instance, in the ways that institutions are structured) and less easy to see, and (b) the copresence of both ingroup members and outgroup members in crowds renders the impact of the inter- on the intragroup immediate, general, and hence easy to see. However, it is reasonable to suppose that similar processes occur in everyday life, albeit more distributed through multiple encounters between individuals or small numbers of ingroup and outgroup members, and then disseminated slowly through the telling of stories which are disseminated through social networks. In this way, ESIM may provide a model for intergroup relations in general, and the practical insights of the model may help us understand the conditions under which members of certain groups disengage from authority and support conflict against authority.

Second, if crowds are important to the formation of wider social identities, this need not be limited simply to those who

participate in them. For crowds are often the embodied reality of broad social categories that are abstractions – groups like nations, classes, religions, ‘races,’ – which are too large for all the members to congregate and which are therefore, in Anderson’s terms, ‘imagined communities.’ What happens in crowd events is therefore often emblematic for all members of the relevant categories whether they themselves were there or not and can therefore impact on the identities of all. Such events tell them about the world, about who they are, and how they are treated in society. What is more, crowd events are high-profile. They are likely to be covered on the television, in the papers, and hence be visible to the broader category membership. In this way, for instance, the US riots of the 1960s impacted on all black people in the United States just like the British riots of the 1980s affected the overall views of black people in the United Kingdom.

To sum up, crowd psychology has come a long way over the last century or so. There is still a long way to go. But at least we now recognize that when many members of a social group assemble together, then what they do has much to tell us about our society and where it is going. At least the value of pursuing crowd studies is more apparent than it once was.

See also: [Group Dynamics](#); [Individualism](#); [Leadership](#); [Persuasion](#).

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Crowding: Effects on Health and Behavior

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Glossary

Community density Number of people in a community area or proportion of people per available dwellings or space in a community.

Crowding A negative psychological state that results from perceiving that there are too many people present in the available space.

Density Number of people in a specified amount of space or proportion of people per available space.

Household density Number of people in a residential dwelling or proportion of people per available rooms or space in a residential dwelling.

Distinction Between Density and Crowding

It is important to distinguish between the subjective, psychological experience of crowding and the objective, environmental source of the crowding experience: high-population density. Daniel Stokols has noted that density is a property of the physical environment whereas crowding is primarily a psychological experience. The negative effects of high density on human health and behavior are strongest and most prevalent when individuals are uncomfortable or stressed by the high density. That is, high density might only affect health and behavior when individuals appraise the high-density setting as being crowded. Density is an important antecedent to the experience of crowding but is often not sufficient to explain everyone's feeling of crowding or a particular individual's experience of crowding in different settings or at different times.

Density is typically measured by calculating a ratio score of the number of people to a given amount of space. There are two broad types of density studied by social scientists, *household density* and *community density* (see Table 1). Household density can be determined in several ways. For example, one could calculate the number of people per room or square footage within a household. According to the US census, households with more than 1.0 persons-per-room are overpopulated. Absolute number of people in a household in a residence also can be used as indicators of objective levels of household crowding. Community density measures reflect the amount of space for a given population over a wider space than an individual's residence. Community density can be determined by calculating the number of people per acre, people per square mile, or people per census tract. Occasionally, community density will be defined as the ratio of dwellings or buildings to a given area or the total number of dwellings in a community area.

Public, health officials, city planners, housing developers, and policy analysts in charge of setting housing standards are particularly interested in understanding the effects of household and community density levels on human health and behavior. In general, ratio measures of density are better predictors of health, especially mental health, than are absolute measures, such as number of persons or number of rooms. In addition, measures of density in a dwelling, such as persons per room, are better predictors of individual health and behavior problems than are community measures of density, such as

dwellings per square mile or persons per acre. These latter two findings may be explained by the fact that individuals will tend to have greater difficulty escaping from or avoiding unwanted interactions with other people when they are inside a highly populated dwelling with little available space than when they are in the outside world or in a highly populated dwelling with lots of space. The different behavioral and health effects of density in a dwelling versus density outside of a dwelling are discussed in more detail below.

Role of Social and Personal Characteristics

The correspondence between density and the psychological experience of crowding often depends upon the individual and the social situation. For example, people can be exposed to high levels of density in a bustling city street, a cramped apartment, a sporting event, a concert, a supermarket, or a political rally. Some of these crowded situations are exciting and inviting and some are threatening and foreboding. While many people would concede that the throngs of people cheering at a football stadium contribute to the excitement of the sport, few would agree that the clanging and banging of shopping carts and waiting in long lines to make a purchase in a crowded supermarket are enjoyable experiences.

Why do different situations evoke different experiences of and feelings toward high density? There are, of course, important differences between high density in different settings, like stadiums, or supermarkets. For example, in a stadium the cheers and enthusiasm of a crowd can be stimulating and help a spectator to have a good time. In the supermarket, the presence of many people can interfere with or constrain a shopper's movement through the supermarket and his or her ability to finish shopping. When high density thwarts goal-directed behavior, it is more likely to be experienced as stressful and crowded than when it does not block goal-directed behaviors. Interference with goal-directed behaviors can diminish individuals' actual and perceived control over their environment. Lack of control over the environment can cause some people to feel psychologically distressed. The role of control in explaining the negative effects of crowding is discussed in more detail below.

There are also wide differences in peoples' reactions to high density. For example, men and women appear to experience

Table 1 Different environmental sources of crowding

<i>Types of household density</i>
Number of people per household area ^a
Number of rooms per household square footage per household
Number of persons per room in a household
<i>Types of community density</i>
Number of residents per community area ^b
Number of households per community area
Number of commercial buildings per residential community area
Number of multiunit housing structures per community area
Proportion of households with more than one person per room in a community area
Proportion of households with five or more persons in a community area
Number of persons per 10 000 ft ² of residential space in a community area
Number of persons living on a street per 1000 ft

^aHousehold areas can be measured in square footage or meters.^bCommunity areas can be measured in acres, square miles, or by census tract.

high density quite differently. When men and women are required to interact in small groups, men are more uncomfortable and less social than are women. Thus, men appear to prefer a larger amount of personal space or physical distance between themselves and other people than do women. Different cultural groups also may experience density differently. For example, American college students appear to be less tolerant of residential crowding than are adult males in India or Turkish college students. Many Chinese and Japanese families appear to be relatively unaffected by living in very high-density homes. Among different American ethnic groups, household density tends to have a stronger negative effect on the mental health and social relations of black Americans than white Americans, and only a weak effect on Americans of Hispanic descent. On the other hand, researchers also have found equally strong positive associations between household density on psychological distress across diverse racial and ethnic groups, including African Americans, Anglo Americans, Vietnamese Americans, and Mexican Americans.

Why do individuals have unique reactions to similar levels of density? One explanation is that people develop methods of coping with the crowding. For example, gender differences in reaction to high density might be explained by adaptation to different levels of closeness in interpersonal interactions. In comparison with males, females might be socialized to expect and to engage in contact with others in closer physical proximity. As they mature, males might become more accustomed than females to having large interpersonal distances between themselves and others. Thus, experience with high-density settings potentially can diminish the negative psychological experience of crowding because individuals can learn how to cope with the undesirable aspects of high density or they become accustomed to close physical contact with others.

Effects of Crowding on Health and Behavior

There has been a long history of interest in the effects of crowding on human health and behavior. The spread of various diseases and social pathologies is often attributed to the vast numbers of people living in urban areas. High-population

density is often cited as a reason for the very high rates of mental and physical health problems and various deviant social behaviors found in cities. Living in close proximity to others can obviously facilitate the spread of infectious diseases. However, transmission of infection through close contact with others is not the only way in which high density contributes to social and biological health problems.

Observations of the negative effects of overpopulation in nonhuman animal species have fueled some of the concern over the effects of high density and crowding in human populations. Much of what has been learned about density and disease processes has been through experimentation with animals because of ethical constraints in experimenting with humans. However, even in animal populations it is difficult to ascertain the exact causes for the negative effects of density on health and behavior. Take, for example, the observation that high density is associated with higher rates of mortality in many animal species. Many animal species exhibit cycles of population escalation followed by a sudden and tremendous mortality, or a 'population crash.' Different pathways have been identified that may link density to mortality. For example, food shortages or the rapid spread of disease, as in plagues and other epidemics, could explain population crashes in high-density settings. However, starvation and contagious disease do not fully explain the effects of high-population density on mortality. One group of scientists observed that deer living on an island multiplied quite rapidly until their population reached about one deer per acre, then their mortality rate skyrocketed. The deer population crashed, even though the deer had plenty of food and water and showed no signs of contagious disease spread. Examinations of the deer's internal organs, however, revealed signs of stress-related disease processes, which suggested another explanation of why high density can increase mortality: social stress.

Social stress can be caused by uncontrollable, threatening, unwanted, or otherwise negative social contacts and interactions with other organisms in an environment. High density can increase social stress, which can induce fighting between animals, interfere with reproductive behaviors, and cause unhealthy metabolic disturbances. Under high-density conditions, rodents' reproduction rates drop, cannibalism and deviant sexual behavior increase, and other social and biological pathologies all increase. In some animal studies, higher mortality among animals in high-density pens appears to be caused by overactive adrenal glandular systems. Many of the biological pathologies manifest in crowded rodents are similar to those observed in many species of animals after they have been exposed to noxious environmental stimuli, or stressors. Thus, it appears that the stress-related disease processes that might be caused by high-population density could contribute to death and illness in different animal species.

It is tempting to draw analogies between overpopulated animal populations and overpopulation that occurs in human settlements. For example, birth and mortality rates of high-density human communities could be compared to similar outcomes in high-density rat colonies. However, many outcomes, such as criminal behavior in humans versus aggression in rats, are not so directly comparable. In addition, it is more difficult to prove that density is the cause of deviant behaviors in humans than it is to do so in animals. In animal research,

scientists can control the effects of external factors other than high density that could influence the behaviors of crowded animals. Researchers studying human crowding can seldom control other factors, such as poverty and noise, which tend to accompany high density and influence humans' health and behaviors independent of density. In social science terms, the uncontrollable factors could cause a 'spurious,' or illusory, relation between density and human health and behaviors. Some researchers use statistical techniques to attempt to examine the effects of density independent of other social factors. The problem with making such statistical judgments is that researchers never know for certain whether they have identified all possible factors that could influence both density and the outcome of interest. These points should be kept in mind when reading the next section on the evidence relating high density to human health and behaviors.

Chronic Versus Acute Crowding

The effects of high-population density on humans do not appear to be as dramatic as in animals. This is partly due to the sophisticated and complex ways which humans experience and adapt to noxious environmental stimuli like high density. For example, humans can hoard food supplies or increase food production to avoid starvation under high-population conditions. Humans also can modify their environments, perhaps through scheduling or architectural interventions, to minimize social stress in high-density settings. Nevertheless, social research has revealed some relations between density and various health and social problems in humans.

In discussing the effects of crowding on humans, it is important to distinguish between *chronic crowding* and *acute crowding*. Chronic crowding takes place in settings where people tend to spend much of their time, like work places, residential settings, or institutional settings such as dormitories, prisons, and military barracks. Acute crowding takes place in settings where people tend to spend very little time, like stores, elevators, sidewalks, restaurants, theaters, stadiums, and other public places. The effects of acute crowding also have been examined by researchers in laboratory settings modified to represent different levels of density.

Effects of chronic community crowding on social pathology

Social pathology can be defined as those phenomena that contribute to the demise of a society, typically by reducing its population, but also by disrupting its institutions and social relations. Thus, high rates of crime, mortality, accidents, disease, and divorce are indicators of social pathology. In the minds of many, social pathologies are linked to large cities, where they seem to proliferate and concentrate. Because large cities are both highly populated and full of social pathology, scientists have attempted to determine whether community crowding is at the root of the pathology evident in cities.

Interest in the relation between community density and pathology has been apparent since at least the end of the nineteenth century. Along with the industrial revolution came a rapid growth in cities throughout the western world. Some social theorists thought that the diversity of people, the personal anonymity, and high levels of individual autonomy existing between people in large cities would lead to

psychological distress and anomie. In contrast, people from small towns and agrarian societies were expected to have richer social lives and greater morale because of familiarity and close interaction with similar others. Other social theorists argued that the high density of cities would expose people to overwhelming amounts of stimulation. In response to the stimulus overload, city-people would socially withdraw. Social withdrawal could be a strategy for reducing stimulus overload. By reducing concern for others and by interacting at a superficial level, there would be fewer stimulus inputs to cope with in day-to-day life. However, there would naturally be social costs if everyone acted this way, including apathy, frustration, conflict, and competition.

Contemporary social scientists pursue many of the same questions regarding community crowding and pathology as did their counterparts from a hundred years ago. Typically, researchers researching on crowding investigate whether areas with high levels of community density also have high concentrations of social, psychological, and biological pathologies or problems. Community population density has been studied in relation to rates of death, infant mortality, perinatal mortality, accidental death, suicide, tuberculosis, venereal disease, mental hospitalization, birth, illegitimate birth, juvenile delinquency, imprisonment, crimes, public welfare, admissions to general hospitals, and divorce. The current evidence suggests that there is little or no relation between population density and major indicators of social pathology, such as mortality, crime, and juvenile delinquency. One research group observed that a higher ratio of persons per acre was associated with slightly elevated rates of mortality, fertility, juvenile delinquency, admissions to mental hospitals, and public assistance. However, the researchers also noted that certain ethnic and economic groups were over represented in the high-density areas. Thus, factors such as poverty, rather than density, could have caused the higher rates of pathology observed among individuals living in high-density areas. Indeed, when the researchers controlled for the effects of social class and ethnic background on the pathological outcomes, the relations between density and the outcomes disappeared.

On the other hand, it is possible that some community-crowding studies have underestimated the effects of high density on human pathology. Aggregate measures of density, such as persons per square mile, and aggregate measures of pathology, such as number of hospital admissions, do not precisely reveal the exposure to high density or its effects on individuals. For example, a person living in a high-density community might spend most of his or her waking hours at a job in a community that has a low level of density. Or, a person from a low-density suburb might work all day in a high-density city. The actual exposure of these respective individuals to high density is different than what one would expect based on the density of their communities. In one instance, the negative effects of living in a high-density community could be underestimated. In the other instance, the benefits of living in a low-density community could be overestimated. If there are many of these peculiar cases in a study population, then an aggregate measure of community density will not be a good estimate of exposure to crowding. Nor would such a measure be useful for examining the effects of crowding on human health and behavior. There are also problems with aggregate measures of

pathology. The principle problem is that data on social pathology originate from official public records, which can be incomplete and inaccurate.

To make matters more complicated, researchers can never know whether the relations between density and pathology are overestimated or underestimated when analyzing aggregate data. That is, the data errors caused by using aggregate measures could make the effects of density on pathology look stronger or weaker than they are in reality. One way around the problems associated with aggregate data is to study the effects of high density on individuals rather than on whole communities. That is, one could carefully measure individuals' exposure to density and their health and behaviors. This is usually done by surveying individuals about the levels of density in their households and about their health, behavior, and psychological well-being. Findings from this type of research are discussed in the next section.

Effects of chronic household crowding on health and behavior

Household crowding stems from high density in the residential environment. Residential environments include individuals' homes and apartments, as well as institutional settings such as prisons, dormitories, and military bases. Household density appears to have a wide range of effects on human health, behavior, and general well-being. Research in institutional settings such as prisons and dormitories is especially compelling because it helps to control for selection biases: prisoners and college students typically cannot choose or control whether they will be in a more or less crowded room.

Prisoners in high-density cells, for instance, report more negative moods, discomfort, and illness symptoms than those in single-person cells or relatively low-density cells. Disciplinary problems, psychiatric commitment rates, suicide rates, and death rates also appear to increase in prison populations that grow in size without increases in the size of prison facilities. Crowding also is a frequent problem in student populations. This often occurs because of a shortage of desirable housing near colleges or because students often double-up in apartments to save money on rent. In comparison with students in low-density dormitories or off-campus apartments, students in high-density residences feel more crowded, have more unwanted social contact and interactions, have more frequent negative moods, are less happy, and try to avoid interactions by socially withdrawing. In comparison with their uncrowded counterparts, crowded students are less sensitive to others' needs, less willing to help others, and less aware that others are available to provide emotional support or help to them when they need it.

People living in high-density residences can become insensitive to social cues even when they are not in high-density setting. That is, the social insensitivity cultivated in high-density environments can carry over into low-density settings. College students who are withdrawn and insensitive to social cues in their high-density residences also act this way in low-density laboratory settings. Crowded students exhibit their withdrawn behaviors by sitting far away from others, not initiating conversation, making little eye contact with others, and not being helpful to others in need.

High household density in noninstitutional settings also results in antisocial behaviors and complaints of excessive

social interaction. High household density is also related to increased negative mood and symptoms of depression and anxiety among adults. People from high-density households tend to have fewer friends and greater difficulty getting along with their neighbors than do people from relatively low-density homes. Parents tend to interact less with their young when they live in high-density homes than when they live in relatively low-density homes.

Children appear to be more negatively affected by high density than are adults, partly because they have less control over their environment than do adults. In comparison with children from low-density homes, those from high-density homes tend to have more behavioral problems in school, more anxiety, greater distractibility, more conflicts, lower achievement motivation, and poorer verbal abilities. However, caution must be applied when interpreting these results. As discussed above, density often accompanies other environmental conditions that could influence children's behaviors. Noise, for example, is likely to be greater in high-density households than in low-density households; and noise can interfere with children's attention, hearing, and learning abilities. Uncoupling the effects of density from those of noise is nearly impossible in naturalistic settings. In studying the effects of crowding on children it is also important to consider the role of other adults, particularly parent, in the environment. Research suggests that parents in crowded households are less responsive to their children relative to parents in less crowded households.

Earlier in this article, it was noted that social factors could influence whether an individual would perceive a particular setting as crowded. The social environment also can have a strong influence on the relation between crowding and psychological distress symptoms. For example, students living in high-density households who have frequent hassles from roommates are more likely to be psychologically distressed than are students living in high-density households with relatively few hassles. Students living in low-density homes do not appear to be adversely affected by social hassles. People living in high-density households may be particularly distressed by roommate hassles because it is more difficult to avoid or escape from the hassles in a high-density home than in a low-density home. In contrast to the effects of social hassles, positive social relations can counteract the negative psychological effects of high-density living situations. For example, college students living in high-density households who have supportive roommates are less likely to be distressed than are students living in high-density households with relatively unsupportive roommates or students living in low-density households. However, as mentioned earlier, chronic household crowding can undermine socially supportive relations because people become withdrawn and insensitive to social cues. Thus, although positive social relations may be beneficial to crowded individuals, such relations may be rare in households that are chronically overpopulated.

Effects of acute crowding on physiology and behavior

Acute crowding has been studied in scientific laboratories and in natural settings, like trains and elevators. In the animal studies discussed above, it was noted that many animals living in high-density populations showed biological signs of stress, such as enlarged adrenal glands. Elevated and sustained

physiological arousal is another sign of stress that is commonly observed in organisms under stress. In high-density laboratory settings, arousal has been exhibited in human subjects using many different measures. People exposed to acute crowding in laboratories exhibit increased perspiration, skin conductance, and blood pressure. Passengers in crowded commuter trains exhibit increases in blood levels of adrenaline. Interestingly, passengers who board a train when it is already near capacity are more negatively affected by the crowded conditions than passengers who board early, when the train is nearly empty. Even though the latter passengers ride the train longer, they had more choice, or control, over where they could sit on the train than passengers who board the train when it is already loaded with other passengers.

It should be noted that although acute exposure to high-density settings usually increases physiological arousal, it is not clear whether there are negative health consequences of the increased arousal. It is possible that elevated and prolonged arousal can wear down the body's defenses against illness and generate illness itself, such as hypertension or ulcers. However, there is not enough evidence at this point to state unequivocally whether the arousing effects of high density have health implications.

Impaired task performance is another common side-effect of acute exposure to high density. Mostly, this research has been conducted in laboratory settings that manipulate individuals' exposure to high or low density and then measure performance on problem-solving tasks or assess one's ability to concentrate or persist on a task. Although high density does not seem to interfere with performance on simple tasks, it does diminish complex task performance. It also appears that individuals are more easily distracted and are less persistent at completing challenging tasks under high- versus low-density conditions.

Short-term exposure to high density produces many of the same withdrawal behaviors observed in people chronically exposed to high density. It is not uncommon, for example, for people on crowded subways to read newspapers and books as a way of avoiding interaction with others. In laboratory settings, crowded people are more likely to leave the settings, increase social distance, withdraw from social interactions, increase defensive posturing, and reduce eye contact than uncrowded people. Another way to maintain space from others is to be aggressive and threatening. Several studies have shown increased competition and aggression between individuals in high-density settings. Interestingly, crowding is more likely to evoke aggression in men than in women and when resources in the environment are scarce rather than plentiful. The adaptive value of withdrawal and aggression in high-density settings is not completely understood, but it does appear that these social behaviors may help people to cope with crowding. For example, social withdrawal might be a way of minimizing physiological arousal by avoiding unwanted social interactions and the excessive social stimulation that is common in high-density settings.

Explaining the Negative Effects of Crowding

Several theoretical explanations of the effects of crowding on human health and behavior have been alluded to throughout

this article. Below we discuss four of the more prominent of these theories: behavioral constraint, control, social withdrawal, and overload/arousal theories.

Behavioral Constraint

According to this theory, high density interferes with individuals' goal attainment by restricting or inhibiting their movements and behaviors. The diminished freedom makes the high density noxious and undesirable. When people are in high-density settings that do not thwart their goal-directed behaviors, they tend to be less negatively affected by the high density than when their goals are thwarted. Imagine, for instance, two groups of individuals performing a task in a crowded room, but one group has to complete the task while sitting still and the other group has to complete the task while moving around the room. It is more likely that crowding will interfere with the task performance of the moving group than of the still group because the crowded group will be coping with the task and the constraints on their movements caused by the crowding.

Behavioral constraints do not refer only to restrictions in bodily movement. Sometimes high density can create resource shortages, such as food shortages, which constrain behavioral choices. That is, density can restrict access to valued resources. In the case of food shortages, behaviors such as eating might be inhibited. In addition, people in such situations might act aggressively to get valued resources. Finally, it should be noted, that high density often can have negative effects on mood and performance because people perceive that there are behavioral constraints in high-density environments. That is, simply believing that high density can limit one's behaviors or access to valued resources is sufficient to diminish task performance or increase discomfort in high-density settings.

Control

Limits to behavioral freedom also can be construed as limits in personal control over the self and the environment. Control models of crowding hypothesize that high density is undesirable and harmful because it renders the environment more unpredictable and exposes individuals to situations over which they have little or no control. A lack of control in high-density settings has been shown to exacerbate the negative effects of density on humans, whereas the availability of control has been shown to reduce the negative effects of density.

One group of researchers tested the control hypothesis by examining the effects of control on people's moods in crowded elevators. Control in the elevator was manipulated by giving some people access to the elevator control panel and other people no access. Those who had panel access, or more control, in the crowded elevators felt less crowded and had more positive moods than those without control. As with behavioral constraint, sometimes it is enough to simply perceive, or believe, that control is available to reduce the negative effects of high density on performance or mood. However, if one's expectations for control in a high-density situation do not match the actual availability of control, then the high density can be more disturbing than if one expected little control in the situation. Thus, it appears that control or beliefs

and expectations about control in high-density environments influence how strongly humans are affected by crowding.

Social Withdrawal

One consequence of crowding is excessive and unwanted social interaction and interference. Social withdrawal is a practical behavioral response for reducing unwanted social interaction. For example, commuters on a crowded subway will often bury their heads in a newspaper and listen to music through headphones rather than engage with fellow commuters. Sometimes individuals will avoid the unwanted social interaction associated with crowding altogether by avoiding the crowded space. For example, college students who are forced to double-up in a small dormitory room might spend more time at the library or gym to reduce time spent in the room. Residents in a crowded apartment might isolate themselves by closing doors between rooms or spending lots of time alone in a bathroom or other private area in the apartment. Whereas social withdrawal is effective at reducing unwanted social interactions, it also can have potentially unintended and undesirable consequences, including reductions in social support and companionship.

As discussed above, several studies have shown that among people living in crowded households social withdrawal is associated with a lower level of social support, which, in turn, is associated with a higher level of psychological distress. Although there is no evidence to date, it is also likely that social withdrawal between intimates could lead to feelings of neglect and social strains, which might have their own adverse health effects. Additional evidence is needed to determine whether social withdrawal and its unintended negative social consequences have any implications for physical health.

Overload/Arousal

A final theory posits that high density increases pathology because of sensory overload from excessive stimulation. Humans have a limited capacity to process information; in high-density settings, the information available in the environment exceeds that capacity. This process is similar to information overload in a computer system, which can cause a computer to make errors or shut-down operations. In humans, overarousal is often unpleasant, can diminish complex task performance, and could contribute to health problems.

Evidence for the overload/arousal model of crowding is found in studies such as those discussed above that have shown increased sympathetic arousal under high-density situations. Some scholars have suggested that heightened social withdrawal in high-density settings is a method of reducing arousal. At present, however, there is no strong evidence that social withdrawal can actually lower sympathetic arousal in crowded people. In addition, there is no evidence that the levels or duration of arousal people experience in high-density settings is significant enough to compromise health or contribute to disease processes.

Conclusions

Crowding in humans is a syndrome of stress associated with exposure to high-density households, community, or laboratory settings. A distinction exists between the subjective experience of crowding and the objective source of that feeling: high-population density. Overpopulation in nonhuman animals leads to deviant social behaviors and health problems. However, exposure to high density and overpopulation in humans seldom results in extreme social pathologies. Unlike lower animals, humans appear to be able to adapt to and cope with high-density situations with a good deal of tolerance. Humans can adapt by limiting their exposure to high density through many means, including architectural interventions, careful scheduling and planning of space usage, and by engaging in distracting or withdrawal behaviors. Unfortunately, some adaptations to density, such as social withdrawal, can have unintended consequences, such as loneliness or deterioration of interpersonal relations.

The research evidence to date suggests that people do have undesirable psychological, social, and biological responses to crowding. However, it is also clear that crowding is more or less aversive and detrimental to people depending on their personal experiences with and preferences for particular levels of density. In addition, social conditions, such as the presence of supportive others or undesirable social hassles from others, can influence the strength of the relation between density and various outcomes, such as psychological well-being. Thus, density does not necessarily increase social pathology in humans. Indeed, low levels of density can be undesirable at some occasions, such as parties, sporting events, or concerts. It appears that density is most detrimental to human behavior and health when individuals feel a lack of control over their own behaviors or the environment, or when they experience excessive stimulation and arousal from the density.

See also: [Crowd Psychology](#); [Group Dynamics](#); [Stress and Illness](#).

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Cultural Psychology

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Glossary

Behaviorism A school of research in psychology that explains behavior in terms of the association between a stimulus in the environment and a behavioral response.

Cognitive Revolution An intellectual movement in the 1950s that was oriented toward establishing meaning as a central concept in psychology.

Cultural tools Culturally and historically based artifacts, symbols, technologies, and forms of language which impact on modes of thought.

Executive functioning The cognitive processes that regulate the ability to organize thoughts and activities, prioritize tasks, and make decisions.

Information processing approaches A perspective on cognitive development that focuses on the operations by which people mentally manipulate information.

Priming The implicit memory process in which a stimulus activates or makes more retrievable one or more memories or associations held by an individual.

Cultural psychology refers to a perspective on psychological research which recognizes the essential role of culture in the formulation of basic psychological theory. The perspective of cultural psychology captures the core psychological insight that psychological processes always occur in socioculturally, historically situated contexts and depends on the individual's participation in those contexts for their emergence; that is, without culture advanced psychological processes would not exist, just as they would not exist without biology. While it is well understood that people are inherently biological beings, the insight of cultural psychology is to recognize that they are also inherently and simultaneously cultural ones. The discussion here provides an overview of the key theoretical assumptions of cultural psychology followed by a select overview of major traditions of research associated with cultural psychology and of the types of empirical findings emerging. Consideration is also given to challenges facing contemporary work in cultural psychology as well as to the contributions and promise of research in this tradition.

Core Premises of Cultural Psychology

The perspective of cultural psychology calls into question the dominant theoretical position that has long dominated work in psychology, which is to downplay the importance of culture in the formulation of basic psychological theory. This theoretical position that has tended to characterize most psychological research treats culture as content or context and assumes that psychological development is not only fundamentally universal but can be understood without taking into account cultural considerations. It is assumed that the basic nature of psychological processes and structures is unaffected by the culturally dependent content on which they operate or by the culturally structured contexts in which they occur. From this type of perspective, cultural variation in human behavior is considered to be of limited interest in that it is viewed as leading away from the search for underlying regularities to a focus on outward appearances. This type of stance has been associated with programs of research in psychology that have tended to present

psychological theory in culture-free terms and to tap culturally skewed populations, focusing predominately on American research participants and neglecting to study the vast majority of the world's populations.

The theoretical stances adopted in cultural psychology differentiate it not only from this mainstream approach in psychology but also distinguish it from earlier traditions of cross-cultural research that were prominent in the mid-twentieth century and that tended to focus on testing the assumed universality of existing psychological theories. These theoretical stances include adoption of symbolic views of culture, acknowledgment of the essential role of cultural mediation in the emergence of higher order psychological processes, and recognition of the mutual constitution of culture and self.

Symbolic Views of Culture

The emphasis on meaning that occurred with the rejection of behaviorism in the mid-twentieth century constituted an important foundation for cultural psychology. This emphasis, which emerged with the transition in psychology known as the Cognitive Revolution, underscored the role of the individual in going beyond the objective information given in making sense of experience. Within behaviorism, the individual had been portrayed as passively responding to objective stimuli in the environment. The Cognitive Revolution, however, made clear that this point of view fails to recognize the individual's role in actively contributing meanings to experience, with the same information potentially giving rise to different interpretations and having contrasting implications for the individual's affective, cognitive, and behavioral reactions. Notably, there was no straight path from this insight of the Cognitive Revolution to contemporary work in cultural psychology, as the emphasis on meaning-making of the Cognitive Revolution was waylaid for many years as more passive information processing approaches came to dominate the field. However, this recognition that an act of interpretation intervenes between the stimulus and the response established an important theoretical basis, which was later drawn upon as investigators came to appreciate the role of culture as a necessary component of meaning.

The emergence of symbolic views of culture in work in anthropology and linguistics formed a key foundation for cultural psychology in making clear not only the collective aspects of meanings but that meaning could not be reduced to objective properties of the situation. In this view, cultural systems are understood to do more than merely provide information about experience or convey norms for behavior. Rather, they are seen as creating social realities whose existence depends, in part, on these cultural definitions and the practices that instantiate them. This meaning creating role of culture extends not only to recognized social institutions (e.g., marriage, school) and their associated roles (e.g., bride, student) and artifacts (e.g., wedding ring, grades), all of which depend on socially shared definitions and activities, but also to core concepts in psychological theory, such as categories of mind, emotion, and self, which also depend, in part, on socially shared concepts and practices.

The theoretical importance of recognizing the role of culture as a system of meanings and practices was that it highlighted the need to take culture into account in psychological explanation. Contexts for psychological development could no longer be understood merely in terms of objective constraints and affordances, but required consideration of culturally shared beliefs and values through which the contexts were interpreted and structured.

This role of culture as a system of meanings and practices may be illustrated through research undertaken by Tobin, Wu, and Davidson on Japanese and US teachers' views of preschool classrooms. US teachers were observed to be highly critical of practices in a Japanese classroom that included a ratio of one teacher per 30–40 students, and to much prefer the ratio found in a US classroom that included 2 teachers per 8–10 students, making the observation that teachers can devote more attention to individual students in the latter setting. However, whereas Japanese teachers recognized this objective affordance provided by the US preschool classroom, they appraised the classroom structure negatively, as not providing children with opportunities to function as part of a larger social group.

Cultural Mediation of Psychological Processes

In addition to recognizing the nature of culture as a system of meanings and practices, the perspective of cultural psychology includes the recognition that human thought and behavior is mediated by culture and that it is only through activity in sociocultural environments that higher order psychological processes emerge. This insight is termed the incompleteness thesis to capture its core assumption that human psychological development cannot be completed without cultural experience.

The incompleteness thesis is based on the recognition that culture is ever-present in human experience. Individuals, it is noted, always act in culturally and historically specific environments and utilize culturally and historically specific tools. They also carry with them in their language and understanding systems, culturally specific assumptions through which they interpret experience. This omnipresent enculturative structure is understood to introduce a cultural–historical grounding to psychological functioning with the assumption made that it is virtually impossible for individuals to act in ways that are not culturally mediated. Even the highly controlled context of a

scientific laboratory, it is recognized, does not fully control for culture and is not culture-free, but rather itself constitutes a highly particular cultural environment. While individuals are assumed to show instinctual responses and other inborn propensities that are not culturally mediated, their environmental experiences (even in utero), reflect a cultural patterning and it is only by the gradual internalization of the tools of a culture that advanced psychological processes emerge.

Importantly, this type of perspective does not assume that all psychological processes are culturally variable. However, it does assume that advanced psychological processes will invariably reflect a cultural patterning, and thus in many more cases than presently recognized will show cultural variability. From the perspective of cultural psychology the acknowledgement that a particular psychological process is culturally dependent or culturally variable is not, however, invariably regarded as a flaw given that it is assumed that many basic psychological theories are likely to reflect a cultural–historical specificity. In fact, a core part of the agenda of contemporary work in cultural psychology is to make this cultural patterning of psychological theories explicit. Work in cultural psychology, in this way, is as much about achieving a greater understanding of the often implicit cultural underpinnings of present psychological theories as it is about gaining insight into cultural diversity in psychological functioning. Rather than being relegated to the role of a footnote, qualification, or exception in the formulation of basic psychological theory, as cultural work is currently presented in many textbooks or handbooks of psychology, cultural evidence is recognized to be an essential basis for the formulation of psychological theory. While cultural psychology is at times portrayed as a subfield of psychology, this constitutes a misnomer. Cultural psychology is coterminous with all of psychology, in sharing its fundamental agenda of contributing to the formulation of psychological theories and in explaining the processes of human development. This recognition of the inherently cultural nature of all fields of psychology implies that there could never be an adequate psychology that is culture-free, just as it cannot be assumed that there could ever be an adequate psychology that fails to take into account the biological foundations of self.

Mutual Constitution of Culture and Self

In addition to recognizing the culturally mediated nature of psychological processes, the perspective of cultural psychology highlights the mutual interdependence of culture and self. Notably, the conjoint term 'cultural psychology' was selected by theorists to convey this insight that, just as psychological processes need to be understood as always based in particular cultural–historical contexts that impact on their form and patterning, cultural meanings and practices depend on the existence and activities of communities of intentional agents. While culture cannot be reduced to individual psychology nor individual psychology understood as purely culturally patterned, culture and psychology are recognized to be mutually interdependent.

This assumption of the mutual constitution of culture and self underscores the need to approach culture in dynamic terms just as psychological processes themselves are understood to develop and change. Cultural meanings and practices are not

static but rather transform over time, in ways that reflect both adaptive functional constraints, such as survival pressures, as well as historical continuities and discontinuities, as traditions are transformed and altered, even as they are forwarded and preserved.

The assumption of the mutual constitution of culture and self also highlights the compatibility, if not the fundamental necessity, of a consideration of both biological and cultural influences on psychological development. It is recognized that just as individual psychological development depends on biological processes, biological phenomena are affected by cultural processes, such as demonstrated in the impact of tool use on the evolution of modern humans. This fundamental compatibility of biological and cultural aspects in constituting the self is seen in the increasing attention being paid to neurological and other biological considerations in research in cultural psychology.

Research Traditions and Findings

Work that shares the theoretical assumptions and goals of cultural psychology is found in all subfields of the discipline, with this work, in cases, being undertaken by theorists who do not explicitly adopt the self designation of cultural psychology, or even by investigators identified with related disciplines, including anthropology, linguistics, and sociology. This work incorporates all types of methodology, and is not restricted to research that is either comparative or ethnographic in nature. While the present discussion cannot cover all of the various traditions of work in cultural psychology, brief consideration will be given here to some of the major areas of work in cultural psychology and to the types of empirical findings emerging.

Sociocultural Approaches

One of the most longstanding traditions of research in cultural psychology is the tradition identified originally with the cultural-historical approach of Vygotsky and his Russian colleagues. This tradition has been extended in recent years by investigators such as Cole, Rogoff, and Wertsch, among many others, and is generally referred to by the contemporary designation of 'sociocultural' perspectives. Within this tradition, extensive consideration is given to the role of cultural tools and other mediational means in qualitatively affecting the form of human cognition and behavior. From this perspective, human activity is understood in a broad-based way that takes into account historical, individual developmental, phylogenetic, and microgenetic levels of analysis. There is also a shift away from an exclusive focus on psychological processes as internal to individuals to a focus on their instantiation in everyday social activities.

A major direction of work in this tradition is to examine how participation in everyday cultural practices leads to changes in thought that are qualitative in form while also contextually dependent. For example, it has been shown that individuals who have extensive experience in using the abacus are more successful in solving math problems and employ more complex and qualitatively different cognitive processing

strategies in their solutions than do individuals who have no experience using this cultural tool, with these contrasting cognitive strategies showing only limited generality to other types of cognitive tasks. Likewise, research conducted in Brazil on children with little education who work selling fruits on the streets has documented their impressive and highly flexible strategies for solving the everyday math problems that they employ in their trade – strategies, however, that do not transfer to their performance on school-based arithmetic tasks. Studies by Michael Cole and his colleagues who have examined the impact of literacy and schooling on cognitive development have also uncovered the powerful, yet localized, impact of exposure to cultural tools on cognition. Thus, it has been demonstrated, for example, that while marked effects of schooling are observed on conventional cognitive measures, these measures are similar in form to the types of tasks that tend to be practiced in school contexts. It is further shown that individuals who have had extensive schooling or who have scored high on cognitive tests are no better than their unschooled or low scoring counterparts in solving everyday cognitive tasks, such as making the most successful bets at the racetrack or the most economical purchases in the supermarket. Providing insight into the processes through which experience with cultural tools and in culturally structured contexts impacts cognition, this work challenges early global stage models that had linked modernization to global differences in thought – a paradigm known as the hypothesis of the primitive versus modern mind.

Work in this tradition also provides insight into the links between social and developmental change. A dramatic example of this type of work may be seen in the variation in everyday practices and in associated styles of cognitive activity observed to occur in Chiapas, Mexico, which was studied by Patricia Greefield and her colleagues over a period of more than two decades from 1969 to 1991. During the early period in which the local economy was heavily agricultural, emphasis was placed on subsistence activities, such as weaving of all the family's clothing, and girls were taught to weave in a process closely guided by their caregivers who were present in the context. However, during the later period in which there had been a shift to an economy based on commerce and money, not only was there a reduction in the economic importance of weaving (since clothes were now more frequently purchased), but the activity of girls in learning to weave had changed to a more trial and error process that was no longer characterized by the hands-on attention and direct involvement of the caregivers. During this historical period, there was also a modification in the weaving products, from a more detailed to a more abstract style of visual representation, and adolescent girls were found to show enhanced abilities in representing novel visual patterns. This type of research notably underscores the dynamic nature both of sociocultural environments and of their impact on developmental outcomes.

Research in the sociocultural tradition has also led to a rethinking of conceptions of development. For example, in research on the teaching of reading, Michael Cole provided a new solution to what is known as the paradox of qualitative developmental change, that is, the problem of accounting for how individuals can acquire more powerful cognitive structures if they do not already possess these structures.

The research demonstrated that a range of meditational means are available in cultures that support reading, including not only literacy activities like storytelling, but artifacts like computer games. This made clear that many of the structures entailed in the achievement of reading exist between persons in the sociocultural context before they appear as individual competencies. In another example, work by Barbara Rogoff has highlighted the role of cultural practices in underlying developmental change. She provides evidence to indicate that the marked cognitive shifts that have been documented by developmental psychologists occur over the age range of 5–7 years old and that have classically been explained solely in cognitive terms to result, in part, from changes in the sociocultural settings and types of cultural supports provided to children during this age period. It is during this period that children commonly move more fully into the school context and gain greater exposure to the peer group, with attendant variation in their activities, which has implications for their emerging cognitive competencies.

Developmental Approaches

The tradition of cultural psychology discussed here includes approaches that draw their inspiration primarily from work in the contemporary mainstream tradition of developmental psychology. Theorists in this tradition focus on the impact of culture on the path of developmental change, and on culturally broadening the theoretical constructs of developmental psychology.

Work in this tradition of cultural psychology has documented that the direction and endpoints of developmental change are, in cases, culturally variable, and thus, that explanations of developmental change need to take into account cultural considerations and universal cognitive or experiential factors. Psychological research that had been conducted primarily on US cultural samples had uncovered an assumed universal developmental change for young children to shift from a focus on viewing the self and others in concrete terms, such as by reference to their physical characteristics, to a focus by adolescence on viewing the self in terms of traits – a developmental trend that was explained as resulting from children's increasing abilities to engage in abstract thought. However, in comparative developmental research conducted among US and Hindu Indian populations by Joan Miller, it was found that not only did Hindu Indian populations not show this developmental increase in emphasis on traits, but they showed a significant developmental increase not found among US populations to give increasing emphasis to contextual considerations. Thus, whereas an American adult might explain behavior in terms of the agent's personality (e.g., that an individual was helpful), Indian adults would show a greater tendency to explain it in terms of features of the situation (e.g., that no one else was around, or that the individuals involved were friends).

This same type of interest in uncovering cross-cultural developmental variation may be seen in a recent program of cross-cultural developmental research by Qi Wang and her colleagues that points to the role of cultural beliefs and practices, such as everyday discourse routines, in the development of autobiographical memory. Wang and her colleagues found

that not only is the age of earliest autobiographical memories later among Chinese than among US child and adult populations, but the form of autobiographical memories is culturally variable, with US respondents tending to recount earliest memories which are emotionally intense and positive and that focus on their individual psychological reactions, and Chinese respondents tending to recount earliest memories that are less emotionally laden and less self-focused and that tend to center on everyday social routines, such as a caregiver's behavior in cooking the daily meal.

A related thrust of work in this tradition is to formulate developmental theories that are more culturally inclusive. An example of this type of stance may be seen in work by Fred Rothbaum and his colleagues that points to the need to broaden conceptions of attachment theory to encompass concerns with *amae* that are salient in Japanese cultural contexts. *Amae* is a culturally grounded Japanese concept that involves positive feelings of depending on another's benevolence. This argument for the need to culturally broaden attachment theory, one of the most central theories of social development, is based not only on the research by Rothbaum but on a growing body of research by a range of investigators that provides evidence of cultural variation in the incidence of secure attachment as well as of uncovering cultural variation in styles of everyday social interaction, such as the greater emphasis found in Japanese families on nonverbal styles of parent-child interchange that promote the development of empathy, a dimension that is not emphasized in attachment theory.

Another example of this focus on culturally broadening theoretical concepts in developmental psychology may be seen in the growing body of work on culture and parenting. For example, one of the most influential contemporary theories of parenting, which was developed by the theorist Diana Baumrind, conceptualizes parental control in terms of a category of assumed harsh authoritarian parenting. However, as theorists such as Ruth Chiao have observed in their research, there exist highly directive forms of parenting among Chinese families that combine an emphasis on standards of conduct and preserving the integrity of the family with deep affective concern and caring for the child. To capture this type of stance on parenting, a stance that notably is associated with positive adaptive outcomes, such as higher levels of educational achievement, it is crucial to conceptually broaden present psychological models of parenting. Cross-cultural developmental research has also demonstrated that, in contrast to the tendency observed among European American children and adolescents, Korean cultural populations show a greater tendency to associate greater parental warmth with greater perceived parental involvement in the child's decision making. Theorists point out the need to recognize that in portraying control exclusively in negative terms, present theories of parenting fail to capture the extent to which parental involvement may be expressed and experienced in positive terms as conveying warmth and a welcome involvement.

Social Psychological Approaches

The tradition of work in cultural psychology under consideration here shares a similar agenda to that just discussed in the area of developmental psychology. However, in this case,

the focus is on culturally broadening theory and research being undertaken in the area of social psychology. Theorists in this tradition center their research on highlighting the role of culture in the formulation of basic social psychological theory, with particular attention given to issues of cognition, motivation, and self.

In terms of cognition, work in this tradition has provided support for claims that there is a greater emphasis on holistic modes of cognition in Eastern cultural settings, with a greater emphasis on analytic modes of cognition in Western cultural contexts. The former perspective privileges a deductive logic, which emphasizes breaking up objects into their component elements, whereas the latter stresses a more dialectical logic, which stresses viewing objects in relational terms. In support of this claim, it has been observed, for example, that Chinese adults perform less successfully than do American adults on category learning that requires the application of formal rules, while performing more successfully than do American adults in detection of covariation, an activity that demands attending closely to the environment. In another example, related cultural differences have been documented in the processes of attention, with the recall of East Asian populations for objects less than that of Americans if the background has been switched, suggesting that European-Americans more fully process contextual information. This difference in attention notably has also been observed in saccadic eye-movements, as assessed with eye-trackers, with East Asians relative to Americans gazing longer at background material.

In the area of motivation, cultural research is highlighting the need to broaden psychological theory to take into account the more social nature of internalization processes in collectivist cultural settings. For example, research has demonstrated that Brazilian adults more fully internalize social norms than do American adults, linking fulfilling a role related request for help by a family member more strongly not only with social expectations but also with satisfaction. Similar cross-cultural differences have been documented in comparisons between Indian and US populations with Indians associating fulfilling role based social expectations to family and friends with choice and US populations experiencing it in less freely chosen terms. While this and other related research does not challenge the existence of a concern with choice universally, it does highlight the need to recognize that the motivational salience of choice varies cross-culturally in ways that are not presently fully accounted for in psychological theory.

In terms of self, recent cultural research is also identifying cultural influences on the determinants of positive self-regard and of psychological well-being. Research, for example, documents the existence of marked cultural variability in the tendency to self enhance. For example, it has been demonstrated that whereas Americans tend to rate their self esteem as higher than that of others, Japanese tend to rate their self esteem as similar in level to their peers. As another example, whereas the self-descriptions of American adults tend to include four to five times as many positive attributes as negative ones, those of Japanese tend to give greater emphasis to their shortcomings. It has also been documented that self esteem as well as the experience of positive emotions correlate more strongly with life satisfaction in individualistic as compared with collectivist cultural populations. While work on this topic does not call

into question the importance of maintaining a positive sense of self in all cultural populations, it does suggest that constructs such as self-esteem, which assume a tendency toward self enhancement, reflect a culturally specific stance and need to be broadened to account for the cultural beliefs and practices of different cultural populations.

Cultural Neuroscience

The perspective of cultural neuroscience is concerned with understanding the cultural underpinnings of brain-behavior relationships. Representing a new direction for research in cultural psychology, this work forms part of the exponential growth over the last two decades in interest in neuroscience in all subfields of psychology, with the advent of functional neuroimaging. Cultural neuroscience provides insight into both common and culturally variable brain-behavior pathways and into the nature and extent of brain plasticity.

A central focus of research in cultural neuroscience is to provide information about the role of cultural contexts in mediating brain-behavior relationships. This work builds on the growing body of evidence of cultural variability in basic psychological processes and documents ways that this variability impacts the brain mechanisms recruited. Recent work in cultural neuroscience has revealed, for example, that the neural correlates of processes of perception, attention, and social understanding show cultural variability that is related to the cultural variability observed in these areas in psychological performance. For example, congruent with recent findings that US adult populations show greater object-focused processing than do East Asian adult populations, work in cultural neuroscience demonstrates that stronger and more distributed neural activation occurs during object processing among US cultural groups than among East Asian cultural groups. Research in this area has also revealed that brain mechanisms are recruited in ways that reflect perceptual tasks which are more culturally preferred being easier and thus requiring less attention than do nonculturally preferred tasks. Thus, it is observed that whereas East Asian adults recruit prefrontal and parietal regions of the brain associated with attention more for culturally nonpreferred context-independent judgments than for culturally preferred context-dependent judgments, the opposite pattern of neural activation is observed among US adults. In another example, in accord with findings that collectivist cultural populations tend to maintain outlooks that incorporate others more fully into the self concept, research has demonstrated that whereas the medial prefrontal cortex of the brain is activated by judgments made about the self among US cultural groups, it is activated by judgments made about both the self and about one's mother among Chinese cultural groups. Such work importantly provides evidence that these two cultural groups use the same part of the brain in different ways.

Work in cultural neuroscience is also addressing key conceptual questions such as the extent to which maturation of the brain is affected by experience in contrasting cultural environments. For example, work on human aging is demonstrating that elderly Asian populations show greater deficits in object processing areas of the brain than do elderly Americans, a pattern of findings that is congruent with the observed

tendencies for Asian cultural groups to less fully process object information than do US cultural groups. Such work provides insight into processes of brain plasticity and lends support to what is known as a use it or lose it view of human aging.

Cultural developmental neuroscience is also demonstrating that neural functioning is not invariably the same in all samples of healthy children but reflects the influence of culturally variable experiences. To give an example, cross-cultural developmental research has demonstrated that Asian children tend to perform better than do North American children on measures of executive functioning. In research conducted with Chinese-Canadian and European-Canadian children who were matched in terms of their performance on a reaction time test of executive functioning, it was shown that the two groups of children showed differential patterns of brain lateralization compatible with the cross-cultural differences observed in executive performance.

Challenges

As work in cultural psychology is gaining in prominence and scope, it is also increasingly embodying a self critical perspective in which investigators work to recognize and address certain limitations of past approaches and to identify important directions for further work. These challenges faced by contemporary researchers in cultural psychology center on developing more adequate understandings of culture and the self, and on more effectively integrating work in cultural psychology with work in the larger discipline of psychology.

Enhanced Understandings of Culture

A major challenge in contemporary work in cultural psychology is to develop more sophisticated and culturally sensitive approaches to culture. With the exception of research from a sociocultural perspective, much of the work in cultural psychology to date has been informed by the interdependent/independent or East-West dichotomy. This distinction gained in prominence with a seminal review paper on culture and the self coauthored by Hazel Markus and Shinbou Kitayama in 1991, with the distinction further promoted in the field by the subsequent development of psychological scales to measure this dichotomy. More recently, this perspective on culture has grown in prominence with the emergence of approaches that utilize priming techniques to assess culture. For example, one of the tasks that has been developed to prime an independent as compared with interdependent cultural view of self presents individuals with a paragraph that describes the behaviors of an individual who is referred to either only with the pronoun *I*, in the independent case, as compared with only by the pronoun *We*, in the interdependent case. As critics have noted, however, this type of approach to culture emphasized to date in much work in cultural psychology tends to gloss over important distinctions between and within cultures, to give limited attention to the impact of context on behavior, and to embody conceptions that treat individual perspectives as isomorphic with trends at a cultural level.

One way that theorists are working to develop more nuanced approaches to culture is through research that is

more fully tapping within and between culture variation in outlooks. Thus, not only are more studies being undertaken that assess psychological variation between different individualistic and collectivistic cultures, such as comparisons of North American with Western European samples, or comparisons that contrast collectivist populations outside of East Asia, but increasing attention is being given to sampling cultural groups who vary in socioeconomic status and/or ethnic background. For example, in research on attachment that was undertaken by Robin Harwood, it was demonstrated that ethnicity and socioeconomic status make distinctive contributions, with the impact of socioeconomic status showing both common and culturally variable patterns in different ethnic groups.

Theorists are also rethinking the assumption that cultural outlooks can be tapped by individual difference measures. It is increasingly recognized that individual differences do not vary in a one to one relationship with cultural differences, a stance that it can be argued reduces one level of analysis to that of another, as well as recognizes that culture impacts behavior in ways that are often implicit and is not the kind of tendency that can be tapped by explicit psychological scale measures. More attention is also being given to assessing cultural processes, such as by attention to discourse routines and other everyday social practices, as well as by tapping cultural products and their associated meanings. While there remains an appeal to the use of priming techniques in social psychological work in cultural psychology, given the amenability of this type of method to experimentation, increasing concern is also being given to the limitations of priming, with calls for greater attention to be paid to the culturally variable knowledge that is elicited by particular priming stimuli.

Greater Impact on Psychological Theory and Research

Work in cultural psychology remains sensitive to the challenges entailed in its goal to culturally broaden theory and research in mainstream psychology. While work in cultural psychology has increased in quantity in recent years, it remains, as it has been historically, in a marginal position in the discipline. In most departments of psychology, little or no attention is given to representing culture in the curriculum or in the hiring of faculty, with culture in many departments relegated only to the important, but still marginal, role of an approach to be applied solely in understanding diversity and not in formulating basic psychological theory. This downplaying of the importance of culture is illustrated, for example, in the contrasting response of departments of psychology to the advent of neuroscience as compared to cultural psychology. While both of these perspectives have gained in prominence in recent years, neuroscience has quickly become fully integrated into the discipline, as seen in departments of psychology not only hiring neuroscientists but frequently restructuring their departments to incorporate sub-divisions devoted to neuroscience, while cultural psychology has not seen a comparable growth in acceptance or influence.

While this marginalization of cultural approaches has roots in the idealized natural science ideal of the discipline and is not likely to change in a dramatic way, the increasing quantity of cultural research being undertaken as well as its increasingly international grounding represents one way for this work to

have a greater impact on the discipline. In recent years, the population of individuals trained as psychologists is becoming more international, with investigators of diverse cultural background more frequently engaging in productive collaborations, and with the growth of psychology journals that are based in non-Western cultural settings. Also, while there is increasing awareness of certain pitfalls associated with the recent wholesale embrace of neuroscience in psychology, such as its adoption by theorists to support arguments that are deterministic or circular in nature, it is also increasingly recognized that taking culture into account is essential in neuroscience work and, thus, that culture must be a key part of any psychology of the future that is grounded in an understanding of brain processes. To the extent that a particular psychological process has been shown to be culturally variable, an account of the neurological correlates of that process will be incomplete, if not misleading, without taking into account this cultural variability. Also, as a growing number of theorists are pointing out that meanings are not given in brain processes but rather require the consideration of culturally shared social concepts and practices.

Promise of Cultural Psychology

Even while facing challenges, this represents an exciting time for research in cultural psychology. Work in cultural psychology continues to pursue its central agenda of making the implicit cultural processes that impact on psychological functioning more transparent, thereby contributing to the creation of basic psychological theory. This work also continues to be integral to developing psychology in ways that increase its social relevance and applicability to solving real world social problems. In this respect, work in cultural psychology is essential in the efforts of the field to give back the insights of psychology to the community. Finally, work in cultural psychology continues to be integral to attempts to develop a more sophisticated understanding of what can be designated as basic psychological mechanisms. While enhancing current understanding of cultural variability in psychological processes and

outcomes, cultural psychology is vital in furthering the goal of creating a truly universal psychology.

See also: [Aging and Cognition](#); [Aging and the Brain](#); [Attribution](#); [Cross-Cultural Adaptation](#); [Individualism](#); [Social Cognition](#).

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Decision Making (Individuals)

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Glossary

Affect A feeling state that is distinguished by valence (positive vs. negative) and sometimes arousal and other dimensions.

Cognitive reflection test A set of three questions, to which people give a response that is assumed to be either automatic and seemingly obvious (but incorrect) or effortful and deliberative (and correct).

Expected utility Similar to expected value, but outcomes are nonlinearly transformed into utilities (indices of relative value).

Expected value The average outcome of a risky choice. For example, a coin-toss for \$200 or \$0 has an expected value of \$100 (i.e., $0.5 \times 200 + 0.5 \times 0 = 100$).

Framing effects Shifts in preferences for objectively identical options when outcomes are described as gains versus losses.

Invariance An axiom stating that individuals should show equal preference for options that have equal consequences.

Numeracy The ability to understand and use numbers.

Preferences In psychology, an underlying construct thought to reflect the value of options; in economics, revealed by choices.

Risk Can be defined in many ways. One version is the possibility of, or variance among, multiple outcomes.

System 1 and 2 Two modes of thought in standard dual-process theories. System 1 is characterized as fast, automatic, effortless, and intuitive, whereas System 2 is characterized as slow, deliberate, controlled, and effortful. Standard dual-process models posit that System 1 is responsible for many cognitive errors and that System 2 can sometimes override System 1 in order to avoid such errors.

Temporal discounting Devaluing of future outcomes relative to immediate ones.

Utility In economics, a measure of relative satisfaction or pleasure associated with an outcome.

Introduction

Decision making can be defined as the selection of a course of action among options. Those options can range from selecting a marriage partner to selecting a political party affiliation. Scholars who study decision making come from many disciplines. For example, decision making has long been of interest in economics and psychology. Early models of the decision making process were mathematical. These mathematical models described the decision making process as a matter of performing calculations, involving such concepts as probabilities of outcomes and the monetary values of outcomes, to select the best course of action. Many modern models of decision making are variations of these original mathematical formulations.

However, recent conceptions of decision making emphasize psychological factors. Among these factors are relatively stable characteristics of people, which are called individual differences. Numeracy, or the ability to understand and use numbers, is a popular example of an individual difference that is thought to influence the quality of financial and health decision making. Intelligence, or cognitive ability, is another. In addition, emotion has received a great deal of attention recently, especially in dual-process theories that contrast emotional with deliberative decision making. Process models of memory are also increasingly influential in research on decision making. For example, how people remember features of options affects their preferences for the options. For these and other topics, neuroscience has become a useful tool for revealing the mental processes that underlie preferences and choices.

There are many societies and organizations dedicated to studying and improving decision making, such as the Society

for Judgment and Decision Making (www.sjdm.org) and the Decision Analysis Society (<http://www.informs.org/Community/DAS>). Decision making is also sometimes studied within particular professional domains, such as business or medical decision making. For example, the Society for Medical Decision Making (www.smdm.org) is an interdisciplinary group of academicians (health economists, psychologists, and others) and health professionals. These societies hold annual meetings and publish journals.

History: Expected Value, Expected Utility, and Prospect Theory

Psychophysical Approaches: Translating Reality into Perceptions

From mathematics to economics

An early decision rule compared the expected values of options. The expected value is calculated as the outcome value multiplied by the probability of that outcome (e.g., a 0.5 probability of winning \$10 is equivalent to winning \$5 for sure, with 1.0 probability, because $0.5 \times \$10 = \5). In the 1700s, Daniel Bernoulli suggested that the utility or personal value of wealth is not simply its monetary value. He suggested that the value of an additional quantity of money (say, \$100) is less for people who start out with more money. An extra \$100 means more to a starving student making \$9000 a year than it means to a successful executive making \$900 000 a year. This idea of declining marginal utility or diminishing returns was captured with a logarithmic function. In other words, utility of additional money does not increase linearly with increasing

wealth, but falls short increasingly as the magnitude of wealth increases. Thus, expected utility, not expected value, was thought to govern decision making.

Expected utility was mainly used by economists to study the behaviors of buyers and sellers. As with expected value, if a decision maker makes choices consistently based on maximizing expected utility, his or her total wealth will be higher (compared to choosing inconsistently or not choosing so as to maximize utility). The idea that choices should be made consistently has been formalized in terms of certain axioms or rules of coherence. Debate continues to this day about which axioms are the most fundamental. For example, the axiom of transitivity holds that if someone preferred A to B and preferred B to C, then the person must prefer A to C. Another axiom called invariance means that if two options have the same consequences, then individuals should show equal preferences for those options.

For most people, the expected utility of a sure bet exceeds the expected utility of the gamble that offers the same expected payout; in other words, people are typically risk averse. Given a sure option of winning \$1000 versus a gamble option that offers a 0.50 probability of winning \$2000, most people will prefer the sure option. (In the rare event that a person is risk seeking, he or she should prefer the fair gamble of equal expected value to the sure bet.) The more common preference for \$1000 can be explained by Bernoulli's decreasing marginal utility of money. Alternatively, various other models attempt to explain it. In expected utility theory, a given utility is reference independent; that is, utility does not depend on the description of the options. Expected utility theorists assumed that people were rational, meaning that they maximized expected utility, obeying axioms of internal coherence, and therefore had consistent preferences for risk. Subsequent research, however, suggests that decisions are based on the decision maker's initial frame of reference.

Prospect theory

In the late 1970s, Daniel Kahneman and Amos Tversky challenged the rational view of decision making. They introduced prospect theory, which was based on psychological research indicating that individuals are not consistently risk seeking or risk averse. Rather, individuals interpret gains and losses relative to a reference point, which is usually the status quo (e.g., the amount of money that they have initially). People tend to be risk averse for gains relative to the status quo (money won) but risk seeking for losses relative to the status quo (money lost). For example, imagine that you were given \$2000, but you had to then choose between two options: losing \$1000 for sure or gambling on a 0.50 probability of losing \$2000 and a 0.50 probability of losing nothing. In response to this problem, which describes the options in terms of losses relative to an original sum, most people prefer to gamble (they are risk seeking). Of course, once you subtract your losses from the \$2000 you were initially given, you are facing exactly the same options as in the previous paragraph, where the options were described as gains to an original sum. However, whereas most people prefer the gamble in the loss problem, they tend to prefer the sure option in the gain problem. In light of this result, Kahneman and Tversky proposed an alternative theory of risk in which utility is based on changes in

wealth rather than absolute states of wealth. This new theory was called prospect theory.

The prospect theory model looked like an S curve; it was concave in the first quadrant (representing gain) and convex in the third quadrant (representing loss). Crucially, the slope of the loss function was steeper than the slope of the gain function, indicating that people place a higher value per unit on loss than they do on gain. That is, people are more upset about losing something than they are happy about gaining the identical amount. This asymmetry between losses and gains is called loss aversion.

Prospect theory fits some hard-to-explain data such as the endowment effect, in which people require more money to give up something they already have than they are willing to pay to get the identical object. This effect is also explained in terms of loss aversion. For example, in one study, subjects were randomly assigned to be buyers or sellers. Sellers were given a coffee mug valued at \$6 and were asked whether they were willing to sell their mugs at a range of prices between \$0.25 and \$9.25. Buyers were not given mugs and were asked whether they were willing to buy mugs from the sellers at the same range of prices. The results of the study demonstrated that sellers consistently valued the mugs higher (\$7.12 on average) than the value the buyers (\$2.87) were willing to pay for the mugs. In some cases, the sellers preferred to keep their coffee cups, rather than to sell them. People are often unwilling to give up what they have to get something else that they might otherwise prefer because a loss has a greater psychological impact than a gain.

Framing

Frames are ways of describing choices. In the example above in which \$2000 is given initially and then dollar amounts are subtracted, the options are described in terms of losses. In an earlier example, the same options were described in terms of gains. Despite being objectively identical, the two versions of the choices are not psychologically equivalent because they result in different preferences for risk (i.e., preferring risk in the gain frame but avoiding risk in the loss frame). Different decision making theories offer alternative reasons as to why frames result in inconsistent preferences, even in the same individual. According to prospect theory, the distortion in the psychological value of gains contributes to perceiving the gamble outcomes (which are larger) as discounted relative to the sure outcomes (which are smaller). The same types of distortions for losses make the losses seem smaller in the gamble than in the sure option. More recent findings have cast doubt on the generality of the prospect theory explanation, although the explanation holds in some circumstances.

There are individual differences in susceptibility to framing effects. For example, framing has been shown to interact with numeracy (the ability to understand and use numbers). The more people understand numbers and probabilities, the less likely they are to shift preferences when numerically identical options are presented. This interaction between framing and numeracy has been obtained with what is called attribute framing, in which the same attribute is described in different but objectively equivalent ways (e.g., test performance is described as 80% correct vs. as 20% wrong) as opposed to risky choice framing as in the examples discussed earlier.

It suggests that people high in numeracy might notice the numerical equivalence of the options by spontaneously converting positively framed attributes into negatively framed attributes, and vice versa, because they are good at such computations. People who score higher on the cognitive reflection test also show less of a framing effect. The cognitive reflection test is a three-item math test in which intuitive answers are wrong and need to be overridden by correct analytical processes.

Contemporary Approaches

Global Models

Global models, in contrast to dual-process models, assume that one or more sets of processes (i.e., a single system) govern decision making. Many resemble the traditional psychophysical approaches already discussed (e.g., expected utility theory and prospect theory). Some recent global models, for example, add multiple reference points in addition to the status quo. New global models include memory theories, such as Query Theory, which predicts a wide range of effects based on the order in which memory is queried or interrogated. For example, asymmetries in buying and selling prices can be predicted by the order in which buyers and sellers think of reasons to have the good versus reasons to have the money. Whichever set of features is retrieved first tends to inhibit the set of features that is retrieved second, producing preference reversals when the order of retrieval is varied.

Standard Dual-Process Theories

Sigmund Freud proposed an early dual process theory on which some contemporary theories are based (e.g., Seymour Epstein's cognitive experiential self theory). According to Freud, primary and secondary processes designated two opposed yet complementary models of psychic functioning. The primary process is driven directly by one's basic needs and serves the pleasure principle without inhibition. The secondary process, in contrast, is the intervening rational system of control and regulation that functions in service of the reality principle. Contemporary dual-process theories similarly posit two opposing processes, one more visceral and the other more reflective. These processes are often called System 1 and System 2, respectively.

System 1 and System 2

There are some judgments that are formulated upon reflection, based on systematic and calculative operations of decision making. Alternatively, there are decisions that are made quickly and automatically. Dual-process theories suggest that at different times, responses can reflect the operations of either the fast, automatic, and intuitive System 1 or the slower, serial, and rule-governed System 2, as they were labeled by Keith Stanovich and Richard West. Because System 1 is faster than System 2, intuitive impressions can outrace rational deliberation, producing wrong or biased responses that would be censored on reflection.

In contrast to System 1, System 2 is conscious and effortful. For example, when cognitive load is high (e.g., people have a lot of information they have to keep in mind), people may revert to System 1 thinking because it is less effortful. System 1

is a source of errors, biases, and fallacies in decision making, although it does not necessarily result in poor performance.

Some standard dual-process theories make slightly different dual-process distinctions. For example, some dual-process theories contrast associative (mindless associations) versus rule-based (mindful rules, such as logic) thinking, others contrast concrete experiential thinking with rational analytical thinking (as in the cognitive experiential self theory of Seymour Epstein), and still others contrast affect (or emotion) and cognition (or rationality).

Affect versus cognition

In standard dual-process approaches, as in Freudian dualism, when people use affect or emotion to make decisions, their thinking is illogical, irrational, or quantitatively inaccurate. For example, relying on affect, people will donate more money to save one starving child than to save eight starving children. It is suggested that portraying a single child stirs stronger emotions than portraying a group; the former seems more personal, whereas the latter seems like a statistic. Thus, the single child elicits more donations. Paul Slovic has suggested that these processes are implicated in the insensitivity that people seem to have to genocide.

This approach has also been called the dual-process valuation model. This model posits that people assess the value of a target in different ways, namely by affect (i.e., valuation by feeling) or by analytic cognition (i.e., valuation by calculation). In one study, participants were asked how much they would be willing to pay for a bundle of either five or ten Madonna CDs. Subjects in the valuation-by-calculation conditions performed mathematical calculations prior to pricing the CDs. They were willing to pay more (on average) for ten CDs than for five CDs. Subjects in the valuation-by-feeling condition engaged in activities designed to generate emotions. The latter group reported no difference in the amount they were willing to pay for ten CDs versus five. In all of these approaches, emotion is expected to flatten the discrimination of quantity (e.g., perceptions of the numbers of CDs) so that it is more distorted away from linearity.

Fuzzy-trace theory

Approaches to rationality differ and include Piagetian logicism (thinking as logic), information-processing formalism (thinking as computation), and intuitionism (thinking as intuition, as exemplified in fuzzy-trace theory). The core assumptions of fuzzy-trace theory are rooted in research on memory, judgment, and decision making, and they take into account the social, cognitive, affective, and developmental factors involved in decision making. According to fuzzy-trace theory, people encode multiple mental representations of their experience at the same time. These representations range in specificity from low (gist representations) to high (verbatim representations). A gist representation is a fuzzy impression of the general meaning of information or experience, supporting intuitive thinking. A verbatim representation is a mental representation of exact details, supporting precise analysis. These assumptions are required in order to account for specific counterintuitive and seemingly contradictory results.

Intuition in fuzzy-trace theory is defined as fuzzy, impressionistic thinking using vague gist representations.

Thus, mindless impulsive reaction (e.g., System 1 in standard dual-process models) is distinguished from insightful intuition that reflects understanding (e.g., gist in fuzzy-trace theory). In other words, there are two kinds of fast and simple ways of thinking: a stupid kind that represents the most primitive form of thinking (e.g., System 1) and a smart kind that represents the highest form of thinking, insightful intuition (i.e., gist). In the foundations of mathematics (i.e., the basic assumptions of the field), mathematical intuition is characterized as a similarly advanced form of thinking.

Fuzzy-trace theory draws on evidence for independent gist (basic meaning) and verbatim-memory (exact detail) representations of information, but it differs from other dual-process models in emphasizing that there are degrees of rationality and that intuition is an advanced form of reasoning. Such claims are based on empirical evidence about the development of reasoning (e.g., evidence comparing reasoning by children and adolescents to that of adults and reasoning of adult novices to that of experts). Research has supported the theory that children's cognitive processes progress from detail-oriented computational reasoning to more intuitive processing: in other words, people process less information more categorically and qualitatively with age. Similar predicted trends were found among experts versus nonexperts. For example, Valerie Reyna and colleagues found that expert cardiologists processed fewer dimensions of information than less expert physicians when deciding whether to admit patients with chest pain to the hospital. Crucially, experts were able to identify the few most influential factors and focus on those in order to make faster and more accurate decisions.

The theory also predicts parallel development of verbatim-based analysis and gist-based intuition, which produces developmental reversals (e.g., children outperform adults) under specific circumstances. As an example, despite increasing competence in reasoning, some biases in decision making grow with age, producing more 'irrational' violations of coherence among adults than among adolescents and younger children. The latter phenomena are linked to developmental increases in gist processing with age. The first framing study in children was conducted to test predictions of fuzzy-trace theory. As predicted, framing effects actually increased from childhood to adulthood, as do other biases that rely on semantic gist. With greater experience and knowledge, decision making is predicted to become more simple and straightforward, that is, based on gist.

These developments have implications for health and well-being, especially regarding adolescent risk taking. Fuzzy-trace theory has been applied to understanding how risk taking changes from childhood to adulthood. In particular, adolescence is a period of vulnerability to risk taking and poor decisions, vulnerabilities that only increase bad outcomes in young adulthood when parental supervision lessens. Surprisingly, across many domains of problem behavior, adolescents who take risks engage in more verbatim-based analysis, but risk avoiders use gist-based intuition.

Fuzzy-trace theory, therefore, differs from other dual-process approaches in three respects. First, intuitions are considered an advanced form of reasoning. Developmental research on children's learning and on expert decision making supports this view.

Second, in addition to inculcating the bottom line meaning of an experience, gist representations also incorporate emotion, including valence (positive/negative; good/bad), arousal (high/low), and feeling states. Emotion can color the interpretation of a stimulus (i.e., its gist), especially when the stimulus is ambiguous. In particular, emotion influences the encoding of stimuli (i.e., how the choice is represented), the retrieval of values and principles, and the implementation of values and principles (i.e., their application to option representations). Research supports the claim that decisions about risk made in the presence of emotion are different from those made in its absence.

Third, fuzzy-trace theory provides specific predictions about rationality that contradict predictions made by standard dual-process and other theories. Most notably, fuzzy-trace theory predicts framing effects, but under a theoretical justification different from that provided by prospect theory. In addition, some effects predicted by fuzzy-trace theory cannot be predicted by prospect theory. According to fuzzy-trace theory, invariance is achieved through gist processing because decision making is based on the substance of information rather than on superficial details.

Subjective understanding: Construal level theory

Drawing on fuzzy-trace theory as well as other approaches, construal level theory posits that people can have two different subjective interpretations (construals) of the same event: abstract and concrete. Moreover, each type of construal affects decisions differently. High-level construals, like gist representations, are broad, abstract generalizations that capture the central immutable features of an event and that help generate the event's general meaning. Low-level construals, in contrast, are like verbatim representations in that they consist of multiple, narrow, concrete categorizations that direct attention to the details of an event. The concept of psychological distance is measured by construal level, such that low-level construals are psychologically proximal (close) and high-level construals are psychologically distal (far).

Construal level theory predicts that, as psychological distance increases, detailed information from that event becomes less accessible, less accurate, and less reliable, whereas the overall understanding becomes more abstract. For example, in one study that tested high-level versus low-level construals, individuals were asked to imagine a set of scenarios (e.g., a camping trip or a friend's visit to NY) that would occur in either the proximal or distant future. For each scenario, participants grouped a set of related objects (e.g., a snorkel or a tent) into as many conceptual piles as they deemed appropriate. In line with the research hypotheses, people in the high-level construal group (i.e., those who received the distal cue) created fewer piles with broader, more abstract criteria than did the low-level group (i.e., those who received the proximal cue). Research based on construal level theory suggests that people are often overly optimistic about choice options in the future because such events are represented in an abstract (high-level) manner and are not readily accessible for cognitive processing at a concrete (low) level.

Construal level theory also makes predictions about temporal discounting, which is the phenomenon in which people devalue (i.e., discount) outcomes that will occur in the future.

For example, people are willing to pay the retail price for a computer they can take home immediately, but they expect a discount if they have to wait for it. Research on temporal discounting reveals that, faced with the choice between receiving a small reward now and receiving a larger reward received 2 weeks from now, most people opt for the immediate reward. However, when both options involve a delay (e.g., receiving the reward 2 weeks from now vs. 4 weeks from now), preferences reverse in favor of the larger reward. In both examples, the options differ by the same amount of time (2 weeks); so, the reversal of preferences suggests a categorical difference in the way people value (construe) rewards that are available immediately versus those they must wait for.

Research combining temporal discounting and construal level theory tested how high- versus low-level construals affect patience and self-control. Results over a series of experiments demonstrated that people who used high-level construals showed greater optimism about their future choices, greater physical endurance over time (indicated by their ability to squeeze a handgrip longer), and more self-control (indicated by their preference for larger delayed rewards over smaller immediate rewards) than did people who used low-level construals.

According to construal level theory, different aspects of a reward's desirability are more salient (i.e., cognitively accessible) at different delays. Specifically, for decisions about the present, low-level, specific, and concrete features such as practicality should be most influential. In contrast, for decisions about the distant future, high-level, abstract, and broad features, such as compatibility with one's ideal self, should be most influential. Accordingly, different decisions should be attractive at different delays. Decisions whose low-level value outweighs their high-level value should be more attractive in the short term. Decisions whose high-level value outweighs their low-level value should be more attractive in the long term.

One experiment that tested how different construals affected self-control asked participants, "Right now, if you had to choose between an apple and a candy bar, which would you choose?" Subjects who preferred apples were defined as having greater self-control in relation to dieting goals. After a pretest activity that primed participants to either a high-level or a low-level construal condition, the study showed that people in the high-level construal condition chose apples over candy bars more often than did those in the low-level condition. This suggests that high-level construals support greater self-control. By changing the cognitive construals that research subjects used, researchers were able to alter the nature of temptation impulses. Construal level theory, therefore, has implications for reducing impulsive decision making.

Emotional Influences on Decision Making

Emotions as Content in Decision Making

Affective or emotional processes have received increasing emphasis in models of decision making. Affect cannot be reduced to only valence (good–bad) and intensity. The appraisal of affect, how it is interpreted, also depends on the situation and the specific emotion that is elicited. Specific emotions are associated with specific action tendencies (e.g., fear with

the action of escaping). For example, risk taking has been shown to be influenced by affect; people experiencing anger or happiness tend to be risk taking, whereas people experiencing fear or sadness tend to be risk averse. Positive emotions result in approach (i.e., increases in the value of associated options), but negative emotions result in avoidance (i.e., decreases in the value of associated options). General feelings of arousal can affect the choices being made even when the choices did not actually generate the feelings. For example, men who were aroused by pictures of attractive women were more likely to choose a sooner smaller amount of money relative to a later larger amount of money. Economists describe this as impatience and psychologists describe it as impulsivity.

Emotion: Supporting or Derailing Adaptive Decisions

Emotions can impair judgments, preventing goal attainment by increasing susceptibility to environmental temptations. However, emotions also provide clear evolutionary advantages to decision making, despite their ability to interfere with higher-level thinking. For example, the intrusion of emotion on attention, which can interrupt goal-directed behavior, is important in supporting the ability to detect and attend to urgent threats. Emotional stimuli are detected more quickly than are neutral stimuli, and people can maintain their focus better on emotional relative to neutral stimuli in the presence of distracters.

Affect as information

Affective signals can, consciously or unconsciously, facilitate memory of past rewards and aversive experiences, compressing this knowledge into a quickly accessible format. This is advantageous to rational decision making because analytical attempts to reason through all relevant past experiences would require a prohibitive amount of time and working memory capacity. In this way, emotional or affective signals automate the application of knowledge from past situations to current situations without straining cognitive resources. Consistent with this helping role of emotion is that, per fuzzy-trace theory, gist-based evaluation of risk leads to more adaptive decisions and increases with both age and expertise.

Common currency

Emotional and affective reactions to different types of stimuli, both primary (e.g., food, sex, or drugs) and secondary (e.g., money or gambling chips), provide a way to assess the relative value of disparate items on a single scale of subjective value. Affective reactions can be used to evaluate current options against counterfactual scenarios, past experiences, and imagined future rewards or punishments (although such imagined rewards are subject to temporal discounting).

Affective priming, mood congruency, and misattribution

In affective priming, an initial stimulus induces a mood that persists and affects the evaluation of the second stimulus in a valence-consistent manner. Subjects who experience a negative mood in response to an initial stimulus often misattribute the negative mood to the second stimulus. Even after the experimenter alerts subjects to the alternate explanation (i.e., that the

first stimulus, not the second, induced the negative mood), subjects persist in their negative evaluations of the second stimulus. Mood congruency is similar to affective priming except that the subject's incidental emotions, rather than a reaction to a prior stimulus, are what color the evaluation of a novel stimulus in a manner consistent with the subject's preexisting mood state.

Impulsivity and the Somatic Marker Hypothesis

Physiological cues of emotional state

One emotion-based model of decision making is the somatic marker hypothesis, according to which decision making in normal individuals is guided by emotional states produced by bioregulatory processes. For example, while playing a gambling card game, normal subjects develop a measurable physiological (skin conductance) response in anticipation of risky outcomes. Drug addicts and people with damage to the frontal lobe of the brain fail to create an anticipatory skin conductance response before drawing a card from a risky deck, and some researchers take this to suggest that their impaired emotional function and suboptimal decision making are connected via an altered physiological response to risk.

The Neuroscience of Decision Making

Measurement Techniques

Neuroscientific models attempt to identify the brain mechanisms that are associated with reasoning. Recent technology has developed methods for correlating neural (i.e., brain) activity with different types of thinking. These techniques include functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and electroencephalography (EEG). Additionally, diffusion tensor imaging (DTI) and magnetic resonance imaging (MRI) are used to infer structural differences or developmental changes in brain regions. Although decision making is one of the most extensively investigated areas using these new techniques, it is important to understand the limitations of the inferences that may be drawn from such studies. Results associating brain activity with decision making are correlational; that is, although brain activation may co-occur with certain behaviors, there is insufficient evidence to infer a causal relationship. Nonetheless, techniques such as fMRI, PET, EEG, and DTI have the potential to greatly inform models of decision making.

Brain Regions

The integration and evaluation of information from memory, emotional cues, and sensorimotor stimuli is thought to occur in the lateral prefrontal cortex and parts of the anterior cingulate cortex. These regions, dubbed areas of executive function, relate to critical decision making behaviors, such as inhibiting unnecessary or goal-defeating information, planning ahead, and contemplating risks and rewards.

Areas including the amygdala, nucleus accumbens, and medial prefrontal cortex are implicated in the processing of salient social information, such as faces, attractiveness, and other social judgments. Whereas the orbitofrontal cortex is associated with simple emotional reactions such as fear, there

is evidence of selective activation of the anterior cingulate cortex when considering the outcome of a decision requires assessment of another person's attitude or behavior. For example, the anterior cingulate cortex is active during cooperation and trust games and is associated with better memory for social versus nonsocial information. Since most real-life decisions occur in a social context, this is an important component of the decision making network.

Reward and Incentive

Another component of social and emotional decision processing is how much the individual values the reward that is likely to result from a particular decision. Research suggests that activity in the nucleus accumbens is linked to reward sensitivity. Further, dopamine, a neurotransmitter implicated in learning and reward, is concentrated in the nucleus accumbens and has been strongly associated with reward-related behavior.

Incentive salience

Dopamine is not thought to be essential to the intrinsic evaluation of a reward. Rather, its function is thought to lie in the connection between that reward and the action (or series of actions) necessary to obtaining it. The association of motivational (reward) value with a behavior is called incentive salience, or value binding. The generation and execution of a reward-oriented action plan is associated with activity in the dorsal striatum. The processing of the magnitude of the reward obtained from an action, particularly if it differed from the expected reward, is associated with activity in the anterior cingulate cortex and ventral tegmental area.

Reward-prediction-error hypothesis

Some researchers have found evidence that changes in the pattern of dopamine release in the ventral tegmental area of the brain reflect the difference between the expected and the actual reward obtained for a given behavior. These phasic surges form a record of reward prediction accuracy. Thus, if a reward is better than expected, there is a burst of dopamine, which indicates a positive reward-prediction error. If a reward is worse (i.e., either less valuable or more aversive) than expected, there is a pause in the pattern of dopamine release, indicating a negative reward-prediction error. Baseline-level dopamine activity indicates that the reward was as expected. Thus, the difference between what you got and what you thought you would get (i.e., the reward-prediction error) is thought to be recorded in the brain by corresponding increases or decreases in dopamine release. The reward-prediction-error hypothesis, supported by evidence from rodents and primates, is thought to describe the way people learn the association between a particular action and the magnitude and desirability of the consequence.

Risk Taking in Adolescence

Adolescents are widely assumed to make riskier decisions than either children or adults. This phenomenon is not explained by theories of decision making that assume that the capacity for rational decision making increases linearly with age, prompting attempts to explain this developmental incongruity. Two classes of explanations have emerged.

Developmental asymmetry

One hypothesis posits that two brain networks important in decision making develop at different rates and that, during the period when one is more mature than the other, adolescents are less able to make adaptive decisions. Some researchers attribute adolescents' proneness to risky decision making to a developmental asymmetry between the socioemotional system (located in limbic areas of the brain), which matures earlier and determines reward sensitivity, and the cognitive control system (located in the prefrontal cortex), which matures later and governs planning and inhibition. According to this account, over the course of development, the functional connectivity of these two regions improves. As a result, it is thought to be the reliance on affect over cognition in adolescence and a deficit in connectivity between areas of emotional processing and areas of cognitive control which cause this group's proclivity for risky decision making. Naturally, brain anatomy and connectivity are thought to be important in risky decision making, but the details of this mechanism are far from established.

Gist versus verbatim processing

Adolescents do not, as many believe, underestimate risks or consider themselves to be invincible. Converging data show that they tend to overestimate risk and often overestimate their vulnerability to negative outcomes. Adolescents possess the basic cognitive capacities to distinguish risky from riskless decisions; their deficiency lies in overanalyzing the situation – that is, in tending to favor calculative over gist-based decision making when it comes to risk. In terms of fuzzy-trace theory, adolescents tend to use verbatim processes more often than do adults (who use gist processes) to make decisions involving risk.

As an example, consider the proposition to play Russian roulette with a six-chamber gun for a gamble of 6 million dollars. In Russian roulette, a gun is loaded with only one bullet and fired to the player's head. If the chamber containing the bullet comes up when the trigger is pulled, the player dies. Otherwise, one of the empty chambers comes up, and the player wins the money. Gist and verbatim thinking result in drastically different approaches to the proposition to play Russian roulette.

A verbatim thinker will calculate the expected reward of the risk, that is, the desired outcome weighted by the probability of attaining that outcome. In this example, this means that there is a five-sixths chance of winning a 6 million dollar prize, which equals an expected reward of 5 million dollars. Given this high expected reward, a verbatim thinker might accept the risk and play the game. By choosing to play, the verbatim thinker elects to take a risk that has a potentially disastrous outcome (i.e., death) so long as there is also the chance for a very high reward. Verbatim thinkers do factor in the high negative value of death; however, there is a price that can be paid that will compensate for it.

To the contrary, a gist thinker will extract the bottom-line meaning from each option. Since the bottom line of Russian roulette is that you could die, gist-based thinkers will refuse to play, no matter what the potential reward is, because the negative outcome is catastrophic. Gist thinkers are able to tolerate a small chance of death for necessary risks (such as crossing the street) but not for unnecessary ones (like having unprotected sex).

According to multiple experiments, adolescents tend to approach risky decisions with verbatim-based analysis, whereas adults take a gist-based approach to the same risk. Studies of real-life risk taking also are consistent with this view; adolescents' perceived risks and perceived benefits predict self-reported risk taking (e.g., substance use), in contrast to hypotheses that such behavior is mainly impulsive and unintentional.

The better decision outcomes associated with gist-based thinking suggest that intervention programs should foster this type of thinking. The idea that risk taking tendencies cannot be altered, nor outcomes improved, because of the immaturity of brain development has been falsified by the effectiveness of gist-based and other educational programs. As a result, intervention programs might do best to shelter younger adolescents from opportunities to engage in risky behaviors, given that they are not fully equipped to make healthy decisions, but to instruct older adolescents in better decision making skills. Recent evidence supports the efficacy of this approach.

Summary

Although scholars continue to debate key aspects of the decision making process, theories have historically shifted from single-process and psychophysical approaches to a variety of dual-process approaches. Current dual-process models such as fuzzy-trace and construal level theories are based on evidence that people mentally encode multiple representations of the same event, and cuing different representations can result in different decisions. This observation is especially relevant in the area of risk taking among adolescents; in particular, adolescents who trade off risks for rewards seem to take more risks than do those who take a categorical stance of avoiding unnecessary risk. Current theories also account for the complex role of emotion in the decision process, acknowledging that this influence is sometimes beneficial and sometimes detrimental. Recent neuroscience research has produced neural hypotheses about several phenomena, including reward valuation and cognitive control. As future research explores synergies between behavioral psychology and behavioral neuroscience, theories from both realms should be mutually constraining.

See also: Addictions and Adolescence; Adolescence; Brain and Behavior Relationships; Brain Chemicals: Global Projections of Ancient Aromatic Neurotransmitters; The Brain; Cognitive Bias; Memory; Neurotechnologies; Uncertainty.

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Relevant Websites

- <http://www.informs.org/Community/DAS> – Decision Analysis Society.
www.sjdm.org – Society for Judgment and Decision Making.
www.smdm.org – Society for Medical Decision Making.

Defense Mechanisms

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The boundary between pathology and adaptation is ambiguous. Whereas early nineteenth-century medical phenomenologists viewed pus, fever, pain, and coughing as evidence of disease, late nineteenth-century pathophysiologists learned to regard these symptoms as evidence of the body's healthy efforts to cope with physical or infectious insult. Similarly, defense mechanisms (often termed involuntary coping mechanisms) produce behaviors that appear pathological but in fact reflect the brain's homeostatic effort to cope with sudden changes in its internal and external environment.

In 1856, Claude Bernard, a French physiologist and a founder of experimental medicine, started us on our understanding of adaptation to stress when he wrote, "We shall never have a science of medicine as long as we separate the explanation of the pathological from the explanation of normal, vital phenomena." Put differently, it is not stress that kills us as much as the homeostatic, often seemingly pathologic, response to stress that permits us to survive.

In 1925, Adolph Meyer, a founder of modern American psychiatry, asserted that there were no mental diseases; there were only characteristic reaction patterns to stress. Meyer's point was that although adaptive mental 'reaction patterns' like denial, phobias, and even projections can appear to reflect illness, they may in fact be 'normal, vital phenomena' related to healing. Just as immune mechanisms and clotting mechanisms heal by distorting bodily equilibrium, defense mechanisms heal by distorting mental processes.

Of course, the symptoms of organic brain damage usually reflect disease and not adaptation. Manic-depressive psychosis is due to a genetic defect; the mental devastation produced by alcoholism is due to poisoning; and the negative symptoms of schizophrenia reflect brain pathology and not adaptation. Nevertheless, much of the so-called mental illness, including some delusions and hallucinations, makes the disruption of disordered brain function easier to bear; and defenses are often analogous to the healthy, but red, hot, and tender swelling – the rubor, color, dolor, and turgor – that immobilizes a fracture so that it may heal.

Much of what is called mental illness in our diagnostic nomenclature – the symptoms of many anxiety disorders, some depressions, and most personality disorders – is the outward manifestation of homeostatic struggles to adapt to life. Admittedly, analogous to acne and autoimmune disease, such reaction patterns often reflect rigid, poorly modulated, and pathologic efforts at adaptation.

Norman Sartorius, the director of the Division of Mental Health of the World Health Organization, wrote,

Research during the past two decades failed to provide evidence that could help to create disease concepts and disease entities in psychiatry . . . Other ways of thinking about health and disease, mind and body, mental and physical, individual and social are needed. . . I believe that in selected instances a return to the allegedly outdated Meyerian reaction patterns and Freudian Defense mechanisms is warranted.

Defense mechanisms are patterns of emotions, thoughts, or behaviors that are relatively involuntary. They arise in response to perceptions of psychic danger or conflict to unexpected change or threat in the internal or external environment or in response to cognitive dissonance. Defense mechanisms obscure or diminish cognitive, emotional, and physiological response to stress that if unmitigated would give rise to depression, anxiety, or impulsive behavior. There is increasing evidence that choice of defensive styles makes a major contribution to individual differences in response to stressful environments. Consider the differing response of individuals riding on a rollercoaster that range from severe anxiety to stress relieving excitement.

Defense mechanisms can alter our perception of any or all of the following: subject (self), object (other), idea, or feeling (affect). Defenses alter the relationship between *self* and *object* and between *idea* and *affect*. In projection, for example, 'I hate him' becomes 'He hates me.'

The task of homeostatic mechanisms, in general, is to buffer sudden change. The task of the defenses is to buffer sudden change in the four 'lode stars' of mental conflict. These lode-stars are relationships, emotions, conscience, and reality. The use of defense mechanisms usually alters perception of both internal and external reality, and often, as with hypnosis, the use of such mechanisms compromises other facets of cognition (Figure 1).

Thus, defenses can mitigate sudden unresolvable conflict with important people, living or dead. Defenses serve to keep affects and ideation within bearable limits during sudden changes in relationships, such as following the unexpected death of a loved one. People become a lodestar of conflict when we cannot live with them and yet cannot live without them; as people exist within us as well as without, internal representations of important people may continue to haunt us and to cause conflict for decades after we have ceased to live with them and thus evoke defensive behavior. Ghosts, ancestor worship, and demonic possession would be such examples.

Defenses can deflect or deny sudden increases in emotions and biological instinct, such as heightened sexual awareness and aggression during adolescence. Psychoanalysts call this lodestar of conflict 'id,' fundamentalists call it 'sin,' cognitive psychologists call it 'hot cognition,' and neuroanatomists point to the hypothalamic and limbic regions of brain.

Defenses enables individuals to mitigate sudden upsurges in conscience or guilt such as might occur for a doctor faced with a malpractice suit. Psychoanalysts call it 'super ego,' anthropologists call it 'taboos,' behaviorists call it 'conditioning,' and neuroanatomists point to the frontal lobe and the amygdala. This lodestar is not just the result of admonitions from our parents that we absorb before age five, but is formed by our whole identification with our culture, and sometimes by irreversible learning resulting from overwhelming trauma.

Finally, defenses allow individuals a period of respite to master reality, such as the events surrounding 9/11 or changes

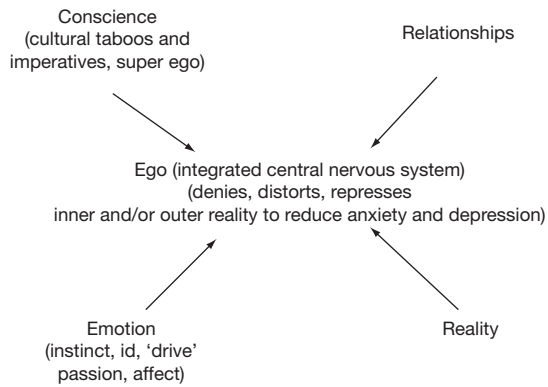


Figure 1 The four sources of intrapsychic conflict.

in self-image that cannot be immediately integrated, as might result from an amputation, or a promotion. Such involuntary mental mechanisms can provide a mental time out to adjust to sudden changes in *reality* and self-image, which cannot be immediately integrated. Sudden good news – the instant transition from student to physician or winning the lottery – can evoke involuntary mental mechanisms as often as can an unexpected accident or a diagnosis of leukemia.

Sudden change in any of the four lodestars produces depression, anxiety, or impulsive disorder. Involuntary ‘denial,’ ‘distortion,’ or ‘repression’ of the lodestars mitigates such dysphoria. However, used indiscriminately, terms like *repression* and *denial* lose the explanatory power of the conceptual scheme – ego mechanisms of defense.

A final reason for paying attention to defenses can be illustrated by the internist’s understanding of *referred* pain. A pain in the right shoulder may reflect an inflamed gall bladder; a pain in the left shoulder may reflect coronary thrombosis. Proper diagnosis depends upon the internist’s seeing behind a symptom often identified as arthritic. By understanding that a function of much of the psychopathology is to distort, displace, and deny the conflict, we learn not to take psychological symptoms too literally. In short, defenses provide a diagnostic template for understanding the distress and for guiding the clinical management of psychology’s most ‘unreasonable’ and baffling clients.

At first, the observer may call the user of a defense stupid, then wicked, and then mentally ill. All such responses are as useless as scolding a child for sneezing. Yet, we can neither condemn a tubercular patient for coughing nor ignore the internal disorder that it portends. Similarly, we must neither condemn the lawful eccentricities of the ego’s mechanisms of defense as sins nor dismiss them as mere chance events. As with the cough of the consumptive, attention must be paid to the odd behaviors of people with emotional disease.

It is important to place defense mechanisms within the broader framework of stress and coping. Psychopathological response to stress may be considered from two perspectives. The first perspective emphasizes relatively nonspecific psychophysiological responses to stress, such as an elevated Hamilton depression scale or elevations in blood epinephrine levels. This is the perspective of Hans Selye and other phenomenologists. Stress kills. The second perspective focuses on how an individual’s integrated central nervous system perceives and copes with the stressor. In this case, the result of stress is

seen not as nonspecific depression and anxiety but as highly differentiated synthetic behaviors that may range from arcane delusional systems to the writing of a great novel. What does not kill us makes us stronger. This second perspective, that of ego psychology, is the orientation of this article.

If stress can be viewed from two vantage points, coping responses to stress can be viewed as divided into three broad categories. The first coping category involves eliciting help from appropriate others, for example, by mobilizing social supports. The second coping category involves voluntary cognitive efforts like information gathering, anticipating danger, and rehearsing responses to danger. The third coping category entails deploying involuntary adaptive mechanisms or automatic psychological processes that protect the individual from the disorganizing effects of internal or external dangers or stressors. These coping processes are often subsumed under the psychoanalytic term *ego mechanisms of defense*.

The first class of coping mechanisms, seeking social support, is analogous to calling 911 in response to one’s own bleeding. The second class, cognitive coping strategies, can be taught and rehearsed; they are analogous to consciously using a tourniquet to stop one’s own bleeding. The third class of coping mechanisms, the involuntary defense mechanisms, are analogous to depending upon one’s own very complex and quite involuntary clotting mechanisms in order to stop bleeding.

Freud’s Discovery of the Concept of Defense

Perhaps, Freud’s most original contribution to human psychology was his inductive postulation that unconscious ‘defense mechanisms’ protect the individual from painful emotions, ideas, and drives. In delineating the nature of ego mechanisms of defense, Freud established not only that upsetting *affects*, as well as *ideas*, underlay psychopathology, but also that much of what is perceived as psychopathology reflects a potentially healing process.

That emotions were significant to humans had been known since ancient times, but our understanding of their modulation through unconscious mechanisms of defense, rather than will-power, originated with Sigmund Freud, who was trained in both neurology and physiology.

It was difficult to develop a concept of defense, however, until psychology could imagine that ideas gain their color, temperature, and importance from emotion. For example, the influential textbooks of the two greatest psychologists of the nineteenth century, Wilhelm Wundt and William James persisted in discussing a psychology that consisted of only cognition, not emotion. Psychology needed to replace neutral terms like intellect, will, moral sentiment, higher feelings, and cognition with terms suffused with emotional color, for example, sadness, lust, rage, and guilty fantasy. From the beginning, Freud’s work effected this change. In 1894, Freud observed that not only could affect be ‘dislocated or transposed’ from ideas (by the mechanism that Freud would later call isolation) but also that affect could be ‘reattached’ to other ideas (i.e., by displacement).

Over a period of 40 years, Freud discovered most of the defense mechanisms that we speak of today and identified five of their important properties.

(1) Defenses are a major means of mitigating the distressing effects of both emotion and cognitive dissonance. (2) They are unconscious. (3) They are discrete from one another. (4) Although often the hallmarks of major psychiatric syndromes, defenses are dynamic and reversible. (5) Finally, they can be adaptive, even creative, as well as pathological. To this list must be added that to the user defenses are invisible, but to the observer defenses usually appear odd.

Unlike most of the defense mechanisms, the concept of repression was not original to Freud. J.F. Herbart had written extensively on 'verdrängung' (Freud's term for repression also) of ideas. Herbart's *Psychology as a Science* (1824) may have influenced Freud indirectly through Freud's psychiatric mentor, Theodor Meynert. Schopenhauer had also perceived that defensive forgetting had something to do with psychopathology; but he, too, wrote of forgetting ideas and circumstances, not feelings.

In 1905, Freud conceived of a special class of defense mechanisms – sublimations – that could transmute conflictual affect, not into a source of pathology, but into culture and virtue. For example, Beethoven was often angry, depressed, lonely, and suicidal. Nevertheless, instead of killing himself, in his Ninth Symphony he put Schiller's 'Ode to Joy' to music. To call such unusual behavior 'being in denial' is to sell the ingenuity of the central nervous system short.

Humor, like sublimation, was another defense that Freud and students of adaptation in general have perceived as having more of an adaptive than a pathogenic quality. In *Jokes and Their Relation to the Unconscious*, by hinting at a hierarchy of defenses, Freud developed the idea of humor as a more mature defense mechanism than wit. Freud viewed wit and practical jokes as inextricably linked with the less adaptive, less mature, and less empathic mechanism of displacement. Freud wrote, "humor is a means of obtaining pleasure in spite of the distressing affects that interfere with it; it acts as a substitute for the generation of these affects; it puts itself in their place. It arises from an economy in the expenditure of affect."

Freud also introduced the concept of an ontogeny of defenses. Defenses such as projection, repression, and sublimation not only lay along a continuum of relative psychopathology but also along a continuum of personality development. Reaction formation, Freud said, reminded him of the proverb *Junge Hure, alte Betschwester* (a young whore makes an old nun). With the passage of decades and the continuing myelination of frontal lobe's connections to the limbic system, the defense of adolescent acting out (e.g., impulsive, temporarily comforting tantrums) could become the parent of reaction formation (anger is bad and should be punished by spanking and jail) and a potential grandparent of altruism (nonviolence, creative parole and believing that conflict mediation is good).

In 1936, Freud advised the interested student that there are "an extraordinarily large number of methods (or mechanisms, as we say) used by our ego in the discharge of its defensive function . . . my daughter, the child analyst, is writing a book upon them." He was referring, of course, to Anna Freud's *The Ego and Mechanisms of Defense* (1936), which to this day remains one of the definitive texts on the subject.

Clinicians have often been reluctant to view defenses as adaptive as well as pathological. This Encyclopedia, for example, has a separate article for 'coping.' This difficulty has slowed

our understanding of the more mature ego mechanisms of defense. The difficulty, of course, is that with brain maturation comes complexity. Thus, self-deception or conflict resolution via humor and sublimation reflects a different level of mental complexity than via the more concrete defenses of projection or turning-against-the-self.

Modern Conceptualizations of Defense

All defenses involve creative synthesis. Defenses often manifest themselves in paintings and in dreams, in phobias and in hallucinations, in humor and in religious experience. As such, defenses reflect the building blocks of interesting behavior, of madness and of art. They help explain the unreason of both the sinner and the saint. However, if defenses integrate, make sense out of and master conflict, they still remain difficult to describe. Like rainbows and shooting stars, now we see them, now we do not.

From the beginning, defenses have posed a problem for experimental psychology. First, there is no clear line between character (enduring traits) and defense (shorter lived response to environmental stress), between behavior and mental mechanism, and between neuropathology and unconscious coping process. Is the self-attack of major depression a result of genetically disordered brain chemistry or anger turned against the self – or both? Second, 'defense mechanisms' can serve other purposes; and conversely, any of the mind's functions, not just standard defenses, can be employed in the service of defense. Third, in any effort to produce a comprehensive list of defenses there will be enormous semantic disagreement.

Differentiated mechanisms of defense become most clear when one can study the psychopathology of healthy everyday life in detail and over time. Our appreciation of the defensive nature of mature behavior awaited studies of normal populations. Over the last 30 years, several longitudinal studies at Berkeley (Norma Haan) and at Harvard (George Vaillant) have clarified our understanding of defenses with experimental and developmental studies. By offering a tentative hierarchy and glossary of consensually validated definitions, DSM-IV has set the stage for further progress. In the last 20 years, several empirical studies reviewed by Cramer (1991) and Skodol and Perry (1993) finally organized defenses into a hierarchy of relative psychopathology.

The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), has included a Defensive Functioning Scale as a proposed diagnostic axis for further study. **Table 1** arranges these defense mechanisms into seven general classes of relative psychopathology. The so-called 'immature' defenses (Levels II–V) in **Table 1** are the ones that underlie much of personality disorder.

There are many ways that we can ignore or distort one or more of these four lodestars in order to mitigate intrapsychic conflict. For semantic consistency, the Defensive Function Scale of DSM-IV has labeled these involuntary mental mechanisms, *defenses* (**Table 1**). These coping mechanisms or 'defenses' can abolish impulse (e.g., by reaction formation), or social learning (e.g., by acting out), or other people (e.g., by schizoid fantasy), or reality (e.g., by psychotic denial). They can abolish our conscious recognition of the subject (e.g., by projection), or the object of a conflict (e.g., by turning against

Table 1 Defensive functioning scale (adapted from DSM-IV) (pp. 751–753)**A. Psychotic defenses**

I. Level of defensive deregulation. This level is characterized by failure of defensive regulation to contain the individual's reaction to stressors, leading to a pronounced break with objective reality. Examples are as follows:

- Delusional projection
- Psychotic denial
- Psychotic distortion

B. Immature defenses

II. Action level. This level is characterized by defensive functioning that deals with internal or external stressors by action or withdrawal. Examples are as follows:

- Acting out
- Apathetic withdrawal
- Passive aggression (turning against the self)

III. Major image-distorting level. This level is characterized by gross distortion or misattribution of the image of self or others. Examples are as follows:

- Autistic fantasy
- Projective identification
- Splitting of self-image or image of others

IV. Disavowal level. This level is characterized by keeping unpleasant or unacceptable stressors, impulses, ideas, affects, or responsibility out of awareness with or without a misattribution of these to external causes. Examples are as follows:

- Denial
- Projection
- Rationalization

V. Minor image-distorting level. This level is characterized by distortions in the image of the self, body, or others that may be employed to regulate self-esteem. Examples are as follows:

- Devaluation (hypochondriasis)
- Idealization
- Omnipotence

C. Neurotic defenses

VI. Mental inhibitions (compromise formation) level. Defensive functioning at this level keeps potentially threatening ideas, feelings, memories, wishes, or fears out of awareness. Examples are as follows:

- Displacement
- Dissociation (empirically placed with the II–V 'immature' defenses)
- Intellectualization
- Isolation of affect
- Reaction formation
- Repression
- Undoing

D. Mature defenses

VII. High adaptive level. This level of defensive functioning results in optimal adaptation in the handling of stressors. These defenses usually maximize gratification and allow the conscious awareness of feelings, ideas, and their consequences. They also promote an optimum balance among conflicting motives. Examples of defenses at this level are as follows:

- Anticipation
- Affiliation (seeking social support)
- Altruism
- Humor
- Self-assertion (cognitive coping strategy)
- Self-observation (cognitive coping strategy)
- Sublimation
- Suppression

the self), or awareness of the idea (e.g., by repression), or of the affect associated with the idea (e.g., isolation of affect).

All classes of defenses in [Table 1](#) are effective in 'denying' or defusing conflict and in 'repressing' or minimizing stress; but they differ greatly in the psychiatric diagnoses assigned to their users and in their consequences for long-term biopsychosocial adaptation. In Level I, the most pathological category, are found denial and distortion of external reality. These mechanisms are common in young children, in our dreams, and in psychosis. To breach them requires altering the brain by neuroleptics or waking the dreamer.

More common to everyday life are the relatively maladaptive defenses found in Levels II–V. Defenses in these categories

are common in adolescents, in immature and substance abusing adults, and in individuals with personality disorders. They often make others more uncomfortable than the user. Such defenses are consistently and negatively correlated with global assessment of mental health, and they profoundly distort the affective component of interpersonal relationships. Like cigarette smoking in a crowded elevator, such behavior seems innocent to the user and deliberately irritating and provocative to the observer. Immature defenses externalize responsibility and allow individuals with personality disorders to refuse help. Defenses in this category rarely respond to verbal interpretation alone. The projection of the paranoid by which unacknowledged feelings are attributed to others is well

known, and so is the capacity of schizoid individuals to relieve loneliness by creating fantasized human relationships within their own minds. The capacity of histrionic personalities to disassociate themselves from painful emotion and to replace unpleasant with pleasant affect, as if they were on stage, is familiar; and so is the fact that passive-aggressive and masochistic characters turn anger against themselves in a most annoying and provocative manner.

The mechanisms of acting out and hypochondriasis are less familiar. In the antisocial personality, acting out reflects a process whereby the direct motor expression of an unconscious wish or conflict allows the individual to remain unaware of either the idea or the affect that the action accompanies. Thus, acting out produces the clinical illusion that all sociopaths do not experience the painful affects of guilt, anxiety, or depression. In fact, nothing could be further from the truth.

Hypochondriasis disguises reproach. The 'borderline's' help rejecting complaints that clinicians make him/her worse may conceal grief, longing, and unacceptable aggressive impulses. By exaggerated focus upon current somatic or psychic pain that cannot be relieved, the hypochondriac attempts to manage past unbearable grief or abuse.

Immature defenses can be breached in two ways. First, by confrontation – often by a group of supportive peers – or by videotaped empathic but focused psychotherapy. Second, immature defenses can be breached by improving intrapsychic competence by rendering the individual less anxious and lonely through empathy, less tired and hungry through food and rest, or less intoxicated through abstinence.

The third class of defenses, those in Level VI, are often associated with what DSM-IV calls Axis I anxiety disorders and with the psychopathology of everyday life. These include mechanisms like repression, intellectualization, reaction formation (i.e., turning the other cheek), and displacement (i.e., directing affect at a more neutral object). In contrast to the 'immature' defenses, these 'intermediate' defenses are manifested clinically by phobias, compulsions, obsessions, somatizations, and amnesias. Also, in contrast to the immature defenses, 'intermediate' defenses usually make the user more uncomfortable than the observer. Such users often seek psychological help and respond more consistently to psychotherapeutic interpretation. Intermediate defenses are common in everyone from 5 years old until death. They are neither healthy nor unhealthy. Across studies, the intermediate (Level VI or 'neurotic') defenses show mixed positive and negative correlations with outcome of only minimal statistical significance.

The mechanisms at Level VII still distort and alter feelings, conscience, relationships, and reality; but they achieve these alterations gracefully and flexibly. These mechanisms allow the individual consciously to experience the affective component of interpersonal relationships, but in a tempered empathic fashion. Thus, the beholder regards Level VII adaptive defenses as virtues, just as the beholder may regard common immature defenses like the prejudice of projection and the tantrums of acting out as sins.

Doing as one would be done by (altruism), keeping a stiff upper lip (suppression), keeping future pain in awareness (anticipation), the ability not to take one's self too seriously (humor), and turning lemons into lemonade (sublimation) are the very stuff from which positive mental health is made.

Unfortunately, like tightrope walking, mature mechanisms cannot easily be deployed; their deployment is facilitated by empathy, safety, and exemplars.

Deciphering a nomenclature of defenses is like translating a foreign language. Thus, the terms that I have found useful in my longitudinal research (given in bold in Table 1) are translated in Table 2 from label into process. As is clear from Table 2, I have found it useful to condense the behaviors listed in Levels II–V into a single level – immature defenses. Rather than dispute my or DSM-IV choice of words, readers are asked to substitute terms that suit them. The fictional defensive processes described for the cases depicted in Table 2 are extensively illustrated by cases from true longitudinal study in *Adaptation to Life and Wisdom of the Ego*.

All classes of defenses are effective in 'repressing' conflict and in 'denying' stress, but the individual defenses differ greatly in the diagnoses associated with their use and perhaps in their consequences for long-term biopsychosocial adaptation.

Writing great tragedy (i.e., sublimation), for example, is financially rewarding, instinctually gratifying, and sometimes life saving for the author. The 'distortion' involved in stoicism (suppression), humor, and altruism seems as ethical and as mentally healthy to an observer as the immature defenses seem immoral and antisocial. Living one's life by laughter, the Golden Mean, and the Golden Rule is not just the stuff of morality tales but can empirically make the user healthy, wealthy, and wise.

Less mature defenses may evolve into more mature defenses. The adolescent's autistic fantasies may become the scholar's intellectualized obsession. Mary Baker Eddy's hypochondriasis evolved first into reaction formation against any complaint of physical illness and then into the highly rewarding altruistic founding of the Christian Science Church. Just as some children outgrow allergies, the second-grader's irritating sadomasochistic pleasure of putting thumbtacks on chairs may evolve into the adolescent's enjoyment of the displaced hostility of cartoon movies and finally into mature, enjoyable humor where the hostile intent is invisible.

However, if defenses are the building blocks of psychopathology, their division into 'levels' or categories is as arbitrary as our division of colors. There will always be as many different colors – and as many defenses – as the taxonomist has imagination.

Identification of Defenses

Identification of defenses is difficult. Rarely can we identify our own defenses, and we often fail to recognize them in others or, still worse, 'project' our own defenses onto others. To identify a defense, an objective observer needs to triangulate past truth with present behavior and subjective report. First, we need to know the biological facts. Second, we need a behavior or symptom or a creative product (that may seem odd, sinful, or amazing). Third, we need the subjects' autobiographical account. In short, we must contrast a patient's *symptoms* (or a healthy person's creative product) with his self-report (mental content) and with someone else's *objective report* (biography, or old charts). Ultimately, like other facets of mental health, the reliable identification of healthy but involuntary coping mechanisms requires longitudinal study. For example, one

Table 2 Case illustration

A woman, married at age 30, after one miscarriage tried for 7 years to have children, which she wished for intensely (*limbic emotion*). Then, following a cervical biopsy that showed cancer, at age 38 she is still hospitalized after a total hysterectomy (*reality*). She had always felt inadequate in relation to her younger sister, who already had four children and had been the one in the family who won praise as 'being good with kids' (relationship). The woman's husband also desperately wanted children (conscience). Below are a number of possible responses to her surgery.

D. 'Mature' defenses

Altruism: The woman, a month after surgery, organized a group of other women who had breast and uterine surgery to counsel and to visit patients undergoing gynecological surgery. They tried to give information, advice, and comfort, and from their experience provide answers to questions and fears that such new patients might have. Diagnosis: Altruist

Suppression: She read Marcus Aurelius and Ecclesiastes in the hospital. She took great care to hide her tear-stained tissues from her husband and made no complaint (even though the process was painful) while her sutures were removed. Knowing that baby pictures upset her, she deliberately gave away an unread copy of her favorite magazine, which featured an article on childcare. Diagnosis: Stoic

Sublimation: She got great pleasure from 'get well' cards from her sister's children, agreed to teach a Sunday School class of preschoolers, and got a poem published in her hometown weekly on the bittersweet joys of the maiden aunt. Diagnosis: Artist

Anticipation: Her doctor was surprised to find out how relaxed and practical she was about her postoperative course and the calm frankness with which she could express her regret at being cheated of children. His surprise was due to the fact that she had spent her preoperative visit anxiously worrying about possible surgical complications and weeping over the fact that she would never be able to bear children. Diagnosis: None

Humor: She laughed so hard that tears came to her eyes and her ribs ached when she read the *Playboy* definition of hysterectomy: "throwing out the baby carriage but keeping the playpen." She explained her private mirth to a startled and curious nurse with, "The whole thing is just so damned ironic." Diagnosis: None

C. 'Neurotic' defenses

Reaction formation: She renewed her old college interest in Planned Parenthood and passionately argued with her younger friends to limit their families. She suddenly 'remembered' that she had always been afraid of the pain of childbirth and remarked to her husband how lucky she was to be spared the burden. Diagnosis: Pollyanna

Isolation (Intellectualization): She read a lot about uterine cancer and asked the doctor a great many questions about the nature of the operation. She concerned herself with minute details preventing postoperative infection and caring for her operative wound. She made a hobby in the hospital of learning medical words. Diagnosis: Obsessive Compulsive

Repression: She found herself unable to remember the name of the operation except that it was for 'a little nubbin in my tumtum.' She 'forgot' her first follow-up visit to the physician. On coming home, she broke into tears when she broke an inexpensive, amphora-shaped flower vase; she had no idea why. Diagnosis: Hysterical

Displacement: She became very interested in growing tulips and daffodils in her hospital window. Although she never asked the doctor questions about her own hospital course, she worried about a funny mold on the bulbs she was growing. Knowing his hobby was gardening, she repeatedly asked her surgeon's advice about the growth on her bulbs. Diagnosis: Anxiety Disorder or Phobia

B. 'Immature' defenses

Projection: Following a slight postoperative wound infection, she wrote long, angry letters to the papers blaming the hospital for unsanitary conditions. Blaming her doctor for not doing a Pap smear earlier, she threatened to institute malpractice proceedings. Diagnosis: Paranoid Personality

Dissociation: Emerging from anesthesia, she felt no regret but instead enjoyed what she felt was a religious experience. Postoperatively, she told all her friends that her pain gave herself a sense of joyous communion with sufferers everywhere. She felt an intense inward sense of good fortune that she had been favored by God to have had her cancer discovered so soon and to have come through surgery so well. Diagnosis: Dissociative Disorder

Fantasy: She asked the nurse not to permit visitors because they made her 'sad.' She threw out all her flowers and instead read and reread a copy of *Parent's Magazine* and looked repeatedly at *The Family of Man*. She would go down the corridor to the newborn nursery daydreaming about what she would call each child if it were hers, and once a floor nurse had to ask her not to whistle lullabies so loudly. Diagnosis: Schizoid Personality

Hypochondriasis: She became worried that the cancer might have spread to her lymph nodes and belabored her visitors with accounts of the tiny lumps in her groin and neck. When her sister came to visit, the patient angrily accused her of caring so much for her own children that she did not care if her own sister died of cancer. Diagnosis: Borderline Personality

Passive aggression: When the intern, while inserting an IV, missed her vein, she smiled at him, told him not to worry, and said, "When you're just a medical student, it must be hard to get things right." Unable to sleep, she watched her IV run dry. Later, at 4 a.m., the night nurse had to call the intern to restart the IV. She cheerfully told him that she had not rung for the nurse because she knew how busy everyone in the hospital was. Diagnosis: Passive Aggressive Personality

Acting out: Shortly after leaving the hospital, she was unfaithful to her husband with four different men in a month, twice picking up men in cocktail lounges and once seducing an 18-year-old delivery boy. Prior to that time, she had no sexual interest in any man but her husband. Diagnosis: Sociopath

A. 'Psychotic' defenses

Distortion: On the third postoperative day, she announced that she was a Christian Scientist and was signing out immediately. Besides, she had to go home because she and her husband were planning a trip to Bermuda that weekend. (In reality, their total income was \$200 a week and their Blue Cross had lapsed.) She added with a naughty laugh that they needed a vacation to do a little 'spring planting.' Diagnosis: Mania

Delusional projection: She felt that the hospital was being run by racists who were trying to sterilize her. She tried to telephone the FBI to report the hospital for genocide. She refused her pain medication, claiming it was an experimental drug for thought control. Diagnosis: Paranoid Schizophrenia

Psychotic denial: She started ordering the nurses to move her upstairs to the maternity ward. She wandered about the hospital looking for her baby. By phone, she ordered an expensive bassinet and baby clothes to be delivered to her house. She experienced no postoperative pain. Diagnosis: Mania

woman wins community praise for founding a shelter for battered women (altruism), but she dismisses her behavior as 'a need to rent my house.' Another woman is imprisoned for breaking her toddler daughter's arm in a tantrum (acting out),

but she dismisses her behavior as an accident. In fact, social agency records from 30 years before reveal that both women had been taken at age two from the care of physically abusive alcoholic mothers.

The Q-sort method (described in *Ego Mechanisms of Defence*) appears the most reliable method for assessing defenses from a clinical narrative.

Prospective Validation of the Hierarchy

The Study of Adult Development at Harvard consisted of three cohorts followed for a lifetime: the COLLEGE sample (Harvard sophomores selected for mental health in 1940), the CORE CITY sample (socioeconomically deprived, but nondelinquent, inner city adolescents selected in 1940), and the TERMAN sample (California 4th grade girls with high IQs selected for longitudinal study in 1922).

For all three samples, the adaptiveness of each subject's defenses was assessed along a 9-point scale; point 1 equaled using only mature defenses, and point 9 equaled using only immature defenses. Table 3 illustrates, that, analogous to clotting mechanisms, choice of defense mechanisms is relatively unaffected by parental social class, IQ, and education. However, Table 4 illustrates that prospectively choice of defense mechanism predicts successful aging and income.

In order to cut through the unreliability of projective tests and the subjectivity of pencil and paper tests, Menninger psychologist, Lester Luborsky, devised a behavioral guide (Health-Sickness Rating Scale or HSRS) to assess psychological functioning on a scale of 0–100. Two of the architects of DSM-III developed a revision of the HSRS called the Global Assessment Scale (GAS). A modified version of the GAS was introduced in DSM-III-R as the Global Assessment of Functioning (GAF or Axis V). Table 5 illustrates how much psychopathology and/or mental health is associated with choice of selected defense mechanisms.

Treatment

Psychiatry needs to understand how best to facilitate the transmutation of less adaptive defenses into more adaptive defenses. The modification of immature defenses occupies the attention of high school teachers, criminal justice personnel, and psychotherapists everywhere. At present, little evidence-based treatment is available; nevertheless, there is literature information on change in defenses over treatment and time, which indicates (mostly noncontrolled studies) that immature defenses decrease and mature defenses increase significantly. (Perry et al., 2008)

Perhaps, the best way to alter a person's choice of defensive style under stress is to make his/her social milieu more predictable and supportive. We are all a little schizoid and paranoid when among strangers whom we fear may treat us harshly. We are all more adept at altruism, suppression, and playful sublimation when among friends and others empathic toward our pain. The second strategy is to facilitate the intactness of the central nervous system (e.g., sleep, nutrition, sobriety, and removal of sources of toxicity and infection).

Toxic brain syndrome is often associated with paranoia; intoxication leads to fantasy; both grief and anger can lead to rage turned upon the self. We are all more mature when not hungry, tired, and lonely.

Finally, if we breach patients' defenses, we must be sure that we have their permission. If in the course of examination we

Table 3 Correlation of social antecedents with adaptiveness of defenses

Antecedent	Adaptiveness of defenses		
	College N = 154 ^a	Core city N = 189 ^a	Terman N = 40
Years of education	0.13	0.10	0.33*
IQ	0.04	0.14	0.07
Parental social class	0.11	0.00	0.13

* $p < 0.05$, *** $p < 0.001$ Spearman correlation coefficient.

^aSample size is reduced. In order to control confounders, men with IQ < 86, depression, alcohol dependence, and schizophrenia have been excluded.

Table 4 Late life consequences of adaptive defenses at age 20–47

	Core city N = 137 ^a	College N = 154 ^a
I. <i>Objective evidence</i>	Adaptiveness of defenses	Adaptiveness of defenses
Income (Midlife)	0.25**	0.28***
Psychosocial adjustment (50–65)	0.16	0.34***
Social supports ^b	0.12	0.34***
II. <i>Subjective evidence</i>		
Joy in living ^b	0.14	0.35***

Spearman correlation coefficient (ρ) was the statistic used.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^aSample size is reduced because men who died before age 65 are excluded.

^bMeasured at age 65 for the core city men and measured at age 75 for the College men.

Table 5 Percent of core city men at different levels of global mental health using selected defenses

Major defense	HSRS			
	Impaired 0–65 n = 53	66–70 n = 36	Healthy 71–84 n = 143	85–99 n = 74
Projection (%)	30	17	7	0
Fantasy (%)	19	11	1	0
Hypochondriasis (%)	21	11	1	0
Passive aggression (%)	32	36	15	1
Dissociation (%)	55	36	15	1
Altruism (%)	0	3	6	35
Suppression (%)	2	14	27	59

ask patients to remove their protective covering, we must protect them with something else. Either we must offer ourselves – a luxury rarely available to busy clinicians – or we must offer and facilitate a substitute defense. It is only sometimes that psychopharmacology is specific enough to do the job.

See also: [Coping](#).

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Delusions

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Glossary

Habit Habitual behavior is rigid, inflexible, and insensitive to the current value of the ends that it achieves. Delusions may be habits of thought.

Heuristic A 'rule of thumb' or educated guess; used to come to an optimal solution as rapidly as possible.

Inference The process of interpolating the next logical step in an intuited pattern. The conclusion drawn is also called an inference.

Judgment The evaluation of evidence in the making of a decision.

Perception The process of understanding sensory information; distinguished from sensation by the observation that it is substantially constructive, that is,

what we have previously perceived influences subsequent processing of inputs.

Prediction error The mismatch between what is expected in a given situation and what is subsequently experienced. Prediction errors relate to the very essence of learning; by minimizing prediction errors, organisms learn to better predict their environment.

Salience The capacity for stimuli, thoughts, and percepts to grab attention and drive action.

Uncertainty Related to prediction error – this quantity is minimized through learning. It drives the allocation of attention toward explanatory cues. In formal models, it is related to free energy or entropy. Motivational factors like need for closure are engaged when uncertainty is high.

Introduction

Delusions occur in the context of numerous pathological states, ranging from head injuries to schizophrenia, Alzheimer's, and Parkinson's diseases, to rare autoimmune encephalopathies. This biological heterogeneity is mirrored in the psychological and philosophical realms; a menagerie of state- and trait-related processes have been invoked to explain delusions. Worse still, delusions have myriad contents, ranging from the mundane ('my partner is cheating on me') to the exotic ('I am the right foot of God'). Hence, delusional beliefs represent a challenge: Can they be understood? Are they aberrations of belief? Are they the rational products of aberrant perception or empty speech acts? To meet this challenge, perhaps a definition is a good place to start. As we shall see, this may be easier said than done.

Delusions Defined?

We all know what delusions are, but can we define them? Clinicians adopt a normative approach to diagnosing delusions, and, since delusions are judged against societal norms, such an approach allows scientists and laypeople to recognize delusions without necessarily understanding or being able to define them.

According to the Diagnostic and Statistical Manual (IV, Text Revision), delusions are

false beliefs based on incorrect inference about external reality that persist despite the evidence to the contrary and these beliefs are not ordinarily accepted by other members of the person's culture or subculture.

There are numerous problems with this definition: for example, delusions may not be beliefs and, even if they are, what are beliefs? Perhaps, a pragmatic approach might help: what are beliefs for? One function they might serve is in representing

and organizing information and thus coordinating adaptive responses, that is, beliefs might be a special kind of memory.

This definition of belief entails a close relationship between beliefs and actions. To this end, some object to delusions being beliefs because individuals with delusions do not act consistently with their beliefs; a patient with Cotard delusion believes that she is dead (note that in describing delusions, one cannot help but use terms like belief!), she will nevertheless eat and move (unlike typical dead people); a patient with Capgras delusion who is convinced that his/her spouse has been replaced by an imposter will share the house with the apparent imposter and will not search for the 'real' spouse. Of course, some patients act on their delusions with violent and tragic consequences. Those who favor the doxastic (belief-based) account of delusions point to the inconsistency with which even healthy individuals act upon their beliefs and the intractable computational power that would be required to act with complete consistency on all of our beliefs all of the time.

The consistency argument also extends to fixity. Delusions are defined as tenacious, fixed in the face of contradictory evidence. Yet, patients' assent waxes and wanes, so fixity or strength is not pathognomic of delusions (despite being an important feature and one that engenders a great deal of distress for the sufferer, and their family and friends).

Next, delusions do not have to be about external reality, for example, patients can be deluded about their internal states; an individual may believe, based on his/her internal sensations, that he/she has a nuclear reactor inside the stomach. Furthermore, emotional factors may guide delusion formation and maintenance and, while these may be responses to external events, they nevertheless involve internal sensations that may or may not be veridical.

Finally, delusions do not have to be based on incorrect inference; a patient who is convinced that his/her spouse is being unfaithful (often called Othello syndrome) may be correct. However, although the belief may be correct, the key

point is that the evidence on which it is predicted is false. This is particularly difficult to discern, as patients often cannot describe the data that support their contentions.

So, is there hope for a scientist who studies delusions? How can one explore the cognitive and neural mechanisms of something that cannot be defined? The answer involves making certain assumptions that may amount to delusions in themselves! One approach that has proved fruitful in recent years involves cognitive neuropsychiatry; that is, we attempt to understand a mental symptom in terms of a dysfunction to one or many cognitive modules; delusions may be understood as aberrations of normal belief function.

The remainder of this article is concerned with the variety of cognitive neuropsychiatric models of delusion, and their strengths and weaknesses. We conclude by suggesting that a unifying theory may be possible but that further empirical and theoretical work is essential to make this a reality.

Perception

One category of models holds that delusions are a normal and rational response to an abnormal percept or percepts. That is, the delusion represents a belief that is formed to explain away an unusual experience. Maher conceives of this perceptual kernel as a 'surprise' that demands explanation and that the particular explanation would be generated by all of us, were we to experience the same surprise. This model has found favor with cognitive neuroscientists and has garnered support from functional imaging studies of belief formation and paradigms that involve the administration of psychotomimetic drugs like ketamine, amphetamine, and cannabis to healthy volunteers. These treatments engender alterations in visual and auditory perception as well as affective responses and, while they also impair cognition and decision-making, there is at least some evidence relating the degree of perceptual aberration they induce to the degree of delusion-like ideation. These studies suggest that all of us have the capacity to experience delusions given the correct perturbation; however, these studies have not demonstrated the primacy of perceptual aberration. Furthermore, top-down cognitive manipulations can also engender delusion-like ideation, for example, hypnosis. Finally, the delusion-like ideas that subjects express are not identical with clinical delusions (although some subjects do lose insight and report considerable conviction). Perhaps it is best to consider these manipulations modeling the very early phases of delusion formation, the delusional mood, in which the world feels changed, strange, and puzzling, pregnant with new meaning, though these experiences have not yet crystallized into a delusion.

One influential neurobiological model of delusions explains this process in terms of the brain systems that ascribe importance or salience to stimuli, thoughts, and percepts. Salience represents the capacity for an experience or idea to grab attention and drive goal-directed action. In a drive for consilience, theorists sought to relate a candidate neurotransmitter, dopamine (implicated in the deluding process, because when its activity is blocked in psychotic patients, delusions resolve), to the phenomenology of having delusions. While it is an admirable effort that garnered some empirical support, the heuristic

explanation of 'too much dopamine, leads to too much salience leads to delusions' has been supplanted by more mechanistic explanations that are capable of explaining more of the empirical data.

Surprising experiences that demand explanations are also salient, and they lie at the heart of a category of delusion models that are grounded in formal animal learning theory. Building upon preclinical data from laboratory animals learning to predict their environment and respond appropriately, these models identify the mismatch between expectation and experience or prediction error as crucial for learning and attentional allocation. These accounts were applied to human causal belief formation in the 1980s with demonstrations that human subjects acquiring cause-effect beliefs showed evidence for the same biases and patterns of responding as experimental animals confronted with contingencies between arbitrary stimuli (lights and tones) and the delivery of salient events (food, water, electric shocks, etc.).

Central to these behavioral effects is prediction error – subjects learn most when their expectancies are violated, and without prediction error, no learning occurs. On the other hand, if there is too much prediction error that is inappropriately timed relative to environmental cues and context, then an organism may learn inappropriately. Delusions form when prediction errors are signaled inappropriately, driving attention toward irrelevant stimuli, forging maladaptive beliefs. There is empirical support for this model from pharmacological model psychoses and from patients with first-episode psychosis; in both cases, aberrant prediction error signals correlated with the severity of delusions.

More recently, this model has been extended in an attempt to explain the fixity of delusional beliefs. Briefly, if delusions form as schemas to explain aberrant experiences, then, once formed, they are deployed to explain future experiences. This process involves activating the delusion representation and adventitiously reinforcing it such that, even when the logical predictions of the delusion are not borne out, the fact that the delusion was reevoked and ruminated upon dominates over any new learning that the delusion is untrue. There are preclinical data that suggest that prediction errors also govern this reactivation and reconsolidation process, and some clinical data to suggest that the phenomenology of delusions conforms with a reconsolidation-like mechanism for delusion maintenance. For example, confronting patients with evidence that contradicts their beliefs induces belief 'elasticity'; they will engage in quite impressive explanatory feats to encompass or explain away the contradictory data, often incorporating the information or the confronting individual into the delusion.

Additionally, as delusions resolve, patients describe a 'double-awareness' in which they endorse the delusion but also reject it, a duality of belief and disbelief. In preclinical animal learning theory, dual representations exist following extinction of prior learning (hence the spontaneous renewal of fear responses after extinction), as well in animals over-trained on instrumental contingencies. Here, there are at least two representations competing for expression in behavior: a flexible goal-directed representation that is sensitive to the value of the outcome of an instrumental response and a more rigid response tendency controlled by contextual cues and insensitive to outcome value (a habit). It is possible that the

fixity of delusional beliefs is explicable if we conceptualize them as instrumental habits that compete with and overwhelm an impaired cognitive system that is attempting to impose a veridical view of the world. Neurobiologically, boosting dopamine function in the prefrontal cortex can switch an animal from habitual responding back to more flexible, goal-directed behavior. Perhaps delusions may be ameliorated by increasing the sufferers' capacity for top-down executive control. In the next section, we discuss such high-level executive cognitive factors in more detail and how they may contribute to the psychopathology of delusions.

Cognition

Perceptual models of delusion formation suggest that delusions represent a rational inferential response to an unexpected percept. While there are empirical data supporting the notion of peripheral perceptual dysfunctions that conform to the thematic content of a patient's delusions, and even nondeluded individuals are suboptimal when it comes to probabilistic inference, there are theories of delusions that appeal to inferential disruptions generating these aberrant beliefs and mediating their maintenance. In this section, we discuss those models.

Reasoning involves the purposeful manipulation of relevant details from previously acquired stored information. Psychotic patients report that the logical sequence of their ideas was replaced by sequences of merely associated thoughts, and the reasoning process therefore became increasingly concrete. Psychotic reasoning involves 'a lack of the inhibition of peripheral ideas necessary for effective abstraction.' Some patients report that almost every thought immediately and automatically suggested an enormous number of associated ideas. Some enjoy this enhanced ability to associate, feeling endowed with enhanced mental reactions and a more sophisticated problem-solving ability; indeed, delusions of grandeur often develop from the apparent insights that accompany this hyperactivity of association.

Chapman reported that most patients who experienced the changes outlined previously reported that, for a time, everything around them looked fascinating and that objects stood out vividly against the background. They regarded everything as significant and found themselves attending to many irrelevant aspects of the environment. There was a general tendency for their interest to be turned to ruminating about psychology, philosophy, art, and literature. Those patients who experienced perceptual and attentional aberrations also experienced hyperactivity of associations. Matussek's patient (R) illustrates this concept clearly: "Out of these perceptions came the absolute awareness that my ability to see connections had been multiplied many times over." These experiences are appraised positively at first; however, as they persist, patients become increasingly anxious. Attempting to account for their bizarre experiences, they arrive at irrational conclusions. Paranoid ideas and delusions of various kinds develop in response to the various alterations of sensory and attentional experience.

Heuristics

Human judges are not always rational. People tend to jump to conclusions, employing shortcuts and heuristics, some of

which are relevant to the present discussion. For example, people tend to assume that the features of a causal event should resemble the features of its outcome (the representativeness heuristic). Unpleasant effects should have unpleasant causes. Furthermore, peoples' causal judgments tend to be greatly influenced by their a priori theories about causation: If someone has the idea that many unpleasant events in the outside world reflect the activities of an international terrorist conspiracy, those same terrorists may be held responsible for unpleasant internal events as well. Thus, in seeking an explanation for their distressing anomalous experiences, the psychotic individual experiencing them may be especially likely to focus on members of out-groups, individuals, and classes of people who are generally feared in his or her culture. It seems possible to appeal to an associative mechanism to explain this heuristic, a particular personal bias may be mediated by associations; the increased salience of a particular out-group may increase the propensity to form associations between that group and events in the environment.

The simulation heuristic posits that the basis for judgment is the ease with which a plausible scenario can be constructed mentally. Judgments of causality are affected by the ease with which the person can imagine a path from a presumed cause to a known effect. When unpredicted events occur, the simulation process traces causal links back to prior causes. Consider a psychotic patient searching the environment for a likely cause for anomalous experiences. Salient objects and events – a honk or a wave from a passing driver, perhaps a member of a minority group standing on a street corner – will inevitably draw attention, and be given special weight as a likely cause of their troublesome internal events. If there is nothing perceptually salient, events may be retrieved from memory – a curse uttered in anger by a coworker or a sin unconfessed to a priest. If no suitable cause is generated through perception or memory, the simulation process may be invoked. The person may imagine possible causes and grasp the first one that comes to mind as the most likely explanation.

It is plausible that the simulation heuristic may be mediated by associative mechanisms, namely, the retrieval of associative chains such that the individual can mentally trace the associations from outcome to cause. A computationally intensive Bayesian tree-search mechanism located in the prefrontal cortex outlined by Daw and colleagues may underpin this heuristic. This mechanism may be invoked to account for the apparent relatedness of stimuli and events or the aberrant attentional salience of previously irrelevant background stimuli.

While the heuristics described are involved in the initial generation of a causal explanation, anchoring and adjustment might be involved in the maintenance of delusional beliefs. Many judgments begin as hypotheses – tentative conclusions that can be revised on the basis of newly acquired evidence. However, it has long been appreciated that final judgments are inordinately influenced by first impressions: the initial judgment serves as an anchor for the final one, and there is very little subsequent adjustment. The anchoring and adjustment heuristic reflects a general tendency to rely on initial or partial judgments, giving too little weight to newly acquired information. By virtue of its use, judgments of causality tend not to accommodate new information that should instigate revision.

Instead, knowledge gained subsequent to the initial judgment may be distorted so as to fit the original causal theory; subjects adopt suboptimal verificationist strategies, seeking and paying special attention to information that is consistent with their hypothesis. As many researchers will attest, when confronted with evidence that counters a cherished belief, individuals often react by challenging the evidence. Once an explanation for odd perceptual and attentional phenomena is arrived at, the patient experiences relief from anxiety. The experience of insight relief diminishes the person's subsequent motivation to question his or her original conclusions and increases resistance to contrary information. This theme is represented in Miller's associative learning-based account of psychosis. He argues that arriving at a causal explanation that accounts for aberrant experiences is so rewarding/relieving that it is accompanied by a surge of dopamine. Dopamine also impacts upon the consolidation of memories and as such, a delusional conclusion may be 'stamped-in' to long-term memory by dopamine, rendering it relatively impervious to disconfirmatory evidence.

Jumping to Delusions?

A prominent cognitive theory of delusion formation involves the 'jumping to conclusions bias.' Deluded individuals tend to make decisions hastily, on the basis of little evidence. Empirical evidence for this account comes from investigations of patient performance on probabilistic reasoning tasks; typically, participants are presented with two jars holding colored beads in different proportions. The jars are removed from view and subjects are presented with beads, drawn one at a time, from a jar and patients are asked to predict from which jar the beads are coming. Deluded individuals tend to make a decision after only one bead. However, rather than maintaining their hasty conclusion, patients also tend to overadjust their judgments in the light of potentially disconfirmatory evidence.

A liberal acceptance bias might account for apparent jumping to conclusions. When only two mutually exclusive options are available (like the beads task), patients rapidly *accept* that the beads are coming from a particular jar, but they do not *decide* that they are to the exclusion of other possibilities. This account allows for patients' overadjustment following contradictory evidence, since although they have strongly accepted one conclusion (the beads are from one jar), they do not exclude the alternative conclusion (that the beads are coming from the other jar). When given more than two alternatives (e.g., in a thematic apperception task, where participants are shown pictures and asked to rate the plausibility of particular interpretations), psychotic patients entertain a broader range of possible interpretations (rating multiple alternatives as excellent or good interpretations of a particular scenario), whereas healthy participants are more cautious and effectively narrow down the set of possible alternatives. Hence, psychotic individuals might entertain a broader range of possible explanations for their experiences and an absurd idea may prevail. This broadening of plausible explanations may be a manifestation of Miller's inappropriate relatedness of entities, but at a higher, representational level, leading to the entertainment of implausible or absurd accounts for a particular set of circumstances.

However, jumping to conclusion biases are not specific to deluded patients and they do not account for the fixity of delusional beliefs (since patients overadjust following disconfirmatory evidence). It is possible that patients' performance on probabilistic reasoning tasks may reflect the bizarre and unlikely nature of delusional conclusions rather than their fixity.

Self-Serving Bias

Since anomalous perceptual and attentional experiences may be unpleasant, it is important to consider the biases that distort causal judgments about negatively valenced events. For example, when humans make causal attributions, they tend to suffer from a benefactance bias, such that they internalize the cause of positive events and externally attribute negatively valenced events. Hence, psychotic individuals seeking an explanation for their unpleasant anomalous experiences will most often look to the environment outside them.

In an fMRI study of the self-serving bias in healthy individuals, subjects silently read sentences describing positively and negatively valenced social events, then imagined the event happening to them, and finally decided the cause of the event, whether internal (Was it something about you?) or external (Was it something about your friend?/Was it something about the situation or circumstances?). Self-serving biased attributions (internal attribution of positive and external attribution of negative events) were associated with striatal activation, previously implicated in the motivational control of behavior as well as in the mediation of hallucinations and delusions.

The cognitive biases outlined are not specific to individuals with delusions, being present in individuals with schizophrenia but not related specifically to delusion severity (like the jumping to conclusions bias) or being present more generally in the population and being engaged by the need to explain an odd percept or experience in an individual developing delusion (like self-serving and simulation). What then is the evidence for an inferential deficit in individuals with delusions and how might that deficit relate specifically to their belief pathology?

Belief Evaluation Deficits

Perhaps the strongest evidence in favor of an inferential deficit related specifically to delusions comes from the elegant work emanating from the Macquarie Center for Cognitive Science, specifically, the Belief Formation program, under the direction of Max Coltheart. This work focuses on neuropsychological delusions, delusions that arise as a result of some sort of head injury or neurological insult, although attempts have been made to extend it to the delusions that occur in the context of schizophrenia. They advocate a two-factor approach in which perceptual and reasoning abnormalities combine. The latter derive from observations that neurological patients with delusions often have two sites of damage: (1) a lesion in a perceptual region (such as the fusiform face area) and (2) an additional lesion in 'belief evaluation' regions, possibly in the right frontal cortex. The first damage engenders odd percepts and the second generates bizarre explanations. The second factor is necessary because there are individuals with damage

to factor 1, engendering aberrant percepts, who nevertheless remain without delusions; for example, subjects who have suffered haptic deafferentation and therefore do not perceive sensory feedback from the actions they perform. While the haptically deafferented subjects have problems performing actions, they do not feel that their actions are under the control of another agent. Two-factor theorists equate the inappropriate prediction error signals reported in the dorsolateral prefrontal cortex with the aberrant belief evaluation process or factor 2.

However, it is important to emphasize the potential consequences of prefrontal cortical damage alone (their factor 2) as well as peripheral perceptual dysfunction (their factor 1); there are patients who suffer from delusion-like spontaneous confabulations following damage to the ventromedial and lateral prefrontal cortex and at least one patient in whom peripheral sensations are perturbed (following damage to the brachial plexus) who has somatic delusions in the absence of any apparent structural damage, and by extension, any deficit in factor 2.

Top-Down Theories

In addition to the probabilistic reasoning dysfunctions outlined earlier (about which the empirical data are equivocal), there are theories of delusion that invoke top-down factors alone. According to such theories, deluded individuals confuse belief with imagination. Individuals susceptible to delusions do tend to confuse the items they perceived with the events they imagined. Such theories are also popular because they allow for the inconsistency observed in patients between their beliefs and actions; if a delusion is aberrant imagination, then the deluded individual need not act upon it. However, these theories do not allow for the role of perceptual dysfunctions in the formation of some delusions outlined previously.

Is there any way to reconcile these groups of explanations? Perhaps, a hybrid model in which bottom-up experiential- and top-down expectancy-based processes can both contribute to delusion formation and maintenance. Such a model involves taking a Bayesian approach to perception, cognition, and brain function. In the next section, we discuss such models.

Bayesian Models

Thomas Bayes was an English mathematician and minister whose theorem on probabilities was published posthumously. The theorem has had an incredible impact on science, in particular, cognitive and neural science, in recent years. In the paper, Bayes' stance on probability is as follows:

The probability of any event is the ratio between the value at which an expectation depending on the happening of the event ought to be computed, and the value of the thing expected upon its happening

Why should a cognitive scientist care about such an arcane mathematical theory? Bayes theorem might help us, as scientists, to reason about new data and evaluate our a priori hypotheses: according to Bayes rule, the probability that a hypothesis is true given the observed data (the posterior probability) is proportional to the likelihood (the probability of those data given that the hypothesis is true) multiplied by the

prior probability (the probability that the hypothesis was correct before the data were seen). For simplicity, the 'prior probability' is often abbreviated as the *prior*.

More formally, we can express the relationship between a hypothesis and some new data as

$$P\left(\frac{H}{D}\right) = \frac{P(D/H)P(H)}{P(D)}$$

where H is the hypothesis and D is the data. $P(H)$ is the prior probability of H : the probability that H is correct before the data D was seen. $P(D/H)$ is the probability of seeing the data D given that the hypothesis H is true. $P(D/H)$ is the likelihood. $P(D)$ is the probability of observing the data D and $P(H/D)$ is the posterior probability.

Hence, surprising data might be discredited in the face of overwhelming prior experience, or it might demand explanation and an updating of our priors. Herman von Helmholtz was a physician and physicist who constructed prescient theories of visual perception that appear steeped in Bayes theorem; Helmholtz postulated that perception was a process of unconscious inference; that the brain entertains hypotheses about possible inputs and compares them with incoming sensations. Through experience, particular candidate hypotheses can come to be favored over others, based on their minimizing the uncertainty or free energy associated with a given situation. A compelling demonstration of this phenomenon involves observing a rotating hollow face mask: the binocular depth inversion illusion. Since our overwhelming experience of faces is that they are convex, the backside of the mask is perceived as convex when it rotates into view, even though the sensory information incident on the retina indicates a concave object.

An important distinction, within Bayesian models, is between prediction errors per se and the precision or uncertainty about those errors. These processes may have separable neurobiological bases and cognitively, these processes may mediate inference and learning, respectively. While inference and learning are intimately connected, they are dissociable to some extent. Inferences involve short-term decisions, like unconscious perceptual inductions, where one perceptual hypothesis is favored over another, for example, the Necker Cube. On the other hand, learning represents the set of prior expectancies brought to bear on current processing; the set of learned predictions that drives healthy individuals to perceive a hollow mask as a convex face.

While Bayesian models are often considered rational and optimal, they have nevertheless been deployed to explain irrational processes such as the spread of panic and rumor within a crowd (which occurs rapidly in salient situations with few explanatory priors). Delusions may involve a disruption to the normal Bayesian predictive mechanisms of the brain such that predictable and irrelevant events mismatch with expectancies and their salience demands new learning and explanation; a delusion represents an explanatory mechanism, an attempt to impose order on a disordered perceptual and cognitive world.

Delusions and the Self

Delusions often involve disruptions to the representation of self. Wegner and others hypothesize that a sense of self-agency and free will may be learned through experience; having an

intention to act very frequently precedes the action itself and this contiguity binds intentions with actions through associative learning. Subjects judge the time between performing an action and producing an outcome as shorter when the action was intentional, a process of action–outcome binding. Patients with delusions show a hyperbinding effect, an exaggerated binding between their actions and the outcomes they produce, consistent with a disturbed agency account of paranoia. This process of learned intentionality has been modeled using Bayesian mechanisms; in essence, the task of inferring causal agency involves conditioning the evidence (whether the outcome occurred?) over the priors (was there an intention to act and would the outcome be consistent with the outcome performed?). Inappropriate engagement of this inference mechanism could account for excessive and inappropriate agency underpinning, for example, beliefs in telekinesis or telepathy, but what about delusions of passivity or external control?

Producing movements over which we feel a sense of agency also involves predictive learning and prediction error; an internal ‘forward’ predictive model of motor commands or efference copy is used to predict the sensory consequences of movements, and these predictions are compared with the actual sensory feedback during movement execution. Impairment in such a predictive system would result in a failure to attenuate the sensory consequences of self-produced actions, making them appear indistinguishable from externally generated sensations and engendering the inference that one’s own movements were externally caused. This theory provides an elegant explanation for why we cannot tickle ourselves, since we cancel the predicted sensory consequences of the action. However, patients experiencing passivity phenomena rate self-generated stimulation as ticklish.

Delusions and Others

Observing, imagining, or in any way representing an action excites the motor program used to execute the same action. Mirror neurons discharge not only during action execution but also during action observation. Implicit in their description is the idea that information is passed by forward connections from low-level representations of the movement kinematics to high-level representations of the intentions subtending the action. Formally, this is a recognition model that operates by the inversion of a generative model. A generative model will produce an estimate of the visual consequences of an executed action given the causes or goals of that action. By inverting the model, it is possible to infer the cause or goal of an action, given the visual input.

Again, bottom-up or top-down biases in this inference process would lead to gross misrepresentations of other’s intentions. Those biases may arise due to aberrant prediction error signals. Such signals would drive learning of maladaptive social expectations. These would manifest phenomenologically as intense feelings of social uncertainty and ultimately, paranoia.

Stress, Need for Closure, and Self-Deception

The impact of our desires and preferences upon our ordinary, everyday beliefs is well documented. Motivational approaches view delusions as extreme instances of self-deception, as

defensive efforts to relieve pain and distress. For example, a motivational explanation of the Fregoli delusion, the belief that strangers one encounters are deceased family members in disguise, would point to the Freudian psychodynamic process of wish fulfillment, gratifying their wish that their dead relatives are still present. Of course, not all Fregoli sufferers believe that they are encountering disguised and deceased relatives so this is not a general explanation; however, it highlights the potential contributions that motivational processes might make to delusion formation.

Motivational models are perhaps more appropriate in the domain of paranoid and persecutory beliefs. Here, persecutory beliefs represent a defense against low self-esteem, hence, those with persecutory delusions should have high overt self-esteem and relatively low unconscious, covert self-esteem. Empirical data from an Implicit Association reaction time task suggest that this is the case.

One construct that may provide consilience between Motivational and Bayesian models of delusions is the need for closure – a motivational construct, associated with a preference for certainty and predictability. Patients with persecutory delusions have a higher need for closure. To ground this psychodynamic process in Bayesian terms, the need for closure may represent a drive to minimize prediction error; in this case, a mismatch between desired and actual self-representation.

Encapsulation, Scaffolding, and Delusion Contents

Early life experiences significantly shape the adult’s understanding of and reactions to the world. Via the process of scaffolding, early sensorimotor experiences serve as a foundation for the later development of more abstract concepts. Scaffolding refers to the process through which humans readily integrate incoming information with extant knowledge structures – a passive natural process through which new concepts are formed, especially in early childhood. Features of abstract or less-understood concepts are mapped onto existing and well-understood concepts such that the structure of the developmentally earlier, primary concept is retained in the newly constructed concept. This structure imbues the newer concept with meaning. This interchange mirrors the updating of priors by new experience in Bayesian learning. Indeed, category formation and the association of categories may proceed by minimizing prediction error.

Delusion proneness may manifest in development as a different set of learned priors predicated on aberrant sensorimotor interactions with the world. These priors may underpin an alternate set of what Wittgenstein called *bedrock beliefs* in delusion-prone individuals. Bedrock beliefs (or priors) are a framework of foundational and indubitable propositional certainties (‘I am Phil Corlett’; ‘The world is very old’; ‘My parents are human’) which globally constrain other empirical beliefs and provide the terms for their rational interrogation.

The alteration of particular bedrock beliefs in isolation might allow for the encapsulation of delusions. That is, although delusions permeate many domains of cognition, deluded individuals tend not to be deluded about all information they come across. Rather they have delusions but retain normal beliefs too and can recognize the absurdity of other’s delusions. Previously, we have speculated that homeobox genes that pattern cortical

development could predispose individuals toward particular delusional content and not others. Psychological scaffolding is a potential cognitive mechanism for this encapsulation process. This speculation has much in common with Gerald Edelman's neural Darwinism and the idea that particular representational categories are sculpted through interaction with the world. Under the influence of aberrant prediction error, present during critical developmental periods, individuals would form aberrant bedrock beliefs or priors on which subsequent delusions are scaffolded.

Conclusion

In considering delusions, we had to make a number of simplifying assumptions. Taking a reductionist cognitive neuroscientific approach, we highlighted the importance of dysfunctions in predictive learning for delusion formation and maintenance. These same processes may account for the perceptual, affective, and social disruptions that attend delusions. In deluded individuals, the ability to use learned information to constrain current experience is impaired, resulting in aberrations of sensory and affective perception as well as cognition. Delusions arise as an explanation for these odd happenings and they engage new learning. They bring such relief that they are stamped into memory and become a new explanatory scheme for the sufferer, that is, delusions are elastic; they encompass new experiences and maintain a certain consistency of the world for the patient. In terms of the Bayesian model we outlined, delusions become the sufferer's new priors, and they are used to predict and explain future experiences. We believe that the same prediction error-driven learning mechanisms can account for the fixity of delusional beliefs, since, now, when subsequent physiological noise elicits a reactivation of the delusion, it is reinforced and reconsolidated more strongly.

However, Brendan Maher, Emeritus Professor of the Psychology of Personality at Harvard, astutely aligned delusions with scientific theories, suggesting that scientists, like individuals with delusions, were extremely resistant to giving up their preferred theories even in the face of damningly negative evidence. While the account outlined is a preferred (some might say cherished!) explanation of delusions, we hope to engender discussion, debate, and investigation. As Maher says

of science and psychosis: "Puzzles demand an explanation; the search for an explanation begins and continues until one has been devised." We hope this article provides some closure on the puzzle, but it is clear that we have much more explanatory work ahead of us.

See also: Alzheimer's Disease; Behavioral Pharmacology; Classical Conditioning; Free Will; Human Mating; Memory, Neural Substrates; The Mirror Mechanism; Motivation; Operant Conditioning; Reasoning; Schizophrenia; Surprise; Tickling.

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Dependent Personality (Disorder)

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Glossary

Agreeableness Personality trait defined by interest in maintaining social harmony. One of five general trait domains in the five-factor model of personality, and theoretically related to dependency. Low levels generally characterize individuals with personality disorder.

Autonomy Personality trait defined by low interpersonal orientation (separation and individuation from others) and high self-governance (e.g., making own decisions without others' advice). Some researchers hypothesize autonomy and dependency to be opposite ends of the same dimension.

Dependency (trait) Personality trait defined by the central motivation to locate and maintain affiliative relationships with specific individuals. Multiple models of dependency exist, but to varying degrees all emphasize lack of self-confidence coupled with overreliance on others. Some researchers hypothesize autonomy and dependency to be opposite ends of the same dimension. Trait dependency overlaps significantly with dependent personality disorder.

Dependent personality disorder (DPD) Personality disorder is defined in the DSM and ICD as pervasive patterns of inner experiences and behavior that are maladaptive, differ from the norm, and cause significant personal or interpersonal distress. In the DSM, Dependent, Obsessive-compulsive, and Avoidant PDs comprise the 'Anxious' cluster of personality pathology. Like trait dependency, DPD is characterized by a view of the self as incompetent/incapable, coupled with neediness and overreliance on others.

Diagnostic and Statistical Manual of Mental Disorders (DSM) Research-based manual published by the American Psychiatric Association (APA) that provides definition, description, and standardized criterion sets for the diagnosis of mental disorders. The current edition is the DSM-IV; 10 personality disorders are detailed on 'Axis II' of this manual. Modifications for the next edition (DSM-5) are currently under way.

Factor A component dimension of a larger structural model that is statistically distinct. A factor is defined by an interrelated set of variables such as items on a trait

dimensional measure, or diagnostic criteria such as those from dependent personality disorder.

Factor analysis A set of statistical procedures used to identify the component dimensional structure of sets of putatively interrelated variables (exploratory factor analysis) and/or to test the replicability of such a structure (confirmatory factor analysis).

Five-factor model (FFM) A dominant model of normal personality consisting of five general trait domains (factors): Neuroticism, Extraversion, Openness (to experience), Agreeableness, and Conscientiousness. The five factors have been shown to be relatively stable across time, culture, and gender, and nonhuman organisms, and provide a broad basis for conceptualizing normal and abnormal personality.

International Statistical Classification of Diseases and Related Health Problems (ICD) A manual published by the World Health Organization (WHO) that provides definition, description, and standardized codes for diagnosing all medical conditions, including mental disorders. The current edition is the ICD-10.

Personality disorders in the ICD roughly correspond to those found in the DSM. Modifications for the next edition (ICD-11) are currently under way.

Neuroticism The tendency to experience negative emotions such as fear, anxiety, anger, guilt, sadness, and irritability. One of five, general trait domains in the five-factor model, and moderately related to dependency in most research. High levels generally characterize personality disorders.

Personality disorder (PD) A diagnosis of a mental disorder currently defined as a pervasive pattern of maladaptive inner experiences (e.g., thoughts, feelings, motivations) and interpersonal behaviors that deviates from the norm (see 'DSM' and 'ICD-10').

Personality trait A defined set of interrelated thoughts, feelings, and behaviors that (1) describe an important quality of individual differences (i.e., can be used to differentiate one organism from another); (2) are stable over time; (3) are consistent across multiple environments; and (4) can be meaningfully linked to functional outcomes and/or behavior.

Dependent personality is defined diagnostically in the *Diagnostic and Statistical Manual*, 4th Edition (DSM-IV), as dependent personality disorder (DPD): "A pervasive and excessive need to be taken care of that leads to submissive and clinging behavior and fears of separation" (American Psychiatric Association, APA). Specific criteria include the following:

1. Difficulty making everyday decisions without excessive reassurance;

2. Dependence on others to take responsibility for important parts of one's life;
3. Difficulty expressing disagreement with others due to fear of losing approval or support;
4. Difficulty beginning and completing tasks/projects due to lack of self-confidence;
5. Excessive seeking of support from others;
6. Discomfort when alone due to fear of not being able to care for oneself;

7. Quick seeking of a replacement source of care and support when one close relationship ends; and
8. Preoccupation with fear of being left alone and inability to care for oneself.

Per the DSM-IV, an individual may be diagnosed with DPD if five of these eight criteria are met. DSM diagnostic criteria are similar to those defined by the World Health Organization in the International Statistical Classification of Diseases and Related Health Problems (ICD-10), which is used internationally to diagnose medical conditions. The ICD-10 requires only three or more of the following criteria for diagnosis:

1. Dependence on others to make one's important life decisions;
2. Subordination of one's needs to those of others on whom one is dependent (i.e., compliance);
3. Inability to make demands of others on whom one is dependent;
4. Feeling of discomfort when alone due to fears of not being able to care for oneself;
5. Preoccupation with fears of abandonment; and
6. Limited capacity for decision making without excessive advice/reassurance.

Both manuals also require that individuals meet general descriptions of personality disorder, which emphasize evidence of significant psychological distress, maladaptive behavior, relative stability of the disorder over time, and broad deficits affecting multiple domains.

A review of these criteria suggests the following basic components of DPD common to both diagnostic systems: First, individuals with DPD present with a self-image of inadequacy, helplessness, and inability to cope, and they view others as much more capable, able to cope, and dominant. Juxtaposed, these views of self and others lead to overvaluing significant relationships and prioritizing the needs of others to maintain the dependent relationships. Thus, DPD necessarily reflects a combination of personal and interpersonal deficits. Theoretically, this may lead to any number of behaviors – even seemingly ‘independent’ behaviors such as decision making – in service of maintaining affiliative relationships. However, the exact behaviors related to dependency have been somewhat less studied, and it is unclear how frequently behavior would deviate from the clinical pictures described in the DSM-IV and ICD-10.

In various forms, dependent personality has been included in all modern formal diagnostic systems. Historically, ‘dependent personality’ is linked to early Freudian theory, specifically to frustration in the oral stage during which the conflict of dependence–independence was expected to be resolved. Since that time, all versions of the DSM and ICD have referenced dependency and dependent PD (in the DSM): first as a subtype of passive–aggressive PD, later as a part of asthenic PD, and, finally, as a separate diagnostic category. Material from the DSM-5 website – which provides the most up-to-date proposals for changes to its psychodiagnostic models – also proposes the inclusion of dependency, although as component traits (submissiveness, anxiousness, separation insecurity) that may characterize personality disorder, rather than as a separate diagnostic category. The proposed change is representative of

a general shift in diagnostic methods from a categorical to a dimensional model for personality disorder, and is not specific to DPD.

Antecedent Validators for Dependent Personality Disorder

Very little research has been done establishing any clear antecedent to DPD per se, and data for biological or genetic antecedents are particularly sparse. Some evidence has suggested that dependent traits are consistent within families, but these results emphasized patterns of interactions and behaviors and did not identify DPD or define dependency specifically. Notably, dependency within families overlapped with avoidant PD traits, with which it shares both low self-esteem and need for social contact. Some researchers suggest that – despite this overlap – the fundamental distinction between avoidant and dependent PD is that, although both desire close relationships, those with avoidant PD nevertheless withdraw from contact. However, among the relatives of the DPD patients studied, withdrawal from contact was found in virtually the same frequency as the dependent characteristic of passively allowing others to assume responsibility for major life areas. On the other hand, the least frequently observed of all the avoidant and dependent criteria was the unwillingness to form relationships unless such relationships guaranteed acceptance, providing some measure of support for this avoidant–dependent distinction.

Nevertheless, in the aforementioned research, immediate family members of DPD-only patients were more likely to report high dependency as compared to control and ‘near neighbor’ samples. These data suggest that DPD patients may have some family-history liabilities. However, much more research is necessary to establish the aggregation of DPD/dependency within families. We did not find any twin or adoption studies examining the heritability of DPD, nor any examining biological or genetic material directly.

Similarly, little research is available on demographic or cultural factors that influence or characterize DPD, except for gender, with self-reported DPD reportedly more common in women than in men. Although the DSM-IV also makes this distinction, some evidence suggests that gender differences may be due to effects of gender stereotyping and/or sex-role identification rather than true differences. For instance, self-report and other rating scales are more likely to yield gender differences than direct behavioral observations of dependent behaviors, perhaps because it is more socially acceptable for women than men to self-report dependency. This hypothesis has yet to be fully explicated. Similarly, when gender is not specified in written patient descriptions that include dependency traits and/or dependency-relevant behaviors, diagnosticians are reportedly more likely to believe the patient is female. This suggests there may be some bias in attention and attribution of patients’ dependent behavior by clinicians.

Moreover, some researchers have not found evidence for gender bias in DPD using patient samples. Such studies also report on age, and find that as compared to other personality disorders DPD is more likely to occur in older patients (>40 years). It is unclear to what extent this is due to naturally

occurring reliance on others over time (e.g., strengthening family relations and decreased physical independence). Although numerous articles discuss the importance of culture in understanding and interpreting dependent behavior, especially in the psychological anthropology literature, this research is largely qualitative or theoretic-analytic. Very little formal research currently exists that examines pathological dependency, as it is conceptualized in DPD.

Much of the research in the epigenesis of DPD has focused on environmental risk factors. For example, research shows that male patients diagnosed with (vs. without) DPD are more likely to report poor home functioning and lower socioeconomic status (SES). The latter (low SES) has been replicated multiple times, and may be mediated by differing parenting styles reported in such families. Overprotective and authoritarian parenting styles may be particular risk factors for later development of DPD. For example, retrospective studies of family environments of females with histrionic and dependent PDs (relative to other psychopathologies and normal controls) have been conducted. These studies show that individuals with DPD reported high-control and low-independence environments compared to both groups. Another study showed similarly that high control and low expressiveness uniquely characterized the early family environment of females with DPD.

Overall, it is clear that little research exists establishing antecedents to DPD. What research there is often uses correlational models, which are insufficient to establish the direction of causality. Although some environmental risk factors have been implicated – most notably authoritarian parenting and control – it remains unclear to what extent such factors interact with or are the result of actions perpetrated by the individual, or are based on biased retrospective recall of individuals with DPD.

Predictive Validators and Treatment for Dependent Personality Disorder

There is no specific or established recommended treatment protocol for DPD. It is widely accepted that clients with personality disorder generally present with unique challenges to therapy, including increased distress and severity of symptoms. With respect to DPD, for example, patients with depression and comorbid DPD are more likely to report suicidal thoughts and attempts than are patients with depression alone. Patients with DPD also report significant functional impairment in their day-to-day lives. Such impairments include difficulty with (or lack of) decision making, task completion, and emotion regulation, and dependency often interferes with the ability to hold a job, complete education, or maintain healthy relationships with significant others.

Research on treatment generally falls into two categories: research protocols/reviews and individual-case or small-sample studies. Both sources suggest that DPD may be treated using cognitive-behavioral, interpersonal, or psychodynamic models of therapy. However, little research has been published using sufficient sample sizes to comment conclusively about specific treatments. In a recent review of treatment for cluster of personality disorders that includes DPD, results were based on only 15 studies of treatment effects for DPD with these

therapies. Results from this study showed little difference in treatment outcomes for specific PDs: all benefited the most from therapy that included components of social skills training, and few showed complete remission of symptoms. It has also been suggested that patient dependency may have an initial positive effect on therapeutic outcome (e.g., due to patients' efforts to please the therapist), but it is likely to inhibit progress over time because the patients' behavior is maintained through interaction with the therapist rather than by 'real-world' environmental outcomes.

In exception to the above, one large-sample study on personality trait change and personality predictors of change in depression severity (over a 20-session cognitive-therapy protocol) has been published. These researchers showed that trait dependency decreased significantly over the 20 sessions. However, higher initial trait dependency predicted less reduction in depressive symptoms for these clients. Overall, studies such as this typically do not report on DPD per se; instead, they report on traits theoretically related to DPD. Thus, treatment options and response to treatment have yet to be established for DPD.

Concurrent Validators for Dependent Personality Disorder

There are currently no published data on biological markers (e.g., molecular genetics, neural substrates) of DPD. In contrast, there is a fair body of research that addresses relations between DPD and other diagnoses, particularly depression. In fact, in the 1980s, researchers were suggesting that dependency and depression were so highly related as to be interchangeable for some clients. However, many such studies used dependency scales that are embedded within depression measures (e.g., dependency/self-criticism in the Depressive Experiences Questionnaire) rather than stand-alone measures of DPD or trait dependency. As such, it remains unclear to what extent DPD and dependency uniquely relate to depression.

In any case, later research suggests that DPD is more broadly related to psychopathology than just depression. Although some researchers replicated a strong relation between depression and dependency, literature reviews more typically reveal only moderate overlap between them; on the other hand, they find notable overlap of DPD with other psychological disorders, including agoraphobia, phobias in general and social phobia in particular, alcoholism, eating disorders, smoking, drug and alcohol abuse, suicidal ideation and attempts, and somatization disorder. DPD is also highly comorbid (overlapping or co-occurring) with other personality disorders, including avoidant and borderline PDs. Such studies strongly indicate that dependency can and does play a broad role in clinical diagnoses.

Research on this issue supports the role of DPD in the development and course of clinical disorders. When multiple DSM-IV disorders are assessed with structured interviews, DPD is typically associated with a broad range of disorders of many different types. Moreover, DPD is not specifically related to any particular disorders above and beyond their associations with other personality disorders. Taken together, these results suggest that DPD may reflect maladaptive traits that are important to virtually all personality pathology, and that it likely taps an even more general, cross-cutting psychological distress.

The DSM-IV states specifically that individuals diagnosed with DPD are likely to be also diagnosed with comorbid anxiety disorders, an association that was found early on and has continued to be supported by subsequent research. Significant relations have been found between DPD and generalized anxiety disorder, separation anxiety disorder, social phobia, obsessive-compulsive disorder, and panic disorder. It must be noted, however, that the meaning of DPD's overlap with anxiety disorders has been questioned because of methodological and conceptual concerns, most notably that dependency on others is a frequent concomitant of anxiety. As such, diagnosable DPD in these studies may reflect functional impairment due to anxiety rather than individual differences in dependency.

As noted previously, DPD also shares diagnostic similarity and comorbidity with other personality disorders, most notably borderline (BPD) and avoidant PDs (AVPD). Interestingly, relations with these disorders may be attributable to correlations between dependency facets (discussed further below) as found in trait measures and DPD criteria. That is, BPD appears to share the 'emotional neediness' component of dependency and even in 'remitted' BPD patients, DPD is more often observed than any other personality disorder (although this relation is not exclusive, as AVPD and self-defeating PD are also observed frequently in these samples). In contrast, AVPD appears to tap the 'perceived incompetence' facet of dependency. For example, in a factor analysis of all DSM-IV PD criteria, AVPD and DPD criteria form a single factor with minimal cross-loadings, which was termed 'neurotic avoidant.' Replications of this research show that AVPD correlates with DPD criteria that addressed perceived incompetence, but not with those pertaining to emotional neediness and attachment. These data underscore the fact that dependency may be conceptualized best as a two-facet dimension. It thus has been suggested that DPD can be differentiated from other PDs when the full dimensionality of dependency is assessed.

Dependent Personality Disorder and Trait Dependency

Dependent PD is one of only a few among the DSM-IV PD diagnoses that are both conceptually defined and empirically represented by a single personality trait, dependency, and its concomitant behaviors. In early analyses, multiple researchers found DPD to be among the more internally consistent of the DSM-III and DSM-III-R PDs, making DPD one of only three DSM-III and DSM-III-R PDs (along with antisocial and borderline PDs) that had sufficiently acceptable psychometric properties, including discriminant validity, to be considered measures of coherent dimensions that were distinct from other personality disorders. More recently, examinations of all the DSM-IV PD criteria using both exploratory and confirmatory factor analyses have been conducted. These studies have found that DPD was best represented by a single latent trait dimension in both types of analyses.

Thus, current research indicates that DSM-III, -III-R, and -DPD criteria, all essentially reflect the characteristics of a single dimension. Later analyses of the DPD criteria alone, however, have indicated that this dimension can be subdivided into two correlated factors. These factors have

been found by others as well, and have been termed variously as (1) attachment/abandonment, emotional neediness, active-emotional, insecure attachment, and separation insecurity; and (2) dependency/incompetence, self-perceived incompetence, passive-submissive, and submissive.

Importantly, DPD as defined in the DSM and trait dependency as defined in the personality literature bear more than definitional similarity. Studies that use both DPD and trait dependency measures consistently find similar results for these variables. In a meta-analytic review of relations between measures of personality disorder and the dominant model of personality, that is, the five-factor model (FFM), comparable results were found for studies that used self-report and interview measures of DPD, as well as trait dependency questionnaires. These data have been replicated multiple times, including in a meta-analysis of dependency and DPD measures in relation to the FFM. Follow-up research indicates that both trait dependency and SCID-II DPD scores accounted for similar variance in depression in an undergraduate sample.

Taken together, these results suggest that (1) DPD can be well modeled using a single trait dimension (perhaps with two subfacets) and (2) current measures of DPD and trait dependency are virtually interchangeable. However, it is noteworthy that, although dependency is well established as a risk factor for a range of psychological disorders, there is a paucity of research on this topic with DPD itself. Indeed, at the time of writing of this article, PsycInfo search of 'dependent personality disorder' in any field (e.g., abstract, keywords, title, etc.) yielded only 223 hits. This is in contrast to similar searches for other personality disorders, such as obsessive-compulsive, schizotypal, borderline, or antisocial PDs (574, 1248, 4765, and 4247 hits, respectively).

Trait Dependency, Temperament, and Normal Personality

Although most PD research suggests that personality pathology is best modeled using traits, it nonetheless can be argued that current trait models do not fully capture all information relevant to currently recognized personality disorders. This may be because models such as the FFM that are designed to reflect normal population variation fail to assess traits specific to personality pathology. Dependency is particularly problematic in this regard. Few measures of normal-range personality contain scales to assess dependency. Moreover, there is currently no official consensus regarding a working definition of dependent personality.

Of further concern is the inconsistency in the empirical relations between dependency and theoretically related traits. Specifically, it has been hypothesized that dependency, which is characterized by a need for approval and prioritization of others' desires, should relate reliably to the FFM trait of agreeableness – the tendency to be motivated by social harmony and minimizing conflict. Moreover, the placement of DPD in the 'anxious' cluster of personality disorders and the fact that the primary affective state associated with dependency is worry/anxiety, suggests a significant overlap with FFM neuroticism or negative affectivity (N/NA) – the tendency to experience negative emotions such as anxiety, sadness, and anger.

This is also reflected by inclusion of 'anxiousness' in the trait description of DPD proposed for the next edition of the DSM (DSM-5). However, only the latter theoretical relation (i.e., that with N/NA) has received empirical support, with one exception, described below.

In patients, moderately high neuroticism has been found to characterize those diagnosed with DPD. This is unsurprising, in that DPD criteria contain clear references to neuroticism correlates (e.g., discomfort, difficulty, and fear). Moreover, when comparing structures of PD and FFM traits from 33 previous datasets, researchers found DPD to have the highest loading on the largest factor, which was identified as akin to neuroticism. Similarly, DPD typically has a high (second or third highest) correlation with neuroticism in meta-analyses of PD–FFM relations. However, these data do not distinguish DPD from the other disorders that are also associated with high neuroticism; moreover, correlations between DPD and neuroticism tend to be moderate. As discussed later, lower order (aka facet-level) traits appear to be needed to diagnose DPD distinctly from other disorders.

In contrast, DPD neither loads (in factor analyses) nor correlates with agreeableness in most of the published research on this topic. Indeed, correlations with agreeableness generally fall in the near-zero range and, in some cases, stronger relations have been found between measures of DPD and the FFM when all agreeableness facets were removed, and neuroticism and conscientiousness facets were added. However, one recent study demonstrated that a 'maladaptive agreeableness' scale – created by altering agreeableness items so that they measure a maladaptive version of same content – correlated more highly, although still only moderately, with a wider range of dependency measures than did the original scale. Thus, somewhat different results might have been found in the other studies if 'maladaptive agreeableness' had been used. Alternatively, different results may obtain simply because the revised scale capitalizes on its conceptual and empirical similarity to neuroticism.

Models of Dependency

Four Factors

As noted previously, when modeled as a single trait, dependency is not well represented in trait models such as the FFM. However, current research suggests that dependency is best modeled as multiple factors. For example, current definitions hold that dependency has at least four principal interrelated components: *motivation* – strong desires to obtain and maintain supportive relationships with others; *cognition* – a perception of oneself as ineffective and incapable, in contrast to a perception of others as effective and capable; *affect* – anxiety and worry in the absence of support from others; and *behavior* – interpersonal yielding, and help and approval seeking. Theoretically, this description of dependency suggests an FFM. However, dependency items generally contain multiple domains, and to date there are no four-factor measures of dependency. Although the APA notes that self-reported dependency is higher in women than in men, there is no hypothesized, gender-based difference in trait content or structure.

Three Factors

In contrast to the four factors described above, early research conceptualized and assessed dependency as having three facets: low self-confidence and emotional reliance on others versus assertion of autonomy, which was thought specifically to assess the opposite or low end of the dependency dimension. The Interpersonal Dependency Inventory (IDI) is based on this model. The IDI autonomy scale's items suggest a pathological rejection of and inability to connect with others, and it is one of only a few attempts to capture the low end of dependency. However, recent research in student samples (some of which utilize the IDI) suggests that autonomy and dependency capture distinct trait variance, and are best modeled separately rather than as opposites.

Yet another three-factor model of dependency draws from interpersonal theory and the interpersonal circumplex (IPC), which conceptualizes interpersonal behavior as reflecting two underlying dimensions of agency and communion. This model also draws from the FFM, of which extraversion (the tendency to be sociable and to experience positive emotions) and agreeableness dimensions represent an alternative rotation of the IPC dimensions. The IPC model reflects three vectors of dependent personality: *love dependency*, characterized by warmth, nurturance, and a need for social interaction; *exploitable dependency*, characterized by being unassuming and by fear of judgment or evaluation; and *submissive dependency*, characterized by unassertiveness and the tendency to yield to others. The resultant measure – the Three-Vector Dependency Inventory (3VDI) – contains items to measure three types of dependency following this model.

It is important to note that, unlike other conceptualizations of dependency, these vectors all hypothetically stem from the same motivation – obtaining and maintaining personal relationships – as manifested in different behavioral and psychological strategies. The authors presented evidence that each dependency facet was associated with a relatively distinct behavioral phenotype (e.g., attachment style and behavior, parental representations, loneliness [in men only], location in the IPC). Further, data show that the FFM traits of openness and conscientiousness related meaningfully and differentially to the three dependency factors. Only high neuroticism typifies all three types of dependency, again suggesting that increased neuroticism is the FFM domain that most clearly and consistently marks *pathological* dependency.

Finally, a later study sampled more widely from the dependency domain, and proposed a model consisting of three single-dimension dependency-relevant constructs reflecting the four-factor multicomponent view of dependency. Thus, the Relationship Profile Test (RPT) models dependency as consisting of three types: destructive overdependence (pathologically high dependency), healthy dependency, and dysfunctional detachment. Contrary to frameworks that conceptualize dependency and detachment as opposing traits, the two dysfunctional types were found to be orthogonal rather than opposed. The RPT has shown moderate levels of test–retest reliability over 85 weeks and 3 years, as well as expected relations to measures of interpersonal relationships. Interestingly, it is also the only current measure to include a formal scale of 'healthy' dependency, or dependency as manifest in

normative interpersonal relationships (e.g., as in a marriage or in a family).

Two Factors

The concept of dependency as a multifaceted structure also is reflected in a considerable body of research on depression. Much of this research has used the term 'sociotropy' rather than 'dependency,' but the constructs appear to be nearly identical in that it emphasizes nurturance and an excessive need to please others. Factor analysis of the sociotropy items of the Sociotropy-Autonomy Scale (SAS) yields three distinct subscales: concern about disapproval, attachment, and ingratiation. Analyses of the (nonoverlapping) set of autonomy items yielded three different subscales. In contrast, later research presents a personality-based model of depression that relies heavily on two correlated dependency facets: dependency, or excessive reliance on interpersonal support; and self-criticism, or excessive emphasis on achievement and fear of failure. These bear superficial similarity to emotional reliance and low self-confidence, the two dependency scales of the IDI. Measures of depression typically do not emphasize autonomy as (negatively) related to dependency.

Several two-factor models for dependency have also been posited in the personality literature. First – and as noted in the RPT – one can conceptualize dependency at both adaptive (connectedness) and maladaptive (neediness) levels, a distinction also reflected by 'love dependence' and 'submissive dependence.' Another measure, the Dimensional Assessment of Personality Pathology (DAPP) also posited two components of trait dependency as separate scales in a multidimensional measure of personality pathology: submissiveness, which also encompasses low self-esteem and need for advice/approval; and insecure attachment, consisting of need for affection, security, and proximity to an attachment figure. The scales show high internal consistency and strong dependability (i.e., short-term stability) over a 3-week test-retest interval, and have been shown to relate meaningfully to other measures of dependency such as that of the Schedule for Nonadaptive and Adaptive Personality (SNAP/SNAP-2).

A two-factor structure for dependency was also found in factor analyses of the diagnostic criterion for DPD both with and without criteria from other PDs. When factored with criteria from other PDs, the DPD criteria did not cohere, but split between those reflecting incompetence or lack of self-confidence (DSM criteria 2, 3, and 4), which formed a factor with most of the avoidant PD criteria, and those reflecting emotional neediness and fear of being alone (DSM criteria 6, 7, and 8), which formed a factor with three criteria from borderline PD. These results were later confirmed by other researchers, who also conducted exploratory analyses using PD criteria from the DSM-IV. Again, most criteria from dependent and avoidant PDs grouped to form a single factor, which the authors named 'neurotic/avoidant.' Notably, this factor had the strongest negative correlation with daily functioning, suggesting that these types of dependent characteristics are quite detrimental to overall functioning.

Taken together, these results indicate that DPD as a diagnosis has a clear two-factor structure ('perceived incompetence' and 'attachment/abandonment') reflecting the distinction posited by the DAPP, but with two of the eight diagnostic

criteria – Criterion 1 (difficulty making decisions) and Criterion 5 (going to excessive lengths to ingratiate oneself to others) – not highly related to either factor. Similar findings emerged in a subsequent confirmatory factor analysis of DPD criteria alone, where a two-factor model of 'perceived incompetence' and 'dysfunctional attachment' provided the best fit for DPD. In these data, Criterion 5 again related only weakly to other criteria, and Criterion 3, difficulty expressing disagreement, correlated more strongly with avoidant than dependent PD. This suggests that the criteria for DPD could be best revised by eliminating Criteria 3 and 5, thus reducing the disorder's bifactorial nature. An alternative conclusion would be that the disorder is best represented by two trait dimensions.

Similar results have been found in student samples, suggesting that the structure of dependent personality (and DPD) is consistent across normal and abnormal populations. One such study combined and assessed all previously described measurement models, using measures consisting of one, two, or three dependency factors. Factor analysis at the scale level yielded three interpretable factors. The first factor consisted of both pathological dependency (e.g., SNAP-2 dependency scale) as well as lack of self-confidence or willingness to assert oneself in the presence of others (e.g., IDI low self-confidence), and was termed 'passive-submissive dependency' ('P-submissive'). The second factor primarily comprised measures tapping emotional neediness in personal relationships (e.g., 3VDI love dependency, DAPP insecure attachment), and was termed 'active-emotional dependency' (A-emotional). The final factor consisted of only two scales that measured theoretically low-end dependency, and was named 'detachment/autonomy' after the two scales' names. All but one scale loaded strongly on only one factor and the factors were moderately correlated, supporting the notion that dependency is at least bifactorial and not simply a single unified construct.

It is noteworthy that dependency scales purporting to reflect DPD as conceptualized in the DSM-IV (e.g., SNAP-2 dependency) all loaded solely or primarily on P-submissive (the first two scales also having moderate negative loadings on autonomy/detachment). This suggests that current self-report DPD diagnostic measures assess low self-confidence (P-submissive) more than emotional neediness (A-emotional), despite the fact that some of the diagnostic criteria for DPD appear to be highly affective/needy in nature. In fact, three (of its eight) DSM diagnostic criteria specifically mention neuroticism in some form. These results are in contrast to those reported previously, where DPD criteria formed two dimensions, which may be due to differences in the study methods: In the study finding two factors, the DPD data were derived in the context of a structured interview for all DSM-IV PDs, and were analyzed at the criterion level, thus increasing the possibility that a given set of PD criteria could load differentially on distinct factors, whereas in the student sample, the data were analyzed at the scale level, which may have favored emergence of the most dominant component of each scale.

One factor

Despite these results, DPD as a diagnostic category has remained a unitary construct, and measures assessing DPD as a disorder necessarily reflect this conceptualization. That is,

ultimately a diagnosis is either made or not made, and the categorical diagnosis does not reflect varying levels of dependency as a trait, nor is the possible bifactorial nature of dependency reflected in the diagnosis (i.e., the diagnosis alone does not indicate the balance of 'perceived incompetence' vs. 'dysfunctional attachment'). One such measure, the Dependent Personality Questionnaire (DPQ), was developed specifically to reflect DPD as in the DSM-IV and ICD-10. Although the authors also took into account research defining trait dependency, and the measure yields dimensional scores, the DPQ consists of eight items essentially reflecting the eight diagnostic criteria for DPD, and the criteria are used to provide a diagnosis. The DPQ was normed on a patient sample and showed high levels of specificity and sensitivity in this population, but its reliability over time has yet to be established.

Similarly, the DPD scale of the Wisconsin Personality Disorders Inventory (WISPI) is a self-report questionnaire rationally derived from the DSM-III-R PD criteria, and is intended to diagnose DPD from an interpersonal perspective, that is, based on interpersonal and trait theory. Nonetheless, the WISPI-DPD scale ultimately yields information about the presence or absence of dependency as a disorder, and not as trait dependency. The scale shows a high level of internal consistency in patient populations, has demonstrated acceptable levels of specificity and sensitivity, and relates meaningfully to established measures of dependent personality.

Notably, several recent measures of trait dependency also treat dependency as a unitary dimension. For example, the Schedule for Nonadaptive and Adaptive Personality, Version 2 (SNAP-2) contains a single unidimensional dependency scale, primarily reflecting decision making and (low) self-confidence, and includes few items assessing pathological attachment. This is similar to the way in which dependency is assessed by measures drawing strictly from the ICD-10 and DSM-IV. For this measure, internal consistency (α) in two psychiatric patient samples was very high, and retest reliability was acceptable across multiple time frames (e.g., 1 week, 1–3 months, 6 months) in a wide variety of patient and student samples.

Detachment/Autonomy

Although not technically part of dependent personality, detachment/autonomy appears regularly in the dependency literature (as detailed above) and thus deserves some mention in this article. Initially, detachment/autonomy and dependency may appear to exist along a single conceptual dimension. However, as indicated earlier, evidence suggests that – at least as concerns measures of detachment/autonomy that have been developed in the context of assessing dependency – they are uncorrelated phenomena with distinct variance. In studies of all personality disorder criteria, the criteria pertaining to aloof detachment and dependency do not form a single factor, and do not appear to represent a single dimension.

Notably, the scales reported in such studies represent only a portion of the larger body of research on trait detachment/autonomy, much of which exists separate from that on dependent personality. In general, results from studies on detachment suggest that detachment itself is a multifaceted construct that includes a dimension termed self-governance, which

correlated strongly with FFM extraversion and conscientiousness. Thus, it may be better to conceptualize the opposite end of pathological dependence simply as healthy levels of dependency rather than as pathological independence. However, more research is needed to confirm this conclusion.

Dependency and the DSM

DPD relates significantly to a wide range of psychopathology and, not surprisingly, trait dependency appears to have similar relations with these disorders. Specifically, in addition to being associated with DPD and other personality pathology, trait dependency has been linked also with mood disorders, suicidal ideation and attempts, anxiety disorders, eating disorders, and adjustment disorder.

Reconceptualizing DSM-V PDs dimensionally – more specifically, multidimensionally – would likely facilitate exploration of the role of personality in these disorders, without the difficulties entailed in examining comorbid diagnoses. As indicated earlier, many researchers have suggested using the FFM for assessing personality in DSM-V. Although this has the drawback that the FFM does not assess dependency per se, use of the 'maladaptive agreeableness' dimension would ameliorate this issue, at least to some extent. Dependency perhaps could more easily be evaluated as a facet or correlate of neuroticism, as is suggested in the proposed changes for the DSM-5.

Interestingly, some researchers have proposed inclusion of more specific FFM components to address the incomplete relation of FFM traits to current DSM-IV PD diagnoses. These components cast a broader net than standard FFM measures to encompass domains of functioning and the environment and to include basic tendencies, characteristic adaptations, self-concept, objective biography, and external influences. Inclusion of such components may provide an alternative framework in which to conceptualize personality disorder in general and traits such as dependency in particular. Some evidence supporting a more detailed approach to maladaptive-range personality traits has already been demonstrated. For example, the two factors of dependency (dependency/incompetence and attachment/abandonment) have been found to relate differentially to maladaptive cognitive schemas in patients. Similarly, more significant correlations are found between dependency and the FFM when more specific (facet) scales are used. The field would benefit from further research exploring relations of the identified two-factor structure of trait dependency with both the 'standard' FFM and an expanded FFM with coverage of the broader domains mentioned above. This is particularly true given that dependency is primarily viewed as a pathological trait, and thus is situated in and reflects current psychopathology research more than normal-range personality research. Integrative research that bridges across the adaptive and maladaptive ranges of this personality traits would be especially beneficial.

See also: Big Five Model and Personality Disorders; Personality, Structure; Psychopathology: Diagnosis, Assessment, and Classification.

Further Reading

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Depression

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Glossary

Anhedonia A lack of interest in daily activities, or the ability to gain pleasure from these activities.

Bipolar disorder An affective disorder that is divided into Bipolar I disorder, which is characterized by the occurrence of mania, and Bipolar II disorder which is characterized by hypomania.

Cardinal features Symptoms that must be present to qualify for a diagnosis of depression. The cardinal features of depression are either sad mood or a lack of interest in daily activities.

Epidemiology Information about the prevalence of disorders in a population. In the case of disorders such as depression, a prevalence rate refers to the number of people who have the disorder during a particular time period (e.g., the percentage of people in a given location diagnosed with major depressive disorder within a 1-year time period). Socioeconomic status differences are quite small.

Hypomania Episodes characterized by the same symptoms as manic episodes, but that are shorter and associated with less impairment.

Mania A state that frequently includes increased energy, inflated self-esteem, a decreased need for sleep, and involvement in potentially harmful activities.

Negative affectivity The tendency to be chronically distressed and to chronically view oneself negatively. Negative affectivity may be a precursor to both depression and anxiety.

Nosology The diagnosis of disorders into discrete entities with the assumption that each disorder that is nosologically classified will have a different cause, course, prognosis, and treatment response.

Unipolar disorder An affective disorder that is characterized by depression without any evidence for the occurrence of manic episodes.

Depression

Depression has been recognized for as long as history has been recorded. Indeed, in the fourth century B.C., Hippocrates described depression and located its cause in an excess of black bile. Descriptions of what appear to be depression can also be found in the Bible, while other historical references show that around 120 AD, Aretius of Cappadocia described sadness, suicidal tendencies, and apathy as symptoms of depression. More 'modern' accounts show that Freud's descriptions of melancholia resemble contemporary accounts of depression, and that he recognized that the emotional and psychological factors play a role in this state.

Today, depression means different things for different people. To many members of the general public, depression can mean feelings of unhappiness or sadness, for example, "I'm feeling a little depressed today." For mental health professionals, on the other hand, depression is a disease or a psychiatric disorder characterized by depressed mood that interferes with living, and that is associated with symptoms such as loss of appetite, lack of concentration, and suicidal thoughts. In 1987, Kendall, Hollon, Beck, Hammen, and Ingram summed up the various meanings of depression in this way:

The professional use of the term *depression* has several levels of reference: symptom, syndrome, nosologic disorder. Depression itself can be a symptom – for example, being sad. As a syndrome, depression is a constellation of signs and symptoms that cluster together (e.g., sadness, negative self-concept, sleep and appetite disturbances). The syndrome of depression is itself a psychological dysfunction but can also be present, in secondary ways, in other diagnosed disorders. Finally, for depression to be a nosologic category, careful diagnostic procedures are required during which other

potential diagnostic categories are excluded. The presumption, of course, is that a discrete nosologic entity will ultimately prove to be etiologically distinct from other discrete entities, with associated differences likely in course, prognosis, and treatment response.

(Beck, 1967, p. 290)

The focus of this article is the nosologically defined disorder of depression, in particular, the idea that depression, as it is used by mental health professionals, is an affective or mood disorder that exceeds normal sadness and mood fluctuations. Even more specifically, the focus will be on unipolar mood disorder or major depressive disorder, even though the other classifications of mood disorder will be noted.

Definition of Depression

Symptoms of Depression

Professional definitions of depression in the United States begin with the fourth edition, text revision, of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR). The DSM-IV is the official diagnostic classification system of the American Psychiatric Association and provides the criteria that are used to diagnose depression. The DSM-IV-TR will soon be replaced by the fifth edition of the DSM, but it is unlikely that any fundamental changes in the definition of depression will take place.

The 'cardinal features' of depression are either sad mood or a lack of interest in daily activities or the ability to gain pleasure from these activities (known scientifically as *anhedonia*). Cardinal features are those features that must be present before the disorder can be diagnosed. Beyond these cardinal features, symptoms of depression fall into several categories that are

Table 1 Symptoms of depression according to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn. Text Revision

1. Depressed mood for most part of the day
2. Diminished interest or pleasure in activities
3. Significant weight loss or gain, decrease or increase in appetite
4. Insomnia or hypersomnia
5. Psychomotor retardation or agitation
6. Fatigue or loss of energy
7. Feelings of worthlessness or excessive or inappropriate guilt
8. Diminished ability to concentrate or think
9. Recurrent thoughts of death, suicidal ideation, a specific plan, or a suicide attempt

grouped together based on their similarities. As would be expected, mood symptoms represent predominant features of depression and are reflected in sad mood. Motivational symptoms include behaviors that are related to goal-directedness. Depressed people often suffer a deficit in this area and some may find it difficult to do even the smallest task. Somatic symptoms refer to the physical changes that may accompany depression and include changes in sleeping patterns, appetite disturbances, and loss of sexual interest. Cognitive symptoms reflect the ability to concentrate and make decisions.

Symptoms of depression may vary according to an individual's age and culture. Children who are depressed, for instance, may express symptoms of irritability rather than sadness or they may fail to make expected weight gains rather than lose weight. On the other end of the age continuum, older adults are more likely than younger adults to experience symptoms such as loss of appetite, loss of interest, and thoughts of death. Cultural differences also exist in the report of depressive symptoms. One study, for example, found that depressed Jewish patients reported more somatic symptoms and less guilt than did non-Jewish patients. Another study that examined depressive symptomatology in American, Korean, Philippine, and Taiwanese college students found that Taiwanese students reported the lowest numbers of somatic symptoms and the highest numbers of affective symptoms. Hence, one's age and culture seems to affect not whether depression is experienced, but rather how it is expressed.

DSM-IV-TR lists nine 'officially recognized' symptoms of depression (see Table 1), although it is important to note that this list does not include all possible symptoms. Pessimism, for example, is often seen in depressed individuals, but is not included in the list. In order to receive a diagnosis of depression, the individual must evidence at least five of the nine symptoms, and one of these symptoms must be either depressed mood or anhedonia. Moreover, these symptoms must be experienced for at least a 2-week period before a diagnosis can be assigned. Given the five symptom cutoff for a diagnosis, it is important to note that even though there are nine recognized symptoms, not all depressed people will experience all nine of these symptoms.

The Relationship Between Depression and Anxiety: Comorbidity

Comorbidity refers to the occurrence of more than one disorder at the same time. Although researchers and clinicians

generally acknowledge depression as a distinct disorder, it does overlap with a variety of other difficulties such as substance abuse. However, much research on this overlap has focused on the relationship between anxiety and depression. This is not surprising, given the high rates of comorbidity found in studies of the two disorder types. One possible explanation provided for such overlap lies in the concept of 'negative affectivity.' Originally proposed in 1984, Watson and Clark described individuals with high levels of negative affectivity as having a tendency "to be distressed and upset and have a negative view of self, whereas those low on the dimension are relatively content and secure and satisfied with themselves" (p. 465). Other characteristics of high negative affectivity include nervousness, tension, worry, anger, scorn, revulsion, guilt, self-dissatisfaction, rejectedness, and sadness.

Both anxiety and depression seem to consist of high negative affectivity (general distress). There are, however, important differences between depression and anxiety. While both depression and anxiety are characterized by high levels of negative affect, only depression is related to low levels of positive affect. Thus, depressed individuals tend to display both high negative affect and low positive affect, whereas anxious individuals display high negative affect and may or may not have low positive affect. Anxious people are also untiringly characterized by physiological hyperarousal. These distinctions have been characterized as a tripartite model that describes those features that are common to both depression and anxiety as well as those features that are unique to each disorder.

Classification of Mood Disorders

Normal Depression

Depression can be classified on a continuum ranging from normal depression to major depressive disorder. Normal depression refers to the mood swings that every individual experiences and is usually expressed as sadness. Normal depression is generally viewed as a symptom and thus, beyond sad mood, few if any of the other depression symptoms are present.

Subclinical Depression

Subclinical depression is a more severe form of depression that includes not only sad mood but also some of the other symptoms of depression. There are differences in terminology, so subclinical depression is similar to 'minor depression' which is an exploratory category of possible depression diagnoses (discussed later in this article). Subclinical depression usually refers to an elevation of depressive symptoms that usually do not warrant treatment but that may nevertheless interfere with an individual's ability to function effectively.

Earlier the DSM-IV-TR was noted. Although there are a number of mood disorders included in DSM-IV-TR (e.g., 'mood disorder not otherwise specified'), the manual lists five major types of mood disorders. These include (1) major depressive disorder, (2) dysthymic disorder, (3) bipolar I disorder, (4) bipolar II disorder, and (5) cyclothymic disorder.

Major Depressive Disorder

As noted, for a diagnosis of major depressive disorder, DSM-IV specifies that at least five symptoms must occur for a period of at least 2 weeks. Major depressive disorder can be further classified according to *severity* (i.e., mild, moderate, severe without psychotic features, severe with psychotic features), *course* (e.g., single episode versus recurrent episodes), and *presentation* (e.g., with catatonic features, with melancholic features). Psychotic features of depression include such experiences as delusions (i.e., false beliefs) and hallucinations (i.e., sensory experiences which have no basis in reality). Catatonic features of depression involve psychomotor disturbances such as excessive movement or stupor. Melancholic features include the inability to experience pleasure even when good things happen and a lack of interest in previously pleasurable activities. No matter what the specific characteristics of a given individual's disturbance, major depressive disorder is, by definition, extremely distressing to the sufferer and is associated with significant impairment in important areas of the person's life (e.g., at work, home, or school).

Dysthymic Disorder

Dysthymic disorder is characterized by a chronic depressed mood which lasts at least 2 years in adults and at least 1 year in children and adolescents. According to DSM-IV-TR, this depressed mood is accompanied by at least two of the following six depressive symptoms: (1) poor appetite or overeating, (2) insomnia or hypersomnia, (3) low energy or fatigue, (4) low self-esteem, (5) poor concentration or difficulty making decisions, and (6) feelings of hopelessness. Because fewer depressive symptoms are required to make a diagnosis, dysthymic disorder is often considered a milder form of depression than major depressive disorder. However, it can be just as upsetting to the sufferer and can cause just as much impairment. In addition, when dysthymic disorder occurs along with major depression, the individual is considered to be suffering from a 'double depression.' The co-occurrence of major depressive disorder and dysthymia is not uncommon.

Bipolar I Disorder

The hallmark characteristic of bipolar I disorder is mania. According to DSM-IV-TR, a manic episode is characterized by elevated, expansive, or irritable mood that is persistent and distinctly different from normal elevated or irritable moods. This period is accompanied by at least three of the following seven possible symptoms: (1) inflated self-esteem, (2) a decreased need for sleep, (3) unusual talkativeness, (4) the feeling that one's thoughts are racing, (5) increased distractibility, (6) increased activity, and (7) involvement in pleasurable but potentially harmful activities (e.g., sexual indiscretions).

Bipolar I disorder is typically recurrent; according to DSM-IV-TR, additional episodes occur in more than 90% of individuals who have had a single manic episode. The manic episodes of those with bipolar I disorder are often intermixed with periods of depression. Like those with major depressive disorder, people with bipolar I disorder may exhibit psychotic, catatonic, and melancholic features as part of either their mania or their depression.

Bipolar II Disorder

Bipolar II disorder is characterized by periods of hypomania intermixed with periods of depression. Hypomanic episodes are characterized by the same symptoms as manic episodes. However, hypomanic episodes may be shorter (e.g., 4 days in duration) and are associated with less impairment. Whereas manic episodes may include psychotic features, interrupt daily functioning, and require hospitalization, hypomanic episodes typically do not. The depression experienced as part of bipolar II disorder, however, can be just as severe as that experienced in major depressive disorder and bipolar I disorder.

Cyclothymic Disorder

Cyclothymic Disorder is characterized by hypomanic periods intermixed with depressive periods that are not as severe as those experienced in major depressive disorder, bipolar I disorder, and bipolar II disorder. In cyclothymia, the periods of mood disturbance may alternate rapidly, with little respite from affective difficulties. For a diagnosis of cyclothymia, these periods of shifting moods must be problematic for at least 2 years in adults and at least 1 year in children and adolescents.

Exploratory Categories of Depressive Disorders

In addition to the five official diagnoses, DSM-IV-TR has denoted four classifications for further study that include depression as a significant component. It remains to be seen whether, and in what form, these syndromes will be included in DSM-V. Even though they are currently exploratory, they are described here because these may represent serious problems. They are (1) premenstrual dysphoric disorder, (2) minor depressive disorder (MDD), (3) recurrent brief depressive disorder (RBDD), and (4) mixed anxiety-depressive disorder.

Premenstrual dysphoric disorder

Premenstrual dysphoric disorder is characterized by several hallmark symptoms of depression (e.g., decreased interest in usual activities, depressed mood, difficulty sleeping, or sleeping too much) in addition to symptoms such as affective lability, feelings of being overwhelmed or out of control, and food cravings. In order to meet the criteria that have been proposed for this diagnosis, such symptoms must have occurred during the late luteal phase of most of a woman's menstrual cycles in the past year. As a number of authors have pointed out, such a classification has potentially serious social, political, and legal ramifications for women. For example, some have argued that if this classification is adopted as an official diagnosis, then women might be stigmatized as more unstable than or inferior to men. Arguments such as these keep the classification of premenstrual dysphoric disorder a topic of considerable debate.

Minor depressive disorder

MDD is characterized by fewer depressive symptoms than are seen in major depressive disorder. The level of impairment is also less than that associated with major depressive disorder. To meet the proposed criteria for MDD, a person must

demonstrate either a depressed mood or loss of interest and two additional symptoms of a major depressive episode. If this classification were included in future DSM editions as a disorder, it would constitute a residual category to be used only after the other mood disorders have been ruled out.

Recurrent brief depressive disorder

The principal difference between RBDD and major depressive disorder is one of duration. RBDD is characterized by periods of depression that meet all of the criteria for a major depressive episode except for duration requirement. While in major depressive episodes, symptoms must last at least 2 weeks, in recurrent brief depressive episodes, symptoms must last at least 2 weeks but less than 14 days. In addition, these brief episodes must occur at least once a month for 12 months to meet criteria for the classification of RBDD. RBDD is quite similar to major depressive disorder in its age of onset and family incidence rates, thus raising questions as to whether this should be considered a distinct disorder.

Mixed anxiety–depressive disorder

The impetus behind a mixed anxious–depressed category lies in the finding that there are many people suffering from symptoms of anxiety and depression who do not meet criteria for any DSM anxiety or mood disorder, but who are nonetheless significantly impaired by their difficulties. The classification of mixed anxiety–depressive disorder (MADD) is characterized by a dysphoric mood for at least 1 month in addition to at least four additional symptoms that primarily reflect anxiety (e.g., mind going blank, worry, hypervigilance). The primary argument in favor of adopting this proposed disorder is that it would cover the large number of people who have significant impairment linked to depression and anxiety but who do not fall into any currently existing diagnostic category. The primary argument against this classification is that people suffering from both depression and anxiety could in fact be categorized into already existing disorders with the use of more precise assessment methods.

Epidemiology

Epidemiology refers to information about the incidence and prevalence of disorders in a population, while a prevalence rate refers to the number of people who have a given disorder during a particular time period (e.g., the percentage of people in a given location diagnosed with major depressive disorder within a 1-year period of time). An incidence rate refers to the number of new cases of a disorder which occur during a given time period (e.g., the number of people diagnosed with dysthymic disorder during April 2010). Because the distribution of a disorder can be examined to determine whether it correlates with other factors or not, epidemiological information can be important for understanding some of the possible causes and correlates of depression.

To assess the prevalence, three major epidemiological studies have been conducted to determine the rates of psychiatric disorders, including depression, in the United States. The first, the National Institute of Mental Health Epidemiologic Catchment Area (ECA) study, interviewed more than 20 000

community and institutionalized adults in five sites, including New Haven, Connecticut; Baltimore, Maryland; St. Louis, Missouri; Durham, North Carolina; and Los Angeles, California. The second major study to examine the rates of psychiatric disorders was the National Comorbidity Survey; the third epidemiological study was the NCS-Replication which surveyed approximately 9000 individuals over the age of 18.

Prevalence

Prevalence in the United States

The ECA study found the lifetime prevalence of major depression (i.e., the number of people experiencing major depression during any point in life) to be 4.9% and the lifetime prevalence of dysthymia to be 3.2%. Alternatively, the national comorbidity survey (NCS) reported much higher prevalence rates: approximately 15% for lifetime major depression, while the NCS-R found a rate of 16.6%. Other studies have reported rates as high as 25%.

Discrepancies between studies are probably accounted for by different assessments, different definitions, and different samples. For example, differences between the ECA and the NCS studies can be found assessment instruments used, slightly different diagnostic criteria, and different age ranges studied (i.e., the ECA sample was 18 years of age or older, whereas the NCS sample ranged in age from 15 to 54 years). Given the various estimates across studies, Kessler has suggested that the actual prevalence rate of major depressive disorders is around 17%.

International prevalence rates

International lifetime prevalence rates vary widely across a variety of different studies (e.g., from a low of 3.3% in Seoul to a high of 15.1% among New Zealand residents aged 25–46). Such differences may indeed reflect true international differences in the occurrence of depression, but other factors such as cultural differences in the sensitivity of the instruments used to assess depression, and different sample ages may also account for this range. Some data on point prevalence (the incidence of a disorder at a particular point in time) are available from the WHO's international consortium on psychiatric epidemiology (ICPE). The ICPE seeks to consolidate data from international epidemiological surveys and finds that point prevalence rates are between 2% and 4% for various samples of adults across countries.

Gender, Age, and Culture

Gender

There are consistent and substantial gender differences in depression rates; roughly twice as many women as men suffer from major depression, and women tend to report more severe depression than men. Furthermore, the gender difference occurs in different and across demographic and cultural groups. These differences tend to be observed around the age of 12 or 13 years (around the time of puberty). Prior to this age, depression is uncommon, although when depression sets in, girls and boys are equally affected. Moreover, in adults, recurrence rates tend not to differ, so that even though women are more likely to experience an initial onset, once an onset has

occurred, men and women experience generally equivalent rates of depression. Additionally, there do not seem to be differences in the length of depressive episodes between men and women.

A variety of explanations of these gender differences have been proposed, although research has yet to confirm the causal validity of these possibilities. Biological views focus on hormonal explanations, genetic factors, and biological stress reactivity. Hormonal explanations, for example, note that many women experience mood disorders at times of peak hormonal change, such as puberty, the premenstrual phase of the menstrual cycle, and the postpartum period. Some psychological theories focus on greater interpersonal orientation; research suggests that women tend to be socialized and to be more likely than men to look excessively to others for reassurance. Another psychological variable, *rumination* (a persistent and obsessive thought about a certain topic) has been suggested to propel women into a cycle of negative affect that eventuates into a depressive state. Social explanations have also been proposed and focus on the greater likelihood that women experience from traumatic events (abuse) or chronic negative events (such as poverty or sexual harassment). Each of these is plausible, and it seems likely that gender differences will eventually be best explained by a model that integrates biological, psychological, and social explanations.

Age

Depression has an average age of onset in early adulthood, typically in the early to mid-20s, although some individuals experience depression at a later age. However, depression rates vary with age and gender. Not surprisingly, depression is more common in younger than older adults, with rates being highest for individuals from 18 to 45. Men have the highest rates among those aged 18–29, with a large decline in incidence for those aged 45 and older. For women, the incidence of major depression is highest for ages 30 through 44 and with declines in incidence not dropping substantially until age 65. For both genders, rates of first onsets are considerably lower for individuals over 65 years old. There are also differences in symptom patterns in different age groups, particularly at the extremes of these groups. Children who are depressed, for instance, tend to express symptoms of irritability rather than sadness and they may also fail to make expected weight gains rather than lose weight, which is more frequently seen in adulthood. On the other end of the age continuum, older adults are more likely to experience loss of appetite, loss of interest, and thoughts of death.

Culture

Despite the numerous studies on culture and depression that have appeared in the literature, Chentsova-Dutton and Tsai note that “it is sobering to realize how little we know about depression across cultures” (p. 378). It is thus not possible to do justice to all the issues involved in understanding depression across cultures, but we do address several different issues. It seems clear that although humans are more alike than different, those differences that are cultural in nature play an important role in depression. Culture can be broken down within countries, so that in the United States, for example, Latino, African-American, Asian-American, Native American,

and Caucasian groups may share a national identity but also share experiences that are common to these cultural and ethnic identities.

One important issue when considering depression and culture is the nature of the depression idea itself and how it might vary across cultures. That is, in some cultures, what might reflect depression is not expressed in ways that are in line with current diagnostic definitions. Hence, in some non-Western cultures, there may be a dominance of the somatic aspects of depression and a relative absence of the psychological components of the disorder. Physiological and psychological responses to stress may also differ for different groups. Clearly, cultural variables are important in understanding depression, but at this point, theory and research is far away from specifying these variables in their conceptual, empirical, and practical complexity.

Social and Environmental Correlates of Depression

These correlates refer to factors such as employment status, socioeconomic status, and marital status. Consider findings from the ECA study which found that people who were separated or divorced had higher 1-year prevalence rates of major depression (6.3%) than those who were currently married (2.1%). The 1-year prevalence rate of major depression was also higher for the unemployed versus those who were employed (3.4% vs. 2.2%). Additionally, the ECA study found higher rates of major depression among white-collar workers and those with at least 12 years of education.

Although all of these variables are important, consider marital status. According to the EPA study: “When current marital status, regardless of past history is considered . . . separated and divorced men and women have the highest rates” of depression. Why is this the case? There are several possible explanations, each of which may be true to at least some degree. One possibility is that marriage provides a protective effect against the stresses and strains that can precipitate depression; having a confidant may help people deal more effectively with the problems in their lives. Another possibility is that people who are prone to depression may lack the stability to successfully navigate the vicissitudes of courtship and then marriage. In this case, marriage may not have a causal relationship with depression but may instead simply reflect a correlation between two variables.

Theories of Depression

Stress and Depression

A variety of different theories of the causes of depression have been proposed. Before examining these theories, it is important to consider the role of stress in depression. Indeed, the link between stress and depression has been recognized for centuries. Research examining this link consistently finds a strong relationship between the experience of stressful life events and the onset of depression. Even though the link between stress and depression is well documented, the precise nature of this link is complex. As noted by Monroe and Hadjiyannakis, although most models emphasize the role of stress in the etiology of depression, it is also important to ask if stress

plays a role in the course of depression (e.g., degree and duration of symptoms). Another question concerns the nature of the stress that is associated with depression; sometimes, depression is associated with a major life event or several major events; sometimes, it is associated with chronic minor life events. Stress can consist of events that independently 'happen' to people, but data have also shown that depressed individuals may play a role in generating stress that prolongs depression and that may predispose to future depression.

However, not all individuals who experience significant stress develop depression, nor do all individuals who develop depression experience significant stress. *Diathesis-stress* ideas can account for these facts. Diathesis refers to a predisposition to an illness, and although not all models of depression emphasize a diathesis, most contemporary theories do make use of the idea to some degree. Stress and diathesis processes may be closely intertwined in that depression, and depression vulnerability, may affect stress responsivity; that is, psychological or biological predispositions to depression may affect how stress is perceived. Individuals who might have a predisposition to depression might therefore also have a predisposition to either perceive or experience stress in an exaggerated way. Furthermore, some approaches suggest an inverse relationship between stress and diatheses, such that as the degree or severity of the diathesis increases, less stress is necessary to initiate depression. Alternatively, both severe stress and a strong diathesis may be necessary to provoke depression.

Psychological Theories of Depression

Cognitive approaches

Cognitive theories of depression are among the most widely studied theories in the etiology of depression. One of the most influential of these theories was proposed by Aaron Beck in 1967. Beck's model argues that depression results from the activation of depressive *self-schemas*. These schemas refer to organized mental structures that, in the case of depression, are negatively toned representations of self-referent knowledge. Moreover, schemas guide appraisals and interact with information to influence selective attention, memory, and cognition. Although all persons evidence schemas, the schemas of depressed individuals are dysfunctional because they lead to negative perspectives about oneself, the world, and the future, or what Beck has termed, the *negative cognitive triad*.

An important aspect of Beck's model is that depressive schemas lay dormant until activated by relevant stimuli: "Whether he will ever become depressed depends on whether the necessary conditions are present at a given time to activate the depressive constellation." Thus, stressful life events are necessary to activate negative schemas, and once activated, schemas provide access to a complex system of negative personal themes that give rise to a corresponding pattern of negative information processing that eventuates in depression.

Learned helplessness and hopelessness theory

The helplessness theory of depression represents a cognitive theory that evolved from an earlier emphasis on learned helplessness in depression. This work began with Seligman who observed that animals which were unable to control negative events often developed behavior that resembled depressive

symptoms. Based on these observations, Seligman developed a theory of depression that focused on depressed individuals' expectations that they were helpless to control aversive outcomes. Even though much of the research on learned helplessness was supportive of the basic tenants of the theory (e.g., that depressed people tended to display more features of helplessness than nondepressed people), other research highlighted substantial shortcomings. In response to these shortcomings, the theory was later reformulated as an *attributional theory* which focused on how attributions about the causes of events were linked to depression. In 1989, Abramson, Metalsky, and Alloy further refined this theory into the *hopelessness theory* of depression to suggest that hopelessness depression represented a specific subtype of depression caused by the expectation that highly desired outcomes will not occur, or that highly aversive outcomes will occur, and the perception that no response can change the likelihood of these outcomes. Both Beck's cognitive model and the hopelessness model have received considerable empirical support.

Interpersonal approaches

Interpersonal approaches to depression focus on the interplay between a depressed person and his or her relations with others. The underlying theoretical idea is that depression is maintained by a vicious cycle that is caused by disruptions in interpersonal interactions. For instance, many depressed individuals understandably seek out social support from others, and initially, others are supportive. However, such support does not alleviate the negative feelings for long, or at all, and further support is sought. Rather than culling additional support, this intensified support seeking has the paradoxical effect of pushing away those who have been supportive. That is, as individuals begin to feel that their support capacity has been exhausted, they pull back from the depressed person, leading to an even further intensification of social support seeking, and the further distancing of potentially supportive people.

Biologically Based Approaches to Depression

Although related in important ways, genetic approaches to depression, biological approaches, and neuroscience perspectives and data are examined here individually. More broadly, both biological function and genetics are intricately tied to brain structure and functioning. To facilitate understanding, we discuss these variables separately, but it is important to keep in mind that these, and other, variables are closely intertwined. Additionally, given their central emphasis in much of the literature, norepinephrine and serotonin are highlighted here, but it is important to note that other biological variables (e.g., neuropeptides and cortisol) may also play a role in depression.

Genetic approaches

Genetic models propose that some of the variance in the onset of depression, at least in some cases of depression, is linked to genetic factors. Genetic models are generally informed by family studies, twin studies, and adoption studies. Family studies are based on the observation that depression runs in families. However, because families share both genes and environments, such studies cannot separate genetic factors from environmental factors. Twin studies, on the other hand, compare

concordance rates for *monozygotic* twins, who are genetically identical, to *dizygotic* twins whose genes are similar but not identical. Research shows that concordance rates for twins are, depending on the study, approximately twice as high concordance rates for dizygotic twins, thus suggesting a genetic component to depression. Adoption studies are a rarely used but powerful method for examining genetic effects. Adopted children are genetically quite similar to their biological parents, and hence evidence for a genetic role in depression is found when adopted children with a biological family history of depression are also more likely to experience a mood disorder.

Taken together, these types of studies have provided some estimates of the degree to which depression is influenced by genes. In general, the heritability of milder forms of depression ranges anywhere from 20% to 45%, with estimates for more severe cases of depression likely to touch as high as 70%. Heritability for recurrent or chronic cases of depression may also be higher than those for single episodes. Therefore, depending on the severity and type of depression, data suggest that heritability of depression is anywhere from moderate to high.

Neurotransmitters

Norepinephrine and serotonin

Data have shown that both catecholamine norepinephrine (NE) and indoleamine serotonin (5-HT) are involved in depression, and research shows that several possible areas of pathophysiological processes in depression are linked to 5-HT and NE. For example, low levels of a metabolite for NE have been found for some patients, while low levels of a metabolite for 5-HT have been found in some subgroups of depressed individuals. One important source of data for the role of 5-HT in depression comes from tryptophan depletion studies. Tryptophan is a precursor to 5-HT and, when depleted, diminishes the availability of 5-HT. Studies have shown that depressed individuals who respond well to selective serotonin reuptake inhibitors (SSRIs) are more likely to experience a return of symptoms with tryptophan depletion. However, tryptophan depletion for depressed patients not taking SSRIs does not appear to cause a worsening of symptoms.

Research clearly shows evidence of biological dysregulation in depression, but several qualifications are important. For example, although a variety of biological processes are disturbed in depression, these processes do not characterize all cases of depression, nor are they necessarily specific to depression. Some biological processes appear to be stable in some depressions, such as decreased 5-HT, but other processes appear to be more characteristic of the depressed state and tend to normalize in recovery. Moreover, there is evidence that the subgroup of individuals who show evidence of biological disturbances tend to be older and more severely depressed. Moreover, rather than a cause of depression, it may be that disrupted neurotransmitters serve as risk factors for depression rather than as primary causes. Hence, one way to think about disrupted biological function is within a diathesis–stress framework, in that these variables may be necessary for the onset of depression but are not sufficient to bring about the disorder until they are triggered by stress.

Neuroscience approaches

Neuroscience focuses on the neural processes that are linked to cognition and emotion. Although neuroscience uses a variety of methods, the use of imaging techniques such as functional magnetic resonance imaging (fMRI) has become increasingly common. fMRI assesses the role and function of brain structures and regions during various tasks by creating images caused by the oxygen in the blood flow to brain areas that are active during these tasks. As such, fMRI can help to map the brain circuitry that may be involved in depression.

Neuroscience approaches have tended to focus most attention on the prefrontal cortex, the anterior cingulate cortex, the hippocampus, and the amygdala. Even though these anatomical structures serve numerous functions and are interconnected in complex ways, several functions that may be particularly involved in depression are highlighted. For example, depressed individuals have been found to evidence left-side activation deficits prefrontal; such deficits may reflect the disruption of goal-directed activities that frequently characterize depression. Some studies have also found that the children of depressed mothers exhibit a similar left-side hypoactivation, suggesting the possibility of a genetic link to this brain abnormality. Like the prefrontal cortex, decreases in the activation of the anterior cingulate cortex have also been found in some depressed individuals and are thought to be linked to social withdrawal and anhedonia that is sometimes seen in depression. Other data have shown reduced hippocampal volume in depressed patients, suggesting the possibility of atrophy because the hippocampus contains high levels of cortisol receptors; cortisol, which is neurotoxic, leads to cell loss. This idea is in line with some data showing that hippocampal atrophy is correlated with the duration of depression.

The amygdala, which is another brain region that has been linked to depression, has been shown to be hyperactivated in depressed individuals, and has been hypothesized by some investigators to be responsible for the maintenance of sad mood states. Moreover, not only is the amygdala linked to the preservation of sad mood, amygdala hyperactivation may result from the failure of the prefrontal cortex to inhibit this region. Hence, failure of the prefrontal cortex to inhibit the amygdala may precipitate the maintenance of emotional information processing in depression that perpetuates sad mood and interferes with adaptive functioning.

Certainly, other areas of the brain are involved in depression, but the prefrontal cortex, anterior cingulate cortex, hippocampus, and amygdala circuit appear to play a key role in at least some forms of depression. It is important to note, however, that much is still unknown about the neural circuitry of depression. For example, it is unclear if deficits in these areas are linked to the cause of depression, might co-occur with depression, or might arise as a result of depression. Moreover, because these brain regions are densely connected, it is difficult to determine whether one region is primarily linked to depression, while other regions are more secondary. Additionally, some researchers hold out hope that patterns of brain abnormality may themselves lead to different subtypes of depression.

See also: Anxiety Disorders; Cognitive Behavior Therapy; Personality Disorders; Psychopathology: Diagnosis, Assessment, and Classification; Suicide.

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Relevant Websites

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- www.depression.com – GlaxoSmithKline.
- www.nimh.nih.gov/health/publications/depression – National Institute of Mental Health.
- www.depression-screening.org – Self-assessment tool for depression.
- www.webmd.com/depression – WebMD.

Depth Perception

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Glossary

Cue The signal or information in a two-dimensional image that can be used to infer or reconstruct the spatial relations in a three-dimensional scene.

Depth Refers to the distance between a viewer and an object as well to the distance between two objects that extend away from a viewer. This is the missing dimension when depicting a three-dimensional scene in a two-dimensional image, whether the image be a picture or the pattern of light projected onto the retina at the back of the eye.

Fovea An area of the retina in the center of each eye in humans (as well as in the eyes of many other sighted animals) containing the most densely packed array of light-sensitive neurons. High-resolution vision is only possible when light from an object falls onto the fovea.

Heuristic A method for solving a problem that begins by first making certain assumptions (e.g., a gradation of shading in an image that runs vertically from light to dark corresponds to a surface with convex curvature, but only on the assumption that light is shining from above the surface and the viewer).

Image A two-dimensional projection of a three-dimensional scene from a specific viewpoint.

Retina(e) The array of light-sensitive neurons at the back of the eye. Light rays passing through the cornea and lens of the eye are focused on the retina and these retinal neurons convert the light into electrochemical signals.

Retinal image The array of light projected onto the retina through the cornea and lens of the eye.

Introduction

Depth perception is the ability of humans and other sighted animals to see objects as having volume (as opposed to seeing flat silhouettes) and to see the relative position of objects in a three-dimensional environment (as opposed to in a two-dimensional picture). This ability is crucial for everyday action. Pushing an elevator button requires information about the button's location relative to our eyes, which acquire the information, and relative to our hand, which must make contact with the button. Picking up a coffee mug requires knowledge of the volume of the handle relative to the cup and to our hand. Thus, depth perception enables interaction with our immediate surroundings. It also grants us information about objects and surfaces that are more distant from us, enabling us to consider future actions. In this article, we review how scientists from several interrelated fields currently understand the problem of depth perception, concentrating on how it is accomplished by humans.

Depth perception is complex and still not completely understood. It begins with the two-dimensional patterns of light that are projected onto the retina, the array of light-sensitive neurons at the back of each eye. When considered in this way – as the problem of recovering the third dimension from a two-dimensional image – depth perception is what scientists refer to as an ill-formed problem. That is, there are infinitely many arrangements of three-dimensional objects that could lead to the two-dimensional array of light that is projected onto the retina. To break this impasse, the visual system uses a wide range of heuristics that are applied to the depth cues that it considers. None of these problem-solving techniques is perfect, but used in combination, they are able to hone in on the likely three-dimensional source of the retinal images.

This article divides depth cues into two broad categories: those cues that are only useful in determining depth for objects

relatively near the eyes and those that are reliable over a wide range of distance, both near and far from the eyes. This is an important distinction because humans have evolved a specialized set of mechanisms for near distance vision, capitalizing on the fact that some of the biological apparatus for seeing can alter the nature of the image before it reaches the retina. This includes changing the shape of the lens at the front of the eye to selectively focus the retinal image (accommodation), changing the relative gaze direction of the two eyes to select one of many possible depth planes for sharp focus (vergence), and integrating different images from the two eyes to form a composite binocular image in the brain (stereovision). It is probably not an accident that these structural cues are useful when objects are a short distance from our bodies, enabling us to use these cues when acting rapidly to intercept or avoid objects. Among the cues that are more generally useful, for both near and far vision, we have further distinguished between those that are based on changes in the retinal image that occur over time (depth from motion) and the so-called pictorial or monocular cues (here referred to as static cues to depth).

Specialized Mechanisms for Near Distance

The depth cues that are restricted in their range of distance to within about 3 m (10 ft) from the viewer are known as structural cues, because they involve alterations to the images on the retina by physical changes occurring in a single eye or in the anatomical relations between the two eyes.

Accommodation

The cornea and the lens at the front of each eye are both curved, so as to focus rays of light on the retinal surface at the

back of the eye. In order to form a sharp image at a given distance, the curvature of the eye's lens is adjusted through contraction of ciliary muscles that surround the lens, with greater curvature for near objects and reduced curvature for distant ones. This process is called accommodation.

In healthy humans between the ages of 2 months and 45 years, the eye's lens is maximally curved when focusing on objects about 20 cm away (8 in.), and is flattest when focusing on objects at a distance of 3 m or more (10 ft). Neural feedback from the ciliary muscles signals the degree of curvature of the lens, which is one indication of the current focal distance of the eye, and hence of the distance of the object the eye is currently focused on, which enables accommodation to be used as a depth cue.

The lenses of newborns are curved to focus on objects about 20 cm (8 in.) away and cannot accommodate for objects at other distances. However, by about 2 months, full accommodation is possible. The material of the lens begins to become more rigid by the age of 20 years and by the time most people enter their mid-40s, the accommodative range of the lens has been sharply reduced. This condition is called presbyopia and is the cause of the widespread use of reading glasses and graduated spectacles in people over the age of 45.

There is some controversy over the utility of this cue in everyday situations because changes in accommodation are rather slow and the neural signal from the ciliary muscles is limited in its resolution. A more likely way in which accommodation contributes to the determination of distance is through the amount of blur that is caused in the image when objects are out of focus. Indeed, observers in controlled experiments are able to judge the relative distance of two spots of light in a completely dark room using only one eye, presumably because when one of the spots of light is in focus, the other spot is slightly blurred.

Vergence

The retina contains a small region of tightly packed receptors at the center known as the fovea. In order to see an object at high resolution, the eye needs to be pointed directly at the object such that light reflected from the object falls on the fovea. This is known as fixating the object. Humans typically make three to five fixations every second, moving their eyes to a new location in order to sample up-to-date, high-quality information about the scene they are viewing. Because the left and right eyes are at different locations in the head, separated by 5–6 cm in an adult, each eye must move differently to fixate the same object.

When the eyes move from fixating a distant object to a closer one, they rotate slightly toward each other (convergence). This increases the angle of convergence between the two eyes, measured as the angle formed at the meeting of two imaginary lines projecting from the pupil of each eye. When the eyes move from fixating a close object to a more distant one, they do the opposite, turning away from each other (divergence). The overall degree of vergence (referring to both convergence and divergence) can be estimated by feedback from the extraocular muscles that control the position of the two eyes, and as such, vergence is a potential cue for determining the absolute distance between the object currently being fixated and the viewer.

The utility of vergence as a general cue to depth is limited, however, by several factors. First, the eyes are already maximally diverged for objects more than 6 m from the viewer, making it potentially useful only as a near distance cue. Second, fairly common eye conditions such as strabismus and amblyopia render vergence ineffective. Third, the signal from the extraocular muscles is quite coarse. Yet, like all the other depth cues, when vergence information is combined with that from other cues, the precision of depth perception improves in a synergistic way. Notably, vergence and accommodation in concert yield more accurate judgments of the distance from the viewer to a single point of light than either cue does alone. Vergence can even be seen working in concert with other depth cues when it is technically unnecessary. For example, research has documented that viewers change their vergence angle when merely viewing pictures. That is, even though all objects in a picture are the same actual distance from the viewer, viewers display greater convergence when looking at objects depicted as closer in the scene than when viewing objects depicted as farther away.

Stereovision

Because our eyes are 5–6 cm apart, the images projected onto each retina are slightly different. This difference in images is a cue to depth called binocular disparity, which enables the experience of depth through the process of stereovision. This process combines corresponding features in each retinal image into a single representation that includes information about distance from the viewer.

We are not normally aware that our eyes contain different images of the same scene, but this can be easily demonstrated. Hold the index finger of each hand in an upright position directly in front of your nose, with one finger about 20 cm away (9 in.) and the other finger about 40 cm away (18 in.). Now focus your eyes on the more distant finger and take turns closing and opening each eye. As you do this, the nearer finger will seem to jump from one side of the farther finger to the other. If you now open both eyes together you should see that there are actually two images of the nearer finger. This is binocular disparity, which enables an accurate perception of depth. The greater the horizontal distance between the corresponding images of the same object in the two eyes (the two images of the closer finger in this demonstration), the greater will be its perceived distance from the object that is currently at the center of the fovea in both eyes (the farther finger).

The positions of an object in the two retinal images are systematically related to the distance of that object from the object that is currently at the center of the two images in each eye. In comparison to the rays of light that project from the fixated object to the center of each retina, light from an object that is closer to the viewer will fall slightly to the right of center in the left eye, and to the left of center in the right eye (this is called crossed disparity). Light from an object that is farther away from the fixated object will do the opposite, falling slightly to the left of center in the left eye, and to the right of center in the right eye (uncrossed disparity). For any object that is fixated, there is an imaginary region of space encircling the viewer at the same distance, called Panum's area. Objects at this distance have no binocular disparity,

meaning that the rays of light projecting from them fall an identical distance from the center of the retina in each eye. As such, these objects also appear to be at the same distance from the viewer as the object currently fixated. Objects outside this region will appear to be nearer or farther, depending on whether they produce crossed disparity (for nearer objects) or uncrossed disparity (for farther objects) in the two eyes. Moreover, the size of the disparity corresponds to an object's relative distance from the fixated object. The process of stereovision, therefore, allows the brain to infer the relative distance of objects on the basis of both the sign (crossed or uncrossed) and the magnitude (size) of the image disparities in the two eyes.

Stereovision can be exploited to create illusions of three-dimensionality, such as seen in Victorian-era stereoscopes, the popular twentieth century Viewmaster series of children's toys, and the glasses worn by audience members at modern three-dimensional films. Though the pictures used in such devices always include depth cues other than binocular disparity, such as occlusion, relative size, and shading (see section on Static Image Cues), it is possible to create a compelling illusion of depth using only changes in disparity, which means that stereovision is a more powerful depth cue than the other structural cues. Bela Julesz invented random dot stereograms at Bell Laboratories in the 1960s to demonstrate this. More recently, the concepts used in making random dot stereograms have been employed to generate the fascinating images known popularly as autostereograms or Magic Eye™ images.

As the name implies, a random dot stereogram appears initially as nothing but a group of dots in a chaotic pattern. However, some of the dots have actually been horizontally displaced relative to one another, such that verging the eyes either in front of or behind the depth of the picture allows an illusion of depth to pop out. When the eyes are focused to the correct distance, each eye's image of the dots is roughly the same, yet some of the corresponding dots in each image are displaced relative to each other. This binocular disparity generates the experience that a subset of the dot pattern has popped into the foreground relative to other regions of the dot pattern that now appear to be in the background.

In addition to demonstrating that stereovision can function independently of other depth cues, random dot stereograms also point to the complexity of the brain's stereovision mechanisms. This is because in order to perceive depth in the pattern of random dots, the brain must somehow know in advance which dots in one retinal image correspond to the same dots in the other retinal image. This is known as the correspondence problem, and like many problems in human vision, it is paradoxically both an ill-formed problem and yet one that the brain seems to solve effortlessly. The fact that it is ill-formed means that in the absence of any information other than that contained in the dot patterns, there are an infinite number of possible ways to align any two retinal images. The fact that the brain solves the problem without effort is interpreted to mean that the brain must be using a priori assumptions about regularities in the environment to solve the problem. A major challenge for vision researchers is to determine what those a priori assumptions are. What is already clear is that the process of stereovision comes to a conclusion more rapidly and more reliably when it is informed by other depth cues, including the monocular cues to depth reviewed later in this entry.

Human infants do not appear to possess functional stereovision at birth, but it develops quite quickly. By the time infants are 6 months of age, most will display stereovision at essentially adult levels. Like the other physiological cues (accommodation and vergence), stereovision is only effectively useful within distances of about 3 m (10 ft) from the viewer. Also, for some of the same reasons mentioned in the discussion of vergence (e.g., conditions of strabismus, amblyopia), between 5 and 10% of the general population does not have usable stereovision because of imbalances in the nature and quality of the information contained in the two eyes.

General Mechanisms for Near and Far Distance

Most of the cues for human depth perception are useful across a wide range of distances. Among these are the cues that derive from motion of objects in the scene and from motion of the viewer, as well as the cues that derive from features in an image seen only by one eye. Here we refer to these single-image cues as static cues, in order to contrast them with the cues available from analyzing motion, but readers should note that they are also called monocular or pictorial cues, since they do not require two eyes and are often used by visual artists.

Depth from Motion

The world is often in motion, giving rise to several rich sources of depth information. For example, when a stationary viewer sees an object in motion, there are systematic changes in what is visible over time. At the leading edge of an object in motion, features of the background that were previously visible will suddenly vanish as the moving object occludes their view (called surface deletion), while at the same time, other features of the background that were previously invisible will suddenly appear (surface accretion). The features of the moving object will remain constantly visible during this time, unless the object is rotating, in which case the systematic deletion and accretion of its features can be used as cues to its three-dimensional shape. Surface deletion and accretion from motion are therefore powerful cues for segregating objects from backgrounds and for determining object volume. These two cues alone are likely the most powerful contributors to the compelling nature of motion pictures, which are not able to benefit from any of the structural cues to depth we have already reviewed, simply because all the information in a motion picture is displayed at the same actual distance from the viewer.

When a viewer moves relative to stationary objects in a scene, and the viewer's eye remains fixated on one object, there are a number of cues to help indicate the relative distance of the various objects in the scene from the viewer. These are collectively referred to as the depth cues from motion parallax. Relative to the object that is at the point of fixation, objects nearer to the observer will move across the retina in the same direction as the observer, while objects further away than the fixated object will move in the opposite direction. Furthermore, the closer an object is to the observer, the faster will its movement be across the retinal image. These changes in the direction and speed of the images of objects across the retina are very effective guides to the relative positions of objects, although less effective for judging the absolute distance of objects.

Motion parallax is not only useful when a viewer is actively and intentionally moving, such as when walking or selectively moving one's head and eyes, but can also be used to accurately judge the relative distance of objects when the viewer is moving passively, as when sitting in a train or in a car watching the world move relative to oneself. However, there are important differences between motion parallax caused by active and passive motion. Most importantly, passive viewers do not generate any muscular feedback from their voluntary actions to refine their passive reception of motion, so the judgments of distance made in such cases are less accurate than when motion is self-generated.

When an object rotates with respect to both its background and a stationary viewer, there is a systematic pattern in the motion of its various parts across the retinal image. These motion patterns contain rich cues for determining the volume of the object. For example, when a car turns toward us, the regions of the retinal image associated with its various parts will move at different speeds, with, for example, the headlight farthest away from us moving at a faster rate than the closer headlight. These differential rates of motion provide the brain with rich information about the relative distance between various object features, thereby allowing the perception of three-dimensional shape to emerge from an analysis of motion patterns alone. This object-relative motion cue was called kinetic depth by Hans Wallach, who first systematically studied the perception of three-dimensional shape that occurs when viewing the shadows of moving objects on a screen, and more recently has been referred to as structure-from-motion by researchers studying the computational complexity of the problem.

When an object moves toward or away from an observer, the size of the region it occupies on the retinal image also increases and decreases proportionately, which is a depth cue from motion known as looming. A particularly important aspect of this depth cue is how symmetrical the changes on each side of the image of the object are. Specifically, a looming image that is expanding symmetrically and rapidly is consistent with an object that will soon hit the viewer on the head. In contrast, a looming image that is expanding asymmetrically is consistent with an object that will move past the viewer without a collision. Human vision is extremely sensitive to looming cues, likely for good evolutionary reasons, and these processes occur largely without awareness.

Research on the development of sensitivity to the entire class of motion cues to depth indicates that these are among the most primary. Newborn infants show sensitivity to the surface accretion and deletion cues of relative motion, to motion parallax, to structure-from-motion, and to looming. Indeed, the newborn startle response to a looming image includes eye blinking, cardiac slowing, and neck and limb stiffening, as though humans are innately programmed to avoid collisions with other objects.

Static Image Cues

Many of the static cues to depth available in static images can be illustrated by considering the beach scene shown in [Figure 1](#).

Researchers have noted that one of the first simplifying assumptions humans make when viewing such a scene is to



Figure 1 This beach scene from Santa Monica California depicts many of the static cues to depth, including edge intersections, attached and cast shadows, familiar size texture gradients, proximity to the horizon, and aerial perspective. Specific examples of each cue depicted are given in the text.

ignore unlikely possible arrangements of the world. One such unlikely possibility in [Figure 1](#) is that the beach umbrellas are really very different sizes, and have been carefully cut out and positioned into a mosaic pattern, such that they are all at the same distance from the viewer. The visual system ignores this possibility in favor of the more likely interpretation that the umbrellas are all more or less the same size and shape, and that they are positioned at various distances, so that the nearer ones occupy a larger retinal size and occlude our view of parts of the umbrellas that are farther away. This is known as the generic viewpoint assumption, because we assume that the image would not change drastically if our viewpoint on the image were to change slightly. Note, in contrast, that even a small change in viewpoint on this scene would quickly confirm or deny the unlikely mosaic interpretation of the umbrellas. So, in the absence of any evidence to the contrary, humans tend to view scenes, including flat pictures, under the assumption that a small change in viewpoint will not alter the spatial layout of the scene. The generic viewpoint assumption is the basis of a compelling and surprising form of visual art known as anamorphic sidewalk or pavement drawings.

The static depth cues that must be considered in conjunction with the generic viewpoint assumption will be presented here, for convenience, along a continuum from local to global. By local, we mean that a cue can be considered quite reliably in

isolation from other regions of the image; by global, we mean that a cue is based on information distributed over a large region of the image.

At the extreme local end of this continuum are the junctions that occur when edges intersect with one another in an image. Edge junctions contain some of the most reliable cues to relative depth in an image. For example, in [Figure 1](#), the edges of the large orange umbrella near the center terminate where they meet the edges of the two umbrellas in front of it, forming T-junctions. T-junctions are formed whenever one edge occludes the view of a more distant edge. The edge in front is continuous, whereas the occluded edge terminates at the intersection, making this a reliable local cue to depth. T-junctions are generally considered to be a local cue for what is classically known as the depth cue of occlusion or interposition.

L-junctions are also quite reliable cues to surface relationships in the scene, but must be used in conjunction with a convexity assumption, which is the assumption that, in the absence of any other information, surfaces in the world are more often convex (bulging out) than concave (indented). The convexity assumption applied to L-junctions suggests that the side of the L with the smaller angle belongs to the surface that is nearer to the viewer than the side of the L with the larger angle. L-junctions can be seen in all of the umbrellas in [Figure 1](#), and invariably they occur when an umbrella lies in front of a surface that is further away from the viewer than the umbrella in question.

A second important class of local depth cues concerns the three-edge intersections (i.e., Y- and arrow-junctions) that occur when surfaces are joined together at corners. Corners are extremely useful pieces of information about the three-dimensional shape of objects, and tend to be interpreted in the absence of other information as being convex rather than concave. Note in [Figure 1](#) how the three-dimensional shape of the orange umbrella is revealed by the intersection of its ribs. These edge intersections are ambiguous with regard to convexity–concavity when considered in isolation, but in conjunction with the convexity assumption, they provide rich information about the umbrella shape.

Shadows also convey information about depth. Researchers have found it important to distinguish between attached and cast shadows. In general, the region of a uniformly colored object that is relatively darker than other regions is said to be an attached shadow, so called because this region of the object is being blocked from receiving direct light by other parts of the same object. Attached shadows are particularly useful for determining the three-dimensional shape of objects. For example, in [Figure 1](#), the shadows on the white T-shirt of the young man standing near the front of the picture reveal the shape of his torso. One critical ambiguity that must be resolved in order to use this information to determine the three-dimensional shape of the surfaces is the direction of the light source. All things being equal, the visual system usually assumes that the light in the scene is assumed to be shining from above, which means that if the object has a convex surface, the region of attached shadow lies toward its bottom. However, if the light was actually shining from below, then the same pattern of image shading would indicate a concavity, and the assumption of light shining from above would lead us into error. The interrelatedness of these assumptions in human depth perception can be vigorously exercised by viewing the hollow mask

illusion, which occurs when our assumptions of convexity, light generally coming from above, and the familiar shape of faces come into conflict with one another.

Cast shadows help resolve this problem. This can be seen in [Figure 1](#), where the shadows cast by the umbrellas indicate that the sun is almost overhead. Cast shadows provide less information than attached shadows do about the three-dimensional shape of the object casting the shadow, because the shape of the shadow is dependent on both the position of the light source and the shape of the surface they are cast upon. However, they do provide a high-fidelity source of information about the relative positions of the objects in the scene with respect to the light source. The position of the inferred light source can then be used to more accurately judge the shape of objects on the basis of their attached shadows.

Cast shadows are also a rich source of information with regard to relative object position. For example, if a cast shadow borders directly on the object that is casting it, then the casting object is very likely resting on the shadowed surface. On the other hand, if there is a gap between the cast shadow and its casting object, then the casting object must be farther from the surface. The distance between an object and its cast shadow is therefore a cue for their relative positions in space. If this cue is combined with motion, it can be used to create powerful illusions.

Another, somewhat more global, static cue to depth can be derived from comparing the relative retinal size of the images cast by similar objects. In general, it is safe to assume that when two objects of a similar actual size differ in their distance from the viewer, the nearer object will project a larger retinal image. But note that the constraint of objects being of similar actual size rests on its own assumption, namely that the viewer is familiar with the objects and therefore knows that their sizes are similar. When this assumption of familiar size is met, as it is for our perception of the people in [Figure 1](#), then we can reliably see the people of smaller retinal size being farther away in the depicted scene. When some of these interrelated assumptions are violated, as occurs when two objects of similar size are depicted in different apparent locations from the viewer, then even familiar people can appear to vary greatly in their perceived size, as occurs in the Ames Room illusion.

An even more global version of the familiar size cue to depth occurs when linear perspective is used to infer relative distance in a scene. Just as objects of the same size will have smaller retinal sizes as they move further away from the observer, so too will parallel edges in a scene converge toward the horizon as their distance from the viewer is increased. The point at which these lines converge, either within the frame of an image or outside of it, is known as the vanishing point, and corresponds to infinity as far as depth perception is concerned. Note that these lines may be explicit, as occurs when depicting architectural drawings, or they may be implicit, as occurs if we look down a road bordered by trees of a similar height. Here the imaginary lines connecting the tops of the trees converge with the imaginary lines connecting the trunks to the ground at the vanishing point. Linear perspective is the depth cue developed most vigorously in Western art made since the time of the Renaissance until the invention of photography. It is especially effective when used to depict the depth relations among carpentered objects, presumably because these objects tend to have

many parallel edges to calibrate the interpretation of depth. When straight lines cannot be assumed in a carpentered scene, then our tendency to interpret the scene as containing linear perspective can go awry, leading to tantalizing ambiguities and even outright impossibilities, as in the art of M. C. Escher.

When the depth cue of linear perspective is combined with the depth cue of the relative retinal size of familiar objects, it leads to a global depth cue called the texture gradient. A texture refers to any collection of objects in an image, and a texture gradient refers to the pattern of changes in the relative size and spacing of these objects. For example, the beach umbrellas depicted in [Figure 1](#) form a semiregular pattern, becoming smaller and closer together in the retinal image as they correspond to actual umbrellas that are more distant from the viewer.

Texture gradients inform the viewer about depth through gradual changes in image size and spacing, as seen in the beach umbrellas in [Figure 1](#), and the discontinuities in the gradient are themselves informative because they indicate a sudden change in the orientation of a surface relative to the observer. For example, if we are in a room that has been tiled consistently on the floor and wall, we can use discontinuities in the texture gradients to determine changes in surface orientation. These occur where the floor meets the wall and where one wall meets another wall. In the famous study of human infant's sensitivity to a visual cliff by Eleanor Gibson and Richard Walk, only a texture gradient was used to signal to the infants that the surface beneath the glass floor they were crawling on consisted of surfaces at two different distances.

At the most global end of the continuum are several static depth cues that require a comparative analysis of almost the entire visual field. Proximity to the horizon (also known as relative height or height in the plane) refers to the observation that objects that are nearer to the horizon are generally seen as being farther away from the viewer than are objects that are farther away from the horizon. This means that below the skyline, more distant objects tend to be higher in the retinal image. Thus, in [Figure 1](#), the people in the water are seen as more distant than the man in the white T-shirt. Above the horizon, these relationships are reversed, with nearer objects in the scene being higher and more distant objects being closer.

Finally, aerial perspective is a global depth cue that is based on relative differences in contrast and color rather than on size or spatial position. When light travels through the air, it is either scattered or absorbed by various particles. This means that the light from distant objects travels through more air before reaching our eyes than the light reflected from nearby objects, with the consequence that less of a distant object's reflected light reaches the eye. As such, distant objects will tend to be more blurred than nearby objects (relative contrast), and they will tend to be darker (relative brightness). They will also have a bluish tinge (relative hue), because air molecules scatter shortwave blue light to a greater extent than light of longer wavelengths, and some of the blue light from the sun is scattered toward the viewer. This can be seen in the hills at the top of [Figure 1](#).

Not surprisingly, given the complexity and interrelatedness of the static cues for depth, these cues tend to appear more slowly in human development than the structural and motion-based cues. Sensitivity to edge intersections develops relatively early in life, with research suggesting that by 3–4 months infants are responding to T-junctions in an adult-like manner.

However, it is not until 6–7 months that most infants can respond reliably to linear perspective, texture gradients, familiar size, or shading. The reliable use of cast shadows may not be fully developed until 3 or more years of age.

Depth Perception in the Brain

There is currently much scientific interest in understanding how the various cues for depth are processed and combined by the neurons of the brain. The cue that has been studied most thoroughly in this regard is binocular disparity, which, as discussed in an earlier section, is critical for the computation of stereovision. Neurons that are tuned to specific binocular disparities have been found in numerous regions of the visually sensitive cortex of primates (including humans). Roughly speaking, the further removed these neurons are from the eye (by virtue of the number of synapses that must be crossed for information to reach them), the more accurate and refined is the stereovision they exhibit. Neurons in area V1, the first stage of cortical visual processing, are sensitive to stimuli in the two eyes that satisfy very loose criteria of similar disparity. Neurons in the next cortical region, area V2, function under stricter criteria, implying that more of the correspondence problem has been solved at this point. In keeping with this trend of increasing sophistication of processing as we move away from the eyes, neurons in higher cortical regions are also specialized to different *kinds* of disparity. For example, one class of neurons may respond only to abrupt changes in depth, whereas other neurons may register more continuously graded changes.

Conclusion

This review of depth perception in humans has emphasized what is currently known about the way various physical factors – both in the structures of the eye(s) and in features of the image – are used by the brain to achieve the experience of depth perception. The review organized depth cues into two broad categories: those specialized for depth at near distances, where direct bodily interaction with other objects is most likely, and those cues that work at any distance from the eyes. The near cues included changing the shape of the eye's lens (accommodation), changing the relative gaze direction of the two eyes (vergence), and integrating disparate images in the two eyes (stereovision). Among the cues more generally useful for both near and far vision, the review further distinguished between those that involve changes in the retinal image over time (depth from motion) and those that are effective when they appear in a picture (static image cues).

See also: [Visual Motion Perception](#); [Visual Perception](#).

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Developmental Psychopathology

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Glossary

Behavioral genetics A methodology for establishing the genetic and environmental bases of individual differences in observable behaviors or traits.

Equifinality Phenomenon in which different pathways may lead to similar expressions of pathology, that is, different initial states can lead to similar end states.

Etiology The causal processes and mechanisms underlying the development of a behavior or trait.

Heterotypic continuity Process when underlying mechanisms remain constant while the actual type or form of the manifested behavior changes with development.

Homotypic continuity Process when an observable behavior remains constant while the underlying mechanism causing the behavior changes with development.

Mediation Statistical model that seeks to explain the relationship between an independent and a dependent variable with the inclusion of a third explanatory (or mediating) variable.

Molecular genetics Study of association and linkage between DNA variants and observable behaviors and traits.

Multifinality Phenomenon in which similar initial pathways may result in different forms of dysfunction; that is, similar initial states lead to multiple possible end states.

Phenomenology Study of individuals' subjective experiences of an event, that is, an individual's unique experience of a psychological disorder.

Psychiatric comorbidity The co-occurrence of two or more diagnosable psychological disorders within one individual.

Psychopathology Atypical and/or maladaptive behaviors and mental/emotional processes.

Introduction

Psychopathology and its associated interpersonal, emotional, and financial costs impact society at multiple levels and across a variety of domains. Research investigating the causes, course, and outcome of psychopathology has the potential to provide enormous benefits to afflicted individuals, their families, and society in general by informing innovative and specialized prevention and treatment strategies for a variety of different disorders. Developmental psychopathology has emerged as a leading scientific framework for identifying the dynamic exchange processes that influence both adaptive and maladaptive behavior.

The developmental psychopathology perspective represents an integration of several distinct scientific disciplines, including genetics, neuroscience, and psychiatry, as well as experimental, clinical, and developmental psychology. Scientists working within this framework aim to use these multiple levels of analysis in order to uncover the mechanisms that give rise to and maintain psychological disorders. This work is anchored on the perspective that the processes underlying typical and atypical development are mutually informative. That is, the continuity between normality and pathology (or adaptive and maladaptive behavior) as well continuity among the underlying causal mechanisms is emphasized.

This article aims to provide an introduction to the developmental psychopathology framework, including discussion of its key concepts and principles, as well as potential challenges to psychopathology research. Antisocial behavior is then discussed as an example, in order to further illustrate the ways in which developmental psychopathology research is advancing knowledge regarding the phenomenology, etiology, and treatment of psychiatric disorders.

Key Concepts, Principles, and Challenges

The principles of developmental psychopathology have become main stream in both the larger fields of psychiatry and clinical psychology. At its core, developmental psychopathology is the broad study of the processes involved in the emergence and course of maladaptive behaviors. While there are many features encompassing the developmental psychopathology perspective, the key concepts and principles involve (1) the approach to the study of causation; (2) the heterogeneity of cause, course, and outcome; and (3) the emphasis on the trajectories and continuity between typical and atypical development.

Causal Processes

Unlocking the etiological factors that give rise to psychopathology undoubtedly offers great potential for advancing treatment and prevention. Recognition of the influence of genetic factors on psychological disorders and the innovation of behavioral genetics has greatly contributed to these efforts. Behavioral genetics, which relies on differences in genetic and environmental relatedness among family members to estimate genetic and environmental effects on a given condition, has been able to quantify the magnitude of genetic and environmental influences on virtually all forms of psychopathology. Advances in molecular genetics, specifically the mapping of the human genome, has inspired work seeking to identify specific DNA variants that may contribute to psychopathology. Importantly, for both behavioral and molecular genetics, influences from genetic and biological factors are typically conceptualized as *probabilistic* (rather than deterministic).

Consistent with the latter perspective, psychosocial and environmental risk factors are also thought to be essential to the development, course, and outcome of psychopathology. These include main effects related to prenatal development, the family environment, as well as neighborhood, community, ecological, and sociocultural elements. In addition, there is growing interest in understanding the exchanges between biological and environmental factors that confer risk and/or protection for psychopathology via studies of gene–environment interplay. Examination of this interplay has been pursued specifically via studies of gene–environment correlation (rGE) and gene x environment (GxE) interaction processes – two related but distinct mechanisms by which genetic and environmental factors influence one another. rGE refers to the extent to which an individual's genetic makeup influences their exposure to particular environmental factors. Alternatively, GxE interaction describes genetic differences in sensitivity to environmental exposures, such that certain environments only contribute to psychopathology for individuals with particular genetic variations. Work examining both rGE and GxE effects for psychopathology has surged in recent years and positive findings have effectively demonstrated that genetic and environmental factors do not operate in isolation from one another. This work has also has reframed the nature–nurture debate in psychology and behavioral sciences by adding weight to a growing consensus that both genetic and environmental factors are important in human development.

Heterogeneity

Two essential concepts, *multifinality* and *equifinality*, are key to the principle of heterogeneity in developmental psychopathology as it relates to causal mechanisms. *Multifinality* refers to the notion that a single risk (or protective) factor can result in multiple outcomes, whereas *equifinality* refers to the idea that a single behavioral dimension or category of psychopathology is influenced by multiple risk factors. Put another way, it is unlikely that a single risk or protective factor will be the sole necessary cause of one specific type of behavior or psychopathology. This greatly complicates the task of researchers attempting to understand the causes of psychopathology, and yet it is critically important for untangling the various causal pathways which can result in disorder across individuals.

In addition to heterogeneity in causal mechanisms, it is also important to consider heterogeneity in terms of behavioral presentation. The types of behavioral symptoms present at any one time, as well as the onset, course, and responses to treatment, often differ even within similar behavioral dimensions and/or diagnostic categories. Thus, subtyping forms of psychopathology in terms of symptom profile, onset, and course has become one particularly common and useful method for focusing on more etiologically homogenous subgroups within more multifaceted or multidimensional forms of psychopathology.

Developmental Continuity and Discontinuity

The developmental psychopathology perspective also highlights issues of continuity and discontinuity between normality and pathology. That is, developmental psychopathology is

focused upon understanding the dimensional aspects of behavior (i.e., the mean and the extremes), as well as the mechanisms that contribute to the etiology of behavioral continua. The primary notion here is that atypical or maladaptive behavior cannot be understood outside of the context of typical development and that each is mutually informative. The study of typical development has served to refine our understanding of psychopathology across many domains. For example, the emergence of theory of mind (i.e., the ability to attribute mental states to oneself and others) has been shown to be an important milestone of cognitive development in early childhood. Deficits in the development of theory of mind are now widely recognized as one core feature of autism spectrum disorders. In short, we cannot identify particular behaviors as psychopathological if we are not yet clear on which behaviors are normative at a given age. Importantly however, while the underlying liability for psychopathology may be conceptualized as dimensional, categorical decisions are often required for clinical and practical purposes (e.g., diagnosis and treatment).

In addition, the developmental context for behavior is an important consideration for the examination of psychopathology. The relative frequency or commonality of behaviors often changes with the developmental stage and what is typical at one stage may be atypical (or maladaptive) at another. Identifying specific trajectories of behavioral development (both common and atypical) may then also aid in making distinctions between normality and psychopathology. This distinction is critical for identifying maladaptive behavior itself, as well as for identifying the individuals that may be at risk for the development of further problems versus those whose atypical or problematic behavior may be more likely to remit with age and development.

Challenges

While the developmental psychopathology framework has provided numerous advantages for the examination of maladaptive behavior, multiple challenges (both theoretical and practical) remain. Put another way, the developmental psychopathology framework has also aided researchers in identifying specific issues that may introduce potential confounds or may complicate the interpretation of findings within the field.

Measurement

Developmental psychopathology research often relies on informant-based approaches on various measures (e.g., questionnaires, interviews, etc.) and is often limited by the extent to which individuals are reliable reporters of their own and others' behavior. The measurement of these behaviors is also sensitive to the informant's own expectations and the understanding of 'problematic behavior,' as well as their exposure to or familiarity with specific behaviors within a particular developmental context.

Heterotypic and homotypic continuity

Heterotypic continuity refers to the notion that the underlying mechanisms or processes that contribute to psychopathology may stay constant whereas the behavioral manifestation of that liability may change with development. By contrast,

homotypic continuity indicates that the behavioral manifestation may stay constant whereas the underlying mechanisms and processes may change with development. Longitudinal work that considers the developmental context and trajectories of maladaptive behavior across time and development is thus necessary for attempting to disentangle these processes. Such work is difficult for researchers to conduct, however, and thus heterotypic and homotypic continuity remain challenges for developmental psychopathology research and theory.

Comorbidity

In addition to issues with causal continuity, the co-occurrence or overlap between various (and presumably independent) forms of psychopathology remains an important issue for developmental psychopathology researchers. Maladaptive behavioral dimensions tend to be correlated with one another and may represent different manifestations of the same underlying liability. Alternately, there may be specific types of comorbidity patterns that represent etiologically distinct forms of psychopathology. In fact, comorbidity among psychiatric disorders is often the rule and not the exception and thus remains an important consideration. Indeed, by complicating the clinical picture, the presence of comorbidity can make it more difficult to identify the etiology, course trajectory, and specific impairments associated with any one particular disorder.

Sex differences

One final challenge related to developmental psychopathology work involves sex differences in frequency and behavioral expression. For example, autism and developmental delays tend to be more common among males whereas depression and anxiety tend to be more common among females. Similarly, the behavioral expression of aggression looks quite different across sex: whereas as boys are more likely to engage in physical aggression, girls are more likely to engage in social aggression (e.g., gossip, name-calling). Questions remain regarding whether these differences are due to sex or gender differences in terms of behavioral expectations and developmental context, sex differences in biological, cognitive, or social development, or potential sex-specific etiological mechanisms or pathways operating for various forms of psychopathology.

Onset versus course

Central to identification of the specific mechanisms involved in psychopathology are some additional principles regarding the potential ways in which causal processes are operating. Among these is the notion that the biological and/or environmental risk processes involved in the *onset* of a particular set of behaviors may be distinct or partially distinct from those contributing to the *course* or maintenance of maladaptive behaviors. Additionally, determination of the direction of environmental/socialization effects remains the key (i.e., the extent to which children influence their environments and vice versa). Longitudinal designs are particularly useful for examining these various distinctions and remain a popular and fruitful investigative tool.

In all, these principles and challenges remain at the core of developmental psychopathology research. We next turn to an exemplar case – antisocial behavior – to highlight the strengths of the developmental psychopathology approach.

Applied Example: Antisocial Behavior

Antisocial behavior represents one behavioral domain in which the developmental psychopathology approach has proven extremely useful. Antisocial behavior refers to a cluster of problematic and disruptive aggressive and rule-breaking behaviors, the core of which involves persistent violations of societal norms and the rights of others (e.g., bullying, stealing).

Causal Processes

It is now well-established that there are significant genetic influences on antisocial behavior, accounting for approximately 50–60% of the variance in the population. Genes may also influence the types of environments individuals seek out as they mature (e.g., antisocial adolescents may actively seek out and chose to associate with delinquent peers, i.e., an example of active rGE). Molecular genetics has also recently begun to identify specific genetic variants that increase the likelihood of developing antisocial behavior. To date, there are several promising genes of interest, mainly related to dopamine and serotonin neural transmission.

Additionally, research has also focused upon identifying the ways in which an individual's genetic make-up may influence their sensitivity to environmental risk factors, referred to as a GxE interaction. Indeed, one of the first and most influential studies of GxE focused upon examining these processes in relation to antisocial behavior. Here, the effects of childhood maltreatment on the development of antisocial behavior varied, depending upon the form of a gene (specifically a gene involved in dopamine neural transmission). That is, for children with the low activity gene, the relationship between maltreatment and antisocial behavior was strong. However, for those with the high-activity form of the gene, the relationship between maltreatment and antisocial behavior was significantly attenuated. Thus, mistreatment may effectively act to 'turn on' genes of risk.

Researchers are also aware that environmental influences are not necessarily independent of genetic risk. Indeed, yet another line of work has focused upon identifying rGE processes, where by genes exert their influence via nonrandom exposure to particular environmental experiences. In the case of antisocial behavior, biological parents both pass on any genes of risk for the behaviors and may also create an aversive environment through their own antisocial acts (i.e., a passive rGE). In contrast, children who engage in antisocial behaviors tend to evoke harsh, rejecting, and inconsistent parenting practices (even when these parents are not biologically related and thus do not share the genes for antisocial behavior, referred to as an evocative rGE).

In sum, genetic and environmental risk and protective factors are thought to influence the onset, development, and maintenance of antisocial behavior through a variety of complex and dynamic processes. These processes include both environmental mediation of genetic risk (as illustrated above) as well as genetic mediation of environmental influences. Work exploring this complex interplay between genetic and environmental risk factors for antisocial behavior will likely remain an active area of research in the years to come.

Heterogeneity

Researchers have identified many demographic, personological, and psychosocial factors that are associated with antisocial behavior. Child sex emerges as a particularly salient risk factor, as boys and men are much more likely to display antisocial behavior than are girls and women. Moreover, children who are impulsive and sensation seeking, and who exhibit low levels of prosocial behavior and high levels of emotional instability, are at greater risk for developing antisocial behavior. A number of environmental factors have also been related to antisocial behavior, including prenatal complications, low birth weight, maternal substance use during pregnancy, low socioeconomic status, association with delinquent peers, and certain family and neighborhood characteristics. Importantly, intervention studies have also emerged as an important tool for examining the etiological role of various environmental factors, as possible causal mechanisms can be extrapolated from successful treatment strategies (e.g., interventions which target the parent-child relationship have been shown to be successful in treating children with disruptive behavior problems). The multitude of both genetic and environmental risk factors associated with antisocial behavior can be interpreted as consistent with the concept of equifinality – that different factors all contribute to the same outcome.

That said, multifinality is also present, in that many of these same factors are also predictive of other psychopathological outcomes. For example, identified family and parenting characteristics including discordant marital relationships, inadequate parental supervision, punitive disciplining strategies, physical or sexual abuse, and neglect as well as neighborhood risk factors (e.g., living in a high-crime area) are all predictive of antisocial behavior as well as depression, anxiety, and inattention and hyperactivity. In addition, antisocial behavior rarely occurs independently of these other psychological problems, and is commonly comorbid with inattention and hyperactivity.

Heterogeneity is also operating in terms of the types of processes underpinning the development of antisocial behavior. For example, some studies suggest that the impact of the familial and contextual environment on the development of antisocial behavior may be greater (and that of genetic influences lessened), when living in a poor, high-crime neighborhood. In sum, research in antisocial behavior has shown heterogeneity not only in terms of the types of risk factors but also with the types of mechanisms that may underlie its development.

Developmental Continuity and Discontinuity, Challenges, and Future Directions

Like many other forms of psychopathology, understanding the nature of antisocial behavior and its causes is dependent upon both its relation to typical behavior and developmental context. For example, physically aggressive behaviors are quite common among toddlers and preschool children (more than 50% of toddlers bite, kick, or hit). However, the behavior becomes less developmentally appropriate as children age, and thus behaviors we consider essentially normative (if unpleasant) in

3-year-olds would be markedly atypical in adolescents. By contrast, the less severe rule-breaking behaviors within the broader construct of antisocial behavior (e.g., shoplifting, vandalism, lying) occur relatively frequently among adolescents (and particularly adolescent males), but are rare during childhood. Future research on antisocial behavior needs to consider these issues of continuity and discontinuity.

Measurement of antisocial behavior is complicated by many contextual factors. Often researchers rely upon parent or teacher reports of a child's behavior, or self-report measures. These measurement techniques are prone to many sources of potential bias, including limited parental knowledge of typical versus atypical child behavior, as well as influences of informant personality and/or psychopathology, and their psychological state at the time they fill out the report. For their part, children may struggle to accurately reflect on their own behavior, and respondents of all ages may not wish to disclose antisocial acts (even when guaranteed anonymity). In an attempt to circumvent some of these difficulties, researchers often obtain data from multiple informants, including observer ratings of videotaped behavior.

Regardless of the informant, however, questions also arise regarding the demarcation between typical and atypical or maladaptive behavior, as well as changes in the manifestation of antisocial behavior with age. The context in which the behavior occurs as well as the developmental timing of the behavior is critical for making these distinctions (see above example of physical aggression in 3-year-olds as compared to adolescents). Furthermore, mechanisms underlying antisocial behavior may stay constant, while the behavioral forms (e.g., physical aggression, rule-breaking behaviors) may change with development, an example of heterotypic continuity. Alternately, there may be homotypic continuity operating, such that the types of behavior may stay relatively constant throughout the lifespan, however, the processes and pathways influencing these behaviors may change. In line with this, the processes that influence the onset of antisocial behavior (i.e., those that influence aggression in toddlerhood) may be distinct or partially separable from those that contribute to the continuation or maintenance of these behaviors across development. These issues still need to be resolved, and research in antisocial behavior is increasingly relying upon longitudinal designs to capture and examine these developmental complexities.

In all, the integration of a broad range of scientific disciplines within the developmental psychopathology framework has aided in identifying the complex exchange processes that contribute to both typical development as well as psychopathology. The heterogeneity of causal processes and outcomes, the multifinality and equifinality of risk and protective factors involved in psychopathology, as well as comorbidity and measurement issues create many challenges for the study of antisocial behavior (and for psychopathology more broadly). Yet, the recognition of these complexities has been critical to many advances in our understanding of the onset and course of maladaptive behavior. While much work remains to be done, the developmental psychopathology perspective provides a useful framework for both identifying causal mechanisms as well as for applying this knowledge toward to the development of effective prevention and treatment strategies.

See also: Antisocial and Narcissistic Personality Disorder; Behavior Genetics of Personality; Childhood Mental Disorders; Personality Development; Psychopathology: Diagnosis, Assessment, and Classification; Socioemotional Development; Temperament and Individual Differences.

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Disgust

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Glossary

Construct A hypothetical entity in brains that is assumed to exist because of a regular pattern of activation and behavioral response to particular cues.

Disgust A system in animal brains that orchestrates behavior that serves to avoid infection.

Hygiene Behavior that serves to avoid sources of infection.

Parasite An organism living on or in another, dependent on it for at least a part of its life cycle and causing damage to the host.

Pathogen A microorganism living on or in another, dependent on it for at least a part of its life cycle and causing damage to the host.

Introduction

Most people have had experience with disgust. Confronted with feces, vomit, dead animals, or bad-smelling food, we react aversively, removing ourselves from contact with the offending object, turning up our noses, saying 'Yuck!' and experiencing unpleasant feelings akin to nausea. But what sort of a thing is disgust? In common with many psychological phenomena, disgust is a construct: a black box we assume to exist in brains because encountering particular cues occasions a regular pattern of response. However, disgust is a slippery construct; the events and objects that occasion it are extremely diverse, ranging from certain organic objects, animals, and people, to unhygienic, transgressive, and immoral behavior. The response is also highly diverse; it includes physiological changes such as lowered heartbeat and galvanic skin response, activation of the basal ganglia and insula, and a variety of facial expressions. It also includes diverse behavioral responses, including laughter, pointing out the object to others, distancing oneself from the object, or approaching so as to remove or clean up the object of revulsion. To a lay person, the one constant factor that is diagnostic of disgust is its accompanying affect – without the feeling of disgust the disgust construct is not activated.

Disgust is thus something of a puzzle. Why should such a wide variety of stimuli occasion this variety of responses and such strong feelings? Though disgust has never been a particularly popular area of scientific study, a variety of psychologists, philosophers, and social scientists have tried to come up with coherent explanations for this phenomenon. In this article, I argue that these attempts at explanation fail, or are at best incomplete, when they do not take into account the evolved function of the disgust system. Taking a biological perspective, I show how animals of all taxa, including humans, have had to solve the problem of parasites: organisms smaller than themselves that attempt to make a living on, or in, their hosts. Animals have evolved a variety of systems to reduce the fitness costs of infection, including coherent self-repairing skin and complex immune systems. They have also evolved behavioral defenses to parasites, avoiding encountering and incorporating them. This behavior is produced by the disgust system, which serves to detect cues that parasites may be present, and to orchestrate relevant protective behavior. Here I describe a selection of disease-avoidance behaviors in animals, and show the

continuity with human parasite-avoidance behavior. I also explore the areas where human disgust has diverged from that of other animals; where its use extends into the moral domain. I argue that the current burgeoning of scientific work on disgust would be more successful if it took better account of disgust's evolutionary purposes.

Attempts at Explanation

Humans report that they are disgusted by a bewildering array of objects and events. These include spoilt or unfamiliar foods, bodily wastes, body contents, dead bodies, poor hygiene, certain sexual activities, certain animals and insects, sick, deformed, or poor people and those seen as outsiders, as well as dirty environments. Actions that imply certain sorts of immorality, including transgression, hypocrisy, and cruelty, are also commonly reported as disgusting.

There have been many attempts at understanding why all of these things should be disgusting. Prescientific explanations made disgusting things offences against God. Later attempts at explanation in the philosophical, anthropological, humanities, and psychological literatures have been almost as unscientific. They made disgust part of the psychodynamics of the repression of desire, or a product of the ordering of society, or of magical folk thinking. Darwin began the scientific exploration of disgust but sent scientists down a number of blind alleys. The current standard approach in psychology explains disgust using a complex composite of these approaches. Recent evolutionary approaches offer a more rational basis for the study of disgust, as I shall argue.

Ancient societies considered disgusting matter and behavior as offenses against the divine. Early religious texts include lists of the unclean such as the 12 impurities of the body ('Oily exudations, semen, blood, the fatty substance of the brain, urine, feces, the mucus of the nose, ear-wax, phlegm, tears, the rheum of the eyes, and sweat ...') in the laws of Manu, one of the sacred texts of Hinduism dating from about 200 BCE. Ancient Greek texts describe the pollutions of childbirth, death, sex, and murder. The abominations of Leviticus include body wastes and deviant sexual practices. Purification rituals were codified to return the offender to a state of purity, thus reducing their threat to society and to the divine order.

Charles Darwin provided one of the earliest discussions of the function of disgust. From linguistic evidence, he proposed that disgust's original purpose was the avoidance of things offensive to the taste. He asked leading questions of his correspondents around the world and from this concluded that the facial expression of disgust was universal in humans. He also related anecdotes about disgusted turkeys and baboons.

Whilst Darwin emphasized the universality of the emotion, Herbert Spencer was one of the earliest of a long line of anthropologists to insist on the differences between what different cultures found disgusting:

Here human flesh is abhorred, and there regarded as the greatest delicacy; in this country roots are allowed to putrefy before they are eaten, and in that the taint of decay produces disgust; the whale's blubber which one race devours with avidity will in another by its very odor produce nausea.

The social anthropologist Mary Douglas did most to entrench the view that disgust is a product of culture. She tackled the much-puzzled-over topic of the different food taboos of different religions and from this extracted a broad theory of culture. Following Durkheim and Mauss's idea that classification is inherent in the organization of social life, she decided that dirt is a by-product of order. Accordingly, anomalous objects and events that do not fit the local cosmology have to be rejected, and classed as dirty or impure, as otherwise they would pose a threat to the social order. The caste system in India is Douglas's paradigm case. Human wastes are anomalous materials, neither alive nor dead, both belonging to, but rejected by, the person. Hence wastes such as feces are dirty and polluting. Humans who deal in wastes become symbolically impure and the rejects of the social system: the castes that henceforth have to be kept apart for fear of social disorder [3]. Douglas' approach is widely cited in anthropological and cultural studies.

Freud had disgust serving a purpose different from that proposed by Douglas. For him, disgust served the psychodynamics of the repression of desire, defending the brain against its baser tendencies. Children are taught to repress their urges, keeping their animal *id* in check by learning to be disgusted. Learning disgust of feces during toilet training represses any temptation to want to contact or eat them. Disgust of the bodies of others reduces the temptation to give in to lust at every opportunity.

In 1927, Aurel Kolnai wrote the first scholarly work entirely devoted to the subject of disgust. Using the phenomenological approach current at that time, he provided a careful account of the experienced emotion, painting a near complete picture of disgust's domains. For him, biological disgusts include putrefaction, excreta, secreta, dirt, animals, and insects – especially crawling ones – certain foods, the human body in too close contact, exaggerated fertility, disease, and deformity. His moral disgusts include excess and satiety, lies, deceit and corruption, moral weakness, and sentimentality. But Kolnai's explanation was in the Freudian tradition. For him, disgust served a balancing function, in encouraging the avoidance of excess, surfeit, and a desire toward death.

As a practicing psychiatrist, Andres Angyal puzzled over the things his patients found disgusting. He found a pattern of disgust objects being "base or mean, capable of permanently

permeating anything they have contacted, leaving a lingering, unpleasant after-sensation, even after washing the hands." For Angyal, disgust objects often had a sense of the uncanny – they may be cold or clammy and imply death. From a few anthropological accounts he concluded that disgust is more universal than culturally specific, and that it operates independent of any knowledge about disease or microbes. However, the nearest he came to an explanation of the patterns he described is that wastes belong outside and it would be a perversion of nature for them to be taken back in.

Today the most cited source for explanations about disgust is the work of Paul Rozin and Jon Haidt. These authors use a composite approach mixing Darwinian, cultural, and Freudian ideas with folk magic. For them core disgust is centered on all animals and their products, as potential foods. In their most recent summary (in the *Handbook of Emotions*, 2008) they suggest that disgust evolved out of distaste, and then expanded to include reminders of our animal nature, certain types of interpersonal contact, and moral violations. They suggest that this core is based on a widespread fear of oral incorporation of substances that might change one's nature, based on the magical folk belief that 'you are what you eat.' They explain the rejection of contaminated foodstuffs that have come into contact with offensive objects or persons with the law of sympathetic magic: 'once in contact, always in contact,' and the law of similarity: when objects that look like something disgusting then they are disgusting. For Rozin and Haidt, cultural dietary and food preparation rules serve to separate foods from their animal nature and help us not to think too hard about the process that brought them to our plate. Otherwise we would not be able to consume them.

These authors suggest that the fear of oral incorporation of animal products has since spread beyond the mouth to the rest of the body. Hence inappropriate sexual acts, poor hygiene, death, and violations of the ideal body 'envelope' or exterior form (e.g., gore, deformity, obesity) are also found disgusting. However, now the concern is Freudian in origin, where disgust represses a drive toward death. They postulate that humans have to deal with the existential terror of knowing that they are animals and, as such, are condemned to die. Disgust develops to repress thoughts of mortality. Hence certain sexual acts and envelope violations remind us of our animal nature, and poor hygiene places us below the level of humanity. Disgust thus protects both the body and the soul from pollution. They describe a further category of interpersonal disgust as a response to strangeness, disease, misfortune, and moral taint. They also set out evidence that disgust may be elicited by certain moral violations, especially in the domain of purity and sanctity, and maintain the view that disgust is unique to humans.

A number of writers in the humanities have also explored the phenomenon of disgust. William Ian Miller continues the Freudian concern with mental balancing, concluding that "ultimately the basis for all disgust is us – that we live and die and that the process is a messy one emitting substances and odors that make us doubt ourselves and fear our neighbours." He also concurs with Kolnai that we are disgusted by that which is too much alive. Robert Rawdon-Wilson explored disgust in all its facets, and found it has many positive uses, for example in humor that ridicules immorality, and in marking where social boundaries can and cannot be transcended.

However, he ultimately labeled it ‘the Hydra’ because he found it too complex to explain.

None of these approaches provide a satisfying scientific solution for the puzzle of disgust. None can explain why such a wide variety of objects and actions cue disgust, or why they produce typical behavioral reactions of disgust. If we are to understand disgust we need to look elsewhere; we need to make reference to the process that designed brains and behavior – evolution. We need to ask what adaptive purpose is served by the disgust system in the brain.

A small, but increasing number of scientists, including Dan Fessler, Debra Lieberman, Mark Schaller, Richard Stevenson, and my group, are exploring disgust from an evolutionary perspective. For us, there is a simple and parsimonious solution to the puzzle of disgust: disgust systems evolved to defend animals from attack by parasites, the tiny, usually invisible, predators that attack by stealth and eat their hosts alive. It orchestrates behavior that encourages animals to avoid the sources of pathogens – whether in the environment, in other animals, or the parasites themselves. That disgust in humans is a product of evolution does not, of course, mean that it does not vary from individual to individual, or from culture to culture. Indeed evolution has designed such systems to be responsive to local conditions. Individuals inherit differing propensities to disgust and individuals tune their disgust responses over their lifetime according to experience and local cultural rules. This is one of the reasons why previous work has found disgust to be a hydra, having multifarious forms in multiple settings. But disgust does have a single basic function: it evolved to orchestrate the avoidance of parasites.

The Problem of Parasites

Parasites are everywhere. Viruses, bacteria, plasmodia, rickettsia, and multiple species of worms and ectoparasites swarm throughout, and over, all animals. The total biomass of parasites on planet earth is greater than that of predators. Parasites cause damage to their hosts by consuming resources, releasing toxins, manipulating their behavior, and spreading to kin and community. Parasites thus exert a selection pressure on their hosts – encouraging them to develop systems to minimize the damage they suffer to their evolutionary fitness. All taxa have immune systems that serve to track down, immobilize or kill pathogenic parasites. All taxa that have been studied also display behavior that serves to minimize contact with parasites, before they can infect the host. This has been dubbed ‘the behavioral immune system.’ In humans (and, debatably, in other animals), this pathogen-avoidance behavior is orchestrated by the disgust system.

The disgust system has a difficult task; it has to recognize a possible risk of infection without being able to detect tiny or invisible parasites directly. One way of doing this is to avoid close contact with conspecifics, especially those that show signs of sickness. Another is to avoid other animals that may be carrying parasites, or indeed, anything that looks like a parasite. A third way is to avoid environments and objects where parasites might be lurking.

Pathogen/parasite-avoidance behavior has been found in the animal kingdom wherever it has been studied. Many

animals avoid others that show signs of sickness. So, for example, the sociable Caribbean spiny lobster *Panulirus argus*, refuses to share a den with other lobsters who are infected with the lethal PaV1 virus, which is transmitted by physical contact. Bullfrogs, *Rana catesbeiana*, suffer from a yeast infection that reduces their mobility and can kill them. Given the choice, healthy tadpoles avoid going anywhere near those that have the infection. Similarly, when experimenters injected Killifish, *Fundulus diaphanous*, with black inkspots to mimic the effects of a common parasite, other killifish avoided shoaling with them. Social primate species will generally only accept a new member into the troop after a long period of quarantine, which includes stressful attacks to expose the state of health of the candidate member. Candidates showing signs of sickness remain marginalized.

Like the animals that avoid sick conspecifics, humans also avoid others that show signs of sickness, and we also find signs of sickness in others disgusting. **Figure 1** shows a photograph of a man’s face which we manipulated to look ill by painting on spots, and mimicking signs of fever. This was scored as twice as disgusting as the same individual in a healthy state by over 40 000 respondents in a web survey. **Figure 2** shows an infected wound, which was scored as 27% more disgusting as a clean burn in the same experiment. **Figure 3** shows that an empty underground train was scored as much less disgusting than one that was full of people. Few humans are prepared to come into close contact with and share bodily fluids with others, whether they are healthy or not, except in particular overriding circumstances, such as for pair bonding or child



Figure 1 Average disgust score of two facial images.

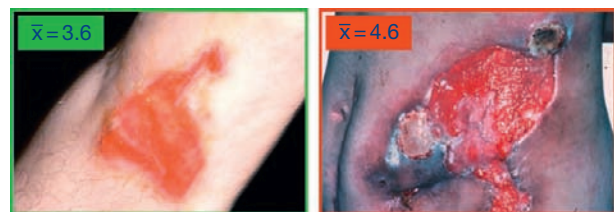


Figure 2 Average disgust score of two wounds.



Figure 3 Average disgust score of two images of an underground train.

care. In a more recent wide-ranging web survey, we found that signs of infection on genitals and poor genital hygiene were amongst the strongest elicitors of disgust.

Animals can, in some cases, detect and avoid or remove parasites directly. *C. elegans*, the tiny and much-studied nematode worm which has only 302 neurons to its name, can tell the difference between pathogenic bacteria, from which it flees, and prey bacteria, on which it feeds. Fish detect and swim away from the cercariae of eye flukes that can cause blindness. Animals also expend a lot of precious energy on removing damaging ectoparasites. Cattle swish their tails to drive away biting tsetse flies, fish scrape themselves to remove fish lice, vampire bats scratch to remove batflies, and impala use their teeth as tick combs. If impala or doves are experimentally prevented from grooming themselves, lice and ticks multiply. Over 250 species of bird are known to 'ant'; rubbing crushed insects such as ants or millipedes over their plumage. This behavior distributes compounds such as formic acid that protect from parasitic bacteria, fungi, and arthropods. Chimpanzees have been seen engaged in penile hygiene-wiping themselves off with leaves after mating. Some animals will pay highly for a groom to rid themselves of parasites; cleaner fish remove ectoparasites but also bite off bits of healthy flesh, and a study of long-tailed Macaques, *Macaca fascicularis*, revealed a biological market system where males paid for sex at the going rate in the currency of time spent grooming.

Humans also expend considerable effort and funds in grooming themselves and others to remove ectoparasites such as lice and scabies mites. Figure 4 shows a head louse, which was found significantly more disgusting than a wasp in the photographic comparison. Humans recognize and avoid parasitic species of worm and find them disgusting. Figure 5 shows *Ascaris* worms which were scored as more disgusting than caterpillars. Humans are further disgusted by species of animals that can vector parasites such as flies, cockroaches, rats, bats, snails, and pigs.

Animals also have to be careful not to come into contact with places where parasites might be lurking. When *Daphnia* are forced by fear of predation to swim near the muddy bottom

of a tank, they acquire more parasites. Ants avoid making nests in the vicinity of ant carcasses; birds abandon nests that are infested with parasites. Many insects have tricks such as 'frass-flinging' or 'turd-hurling' to keep their environment free of feces, penguins eject projectile poo, and tapirs, badgers, and blind mole rats use latrine sites. Sheep avoid feeding on pasture that is heavily dunged, and it has been suggested that the reason why many herbivores, such as reindeer and caribou, migrate is to avoid parasite build-up in calving grounds. Anecdotal evidence suggests that human nomads also move on when camping grounds get too insanitary.

Like other animals, humans avoid substances in the environment that might harbor parasites. In our web survey, urine and excrement, as well as sticky door handles and filthy buses, were rated highly disgusting. Figure 6 shows that a plate of food looking like bodily wastes scored more highly than a plate of what looked like inorganic matter.

Humans have a further ability, that it seems is not found in other animals: to track contamination. When an object of disgust comes into contact with a previously nondisgusting object, the second object can become disgusting. So for example tooth brushes, eating implements, or bedclothes known to have been used by strangers tend to be rejected. This response is what Steven Pinker has called 'instinctive microbiology.' Objects that harbor microbes can deposit microbes on the surface of other objects; hence these others become as disgusting as the original source.

Since the problem of parasites is common to all animals, including humans, it is not surprising to find that the basic avoidance behavior of humans is similar to that of other animals. Like other animals, humans avoid close contact with most others of the same species, especially if they are sick; they avoid other species that are parasites or parasite vectors; and they avoid environments and objects where parasites and pathogens are likely to be encountered. This gives us a parsimonious explanation for why humans should have a disgust system. From this perspective, then, disgust is the construct in the brain that takes cues of potential parasite presence and then orchestrates the behavior that serves to avoid them.

Parasite detection and avoidance was a hard problem to solve for a number of reasons. Apart from the problem posed by their size, there is also the problem of their indirect effect. While animals can learn from painful experience with predators, sickness does not usually immediately follow pathogen contact, so it is hard to learn what to avoid from experience of what has caused illness. A further problem animals have to solve is that it can be costly to avoid parasites. Refusing to consume rotten food may cause one to miss an opportunity for a scarce meal, and avoiding a sick person may cause one to miss a mating opportunity, for example. Over evolutionary

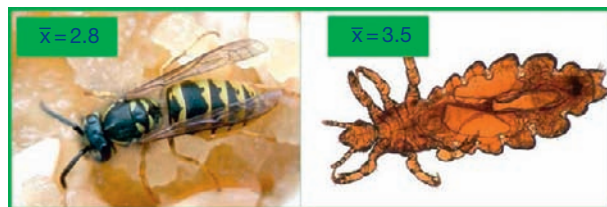


Figure 4 Average disgust score of two insect images.



Figure 5 Average disgust score of worms and caterpillar images.

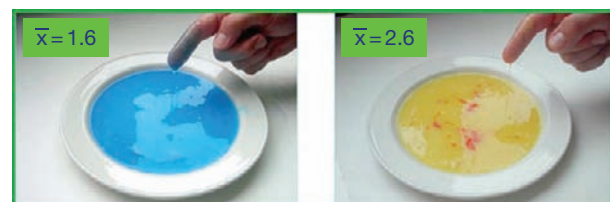


Figure 6 Average disgust score of two plates of 'food'.

history, the genes of those animals which, on average, did best at solving these parasite-posed problems did better at passing on their genes.

Have we now solved the puzzle of disgust by invoking the disease avoidance function? Well, not quite. It is easy to see why the main disgust elicitors should be avoided: spoiled foods, bodily wastes, body contents, dead bodies, poor hygiene, certain sexual activities, certain animals and insects, sick, deformed, or poor people and those seen as outsiders, as well as dirty environments can all harbor pathogens and hence pose a risk of infectious disease. Objects that have contacted any of the above may have also been contaminated with microbes; hence the disgust associated with contagion. Questions, however, remain about why unfamiliar foods should elicit disgust and also about the evolutionary purposes of moral disgust.

Disgust of Unfamiliar Food

Humans are omnivores who live in a huge range of ecological zones. In principle, humans could eat almost any living thing; however, given the potential for foods, especially those of animal origin, to contain pathogens and parasites, it makes sense to be neophobic. Since the current social group is still alive, it is probably a good rule of thumb to eat what others in the current environment are eating. This is, in fact, what happens in humans (similar patterns are observed in another omnivore, the rat). Children are prepared to eat a huge variety of foods that are fed to them by their family until the age of about 2 years. Then an extreme reluctance to try new foods sets in. This helps explain why food rules differ between cultures and why disgust is often evinced by people offered unfamiliar types of food, especially those of animal origin. Though disgust's core concern with infection prevention is constant, the way in which it is expressed in individuals is developmentally, and adaptively, tuned.

The final piece of the disgust puzzle is why certain sorts of immorality – including transgression, hypocrisy, and cruelty – are also commonly reported as disgusting.

Moral Disgust

We recently asked 77 UK-based adolescents to list what they found morally disgusting. Top ten on their lists came rape, racism, murder, torture, bullying, pedophilia, discrimination, necrophilia, genocide, and exploitation. High on the list also came stealing, abuse of trust, and corruption. Two concerns can be distinguished here. One is moral outrage concerning taking unfair advantage, especially in the maltreatment of the weak. Some of these outrages also involve exposure to bodily fluids and so are doubly disgusting. While the latter concern has already been explained, why is it that unfairness, cruelty, and exploitation are found to be morally disgusting?

One explanation that has been offered is that the word disgust is being used as a metaphorical sense. The disgust of moral offenses is like that felt for infective organic material but is not the same. People use the word disgust for a feeling of revulsion for moral violations. But this is not, in fact disgust; it is more akin to anger. However, a recent series of fMRI studies

have suggested that there is considerable similarity in the activation patterns of moral and organic disgust. People offered unfair deals in an ultimatum game, for example, show activity in the anterior insula, a locus that is characteristic of disgust. The same facial muscles are involved in the expression of both moral and organic disgust. More recently, a series of studies have shown interactions between the two; priming with an organic disgust, or sitting beside a smelly waste bin makes moral judgment more severe, while hand washing can assuage feelings of moral guilt.

It thus seems likely that while the proper domain of disgust is the avoidance of the likely sources of infection, it has evolved an extended domain in humans that causes aversion to morally reprehensible behavior. One explanation may be that instead of responding to the likely presence of a parasitic organism that threatens bodily resources, the brain is responding to cues that an individual is behaving like a parasite, using unfair means to take more than his or her fair share of social resources. Racists gain unfair advantage by denigrating others; pedophiles, rapists, and bullies take advantage of the weak, while necrophiliacs abuse bodies that cannot defend themselves. Revulsion from such parasitic behavior leads to shunning of the perpetrators, and their exclusion from the benefits of social life. The threat of punishment by exclusion is a powerful one, and one that helps keep individuals behaving cooperatively. Disgust thus serves to police the boundaries of society, keeping social parasites out, in a way that is functionally equivalent to the purpose it serves in keeping parasitic organisms out of the host body.

While this explanation fits the pattern of moral disgusts, by what mechanism could disgust of the organic sources of infection have been exapted to extend to revulsion for the social parasite? Here we can turn again to animal models for some insight. While few animals are as ultrasocial as humans, the eusocial insects including ants, termites, wasps, and bees live colonial and cooperative lives. Like humans, insects have to deal with threats from parasitic species, which threaten them as individuals and as a colony. Ants, for example, clean food of parasitic fungal spores; bees remove sick individuals from the nest and prevent sick individuals entering; termites warn of parasites through a special dance. Further, individuals of the same species can act as parasites. In the social Hymenoptera, including most ants, Apis honeybees, Meliponinae stingless bees, and Vespinae wasps, workers retain ovaries even though they cannot mate. These workers can lay unfertilized, male-destined eggs and thereby challenge the reproductive primacy of the queen. However, other conspecifics do not tolerate this selfish behavior and eat the eggs of the rebel. Another example is caste fate policing. In many bee species, individuals that do not accept their fate to become a worker and try to develop into a supernumerary queen are discriminated against or killed by conspecifics.

The punishment of cheaters is one of the mechanisms that allow societies to keep cooperating. In humans, punishment by disgust – the avoidance and shunning of social cheaters – is a powerful disincentive to selfish behavior. Social parasites such as rapists and thieves are subjected to public disgust and revulsion when they are exposed. Indeed, such public contempt is not always required. We humans police ourselves to great extent, being disgusted with ourselves for selfish behavior. We fear the embarrassment and shame we may feel if we behave badly,

for example subjecting others to our own disgusting bodily emanations, or subjecting others to our own dishonest or greedy parasitic tendencies. Having the human ability to imagine the disgust of others leads to plans being made to behave cooperatively, so as to avoid shame and embarrassment at all costs.

Explaining Disgust

I have argued in this article that the explanation for the construct of disgust in the human brain is the evolutionary need to avoid damage from parasitic infection. This need is something we have in common with all animals. I have also argued that, beyond its proper domain of parasite avoidance, humans have extended the function of disgust to apply to moral revulsion at social parasitism.

This Darwinian explanation differs from those offered previously by anthropologists, psychoanalysts, and psychologists. It is even somewhat at odds with Darwin himself.

While Darwin was surely right that the expression of disgust is near universal in humans and that disgust can be observed in animals, he was incorrect to suggest that disgust originated in distaste. Parasites have many routes of access to the resources of a host body and humans, like all of their animal ancestors, must police those portals of entry, by removing ectoparasites from the skin, avoiding contact with diseased sexual organs, or avoiding breathing in the exhaled droplets of diseased conspecifics. Avoiding consuming spoilt or contaminated food is only one amongst many of the strategies animals use to avoid parasites. Humans must have inherited all of these multiple aversions from their animal ancestors. It is thus highly unlikely that human disgust originated in human distaste, which then later diverged into a variety of other aversions, as Rozin and Haidt, following Darwin, have argued.

However, does it make any sense to suggest that animals can be disgusted, as Darwin proposed and Rozin and Haidt refute? The answer to this question depends entirely on how one defines disgust. If it is defined, as I propose, as a system in brains that recognizes cues to infectious diseases and orchestrates appropriate avoidance responses, then disgust is ubiquitous in the animal kingdom. The nematode worm, *C. elegans*, fleeing parasitic microbes in its petri-dish, is exhibiting disgust-driven behavior. However, if we define disgust as an emotion and if having an emotion depends on being able to report its characteristic qualia of feelings, then disgust must be confined to humans, since only they can report feelings. In my view, it is more helpful to see feelings as an epiphenomenon of such motivation systems. Feelings are used in the theatre of the conscious brain to learn the consequences of behavior and to imagine its future consequences. Knowing that one is likely to feel disgusted by rotten food tomorrow encourages one to store it correctly today. Knowing that one may step in feces tomorrow encourages one to save to build a latrine next year. Knowing that one might meet, and be disgusted by, sick people helps to encourage one to stay at home in times of plague. While the feeling of disgust is probably confined to the small number of higher animals with conscious imaginations, all animals have disgust systems.

For Rozin and Haidt, the paradigmatic source of core disgust in humans is the consumption of animals and their

products. From an evolutionary perspective, however, animals are just one likely source of parasites, amongst others. Other humans harbor more human pathogens and hence should be more central to the disgust system than other animals (cannibalism is especially disgusting, for example). Animals should be disgusting inasmuch as they pose a risk of transmitting infection. So pigs share more parasites with humans than herbivores such as sheep, and hence pig meat is more likely to be treated with disgust than lamb, for example. Animal products such as fish and meat are more risky to consume than vegetable matter, especially if spoilt. Interestingly, it has been hypothesized that microbes may have evolved to exploit our aversion to rotten meat by producing large amounts of volatile warning chemicals. These heighten our disgust, thus allowing the smell-emitting microbes to feast on the nutrient-rich material that we have rejected. Our disgust systems may thus be being fooled into overreacting to gone-off animal foods. The avoidance of animal materials as one source of pathogens provides a more parsimonious explanation for their rejection than Rozin's invocation of magical thinking such as 'you are what you eat.' Indeed it is clear that 'animal nature' is not a key issue since not all animals disgust us and humans will sometimes compare animals favorably with themselves. Further, Rozin and Haidt's suggestion that people distance themselves from meat preparation so as not to be too disgusted to eat it may be true for modern American societies but does not hold in most developing countries, and was probably untrue for most of recorded history, where families had no choice but to butcher their own produce.

Rozin and Haidt propose a magical 'law of similarity' for why children will refuse to eat fudge shaped like feces, despite the children knowing that it was fudge. Here, again, no magical thinking is needed to explain this phenomenon; in the environments in which our brains evolved, things looking like feces simply were feces. The instinctive reaction cannot simply be overridden by the experimenter's reassurance as to edibility. Similarly the law of contagion – 'once in contact, always in contact' – is better explained by 'instinctive microbiology' than magical beliefs. Disgusting objects are disgusting because they may contain invisible pathogens. These microbes can be transferred by simple contact. Hence, it is not surprising that those of our ancestors who took note of objects with a recent history of contact with disgusting objects thrived better than those who did not. Though the same argument should apply to animal behavior, we know of no experiments that have tried to ascertain whether animals record, remember, and avoid objects that have become contaminated in this way.

Freud argued, as do Rozin and Haidt, that disgust is part of an internal psychodynamic regulation system, where the dysfunction of one part of the brain is relieved by the functioning of another. For Freud inappropriate appetites and maladaptive lust after sex are countered by learning to be disgusted by bodily wastes such as feces and sexual fluids. Evolutionary psychologists recognize that there are conflicts internal to brains but do not make one system regulate another. They rather recognize such internal conflicts as trade-offs. Animals have to constantly balance a range of evolutionary needs. People who are hungry, for example, have to balance their need for food with the danger of eating unsafe foods, and will lower their disgust thresholds to expand the range of what they can eat.

Rozin and Haidt follow Freud in positing a psychodynamic use for disgust in controlling our own reactions to the fact of our mortality. For Rozin and Haidt, disgust helps to keep us from dwelling on the terrifying truth of our own animality and of our future annihilation. Fessler and Navarette have challenged their use of the so-called Terror Management Theory (TMT), showing that death disgust is negatively correlated with age, when TMT predicts the opposite, and that priming thoughts of mortality do not increase disgust. They argue, as do we, that disgust is better seen as an adaptation for disease avoidance.

The approach to disgust in the social sciences tends to follow the work of Mary Douglas, who held that we categorize items as disgusting when they are 'out of place,' when they are anomalous and do not fit the local cosmological system, as we saw. For Douglas, societies came first, and disgust is one of their products. Yet it cannot be true that disgust is a human cultural production, since as we have seen, disgust predates humans and certainly predates societies. Douglas does, however, point us toward some of the symbolic uses of disgust in society where, for example, the caste system is extrapolated from the principle that those with contaminating jobs should be kept apart from the rest. Street sweeping, house cleaning, and waste collection remain low-status jobs in most countries today. Douglas's work on the symbolic and ritual uses of disgust in making social separations between pure and polluted, in group and out group remains deeply insightful. However, from the Darwinian perspective, disgust is not purely a product of culture but a factor that shapes culture – disgust came first. Cultures may have elaborate rules about purity and pollution, but these tend to be based on our organic disgusts.

I have argued that the work of Darwin, Freud, Douglas, Rozin and Haidt, and their followers have sent disgust studies down a number of blind alleys. Disgust is not unique to humans, it does not originate in distaste, it is not a product of magical thinking, nor of the cultural constructions of societies, neither did it arise to psychodynamically balance inappropriate appetites or fears of death. There is one simple explanation for why humans and all animals avoid others, certain other animals, and contaminated environments, and that is the threat of infectious disease. Humans have extended the domain of disgust, using it to police and punish social parasites, hence reinforcing the cooperative behavior that makes social life possible. This explanation for disgust should be preferred on grounds of parsimony; it provides a simple, single explanation for all of the diversity of disgust-related phenomena we have been considering.

Disgust and Its Uses

Does it matter in the end whether disgust is an adaptation to the threat of parasites as I contend? Since disgust has tentacles that go deeply into the human psyche, influencing our everyday hygiene and our everyday aversions, as well as being one of the sources of both prejudice and moral behavior, understanding it fully must be an important task for life scientists. Further, disgust may hold the key to improving our ability to fight infectious disease on a planet where infections still kill over 13 million children every year.

There is still controversy in neuroscience over the exact parts of the brain that are activated in the case of disgust. One reason

for this may be that neuroscientists still tend to take disgust stimuli off the shelf, rather than selecting them in a principled manner from the stimuli that should be disgusting according to evolutionary theory; that is, those containing a threat of infection or social parasitism. Until they do this, it will be impossible to develop a detailed and replicable picture of the mechanics of disgust and its component parts using brain scanning.

Beyond better science, there are practical benefits to adopting an adaptive view of disgust. Those who have to deal with disgusting material as part of their job would benefit from a recognition that disgust is a part of human nature. Those who have to deal with wastes, care for the sick, or groom others have to do emotional labor in overcoming disgust and would benefit if this fact were acknowledged and increased support provided. Tendencies to marginalize such individuals can also be recognized and counteracted, in the same way that societies have increasingly come to reject racism or other types of prejudice.

In the domain of public health, it would be helpful to recognize that evolved responses to infection avoidance may not be a good guide to the best way to avoid disease in our modern environments. For example, quarantine and the avoidance of physical contact were intuitive, but not useful responses in the HIV/AIDS pandemic. Recent campaigns have successfully harnessed the power of disgust to get people to wash their hands with soap in a variety of settings to avoid diarrheal and influenza pathogens. Regular panics about the contamination of food are costly for companies and countries and might be avoided if we understood more of the operation of intuitive disgust.

In the moral domain politicians have a sorry history of making capital by exploiting a tendency to xenophobia – disgust of the outsider, as an aid to entrench their own power. The more such behavior is recognized and is generally understood, the less effective it will become.

Probably our most important scientific task in the domain of disgust is to tease apart the story of the role that disgust plays in the evolution of human morality. This is the frontier to watch where exciting discoveries are going to be made in the next decade.

See also: [Anxiety Disorders](#); [Evolutionary Psychology](#); [Obsessive–Compulsive Disorder](#).

Further Reading

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Dissociative Disorders

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Glossary

Depersonalization disorder Persistent and recurrent episodes of feeling estranged from the self and/or the environment.

Dissociation Experienced loss of information or control over mental processes that, under normal circumstances, would be available to conscious awareness, self-attribution, or control.

Dissociative amnesia A dissociative disorder characterized by a nonmedically caused loss of personally significant memories.

Dissociative fugue A type of psychogenic amnesia that also includes sudden wandering away from one's residence or job alongside with other alterations of consciousness.

Dissociative identity disorder The most severe of the dissociative disorders, characterized by a lack of integration and control among different psychophysiological states or identities, and a number of other symptoms.

Spirit possession The experience, often accompanied by amnesia, in which one's identity is substituted by that of another being. It most often occurs as part of religious practices that do not involve any psychopathology.

Trance An alteration of consciousness featuring apparent lack of awareness or unresponsiveness to the surroundings, sometimes accompanied by automatic movements.

Dissociation

At the same time that Aristotle was explaining learning as a conjoining or association of different psychological elements, Greek sibyls in the Delphi and other oracles had episodes in which they seemed to have their ordinary identity substituted by that of Apollo or other Gods. All throughout history, there have been descriptions in which ordinary processes such as memory and personal identity seemed to be in abeyance, or parallel psychological strands vied for the person's cognition and behavior. Those phenomena are currently being studied under the rubric of dissociation, a complex term encompassing a broad domain of psychological processes and experiences. In contrast with *association*, the assembling of different processes or parts, *dissociation* implies either that processes that were conjoined were split asunder or that they did not become integrated or associated in the first place as would be expected. Before focusing on the dissociative disorders (DD) per se, it is important to understand what is meant by dissociation, including its pathological manifestations.

Dissociation is a term used in various disciplines (e.g., dissociation of chemical processes). In psychology, it generally refers to a discrepancy between indexes of information (e.g., variations between implicit and explicit perception or memory). In the areas of clinical and personality psychology and neurology, this idea can be subdivided into (1) the apparent absence of conscious awareness of impinging stimuli or ongoing behaviors (e.g., becoming unresponsive to or unaware of the surroundings as a consequence of a ritually induced altered state of consciousness or an epileptic seizure), (2) the seeming coexistence of separate mental systems or identities that are not integrated with the self (e.g., instances of dissociative identity disorder (DID) and spirit possession or, in neurology, cases of 'alien hand'), and (3) ongoing behaviors or perceptions inconsistent with an honest introspective verbal report (e.g., the 'blindsight' phenomenon in which an individual with damage

in the striatal cortex reports being blind in a hemifield while behaviorally showing awareness of occurrences in that hemifield, or a similar uncoupling of reports and behavior in a patient with a conversion – or pseudoneurological – disorder). In order to differentiate *dissociation* from the more general concepts of nonconscious processes, a requirement is that these events are not just part of ordinary processes such as overlearning.

Another descriptive notion of *dissociation* is that of consciousness alterations characterized by experiential disconnection with all or parts of the self (e.g., depersonalization, out-of-body experiences) or the environment (e.g., derealization, a sense of unreality of the environment and other beings). Some authors use dissociation to refer to any alteration in the state of consciousness, but this is inappropriate; mystical states, for instance, produce a sense of enhanced connectedness rather than the opposite.

Dissociation has also been used as an explanatory theoretical construct. In this sense, based on psychodynamic theory, the assumption is that dissociation is an intentional mechanism with the goal to experientially and/or cognitively distance oneself from traumatic or other material that is threatening. Naturally, it is perfectly reasonable to postulate that dissociative processes may at times be consciously controlled or even unconsciously intentional, whereas at other times, they may not have any specific purpose and just be epiphenomena of attentional or other cognitive changes.

Figure 1 is a bidimensional heuristic to characterize dissociative phenomena. Axis x indexes whether the processes causing the phenomena are mostly biological (e.g., neuroendocrine processes) or psychological (e.g., psychological trauma, hypnotic suggestions) processes, whereas axis y groups them as to whether they can be considered pathological or innocuous. The remaining of this article focuses on the upper right-hand quadrant, that is, pathologies whose etiology is mostly psychological (naturally, this does not mean that there are no biological

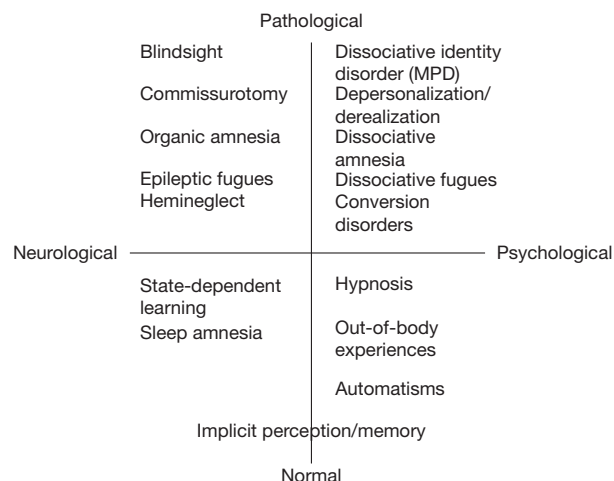


Figure 1 The domain of dissociation. Modified with permission from Cardeña E (1994) The domain of dissociation. In Lynn SJ and Rhue J (eds.) *Dissociation. Clinical and Theoretical Perspectives*, pp. 15–31. New York: Guilford.

correlates of these experiences, but that psychological processes such as exposure to trauma play the major role). With the exception of DID, which does not have a clear parallel among neurological disorders, the latter should be considered as differential diagnoses for all of the other DD, as they may have, at least superficially, similar presentations.

I would like to emphasize that dissociation should be considered a particular form of psychobiological functioning rather than something necessarily pathological. For instance, a number of dissociative alterations in consciousness and identity can be part of ritual or religious activities, are not necessarily associated with pathology, and can even foster creative endeavors as in the case of some instances of automatic writing or drawing. The clinician should look at other factors such as how controllable, organized, desired, and culturally appropriate the dissociative experience is to determine whether it is pathological.

A comprehensive definition of pathological dissociation is an experienced loss of information or control over mental processes that, under normal circumstances and for the age and developmental level of the person, would be available to conscious awareness, self-attribution, or control. These phenomena are characterized by (a) involuntary and unwanted intrusions into awareness or behavior of memories or experiences, with an accompanying loss of continuity in subjective experience (so-called 'positive' dissociation); and/or (b) an inability to access information or control mental functions, manifested in symptoms such as gaps in awareness, memory, or self-identification, that are normally amenable to such access/control (so-called 'negative' dissociation), and/or (c) a sense of experiential disconnectedness, which may include perceptual distortions, about the self or the environment.

With respect to distal and proximal variables associated with the propensity to dissociate, there is evidence for both genetic and nonshared environmental contributions. With regard to the former, studies have found that the propensity to dissociate has a heritability component and that the COMT

gene is likely to be implicated. As far as early environmental contributions are concerned, there is a body of literature showing that disorganized attachment and related factors such as dissociative behaviors from the caretakers (e.g., suddenly 'freezing,' acting as if they were someone else, or their inability to have affective control of their inner states) are strong predictors of the adult dissociation of their children. With regard to proximal factors, there is abundant evidence that traumatic events are closely related to acute and chronic dissociation. If the traumatic events are not very severe and chronic, such as the possible consequences of short-term natural disasters, most people experience just short-lived dissociative episodes. In contrast, particularly virulent events such as early abuse or being a victim of prolonged brutalization can give rise to chronic dissociative phenomena. Although a few authors have argued against a trauma-dissociation link proposing that dissociative individuals just fantasize traumas that never occurred, a voluminous body of literature with retrospective and prospective studies on clinical and nonclinical samples does not support their case.

Dissociation in general, and the DD in particular, can be evaluated in a number of ways, including behavioral observations in attachment tests (e.g., stopping all behavior or 'freezing') or in the clinical situation (e.g., suddenly seeming to become a very different person without an obvious reason), and a number of valid and reliable instruments, including standardized and semistandardized interview and questionnaires, many of them translated into various languages. Research on measures of neuroendocrine dynamics may also be able to serve as reliable indicators of dissociation in the future.

The Dissociative Disorders

The fairly universal phenomenon of spirit possession was partly replaced in the West by mesmeric/hypnotic and spiritualist/channeling phenomena. Although these phenomena were mostly manifestations of experiences and beliefs that did not bring about serious distress or dysfunction, there have always been cases that were pathological even within the cultural standards of the time. At the inception of psychology as a science at the end of the nineteenth century, many of the foremost theoreticians and clinicians in Europe (e.g., J. M. Charcot, F. W. H. Myers, Pierre Janet, Sigmund Freud) and the United States (e.g., William James, Morton Prince) sought to explain and treat such unusual phenomena as patients presenting with strange paralyses, or behaviors or reservoirs of knowledge for which they claimed no conscious knowledge or control but which were psychologically meaningful and did not have a medical basis. When these manifestations were associated with dysfunction or distress, they were subsumed under the rubric of *hysteria*, a sexist term referring to the uterus, and later became known as the dissociative and some somatoform disorders (mainly pseudoneurological or conversion symptoms) in the Diagnostic and Statistical Manual (DSM) taxonomy. However, the International Classification of Diseases (ICD) did not split asunder the DD from conversion. The rationale for the DSM was that pseudoneurological symptoms seem to be medical, the same as other symptoms such as hypochondriasis. On the other hand, it has been shown that the disorders covered in the following sections have high positive correlations with

pseudoneurological and similar symptoms, and both have strong associations with a history of trauma and seem to share underlying psychological processes. Conversion and somatoform disorders in general will not be further considered here, but it is worth pointing out that the earlier observation of a relation between hypnotic suggestion and conversion symptoms has been supported by brain imaging and other research procedures. It has also been proposed that self-suggestion processes underlie at least some types of conversion, mediated by changes in the frontal lobe affecting the cingulate cortex. In a related fashion, research has shown that individuals with DD and posttraumatic disorder are more hypnotizable than other psychiatric groups, so hypnotic susceptibility may very well be a predisposing factor in the inception of various dissociative phenomena.

The initial interest in dissociative processes and disorders during the late nineteenth and early twentieth centuries was short-lived. The focus on alterations in consciousness and cognitive processes were replaced by an emphasis on behavior in academia and on unconscious processes in clinical psychology. It was not until the latter part of the twentieth century, when a number of cultural and intellectual forces came together, that research on consciousness at large, and dissociation in particular, reemerged. I can mention the development of parallel-processing cognitive and neurodevelopmental models consistent with dissociative processes, as well as the increasing realization that traumata (e.g., war, accidents, early abuse) are far more common than realized earlier and that these events are clearly related to acute and chronic dissociative phenomena. With regard to the DD, the last years have witnessed increasingly careful and sophisticated treatment, development of valid and reliable measures, and research which has most recently included brain imaging techniques.

A word now about the denial by some authors of the validity and prevalence of DD, especially DID (erstwhile known as *multiple personality disorder*), which they claim to be iatrogenic and/or culturally created, mostly produced by therapists' leading suggestions and circumscribed almost exclusively to Anglo-Saxon countries. The critiques have been based almost exclusively on a reconsideration of the literature rather than on new research and are contradicted by various studies showing that these disorders are found across the globe, although with some variations (e.g., the experience of being chronically possessed by an external agency rather than having alter identities), and that hypnosis is not a tool used for diagnostic purposes, but for therapy. Furthermore, if therapists' suggestions were the main cause of symptom presentation, considering that many if not most DID patients have received earlier diagnoses, they should continue to manifest the initially diagnosed condition, rather than providing refractory to treatment until dissociative processes are considered (there is now budding research on the efficacy of therapy for DD). There are also both cognitive and neurophysiological studies that are inconsistent with the theory that DD are forms of malingering or mere role-playing. Naturally, these studies do not eliminate the influence of culture in the shaping of a syndrome nor the possibility of iatrogenic factors in a few diagnoses, but the same could be said for any psychiatric condition. Of especial value in this controversy have been a number of longitudinal studies showing that dissociative phenomena in adulthood are

strongly predicted by such earlier variables as traumata (e.g., abuse, loss, anatomical malformation requiring painful and intrusive medical procedures), and disturbances in attachment to the early caretaker.

With regard to the prevalence of the DD, although it has been at times stated that *hysteria* was circumscribed to the Victorian times, epidemiological research in various countries has shown that patients in outpatient and inpatient units could receive a primary or secondary DD diagnosis within a range of 10–45%, depending on their history of trauma and other serious adversities. In the general population, it has been reported that up to about 11% might fulfill the criteria for DD, although this figure probably would vary considerably across cultures with different levels of exposure to trauma and different criteria for dysfunction. In the following sections, the DD according to the DSM-IV are described.

Before this, I should mention, albeit briefly, pathological dissociation among children. There has not been nearly as much research with children and teens as there has been with adults for a number of reasons, including the difficulty of differentiating what may be age-appropriate manifestations (e.g., not having a sense of self across time in early childhood) from actual pathological manifestations, the lack until relatively recently of valid measures for this group, and the differing presentations of pathological dissociation of children and adults. Regarding the last point, an expert has written that *trance* (i.e., seeming unresponsiveness to the surroundings) may be the most prevalent form of dissociation among children, a phenomenon that does not seem to be quite as central in the DD of adults. Also, rather than the multiplication of identities found among adults, dissociative children seem to fail to reflect on, or mentalize, their own psychological processes and those of others, besides having uncontrolled alterations of consciousness.

Dissociative Amnesia

The definition of this disorder by the DSM-IV centers on one or more instances of amnesia for important personal information, which cannot be explained by a medical condition, ordinary forgetfulness, or the developmental amnesia for the first years of life. This diagnosis is given when the amnesia is the only or central symptom, rather than just being part of a syndrome as is the case in acute stress disorder (ASD) and posttraumatic stress disorder (PTSD), or in more complex forms of DD such as fugue and DID.

The material that is forgotten is typically related to intense stress or trauma (e.g., a very painful divorce, a war battle) and can adopt different forms. Amnesia can be *localized* in time, either to a previous event such as the loss of a close person, or to a period of time such as not remembering some years of life during which chronic abuse occurred. Amnesia can be *selective* in the sense that certain aspects of a trauma that would be expected to be remembered cannot be accessed (e.g., not recalling how a brawl concluded in the person shooting someone else). *Systematized* amnesia is characterized by a theme connected to trauma or stress, for instance, not recalling the various visits of a perpetrator during the holidays or events having to do with an impeding marriage. Lastly, in the rarely encountered *generalized* or *global* amnesia, the person forgets much or most episodic memory, not being able to remember even one's name or other basic

personal information. The great majority of amnesia episodes are not generalized or global, and the material that is inaccessible at some point may become accessible later on, as the basic mechanism of memory would predict, notwithstanding some pronouncements about the impossibility of 'recovered memories.' Besides these symptom presentations, it is worth stating that a history of trauma and dissociation have also been associated with impaired working memory. Currently, the mechanisms through which dissociative amnesia occur are far from clear, but there is some evidence that both failures to store memories and inability to retrieve memories may be implicated.

This disorder, the same as other DD, is commonly associated with other symptoms, including depression and anxiety, and typically manifests early in life up to early adult years. There are various medical conditions (e.g., concussions, vascular problems, dementia) that also produce amnesia, but the memory problems in these cases are not so clearly related to severe stress or trauma and may include such memory problems as antero-grade amnesia, or inability to learn, that is not a typical feature of dissociative amnesia.

Dissociative Fugue

This disorder is characterized by generalized amnesia, confusion about one's identity and sudden wandering away from home or place of residence. Sometimes, the confusion/amnesia about one's identity may give place to an alternate identity. Because of the nature of the disorder, these individuals may first be encountered by law agencies or acute care hospital units, become homeless, or be taken advantage of by other individuals (there is some evidence that prostitutes and exotic dancers dissociate more than average, although it is not clear whether this symptom preceded their profession, may result from it, or both). During the fugue episode, the person may seem partially or totally unresponsive to the external environment and flees away from a source of stress or trauma (e.g., an upcoming wedding that produces strong conflict, or a violent household).

In a differential diagnosis, the clinician should consider the postictal episodes of wandering known as epileptic poriomania, and psychotic episodes in which, for instance, voices may tell the person to flee. The pattern of symptoms of these other conditions and the close association with stress or trauma in the case of fugue help with the differential diagnosis. Currently, there is a suggestion for the DSM-5 that dissociative fugue should be considered a special case of dissociative amnesia, which I have also advocated for earlier.

Depersonalization Disorder

The DSM-IV defines depersonalization disorder as persistent and recurrent experiences of feeling separated from one's body or psychological processes, but with intact reality testing. During a depersonalization episode, individuals may feel disconnected from sensations, feelings, or thoughts, or as if they were not quite real or were dreaming. Also commonly found are sensory alterations such as a strange quality to colors or sounds. Technically, *depersonalization* refers to this experience as it relates to the self, whereas *derealization* relates to the surrounding environment or to other people, for instance,

'feeling' that others are not quite real. These experiences commonly co-occur.

Depersonalization *disorder*, in which these experiences are recurrent, chronic, and the central aspect of the person's suffering or dysfunction, must be distinguished from depersonalization *episodes*, which may be isolated and innocuous, or be part of a larger syndrome such as in DID or panic disorder in which great fear is often associated with depersonalization. With respect to reality testing, whereas in psychosis, the person may, for instance, *believe* that he/she is dead, in depersonalization, the person does know that he/she is not dead but *feels* that way.

Depersonalization episodes can happen in connection with a seizure disorder, may be triggered by great anxiety or exposure to trauma, or be the by-product of ingestion of psychoactive drugs or of mental techniques such as meditation and hypnosis. Although depersonalization episodes may have appeared initially as part of a mood or an anxiety disorder, they may remain after the other symptoms have cleared, thus becoming a unique disorder.

Recent studies on depersonalization disorder have shown that a frequent etiological factor is early emotional abuse (rather than, say, physical and/or sexual abuse as in the case of DID, see below) and, more proximally, severe stress or trauma. The disorder is associated with memory and attention problems, functional abnormalities in brain areas related to sensory integration and body schema, blunted neuroendocrine response, and hypothalamic-pituitary-adrenal dysregulation.

Because depersonalization and derealization episodes often happen in tandem or may alternate and there are no clinical reasons to differentiate them, it has been recommended that the DSM-5 expand its definition of depersonalization disorder to also include derealization episodes, which are currently diagnosed as DDNOS (DD not otherwise specified).

Dissociative identity disorder

The phenomena subsumed under DID have been previously called double or multiple personality, but the DSM-IV changed the name to underline that the core of the condition is *not* the presence of many personalities, but the failure to integrate various aspects of the individual into a single personality. This terminological change has the important implication that a unified personality is an achievement rather than a given. Thus, the current therapeutic goal in the treatment of DID is to integrate different aspects or states of the person so that the person can partake of a common memory, self-attribution, and control, rather than trying to find the *real* personality, as was the goal earlier on.

DID is defined by the DSM-IV as the presence of two or more distinct identities or personality states (or alters), with characteristic patterns of perceiving and behaving, and which recurrently take control of the individual. Another diagnostic requirement is psychogenic amnesia, which in the case of DID can take an additional form besides the ones described earlier, namely that one identity may remember what another one did but not vice versa. DID is the most severe of the DD and typically subsumes a number of other symptoms, including depersonalization, anxiety, depression, and affective lability (including attempts at self-injury), chronic anxiety, various phobias, conversion and other somatization problems, and

substance abuse, eating, sexual, and personality disorders (especially avoidant and borderline disorders within the last category). This multiplicity of symptoms has led some authors to propose that the lack of identity integration is not as important as the multiplicity of symptoms, which helps explain why patients with DID have a history of many previous diagnoses, often of a mood disorder or schizophrenia, before receiving the DID one. It has also been observed that the severity and patterning of symptoms can vary across individuals and times. There are DID patients who can function quite well and may even go undetected by those around them, whereas other patients may at times become frankly psychotic.

Other authors have remarked that the presentation of distinct identities is not easy to detect (contrary to the popular stereotype DID patients are socially avoidant rather than histrionic) and instead propose as diagnostic criteria simpler dissociative symptoms, including hearing voices that are not attributed to the self and may, at times, exert control on it, amnesias, pseudoneurological or other somatization symptoms, depersonalization/derealization, becoming unresponsive to the surroundings, and experiencing various alterations in the sense of self. At this point, it is seems that the DSM-5 will maintain a minimalistic approach to DID rather than have many symptoms as part of its definition.

As mentioned earlier, some authors have questioned the validity of this diagnosis but have failed to provide empirical support for an iatrogenic hypothesis. On the other hand, a study found that the validity and reliability of the DID diagnosis was comparable to that of some noncontroversial diagnoses, and memory and neuroimaging studies have been consistent with the DID patients' reports that they experience alternate, not consciously integrated psychophysiological states.

Regarding etiological factors, in a number of studies, the vast majority of DID patients have reported severe and chronic forms of early abuse. Some critics have countered that such reports, coming from highly hypnotizable individuals are suspect, but other studies have shown that the search for some type of independent corroboration, which may be very difficult after many years have elapsed, has been substantially consistent with the patients' reports. Nonetheless, it is clear that the vast majority of children who suffer severe abuse or neglect do not develop DID, thus other factors have to be involved. A genetic predisposition to dissociate interacting with some form of disorganized or disrupted attachment seems to also be important etiological factors. I should underline that traumas are important particularly if they occur early in life, when a sense of an integrated self is being developed and is thus vulnerable to disruptions.

Pathological Spirit Possession and Trance

In the DSM-IV, *dissociative trance disorder* (DTD) was defined as 'worthy of further study,' although still lacking enough evidence to consider it a DD on its own rather than just being an example of DDNOS. DTD includes *trance*, namely marked alterations of consciousness or loss of the usual sense of identity characterized by a lack of or unusually narrow awareness of the surroundings and stereotyped behaviors or movement, but without replacement by another identity. DTD also includes *possession trance*, a temporary alteration of

consciousness defined by the replacement of the usual sense of identity by another one (which may be recognized as an ancestor or a spiritual force), stereotyped behaviors attributed to the possessing entity, and typically full or partial amnesia for the possession episode.

The alterations of consciousness just described are usually not pathological and are associated with religious or other rituals, following a cultural syntax for such events. Research shows that most experiences, under these circumstances, evidence good psychological adjustment. Nonetheless, in a few cases in both industrialized and nonindustrialized societies, they may occur outside of cultural norms, be dysfunctional, and produce distress, thus becoming pathological. A case can be made that pathological spirit possession is the nonWestern version of DID (and, with logical equivalence, that DID is a Western version of pathological spirit possession). Although this formulation has been made without much empirical grounding, a recent study in Uganda found that pathological spirit possession sufferers reported greater traumatic events and various types of dissociative symptoms than a comparison group, a pattern similar to that of DID patients in the West.

Both for conceptual and now for empirical reasons, it has been recommended that the DSM-5 criteria for DID include an expansion of the phrasing to cover pathological spirit possession. An obvious advantage of this change would be to have a more specific diagnosis than the vague DDNOS. DTD would remain, however, one of the examples of the DDNOS.

DD Not Otherwise Specified

Studies in both Western and non-Western cultures have found that the catch-all bag diagnosis of DDNOS is the most prevalent DD diagnosis, which suggests that the DSM classification is incomplete in some important ways. The proposed changes to the DSM-5, if accepted, will partly ameliorate the problem by having derealization without depersonalization being included within depersonalization disorder, and pathological spirit possession within DID. Nonetheless, it is very likely that some presentations will still remain outside of the main diagnostic entities. One example is likely to be individuals who are mostly unable to regulate their states of consciousness, especially when dealing with even minor stresses, which may be experienced by them as severe stresses or even traumas. They may then have mixed episodes of 'blacking out' (i.e., seemingly becoming unaware or unresponsive to the environment), either because they do not seem to have conscious experiences at that time or they are absorbed in some distressing memory or fantasy, alongside with bouts of depersonalization, amnesia, feeling that they cannot control different aspects of their selves, and so on.

Currently, the DSM-IV provides the following examples of DDNOS: cases similar to DID that do not fulfill all of its criteria (for instance, experiencing multiple identities without amnesia); derealization without depersonalization; dissociative states in those subjected to coercive persuasion; DTD (including both the pathological possession and trance manifestations described earlier); loss of consciousness, stupor, or coma not attributable to a medical condition; and Ganser's syndrome or the giving of approximate answers to questions (when it is associated with alterations of consciousness and is not the

product of ignorance or temporary confusion). Two further examples of DDNOS are being proposed for the DSM-5: acute dissociative reactions to stressful events and acute states characterized by mixed dissociative and psychotic (e.g., hallucinations, delusion) symptoms.

I would like to comment further on two of the current or proposed examples.

The first one refers to nonmedical loss of consciousness, stupor, or coma. This is a case in which the frontier between dissociative and conversion symptoms is so blurred as to have no meaning. For instance, how can one really distinguish between a pseudoneurological petit mal or absence seizure from stupor or loss of consciousness? Another important issue is that even though there is a common assumption that psychological disorders are typically individual, the literature on mass unexplained medical illness shows that such symptoms as fainting or hallucinations can spread within a group of susceptible individuals in both Western and non-Western countries.

The second point is that at least as currently phrased, the proposed example of 'acute dissociative reactions to stressful events' has a great overlap with ASD, an entity listed under the Anxiety Disorders and defined as an acute posttraumatic reaction that includes dissociative and PTSD (i.e., reexperiencing, avoidance, or hyperarousal) symptoms.

Worthy of mention also are a number of culture-bound syndromes (e.g., latah, amok) that include dissociative phenomena and are not covered by the DDNOS examples provided. Thus, a clinician is well advised to consider that dissociation can occur in all major areas of functioning (self-image, volition, memory, identity, perception, emotion) above and beyond the descriptions provided by psychiatric taxonomies. Whether these phenomena are pathological or not requires not only consideration of the concept of dissociation in general, but of the semantic networks of diseases, values, and ethnoepistemologies present in every culture, along with such aspects as the ability to control and organize the experience.

In sum, after a hiatus of a few decades, the interest in the research, evaluation, and treatment of the DD has been rekindled. We have barely begun to investigate and try to understand what dissociation can reveal to us about how humans achieve epistemological and phenomenological integration and what produces its willed and unwilled disruptions. Wherever these studies may lead, there is good evidence now that DD are not nearly as rare or exotic as clinicians used to think even some years ago. The founder of the most important psychopathology journal, Morton Prince, may have had the last word when he wrote in 1906–1907 that dissociative phenomena in their mild forms are 'an almost every-day clinical affair.'

See also: Posttraumatic Stress Disorder; Somatoform Disorders.

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- www.istss.org – International Society for Traumatic Stress Studies.
- www.dsm5.org/ProposedRevisions/Pages/Default.aspx – Webpage for proposed DSM-5 diagnoses.

Divorce

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Glossary

Agreeableness A tendency to be warmhearted, a team player, supportive, trusting, and generous; one of the five principal dimensions of personality in the five-factor model.

Crude divorce rate The number of divorces per 1000 persons in the general population.

Divorce A dissolution of a marriage.

Five-factor model of personality A model of personality orientations based on five principal dimensions of personality including openness, conscientiousness, extroversion, agreeableness, and neuroticism.

Mania A psychiatric disorder marked by long-term tendencies toward abnormally elevated expansive or irritable moods, and supplemented by such characteristics as grandiosity, racing thoughts, and pressure to keep talking.

Social integration The strength of the bonds between the individual and the social order, including the number of shared beliefs and practices.

Suicide The act of taking one's own life knowingly and intentionally.

Over the last half century, the percentage of the population that reported that "having a good marriage and family life is extremely important" has remained relatively constant at 70–85%. Nevertheless, given the rising number of divorce cases, fewer people realize this cultural value.

Divorce is a significant indicator of the quality of marriages and, more generally, of the quality of life. Divorce often breeds feelings of rejection, loss, and failure. On scales of traumatic life events, divorce is second only to the death of a spouse. For adults, divorce increases the odds of many social problems, including financial strain, depression, a sense of disorientation, and suicide. Divorce is also associated with lower well-being for children both in the short term on such indicators as school performance and psychological distress, and in the long term on indicators such as social mobility, psychological problems, and divorce as an adult. As divorce becomes more prevalent, it can interfere with the production of the next generation of appropriately socialized and trained persons for society.

While divorce is associated with many stress-producing consequences, approximately a million couples continue to obtain divorces every year. Recent national survey data indicate that 43% of first marriages end in divorce within 15 years. At least half of the persons currently getting married will ultimately have their marriages end in divorce. Divorce is becoming part of the normal 'life course' or socialization experience of people. Most people will ultimately and eagerly seek a divorce at some point in their lives. It is not clear, however, if the benefits of ending an unhappy marriage are, in fact, greater than the costs of a divorce.

The Extent of Divorce

Descriptive Data and Trends

The United States

Currently, there are 23 million divorced adults in the United States and an even larger number of remarried, formerly divorced persons (four of ten marriages involve a bride and/or a groom who were previously divorced). The number of

children of divorced parents is approaching the number of children from intact homes.

Divorce rates measure the flow of marital breakdown. They refer to divorces per 1000 general population in a particular year. Rates vary across geographic space. The rates for the South and West tend to be higher than those for the Midwest and Northeast. These differentials have been narrowing over time. In 2007, states with the highest rates of divorce were Nevada (6.5) and Arkansas (5.9) and states with the lowest rates were Massachusetts (2.3) and Rhode Island (2.8), states with a high proportion of Catholics.

A second measure of the incidence of divorce is the stock of divorced persons (the percentage currently divorced or the percentage ever divorced). The percentage of the population that has ever been divorced varies little across regions. This stock measure is lower in the Northeast at 19% compared to 26–27% elsewhere.

Gender is related to the odds for remaining divorced. Females, being somewhat less likely to remarry than males, are more apt to be divorced than males. Using a stock measure for 2008, for example, 8.5% of males over 15 were divorced compared to 11.1% of females over 15.

The risk of being divorced varies over the life course. [Table 1](#) provides data for the percentage of nine gender/age groups who were divorced in 2008. The percentage of males who are currently divorced increases with age and peaks at 15.0% for males aged 50–54. For females, there is a similar age gradient, but the peak is at 55–64. In all age ranges, the percentage of females who are currently divorced is higher than that for males. Divorced males opt to remarry at a higher rate, and sooner, than do divorced females.

As the proportion of persons in society who opt to marry decreases, it is increasingly important to conceptualize divorce in the context of the population at risk: the married population. This is especially important in describing the incidence of divorce between Caucasian and African-Americans.

For example, in 2008, 10.5% of Caucasians were divorced and 57.7% were married, the ratio being approximately one divorced white for every six married ones. In 2008, 12.1% of

Table 1 Percentage of selected age groups who are currently divorced by gender, 2008, United States

Age group	Percentage of males divorced	Percentage of females divorced
20–24	0.8	1.4
25–29	3.0	4.6
30–34	6.4	8.1
35–39	9.1	11.4
40–44	11.9	15.2
45–49	14.2	17.5
50–54	15.0	17.6
55–64	14.0	18.7
65–74	9.5	13.9

Table 2 The percent divorced and married by race, 1990–2008

	1990	2000	2008
Caucasians % divorced	8.1	9.8	10.5
Caucasians % married	64.0	62.0	57.7
Blacks % divorced	10.6	11.5	12.1
Blacks % married	45.8	42.1	35.1

Source: US Bureau of the Census (2009) Statistical Abstract of the US, 2009.
Washington: US Government Printing Office.

blacks were divorced, but only 35.1% were married, the ratio being approximately one divorced black for every three that were married. **Table 2** presents trend data on the marital status of whites and blacks indicating that the ratio of the stock of divorced persons to the stock of married persons has increased over the two decades for both races. It is also noted that in 2008, among adults, four of ten blacks and two in ten whites fell into the category 'never married.'

As the proportion of married persons in society dwindles, the divorce rate (divorces per 1000 general population) would be expected to go down since the population at risk of divorce is smaller. This is what has been happening in the last two decades in the United States and many other industrialized nations.

There is some inequality in who initiates divorce. Wives initiate approximately six out of every ten divorces, while men initiate about three in ten. Joint actions constitute the remainder of the filings. When children are present, wives initiate nearly the same percentage of filings.

Half of all divorces involve at least one child under the age of 18. The average number of children per divorce has been falling since 1964, a reflection of a decline in overall family size. The median duration of marriages that end in divorce has held relatively steady since 1970: 7 years.

Prior to the twentieth century, the custody of children was uniformly given to the father who was legally responsible for providing for his children. Given the spread of Freudian ideas on child development, this pattern totally reversed in the twentieth century, with the courts uniformly awarding custody to mothers. Today, while fathers are increasingly awarded joint (or shared) *legal* (decision-making) custody, it is still unusual for fathers to obtain *physical* (residential) custody of their children. However, joint physical custody is becoming more common.

Trends

The incidence of divorce has increased substantially over the last century and a half. The earliest data on the estimated percentage of marriages that ultimately ended in divorce are for 1867. Ultimately, 5.3% of the persons who married in 1867 became divorced. This figure doubled to 12.0% for those married in 1900. Currently, most marriages will ultimately end in divorce.

Between 1921 and 1965, the divorce rate had been rising very slowly in the United States. The two noticeable departures from this pattern were a drop in the depths of the Great Depression and a short-term substantial upswing in the aftermath of WW II. As the postwar baby boomers began to wed, the divorce rate nearly doubled between 1965 and 1975. It reached a record high of 5.3 in 1981. Since that time it first leveled off and has been declining since 1992. Currently, the American divorce rate is 3.7. The decline is associated with the aging of a large cohort, the 'baby boomers,' who are now well past their divorce-prone years. In addition, marriage rates, generating a population at risk for divorce, have fallen. The population of persons living together without marriage has increased more than tenfold in a space of a generation, thus further decreasing the stock of persons at risk for divorce.

Comparative perspectives: other nations

The United States has one of the highest divorce rates in the world. This has been true for over a century. In 1869, the rate was 1.2, a rate higher than some industrialized nations in the 1990s.

Table 1 presents data on divorces per 1000 population for selected nations of the world. Nations with a high proportion of Catholics (e.g., Ireland, Italy) tend to have a low divorce rate; Ireland had no legal provision for divorce until 1997.

Norms against divorce are especially strong among Catholics and loosen with economic development. The Russian Federation has surpassed the United States and now has the highest divorce rate of this group, with the United States in second place.

It has not been fully understood why the rate of divorce in the United States is so high. One possibility is the high level of individualism, a quest after the maximization of individual goals and pleasures. The country is relatively low in 'collectivism.' For example, the proportion of the labor force that belongs to unions, a collective form of organization, is the lowest in the industrialized world. If the costs of a marriage outweigh its benefits, Americans are apparently more likely than the members of most other nations to seek a divorce.

Between 1990 and 2007, the divorce rate decreased in 7 nations, in 14, it increased, and in 4, it remained relatively constant. In four nations, the increase was 100% or more, including Ireland where divorce was legalized in 1997 (**Table 3**).

The Causes of Divorce

Macrosociological Explanations

Changes in divorce legislation

In colonial America, there were no divorce courts and divorces were rare events. Divorces were a *legislative* matter, and each and every divorce was debated in the colonial congress!

Table 3 Divorces per 1000 population circa 1990, and circa 2007 selected nations, and trend (if > 10% change)

<i>Nation</i>	<i>Divorce rate 1990</i>	<i>Divorce rate 2007</i>	<i>Trend</i>
Australia	2.5	2.3	Constant
Austria	2.1	2.5	Up
Belgium	1.9	2.8	Up
Canada	3.1	2.2	Down
Denmark	3.1	2.6	Down
Finland	2.9	2.5	Down
France	1.9	2.2	Up
Greece	0.9	1.2	Up
Hungary	2.9	2.5	Down
Ireland	0.0	0.8	Up+
Italy	0.5	0.8	Up
Israel	1.3	1.9	Up
Japan	1.3	2.0	Up
Luxembourg	1.1	2.3	Up+
Netherlands	1.9	2.0	Constant
New Zealand	2.7	2.3	Down
Norway	2.4	2.2	Constant
Poland	0.9	1.7	Up
Portugal	1.0	2.4	Up+
Russian Federation	3.9	4.8	Up
Spain	0.6	2.8	Up+
Sweden	2.2	2.3	Constant
Switzerland	2.2	2.6	Up
UK	2.9	2.4	Down
USA	4.7	3.6	Down

Source: United Nations (1992) *Demographic Yearbook*. New York: United Nations;
United Nations (2009) *Demographic Yearbook 2007*. New York: United Nations.
Notes: up+ = more than a 100% change.

Further, one alternative to marriage, living alone, was either banned or heavily taxed. With the development of judicial divorce, more lenient divorce legislation, female labor force participation, and other changes, divorce was more common by the late nineteenth century.

An analysis of 17 industrial nations found that the degree of liberality in the divorce law was the variable most closely associated with the variance in divorce rates; it was more important than economic conditions and female labor force participation. However, the liberality of divorce legislation was largely determined, in turn, by the strength of Catholicism. Divorce law itself may be a reflection of the status of religion in society.

Economic factors

Two conflicting theories link the business cycle to the divorce rate. In the first view, economic prosperity should increase the divorce rate since divorce is less costly in prosperous times. Prosperity provides unhappy couples the financial means for a divorce. Proponents of this first view often note the sizable drop in the divorce rate during the worst years of the Great Depression. According to the second view, economic prosperity should decrease the divorce rate since it reduces stress on families. In this perspective, it is economic depression that increases the divorce rate. Financial strain adds tensions to family life that in turn increase the probability of divorce.

While surprisingly little rigorous empirical testing has been done on these opposed perspectives, the weight of the evidence, from the post-WW II era, suggests that economic prosperity (e.g., low unemployment) has a slightly negative effect on divorce. The size of this effect is typically less than that of the age structure and the extent of female labor force participation.

Women's increased labor force participation is perhaps the most frequently cited factor underlying the increase in the divorce rate since World War II. As economic opportunities for women have increased, more women have obtained an independent financial base. They are less dependent on marriage for monetary support and more apt to seek a divorce from an unhappy marriage. Increased female labor force participation has often been the leading determinant of shifts in the incidence of divorce. However, other nations have even higher rates of employed women than the United States and such nations as Sweden often have lower divorce rates. There is more to the divorce equation, then, than this factor.

The age structure of the population can affect divorce through influencing economic opportunities for different age cohorts. As the proportion of young people in society expands, this sets in motion certain rigidities in the supply of labor. An oversupply of labor results in more competition for employment. An abundance of young workers results in the fall of their incomes, more financial strain on their marriages, and, hence, a higher incidence of divorce.

Social integration

Factors such as religiosity, migration, urbanism, and war can affect the strength of the bond between the individual and society. The extent of shared beliefs and practices can be affected by these conditions; when bonds to social institutions like religion and neighborhoods are weakened, life can become less meaningful. Urban life can promote a sense of anonymity undermining integration and increasing tolerance for divorce. In such contexts, the probability of divorce increases.

A study of divorce rates in 3000 counties found that indicators of social integration were more important than socio-economic variables in explaining the variation in divorce rates. In particular, the higher the incidence of church membership, the lower the rate of divorce. Also, the higher the rate of population growth, the higher the rate of divorce. Finally, the higher the urban percentage, the higher the incidence of divorce.

As divorce becomes more commonplace, the normative climate surrounding divorce is liberalized. The stigma associated with divorce may decline, resulting in an increase in divorce; divorced persons can provide role models and encourage others to follow suit. Overtime data for the United States confirm a positive association between divorce and the previous level of divorce. This suggests some support for a cultural perspective.

Individual-Level Explanations

Personality, psychiatric disorders, dissimilarities

According to the selection hypothesis, persons who succeed in long-term marriage are a select group. Such persons have solid personalities before and during marriage, which help their

marriages to be satisfying and rewarding. Thirteen studies are available that measure personality in large samples of married persons and then keep track of who gets divorced as time goes by. A recent meta-analysis reviewed all 13 over time studies, which measured personality using the dominant 5-factor model. Three of the five major dimensions of basic personality orientation were predictive of divorce. The best predictor was agreeableness (a tendency to be warm, a team player, supportive, trusting, and generous). Agreeable persons were significantly less apt to become divorced. The second best predictor was neuroticism. Neurotic persons (e.g., chronically depressed, overanxious) were considerably more apt than nonneurotic persons to eventually divorce. Finally, conscientious persons (tendency to be well organized, industrious, efficient, enterprising) were less apt to become divorced. Importantly, these understudied personality dimensions were at the same level of importance in predicting divorce as more traditional major predictors, including socioeconomic status. The risk of divorce also has a heritable component, perhaps operating through personality constructs.

One of the best predictors of divorce is age at first marriage: the higher the age, the lower the odds of divorce. For example, in the United States, marrying at over 25 years of age lowers the risk of divorce by 24% (compared to marrying under 18). Age at first marriage predicts the risk of divorce across 17 nations for which data are available. However, to the extent that age captures maturity, it may be, in part, a proxy for aspects of the conscientious and agreeable personality types.

While there is little systematic, overtime research, evidence suggests that long-standing, serious psychiatric problems increase the odds of divorce. Analyses using the national comorbidity surveys determined that 11 of the 14 psychiatric disorders investigated were associated with an elevated risk of divorce over time. The manic disorder (marked by abnormally and persistently elevated, expansive, or irritable moods and supplemented by such considerations as grandiosity, racing thoughts, pressure to keep talking, requiring <3 h sleep) was the best predictor of divorce. It elevated the odds of divorce by 3.2 times. Persons diagnosed with major depression had an enhanced risk of divorce 1.7 times that of the general population. The greater the number of psychiatric disorders, the greater the risk of divorce.

Studies tend to find that the greater the differences in status between spouses, the higher the odds of marital disruption. This is especially true for dissimilarities in religious preference, but also extends to differences in age, education, and race. Communication between the spouses is a function, in part, of similarities on these characteristics. The associated value conflicts can increase divorce risk.

Social integration

Social isolation increases risk of divorce. Measured in terms of the number of ties to friends and community organizations, the greater the 'integration' the lower the probability of divorce. This is mainly for the first 7 years of marriage. Stronger results are found for 'normative integration' or the number of close relatives and friends who have experienced a divorce. In an 8-year panel study of 2000 married couples, the probability of divorce was only 9% among those with no significant others divorced, whereas the probability of divorce

was 16% among those who had both a friend and relative who had divorced. As normative standards permit or encourage divorce in one's social networks, the likelihood of divorce increases.

One particularly strong predictor of divorce is low religious integration. Catholics have a lower incidence of divorce than Protestants, given the stronger norms against such in the former. From national survey data, being a member of any religious group versus not having a religious affiliation lowers the risk of divorce by 13%.

Economic factors

The occupational status, education level, and income of the husband lower the risk of divorce. Having some college education lowers the chances for a divorce by 13%. However, only income tends to remain significant if one holds the other variables constant. National survey data in the United States indicate that persons living in households with incomes over \$50 000 were 30% less apt to divorce than their counterparts over the first 10 years of marriage. Financial strains place the family under stress which, in turn, increases the probability of marital dissolution.

Table 5 presents data on the percentage of men who are divorced in each income class. Since age status is confounded with income status (older men tend to make more money than their younger counterparts), the data refer to a particular age range containing the 'baby boomers,' those 55–64 in 2008. While these men in Table 4 are about the same age, the percentage of them who are divorced varies from a low of 8.3 for those with personal incomes of over \$100 000 to a high of 18.5 for those men with the lowest incomes. Importantly, as one goes from the income group of men earning \$40 000–\$75 000 to a group above the median or typical income (\$75 000–\$99 999) for men of this age, the percentage divorced drops from 11.3 to 8.8. That income is associated with the odds of being married is indicated by the ratio of the percentage married to the percentage divorced. This ratio improves from 3.3 for the poorest group to 10.4 for the richest group of men.

Table 4 The odds of divorce for persons diagnosed with selected psychiatric disorders, national comorbidity surveys, United States

<i>Disorder</i>	<i>Increased risk for men</i>	<i>Increased risk of divorce for women</i>	<i>Increased risk of divorce, total population</i>
Mania	3.3×	4.8×	3.2×
Major depression	1.7×	1.7×	1.7×
Generalized anxiety	2.3×	1.4×	1.7×
Drug abuse	1.4×	1.4×	1.4×
Number of disorders			
One disorder	1.3×	1.7×	1.3×
Two disorders	2.3×	1.7×	1.5×
Three disorders	2.5×	2.5×	1.9×

Table 5 The percentage of men, ages 55–64, who are currently divorced, and currently married by personal income range, 2008, United States, current population reports

<i>Income range</i>	<i>Number of males, 55–64</i>	<i>(A) percent married</i>	<i>(B) percent divorced</i>	<i>Ratio of (A)/(B)</i>
\$1–\$5 000	411 000	62.3	18.8	3.31
\$5 000–14 999	888 000	65.5	17.0	3.85
15 000–24 999	1 306 000	71.4	15.1	4.72
25 000–39 999	2 255 000	73.0	15.0	4.87
40 000–74 999	3 998 000	79.9	11.3	7.1
Above median income ranges:				
75 000–99 999	6 567 000	84.3	8.8	9.6
100 000+	1 805 000	86.3	8.3	10.4

Source: <http://www.census.gov/population/www/socdemo/hh-fam/cps2008.html>.

Table 6 Top five perceived causes of divorce reported by divorced persons themselves, marital instability over the life course survey, United States

<i>Perceived cause</i>	<i>Total (%)</i>	<i>Males (%)</i>	<i>Females (%)</i>
Infidelity	21.6	15.6	25.2
Incompatibility	19.2	19.5	19.1
Drinking/drugs	10.6	5.2	13.7
Grew apart	9.6	9.1	9.9
Personality problem	9.1	10.4	8.4

Divorced persons' perceptions of causes of divorce

When queried about what caused their divorce, divorced persons tend to give little credence to widely referenced factors in the academic research such as age at first marriage or conflict resolution skills. Infidelity, for example, rates high on the list, a relatively unstudied factor in academic research. **Table 6** provides national data on the top five causes of divorce as reported by divorced persons themselves.

Further insight into the cross-cultural causes of divorce is provided by anthropologists. Betzig reviews contributing factors to divorce as recorded by anthropologists in 186 societies, including the Aztec and Native American tribes such as the Apache, Huron, and Pawnee.

Family dynamics and process

Premarital cohabitation

While premarital cohabitation might be seen as 'preparation' for a successful marriage, persons who cohabit before marriage are at relatively high risk of divorce. This risk factor for divorce is consistent across 17 nations. Both cohabitation and divorce may be indicators of a predisposition to go against normative behavior regarding marital conventions.

Children

On the one hand, children are often thought to decrease the odds of divorce since they can give an unhappy couple 'a reason to stay together,' or perhaps problems concerning

children per se help to prevent a focus on marital problems, thereby lowering the risk of divorce. On the other hand, children can increase stress; children also represent a source of numerous economic and social demands on parents. In a study of over 40 000 marriages across 17 nations, it was determined that the greater the number of children that a married couple has, the lower the risk of divorce.

Esteem for spouse

Spouses in happy marriages tend to hold each other in higher esteem than do divorced persons. The former group is considerably more likely to describe their mate's traits as superior to their own than the latter group. This factor of support for the spouse is related to having an agreeable personality.

Sexuality

A badly neglected variable, sexual adjustment distinguishes happily married couples from divorced spouses. The former report significantly more enjoyment and higher actual/preferred sex frequency ratios than the latter. Sexual incompatibility is one of the more frequent explanations that divorced persons themselves give for the breakdown in their marriages. Further, adultery is a much-cited reason for divorce among divorcees.

Consequences of Divorce

Probably, the best researched area in divorce studies is that of the consequences of divorce. The effects of divorce include psychological, economic, and social consequences. The literature on the effects of divorce is divided first into that discussing effects on children and that discussing effects on adults. For children, effects are further subdivided into short- and long-term impacts. Finally, the sources of variation in the extent to which people are affected by divorce are discussed for both children and adults.

Effects on Children

Short-term consequences

Psychological impacts

Meta-analyses of over 100 relevant studies found that parental divorce increases the risk of psychological maladjustment and low self-esteem in children.

There is some evidence that the children of divorced parents have lower peer popularity at school than the children of intact families. This may be a social consequence of psychological impairment.

School performance. Two meta-analyses of over 100 studies found that parental divorce is associated with decreased school performance. Contributing factors to low-grade point averages included mothers with high levels of depression and low education levels.

The 'task overload' often found in single-parent, divorced families is associated with weaker supervision, increased labor force participation of the custodial parent to offset the loss of the income of their former spouse, and less parental monitoring of school work.

Criminal behavior

Divorce tends to be associated with a higher incidence of criminal behavior. A meta-analysis of 72 studies determined that children from divorced homes have higher rates of felony thefts, crimes against persons, drug abuse, and other offenses than children from intact homes. Divorce reduces the amount of supervision and control of children, both within the family and in neighborhoods with high proportions of single-parent families.

Long-term consequences

Psychological impacts: depression

Life-course approaches to divorce and depression have established a link between parental divorce and the odds for depression among children after they become adults. This association is independent of other marital and socioeconomic life outcomes of the children.

Divorce

A systematic analysis of 40 000 marriages in 17 nations determined that parental divorce increases the risk of divorce among children when they reach adulthood. The children of divorced parents tend to have more favorable attitudes toward divorce than the children of intact families. Divorced parents can constitute a negative role model for their children. Children growing up in families with constant bickering may not adequately learn the interpersonal skills that contribute to successful marriages.

In addition, personality orientations and disorders have genetic components. The intergenerational transmission of divorce may involve the transmission of genes that promote disagreeableness, low conscientiousness, and forms of neuroticism.

Social mobility

The experience of family disruption during childhood substantially increases men's odds of ending up in the lowest occupational stratum. Family disruption also weakens the association between the father's occupational status and the occupational status of the son. These relationships hold for both blacks and whites.

At the macrolevel of analysis, the increase in divorce rates since the 1960s is tied to the weakening of the association between sons' class of origin and class of destination. As more sons have been coming out of divorced homes, fewer of them are achieving the amount of occupational advancement that one would ordinarily expect on the basis of their father's occupation.

Explaining the variation in effects among children

Some children of divorced parents fare better than others in their level of well-being. Amato's review of 180 relevant studies suggests five indicators of well-being: academic achievement, behavior problems, psychological adjustment, self-esteem, and quality of social relations. Evidence-based investigations have reported the most consistent results for two moderating factors: the quality of the custodial parent's mental health and the level of conflict between the former husband and the former wife.

First, the hypothesis that the well-being of the children of divorced parents is positively linked with the postdivorce

psychological adjustment of the custodial parent is supported in nearly all studies. Better-adjusted parents are able to foster higher levels of well-being in their children. Further, the higher the quality of the relationship between the custodial parent and the child, the greater the well-being of the child.

Interparental conflict generally lowers the well-being of the child. Nearly 90% of the relevant studies support the notion that children's well-being is inversely correlated with the level of postdivorce conflict between their parents.

A majority of studies support the notion that the greater the economic well-being of the postdivorce household, the greater the well-being of the child.

The life-stress perspective contends that it is not a single stressor that erodes children's well-being, but a series or accumulation of stressors. Changing schools, moving, financial strain, loss of contact with grandparents, and so on, may ultimately wear down the child and threaten his/her basic well-being. Two-thirds of the relevant investigations confirm this notion that the greater the number of stressful life events, the lower the well-being of the child.

Generally speaking, children of divorced parents are more apt to have better well-being if their custodial parent is in good mental health, interparental conflict is low or absent, and the number of stressful life events is low.

Effects on Adults

Psychological and physical health

Generally, research has found a strong association between divorce and psychological impairment. For example, national survey data find that the divorced have a level of depression that is 40% higher than the national average. Levels of problems such as loneliness, guilt, anger, and anxiety are higher among divorced persons than among married persons. These problems are often attributed to such factors as a deterioration of the standard of living after divorce, a relative lack of confidants, and a deep sense of loss.

Divorced persons have a risk of suicide that is 2–4 times greater than married persons depending on the gender and age group one inspects. For example, divorced males aged 40–44 have a suicide rate of 104.4/100 000, 4.58 times that of married males of the same age (20.3/100 000). At the societal level, the relationship between suicide and divorce rates is like a sociological 'law.'

Turning to physical health, research on both the United States and other nations has tended to find a higher rate of both morbidity and mortality among the divorced than among the married. The increased risk of illness among the divorced has been linked to suppressed immunological functioning, which is especially pronounced among persons who are still attached to their exspouse.

Economic effects

In an egalitarian marriage where both husband and wife earn \$50 000 a year, they may be able to make a \$2000 per month mortgage or rent payment on a large home place in a desirable neighborhood. However, after a divorce, all else being equal, each would half their pooled income. A home place with a \$1000 per month payment might be all each could afford. It would probably be smaller and in a less desirable

neighborhood, probably with poorer schools for their children. On the whole, the custodial parent is faced with an ~30% or more reduction in their income and standard of living. Remarriage is the main avenue for restoring the predivorce standard of living.

Social effects

An immediate target for criminal violence is the exspouse, a person who is often the perceived source of considerable anger. Crimes of violence occur among one-quarter of all divorcing couples. At the aggregate level, the divorce rate is a fairly reliable predictor of the crime rate in cities.

Explaining the variation in effects among adults

Gender differences

Women experience greater negative financial consequences from divorce than do men. The degree of this difference, however, may be changing as the income gap between men and women's predivorce income narrows.

While both men and women experience an increase in depression following divorce, the causes of the depression tend to be somewhat different. For men, loss of emotional support is cited ahead of financial problems. In contrast, for women, financial problems are cited ahead of loss of emotional support.

Economic

The financial consequences of divorce are cushioned by the economic resources, such as skills and degree of labor force participation, of the custodial parent. Custodial parents with higher levels of education and training, and who increase the number of hours worked, fare better than their counterparts.

Support systems/social isolation

A recent meta-analysis of 21 studies determined that the higher the degree of social relationships following divorce, the lower the level of maladjustment. Maladjustment indicators include depression, anxiety, negative affect (e.g., unhappiness, life dissatisfaction), generalized psychological distress, and physical symptoms. Social support involving specific relationships (e.g., one-on-one relationships such as that with a best friend) buffer against maladjustment. Network-based or secondary social support such as that gleaned from membership in groups (e.g., church, circle of friends, neighborhood, and support group) may especially promote positive adjustment. For older divorced persons, relationships

with their adult children, who can now provide support, are often critical to divorce adjustment.

Relations with exspouse

Interspousal hostility and bitterness over the divorce impedes divorce adjustment. Positive attachment, such as dependence, to a former spouse may account for long-term psychological distress in some divorces. A relationship with one's ex marked by indifference may be the healthiest mode. The development of a new intimate relationship with someone of the opposite sex improves divorce adjustment.

Cultural beliefs

A belief in the immorality of divorce is associated with higher levels of psychological stress among divorcing couples. Adherence to liberal gender roles improves divorce adjustment for women.

Sexuality

An important aspect of divorce adjustment is reestablishing an intimate sexual relationship. Research at the national level has found that males were considerably more sexually involved than females, especially at older ages. Persons low in religiosity, high in education, and high in political liberalism were more sexually active than their counterparts.

Conclusions

Divorce in the Context of Rising Cohabitation Rates

While there have been declines in divorce recently in some nations, this trend is associated with parallel declines in marriage rates and upticks in the incidence of cohabitation, a key alternative to marriage. [Table 7](#) provides the essential data for establishing a context for the study of relationship breakdown in the future.

In the space of under 50 years, the number of cohabiting, unmarried American couples increased more than 15-fold from 439 000 in 1960 to over 6 million in 2008. In the same period, the percentage of persons who were divorced rose. Marriage became correspondingly less popular. A total of 88% of males were married in 1960, but only 65.7% were married by 2008. Importantly, the marriage rate, here, the number of marriages for every 1000 unmarried women 15 and over, declined by 50% from 73.5/1000 in 1960 to just 39.9/1000 in 2004.

Table 7 Trends in divorce and associated social indicators, 1960–2004

Year	% divorced males	% divorced female	% married male	% married female	Married rate per 1000 married female	Number of cohabitants (1000s)	% kids with both parents	% births to unmarried mothers
1960	1.8	2.6	88.0	87.4	73.5	439	88	5.3
1970	2.2	3.5	89.3	86.9	76.5	523	85	10.7
1980	4.8	6.6	84.2	81.4	61.4	1589	77	18.4
1990	6.8	8.9	74.1	73.0	54.5	2856	73	28.0
2000	8.3	10.2	69.0	71.6	46.5	4736	69	33.2
2004	8.2	10.9	65.7	67.3	39.9	5080	68	34.6
2008	9.0	11.7	Na	Na	Na	6800	Na	Na

The rise in unwed births and rise in divorce is associated with a substantial drop in the percentage of children under 18 who live with both biological parents: from 88% in 1960 down to 68% in 2004. For African-Americans, this figure is substantially less, with only 35% of children now living with both biological parents.

Importantly, there has been a sevenfold increase in the percentage of children born to unmarried mothers: 5.3% in 1960 rising to 34.6% by 2004. For African-Americans, fully 68% of births are to unwed mothers.

Cross-national research spanning 17 nations has consistently found that cohabitation before marriage raises the odds of divorce after marriage. Far from being a way to reduce the chances of divorce, it apparently backfires and enhances the chances of divorce. In the United States, over half of all first marriages are now preceded by cohabitation.

With so many children being born to unwed mothers, and with the fall in the marriage rate and rise in unmarried cohabitation, future research on divorce needs to include not just the breakups experienced by married couples, but also the breakups of the unions of unmarried couples. In some nations, the proportion of unmarried cohabiting couples is now greater than the proportion of married couples.

It seems unlikely that these trends which began a generation ago are apt to reverse. They are best understood as an expression of a highly individualist culture. Cultural attitudes of young people, the group constituting the future of the family, increasingly support new marriage and family forms. For example, after increasing over the years, a majority of youth in the United States now report that "having a child without being married is experimenting with a worthwhile lifestyle and not affecting anyone else." Academic research needs to respond to these trends and begin the systematic study of union dissolution among cohabitants.

See also: Aggression; Alcohol: Psychosocial Effects; Anxiety Disorders; Big Five Model and Personality Disorders; Depression; Homicide; Love and Intimacy; Marital Dysfunction; Personal

Relationships in Everyday Life; Personality Disorders; Sexual Behavior; Stress and Illness; Suicide.

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Drugs, the Brain, and Behavior

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Glossary

Agonist A chemical that binds to a neurotransmitter receptor and mimics the action of an endogenous neurotransmitter.

Antagonist A chemical that binds to a neurotransmitter receptor and has no effect other than to block the action of endogenous neurotransmitters and other receptor agonists.

Drug A chemical that, in small amounts, has significant effects on physiology.

Hallucination Perceptual experiences in the absence of associated external sensory stimuli.

Neurotransmitter A chemical that is released by nerve cells and diffuses extracellularly to bind to receptors on nerve cell membranes, thereby mediating intercellular communication of neural signals.

Neurotransmitter receptor Proteins located in nerve cell membranes that specifically bind neurotransmitters, undergo a resulting conformational change, and thereby mediate changes in cell membrane electric potential or initiate various intracellular biochemical processes.

Synaptic cleft At a synapse, the narrow gap between a neuron and an adjacent neural cell.

Uptake transporter Proteins located in nerve cell membranes that function to remove neurotransmitter from the synaptic cleft and move it into the interior of the cell; often located on the presynaptic axon terminal, thus returning neurotransmitter into the cell from which it was released.

Introduction

Drugs are chemicals that, in small amounts, have significant effects on physiology. Psychoactive drugs are chemicals that have effects on the psyche or mind, presumably by way of their interaction with the nervous system and, in particular, the brain. The human brain is likely the most complex object thus far encountered in the universe. Its complexity is manifest in its ~100 billion neurons interconnected by trillions of synapses. In addition, the human brain contains several hundreds of billions of various kinds of glia cells, some of which are intimately involved in cellular signaling processes. Astrocyte glia cells, for example, play central roles in cell-to-cell signaling at synapses, exhibiting many of the properties formerly considered unique to neurons.

Each and every synapse is the setting for an intricate molecular drama involving release of chemical neurotransmitters, rapid diffusion of neurotransmitter across the narrow gap (cleft) separating the presynaptic from the postsynaptic neuron, binding of neurotransmitter to receptor proteins – located in the membranes of the postsynaptic and presynaptic neurons and of astrocyte glia cells – and resulting conformational changes of the receptor proteins. If the receptor is an ionotropic receptor, the effect will be ion flow across the cell membrane, a change in the membrane voltage, and a resulting change in the excitability of the cell. If the receptor is a metabotropic G-protein-coupled receptor (GPCR), the result will be the modulation of intracellular processes that include ion-channel gating, enzyme activation, and gene transcription. The neuronal signaling process is terminated when the neurotransmitter is taken back up into the neuron that released it, or into other nearby cells, via membrane proteins called uptake transporters, or is enzymatically degraded.

Dozens of different molecules have been identified as neurotransmitters in the human brain. Glutamic acid or glutamate

is the primary excitatory neurotransmitter in the human brain. GABA (γ -amino-butyric acid) is the major inhibitory neurotransmitter. Other neurotransmitters include acetylcholine, serotonin, dopamine, norepinephrine, epinephrine, histamine, glycine, adenosine, anandamide, nitric oxide, and the opioid polypeptides. Additional neurotransmitter molecules no doubt remain to be discovered. The diversity of chemical neurotransmitters and the numerous different receptor proteins – typically, many different types of receptor proteins for each type of neurotransmitter – are another facet of the vast complexity of the brain.

As far as is presently known, psychoactive drugs exert their influence by interacting with the signal transmission process at synapses. There are various ways in which this can happen. A drug can mimic the effect of a neurotransmitter because sufficient similarity in molecular structure allows the drug to bind to and activate a receptor in a manner similar to that of endogenous neurotransmitter. Such a drug is called a receptor agonist. Or it could bind to a receptor and block the receptor, preventing its being activated by endogenous neurotransmitter. Such a drug is called a receptor antagonist. Some drugs enhance neurotransmitter release or leakage from the presynaptic neuron. Others block uptake of neurotransmitter from the synaptic cleft, or interfere with the synthesis or degradation of neurotransmitter, or interact with the chemistry of the brain in ways not yet elucidated.

Psychoactive drugs include the following chemicals: commonly used nonmedical substances such as caffeine, alcohol, and nicotine; medically prescribed substances such as amphetamine, morphine, and benzodiazepines; mind-altering substances that have been excluded from accepted medical use and are declared illegal, such as heroin, cannabis, and psychedelics like lysergic acid diethylamide (LSD) and mescaline; and medications used to treat mental-health conditions, such as antidepressants and antipsychotics. Among these drugs, some

are frequently used for their pleasure-producing effects (alcohol, caffeine, etc.), some are used medicinally (antidepressants, antipsychotics, etc.), some are used for both (amphetamine, opioids, benzodiazepines, cannabis, etc.), and some are more prone to fostering problematic relationships such as addiction (nicotine, alcohol, benzodiazepines, opioids, etc.).

Historically, psychoactive drugs were all natural products, ingested in the form of plants or fungi, or extracts of these organisms. The word 'drug' comes from the Old English word 'drogge' and the Old French word 'drogue,' words that may have earlier had the meaning of 'dry' or 'dried plant.' Beginning in the 1800s, chemists isolated and identified a number of molecules from plants that had psychoactive effects. Morphine, caffeine, nicotine, atropine, cocaine, and mescaline were all identified as psychoactive compounds from plants by nineteenth-century European chemists. Beginning near the end of the nineteenth century and continuing to the present day, medicinal chemists have synthesized previously unknown molecules having psychoactive effects. Some of these new molecules have been marketed by the pharmaceutical industry as drugs for the treatment of various conditions.

In the United States, many psychoactive drugs are classified according to the Controlled Substances Act, a federal law first instituted in 1970 and copied in some form by all of the states. The US Controlled Substances Act classifies psychoactive drugs that have been declared to have potential for abuse (problematic use leading to possible addiction) into five categories or schedules. Schedules II, III, IV, and V are legally available for medical use with an appropriate physician's prescription. Examples are amphetamine, morphine and other opioids, and the benzodiazepines. Schedule I drugs have been declared categorically illegal and are not available for legal medical use. Examples are heroin and the psychedelics. Alcohol and nicotine (or tobacco) are not regulated by the Controlled Substances Act. Some other countries have similar classifications of psychoactive drugs, such as the Misuse of Drugs Act in the United Kingdom. This UK Act classifies drugs having abuse potential into one of three classes: A, B, or C, with Class A drugs considered to be potentially the most harmful. Many countries worldwide have signed on to an international classification of controlled substances: the United Nations Convention on Psychotropic Substances, instituted in 1971.

Abuse and addiction are toxic aspects of certain drugs. Even drugs that have substantial medicinal benefits may also have significant toxic effects. Indeed, as the pioneer pharmacologist Paracelsus (1493–1541) said nearly 500 years ago: "Everything is a poison. The difference between a poison and a medicine depends on the dose."

In terms of both physiology and behavior, the effects of any psychoactive substance may be impacted by both the mental state or set of the user (expectations, prior experience, mood, etc.) and the physical setting of use (alone, social, therapeutic context with a healer, spiritual ritual, etc.). Some drugs are more susceptible to these 'set-and-setting' effects than others. Thus, caffeine may generally have a small set-and-setting effect and alcohol an intermediate one, while for substances such as cannabis and the psychedelics the set-and-setting effect may be very large.

This article will briefly describe the essence of what is currently known about the neurochemical effects of various

psychoactive drugs, as well as something of their effects on behavior. Sometimes knowledge of neurochemical effects can be mechanistically related to behavioral actions, and sometimes there is little understanding as to how the known neurochemistry and a drug's effects on behavior are related. As knowledge about the brain increases, we may find that many of the neurochemical actions of psychoactive drugs are far more complex than are presently understood.

Caffeine

Caffeine (1,3,7-trimethylxanthine) is by far the most widely used psychoactive drug in the world. It is found in a number of plants, the most well-known being coffee (*Coffea arabica*, native to Africa), tea (*Camellia sinensis*, native to China), and cacao (*Theobroma cacao*, native to South and Central America), from which chocolate is made. Other caffeine-containing plants include kola (*Cola acuminata*, native to Africa), guarana (*Paullinia cupana*, native to South America), and yerba mate (*Ilex paraguayensis*, native to South America). Closely related to caffeine are two other methylated xanthines with similar psychoactive effects. These are theophylline (1,3-dimethylxanthine), found in tea, and theobromine (3,7-dimethylxanthine), from cacao. Caffeine is believed to act by antagonizing (blocking) receptors for the inhibitory neurotransmitter adenosine, thereby producing a stimulant effect on brain activity.

Nicotine

Nicotine comes from the tobacco plant – *Nicotiana tabacum*, *Nicotiana rustica*, and related species – native to the Americas. It is generally taken into the body by smoking the dried leaves of the tobacco plant. It may also be absorbed through the nasal mucosa or oral-buccal cavity, using a snuff preparation or chewing tobacco. The major known neurochemical effect of nicotine is to bind as an agonist at the nicotinic-type receptor for the neurotransmitter acetylcholine. This produces complex effects in the brain that are presumably related to the behavioral effects of relaxation, mental stimulation, and focused attention experienced by users of tobacco. Nicotine also stimulates the cardiovascular system, producing an increase in heart rate and blood pressure. Chronic exposure to nicotine can result in cardiovascular disease and increased risk of heart attack and stroke. Tobacco smoking is related to increased risk of lung diseases such as cancer and emphysema, apparently due to irritant and carcinogenic substances in smoke. The carbon monoxide component of smoke produces additional stress to the cardiovascular system and other body organs by decreasing the oxygen-carrying capacity of the blood.

Sedative-Hypnotics

Sedative-hypnotics produce relaxation and sometimes euphoria in low doses, drunkenness and sleep in higher doses, and possible coma and death if the dose is sufficiently large. Alcohol (ethyl alcohol or ethanol) is the most widely used sedative-hypnotic drug. Ethyl alcohol is a natural product of

the fermentative metabolism of carbohydrate by yeasts. As this process occurs easily and naturally in the environment, it is likely that human consumption of alcoholic beverages goes far back in history.

Synthetic pharmaceutical sedative-hypnotics include the benzodiazepines (diazepam (US brand name, Valium), alprazolam (Xanax), lorazepam (Ativan), temazepam (Restoril), etc.), barbiturates (phenobarbital, secobarbital, amobarbital, etc.), and other substances such as chloral hydrate, meprobamate (Miltown), and methaqualone (Quaalude). Pharmaceutical sedative-hypnotics have been prescribed medically as treatments for anxiety (anxiolytic agents), as aids to sleep, as muscle relaxants, and as antiseizure medications. A variety of primarily hypnotic drugs have also been introduced to the marketplace in recent years. There include zolpidem (Ambien), zaleplon (Sonata), and eszopiclone (Lunesta).

General anesthetics are powerful sedative-hypnotics used to induce loss of conscious awareness and insensitivity to pain during surgical procedures. They are often volatile organic compounds inhaled as part of a gas mixture during surgery. Historically, diethyl ether and chloroform were used in this way. Contemporary examples include halogenated compounds such as desflurane, enflurane, halothane, isoflurane, and sevoflurane.

GHB, γ -hydroxy butyric acid, is a sedative-hypnotic whose chemical structure is similar to that of the neurotransmitters GABA and glutamate. In the United States, GHB has been declared a Schedule I drug because of its use in recreational settings. However, it is also available as a Schedule III pharmaceutical for the treatment of certain sleep disorders.

Kava kava (*Piper methysticum*, native to South Pacific islands), valerian (*Valeriana officinalis*), chamomile (*Matricaria recutita*), lavender (*Lavandula angustifolia*), catnip (*Nepeta cataria*), and hops (*Humulus lupulus*) are examples of plants with sedative-hypnotic properties.

Many sedative-hypnotic substances are believed to exert their effect on the brain by interacting with receptors for the neurotransmitter GABA. While not acting as direct receptor agonists, their effect at these receptors enhances the action of GABA as an inhibitory neurotransmitter and thus results in decreased excitation in the brain. Some (alcohol, for example) may also have actions at glutamate receptors, reducing the action of glutamate, which is the brain's major excitatory neurotransmitter. In addition, GHB may itself have direct inhibitory neurotransmitter action in the brain, with its own distinct receptors. The various plants listed above may contain chemical constituents that act at the GABA receptor. They may well also contain multiple psychoactive molecules that contribute to their overall effects. This is an important distinction between plants and molecules: Although a single molecular species may be associated with the primary medicinal effects of a plant, the plant will always have more complex effects, as the plant contains numerous different chemicals, a number of which may possess physiological activity.

Cocaine

Cocaine comes from the plant *Erythroxylum coca* and several related species, native to South America. Cocaine blocks

reuptake transporter proteins for the neurotransmitters dopamine, norepinephrine, and, to a lesser extent, serotonin. In the brain, this results in the activation of circuits that increase alertness and wakefulness, produce euphoria, and decrease appetite. In the peripheral nervous system, cocaine activates the sympathetic branch of the autonomic nervous system, with resultant increased heart rate, blood pressure, pupil size, and bronchial airway size. The leaves of the coca plant have been used by indigenous peoples of South America for centuries (and possibly millennia) as a stimulant and for other medicinal qualities. Cocaine, extracted and purified from the coca plant, has far more intense effects on the body than does coca leaf. Sympathomimetic effects may damage the cardiovascular system and may be acutely toxic by precipitating a heart attack or stroke. Excessive stimulation of the central nervous system (CNS) may result in stimulant psychosis (paranoia, other delusions, hallucinations) and seizures.

Amphetamine

Amphetamine and its close chemical relative, methamphetamine, are synthetic substances that cause the neurotransmitters dopamine, norepinephrine, and serotonin to leak out of the presynaptic nerve terminal into the synaptic cleft. The leakage occurs not via the usual process of synaptic-vesicle fusion and exocytosis of neurotransmitter, but by way of the reuptake transporter protein somehow passing neurotransmitter from the interior of the axon to the exterior. This results in activation of the same brain and peripheral nervous system circuits as with cocaine and substantially similar behavioral effects. There are a number of pharmaceutically manufactured substances that can be considered molecular relatives of amphetamine and that work in similar ways. They have been prescribed as CNS stimulants for the treatment of narcolepsy, as appetite suppressants, and as treatment for attention deficit hyperactivity disorder (ADHD). Ephedrine and pseudoephedrine (from plants of the genus *Ephedra*, found worldwide), cathinone (from the khat plant, *Catha edulis*, native to northeast Africa and Yemen), and the synthetic compounds methylphenidate (Ritalin) and phenylpropanolamine are examples of other related molecules with both central and sympathetic nervous system stimulant effects resulting from cellular actions similar to those of amphetamine.

Opioids

Opioids (or opiates) are a group of naturally occurring and synthetic chemicals that act on the nervous system like opium, the gummy secretion from the unripe seedpod of the opium poppy, *Papaver somniferum*, native to central Europe and the region around the Mediterranean Sea, and now grown throughout the world. Natural opium contains morphine and codeine. The discovery of morphine by Friedrich Wilhelm Sertürner (1783–1841) in the early years of the nineteenth century (the reported date of discovery ranges from 1803 to 1817) was a landmark event in the history of science. It was the first time a chemical was isolated and purified from a plant and shown to account for some aspect of the medicinal properties of the

plant. This became a defining event for organic natural-products chemistry and contributed to the perspective that purified chemicals were a more valuable basis for understanding the actions of medicinal substances than whole plants.

Opioids act on opioid receptors in the brain to reduce the perception of pain (analgesia), suppress cough, constrict pupils, and slow respiration. They may also produce relaxation, euphoria, and a dreamy state of consciousness. Medicinally, opioids are invaluable as analgesics and cough suppressants. Acting at opioid receptors in the digestive system, opioids slow intestinal motility and thus are valuable treatments for diarrhea. The most significant potentially toxic aspects of opioids include the risk of dependence and addiction, and the acute depression of respiration, which can lead to death.

A number of opioids are either chemical derivatives of morphine, codeine, or other related molecules in opium, or are synthesized from nonopioid precursors. Heroin (diacetylmorphine) is a simple chemical derivative of morphine that allows it to cross the blood-brain barrier about 3 times more efficiently than morphine. It was first introduced in 1898 as a pharmaceutical medicine for the treatment of pain and cough by the Bayer company. Hydromorphone (Dilaudid), oxycodone (Percodan, OxyContin), and hydrocodone (Vicodin) are all derived from opium precursors. Methadone, meperidine (Demerol), and propoxyphene (Darvon) are examples of synthetic opioids, not derived from opium-based precursors. The synthetic opioids fentanyl, sufentanil, and carfentanil range from being about 100 times to nearly 10 000 times more potent than morphine.

The known opioid receptors are widely distributed in the brain and spinal cord, and are also found in the digestive system and elsewhere in the body. Receptors are GPCRs and are generally characterized as one of three subtypes: mu, delta, or kappa. The neurotransmitters acting at opioid receptors are a class of small peptide molecules collectively called endogenous opioid polypeptides or endorphins (from 'endogenous morphine'). These range in size from the 5-amino-acid-long leu-enkephalin and met-enkephalin to the 31-amino-acid-long β -endorphin. The endorphins are derived from the post-translational processing by specific enzymes of three larger polypeptide products of gene transcription and translation: pro-opiomelanocortin, pro-enkephalin, and pro-dynorphin.

Cannabinoids

The cannabinoids are a class of chemical substances found in the *Cannabis* plant, the source of marijuana (dried buds and leaves) and hashish (concentrated resinous exudate from the buds and leaves). The primary psychoactive cannabinoid in cannabis is delta-9-tetrahydrocannabinol, often referred to simply as THC. The cannabis plant is one of the most ancient human cultivars, with medicinal use documented in Chinese medical texts from more than 3000 years ago. Some botanists recognize distinct species of *Cannabis sativa*, *Cannabis indica*, and *Cannabis ruderalis*, while others believe cannabis has been cultivated by humans for so long that no distinct wild-type species remain. Whether they are considered different species or not, certainly different varieties exist. The plant is believed

to have originated in central Asia and now grows throughout the world.

The psychoactive effects of cannabis may include relaxation, sedation, intensification of thoughts and feelings, alterations of perception, and increased appetite. Medicinally, cannabis has been used as an analgesic, an anti-inflammatory, a treatment for migraine headache, an antiemetic (to decrease nausea), an anticonvulsant, a muscle relaxant, a treatment for glaucoma, and an appetite stimulant. It was widely used as a medicine prior to the initiation, in 1937, of repressive legislation by the US government. Recent years have witnessed a resurgence of interest in the medicinal properties of cannabis and consideration of new laws allowing resumption of legal medical use and clinical research.

For many years, the neurochemical mechanism of action of THC remained obscure. The last decade of the twentieth century saw the discovery of specialized receptors responding to THC (cannabinoid receptors). Cannabinoid receptors are widespread in the human brain, as well as elsewhere in the body, such as in the immune and endocrine systems. Thus far, at least two endogenous compounds have been implicated as neurotransmitters for the cannabinoid system. These are anandamide and 2-arachidonyl glycerol (2-AG), both of which are long-chain, polyunsaturated compounds derived from membrane lipids. The function of the cannabinoid signaling system remains largely unknown, although it is likely to be involved in things such as appetite, memory, and the perception of pain.

A very exciting aspect of endocannabinoid neurochemistry is the notion that cannabinoid signaling at synapses is involved in the modification of synaptic strength. These effects are mediated by way of a novel mechanism that has been termed retrograde signaling. In locations where this occurs – and these locations appear to be pervasive throughout the brain – conventional neurotransmission via the abundant excitatory neurotransmitter glutamate may trigger the postsynaptic on-site synthesis of endocannabinoids. These then diffuse into the synaptic cleft and carry signal information in a retrograde fashion back to the presynaptic neuron or to other nearby neurons and glia cells. The effects of these endocannabinoid transmitters at cannabinoid receptors may then alter the properties of the presynaptic neuron as well as other nearby cells.

Psychedelics or Hallucinogens

The psychedelics are among the most interesting and poorly understood of all the psychoactive drugs. They produce a variety of complex effects on the brain and mind, including intensification of thoughts and feelings, alterations of sensory perception, and loosening of psychological defenses. Reported effects range from euphoria, therapeutic insight, and mystical experiences, to anxiety and panic. The effects of psychedelic drugs on behavior and mental experience, to a greater degree than is the case for other drugs, are significantly influenced by the mental state and the physical setting of the user.

As their properties came under investigation by twentieth-century biomedical science, many of these compounds were initially called psychotomimetics, because it was believed their effects were much like the symptoms of psychosis. This term was eventually eclipsed in favor of hallucinogen, highlighting

that effects may include alterations of perception, including hallucinations. In 1956, the psychiatrist Humphry Osmond (1917–2004), in correspondence with the author Aldous Huxley (1894–1963), proposed the word ‘psychedelic’ (from the Greek roots ‘mind manifesting’) to describe the unique effects of these compounds on consciousness. In their plant forms, psychedelics have been used by cultures around the world for thousands of years to facilitate states of consciousness conducive to mystical experiences. This has led to the use of the word ‘entheogen’ (generating god within) to emphasize their ritual use in spiritual settings.

Although it has not been found as a natural product in plants or fungi and its profound psychoactive properties were not known until it was synthesized and tested by Albert Hofmann (1906–2008) in 1943, LSD is perhaps the most widely known psychedelic chemical. It is one of the most potent psychoactive substances known, active in quantities of a few micrograms. Psychedelics identified from plants and fungi include lysergic acid amide from morning glories (family Convolvulaceae), psilocybin and psilocin from a variety of mushrooms (many from the genus *Psilocybe*), dimethyltryptamine (DMT) from a variety of plant species found throughout the world, and mescaline from several species of cacti, one of which is peyote (*Lophophora williamsii*). Numerous chemical relatives of the compounds named above have been synthesized, tested, and found to have psychedelic effects in humans. This broad category of substances is sometimes additionally delineated as the ‘classical’ psychedelics or hallucinogens, to distinguish them from other substances discussed later that also possess psychedelic and hallucinogenic effects.

The therapeutic utility of psychedelic plants and fungi has been appreciated for centuries in cultures where shamanic practitioners provided medical and psychotherapeutic care. And prior to their being declared illegal in the United States, these compounds were researched and utilized for their psychotherapeutic properties. Clinical research during the 1950s–1960s found them to be of value in the treatment of alcoholism and in psychotherapeutic work addressing death in terminally ill patients. There is ample reason to believe that when used with therapeutic intent in carefully controlled settings, they can be of extraordinary value. Such use may exclude some individuals having preexisting mental illness, as their powerful effects on the brain and mind may exacerbate preexisting symptoms or tendencies toward psychopathology.

Neurochemically, psychedelics have been found to bind as agonists to various serotonin receptor subtypes, especially type-2A serotonin receptors. Psychedelics also bind to other neurotransmitter receptors, including those for dopamine and norepinephrine. The connection between their neurochemical effects and their profound effects on mental function remains largely obscure.

Methylenedioxymethamphetamine

Methylenedioxymethamphetamine (MDMA), popularly known by the street name ‘ecstasy,’ and its close chemical relative methylenedioxyamphetamine (MDA), are often considered together with the psychedelic drugs. While MDMA does have some of the mind-manifesting characteristics of the

psychedelics, its overall properties are distinct enough to warrant a separate category. Chemically related to methamphetamine, MDMA produces CNS stimulation, euphoria, and sympathetic nervous system stimulation. The methylenedioxy moiety confers upon the molecule additional psychoactivity that is psychedelic-like, characterized by intensification of thoughts and feelings and enhanced feelings of connection with others. For many individuals, there is a reduction in anxiety and an enhanced ability to verbalize feelings. These qualities led to the use of MDMA as an adjunct to psychotherapy prior to its being declared an illegal Schedule I substance in 1985, an act that followed media attention to its use as a recreational drug in dance clubs. Though illegal, MDMA continues to be used for both its psychotherapeutic and recreational properties by some individuals. Recently it has been the subject of clinical research for the treatment of posttraumatic-stress disorder.

While MDMA has been found to interact with a number of CNS neurochemical systems, the primary neurochemical effect of MDMA appears to be the release of serotonin and dopamine from nerve terminals into the synapse. Release is not via the usual process of storage vesicle fusion with the cell membrane, as occurs with a nerve impulse, but is by way of leakage of neurotransmitter out of the cell through the reuptake transporter. Animal studies have indicated that MDMA may result in oxidative damage to serotonin nerve terminals. The implications of these findings for human use remain to be determined.

Nitrous Oxide

Nitrous oxide (N₂O) is a gas (sometimes called ‘laughing gas’) widely used in medicine and dentistry for its anesthetic and analgesic properties. It is used by dentists as a sole anesthetic agent and is a component of the inhalation anesthesia (together with potent volatile sedative-hypnotic general anesthetics) for major surgeries. In addition, in subanesthetic doses it can produce a powerful psychedelic-like state of consciousness. Its various psychoactive properties were documented in 1800 by the British chemist Humphry Davy (1778–1829). Davy’s work, published as a book of more than 300 pages in length when he was only 21 years old, represented the first detailed study of the effects of a defined chemical substance on the human mind. Although nitrous oxide has been found to interact as an antagonist at the *N*-methyl-D-aspartate (NMDA)-type of glutamate receptor (a variety of ionotropic glutamate receptor occurring throughout the brain), the mechanism of its psychoactive effects remains obscure.

Dissociative Anesthetics

This class of psychoactive drugs consists of ketamine and PCP (phenyl cyclohexyl piperidine or phencyclidine). These are synthetic compounds introduced into medicine to produce an anesthetic loss of bodily sensation without depressing the vital functions of respiration and cardiovascular action, as do the general anesthetics. While PCP is no longer used medically, ketamine is used in both human and veterinary surgical

procedures. For human surgeries, it is perhaps used most often in infants, the elderly, and in trauma cases, where depressing vital functions may be particularly dangerous. At subanesthetic doses in humans, ketamine catalyzes a change of consciousness having some hallucinogenic and psychedelic characteristics and may be accompanied by a loss of body awareness. Recent research has suggested that subanesthetic doses of ketamine may have prolonged antidepressant effects, that is, elevation of mood in persons suffering from clinical depression. The primary neurochemical effect thus far discovered for these drugs is antagonist action at the NMDA-type glutamate receptor.

Anticholinergics

These substances act as antagonists at muscarinic-type receptors for the neurotransmitter acetylcholine. Such receptors are found in the brain and in the parasympathetic branch of the autonomic nervous system. Psychoactive effects can range from feelings of disorientation to dreamlike alterations of consciousness to powerful hallucinations. Effects on the autonomic nervous system produce a cluster of symptoms that include dry mouth, difficulty urinating, constipation, blurry vision, and orthostatic hypotension. Hyoscyamine (named after henbane), atropine (a mixture of D and L stereoisomers of hyoscyamine, and named after *Atropa belladonna*), and scopolamine (named after *Scopolia*) are anticholinergics found in a number of species of plants from the family Solanaceae. These include *A. belladonna* (deadly nightshade), *Hyoscyamus niger* (henbane), *Mandragora officinarum* (mandrake), *Scopolia*, *Brugmansia*, *Datura*, and *Brunfelsia*.

Atropine, scopolamine, and tincture of belladonna are used to treat intestinal motility problems such as diarrhea and irritable bowel syndrome. Several synthetic anticholinergic drugs are used as adjunctive treatments for Parkinson's disease. Several of the phenothiazine antipsychotics and tricyclic antidepressants (TCAs) described below have anticholinergic effects in the brain and autonomic nervous system.

Salvia divinorum

This plant is put into a class of its own, as there are no other substances that are known to have its peculiar effects on mental experience. A member of the mint family, its Latin name literally means 'sage of divination,' and it has been used for centuries by shamanic healers in southern Mexico (its only known indigenous location) for ritual spiritual purposes. It was introduced to the modern world when the shaman Maria Sabina (1888–1985) told Gordon Wasson (1898–1986) about it in the 1950s. Its effects are powerful and of a hallucinatory nature, although of a very different sort from the classical psychedelics or the anticholinergics. The historical use of the plant was by way of chewing the leaves in a ritual context with a shaman. This plant was unknown outside of a relatively narrow ritual context and likely would have remained so without the aid of the Internet. Contemporary use includes smoking of the dried leaves or of concentrated psychoactive extracts.

The primary psychoactive molecular component has been identified as salvinorin A, a terpenoid compound acting in the brain as an agonist at kappa-opioid receptors.

Antipsychotics

In Indian ayurvedic medicine, from ancient times to the present, extracts of the snakeroot plant, *Rauwolfia serpentina*, have been used to treat symptoms of psychosis (troubling hallucinations and delusions). In the mid-twentieth century, the chemical reserpine was isolated and identified from *Rauwolfia serpentina* and found to cause decreases in the activity of monoaminergic neurons using the neurotransmitters dopamine, norepinephrine, and serotonin.

The first pharmaceutical antipsychotics were the phenothiazines such as chlorpromazine (Thorazine), introduced in the 1950s. Other phenothiazine antipsychotic drugs include perphenazine, thioridazine, trifluoperazine, and pimozide. Non-phenothiazine antipsychotics introduced in the 1960s and 1970s include haloperidol (Haldol) and thiothixene (Navane).

The primary neurochemical effect of all these compounds is to block various types of dopamine receptors. This is believed to lead to a reduction of psychotic symptoms and also to the production of various motor side effects, such as Parkinsonian-like symptoms and movement dyskinesias.

More recently, several antipsychotic medications have been introduced that have fewer motor side effects. These so-called 'atypical' antipsychotics include clozapine (Clozaril), risperidone (Risperdal), paliperidone (Invega), olanzapine (Zyprexa), quetiapine (Seroquel), ziprasidone (Geodon), and aripiprazole (Abilify). In addition to being antagonists at dopamine receptors, these drugs are also antagonists at type-2 serotonin receptors. The serotonin-receptor antagonism is believed to compensate for some of the dopamine-blocking effects in the motor circuitry of the brain, thereby reducing problematic movement symptoms. Many of the atypical antipsychotics have been associated with endocrine-system effects related to problematic weight gain and increased risk of diabetes.

Antidepressants

Extracts of the plant Saint John's Wort, *Hypericum perforatum*, have been used for centuries in Europe for its antidepressant effects. This plant also facilitates wound healing when preparations are used topically. Its healing properties were mentioned in the ancient medical texts of Hippocrates, Pliny, and Galen.

The first pharmaceuticals developed and marketed specifically for their antidepressant effects were the monoamine oxidase inhibitors (MAOIs), discovered in the 1950s. Examples of MAOIs currently on the market are isocarboxazid, phenelzine, tranylcypromine, and selegiline. Via inhibition of the enzyme MAO, these compounds may produce enhanced activity in circuits utilizing the neurotransmitters serotonin, norepinephrine, and dopamine.

A second class of contemporary pharmaceuticals developed and marketed for their antidepressant effects are the TCAs, so called because their molecular structures contain a three-ringed central core. They include imipramine, amitriptyline,

desipramine, nortriptyline, doxepin, and clomipramine. TCAs inhibit monoamine reuptake transporters, primarily for norepinephrine and serotonin.

Newer-generation antidepressants include the serotonin selective reuptake inhibitors (SSRIs), represented by fluoxetine (Prozac), paroxetine (Paxil), sertraline (Zoloft), fluvoxamine (Luvox), citalopram (Celexa), and escitalopram (Lexapro). Other antidepressant drugs include trazodone (Desyrel), nefazodone, bupropion (Wellbutrin and Zyban), venlafaxine (Effexor), desvenlafaxine (Pristiq), mirtazapine (Remeron), and duloxetine (Cymbalta). These later compounds interact in various ways with monoamine neurotransmitter receptors and reuptake transporters.

The prevailing hypothesis regarding antidepressant mechanism is that some sort of change in serotonin and/or norepinephrine synaptic chemistry underlies their clinical action, but exactly what sort of change it is remains unclear. As these neurotransmitters act on a variety of GPCRs, it is likely that the ultimate antidepressant effects involve modulation of gene transcription, resulting in production of nerve growth factors and subsequent synaptic plasticity and neurogenesis.

Mood Stabilizers

These substances are used in the treatment of bipolar or manic-depressive disorder. The most well-known such mood stabilizer is lithium, administered as a salt that produces lithium ion upon ingestion. The therapeutic effects of lithium in the treatment of manic depression were discovered in 1949, and it has been widely used as a medication in psychiatry for more than half a century. The most robust neurochemical effect of lithium thus far elucidated is its interference with G-protein-coupled pathways using phosphatidylinositol as an intracellular messenger, thereby producing a damping effect on many GPCR systems.

Several chemicals, first discovered for their antiseizure properties and used to treat epilepsy and other seizure conditions, are also used to stabilize mood in manic-depressive disorder. These include carbamazepine (Tegretol), valproic acid (Depakote), lamotrigine (Lamictal), and oxcarbazepine (Trileptal). This connection between unstable mood and seizures suggests that similar neuronal properties of hyperexcitability may be involved in both conditions.

Drugs and the Brain

The functioning of the brain can be understood in part by way of a symphony of complex chemical interactions. Psychoactive drugs are believed to work by influencing the chemistry of the brain, primarily by perturbing activity at synapses. This gives rise to short-term behavioral effects such as relaxation, alertness, euphoria, analgesia, sleep, and so forth, presumably related to changes in activity in various brain networks. Repeated perturbation of the brain's chemistry brings about changes in the circuitry of the brain and results in lasting changes in behavior: improved mood from antidepressants, decreased psychosis from antipsychotics, symptoms of dependence and addiction from a variety of drugs, movement disorders from antipsychotics, and so forth. Changes in the

brain's circuitry presumably reflect the strengthening and weakening of synapses through mechanisms such as changes in the number of receptors, changes in the amount of neurotransmitter released, and modulation of intracellular biochemical pathways activated by membrane receptors. Growth of dendrites to form new synapses or deterioration of existing synapses may also be involved. Many of these processes may be regulated by calcium entering the cell via ionotropic receptors or gene transcription modulated by way of GPCRs.

Withdrawal, Dependence, and Addiction

Changes in brain physiology resulting from repeated exposure to psychoactive drugs may result in withdrawal symptoms when use of the drug is decreased or stopped. It is likely that extended use of any psychoactive drug will bring about homeostatic changes in brain physiology that result in symptoms of withdrawal if use of the drug is stopped. In some cases the withdrawal symptoms will be clinically significant and in other cases they may not. For example, repeated use of sedative-hypnotics may produce rebound withdrawal symptoms of arousal, anxiety, and insomnia, and in more severe cases, hallucinations, delirium, and seizures. Situations of clinically significant withdrawal are taken to indicate physical dependence.

Some psychoactive drugs, especially those that produce an experience of pleasure, euphoria, or reduced anxiety, appear to influence neural circuits in the limbic system of the brain. These so-called reward circuits contribute to reinforcement of behaviors important for survival, such as eating, drinking, sexual activity, and finding shelter. Euphorogenic psychoactive drugs may hijack these circuits and produce unusually intense stimulation. The resulting homeostatic changes in the circuits might then produce symptoms of withdrawal that include cravings (intense desires) for the drug, dysphoria, anxiety, and compulsive drug-seeking actions. Clinically significant compulsive drug use is termed addiction.

The reward circuits connect the ventral tegmentum with the nucleus accumbens and the frontal cortex. The primary neurotransmitter in these circuits is dopamine. Various drugs known to be euphorogenic and potentially addiction-producing have been shown to increase the release and activity of dopamine in these circuits. While different psychoactive drugs (sedatives, stimulants, opioids, etc.) have a variety of different effects on the brain and behavior, it is possible that their actions on the dopaminergic reward circuits may be part of a common neurochemical mechanism involved in addiction.

Whether or not an individual develops an addictive relationship with a drug is in part dependent on the drug's pharmacology and its direct effects on brain neurochemistry. These factors are modulated by genetic risk factors for addiction, as well as psychological and sociocultural factors, such as availability of coping strategies for stress and extent of drug use by others in one's surroundings.

Drugs and the Mind

Let 'mind' refer to the collection of mental processes – including thoughts, feelings, and perceptions – experienced by the

organism. Of such mental processes, one may be conscious (aware) or unconscious. There is abundant evidence that the mind is intimately associated with brain physiology: damage to the brain results in specific changes to mental processes, and chemical perturbations of the brain with psychoactive drugs produce specific effects on mental processes. Exactly how mind is related to brain physiology is one of the great unsolved problems of psychology and neuroscience – the so-called mind–body problem. Drugs that affect conscious awareness and other qualities of the mind are powerful probes to the mind–brain connection.

Pioneering neuroscientist, psychologist, and philosopher William James (1842–1910), whose thinking on the nature of the mind was profoundly influenced by experiences with nitrous oxide, said more than a century ago, in words that are every bit as relevant today:

One conclusion was forced upon my mind at the time and my impression of its truth has since remained unshaken. It is that our normal waking consciousness, rational consciousness as we call it, is but one special type of consciousness, while all about it, parted from it by the filmiest of screens, there lie potential forms of consciousness entirely different. We may go through life without suspecting their existence; but apply the requisite stimulus, and at a touch they are there in all their completeness, definite types of mentality which probably somewhere have their application and adaptation. No account of the universe in its totality can be final which leaves these other forms of consciousness quite disregarded. How to regard them is the question. . . .

See also: Addictions and Adolescence; Alcohol: Psychosocial Effects.

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Relevant Websites

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- www.heffter.org – Heffter Research Institute.
- www.maps.org – Multidisciplinary Association for Psychedelic Studies.
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Dyslexia

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Glossary

Causal modeling The use of statistical models to assess the causes of a skill/disorder within a conceptual framework.

Comorbidity The tendency for two or more developmental disorders to occur together.

Dyslexia A learning disorder primarily characterized by reading delay and spelling difficulties, usually accompanied by phonological deficits.

Heritability An index of the amount of variance in a quantitative trait or skill that is due to genetic factors.

Phonological pathway A set of mappings between orthography and phonology.

Poor comprehender Term given to describe a child who can decode accurately but has specific difficulty in understanding what they read (also known as reading comprehension impairment).

Semantic pathway A set of mappings between orthography, semantics, and phonology.

Treatment nonresponders Term given to child who show no or at least a poor response to intervention.

Reading is a uniquely human accomplishment, essential to educational achievement, career prospects, and ultimately adult well-being. It is therefore crucial to understand why children have reading difficulties. Reading is not just a simple matter of recognizing and understanding individual words as our eyes pass over text. The purpose of reading is to understand text. Being a successful reader requires building up a mental representation of the text, a process that requires integration of multiple sources of information, from lexical features to event knowledge and prior experience. In developing this skill, children make a transition from learning to read, to reading to learn.

Models of Reading

The 'triangle model' provides a framework for understanding the development of word recognition (Figure 1). According to this model, the process of learning to read consists of creating mappings between orthography (print) and phonology (speech sounds; the phonological pathway), and between orthography and phonology via semantics (the semantic pathway). The phonological pathway is crucial for reading unfamiliar words which can only be read by translating letter strings into phonological forms (referred to as orthography-phonology mappings). The semantic pathway, on the other hand, is important for accurate and fluent reading and in English, for reading irregular and inconsistent words (e.g., yacht), which cannot be read accurately using orthography to phonology mappings. Early in reading development, children rely heavily on the phonological pathway but there is an increasing need, as development proceeds, for the semantic pathway to be used in order to develop reading fluency and automatic word recognition.

The simple view of reading (see Figure 2) suggests that reading is the product of two distinct but related processes, which are essential for learning to read; word recognition and language comprehension (i.e., understanding the message that the print conveys). Children can vary in their aptitude on these two dimensions and this model can be used to describe different patterns or 'profiles' of performance. Recently, this model

has been adopted by the government in England to provide a framework to guide the teaching of reading and also to help identify children whose reading skills are developing out of step, as illustrated by cases of dyslexia and reading comprehension impairment. Children who fall within either the upper or lower left quadrants are those who have dyslexic difficulties because of poor word recognition skills. Children with good word reading but poor comprehension (lower right quadrant) are often referred to as poor comprehenders. As reflected in the dimensional nature of the simple view model of reading, both dyslexia and reading comprehension impairment are best thought of as continuum, rather than distinct categories with clear cut-off points. Whilst dyslexia is well understood, research into reading comprehension impairment is in its infancy.

What Is Dyslexia?

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM V) of the American Psychiatric Association plans to use the term dyslexia rather than reading disorder (RD) which was used previously. DSM V defines dyslexia as difficulties in the "accuracy or fluency of reading that are not consistent with the person's chronological age, educational opportunities, or intellectual abilities" that "without accommodations, significantly interferes with academic achievement or activities of daily living that require these reading skills."

The definition of dyslexia used by the International Dyslexia Association (IDA), on the other hand, highlights both the neurological and cognitive underpinnings of the disorder as well as its symptoms. The IDA defines dyslexia as "a specific learning disability of neurological origin which is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities" resulting from "a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction." In line with this, a recent government review in England led by Sir Jim Rose also highlights difficulties in phonological awareness, verbal memory, and verbal processing speed as being characteristic of dyslexia.

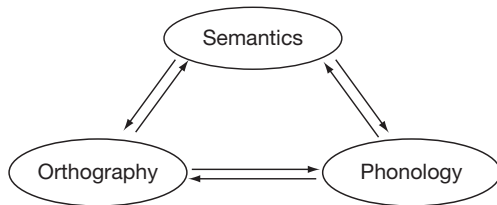


Figure 1 The triangle model of word recognition.

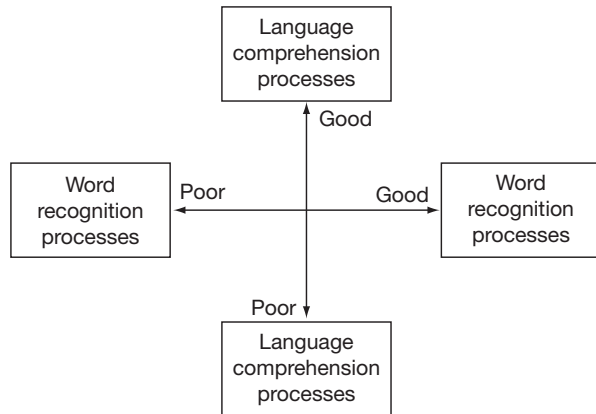


Figure 2 The simple view of reading.

The Discrepancy Definition

For years dyslexia has been considered as a specific reading disability that is unexpected in relation to an individual's IQ. However, the use of this IQ discrepancy definition of dyslexia is controversial. Recent research evidence suggests that, at a cognitive level of description, children with reading difficulties of lower and higher IQ, share deficits in phonological processing and make equivalent responses to intervention programmes targeting phonological skills. Moreover, dyslexia can occur across a wide range of intellectual abilities. The use of the IQ discrepancy definition means that many children who have significant reading difficulties that interfere with daily living and scholastic achievement fail to fulfill diagnostic criteria even though their reading is significantly below age expectations. For these reasons, the DSM V does not make any recommendations about using IQ discrepancy in the definition of dyslexia.

What Is Reading Comprehension Impairment?

Children referred to as 'poor comprehenders' present the mirror image of dyslexia: they have difficulty understanding what they read, despite having age appropriate word reading accuracy and fluency, normal phonological skills and nonverbal ability. Thus, poor comprehenders can read passages of text as accurately and as fluently as their peers but have significant difficulties when questioned about the content of the text. Given the demands on comprehension in primary and secondary school, poor comprehenders are at a significant disadvantage.

In the DSM V, reading comprehension impairment is separated from dyslexia. Instead it is to be considered as a

communication disorder or a learning disability characterized by impairments in both reading and listening comprehension (in the absence of decoding difficulties). The precise definition remains vague in comparison to dyslexia. However, the majority of research studies adopt variants around the following selection criteria for poor comprehenders:

- Reading comprehension below the average range on standardized tests (i.e., below a standard score of 85).
- Word and/or passage reading accuracy in the average range on standardized tests (i.e., above a standard score of 90).
- A discrepancy between reading comprehension and word/passage reading accuracy (e.g., one standard deviation in standard scores or 1 year in age equivalent scores).

Prevalence

RD affects a sizeable minority of the child-population. Prevalence rates vary depending on the criteria used to define the disorders, the measures used to assess reading skills and environmental factors. Prevalence rates of dyslexia vary between 3% and 15% of school age children. Several epidemiological studies have reported that dyslexia is only slightly more frequent in males than in females (about 1.5:1). However, a metareview including all such studies showed that dyslexia is more frequently diagnosed in males than in females and studies of referred samples have found male to female ratios as high as 6:1. This overrepresentation of males in referred samples has often been attributed to a higher frequency of comorbid behavioral disorders, such as attention deficit hyperactivity disorder (ADHD), in males with dyslexia than in females with dyslexia. Fewer studies have investigated prevalence rates of poor comprehenders, however, recent studies suggest that this RD affects between 7.5% and 10% of primary school children in unselected samples. In contrast to dyslexia, reading comprehension impairment appears to affect similar numbers of males and females. Of course dyslexia and reading comprehension impairment are best thought of as extremes of the normal distribution of reading ability rather than distinct categories; hence prevalence rates depend on the arbitrary cut-off points used to define the disorder.

Referral Routes and Assessment

It is important to consider the routes by which children with dyslexia and poor comprehenders are referred for assessment since these will account for the kinds of diagnosis and interventions prescribed. Children with dyslexia are readily recognized by teachers and parents; hence the most common referral route is through educational professionals. Children with dyslexia are also occasionally referred for assessment by optometrists, general practitioners, occupational therapists, and speech language therapists, particularly if the child has a comorbid condition. In comparison, poor comprehenders often go unnoticed in the classroom and are rare in clinically referred samples of children with reading difficulties. However, this is likely to be a reflection of referral bias and the fact that there are currently no established referral routes for these children. Assessments for RDs are

usually conducted by educational psychologists or chartered research psychologists trained in educational assessment.

A comprehensive assessment of reading should comprise measures of reading accuracy (reading aloud a list of single words which increase in difficulty), decoding (reading aloud nonsense words graded in difficulty), reading fluency (reading a list of single words which increase in difficulty at speed), prose reading and comprehension (passage reading followed by an assessment of understanding). Spelling performance should also be considered. Given the evidence that a phonological deficit is central in dyslexia, assessments should include tests of phonological skills; phonological awareness (e.g., phoneme deletion/isolation); phonological/verbal memory (e.g., nonword repetition or digit recall) and naming (e.g., Rapid Automatized Naming (RAN)). Furthermore, difficulties in reading comprehension are often accompanied by deficits in broader oral language (OL), for example, semantics (vocabulary) and grammar; hence it is also important to assess these skills.

Causes of RDs

So far we have focused on the behavioral features of RDs; a proper understanding of these difficulties requires consideration of their causes. A general 'causal modeling' framework can be used to consider causation at biological, cognitive, and behavioral levels, with environmental factors interacting at each level. **Figure 3** illustrates several factors thought to be causally associated with dyslexia (to the left) and reading comprehension impairment (to the right). Within this model, solid lines represent causal pathways that have been empirically validated, while dotted lines represent putative causes which are not yet proven.

Cognitive Explanations

Cognitive theories seek to explain the processes underlying behavioral features of disorders. Indeed, cognition provides an important bridge between biological and behavioral levels of explanation; with respect to dyslexia, a great deal of research during the past 40 years has focused on cognitive explanations of the disorder.

Phonological Deficit of Dyslexia

An important cognitive theory of dyslexia proposes that a core phonological deficit underlies the reading difficulties characteristic of dyslexia. The phonological deficit hypothesis suggests that a failure to develop adequate phonological skills interferes with the learning of grapheme-phoneme correspondences, which are critical in reading acquisition; within the triangle model discussed earlier, poorly specified phonological representations compromise the development of the 'phonological pathway' to reading. A considerable amount of research has found that children with dyslexia perform significantly worse than typically developing children on measures of phoneme awareness, which requires the ability to make explicit judgements about the sound structure of words. Unlike phonological awareness, phonological processing (such as nonword repetition, RAN, and paired-associate learning) requires the use of speech and is free of metacognitive demands. Children with dyslexia also perform poorly on measures of phonological processing supporting the idea that they have poorly specified phonological representations – difficulties with which the brain codes phonology.

Further support for the phonological deficit hypothesis comes from longitudinal studies which suggest that children's early phonological skills and letter knowledge play a causal

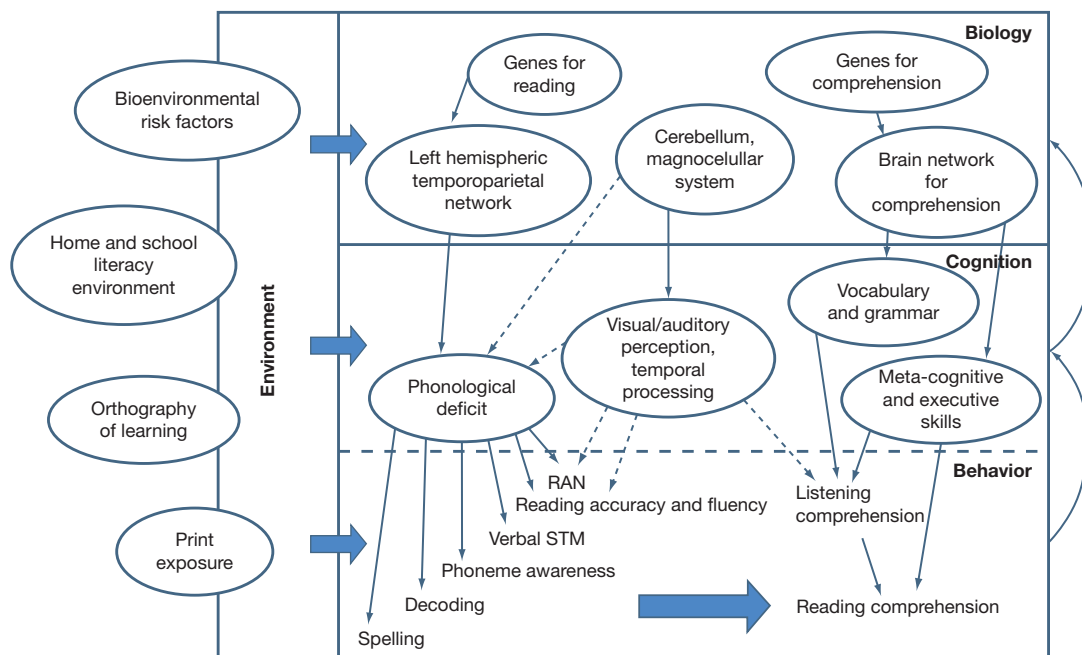


Figure 3 Causes of dyslexia and reading comprehension impairment.

role in their later reading development. Children at risk of dyslexia, who go on to receive a diagnosis, display deficits in phonological skills prior to reading instruction (at around age 4 years). These children also exhibit weaknesses in nonphonological OL skills compared to children at risk of dyslexia who do not go on to receive a diagnosis. However, mild deficits in phonological skills are sometimes present in children at risk of dyslexia but who do not fulfill diagnostic criteria. This suggests that a phonological deficit could represent an 'endophenotype' or risk marker of dyslexia that can be moderated by other risk and protective factors, such that some of the 'at risk' children develop dyslexia while others compensate and do not succumb to reading problems.

Two factors that may potentially impede phonological development are speech perception and auditory processing skills. Research has aimed to establish whether a deficit in the perception of speech sounds, possibly underpinned by a broader weakness in auditory processing, may cause the phonological deficit in dyslexia (Figure 4). However, deficits in auditory processing are not characteristic of all children with dyslexia and although there is some evidence that children with dyslexia have mild impairments in speech perception, this may be restricted to those who have broader OL impairments. Longitudinal studies are needed to elucidate the causal relationships among these skills.

Alternative Causal Theories of Dyslexia

The phonological deficit hypothesis is successful in accounting for the reading failure, the nonword reading deficit and the weak spelling skills, characteristic of individuals with dyslexia. However, some researchers have identified a range of difficulties associated with dyslexia not easily accounted for by this theory. Proponents of the double-deficit hypothesis of dyslexia, suggest that some children with dyslexia have impairments in phonology, others have problems in temporal processing and perceptual speed and a third group has impairments in both.

The magnocellular deficit hypothesis suggests that individuals with dyslexia have impairments in processing rapidly presented auditory and visual stimuli resulting from impairments in the magnocellular pathway in the brain. However, there is little evidence that these skills predict variations in reading in the typical population and not all studies have replicated findings of magnocellular processing deficits in

dyslexia; arguably such deficits may be associated with broader neurological abnormality rather than playing a critical role in the determination of reading difficulty.

Other researchers argue that the apparent link between reading disability and timing deficits is associated with abnormal cerebellar activation and functioning; this has been termed the 'automatization deficit' or the 'cerebellar deficit' hypothesis. This theory suggests that children with dyslexia have problems automatizing cognitive/motor skills and impaired time perception – difficulties that originate from mild cerebellar dysfunction. In support of this, the cerebellum has been implicated in motor activities, balance, skill automatization and adaptive learning, and in perceptual tasks that require the precise representation of temporal information. However, it is possible that cerebellar/automaticity impairments may be associated with comorbid conditions such as ADHD or developmental coordination disorder. Consistent with this hypothesis, balance deficits have been found to be associated with ADHD rather than dyslexia.

Cognitive Theories of Reading Comprehension Impairment

Reading comprehension is a complex skill and consequently there are many potential routes for failure. Knowledge of word meanings is critical for comprehension and poor comprehenders have been reported to have difficulties on a range of tasks that require access to a knowledge of vocabulary (*semantic deficit hypothesis*). Poor comprehenders are often slower and less accurate when naming pictures with low-frequency names and are poorer at making synonym judgements (e.g., when asked to decide whether two words have a similar meaning) particularly for more abstract words. Impairments in semantic processing can also compromise some aspects of word recognition in poor comprehenders. For example, they tend to be poor at reading irregular and low-frequency words although they are able to read regular and high-frequency words. It has been argued that irregular and low-frequency words are harder to read using the phonological and orthographic skills alone and they require greater input from the 'semantic pathway' to word recognition. Semantic processing impairments in poor comprehenders should be considered in the context of broader weaknesses in OL skills including listening comprehension, receptive and expressive vocabulary, oral expression, narrative production, and grammar though phonological skills are normal.

Beyond OL weaknesses, poor comprehenders also have text level difficulties. Successful comprehension relies on making inferences that go beyond what is written in the text to construct an adequate and coherent representation. Inferences are either 'cohesive' (i.e., they are necessary for comprehension and support text integration) or 'elaborative' (i.e., they embellish information provided in the text). Poor comprehenders have difficulties inferring specific meanings of nouns from sentence context (e.g., inferring that 'fish' is most likely a 'shark' in the following sentence: 'The fish frightened the swimmer'). Poor comprehenders have also been shown to generate fewer constructive inferences that require the reader to integrate information from two different sources in text. However, it remains possible that poor inference-making in poor comprehension is due to impairments in accessing relevant

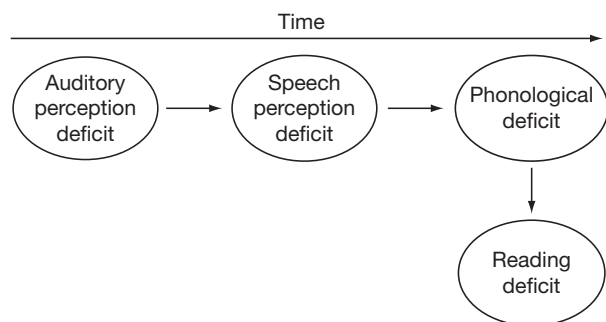


Figure 4 Figure showing the possible causal role of an auditory perception deficit in the development of reading problems.

knowledge, maintaining motivation and a drive to read for meaning, or due to a processing limitation (e.g., poor working memory or the failure to inhibit irrelevant information).

Reading comprehension also relies on metacognitive strategies such as comprehension monitoring (the ability to regulate reading to the demands of the task and engage with the comprehension process). For example, if an individual realizes that their comprehension is inadequate, they can take appropriate steps, such as slowing their reading speed or rereading to remedy the situation. There is evidence to suggest that poor comprehenders have weak metacognitive knowledge and/or are less good at applying this knowledge during comprehension.

Considering the complex nature of reading comprehension, and the range of associated deficits, it seems likely that multiple causal factors will explain reading comprehension impairment. Poor comprehenders are a heterogeneous group and no clear cognitive profile has emerged from the extant research. Although many poor comprehenders have weaknesses in OL, a substantial proportion of the population do not show such weaknesses and some poor comprehenders show average or even good performance on measures of verbal working memory, comprehension monitoring, and inference making.

Biological Bases

It has been known for many years that reading skills are heritable and therefore that reading difficulties run in families. Several 'family-risk' studies have suggested that between 30% and 50% of children whose parents have dyslexia, will also develop the disorder. However, families share genes and also environments so findings of familial aggregation of RDs alone are not sufficient to demonstrate that reading skills are heritable. Twin studies that compare the reading skills of monozygotic twins (who share 100% of their genes) with dizygotic twins (who share on average 50% of their genes) provide a more sensitive design for separating genetic and environmental influences. Such studies suggest that the concordance rates for dyslexia are higher for monozygotic twins than for dizygotic twins, confirming the genetic liability for dyslexia.

More recent research on the heritability of reading and its difficulties has moved away from the use of a categorical 'diagnosis' of dyslexia to define reading as a continuous trait. Within this view, quantitative genetic analyses confirm that reading skills are significantly heritable across the distribution, as are the skills which underlie them, including phonological abilities and other language skills. Moreover, studies with a longitudinal perspective have shown that there is shared genetic variance between preschool phonological awareness and early measures of reading, and also new sources of genetic variance in reading which emerge after reading instruction (perhaps contributing to orthographic learning). Findings such as these illustrate that reading is underpinned by a range of more primitive cognitive skills, many of which are also heritable. However it needs to be borne in mind that genes act through environments and individual differences in any trait, and reading is no exception, also depend on environmental factors. A recent behavior-genetic analysis assessed the genetic and environmental influences on both initial

performance and growth in reading skills. While there were significant genetic and environmental contributions to initial reading level, some of the environmental influences on growth in decoding ability were independent of initial performance. It can be concluded that new environmental influences operate on reading as it develops, over and above those that determine initial performance; it is plausible that these are mediated by the home and school environment and/or the child's personal motivation to read.

Turning to reading comprehension, similar analyses, using the quantitative approach, have shown that shared genetic influences on word recognition and reading comprehension are partly independent of shared genetic influences on listening and reading comprehension. Such findings, which are in line with the simple view of reading, support the position that individual difference in word recognition and reading comprehension are partly underpinned by different genetic etiologies.

Findings of family and twin studies showing the heritability of RDs set the stage for molecular genetic approaches which aim to identify genes that may be associated with the disorder. Dyslexia, in common with other developmental cognitive disorders is genetically heterogeneous and the risk of inheriting dyslexia depends on the combined influence of many genes as well as environmental influences. At the time of writing, a number of gene markers and several candidate genes (on chromosomes 6, 15, and 18) have consistently been associated with dyslexia; moreover the same genes appear to operate across the normal distribution underpinning component reading skills. To date, the genes associated with individual differences in word-level reading are different from those associated with the language impairments implicated in reading comprehension impairments but further research is needed to investigate these associations.

Genetic differences between good and poor readers are likely to have an impact on the neurodevelopment in children with dyslexia. Indeed there is considerable evidence that dyslexia is associated with structural and functional abnormalities in various systems in the left hemisphere of the brain, particularly structures within the temporal lobe which are involved in language and learning to read. More specifically, studies have shown disrupted temporoparietal brain responses during phonological tasks and less left prefrontal brain response during tasks that require the rapid processing of auditory stimuli in both adults and children with dyslexia. However, in interpreting such findings it is important to be aware that becoming literate has an impact on brain structure and function, so some of the effects observed may be a consequence rather than a cause of dyslexia.

Findings from neuroimaging studies also provide some support for alternative, sensory, theories of dyslexia. Support for the magnocellular (visual) theory of dyslexia comes from studies which have found abnormalities in the magnocellular layers of the lateral and medial geniculate nuclei, in individuals with dyslexia. Additionally, in support of the cerebellar deficit hypothesis of dyslexia, studies have shown that the cerebellum, an area of the brain that plays an important role in motor control, is also implicated in cognitive processes involved in reading and verbal memory. Furthermore, the cerebellum has been found to be underactive in adults with dyslexia during performance of a motor sequencing task. However, it is unclear

how deficits in cerebellar function can cause the phonological deficit which underpins dyslexia. Furthermore, the specificity of impairments in the cerebellum to dyslexia is questionable given that the cerebellum is also implicated in disorders such as ADHD.

Far less attention has been devoted to understanding the functional neuroanatomy of comprehension than of phonology and word reading. However, studies using positron emission tomography (PET) have revealed increases in blood flow to the left and right temporal poles during reading when stories are compared with incomprehensible stories. Such regions may therefore be involved in linking propositions to build a mental representation of the text, and the anterior medial parietal/posterior cingulate cortex has been associated with linking incoming information with prior knowledge. Furthermore, neuropsychological studies have reported deficits following right brain damage in narrative comprehension and semantic integration. Only one study to date has investigated neuroanatomical abnormalities in poor comprehenders. This study revealed that reading comprehension impairment is associated with smaller cerebral volume and less leftward asymmetry of the planum temporal, plana, and cerebellar anterior lobe.

Environment

A range of environmental factors affect the development of language and literacy. Significant effects of social and economic circumstances typically associated with parental education level, affect the language skills that children bring to the task of learning and such differences may be compounded by factors such as the amount of literacy related activities in the home. Studies of home literacy environment have shown that direct reading instruction in the home, focusing on letter knowledge and print-related concepts, have positive effects on children's development of decoding skills whereas language activities surrounding shared book reading primarily affect reading comprehension. All of these factors can be assumed to affect the behavioral manifestation of dyslexia in the early school years, and after school entry, different types of reading instruction will also exert an influence on the extent to which an early risk may translate into an identifiable RD. Beyond reading instruction, it has been demonstrated that the amount of reading practice a child undertakes affects reading development such that good readers, who are more likely to enjoy reading, practice more and gain further benefits (Matthew effect). Contrary to this, for children with dyslexia, declining levels of motivation may feed into low levels of print exposure and a downward spiral of poor reading, low levels of literacy and educational achievement (a powerful example of gene-environment correlation is that children who inherit a risk of reading difficulty select an environment not conducive to reading development).

At the level of the 'macroenvironment' the effects of culture will also impinge on the child's emergent literacy skills. Amongst these, a potent example is the language of instruction. Languages vary in the transparency or consistency of the orthography-phonology mappings as well as in the accessibility of different phonological units. There is now a large body of

evidence showing that learning to read in an alphabetic system is easier in more transparent languages and hence it has been predicted that the behavioral manifestation of dyslexia varies among languages. For example, problems of reading accuracy are the primary sign of dyslexia in English whereas in Finnish which is highly consistent, the main manifestation is a problem of reading fluency. Notwithstanding this, the cognitive deficits underpinning dyslexia appear to be universal among alphabetic readers. Burgeoning research with readers of logographic (e.g., Chinese) and, alphasyllabic (e.g., Korean) languages indicates that the predictors of individual differences in reading are somewhat different and include morphological awareness. Against this backdrop, the predictors of dyslexia may be different in these languages.

Development

Clinical observation reveals that, although dyslexia is a persistent disorder across the life-span, the primary signs of dyslexia change with development, and longitudinal studies have begun to elucidate the developmental trajectory of dyslexia (Table 1).

Comorbidities

Comorbidity refers to the tendency for two or more developmental disorders to occur together. Dyslexia frequently co-occurs with difficulties in aspects of language, motor coordination, mathematics, attention, and organization but these difficulties

Table 1 Developmental changes in the cognitive and behavioral features of dyslexia

<i>Developmental phase</i>	<i>Behavioral signs of dyslexia</i>	<i>Cognitive features consistent across time</i>
Preschool	Delayed or problematic speech Poor expressive language Difficulty learning letters	Poor verbal short-term memory Slow naming of familiar objects and colors Slow speed of verbal processing
Early school years	Poor letter sound knowledge Poor phoneme awareness Poor decoding skills Idiosyncratic spelling Problems copying	
Middle school years	Slow reading Poor decoding when faced with new words Poor spelling that is phonetic or nonphonetic	
Adolescence and adulthood	Poor reading fluency Slow speed of writing Poor organization and expression in written work Poor spelling	

by themselves are not thought to be markers of dyslexia. Rather, they are likely to reflect the comorbidity between dyslexia and other developmental disorders such as specific language impairment (SLI), dyspraxia/developmental coordination disorder, dyscalculia, and ADHD. Both dyslexia and SLI have phonological impairments at their core however children with SLI also have additional difficulties with vocabulary and grammar. It is debated whether the overlap between these two disorders truly reflects comorbidity or whether SLI is a more severe form or an earlier manifestation of dyslexia.

Difficulty with reading comprehension has been reported in a number of different clinical disorders, including early onset hydrocephalus, autism, nonverbal learning disorder, SLI, Turner's syndrome, ADHD, pragmatic language impairment, and William's syndrome. However, it is likely that the comprehension difficulties in these disorders have different manifestations. As with dyslexia it is tempting to draw parallels between poor comprehenders and children with SLI. As outlined above, poor comprehenders have weaknesses in spoken language similar to children with SLI and there is a raised incidence of poor reading comprehension in SLI. However, poor comprehenders have clear strengths in phonological processing, which is an area of deficit for many children with SLI. Given the reported weaknesses in attention and working memory in poor comprehenders there is also speculation as to whether poor comprehenders have some form of ADHD but this remains to be formally tested.

Although the extant research precludes strong conclusions, **Figure 5** illustrates the putative overlap of dyslexia and reading comprehension impairment (PC) with ADHD and SLI.

Interventions

Interventions for dyslexia have been in use for many years and there are accepted guidelines for good practice. However, it is only recently that the effects of interventions have been evaluated rigorously using controlled designs.

In the ideal scenario of a virtuous circle, causal theories of dyslexia lead directly to principled interventions and the efficacy of these interventions in turn provide a powerful test of the causal theories. Thus, starting from the premise that poor readers have phonological deficits, if training in phonological skills leads to improvements in reading skills, then this provides evidence for the causal theory. Findings from a large number of studies now show that boosting phonological skills is an effective intervention for poor readers provided it is combined with training in letter-sound knowledge and linking

the two. Arguably such interventions aim to improve the functioning of the phonological pathway in the triangle model. However, it is important to bear in mind that not all children with dyslexia respond to such effective interventions to the same degree. Current research is focusing on the characteristics of these 'treatment resisters' and assessing the validity of 'response to intervention' as a measure of the severity of dyslexia.

Meanwhile, an unfortunate consequence of the poor response of some children is to encourage parents to seek alternative therapies for dyslexia. Such interventions, such as the use of colored filters or of motor programs, have a poor evidence-base and are likely to impact comorbid features, such as visual stress or dyspraxia, rather than the RD per se.

Very few studies have evaluated support for children with reading comprehension impairment. Encouraging children to use representational and transformational drawings to visualize stories and answers to comprehension questions in their minds has been shown to improve reading comprehension in poor comprehenders compared with training that involves reading and question answering. Studies that have trained children's ability to make inferences have also been shown to be effective. Such training has involved asking children to pick out words from passages and explain how they contributed to the overall meaning of sentences or stories, and asking them to generate questions and predictions about the text. However, many of the studies that have supported this position have methodological weaknesses that render the results difficult to interpret.

Moving beyond text-level training, a recent randomized controlled trial has evaluated the effectiveness of three multi-componential training programs on reading comprehension in poor comprehenders aged 8–9 years. The training programs were designed to promote text level processing (TC), OL skills, or a combination of the two (COM). The progress of children in the intervention groups was compared against the progress of a waiting control group. All intervention groups made significant improvements in reading comprehension relative to the control group immediately following training. Furthermore, 11 months after training, gains increased for the OL group beyond the TC and COM groups. The OL and COM groups also made significant progress in expressive vocabulary and this was a mediator for these groups' improved reading comprehension. These results provide strong support for a causal relationship between OL and reading comprehension and suggest that specific reading comprehension difficulties reflect (at least partly) underlying OL weaknesses.

Progress has been made in recent years in understanding both the nature of the difficulties experienced by children with reading difficulties and the best methods for supporting their development. Future research must endeavor to identify the factors that influence response to intervention and to replicate and extend previous findings in educationally realistic contexts in order to determine their practicality outside research settings.

Future Directions

The field of research on RDs is rapidly expanding to encompass studies of dyslexia in different languages, its genetic foundations and neural correlates; against this backdrop, there is a

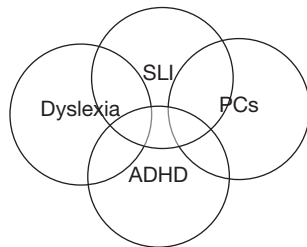


Figure 5 Possible comorbidities with dyslexia and reading comprehension impairment.

growing evidence base regarding interventions. There is likely to be major expansion in research on the neuroscience of dyslexia in the coming decade, including investigation of the neural markers of response to intervention. For this research agenda to succeed it will be important to continue the emerging trend away from considering dyslexia as a categorical diagnosis to viewing it as a the culmination of a number of different risk factors (or endophenotypes) with no clear cut offs. Essentially then the threshold for diagnosis will become free to vary according to the language, age and stage of learning, and the extent to which the difficulties affect everyday functioning in the classroom or workplace. Arguably, progress in the understanding of endophenotypes will depend upon the findings of longitudinal studies, which investigate how risk and protective factors conspire to produce or compensate for the risk of dyslexia. In turn, such studies should improve our understanding of both the comorbidities of dyslexia and the broader phenotype and will be essential to progress in genetics and neuroimaging. In contrast to dyslexia, much less is known about the many causes of reading comprehension impairment (of which dyslexia is of course one). Here the field is wide open for longitudinal studies examining its nature and causes.

Finally, research on RDs and their interrelationships with other developmental neurocognitive disorders is critical to developing effective interventions. At the present time we know a lot about interventions to develop decoding in the early stages and a little about reading comprehension interventions. However, the evidence base is lacking for those with dyslexia who have moderately well developed skills but still struggle to achieve their potential and for those with broader language impairments. Since reading is fundamental to educational achievement, adult employment and mental capital, this research agenda is well worth pursuing.

See also: Attention Deficit Hyperactivity Disorder; Autism and Pervasive Developmental Disorders; Language Development; Phonetics; Reading and Phonological Processing; Sentence Processing.

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He has received many honors and awards, including a fellowship from All Souls College, Oxford, an honorary doctorate from Connecticut College, a gold medal from the Australian National University, the Ariens Kappers Medal from the Royal Netherlands Academy of Sciences for landmark contributions in neuroscience, and the presidential lecture award from the American Academy of Neurology. He is also a fellow of the Neurosciences Institute in La Jolla and a fellow of the Institute for Advanced Studies in Behavioral Sciences at Stanford. He was invited by the BBC to give the Reith Lectures on 'The Emerging Mind' in 2003 and is the first physician/experimental psychologist to be given this honor since the series was begun by Bertrand Russell in 1949 – these lectures were subsequently published as *A Brief Tour of Human Consciousness: From Impostor Poodles to Purple Numbers*.

In 1995, he gave the Decade of the Brain Lecture at the 25th annual (silver jubilee) meeting of the Society for Neuroscience and more recently, the inaugural keynote lecture at the Decade of the Brain conference held by NIMH at the Library of Congress and a public lecture at the Getty Museum in Los Angeles. He also gave the first Hans Lucas Teuber lecture at MIT, the D.O. Hebb lecture at McGill, the Rudel–Moses lecture at Columbia, the Dorcas Cumming (inaugural keynote) lecture at Cold Spring Harbor, the Raymond Adams neurology grand rounds at Massachusetts General Hospital, Harvard, and the Jonas Salk memorial lecture, Salk Institute.

Ramachandran is a trustee for the San Diego Museum of Art and has lectured widely on art, visual perception, and the brain. Ramachandran has published over 120 papers in scientific journals (including three invited review articles in *Scientific American*), coauthor (with Sandra Blakeslee) of *Phantoms in the Brain* that has been translated into eight languages and formed the basis for a two-part series on Channel Four TV in the UK and a one-hour PBS special in the United States. His work is featured frequently in the major news media including BBC and PBS. *Newsweek* magazine recently named him a member of 'The Century Club,' one of the "hundred most prominent people to watch in the next century."

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David M. Buss received his BA from the University of Texas at Austin and his PhD from the University of California at Berkeley. He served in professorial positions at Harvard University, the University of Michigan, and the University of Texas, where he is currently professor of psychology. David Buss received the American Psychological Association (APA) Distinguished Scientific Award for Early Career Contribution to Psychology, the APA G. Stanley Hall Award, and the APA Distinguished Scientist Lecturer Award. The University of Texas awarded Buss the President's Associates Teaching Excellence Award. He served as President of the Human Behavior and Evolution Society (HBES). He is currently Head of the Individual Differences and Evolutionary Psychology Area of the Psychology Department at the University of Texas at Austin.

Buss's books include *The Evolution of Desire: Strategies of Human Mating* (Basic Books; translated into 11 languages); *Evolutionary Psychology: The New Science of the Mind* (Allyn & Bacon); *The Dangerous Passion: Why Jealousy is as Necessary as Love and Sex* (Free Press; translated into 13 languages); *The Murderer Next Door: Why the Mind is Designed to Kill* (Penguin; translated into 12 languages); *The Handbook of Evolutionary Psychology* (Wiley), for which he served as editor; *Why Women Have Sex* (Holt; co-authored with Cindy Meston; translated into 16 languages); and *The Evolution of Personality and Individual Differences* (Oxford University Press). Buss has more than 250 scientific publications to his credit.

Buss has extensive cross-cultural research collaborations and lectures widely within the United States and abroad. His primary research interests include the psychology of sex differences, human sexuality, mating strategies, conflict between the sexes, why people kill, warfare, terrorism, stalking, and the psychology of prestige, status, and reputation.



Richard B. Buxton received his BS (1976) and PhD (1981) degrees in physics from the Massachusetts Institute of Technology, followed by a postdoc in biomedical imaging (PET and MRI) at the Massachusetts General Hospital. He has been on the faculty of the Department of Radiology at the University of California, San Diego, since 1990. Buxton's primary research is in functional magnetic resonance imaging (fMRI), focused on understanding the connections between neural activity, blood flow, and energy metabolism in the human brain. His experimental work combines arterial spin labeling (ASL) methods with blood oxygenation–level dependent (BOLD) methods to estimate changes in brain oxygen metabolism in response to a stimulus or a drug. His more theoretical work involves mathematical modeling of the imaging methods, the BOLD effect, and oxygen transport from blood to tissue. Buxton is based at the Center for fMRI and served as the center's founding Director (2000–2007). He has written a textbook on fMRI, now in its second edition, published by Cambridge University Press (2009).



Nicholas Christenfeld received a bachelor's degree in psychology and social relations from Harvard, and a doctorate in social psychology from Columbia, and joined the faculty at the University of California – San Diego and has remained there for two decades. His research program comprises multiple, changing, only partly overlapping areas. He has addressed such topics as why some people say 'um' so often, whether babies look like their mothers or their fathers, how we choose which box of cereal to buy, why a baseball season is ten times as long as a football season, which parts of the month carry the greatest risk of untimely death, whether the support of a woman is better for one's blood pressure than that of a man, what sort of music might be useful in stress reduction, whether some initials extend and some shorten the lives of their bearers, if people who live in, or even just visit, New York City are at risk of heart attacks, and whether story spoilers do spoil stories. Currently, Christenfeld is also exploring the role of forgiveness in poststress cardiovascular recovery, the impact of crying on hormones, and the nature of a sense of humor. An overarching theme, if one exists, might be the empirical exploration of the everyday phenomena of the world.



Orrin Devinsky is professor of neurology, neurosurgery, and psychiatry at New York University (NYU). He directs the NYU Epilepsy Center and St. Barnabas Institute of Neurology. His research on epilepsy includes phenomic-genomic relations, sudden unexpected death in epilepsy, surgical therapies, new medicines and devices, quality of life, cognition and behavior, and neuroinflammation. His research on behavioral neurology includes hyperfamiliarity, delusions, autonomic nervous function, and anterior cingulate cortex functions. He founded the organization Finding A Cure for Epilepsy and Seizures and cofounded epilepsy.com and the Epilepsy Therapy Project. He serves on the boards of these organizations and has served on the board of the American Epilepsy Society and Epilepsy Foundation. His other interests include the history of neuropsychiatry, evolution, anthropology, and animal intelligence.



Albert M. Galaburda is a cognitive neurologist and neuroscientist, specializing in developmental cognitive disorders in adults and children. He received his medical degree from Boston University in 1971, trained in neurology at Harvard Medical School from 1973 to 1976, and began his research on dyslexia in 1979, when with neuropathologist Thomas Kemper, he reported for the first time minor cortical malformations in the brain of an adult dyslexic who had died in an accident. Following that original report, he published several other cases with similar malformations and launched a research program modeling these malformations in rodent models, which continues to this date.

He uses RNAi and transgenic technologies in his present research to induce cortical malformations in rat and mouse brains, which in turn are tested anatomically, molecularly, and behaviorally in collaboration with Glenn Rosen, Joseph LoTurco, and Holly Fitch, respectively. This latest research has shown that manipulation of dyslexia candidate gene homolog's 1 rodent embryos results in molecular interference with neuronal migration, cell autonomous and noncell autonomous effects on cortical development that mimic the changes seen in dyslexic brains, and behavioral changes affecting auditory perception. *Ex vivo* imaging of the brains of genetically manipulated animals discloses changes in cortical circuits affecting corticocortical and corticothalamic relationships.

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HOW TO USE THE ENCYCLOPEDIA

The *Encyclopedia of Human Behavior* is intended for use by students, research professionals, and interested others. Articles have been chosen to reflect major disciplines in the study of human behavior, common topics of research by professionals in this domain, and areas of public interest and concern. Each article serves as a comprehensive overview of a given area, providing both breadth of coverage for students and depth of coverage for research professionals. We have designed the encyclopedia with the following features for maximum accessibility for all readers.

Articles in the encyclopedia are arranged alphabetically by subject. Complete tables of contents appear in all volumes. The index is located in Volume 3. Because the reader's topic of interest may be listed under a broader article title, we encourage use of the index for access to a subject area, rather than use of the table of contents alone.

Each article contains a glossary, cross-references, and a further reading list. The outline allows a quick scan of the major ideas discussed within each article. The glossary contains terms that may be unfamiliar to the reader, with each term defined *in the context of its*

use in that article. Thus, a term may appear in the glossary of another article defined in a slightly different manner, or with a subtle nuance specific to that article. For clarity, we have allowed these differences to remain so that terms are defined relative to the context of each article.

Each article has been cross-referenced to other related articles in the encyclopedia. Cross-references will always appear at the end of an article. Where multiple cross-references apply to an article, the cross-references will be listed alphabetically. We encourage readers to use the cross-references to locate other articles in the encyclopedia that will provide more detailed information about a particular subject.

The further reading section lists recent secondary sources to aid the reader in locating more detailed or technical information. Review and research articles that are considered to be of primary importance to the understanding of a given subject area are also listed. The further reading lists are not intended to provide a full reference listing of all the material covered in the context of a given article, but are provided as guides.

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PREFACE

The social scientists have a long way to go to catch up, but they may be up to the most important scientific business of all, if and when they finally get to the right questions. Our behavior toward each other is the strangest, most unpredictable, and almost entirely unaccountable of all the phenomena with which we are obliged to live.

Lewis Thomas

Psychology, the study of the human mind, has made many rapid strides during the past four decades. There is now, more than ever before, a real need for a standard reference work covering all aspects of human behavior. The *Encyclopedia of Human Behavior* is the most up-to-date and comprehensive collection of reviews currently available. The essays will be of interest not only to clinical and experimental psychologists but also to students in fields such as psychiatry, neuroscience, philosophy, cognitive science, and medicine. Indeed, given the enormous range of topics covered, no one interested in human nature can fail to find something of interest in each volume. The format of the volumes lends itself just as readily to casual perusal as it does to serious inquiry.

My colleagues and I are often asked questions such as: What is the superego? What is repression? How reliable is eyewitness testimony? How much sleep do we need? What do we know of the psychology of laughter, language, cruelty, or politics? Or of love, cunning, and deceit? We have all experienced the frustration of not being able to answer such questions or find the answers quickly without recourse to extensive library research. This encyclopedia should prove to be an invaluable resource in such situations. Also, students of psychology and related health professions will find this collection of articles useful as a starting point when they embark on new research projects dealing with specific aspects of human behavior.

The study of human behavior is an enterprise that covers an enormous variety of subjects, ranging from the minutiae of neurophysiology to such familiar but poorly understood topics as Freudian psychology. Psychology is a science that is still very much in its infancy even though it has had a very long history, almost as long as that of physics and biology. Anyone interested in the history of ideas should be puzzled by the differences between advances in biology and advances in psychology. The progress in biology has been characterized by a number of landmark discoveries, each of which resulted in a breakthrough in understanding, for example, the discoveries of cells, Mendel's laws of heredity, chromosomes, mutations, and most recently DNA and the genetic code. Psychology, however, has until recently been characterized by an embarrassingly long sequence of 'theories,' each of which was really nothing more than a passing fad that rarely outlived the person who proposed it. I have always found this contrast to be quite remarkable and can think of no simple explanation for it other than the fact that human behavior is inherently more complex, quixotic, and difficult to fathom. Fortunately, the picture has changed radically over the past four decades, particularly in psychiatry and cognitive neuroscience. There are two reasons for this change: First, there has been a growing dissatisfaction with metaphorical explanations (Peter Medawar calls explanations of this kind "analgesics," for "they dull the ache of incomprehension without removing the cause") and a healthy trend toward replacing them with more mechanistic explanations. Second, progress has been aided by the advent of several new technological innovations for studying the structure and function of the human brain. This encyclopedia covers as many of these recent advances as possible within a three-volume set.

My own experience is mainly in neuropsychology, medicine, and visual science, and I am therefore indebted to the editorial advisory board, as they selected the authors in other areas and saw each essay through the long process of peer review, revisions, and copy-editing. Most of the entries are by acknowledged experts in the field.

Given the nature and scope of this enterprise, some degree of overlap among the essays was not only inevitable but also desirable since our goal was to ensure that each article was a self-contained summary of one specific aspect of human behavior. Given the space limitations, each author was encouraged to provide an overview and convey the general flavor of an area of research rather than attempt an exhaustive review. The result is a very stimulating and informative collection of essays.

I have no doubt that this work will prove useful to specialists. If it also succeeds in kindling a spark of interest in some aspect of human behavior among undergraduate and graduate students, then our efforts will have been amply rewarded, for no enterprise is more important to the future of our species than an understanding of human nature in all its diverse manifestations.

V S Ramachandran

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Eating Disorder Not Otherwise Specified

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Glossary

Amenorrhea In women and postpubertal girls, loss of three consecutive menstrual periods.

Anorexia nervosa An eating disorder in which one is significantly underweight and exhibits fear of gaining weight, body image disturbance, and amenorrhea. It is explicit or inferred that the weight loss is purposeful.

Binge eating Episodes of uncontrolled eating of a larger amount of food than is usual under the circumstances, within a 2-h period of time.

Bulimia nervosa An eating disorder in which one experiences recurrent episodes of binge eating and inappropriate compensatory behavior, and one's self-evaluation is unduly influenced by one's shape and weight.

Compensatory behavior Inappropriate behaviors undertaken with the intent to lose or avoid gaining weight. Encompasses both purging and nonpurging behaviors.

DSM An abbreviation for the Diagnostic and Statistical Manual of Mental Disorders, which provides definitions of mental disorder categories. It is sometimes referred to as the 'psychiatrist's Bible.' The DSM is currently in its fourth edition (DSM-IV) and is used by mental health professionals who are primarily located in North America.

Eating disorder A persistent, severe disturbance in eating behavior that is not better explained by a medical disorder or another psychological disorder. Typically also involves pathological attitudes related to eating, shape, and/or weight.

Nonpurging behavior Inappropriate compensatory behaviors, such as excessive exercise or fasting for a day or more, that do not involve purging.

Not otherwise specified (NOS) In DSM-IV, this residual category is reserved for disorders of clinical severity that do not fit other, more specific categories. For eating disorders, the specific categories are anorexia nervosa and bulimia nervosa.

Purging Compensatory behaviors such as self-induced vomiting or misuse of laxatives, diuretics, or enemas, which are undertaken to induce immediate or rapid weight loss or to prevent weight gain.

Residual A type of diagnostic category composed of symptom patterns of clinical severity that are left over and not otherwise accounted for by existing diagnoses.

Subsyndromal Symptoms exhibited that do not meet a diagnostic threshold for severity or frequency. For example, subsyndromal bulimia nervosa might involve binge eating on average once a week for 3 months, in contrast to full-threshold bulimia nervosa in which binge eating occurs at least two times a week for 3 months.

Far from being fixed entities, definitions of mental disorders may change over time, as research findings and clinical observations continue to impact experts' understanding of these problems. In particular, an evolution in conceptualization has profoundly affected eating disorders, which have become relatively common and have sprung to the attention of mental health researchers and practitioners and the general public only since the final quarter of the twentieth century. Among eating disorders, this evolving conceptualization is particularly relevant for the residual diagnostic category of eating disorder not otherwise specified (EDNOS).

What is EDNOS? In a nutshell, an EDNOS diagnosis describes clinically significant eating disorders that do not satisfy the criteria for either of the two, officially recognized eating disorders: anorexia nervosa and bulimia nervosa. The EDNOS category spans binge-eating disorder, subsyndromal variants of anorexia nervosa or bulimia nervosa, and a range of other symptom patterns.

A Brief History of EDNOS

Like it or not, our understanding of mental disorders relies to a great extent on our nosology, or classification system. Classification systems provide a lens through which psychopathology

is construed, a framework within which mental disorders are studied and treated, and a critical means of communication among professionals about the problems they encounter in clinical practice and research. The classification system used in North America is summarized in a text called the Diagnostic and Statistical Manual of Mental Disorders (DSM), which is published and updated periodically by the American Psychiatric Association. It describes mental disorders and provides criteria for their diagnosis, and is currently in its fourth edition (i.e., DSM-IV). A revision of the descriptive material, but not the diagnostic criteria, was published in 2000 (i.e., DSM-IV-TR); for simplicity, however, only DSM-IV is referred to here.

The residual diagnostic category of EDNOS was first introduced in the 1987 revised version of the DSM (i.e., DSM-III-R). In the 1980 edition of the DSM (i.e., DSM-III), a comparable residual category was included under a different name: atypical eating disorder. Despite the name change, in both cases this residual diagnosis was intended to be used when an individual experienced clinically significant eating-disorder symptoms that did not meet specific criteria for either anorexia nervosa or bulimia nervosa. In the current DSM system, not otherwise specified (NOS) diagnoses are used to describe atypical, presumably uncommon variants within a diagnostic category. NOS categories exist for all major mental disorder categories

in the DSM. The DSM-IV retained the EDNOS definition used in DSM-III-R but added more examples of symptom patterns eligible for an EDNOS diagnosis.

Current Definition of EDNOS

EDNOS encompasses diverse, clinically significant eating disturbances. Six specific examples of subtypes of EDNOS were provided in DSM-IV, although other, unspecified variants of clinical severity – in other words, syndromes that cause distress, impairment in functioning, or both – may be included as well. Roughly speaking, the EDNOS category can be divided into the following three parts, which do not necessarily reflect their relative prevalence in the population at large. The first domain is subsyndromal anorexia nervosa and bulimia nervosa. The second domain is binge-eating disorder, included in DSM-IV as a provisional diagnosis that merited further study. The third domain includes patterns of eating disturbances distinct from the officially recognized eating disorders (anorexia nervosa and bulimia nervosa) and other forms of EDNOS already described.

As a residual category, EDNOS is primarily a diagnosis of exclusion. In other words, to date it has been defined largely by what it is *not* (i.e., anorexia nervosa or bulimia nervosa) rather than what it is. To understand the diverse patterns of symptoms described by this diagnostic category, first it is essential to understand how the core eating disorders of anorexia nervosa and bulimia nervosa are defined.

Subsyndromal Anorexia Nervosa and Bulimia Nervosa

In DSM-IV, anorexia nervosa is described as the refusal to maintain a minimally normal body weight, accompanied by the following symptoms:

- intense fear of gaining weight;
- distortions in the experience and significance of body weight and shape, or undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight;
- amenorrhea, in girls who have started menstruating.

The weight threshold guideline provided for a diagnosis of anorexia nervosa – $<85\%$ of expected body weight for age and height, or a body mass index of 17.5 kg m^{-2} – tends to be strictly observed, providing a sharp cut-off at a given point in time between those whose weight meets this criterion and those whose weight does not. Two subtypes of anorexia nervosa are recognized: restricting type, characterized by no regular binge-eating or purging behavior, and binge-eating/purging type, characterized by regular binge-eating or purging behavior. Note that the primary difference between the binge-eating/purging type of anorexia nervosa and bulimia nervosa is weight: by definition, one must be significantly underweight to qualify for a diagnosis of anorexia nervosa.

DSM-IV lists two examples of EDNOS that constitute deviations from the prototypical presentation of anorexia nervosa. Many individuals with anorexic-like problems are not deemed eligible for a diagnosis of anorexia nervosa because, although underweight, they do not quite meet the weight criterion (i.e., their weight is 85–90% of ideal body weight), or, alternatively, because, if female, they continue to menstruate. Currently,

individuals with either of these anorexic-like eating disorders would be diagnosed with EDNOS rather than anorexia nervosa.

In DSM-IV, bulimia nervosa is defined as involving binge-eating and compensatory behaviors to influence weight that occur, on average, at least twice weekly for 3 months, along with self-evaluation that is disproportionately influenced by one's body weight and shape. By definition, an episode of bulimia nervosa may not occur exclusively during an episode of anorexia nervosa. A third example of EDNOS that is listed in DSM-IV describes symptoms that fall short of the prototype for bulimia nervosa. This example describes those with subsyndromal bulimic-like symptoms: in other words, those who binge eat and use compensatory behaviors regularly, yet less often than twice weekly for 3 months or for a shorter duration than 3 months.

Binge-Eating Disorder

Although formally still considered a specific subtype of EDNOS, binge-eating disorder was introduced as a provisional eating-disorder diagnosis in DSM-IV, with the aim of furthering research to ascertain the validity of the diagnosis. The inclusion of diagnostic criteria for binge-eating disorder in DSM-IV has indeed facilitated a subsequent proliferation of research on this syndrome. Since its publication, more research by far has been conducted on binge-eating disorder than on any of the other specific examples of EDNOS listed in DSM-IV. Research on binge-eating disorder has aimed to determine, among other things, its severity, effective treatments, its distinctiveness from bulimia nervosa, and its utility as a diagnostic category.

According to the DSM-IV's provisional criteria, binge-eating disorder entails recurrent, distressing episodes of binge eating, as described earlier. In binge-eating disorder, binge-eating episodes must not be accompanied by regular compensatory behavior such as that seen in bulimia nervosa, that is, purging, fasting, or excessive exercise. Binge eating must occur on at least 2 days a week for 6 months, on average. In addition, binge-eating episodes must be accompanied by at least three of the following five features:

- eating more rapidly than normal;
- eating until one feels uncomfortably full;
- eating large amounts of food when not hungry;
- eating alone due to embarrassment or guilt;
- eating amounts that lead one to feel disgusted, depressed, or very guilty.

Finally, binge-eating disorder may not occur exclusively during a period in which one has either anorexia nervosa or bulimia nervosa.

Atypical Symptom Patterns

Other eating disturbances that are distinct from anorexia nervosa, bulimia nervosa, their subsyndromal variants, and binge-eating disorder also fall into the EDNOS diagnostic category. The following two examples are presented in DSM-IV as additional subtypes of EDNOS.

Purging disorder

The fifth example of EDNOS has been referred to variously as purging disorder, subjective bulimia nervosa, compensatory

eating disorder, and EDNOS-purging only. It involves the regular use of inappropriate compensatory behaviors among normal-weight individuals after eating small amounts of food, accompanied by intense fear of gaining weight or becoming fat. Although the topic has begun receiving intensive study by researchers, the precise boundaries of this problem relative to anorexia nervosa and bulimia nervosa have not yet been widely agreed upon, and its validity as a unique diagnostic category remains under debate. Most experts believe that insufficient evidence has accrued so far to merit the designation of purging disorder as a diagnosis in DSM. A few studies suggest that purging disorder may be as common as anorexia nervosa and bulimia nervosa and that it involves significant distress and impairment, although the findings have not been entirely consistent.

Chewing and spitting food

The sixth example of EDNOS included in DSM-IV is the recurrent chewing and spitting out of large amounts of food without swallowing. Little systematic study has addressed this problem, but it may be common among those with eating disorders, and may be associated with food restriction rather than binge eating. It is unclear to what degree chewing and spitting occurs among people who do not have other eating disorders.

Other atypical EDNOS symptom patterns

Several other atypical eating disturbances that have been described in the empirical literature are not listed as examples of EDNOS in DSM-IV, yet may still qualify for an EDNOS diagnosis if they are of clinical severity and not due to an underlying medical illness. These problems include, but are not limited to, non-fat phobic anorexia nervosa (a self-starvation syndrome that is not associated with a fear of fatness) and night-eating syndrome (overeating at night, including after having fallen asleep). Our knowledge of these symptom patterns tends to be limited.

Epidemiology and Significance of EDNOS

Given the initial, common sense view that problems described by NOS categories are inherently rare and less severe than their officially recognized counterparts, several myths about EDNOS have been hard to shake, despite the accumulation of research findings contradicting them. First, eating disorders have been recognized by the scientific community as significant, noteworthy conditions only since approximately the late 1970s. In the years immediately following the initial inclusion of eating disorders in DSM-III in 1980, almost all eating disorder related clinical and research attention focused on anorexia nervosa and bulimia nervosa, which were widely believed to be the most common and severe forms of eating disturbance.

Subsequent research has demonstrated that ~40–60% of those seeking treatment for an eating disorder do not, in fact, have anorexia nervosa or bulimia nervosa. Instead, they merit an EDNOS diagnosis. Similarly high rates of EDNOS have also emerged from studies of nonclinical samples. These consistent findings indicate that, far from being a rarity, as currently defined, EDNOS actually is the most common eating-disorder diagnosis. Studies of the prevalence of eating disorders suggest that as many as 12% of young women experience some type of

eating disorder, including EDNOS. However, because EDNOS is not a unitary phenomenon and because the diagnosis lacks inclusion criteria, it is difficult to estimate population prevalence of EDNOS in a precise manner.

Second, EDNOS is often mistakenly believed to affect mainly, or only, Caucasian girls and young women. However, EDNOS affects a wide range of people, probably in part because it includes such a diversity of different symptom patterns. It affects men, ethnic minorities, athletes in aesthetic sports such as ballet and gymnastics, young children, and the elderly.

Third, there is a widespread misperception among mental health professionals, other health care professionals, third-party payers, and the general public about the meaning and import of a residual eating-disorder diagnosis. Although EDNOS is often believed to describe eating disturbances that are subclinical and therefore less severe, research has shown that the consequences or impact of EDNOS symptoms are often no less severe or problematic than in anorexia nervosa or bulimia nervosa. That is, people with EDNOS tend to experience a degree of general psychopathology, distress, and impairment that is on a par with anorexia nervosa and bulimia nervosa. Thus, the EDNOS diagnosis describes serious, problematic mental disorders, not merely atypical or minor variants of eating disorders.

Binge-Eating Disorder

As noted above, the inclusion of specific, provisional diagnostic criteria for binge-eating disorder in DSM-IV sparked a great deal of research related to it, including its epidemiology and significance. The diagnosis of binge-eating disorder affects ~3–6 % of adults in their lifetimes, which is at least twice as common as diagnoses of bulimia nervosa (1–3% of women) or anorexia nervosa (0.5% of women). Binge-eating disorder is more common among obese individuals, with some estimates indicating that as many as 30% of obese individuals have binge-eating disorder. Those with binge-eating disorder also typically exhibit poor psychosocial functioning and poor social adjustment and often experience other mental disorders as well.

Binge-eating disorder is the most prevalent form of EDNOS. The gender ratio for binge-eating disorder is approximately two males to three females, indicating that it affects a much greater proportion of males than does anorexia nervosa or bulimia nervosa, which are estimated to affect about ten times as many females as males. The average duration of illness for binge-eating disorder among those studied is at least 14 years, suggesting that it is a chronic and reasonably stable disorder, similar to bulimia nervosa. Family studies demonstrate that it is transmitted separately from anorexia nervosa and bulimia nervosa.

Taken as a whole, the body of research conducted on binge-eating disorder demonstrates that this syndrome is distinct from anorexia nervosa and bulimia nervosa on a number of key dimensions, and that it poses a significant problem for those it affects. Given its severity, it is likely that binge-eating disorder will be added to future versions of the DSM.

Assessment of EDNOS

As with all eating disorders, careful, rigorous assessment is critical for obtaining accurate estimates of the prevalence of the component symptoms as well as symptom patterns of

EDNOS. Because the lay person's understanding of binge eating is broader than the scientifically accepted definition, rates of binge eating tend to be higher when assessed by self-report rather than by diagnostic interview. As a result, self-reports of binge eating should be interpreted cautiously. Rather, semi-structured interviews administered by trained individuals, who apply standardized definitions to criteria that are often not clear-cut and who may ferret out answers to often complicated questions, are considered the gold standard for diagnosis. Semistructured interviews commonly used to assess eating-disorder symptoms and diagnoses are the Eating Disorder Examination and the Structured Interview for DSM-IV Disorders. A substantial investment of time and expertise is required for training in the proper conduct of these interviews.

Self-report questionnaires are often used in assessing eating-disorder symptoms and associated constructs, such as body image. Self-report questionnaires may be used to screen for or to more fully describe one's eating-disorder symptoms. The choice of questionnaire should depend on the constructs one wishes to assess. Some frequently used questionnaires of eating-disorder symptoms include the Eating Disorder Examination Questionnaire, Eating Disorder Inventory, Eating Attitudes Test, Multiaxial Assessment of Eating Disorder Symptoms, Stirling Eating Disorder Scales, Eating Disorder Questionnaire, DSM-IV Diagnostic Questionnaire, Minnesota Eating Behavior Survey, and Questionnaire on Eating and Weight Patterns-Revised.

Treatment of EDNOS

To date, very few researchers have attempted to design and study treatments addressing the broad assortment of problems comprising EDNOS. The single exception has been transdiagnostic cognitive-behavioral therapy for eating disorders, which represents a recent, promising approach for ameliorating a variety of eating-disorder symptoms including EDNOS as well as bulimia nervosa, although it excludes individuals whose body mass index falls below 17.5 kg m^{-2} . This treatment has a focused form, targeting eating-disorder symptoms alone, and a broad form, also targeting mood intolerance, clinical perfectionism, low self-esteem, or interpersonal difficulties.

By contrast, research focused on treatments for binge-eating disorder has flourished. Cognitive-behavior therapy, including individual and group formats as well as self-help versions, has proved to be the most effective treatment for symptoms of binge-eating disorder thus far. There is evidence that interpersonal psychotherapy may be similarly effective in reducing binge-eating symptoms. Other forms of psychotherapy that show promise in treating binge-eating disorder are dialectical behavior therapy, behavioral weight loss programs, and motivational interviewing. Certain medications have also demonstrated short-term efficacy in reducing binge-eating frequency and inducing modest weight loss among individuals with binge-eating disorder.

Problems with the EDNOS Diagnosis

The fact that a single EDNOS diagnosis describes a hodgepodge of eating problems poses several substantial problems that affect our understanding of eating disorders as a whole.

As noted earlier, residual categories are usually assumed to apply only to the minority of individuals who experience atypical manifestations of a type of problem. In that light, EDNOS presents a problem because it encompasses numerous symptom patterns, none of which constitutes a majority of the category. People with an EDNOS diagnosis may experience entirely distinct symptoms and are bound together only loosely through their shared characterization as experiencing eating pathology. The breadth of symptom patterns encompassed by the EDNOS category hampers efforts to identify epidemiology, course, prevention strategies, and effective treatments for these problems. Researchers and clinicians need a common language to advance knowledge, and an EDNOS diagnosis describes too many symptom patterns to make it meaningful. The heterogeneity of this diagnosis has been a major impediment to our accumulation of knowledge about, and treatment of, eating disorders.

The lack of inclusion criteria for EDNOS means that there is no clear demarcation between EDNOS and eating disturbances that may be unusual but are not pathological. Clinical judgment, which is inherently subjective, is required to make this determination, and the necessity of using clinical judgment has the effect of impeding reliability, or agreement across experts and, therefore, communication. In short, the basic problem is that the syndromes and symptoms we look for inevitably affect what we find. For example, we thought previously that binge-eating disorder was uncommon and not very problematic, but systematic research has indicated that the opposite is true. This pattern may prove to be evident with other forms of EDNOS, such as purging disorder.

It is important to note that an eating disorder diagnosis describes a person's symptoms at a single point in time (or for a fairly short period of time) and does not consider the longer-term trajectory or course of the symptoms. Thus, an EDNOS diagnosis may describe a person who is on the way toward developing, or recovering from, anorexia nervosa or bulimia nervosa, as well as a person whose eating-disorder symptoms are not in flux. EDNOS is associated with symptoms that vary from mild to severe, in part according to one's symptom course and the phase of the disorder being currently experienced. Longitudinal research has also shown that diagnostic migration, or movement among diagnostic categories, including EDNOS, is common among those affected with eating disorders. This movement is not random, but shows trends over time from more restrictive behaviors toward more dyscontrolled ones, such as binge eating and purging behaviors, as well as trends toward recovery for a substantial number of those affected.

Certain time-related elements of binge-eating disorder criteria have been criticized by experts, including the appropriateness of the 2-h maximum duration for each binge-eating episode, the frequency of 2 days a week of binge eating, and the 6-month duration for the symptom pattern. Specifically, questions have been raised about the utility of such strict inclusion criteria when those with symptoms slightly less severe than these have been shown to be indistinguishable from those with full-threshold binge-eating disorder. As a result, some or all of these time-related elements may be revised if binge-eating disorder receives full disorder status in a future edition of DSM.

As the reader may have already noticed, there has been little discussion of children or adolescents thus far. Indeed, a large proportion of eating disorders related research is conducted with individuals university-aged and older; much less research is available on adolescents and even less on children. As eating disorders are most common among those who have reached puberty, and affect large numbers of adolescents in particular, the lack of data on younger sufferers may be largely attributable to the greater number of challenges inherent in studying children.

Clinical presentations of children and adolescents with eating disorders may differ from those described in DSM-IV in part because of their stage of development, and the consequences of delaying an eating-disorder diagnosis may be severe. In particular, experts from the Workgroup for Classification of Eating Disorders in Children and Adolescents have argued for the use of lower, more sensitive thresholds of severity as diagnostic boundaries in children and adolescents, for example, lower frequency of purging behaviors, and significant declines from growth curves for determining whether a child or adolescent satisfies the weight criterion for anorexia nervosa. These experts have also recommended that behavioral indicators of fear of gaining weight and body image disturbance should be allowed in lieu of self-reported symptoms, and have pointed out that requiring that certain symptoms be articulated by the child or adolescent may be developmentally inappropriate. Furthermore, these experts have recommended that multiple informants, including parents, be used in determining eating-disorder symptom patterns. If adopted, these alterations to DSM criteria would reduce the number of EDNOS cases and simultaneously increase the number of officially recognized eating disorders that are seen in children and adolescents.

Current Trends

At the time of writing in early 2010, proposed criteria for the next edition of the DSM (i.e., DSM-5) had been recently published online and a call for experts' feedback gone out. These draft criteria are subject to change before the DSM-5 publication, but the proposed changes suggest that concerns over the excessive breadth and heterogeneity of EDNOS will probably yield a tightening of its criteria by creating a new diagnostic category and shifting the boundaries of the other eating disorders. Specifically, binge-eating disorder may achieve the status of a full-fledged eating disorder comparable to anorexia nervosa and bulimia nervosa, and criteria for both anorexia nervosa and bulimia nervosa may be loosened to accommodate those with anorexic-like and bulimic-like syndromes. Anorexia nervosa may no longer require amenorrhea for diagnosis, and bulimia nervosa and binge-eating disorder both may require binge eating only once a week, on average, for 3 months. Altogether, these changes would diminish the number of individuals captured within the EDNOS category, allowing researchers to focus on and better characterize the remaining symptom patterns. Efforts are under way to identify and examine the remaining symptom patterns that make up EDNOS, such as atypical anorexia nervosa, atypical bulimia nervosa, atypical binge eating disorder,

purging disorder and night-eating syndrome. In DSM-5, the category of Eating Disorders may also be broadened and renamed, *Feeding and Eating Conditions Note Elsewhere Classified*.

Summary and Conclusions

EDNOS is a residual diagnosis for those clinically significant eating disorders that do not fit the criteria for either of the two officially recognized eating disorders, anorexia nervosa and bulimia nervosa. EDNOS spans symptom patterns that include binge-eating disorder and subsyndromal variants of anorexia nervosa or bulimia nervosa, as well as other problematic eating disturbances, such as purging disorder. Its symptoms may include food restriction, binge eating, compensatory behaviors, preoccupation with weight and shape, and body image disturbance. Studies of clinical and community samples have demonstrated that EDNOS is the most common eating-disorder diagnosis. Furthermore, EDNOS tends to be just as severe, persistent, and problematic as anorexia nervosa or bulimia nervosa.

The most common subtype of EDNOS is binge-eating disorder, which has been well characterized and affects at least twice the number of people as do anorexia nervosa and bulimia nervosa together. Binge-eating disorder affects men as well as women, children as well as the elderly, athletes in aesthetic sports, and people of diverse cultural backgrounds and ethnicities. It is often a chronic problem that increases the risk of weight gain and obesity. Cognitive-behavior therapy is considered the first-line treatment for binge-eating disorder, although other treatment approaches also have shown promise.

The heterogeneous nature of the EDNOS diagnosis has proved to be unwieldy, and has slowed efforts to further our understanding of eating disorders as a whole, as well as to identify effective treatments. Consideration is being given to diminishing the scope of this diagnostic category in future editions of our nosological scheme, the DSM, by broadening criteria for the diagnoses of anorexia nervosa and bulimia nervosa, and by designating binge-eating disorder as an officially recognized, specific eating disorder. Taking these steps would enable experts to isolate and study in depth the atypical symptom patterns that remain within the EDNOS category, and would help bring EDNOS into line with the other residual diagnostic categories for mental disorders that are recognized in the DSM.

See also: [Body Image](#); [Bulimia Nervosa](#).

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Relevant Websites

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- <http://www.nimh.nih.gov/health/topics/eating-disorders/index.shtml> – Eating Disorders information (USA).
- <http://www.feast-ed.org/> – Families Empowered and Supporting Treatment of Eating Disorders.
- <http://www.maudsleyparents.org/> – Maudsley Parents - A site for parents of eating disordered children.
- <http://www.nami.org/> – National Alliance on Mental Illness (USA).
- <http://www.anad.org/> – National Association of Anorexia Nervosa and Associated Disorders (USA).
- <http://www.nationaleatingdisorders.org/> – National Eating Disorders Association (USA).
- <http://www.nedic.ca/> – National Eating Disorder Information Centre (Canada).
- <http://www.nice.org.uk/> – National Institute for Health and Clinical Excellence (UK).
- <http://www.something-fishy.org/> – Something Fishy Website on Eating Disorders.

Ecological Psychology

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Glossary

Activities of perception Self-generated movements that expose organisms to patterns of ambient energy, especially when particular movements make it possible to perceive things that would otherwise be missed.

Affordance The relationship between a given organism and aspects of its environment that make specific actions (or outcomes by means of action) possible.

Behavior setting A bounded, self-regulated, and ordered system composed of replaceable human

and physical components that interact in a synchronized fashion to carry out the activities expected to take place in the setting.

Higher-order invariants Patterns in ambient energy that specify environmental properties.

Perceptual system All parts of an organism involved in actively looking, smelling, touching, etc. This is contrasted with the more limited parts of the organism studied for their role in passive sensation.

Ecology in the Biological Sciences

Ecology, derived from a Greek word meaning 'household,' is the branch of biology that studies the relationships between organisms and their surroundings, especially with regard to the adaptations of organisms to environments and the resulting population distributions. It also studies invasion and succession among communities and the gradual replacement of one species by another that is more suited to a changed environment.

Ecological study of a species requires a description of its habitat and the species' relationship to that habitat, its social organization, and its relationships to other species, emphasizing functional adaptations. Because of its broad scope, the term has been introduced into the social and behavioral sciences and is used in different ways, often in combination with other terms as in social ecology, human ecology, ecological psychology, and ecopsychology. All these fields describe how organisms are affected by their surroundings and how they, in turn, contribute to changes in those surroundings through their behavior. Studies of human populations from an ecological perspective are not as common as in the case of other species. The great diversity of human habitats and the ability of humans to adapt to different environments as well as to change their environments are likely reasons for the lesser influence of an ecological perspective in the behavioral sciences.

Ecological Approaches in Psychology

The term *ecological psychology* is most commonly applied to J. J. Gibson and E. J. Gibson's approach to studying perception and to R. Barker's approach to studying social interactions. H. Heft traces the origins of both approaches to William James's radical empiricism. James was one of the early proponents of incorporation of evolutionary thinking into psychology. He advocated a psychology that did not neglect normal everyday experience.

The term 'psychological ecology' was introduced by K. Lewin in 1943 in an attempt to shift the emphasis in psychology away from individual organisms and their mental processes to organism–environment relationships. Coming out of gestalt psychology, Lewin's usage of the term was primarily psychological, referring to a person's interpretations of the external environment in terms of goals, barriers, and boundaries. Lewin defined psychological ecology as the relationship between psychological and nonpsychological factors. In approaching a problem, a researcher examines nonpsychological data first to find out how they determine the conditions of life for an individual or group. Only after the nonpsychological factors are known can research begin on the psychological dimensions of a problem. A. Wicker describes how this approach necessarily focuses on the ordinary environments in which people spend most of their time. Wicker and Sommer developed this strategy further in a paper documenting psychology's lack of interest in common, mundane behavior settings.

E. Brunswik, Lewin's contemporary and also from the gestalt tradition, developed an ecological model of perception in an attempt to widen the scope of research beyond the narrow range of stimuli used in laboratory experiments. Brunswik maintained that research on perception should employ stimuli typical of real life situations in an approach called 'ecological sampling.' According to Brunswik, the researcher's task is to locate within the richness and variety of real-world stimuli invariant patterns that are capable of representing a stable external world and relevant to the functional adaptation of a species.

These approaches influenced two separate lines of research and theory in psychology, both calling themselves 'ecological,' one emphasizing perception and the other, behavioral adaptations. Although the two lines of research share the ecological perspective of examining functional adaptations of organisms to their environments, they are concerned with different issues, employ different methods, and publish their studies in different journals for different audiences. The perception research is most closely identified with J. J. Gibson and the behavioral studies with R. Barker and his associates. Gibson's studies are

almost entirely experimental and theory driven, while Barker's work is largely observational and atheoretical. Because the two approaches to ecological psychology are so different, they will be described separately.

The terms 'ecological' and 'psychology' have also been blended into *ecopsychology*, an applied field whose central tenet is the reciprocal relationship between the personal well-being of individuals and the well-being of the planet. This approach gained recognition in a 1992 book and subsequent anthology by T. Roszak. Ecopsychology uses examples of traditional peoples who have evolved a harmonious relationship with nature. Similar to E. O. Wilson's concept of biophilia, which describes the innate bond between humans and other living organisms, ecopsychology emphasizes positive emotions such as caring, connectedness, and the healing powers of contact with nature. The latter is the basis of ecotherapy, which is accumulating a research base. There is increasing research evidence on the psychological benefits of nature contact, especially wilderness experience and human-animal bonds. Separation of humans from nature is viewed as responsible for environmental destruction as well as people's alienation and sense of incompleteness. Restoration of the connection between humans and nature is considered beneficial to both. The field has also brought psychological principles into environmental education and promoted sustainable lifestyles. Related intellectual movements are Conservation Psychology and Deep Ecology.

Gibson's Ecological Psychology

J. J. Gibson and E. J. Gibson's professional careers were dedicated to explaining how organisms used perception to successfully match their behaviors to their circumstances. Early in their partnership, the two agreed to focus on slightly different aspects of the problem, J. J. Gibson focusing broadly on established perceptual abilities, and E. J. Gibson focusing on perceptual development. Each of their four independently authored books appeared on a recent list of the 100 most important publications in the history of cognitive psychology, and they continue to influence the current generation of researchers, though the more devoted enthusiasts remain a bit marginalized. As *ecological psychology* is most closely associated with J. J. Gibson's work, and he was more interested in the theoretical novelty of their approach, the references to 'Gibson' below will be to him.

Gibson completed his graduate studies at Princeton in 1920 under the direction of E. B. Holt (1842–1910) who was a protégé of William James and a leader in the philosophical movement known as New Realism. Thus, Gibson's work can be seen as part of a continuing lineage of American philosophy. It has hints of pragmatism, a general rejection of dualism, and, in toto, is taken by its supporters as a successful explanation for how direct perception can occur. The term 'direct' has kindled a number of debates regarding Gibson's approach. It draws contrast with 'indirect' theories of perception in which some psychological intermediary, such as mental interpretation or past memories, supports perceiving. Gibson considered perception as a type of relationship between the organism and the environment; presaging modern systems theory. Gibson's approach does not attribute the activity of

the organism–environment system to any single component of the system (i.e., the brain), nor does it allow us to treat the bidirectional causality of the system as if it were linear (making it incorrect to imply that sensation causes perception). Because much attention is drawn to the philosophical aspects of Gibson's work, the methodological innovations developed in tandem with the theory are often neglected. Gibson claimed that the main purpose of empirical studies should be to demonstrate something unexpected. To that end, his thinking often dwelled on results that did not seem to fit within established models and addressed research questions not easily answered by established theories.

Gibson's thinking developed over time, and one could treat his books as rough markers of stages in his career. Many of Gibson's early-career innovations highlighted in *The Perception of the Visual World* are now widely accepted. In that period, he popularized the notion that people were sensitive to optic flow, moving patterns of stimulation on the retina. He also argued for the value of naturalistic studies of perception, providing evidence that real-world perceptual accuracy is often far better than what is suggested by constraining laboratory studies or research on picture perception. He also provided some of the earliest studies using motion pictures in psychological research. In contrast, many of Gibson's mid-career innovations described in *Senses Considered as Perceptual Systems* are still viewed with skepticism: At that stage, he argued that we could study the ecology of energy (light rays, sounds waves, etc.) to identify the environmental structure that an organism's perceptual abilities evolved to monitor. His first paper explicitly on that topic was titled '*Ecological Optics*,' from which his approach acquired the term 'ecological.' He also explained perception in terms of an almost whole-body attunement, in which the brain could play a minor role. This was largely motivated by an attempt to define perception in a manner that was egalitarian with respect to organisms that bear little resemblance to humans, but still perceive their world (insects, squid, etc.). Many of Gibson's late-career innovations, outlined in *The Ecological Approach to Visual Perception*, have become popular, but not typically in connection with his larger system of thinking. During this period, he emphasized the concept of affordances, which he saw as opportunities for action created by a match between environmental properties and organism properties (i.e., given my hand shape, my coffee mug affords picking up, whereas it does not afford the same to a deer or an ant). He also claimed that his approach could make obsolete many of the classic debates regarding perception. Most notably, he argued for 'direct perception' and laid out a sophisticated argument that many supposedly complex cognitive problems were solvable quite easily via perception.

The central tenets of Gibson's last approach are (1) perception is possible because of higher-order invariants in ambient energy arrays that specify environmental properties, (2) perception is an active process, and (3) organisms are specifically sensitive to the actions afforded them by their surroundings. If these points are treated as purely axiomatic, they can easily become the type of 'very abstract' or 'purely theoretical' jargon to which many research scientists are averse. However, if they are treated as working hypotheses, then each tenet opens lines of research that are grounded in past empirical observations and can make clear predictions:

1. *Higher-order invariants*: Perception is a process of discriminating between different types of situations. Patterns in energy fluxes are created by aspects of the world and some of the structure of the ambient energy specifies (is specific to) the properties of the environment. As a working hypothesis, this suggests that (1) we can identify the specific patterns of energy to which people are sensitive, (2) some pattern of energy exists that can be used to accurately make whatever perceptual distinction we are interested in, and (3) over the course of development, the specifying patterns become the patterns to which we are sensitive. For example, the optic parameter *tau* specifies time-to-contact when velocity is constant. D. Lee and colleagues demonstrated that gannet dives and pigeon landings are guided by sensitivity to that higher-order invariant. Research has subsequently shown that people exhibit direct sensitivity to *tau* in tasks ranging from baseball catching to automobile braking.
2. *Active perception*: Because the higher-order invariants are spread out across time and space, sensitivity to them requires movement. Thus, it can be argued that perception is an active process, and that every part of our body involved in the acts of perception can be considered part of the perceptual system. As a working hypothesis, this suggests that (1) people should perceive more accurately when they are allowed to move freely, (2) not all ways of moving will lead to better perception, and (3) over the course of development, people's movements should come to approach the ideal movements. For example, the length of an object (such as a rod) is specified by its inertial tensor, which can be detected only if the object is moved around in multiple dimensions. M. Turvey and C. Carello have demonstrated that people trying to determine the length of a rod they cannot see are remarkably accurate in a multiplicity of conditions (varying from holding the rod to having the rod taped to their backs), under a variety of circumstances (even underwater). However, participants are accurate only if they are allowed to move the rod, and only if they are allowed to move the rod in the right ways – ways that reveal the inertial tensor 'I.'
3. *Affordances*: In different situations, different actions are possible. Thus, relative to any given organism, the world can be described in terms of what it affords. The world is made up of affordances, opportunities for action. Due to evolutionary and developmental factors, organisms are able to perceive these affordances. As a working hypothesis, this suggests that (a) we can identify the physical properties of an organism and its environment that determine which actions are possible, (b) we can identify patterns of energy that specify many, if not all, of those affordances, and (c) organisms should be (or should develop to be) sensitive specifically to transitions between situations in which actions are possible and situations in which they are not. For example, K. Adolph and colleagues have shown that infants rapidly learn to attend to the steepness of slopes when determining whether or not to crawl down a surface and that they accurately distinguish dangerous from safe situations. Further, infants must learn these sensitivities anew for different styles of locomotion, as they develop.

Certainly, a theoretical or methodological commitment to any one of these points does not necessitate a commitment to the other two. However, those in the tradition of Gibson's ecological psychology see them as intimately intertwined: Organisms successfully match their behavior to the environment because they learn to discriminate between complex patterns of energy that specify which actions are possible. Perceptual systems attune to higher-order invariants that specify affordances.

Gibson's ecological approach thus offers an explanation for the way organisms can accomplish many sophisticated things through perceptual processes. This has led to a great deal of controversy as it offers the potential for a broad assault on traditional cognitive psychology. In the extreme, some ecological psychologists argue in favor of the radical position that perceptual explanations can be used to solve all supposedly 'cognitive' tasks. For example, traditional explanations of how people learn to drive rely on their remembrances of past driving experiences. However, ecological explanations can explain the same changes in terms of improved attunement to driving-relevant affordances, without reference to memory of any kind. That is, if a person's perceptual system is developed properly, he or she can directly perceive how to drive. Problems like stopping before you hit another car need not involve 'thinking' about how hard to press the brake or 'computation' based on distance and velocity, nor need it involve other cognitive processes such as 'anticipation,' 'representation,' or 'simulation.' A simpler explanation is that one can perceive what to do, probably through a real-time coupling between brake pressure and optic invariants specifying time to impact. While this style of explanation becomes more awkward in certain circumstances, such as when dealing with picture perception, abstract activities such as higher math, or complex verbal interactions, those of the more radical persuasion believe that the awkwardness will disappear when we learn to phrase the problems in a proper manner.

While Gibson's ecological psychology began as a somewhat narrow attempt to provide more sophisticated answers to classic perceptual problems, it has developed into an approach capable of making insightful contributions to many fields of psychology. Methods developed by Gibson and neo-Gibsonian researchers continue to lead to new discoveries in an expanding array of experimental settings.

Barker's Ecological Psychology

Barker was strongly influenced by the field theory of Lewin, with whom he collaborated on several classic experiments in child psychology. Barker subsequently became disenchanted with experimentation, which he believed failed to provide information about the frequency, duration, and complexity of behavior as it occurred in actual life. While admiring Lewin's choice to study problems from real situations, Barker maintained that behavior should be studied without outside manipulation or imposition of structure. Rather than the study of contrived artificial conditions in the laboratory, he advocated the study of behavior settings that already existed, using methods that exerted as little influence as possible upon the situation being studied. Barker's method relied almost exclusively upon nonreactive observations of people

in their ordinary environments. With his associates H. Wright and P. Gump, Barker initially called this approach psychological ecology, then ecological psychology, and subsequently, eco-behavioral science. The methodology drew more heavily from natural sciences such as botany and geology, which encourage documentation of processes as they occur naturally, than from physical sciences such as physics and chemistry, whose laboratory experiments isolate elements from their natural contexts.

Barker realized that psychology differed from other sciences in having proceeded directly from theory to laboratory experimentation without passing through a separate descriptive phase. As a consequence, psychology generally lacks ways to systematically describe, classify, and conduct research on human behavior in its natural context. To remedy this deficiency, Barker and Wright established in 1947 a field station in Oskaloosa, Kansas, a small community with a population of about 700. Field stations had been used previously in psychology to study animal behavior, but not human behavior. The goal of the field station was to bring to psychology the opportunities long available to biologists – easy access to the subject matter of the science unaltered by the selection and processing that occurs in the laboratory or clinic.

The small size of the community, and the fact that Barker resided there, made it possible for him to study local behavior settings for 25 years. As Barker had intended, the psychological field station was an established organizational unit continuing over time, whose staff included a cadre of long-term researchers and staff, with space for visiting researchers. It contained facilities for collecting, preserving, and retrieving naturalistic data; archives of primary data comparable to those collected in other natural sciences over long periods of time, which will be accessible to other researchers who can analyze them in their own ways; and statistical methods appropriate for naturalistic data, perhaps similar to those used in quantitative botany and geology.

Observers from the field station ranged throughout the town to record everyday activities of children. Sometimes a researcher followed a single child for a designated period of time, recording where the child went, who was present there, and what the child did. At other times, a researcher remained in a designated location and recorded which children visited and their activities while they were there. Based on these observations, Barker concluded that the behavior of a child could be predicted more accurately from knowing the situation the child was in than from knowing the child's individual characteristics. This laid the groundwork for studies by S. Milgram, P. Zimbardo, and others demonstrating the power of situations to influence behavior vis-à-vis personality characteristics. Throughout the existence of the field station, there were continuous attempts to keep the community informed about the project's methods and goals. The approach followed the naturalists' credo of studying phenomena without changing them, although there is some question as to whether, and if so, how the presence of professors and graduate student observers affected life in a small community. Subsequently, Barker and P. Schoggen compared the results of behavior setting surveys in Oskaloosa and Yoredale, England.

Barker maintained that the ecological environment has an objective reality with observable geographical, physical, and

temporal attributes. He stated the agenda for ecological psychology as a series of questions, such as 'What are environments like?'; 'How do environments select and shape the behavior of their occupants?'; and 'What are the structural dynamics of environments to which people must adapt?' Barker's conception of ecological psychology rested on several assumptions: (1) the systems of relationships that link individuals and groups with their social and physical environment are complex; (2) such systems cannot be understood piecemeal; (3) environment-behavior systems have properties that develop and change over long periods of time; (4) change in one part of the system is likely to affect the other parts of the system; (5) the challenge of ecological psychology is to obtain sufficient understanding about environmental systems to be able to predict and control the effects of planned and unplanned interventions.

The initial methodological problem of ecological psychology, as Barker saw it, was the identification of the natural units into which environments could be divided. These units, called behavior settings, have replaceable human and physical components that interact in a synchronized fashion to carry out an ordered sequence of events, which constitutes the setting program. Because they are discovered through observation, they are in no way imposed or created by the experimenter. To the lay observer, behavior settings such as a gas station or a lunch counter are as objective as a building or a river. Units are identified through a behavior setting survey – a comprehensive inventory and description of all the public behavior settings in a community or institution. Even though the occupants may change, the behavior setting will persist. Behavior settings are common phenomena in everyday life and lay people have no difficulty recognizing them; ecological psychology is thus linked to readily understood concepts. The same behavior setting might provide different inputs to the same person as that individual's behavior changes. Adding to Barker's construct, Wicker maintains that behavior settings have developmental cycles, including a beginning and an end, and are linked to other settings, thus requiring a larger and more complex range of investigations, including the effects of founders and successors upon setting functions.

Barker's ecological psychology tended to be atheoretical. One exception is now called Staffing Theory (originally known as Manning Theory). Comparison of the behavior of inhabitants of underpopulated, adequately populated, and overpopulated settings provides a test of the proposition that the environment is an interdependent whole with predictable effects on its human inhabitants. According to Staffing Theory, when there are too few people to perform the necessary roles, the number and range of pressures on each inhabitant increases because the same pressure to perform necessary roles will be distributed over fewer inhabitants. From this, it follows that inhabitants of underpopulated settings, in comparison with those in adequately populated settings, are likely to be more active within the setting and engage in a greater variety of actions. Admission standards may be lowered, differences among applicants may be virtually ignored, and occupants must work harder at more difficult tasks to keep the setting going. Each occupant will be more valued and given greater responsibility. Overpopulated settings encourage the creation of mechanisms to control the number of applicants

along with attempts to increase the capacity of the setting, either through enlargement or through shifts to alternative larger settings. Predictions based on population size have generally been confirmed in studies conducted in schools, churches, and workplaces.

Barker's interpretation of ecological psychology as a descriptive naturalistic behavioral science has been extended and refined in recent years. Behavior setting surveys have been conducted in a variety of locations, including schools, churches, workplaces, retail shops, mental health centers, virtual communities, and clinics for HIV patients. K. Fox has linked Barker's eco-behavioral approach to social accounting theories, showing how data from large-scale inventories of behavior settings can reveal changes in the quality of community life, thereby complementing other social and economic indicators. J. Barker has extended the approach to political science, demonstrating how residents can make behavior setting inventories to obtain valid knowledge about community activities in order to improve their situation. G. Kaminski has focused attention on individual and group goal-setting in the formulation of behavior setting programs. G. Taylor has used an ecological perspective to study urban crime. E. Morris attempts to integrate ecological psychology with Applied Behavioral Analysis. Wicker has extended both the methods and objectives of ecological psychology, and recommends a combination of qualitative and quantitative approaches with the latter used to study the purposive goal-directed behavior of individuals. While Barker emphasized commonalities among behavior settings of the same type, Wicker focuses on the uniqueness of settings. As an alternative to laborious and lengthy specimen records of individual behavior, Wicker uses intensive longitudinal case studies. He also extends Barker's nonintrusive descriptive methods to provide a framework for positive interventions to improve community settings and to develop new settings to meet new community needs.

Future of Ecological Psychology

Barker and Gibson shared a deep suspicion of laboratory experiments that distorted the processes they were designed to study. They preferred to study behavior in its natural context rather than in the artificial conditions of the laboratory or clinic. When they started their research careers, both men found that the laboratory-based techniques they had learned in graduate school were inadequate for encompassing the real-world phenomena that interested them. Gibson realized that elaborate methods for studying the perception of static stimuli by a stationary observer in a darkened experimental room would be useless in explaining pilot responses in a moving aircraft. As for Barker, it meant recognizing that elaborate developmental studies using conceptually loaded artificial tasks did not provide insight into the everyday lives of children at lunch, on the playground, and at church.

Present Status and Future of Gibson's Approach

In many ways, the present and future of Gibson's approach look far brighter than its past. There are still many who

view Gibson's work with suspicion, almost as a type of mysticism, but typically their only exposure is to the philosophical arguments associated with the approach. As the public face of the field comes to include more and more in-depth studies, the methodological advances offered become hard to deny, and the appeal of the approach is broadened. Thus, Gibson's approach continues to inspire a considerable amount of research and theory. Work by ecological psychology purists has managed to become at least slightly more mainstream, aided by the growing popularity of dynamic-systems approaches and by the success of ecological psychologists in analyzing problems faced by people with degenerative diseases that affect perception-action systems. In addition, ecological psychology has begun to have tremendous influence in fields such as kinesiology and sports psychology. In addition, some of the tenets of ecological psychology have proved to be appealing to researchers less interested in the system as a whole. Most obviously, the term 'affordance' has become commonplace in many areas of psychology and computer science.

Much of this success can be attributed to dedicated adherents at major universities. The International Society for Ecological Psychology, though small, continues to grow. Its biannual meeting, the International Conference on Perception and Action, is well attended, as is the European Workshop of Ecological Psychology. The society's publications include the journal *Ecological Psychology* and a book series '*Resources for Ecological Psychology*.' The current academic headquarters of the field is the Center for the Ecological Study of Perception and Action at the University of Connecticut. Many past and current leaders of the field taught at or graduated from this program.

There are obstacles yet to be overcome. Ecological psychology has yet to gain many of the trappings of more mainstream approaches. There are few academic courses in the subject; there are neither any textbooks nor other book-length surveys attempting to codify a broad range of recent advances in the field (except perhaps some published conference proceedings); and universities rarely think they need an ecological psychologist on the staff to round out their departments. In the end, it may be that the ecological approach is too far removed from lay beliefs to flourish to the same degree as cognitive psychology, but its influence continues to grow.

The long-term direction of any field is difficult to guess, but some short-term trends in psychology should be predictable: (1) While past work typically focused on object perception, future work will forge links between the ecological approach and social psychology. (2) While past work typically took participants' motives for granted, future work, inspired largely by the work of B. Shaw, will try to understand how intentionality affects the perceptual control of behavior. (3) While past work focused on philosophical systems with which the ecological approach clashed, future work will try to contextualize ecological theory with respect to traditions with which it is more compatible. (4) It is also clear that ecological psychologists will continue to be at the forefront of generating and applying ever more sophisticated mathematical models of behavior and behavior control, and will continue to be important in creating and utilizing the equipment required to test such models.

Present Status and Future of Barker's Approach

Barker's interest in real-world behavior in ordinary settings has had a mixed reception in the behavioral sciences. Although some cognitive researchers venture outside the laboratory to study behavior in mundane settings, the majority remain in their laboratories. Environmental psychologists have been more open to leaving the laboratory, but their methods typically involve paper-and-pencil tests, interviews, and questionnaires. Few have adopted Barker's reliance on naturalistic observation. Qualitative sociologists were never wedded to the laboratory, are familiar with case study methods, and do not object to observing mundane settings. However, they have shown little interest in the measurement of reliability or in quantification, both hallmarks of Barker's approach. By the 1980s, Barker's ecological psychology was described as an isolated and self-contained enterprise. Since then, its marginalization has increased as the field station in Oskaloosa closed without being replicated. Barker, his associates, and his students have retired from academic positions without being replaced, and there is no journal or Ph.D. program specifically devoted to Barker's type of eco-behavioral research. The labor-intensive, costly, time-consuming surveys that Barker advocated require decades rather than years: as such, they do not find favor with grant-supporting agencies, and publishers are uninterested in lengthy monographs that devote hundreds of pages to mundane behaviors of ordinary people. In addition, Barker's approach lacked an action component, either to halt environmental degradation or to remedy its effects and promote more sustainable settings and communities.

While Barker's work at the Midwest Field Station remains largely a footnote in developmental and social psychology, there have been some changes that suggest a future for an ecological approach in psychology. The effects of context or situation upon behavior are widely recognized. Milgram's obedience studies and Zimbardo's simulated prison research, along with real-world examples such as the conduct of American guards at Abu Ghraib prison, have demonstrated the inadequacy of trait-based explanations of behavior relative to the power of situations. The actions of two people in a single situation (e.g., sitting in a dentist's chair or shopping in a grocery store) will be more similar due to situational constraints than the action of a single individual in these two different situations. This raises questions about the predictive value of personality trait measures when information about situational influences is lacking. While Barker remained committed to the naturalist's hands-off style of research, future researchers may want to explore the behavior setting model not only to predict but also to change behavior. Whether Barker's ecological psychology, which involved an adult researcher following children throughout the day or stationed in a public location taking notes, is truly nonreactive, is debatable. There is no question that some habituation to a researcher's continued presence in a setting will occur, but issues of residual reactivity remain.

Technical developments, such as the availability of small inexpensive motion-activated video cameras to record behavior, software programs for classifying and digitizing visual data,

and easy compact storage of highly detailed digital specimen records, should make it easier to conduct eco-behavior studies. No longer will rooms of file cabinets with paper notes be required. Digitized material can be distributed online, circumventing publisher resistance to books and monographs containing essentially raw behavioral data, and making it easier for investigators to access original data.

Ecological psychology is taught in many different academic departments and institutionalized under headings such as ecopsychology, ecotherapy, human ecology, and conservation psychology, which have journals, training programs, and practitioners. In its insistence on external validity, ecological psychology has some resemblance to anthropological and sociological fieldwork. However, there are major differences. Most ethnographic fieldwork is qualitative, while Barker's approach was entirely quantitative. Furthermore, Barker's ecological psychology was nonevaluative and showed little interest in changing, improving, or even questioning the settings studied in terms of power relationships (e.g., What is the purpose of a school system or of a school board?), which contrasts with a more activist and critical social science. Nor does it view the topics it studies within a larger cultural context. As a remedy, D. Georgiou and D. Carspecken attempt to integrate Barker's Behavior Setting Survey with Critical Qualitative Research.

Gibson drew his examples from the outside world, but he and his students, when possible, tested their hypotheses in the laboratory which is not often done in anthropology or sociology. Gibson's and Barker's versions of ecological psychology are both different from each other and from mainstream trends in the social and behavioral sciences.

See also: [Environmental Psychology](#).

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- <http://online.sagepub.com/cgi/searchresults?qbe=speab;37/3/295&journalcode=speab&minscore=5000> – Sage Publications

Electroconvulsive Therapy and Transcranial Magnetic Stimulation

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Glossary

Dorsolateral prefrontal cortex (DLPFC) Frontal lobe area, which coordinates executive functioning.

Major depressive disorder (MDD) Clinical syndrome characterized by low mood, anhedonia, and multiple

somatic symptoms. ECT is primarily used for MDD that has not responded to antidepressant medications.

Psychosis Characterized by delusions, hallucinations, and abnormal thought processes leading to disorganized speech and behavior.

Electroconvulsive Therapy

Electroconvulsive therapy (ECT) is the most effective somatic treatment available in psychiatry today. Over seven decades, a refinement in the delivery of electrical stimulus, use of anesthetic agents (usually a short-acting barbiturate), and muscle relaxants (succinylcholine) have established ECT as a safe, rapid, and effective treatment in clinical psychiatry. It is one of the safest procedures under general anesthesia, with a reported mortality rate of <0.002%. ECT is most commonly used for severe or medication-resistant major depressive disorder (MDD). Compared to antidepressant medications, ECT has a quicker onset of action and a higher response rate. However, the response rate varies from around 80–90% in patients who were given ECT as a first line treatment or early on in the course of illness to around 60% in patients who were resistant to treatment with antidepressants. Often, it has been used in elderly patients with MDD, especially those with psychotic features, and also in pregnant patients in whom a quicker response is needed and use of medications may be restricted. It is also a valuable option for intractable psychosis, mania, and catatonia. Furthermore, it has also been used effectively in refractory Parkinson's disease, neuroleptic malignant syndrome, and intractable epilepsy. Due to the higher and more rapid response rates of ECT, it is trending toward an earlier placement in treatment algorithms.

While the mechanism by which ECT delivers its therapeutic benefits is unclear, etiological theories range from neurogenesis (with an increase in brain-derived neurotrophic factors), alterations in regional cerebral blood flow, modulation of numerous neurotransmitters and hormones, and the anticonvulsant effects of ECT. A comprehensive pre-ECT work up involves taking a detailed history and performing a thorough physical examination as well as screening blood tests, such as complete blood count and comprehensive metabolic profile. Additional tests such as an electrocardiogram, chest radiography, or computerized tomogram of the head may be ordered if clinically relevant. Baseline cognitive functioning should be assessed. ECT has been performed with both unilateral and bilateral electrode placement. The most common electrode placements involve bilateral temporal or unilateral (nondominant) placement with electrodes in temporal and vertex positions. Bilateral placement is often more efficacious but also more prone to

adverse effects, notably pertaining to confusion and memory. With the evolution of ECT, there has also been a significant shift in using brief and ultra-brief pulse-wave stimulation rather than prolonged sine-wave stimulation, since the brief pulse wave is less likely to produce cognitive adverse effects. Though there is no consensus on stimulus dosing, doses that have usually been found to be effective are 1.5–2.5 times above the seizure threshold for bilateral and 2.5–6.8 times above the threshold for unilateral placement. The duration of a seizure does not correlate with ECT outcome. A course of ECT is usually 6–12 in number, with ECTs delivered twice or thrice weekly. There is no consensus on continuation and maintenance ECT to prevent relapse and recurrence but this is often offered to patients who are resistant to medications and have responded well to ECT. Usually, antidepressants and antipsychotic medications are continued but it is advisable to taper anticonvulsants and benzodiazepines since they increase seizure threshold. Lithium is also best avoided as it can contribute to confusion and prolonged seizures. There is no absolute contraindication for ECT. Relative contraindications of ECT include recent myocardial infarction, arrhythmias, decompensated congestive heart failure, and intracranial hypertension. Common adverse effects of ECT include transient elevation in blood pressure, irregular heart rate, headache, and muscle aches. Rarely, prolonged seizures and even *status epilepticus* can occur although these typically can be quickly diagnosed and treated given constant EEG monitoring. A spectrum of cognitive impairments can occur from use of ECT. These include acute confusion due to the actual seizure, which resolves within minutes to hours, and anterograde amnesia, which resolves in about 1–3 weeks after ECT discontinuation. Another cognitive adverse effect, retrograde amnesia, involves episodic memory from about 1–3 months prior to the commencement of ECT. Unilateral electrode placement with brief and ultra-brief pulse-wave stimulus delivery has improved the tolerance of ECT and minimized some of the above mentioned cognitive impairments. Subjective reports of persistent or severe memory impairments are not confirmed when assessed by available testing.

Transcranial Magnetic Stimulation

Transcranial magnetic stimulation (TMS) is a neuromodulatory technique that involves passing of brief current through a

stimulating coil placed over a particular area of the scalp to induce a magnetic field. This magnetic field, in turn, induces a low grade electrical current in underlying brain region. TMS has been used for research purposes in the field of neurosciences for more than two decades, is now approved by the US Food and Drug Administration (FDA) for refractory depression, and continues to be tested for further clinical use in a variety of neurological and psychiatric disorders. The use of current with a frequency <1 Hz is referred to as *low frequency* or *slow* and has inhibitory effects. Current above 1 Hz is termed as *high frequency* or *fast* and has excitatory effects. Delivery of a series of pulses or a *train of stimulation* is termed as *repetitive TMS* (rTMS). This is believed to have longer-lasting effects on neurotransmission. rTMS is being tested for both research and clinical purposes involving neuropsychiatric disorders. Single pulse TMS has been used to map motor cortex output and paired pulse TMS has been used to identify interactions involving various cortical areas. An rTMS device was approved for the first time by the FDA in 2008 for treatment of MDD in adult patients who have failed one antidepressant trial in the current episode of illness. In MDD, TMS is usually delivered 5 days a week with each course lasting between 20–30 sessions. One of the parameters used in TMS is motor threshold (MT). MT is defined as the minimal amount of energy required to activate a motor area. In each session, current is delivered at a strength of 80–120% of the MT over the left dorso-lateral prefrontal cortex (DLPFC). Though the mechanism of action is not clear, TMS is hypothesized to modulate serotonin transmission and alter regional blood flow. In an interesting study, Li et al. reported that 1 Hz TMS over the left prefrontal cortex was associated with increased activity at the site of stimulation as well as in connected limbic regions, including bilateral middle prefrontal cortex, right orbital frontal cortex, left hippocampus, mediodorsal nucleus of the thalamus, bilateral putamen, pulvinar, and insula. Interestingly, significant deactivation was found in the right ventromedial frontal cortex.

TMS is a completely noninvasive procedure administered in an outpatient setting. Unlike ECT which has a recovery period with caution against driving on the same day, patients receiving TMS can immediately resume their day-to-day activities. Some of the more common side effects include headache and pain at the application site. In some studies, TMS has been associated with transient increase in the auditory threshold

which can rarely become permanent. Use of ear plugs has been recommended as a protective measure and should be accompanied by regular monitoring for emergence of side effects such as hearing difficulties and tinnitus. One of the most serious side effects reported till date with TMS is the occurrence of seizures and its incidence is estimated at 1 for every 10 000 treatment sessions administered. The risk of seizures increases with increase in stimulation intensity, increased frequency, increased train duration, and decreased intertrain interval. Another rare side effect reported has been treatment-emergent mania. There are ongoing clinical trials involving TMS for schizophrenia, MDD, bipolar, anxiety disorders, Alzheimer's disease, addictions, obsessive compulsive disorder, smoking cessation, chronic pain, Parkinson's disease, migraine, aphasia, tinnitus, stroke, and Tourette's syndrome.

See also: [Depression](#).

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Electroencephalography

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Glossary

Cerebral cortex The outer layer of mammalian brains; in humans about 2–5 mm thick with surface area of roughly 1500–3000 cm².

Coherence A squared correlation coefficient measuring the phase consistency between two signals, expressed as a function of signal frequency.

Conductivity ($\Omega^{-1} \text{mm}^{-1}$) The property of a material (living tissue, for example) that determines the ease with which charges move through the medium to produce current.

Current density ($\mu\text{m mm}^{-2}$) The flux of positive plus negative charge passing through a unit cross-sectional area.

Electric potential (mV) The negative gradient of the local electric field vector.

Electrocorticogram (ECoG) Electric potential recorded directly from the brain surface.

Electroencephalography (EEG) The electric potential recorded from the human scalp; sometimes used more generally to include intracranial recordings in humans and lower mammals.

Event-related potential (ERP) Average brain electric potential produced by a combination of sensory stimulus and cognitive task.

Evoked potential (EP) Brain electric potential produced on average by a sensory stimulus.

Ohm's law for a volume conductor Vector current density equals the product of conductivity and vector electric field. Ohm's law simplifies to the usual scalar expression.

Voltage change = Current \times Resistance For current flow confined to one spatial direction, for example, in electric circuit wires.

Window on the Mind

Human electroencephalography (EEG) provides a convenient, but often opaque, 'window on the mind,' allowing observations of electrical processes near the brain surface. The outer brain layer is the cerebral cortex, believed to be largely responsible for cognition: perception, memory, thinking, emotions, actions, and behaviors. Cortical processes involve electrical signaling between neurons that change over many times in the 10 ms (0.01 s) range. EEG is the only widely available technology with sufficient temporal resolution to follow these quick dynamic changes.

EEG can be recorded using electrodes placed inside the skull to study nonhuman mammals or human epilepsy patients. Such intracranial recordings provide measures of cortical dynamics at small spatial scales, dependent on electrode size. However, there are significant limitations to intracranial EEG recording for studies of cognition and behavior. Intracranial recordings in humans are mostly limited to patients with intractable epilepsy, often in preparation for brain surgery. These recordings are called electrocorticograms (ECoGs). ECoG recordings are usually obtained only over a very limited portion of the cortex, areas which vary widely across individuals, partly guided by EEG recordings of epileptic activity using electrodes placed on the scalp prior to surgery.

In both clinical and research studies, EEG is nearly always recorded from electrodes placed on the scalp. Each scalp electrode records electrical activity at large scales, measuring electric currents (or potentials) generated in cortical tissue containing about 30 million to 500 million neurons. Luckily, these large-scale estimates provide important measures of brain dysfunction for clinical work and cognition or behavior for basic scientific

studies. Human 'mind-measures' are easily obtained at the large scale of scalp recordings. EEG monitors the state of consciousness of patients in clinical work or experimental subjects in basic research. Oscillations of scalp voltage tell a very limited but important part of the story of brain functioning. For example, states of deep sleep, coma, or anesthesia are mostly associated with very slow EEG oscillations and larger amplitudes. Modern signal analyses allow for identification of distinct sleep stages or quantitative measures of the depth of anesthesia. More sophisticated experimental designs and methods of signal analysis have revealed robust connections to detailed cognitive events.

On the other hand, EEG spatial resolution is poor, compared to modern brain functional imaging methods such as PET and MRI. But these latter methods have very poor temporal resolutions on the timescale of seconds and thus do not offer detailed information about the rapid neural dynamics available to EEG. The related technology, magnetoencephalography (MEG), consists of recordings of the magnetic field generated by brain current sources. MEG also provides high temporal resolution and low spatial resolution, similar to EEG. MEG is preferentially sensitive to brain current sources oriented tangential to the scalp surfaces, which are typically located in the sulcal walls (folded cortex), while EEG is more sensitive to radial sources that are mainly located in the gyral surfaces (see [Figure 1](#)).

Sources of Scalp Potentials

The *generators* of scalp potentials are best described as micro-current sources at cell membranes. Relationships between such very small-scale sources and macroscopic potentials at the

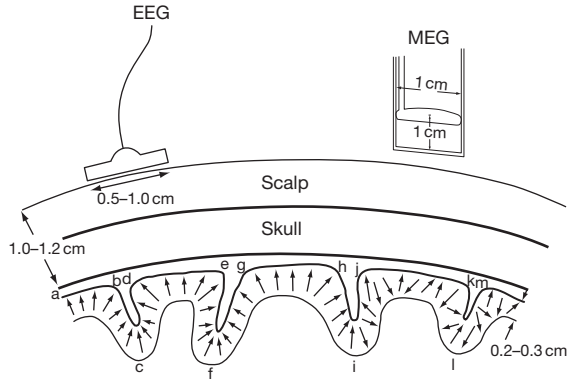


Figure 1 Sources of EEG and MEG. Neocortical sources can be generally pictured as *dipole layers* (or ‘dipole sheets’, in and out of cortical fissures and sulci) with mesosource strength varying as a function of cortical location. EEG is most sensitive to correlated dipole layer in gyri (regions ab, de, gh), less sensitive to correlated dipole layer in sulcus (region hi), and insensitive to opposing dipole layer in sulci (regions bcd, efg) and random layer (region ijklm). MEG is most sensitive to correlated and minimally apposed dipole layer (hi) and much less sensitive to all other sources shown, which are opposing, random or radial dipoles. For this reason, MEG signals are more likely to ‘fit’ localized equivalent sources while ignoring the dominant EEG sources.

scalp are made easier by employing an intermediate (*mesoscopic*) descriptive scale. This approach makes use of the columnar structure of the neocortex, believed to contain the dominant sources of spontaneous scalp potentials. For macroscopic measurements, the ‘mesoscale source strength’ of a volume of tissue is defined by its electric (current) dipole moment per unit volume

$$\mathbf{P}(\mathbf{r}', t) = \frac{1}{W} \iiint_W \mathbf{ws}(\mathbf{r}', \mathbf{w}, t) dW(\mathbf{w}) \quad [1]$$

Here, the three integral signs indicate integration over a small, local volume W of tissue where $dW(\mathbf{w})$ is the tissue volume element. $s(\mathbf{r}', \mathbf{w}, t)$ is the local volume source current ($\mu\text{A mm}^{-3}$) near membrane surfaces inside a tissue volume with vector location \mathbf{r}' . \mathbf{w} is the vector location of sources within $dW(\mathbf{w})$. The current dipole moment per unit volume $\mathbf{P}(\mathbf{r}', t)$ in a conductive medium is fully analogous to charge polarization in a dielectric (insulator). Macroscopic tissue volumes satisfy the condition of electroneutrality at EEG frequencies. That is, current consists of the movement of positive and negative ions in opposite directions, but the total charge in any mesoscopic tissue volume is essentially zero. Cortical morphology is characterized by its columnar structure with pyramidal cell axons aligned normal to the local cortical surface. Because of this layered structure, the volume elements $dW(\mathbf{w})$ may be viewed as cortical columns with height $\approx 2\text{--}5$ mm. For purposes of describing scalp potentials, the choice of basic cortical column diameter is somewhat arbitrary. Anything between the cortical *minicolumn* (≈ 0.03 mm) and *macrocolumn* scales (≈ 1 mm) may be used to describe scalp potentials. The main consideration is that tissue volumes are assumed to be sufficiently large such that current conservation within the volumes is satisfied. Otherwise, monopole contributions to distant potentials are expected.

The microsources $s(\mathbf{r}', \mathbf{w}, t)$ are generally mixed positive and negative due to local inhibitory and excitatory synapses, respectively. In addition to these active sources, the $s(\mathbf{r}', \mathbf{w}, t)$ include passive membrane (return) current required for current conservation. Dipole moment per unit volume $\mathbf{P}(\mathbf{r}', t)$ has units of current density ($\mu\text{A mm}^{-2}$). For the idealized case of sources of one sign confined to a superficial cortical layer and sources of the opposite sign confined to a deep layer, $\mathbf{P}(\mathbf{r}', t)$ is roughly the (negative) diffuse current density across the column, $-\mathbf{J}(\mathbf{r}', t)$. This might occur due to superficial inhibitory synapses and deep excitatory synapses, for example. Generally, column source strength $\mathbf{P}(\mathbf{r}', t)$ is reduced as excitatory and inhibitory synapses overlap along column axes. In the case of fully mixed synapses, $\mathbf{P}(\mathbf{r}', t) \approx 0$, and a so-called *closed field* results.

Human neocortical sources may be viewed as forming a large *dipole sheet* (or *layer*) of perhaps $1500\text{--}3000\text{ cm}^2$ over which the function $\mathbf{P}(\mathbf{r}', t)$ varies continuously with cortical location \mathbf{r}' , measured in and out of cortical folds. **Figure 1** shows an idealized cortical surface with sources generally oriented normal to the cortical surface. In limiting cases, this dipole layer might consist of only a few discrete regions where $\mathbf{P}(\mathbf{r}', t)$ is large, consisting of localized or *focal sources*. But, more generally, $\mathbf{P}(\mathbf{r}', t)$ is distributed over the entire folded surface. The question of whether $\mathbf{P}(\mathbf{r}', t)$ is distributed or localized in particular brain states is often controversial. The averaging of evoked potentials over trials substantially alters the nature of this issue. Such time averaging strongly biases evoked potentials toward (trial to trial) time stationary sources, for example, sources confined to the primary sensory cortex.

Volume Conduction of Head Currents

Scalp potential may be expressed as a volume integral of dipole moment per unit volume over the entire brain, provided $\mathbf{P}(\mathbf{r}', t)$ is defined generally rather than in columnar terms. For the important case of dominant cortical sources, scalp potential may be approximated by the following integral of dipole moment over the cortical volume Θ

$$V(\mathbf{r}, t) = \iiint_{\Theta} \mathbf{G}(\mathbf{r}, \mathbf{r}') \cdot \mathbf{P}(\mathbf{r}', t) d\Theta(\mathbf{r}') \quad [2]$$

If the volume element $d\Theta(\mathbf{r}')$ is defined in terms of cortical columns, the volume integral may be reduced to an integral over the folded cortical surface. **Equation [2]** indicates that the time dependence of scalp potential is the weighted sum (or integral) of all dipole time variations in the brain. Deep dipole volumes typically make negligible contributions because of the greater separation from the scalp electrodes. The weighting function is called the vector Green’s function $\mathbf{G}(\mathbf{r}, \mathbf{r}')$, essentially an inverse *electrical distance*. $\mathbf{G}(\mathbf{r}, \mathbf{r}')$ contains all geometric and conductive information about the head volume conductor. The most common head models consist of three or four concentric spherical shells, representing the brain, cerebrospinal fluid, skull, and scalp tissue with different electrical conductivities σ as shown in **Figure 2**. In genuine heads, however, $\mathbf{G}(\mathbf{r}, \mathbf{r}')$ is much more complicated. More complicated numerical methods may also be used to estimate $\mathbf{G}(\mathbf{r}, \mathbf{r}')$, sometimes employing MRI to determine tissue boundaries. However, the accuracy of both analytic

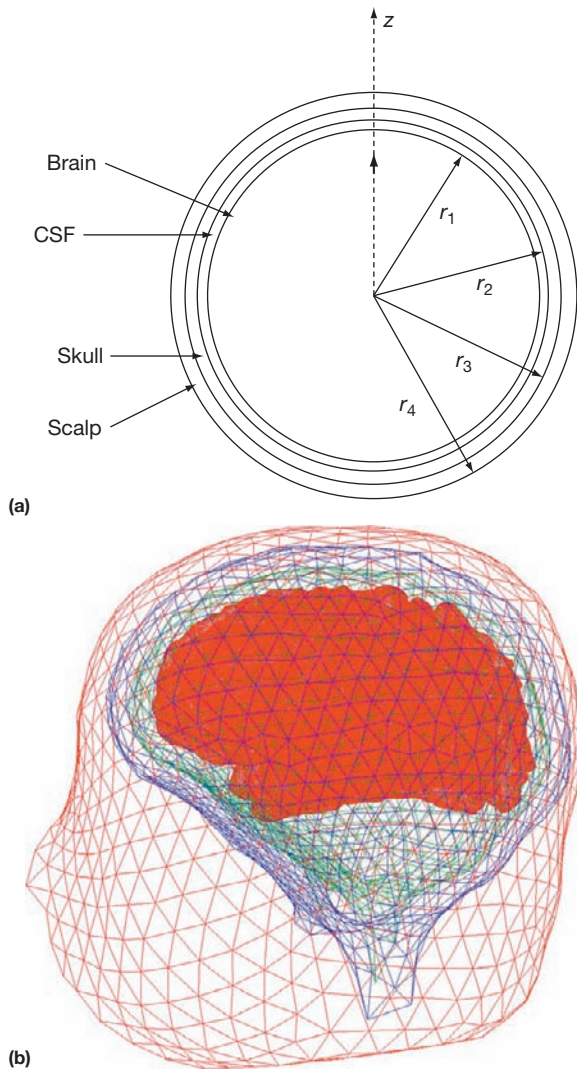


Figure 2 Volume conduction models for EEG. (a) A dipole is shown in the inner sphere of a 4-concentric spheres head model consisting of the inner sphere (brain) and three spherical shells representing CSF (cerebral spinal fluid), skull, and scalp. The parameters of the model are the radii (r_1, r_2, r_3, r_4) of each shell and the conductivity ratios ($\sigma_1/\sigma_2, \sigma_1/\sigma_3, \sigma_1/\sigma_4$). Typical values are radii (8, 8.1, 8.6, 9.2 cm) and conductivity ratios (0.2, 40, 1). (b) A realistically shaped boundary element model (BEM) of the head. The brain and scalp boundaries were found by segmenting the images with a threshold, and opening and closing operation respectively, while the outer skull boundary was obtained by dilation of the brain boundary (ASA, Netherlands). Although geometrically more accurate than the spherical model, the (geometrically) realistic BEM suffers a potentially fatal flaw because tissue resistivity is poorly known.

and numerical methods may be severely limited by incomplete knowledge of tissue conductivities. MRI has also been suggested as a future means of estimating tissue conductivities, based on the close relationship of diffusion to current flow processes.

Despite these limitations preventing highly accurate estimates of the function $G(\mathbf{r}, \mathbf{r}')$, a variety of studies using concentric spheres or numerical methods have provided reasonable

quantitative agreement with the experiment. The cells generating scalp EEG are believed to have the following properties:

1. In the case of potentials recorded without averaging, cells generating EEG are mostly close to the scalp surface. Potentials fall off with distance from source regions. In real heads, tissue inhomogeneity (location-dependent properties) and anisotropy (direction-dependent properties) complicate this issue. For example, the low conductivity, three-layered skull tends to spread currents (and potentials) in directions tangent to its surface. Brain ventricles, the subskull cerebrospinal fluid layer, and skull holes (or local reductions in resistance per unit area) may provide current shunting. But generally, sources closest to electrodes are expected to make the largest contributions to scalp potentials.
2. The large *pyramidal cells* in the cerebral cortex are aligned in parallel, perpendicular to local surface. This geometric arrangement encourages large extracranial electric fields due to linear superposition of contributions by individual current sources. Columnar sources $\mathbf{P}(\mathbf{r}', t)$ aligned in parallel and synchronously active make the largest contribution to the scalp potential. For example, a 1-cm² crown of cortical gyrus contains about 110 000 minicolumns, approximately aligned. Over this small region, the angle between $\mathbf{P}(\mathbf{r}', t)$ and $\mathbf{G}(\mathbf{r}, \mathbf{r}')$ exhibits relatively small changes. By 'synchronous' sources, it is meant that the time dependence of $\mathbf{P}(\mathbf{r}', t)$ is roughly consistent (phase locked) over the area in question. In this case, eqn [2] implies that individual synchronous column sources add by linear superposition. By contrast, scalp potentials due to asynchronous sources are due only to statistical fluctuations, that is, imperfect cancellation of positive and negative contributions to the integral in eqn [2]. Scalp potential may be estimated as roughly proportional to the number of synchronous columns plus the square root of the number of asynchronous columns. For example, suppose 1% ($s_1 \approx 10^3$) of the gyral minicolumns produce synchronous sources $\mathbf{P}(\mathbf{r}', t)$ and the other 99% of minicolumns ($s_2 \approx 10^5$) produce sources with random time variations. The 1% synchronous minicolumn sources are expected to contribute roughly $s_1/\sqrt{s_2}$ or about three times as much to scalp potential measurements as the 99% population of random minicolumn sources.
3. The observed ratio of brain surface (dura) potential magnitude to scalp potential magnitude for widespread cortical activity like alpha rhythm is roughly in the 2–6 range. By contrast, this attenuation factor for very localized cortical epileptic spikes can be 100 or more. A general clinical observation is that a spike area of at least 6 cm² of cortical surface must be synchronously active to be identified on the scalp. This area contains about 700 000 minicolumns or 70 000 000 neurons forming a dipole layer. These experimental observations are correctly predicted by eqn [2].
4. For dipole layers partly in fissures and sulci, somewhat larger areas are required to produce measurable scalp potentials. First, the maximum scalp potential due to a cortical dipole oriented tangent to the scalp surface is estimated to be about 1/3 to 1/5 of the maximum scalp potential due to a dipole of the same strength and depth, but orientated normal to the surface. Second, tangential dipoles tend to be located more in fissures and (deeper) sulci, and

may also tend to cancel due to opposing directions on opposite sides of the fissures and sulci. Third, and most importantly, synchronous dipole layers of sources with normal orientation covering multiple adjacent gyri can form, leading to large scalp potentials due to the product $P(\mathbf{r}', t) \cdot \mathbf{G}(\mathbf{r}, \mathbf{r}')$ having a constant sign over the integral in eqn [2].

Recording Methods

EEG Machines

Human EEG is recorded using electrodes with diameters typically in the 0.4–1-cm range, held in place on the scalp with special pastes, caps, or nets, as illustrated in Figure 1. EEG recording procedures are noninvasive, safe, and painless. Nevertheless, experimental subjects used in research laboratories must provide informed consent. Special gels are applied between electrodes and scalp to improve electrical contact. Wires from scalp electrodes connect to special EEG machines containing amplifiers to boost raw scalp signals, which are typically in the 5–200-mV range or roughly 100–1000 times smaller than EKG (heart) signals.

Electrode Placement

The electrode positions (which are referred to collectively as the electrode ‘montage’) vary considerably across laboratories. Standard electrode-placement strategies use the 10-20, 10-10, and 10-5 placement systems. These montages are based on systematic extensions of the clinical standard 10-20 electrode montage, and they are widely but not universally used. The basis of these standard electrode placements is to define contours between skull landmarks (e.g., nasion and inion) and to subdivide the resulting contours in proportional distances. The 10-5 system uses proportional distances of 5% of the total length along contours between skull landmarks, compared to the 20% and 10% distances used in the 10-20 and 10-10 systems, respectively. EEG caps are commonly commercially available with these electrode positions. However, most modern EEG systems in research laboratories that use a larger number of channels (perhaps 64–130 or more) make use of other placement systems developed with the aim of obtaining more regularly spaced sampling of the EEG, with nearly equal nearest-neighbor electrode separations.

Potential differences between electrode pairs are recorded with EEG machines containing amplifiers, filters, and other hardware. A ground electrode is also required to provide a reference signal to the differential amplifiers. The distinction between ‘recording’ and ‘reference’ electrodes is mostly artificial since it is the potential differences between the two sites that allow closed current loops through the tissue and the EEG machine. In *referential recordings*, potentials between each recording electrode and a fixed reference electrode are measured over time. The potential difference between any pair of electrodes can then be easily obtained by subtracting one signal from the other. A widely used strategy in research EEG is the *common average reference*, where the average potential of all channels is subtracted from each channel. *Bipolar recordings* measure potential differences between adjacent scalp electrodes and are a

commonly used strategy in clinical EEG. When such bipolar electrodes are placed close together (say 1 or 2 cm apart), potential differences are estimates of the tangential electric fields (or current densities) in the scalp between the electrodes.

Standard clinical practice makes use of a 10-20 electrode montage consisting of only 21 electrodes. Often 48–136 recording electrodes are used in research; some laboratories now use as many as 256 channels to obtain more detailed information about brain sources by means of sophisticated computer algorithms. The resulting multichannel data are submitted to two distinct types of computer algorithms: (1) *High-resolution EEG* methods estimate potentials on the brain surface by accounting for distortions caused by intervening tissue and the physical separation of electrodes from the brain. (2) *Dipole localization* methods can estimate the location of source regions in the brain in a few specialized applications where EEG is expected to be generated mainly in only one or two isolated source regions.

Artifact

Potentials recorded from the scalp are generated by brain sources, environmental and hardware system noise, and biological artifacts. Biological artifacts often contaminate EEG records and generally pose a more serious problem than environmental or system noise, the latter substantially reduced by modern amplifier systems. Common artifact sources include whole body movement, heart, muscle, eye movements, and eye blink. EEG records containing large artifacts are usually discarded. Artifact removal by computer is typically successful only for a highly stereotypical low-frequency artifact such as eye blinks. The effectiveness of automated artifact editing is severely limited because the frequency bands of biological artifacts substantially overlap the important EEG bands, making distinctions between artifact and brain signal very difficult. This problem is severe at frequencies above 20 Hz, where the electrical artifact from scalp muscles is recorded along with the EEG. Such high-frequency muscle artifact can easily dominate EEG in the same high-frequency range.

The Reference Electrode

Ideally, an EEG would represent the *reference-free potential* or *nominal potential with respect to infinity*. The label ‘nominal’ means that even if it were possible to measure scalp potentials with respect to ‘infinity’ (or a distant wall of the laboratory), such large potentials (measured in volts) would have no physiological relevance, being dominated by power line fields and other environmental sources. The ‘nominal potential with respect to infinity’ is defined as the potential with respect to infinity due only to sources generated by the brain. For many years, EEG scientists seemed to insist (based on both word and deed) that if only some body location could be found with no active local sources, such a reference location would allow for genuine reference-free recordings. This old idea has long been discredited using both simulations and genuine data; EEG always represents the potential difference between two body locations. Any set of data recorded with some reference location may be referenced to another location. For example, the average reference is obtained by simply adding up all recorded

potential differences and subtracting this sum from each individual potential difference. Like any other choice of reference, the average reference provides imperfect estimates of reference-independent potentials, but when used with large number of electrodes (>64) it often performs reasonably well.

Time Dependence

Oscillatory Waveforms

Voltage traces of EEG signals recorded from each electrode pair oscillate with mixtures of component waveforms with different frequencies. Standard EEG analyses often begin with the spectral analysis of the EEG signal using Fourier methods. Each frequency component may be defined in terms of three parameters, its amplitude (A_{nm}), frequency (f_{nm}), and phase (ϕ_{nm}). The subscript n denotes the frequency component and the subscript m indicates an electrode pair used to record a potential difference. The electrical power associated with each frequency component is proportional to the square of the corresponding amplitude. One may express any physical waveform as a sum of components with different frequencies, amplitudes, and phases called a Fourier series. Fourier series are analogous to expressions of music or other sounds as compositions of tones or of white light composed of many colors. The EEG voltage $V_m(t)$ recorded from any electrode pair m may be expressed generally as a sum over frequency components

$$V_m(t) = \sum_{n=1}^N A_{nm} \sin(2\pi f_{nm}t - \phi_{nm}) \quad [3]$$

Waveform frequencies f_{nm} are expressed in terms of number of cycles per second (or Hertz, abbreviated Hz). EEG frequency ranges are categorized as *delta* (1–4 Hz), *theta* (4–8 Hz), *alpha* (8–13 Hz), and *beta* (>13 Hz). Very high frequencies (typically 30–40 Hz) are referred to as *gamma* activity. These distinctive labels correspond roughly to frequency ranges (or bands) that often dominate particular human brain states. Disparate rhythms may be associated with behavioral or cognitive state, brain location, or other criteria. For example, delta activity with frequencies lower than about 1 or 2 Hz provides the largest EEG amplitudes (or power) during deep sleep and in many coma and anesthesia states. Alpha, often mixed with low-amplitude delta, theta, and beta, is typically predominant in awake-resting states. Alpha is the dominant rhythm in *alpha coma* and is superimposed on delta activity during some sleep stages. Distinct rhythms can also occur in the same frequency range. Thus, the plural terminology, alpha rhythms, beta rhythms, and so on, appropriately describes the wide variety of EEG phenomena.

Modern methods of time series analysis are often used to simplify complicated waveforms like EEG. Many industrial applications involve such methods, including electric circuits, signal processing (television, radar, astronomy, etc.), voice recognition, and so on. Most time series analyses are based on spectral (or Fourier) methods. Computers extract the amplitudes A_{nm} and phases ϕ_{nm} associated with each data channel (m) and frequency (n) from the often complicated EEG, represented by eqn [3]. The computer ‘unwraps’ the waveform $V_m(t)$ to reveal its individual components. Such spectral analysis is

analogous to the physical process performed naturally by atmospheric water vapor to separate white light into its component colors. Each color is composed of electromagnetic waves within a narrow frequency band, providing the basis for rainbows.

The Rhythmic Zoo

Human EEG exhibits many waveforms, especially in the experience of clinical electroencephalographers (neurologists with this specialized training). Some EEG have known clinical significance and some do not. Any complicated waveform can be described as a mixture of oscillations with different frequencies and amplitudes, as indicated by eqn [3]. But more picturesque descriptions are often preferred by clinical electroencephalographers to characterize the ‘zoo’ of EEG waveforms. Such labels include *paradoxical alpha*, *spike and wave*, *delta focus*, *sharp transient*, *sleep spindle*, *nonspecific dysrhythmia*, and others.

Cortical EEG (ECoG) typically consists of even more complex waveforms, composed of rhythms with different frequencies, locations, and spatial extent. Such highly localized cortical rhythms are not recorded on the scalp. Cortical beta and gamma rhythms are often strongly attenuated between cortex and scalp because they are more localized or less synchronized over cortical areas than some of the alpha, theta, and delta band activity. EEG during sleep, coma, and anesthesia typically exhibits large scalp amplitudes of low-frequency oscillations, implying widely distributed and highly synchronous cortical source activity.

Alpha Rhythms

Alpha rhythms provide an appropriate starting point for clinical EEG examinations. Some initial clinical questions are: Does the patient show alpha rhythms, especially over the posterior scalp? Are their spatial–temporal characteristics appropriate for the patient’s age? How do they react to eyes opening, hyperventilation, drowsiness, etc.? For example, pathology is often associated with pronounced differences in EEG recorded over opposite hemispheres or with low alpha frequencies. A resting alpha frequency lower than about 8 Hz in adults is considered abnormal in all but the very old.

Alpha rhythms may be recorded in roughly 95% of healthy adults with closed eyes. The normal waking alpha rhythm usually has larger amplitudes over posterior regions, but is typically recorded over widespread scalp regions. Posterior alpha amplitude in most normal adults lies in the range of 15–50 mV; alpha amplitudes recorded from frontal electrodes are usually lower. A posterior rhythm of ~ 4 Hz develops in babies in the first few months of age. The amplitude increases with eye closure and is believed to be a precursor of mature alpha rhythms. Maturation of the alpha rhythms is characterized by increased frequency and reduced amplitude between the ages of about 3 and 10.

Normal resting alpha rhythms may be substantially reduced in amplitude by eye opening, drowsiness, and in some subjects, by moderate to difficult mental tasks. Alpha rhythms, like most EEG phenomena, typically exhibit an inverse relationship between amplitude and frequency.

For example, hyperventilation and some drugs (alcohol, for example) may cause reductions of alpha frequencies together with increased amplitudes. Other drugs (barbiturates, for example) are associated with increased amplitude of low-amplitude beta activity superimposed on scalp alpha rhythms. The physiological bases for the inverse relation between amplitude and frequency and most other properties of EEG are largely unknown, although physiologically based dynamic theories have provided several tentative explanations.

Figure 3 describes a 60-s recording of alpha rhythm from two scalp locations. The subject is a healthy waking adult, relaxed with eyes closed. By examining the power spectra for the occipital (**Figure 3(a)**) and frontal sites (**Figure 3(b)**) for individual epochs with frequency resolution of 0.5 Hz, support for two different kinds of oscillation within the alpha band is obtained. At the occipital channel, individual epochs display distinct peaks at 9.5 and 10.5 Hz. The first 15 epochs show a strong response at 10.5 Hz but the later epochs show a stronger response at 9.5 Hz. The dominant frequency in each epoch is summarized in the peak power histograms in **Figure 3(c)** showing that individual epochs displayed peak frequencies at both 9.5 and 10.5 Hz. By contrast, very few epochs have a peak frequency of 10.5 Hz at the frontal site (**Figure 3(d)**); most epochs have peak frequencies either at 9.5 Hz or in the delta band (<2 Hz). Note that during most epochs with strong delta activity as in **Figure 3(b)**, the alpha peaks are attenuated. The amplitude spectra show mixtures of frequencies that depend partly on scalp location; however, alpha rhythm is dominant at all locations in this typical example. This subject has two frequency peaks near 10 Hz, a relatively common finding. These two alpha oscillations are partly distinct phenomena as

revealed by their separate distributions over the scalp and their distinct behaviors during mental tasks. The multiple underlying source regions are believed to overlap substantially.

Alpha, Theta, Cognitive Tasks, and Working Memory

Two prominent features of human scalp EEG show especially robust correlation with mental effort. First, alpha band amplitude normally tends to decrease with increases in mental effort. Second, frontal theta band amplitude tends to increase as tasks require more focused attention. A common but oversimplified view of alpha rhythms is one of brain idling. But upper and lower alpha band amplitudes may change independently, depending on scalp location and task. Some working memory tasks cause lower alpha band amplitude to decrease while upper alpha band amplitude increases. Alpha amplitude reductions may reflect local cortical desynchronization occurring in task-relevant brain areas, whereas task-irrelevant regions may be unchanged or even produce larger alpha amplitudes. Another (possibly complementary) hypothesis is that increases in higher frequency alpha amplitudes reflect a specific memory processing function and not simple idling.

Generally, intracerebral electrodes record a variety of alpha rhythms. Some intracerebral alpha rhythms are blocked by opening the eyes and some are not. Some respond in some way to mental activity and some do not. The alpha band rhythms recorded on the scalp represent spatial averages of multiple alpha phenomena and a large number of alpha components. For an alpha rhythm of a particular type to be observed on the scalp, it must be synchronized (roughly in phase) over a large cortical area.

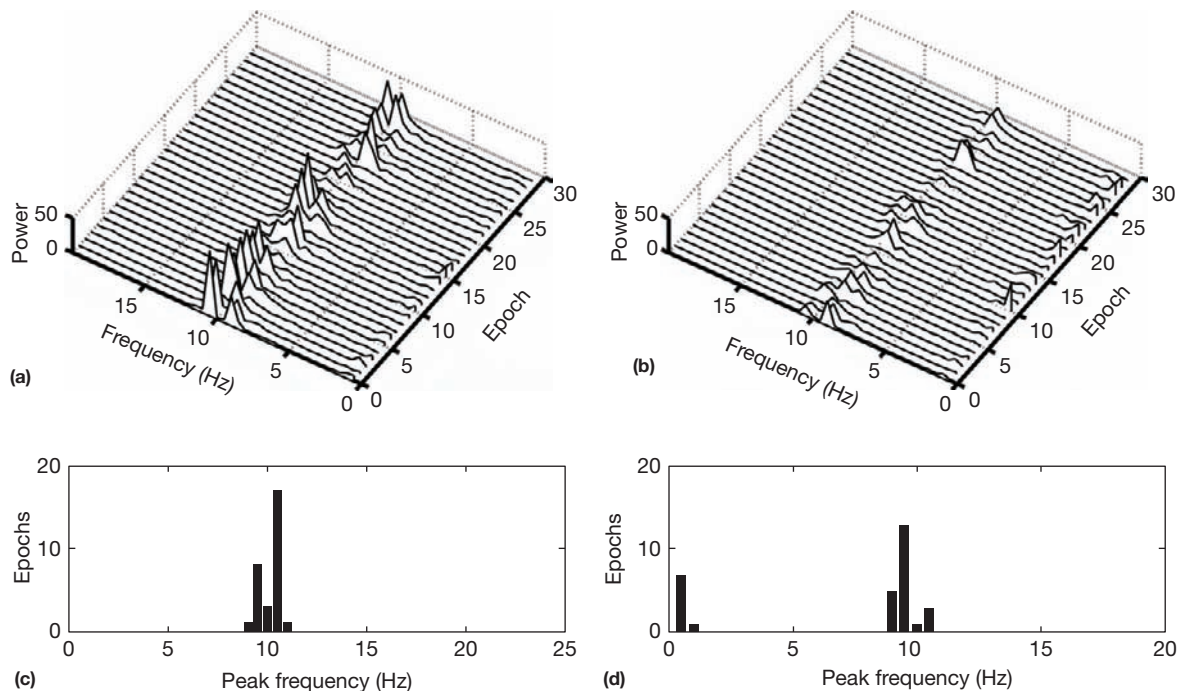


Figure 3 An example of power spectra from a single subject (female, 22 years). The subject is at rest with eyes closed. (a) Plots of 30 (individual 2-s epoch) power spectra for a channel over the occipital lobe. (b) Plots of the same 30 individual epoch spectra for a frontal channel. (c) Peak power histograms show the distribution of peak frequencies for the 30 epochs shown in (a). (d) Peak power histograms for the 30 epochs shown in (b).

Topography

Dynamic Measures that Depend on Spatial Location

The EEG recorded from a single electrode pair is fully characterized by its time dependence, as in eqn [3]. In spatially extended systems, however, dynamic behavior generally depends on time and spatial location, the usual independent variables of spatially extended dynamical systems. Thus, multi-channel recordings potentially introduce many new measures of brain dynamic behavior. Amplitude, phase, and frequency, for example, may vary with scalp or cortical spatial location.

Spatial Distribution of Alpha Rhythms

Alpha rhythms have been recorded from nearly the entire upper cortical surface (ECoG), including frontal and prefrontal areas. High-resolution EEG scalp recordings also show widespread distribution of alpha rhythms over nearly the entire scalp in healthy, relaxed subjects. EEG clinical populations differ, typically involving patients who are older, have neurological problems, and may be anxious during recording. These factors all tend to work against the production of robust, widespread alpha rhythms. Second, the clinical definition of alpha is based on raw waveforms rather than the spectra. Often alpha is identified simply by counting the number of zero crossings of recorded waveforms. This can sometimes provide a misleading picture because raw EEG composed of broad frequency bands can appear very 'nonalpha' to visual inspection, even though its amplitude spectrum shows substantial contribution from the alpha band. Such alpha rhythms may consist of mixtures of both localized and widely distributed activity.

Larger amplitude frontal alpha often occurs as subjects become more relaxed, for example, by employing relaxation or meditation techniques. Alpha rhythms of unusually large amplitude or exhibiting frontal dominance may be associated with mental retardation and some types of epilepsy. Large amplitude and dominant frontal alpha rhythm may also be recorded in some coma and anesthesia states. In summary, frontal alpha rhythms of moderate amplitude are common in healthy relaxed subjects with closed eyes, but very large frontal alpha is associated with disease or anesthesia. The physiological relationships between these disparate alpha phenomena are unknown, but they appear to share some underlying physiological mechanisms since their frequencies and widespread distributions are similar.

Coherence

Other dynamic measures involve a combination of location and time measures. For example, the (normalized) covariance of two signals is a correlation coefficient expressed as a function of time delay for characteristic waveforms recorded at the two locations. Covariance is used in ERP studies of cognition. A measure similar to covariance is the coherence of two signals, which is also a correlation coefficient (squared). It measures the phase consistency between pairs of signals in each frequency band. Scalp potential (with respect to a reference) recorded at many scalp locations over (say) a 1-min record may be represented by eqn [1]. Consider any two locations

with time-dependent voltages $V_i(t)$ and $V_j(t)$. The methods of Fourier analysis may be used to determine the phases ϕ_{ni}^p and ϕ_{nj}^p associated with (say) each 1-s period or *epoch* (indicated by superscript p) of the full 60-s record. The frequency component is indicated by subscript n and the two electrode locations are indicated by subscripts i and j . If the voltage phase difference $(\phi_{ni}^p - \phi_{nj}^p)$ is fixed over successive epochs p (*phase locked*), the estimated EEG coherence between scalp locations i and j is equal to 1 at frequency n . On the other hand, if the phase difference varies randomly over epochs, estimated coherence will be small at this frequency.

The low spatial resolution of conventional EEG limits the information available using coherence (or any correlation measure) between electrodes. High-resolution EEG methods improve the spatial resolution of EEG, minimizing the smearing of the potentials by volume conduction through the head. High-resolution EEG coherence between one electrode (labeled x) and a set of electrodes (1–8) at progressively larger distances from posterior to anterior locations of the left hemisphere is shown in Figure 4. (High-resolution EEG was estimated by using the entire 111 channel data set.) The subject was at rest with eyes closed to facilitate a robust alpha rhythm. Power spectra for two midline channels of this subject are shown in Figure 3, demonstrating two peaks in the alpha band (9.5 and 10.5 Hz). Even the closest neighbor pair ($x:1$) indicates very low coherence except at the coherence peaks at 9.5 and 10.5 Hz. At the next closest pair ($x:2$) a different pattern is seen with stronger coherence at 10.5 Hz. The electrode pairs involving prefrontal electrodes ($x:7$ and $x:8$) show higher coherence at 9.5 Hz than 10.5 Hz. For two pairs ($x:3$ and $x:6$) coherence is very low over the entire frequency range. The highest coherences at 9.5 and 10.5 Hz involve temporal electrodes ($x:4$ and $x:5$). For these pairs additional peaks can be seen at the harmonics (19 and 21 Hz). In summary, coherence estimates show significant spatial specificity and reveal much more detailed patterns of synchronization of neuronal activity across the brain.

Dynamic Behavior of Sources

EEG waveforms recorded on the scalp are due to a linear superposition of contributions from billions of microcurrent sources or, expressed another way, by thousands to millions of columnar sources $P(\mathbf{r}', t)$ located in the cerebral cortex, as indicated by eqn [2]. However, the underlying physiological bases for the dynamic behavior of the sources themselves are mostly unknown. The 10-Hz range oscillations of alpha rhythm, the 1-Hz range oscillations of deep sleep, and other waveforms in the EEG 'zoo' must be based on some sort of characteristic time delays produced at smaller scales. Such delays can evidently be developed in *cell assemblies* (*neural networks*) that cover a wide range of spatial scales. Locally generated activity in small networks and more globally generated activity involving spatially extensive networks up to the global scale of the entire cerebral cortex may be reasonably assumed. The local network category includes the so-called *thalamic pacemakers* that could possibly impose oscillations in specific frequency ranges on the cortex (*local resonances*). Other possible mechanisms occur at intermediate scales between the local and

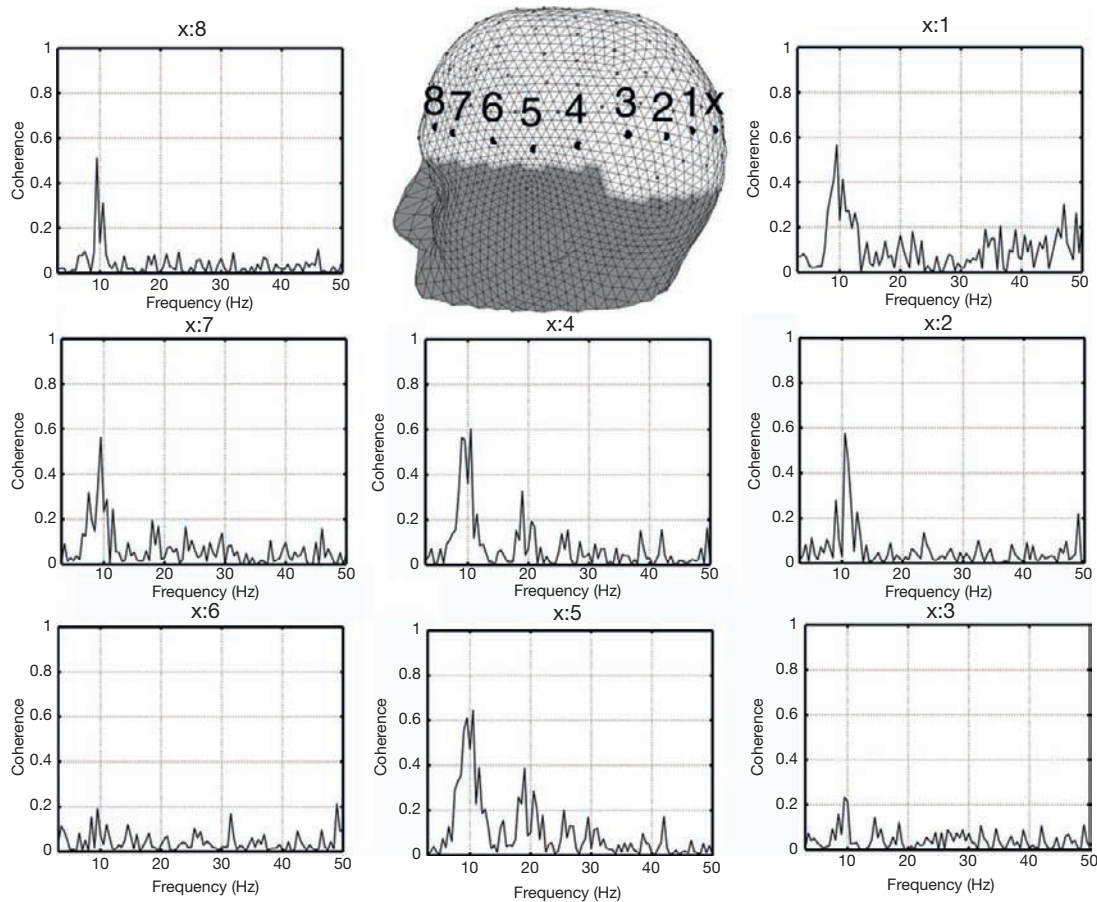


Figure 4 Coherence spectra from a 22-year-old female subject at rest with eyes closed (to maximize alpha coherence). Coherence was estimated with $T = 2$ s ($\Delta f = 0.5$ Hz) in a 60-s record. The head plot shows the location of 9 electrodes, labeled x and 1 through 8. Coherence spectra between electrode x and each of the other electrodes 1–8 are shown, with increasing separations along the scalp. High-resolution EEG methods were used to increase the spatial resolution of 128 EEG signals by removing the effect of smearing by the skull. This process can also remove genuine EEG signals that are broadly distributed. The coherence spectra show complex patterns of coherence according to frequency and scalp locations, changing even with small changes in frequency or location.

the global. These involve feedback between the cortex and the thalamus or between specific cortical locations. Preferred frequencies generated at intermediate scales may be termed *regional resonances*. At the global scale, the generation of resonant frequencies (*global resonances*) due to *standing waves* of synaptic action has been proposed.

Delays in local networks are believed to be mainly due to *rise and decay times of postsynaptic potentials*. By contrast, global delays occur as a result of *propagation of action potentials* along axons connecting distant cortical regions (*corticocortical fibers*). Delays in regional networks may involve both local and global mechanisms. A working conjecture is that local, regional, and global resonant phenomena all potentially contribute to source dynamics. However, the relative contributions of networks with different sizes may be quite different in different brain states. The transition from awake to anesthesia states is an example of a local to global change. The ECoG changes from rhythms depending strongly on location to rhythms that appear similar over widespread cortical locations. Another example is the desynchronization (amplitude reduction) of alpha rhythms that occurs with eye opening and certain mental tasks.

A number of mathematical theories have been developed since the early 1970s to explain the physiological bases for source dynamics, that is, the underlying reasons for specific time-dependent behaviors of the source function $P(\mathbf{r}', t)$. Distinct theories may compete with, or complement each other, or both. Some common EEG properties for which plausible quantitative explanations have emerged naturally from mathematical theories include the following observed relations: frequency ranges, amplitude versus frequency, spatial versus temporal frequency, maturation of alpha rhythm, alpha frequency–brain size correlation, frequency versus corticocortical propagation speed, frequency versus scalp propagation speed, frequency dependence on neurotransmitter action, and mechanisms for cross-scale interactions between hierarchical networks. Because the brain is so complex, such theories must involve many approximations to genuine physiology and anatomy. As a result, verification or falsification of specific theories for the physiological bases for EEG is difficult. However, such mathematical theories can profoundly influence our general conceptual framework of brain processes and suggest new studies to test these ideas. Furthermore, this

framework can strongly influence the design of cognitive studies, for example, when estimating various measures of functional connections between cortical regions such as EEG coherence or ERP covariance.

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Embarrassment and Blushing

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Glossary

Appeasement display A display by which individuals seek to placate or pacify others or as a 'remedial display' serving to mitigate others' negative reactions to behaviors that might otherwise result in public humiliation or loss of self-esteem.

Blushing Spontaneous reddening or darkening the face, ears, neck, and/or upper chest caused by blood vessels dilating and increasing blood volume in those areas in response to social evaluation or public scrutiny.

Embarrassment A state of emotional discomfort resulting from a projection of an undesired image to others present.

Face saving All coping actions, both verbal and nonverbal, taken by both the embarrassed person and observers to the event to overcome feelings of embarrassment in an attempt to regain social composure.

Self-consciousness The focusing of attention upon oneself either as a result of the situation (e.g., in the presence of an audience) or as a result of individual differences in the tendency to be self-attentive.

Self-presentation Attempts to control the image of ourselves that we present to others.

Social phobia A marked or persistent fear in social situations that the person concerned will behave in a manner which is perceived by others as being embarrassing or humiliating.

Introduction

Embarrassing blunders, faux pas, and improprieties are everyday social occurrences. However, because embarrassment is essentially a state in which a person has failed to maintain social poise or a desired image in the presence of others, it is an uncomfortable social state which people seek to avoid. Because of the aversive nature of embarrassing situations people try to avoid them when possible or, if embarrassment has occurred, make efforts to restore identity or self-view, as well as attempt to save face or preserve a desired identity in the eyes of others present. In addition to external cues, which can relate either to the nature of the social accident or to the reactions of others to our faux pas, a feeling of embarrassment can also be elicited by internal cues (notably blushing) in the absence of an intrinsically embarrassing situation. Indeed, Arnold Buss described blushing as the hallmark of embarrassment and numerous authors including Charles Darwin writing in 1872 have argued that the blush is the primary nonverbal signal of embarrassment. While there is not a one-to-one link between embarrassment and blushing, it is possible to be embarrassed without blushing and to blush without being embarrassed; nevertheless, for some people the fear of blushing can be a socially debilitating experience. Many people who suffer from social phobia are particularly concerned that they will blush and that others will then interpret this as a sign of social ineptitude.

Theoretical Explanations for Embarrassment and Blushing

Although embarrassment is a common and dramatic experience with which nearly everyone is familiar, there is a lack of agreement about both the precise psychological circumstances underlying embarrassment and the function of blushing. Indeed, proposals about the factors underlying embarrassment

do not link precisely to those delineating the function of blushing. Three broad theoretical explanations for embarrassment have been advanced; the first focuses upon self-presentational concerns and fear of negative evaluation; in this context, blushing is also explained as being evoked following undesired attention; the second emphasizes the individual's flustered uncertainty about how to proceed following a social accident and the third focuses upon anxiety and worry about the need to create a desired impression. Additional explanations for blushing are that it serves as an appeasement display by which individuals seek to placate or pacify others or as a 'remedial display' serving to mitigate others' negative reactions to behaviors that might otherwise result in public humiliation or loss of self-esteem. These latter accounts are discussed in more detail in section 'Blushing and the Expression of Embarrassment'.

Theories focusing upon self-presentation concerns suggest that embarrassment has to do with a failure to present a desired image to others whom we regard as evaluating our performance. This assumes that the individual concerned is motivated to make a particular impression on others. Falling over in front of friends is likely to cause us less concern about the impression we create than falling over just as we are about to introduce a guest of honor to a large audience at an important function. Factors that increase the negative consequences of failure, such as larger, more competent audiences, novel or ambiguous contexts, or facets of one's own personality, are likely to increase our desire to protect our image before others.

A further assumption, however, is that the prevailing circumstances during an interaction do not allow us to present a desired image to others present. The latter circumstances involve the violation, witnessed by others, of some taken-for-granted social rule. This, in turn, assumes that the person concerned has violated the rule unintentionally while at the same time being aware that a violation has occurred. Someone unaware of the rules of conduct will remain unembarrassed by their 'inappropriate' behavior no matter how concerned

they are with the evaluative reactions of others, unless others present make it clear that their behavior is inappropriate. If we are unaware of the rules of etiquette at a social function, transgressing such rules will not cause us concern unless others draw our attention to our failings. Similarly, someone aware of the rules but unconcerned with the evaluative reaction is likely to remain unembarrassed by social mishaps. Conversely, someone acutely concerned with negative audience evaluations is likely to be embarrassed by seemingly trivial events. It is only when our knowledge of, and motivation to concur with, these rules exists that embarrassment is a consequence of social failure.

Others have argued that it is not self-presentational concerns per se that cause embarrassment but flustered uncertainty about how to proceed once an unexpected or disruptive social event has occurred. Thus, forgetting someone's name or falling over in public disrupt the working consensus of identities that exist in social interaction, leaving a new consensus to be created. Until such a new consensus exists, awkwardness or flustered uncertainty predominates. Although such a reaction may well be important, flustered uncertainty is itself likely to be directly related to a concern with the evaluation of others. Appearing to be flustered or uncertain is not an image we would wish to present to others and hence may be embarrassing in its own right.

Finally, some have pointed out that anxiety and worry about whether one has actually created, or indeed will create, an undesirable impression is a central feature of self-presentational concerns. Indeed, some people seem to be so concerned about the impression they will create that they suffer extreme embarrassment in the absence of any clearly defined evoking event. Indeed, they may be so concerned that they might behave in a way which is humiliating or embarrassing that they actively seek to avoid social situations. Indeed, one of the defining features of social phobia as detailed in the Diagnostic and Statistical Manual of the American Psychiatric Association is a marked and persistent fear of social or performance situations in which embarrassment may occur.

Clearly, there are common features to the three theories described. Although flustered uncertainty and anxiety about one's social performance seem to be important aspects of embarrassment, self-presentational concerns are central. Thus, the emphasis in each theory is that embarrassment has to do with the actual, or anticipated, occurrence of an unwanted event that communicates undesired information about oneself to real, or imagined, others, whom we regard as evaluating our performance.

Causes of Embarrassment and Blushing

There have been a number of attempts to collect descriptions of, and categorize, embarrassing events on the basis of the situations involved; fewer studies have sought to classify blush-inducing rather than embarrassing circumstances. One factor illustrated by the former studies is the sheer variety of embarrassing circumstances people document. It is perhaps not surprising therefore that the various attempts to systematically categorize embarrassing acts produces a variety of different solutions. The broad categories do though correspond with

categories of situations which elicit blushing. The first two categories describe inappropriate identity (e.g., uncontrollable laughter or tears) and loss of poise. The latter includes loss of physical poise (e.g., tripping over furniture), impropriety (e.g., failure to control bodily behaviors, for example, when fainting), forgetting someone's name or introducing them by the wrong name, and awkward interactions (e.g., asking inappropriate or unfortunate questions or simply not knowing how to proceed). The third category concerns false identity (i.e., telling someone untruths about oneself and being found out), the fourth consists of breaches of privacy (e.g., unintentional exposure of bodily parts, touching or coming too close to someone, or revealing feelings that the person wished to hide), while the fifth involves being made to feel conspicuous as when over-praised (e.g., discomfort occasioned by excessive compliments). Still others have included a category of empathic or vicarious embarrassment to describe instances when we feel embarrassed for another person who is in a seemingly embarrassing situation (e.g., when an actor forgets their lines). Although there are clearly a number of ways of classifying embarrassing events, these tend to reflect the methodology used; there do not tend to be radical differences in the general descriptions of embarrassing events obtained. Thus, some categorization schemes refer to specific actions (e.g., tripping and falling) while others pinpoint dimensions (e.g., who is embarrassed, as in empathic embarrassment).

Therefore, rather than considering categories of acts, a more useful strategy for classifying embarrassing episodes is to consider psychologically meaningful dimensions. Two such dimensions appear to be of particular importance: who is embarrassed by the events and who is responsible for causing the embarrassment. The first dimension, who is embarrassed, considers whether it is an individual and/or social group, both (or all) the interactants, or the bystander/viewer. The second dimension, who is responsible for causing the embarrassment, considers whether it is the embarrassed person themselves (i.e., the actor), someone present and involved when the embarrassment occurs (i.e., the observer) and someone present but not directly interacting (i.e., person viewed). By combining these two dimensions, four broad categories of situation can be recognized: (i) those in which the individual and/or social group is responsible for their own embarrassment (individual/group behavior, actor responsible); (ii) those in which the interaction itself is embarrassing (interactive behaviors, shared responsibility); (iii) situations in which embarrassment is caused by an observer (individual/group behavior, observer responsible); and (iv) an empathic reaction of embarrassment to someone else's behavior (bystander/viewer, person viewed responsible).

The actual types of embarrassing and blush-inducing episodes described by earlier classification schemas can readily be incorporated by the dimensional categorization approach. Examples from the first category (individual/group behavior, actor responsible) include loss of poise (e.g., forgetting someone's name), impropriety (e.g., wearing the wrong clothes to a social function), and false identity (i.e., telling someone untruths about oneself and being found out). Examples from the second category (interactive behavior, shared responsibility) include any awkward interaction where neither person is sure what to say, when there are long uncomfortable silences, unsuccessful

attempts by both parties to end the conversation, and so on. Examples from the third category (individual/group behavior, observer responsible) include conspicuousness (e.g., being the 'victim' of people singing "happy birthday to you" or when being complimented or congratulated), being the victim of teasing, or when people make public our past embarrassing predicaments. Examples of the final category (bystander/viewer, person viewed responsible) include any occasion of empathic embarrassment when we feel embarrassed because of someone's or something's behavior (e.g., going to the zoo and seeing animals engage in sexual behavior).

Central to each is a desire to present oneself in a way that meets one's own standard for self-presentation and/or a desire to avoid focusing attention toward the public aspect of oneself. Thus, any event that involves the transgression of an unwritten social rule (e.g., falling over in public, dressing inappropriately for social occasions, awkward interactions), results in both the presentation of an undesired image and self-attention. Being made the centre of attention (e.g., through teasing) inevitably draws attention to the public aspect of ourselves and a concern with the image we are likely to present.

Interestingly, blushing, which is often regarded as the hallmark of embarrassment, may actually make us more self-aware and lead us to assume we are presenting an image (i.e., embarrassment) that is discrepant from the image we wish to present. We tend to assume that people feel embarrassed when they blush, although visible facial reddening also occurs with other emotional states such as anger. Thus, it is possible to make someone embarrassed simply by telling them they are blushing, even in nonembarrassing situations. Blushing may then be sufficient to generate embarrassment in the absence of specific situations that are defined as embarrassing. People who are over-attentive to internal and expressive cues may be particularly prone to generate a feeling of embarrassment from a perception of their own blushing. Because of the negative experience of embarrassment with which blushing is associated, this may, in some cases, lead to a chronic fear of blushing. This issue is developed further in the following section.

Blushing and the Expression of Embarrassment

Embarrassment is marked by a well-defined set of behaviors. Eye contact is reduced, body movements, speech dysfluencies, and smiling all increase, and blushing is likely to occur. This reaction seems nearly universal, although the intensity and relative importance of different components of the reaction seem to differ across cultures. Indeed, the display of embarrassment is readily recognizable by others. But why should an emotion we wish to hide be so evident to others? There are a number of suggestions for the functions of behaviors associated with embarrassment.

The desire to look away or hide behind one's hands when embarrassed has been studied in laboratory experiments as well as being widely referred to in people's reports of their embarrassment. A common feeling when embarrassed is a wish to disappear or escape from the situation. Unfortunately, departing the scene of an embarrassing mishap is rarely possible to achieve without attracting even more attention to oneself. Hence, as we are unable to increase our physical distance

from others, we may use avoidance of eye contact, turning away, or covering our eyes as a way of increasing our psychological distance from them. A further possible explanation is that people look away when embarrassed to avoid seeing the signs of rejection on the faces of other people. Alternatively, reduced eye contact may be a reflection of tension or anxiety associated with embarrassment. Such nervous responses may also include manipulative gestures (such as fingering one's clothes, hair, or surrounding objects), turning one's body away and stammering.

There are a number of ways in which anxiety associated with embarrassment might interfere with speaking. First, preoccupation with the reason for our embarrassment may make it difficult to pay attention to what we wish to say. Alternatively, increased anxiety may make us pay too much attention to our speech with the result that we stumble over our words. Finally, anxiety may interfere with normal breathing, with shorter, faster respiration interfering with speech output.

A 'silly' self-conscious grin and a 'strangled' laugh are also common reactions to embarrassment. The fact that, during embarrassment, smiling usually occurs while the person looks away (aversion of gaze occurs when the smile reaches its peak intensity), distinguishes it from a smile of pleasure (when looking away is more likely to occur when the smile intensity is diminishing). In addition muscular actions associated with smiling such as pressing the lips together, stretching, biting or sucking them, puffing the cheeks or bulging the tongue occur more frequently, for longer and in greater number in relation to smiling when embarrassed than when such actions occur in association with amusement. There are four possible explanations for such a reaction. First, people may use smiling in an attempt to hide or conceal their embarrassment; such attempts may occasionally succeed, as embarrassment can be mistaken for amusement. Second, smiling and laughter when embarrassed may serve as an admission of the person's inappropriate behavior, while at the same time attempting to reduce the importance of the event giving rise to the embarrassment. Third, laughter may serve to reduce the tension or anxiety engendered by the embarrassing event. Fourth, it may be a purposeful nonverbal strategy used by the embarrassed person to change the meaning and focus of the situation in an attempt to save face. By diminishing the importance of the event, the identity 'victim' can be transformed to 'co-actor' and the label 'embarrassing' transformed to 'humorous.' Finally, the 'silly grin' of embarrassment may be related to the submissive, appeasement grin which occurs in other primates when threatened. Embarrassment presents a threat to the person's sense of self and, in such circumstances, smiling may serve to conciliate a potential 'aggressor.'

Although it is possible to feel embarrassed without visibly blushing and to visibly blush without experiencing embarrassment, blushing and embarrassment have been inextricably linked by a number of authors. Although the faces of nonhuman primates redden or 'flush' with rage, blushing is a peculiarly human expression that is restricted to certain specific regions of the body. The 'blush region' is located in the face, ears, neck, and upper chest. The redness itself is caused by the bed of capillaries close to the skin filling with blood in order to allow the body to lose heat. It seems that the blood vessels in the face and upper body differ structurally from blood vessels

in other parts of the body. In addition, people seem to differ with regard to their degree of response, hence, individual differences in actual intensity of blushing. But, how might blushing and embarrassment be interlinked?

One possibility is that people use their own expressive behavior to interpret their inner feelings. Thus, skin blood-flow changes associated with blushing may play a significant part in influencing the intensity of reported embarrassment. Our attention shifts between ourselves and the environment on a continual nonrandom basis. If a social accident has occurred, attention may initially be directed toward an evaluation of the event itself. This may be followed quickly by an inward focus of attention directed specifically toward those aspects of the self that are presumed to be associated with embarrassment, most notably blushing. The subsequent environmental focus of attention may be directed toward a search for the evaluation of others, again followed by an inward focus toward our blushing. The fact that the process is rapidly repeated serves to explain why blushing and embarrassment escalate. Further, for those who are particularly sensitive to, or predisposed to attend to their bodily reactions, the sequence of reactions might be initiated internally, perhaps by a mere suspicion that one is blushing, rather than by a specific external event. Reactions to the suspicion that one might be blushing could explain why people can be made to blush by telling them that they appear to be blushing even when they are not. Such information leads them to infer that others might infer they are embarrassed, thereby leading them to blush.

Blushing is additionally curious in that it is a clearly visible sign of an emotion that, in most cases, we would prefer to conceal. Its very visibility has led some to argue that blushing is indeed communicative and acts as a 'nonverbal apology.' It is a visible statement to others that we are aware that our behavior was untoward, inappropriate, or inadequate and, because we care about other people's evaluations, our blushing is a way of seeking forgiveness from other group members. Indeed, studies indicate that those who blush after a social accident are evaluated more positively than those who do not do so.

It is also possible that blushing, like the silly grin, serves a function similar to nonhuman appeasement gestures. For non-human primates, appeasement frequently results in loss of interest in the victim by the threatening animal. One purpose of blushing may, paradoxically, be to reduce attention from observers. Although some people may deliberately embarrass or humiliate others, or deliberately draw attention to another's blushes, in general we tend to avoid focusing on people when they are blushing.

Individual Differences in Embarrassment

People differ markedly both in their tendency to blush and in their reported frequency of embarrassment experienced. Four factors related to such differences are examined here: age, gender, personality, and culture.

Age

Embarrassment is systematically built into our social system. Societies everywhere have unwritten social rules which regulate

our everyday behavior. It seems that the aversive consequences of embarrassment are such that one reason for our tendency to follow the rules, conventions, and behavior expected by others is our fear of the possibly embarrassing consequences of not doing so. Indeed, laughing at, ridiculing, or in short, embarrassing another person for rule-breaking is likely to result in attempts to avoid such rule-breaking in future. Some have argued that, via such mechanisms, embarrassment exerts a powerful influence on the acquisition of social rules in children and adolescents. Thus, children are introduced to modesty, self-control, and manners by means of teasing, laughter, and ridicule for mistakes. During adolescence there is an increasing desire to manage the impressions we create for others and hence we are increasingly motivated to avoid being singled out for laughter and ridicule. Embarrassment thus becomes a particularly powerful method by which social rules can be acquired.

Although there is limited research pertaining to developmental aspects of embarrassment, there seem to be discernible age related changes. Embarrassment seems to occur infrequently in very young children, research suggesting that the first signs seem to be around the age of 2 years. Over the next few years the tendency to experience embarrassment increases, until by the ages of 5–7 embarrassment is experienced as frequently as in adulthood. A peak period of embarrassment is during adolescence. There is then a decline in reported embarrassment in later adult life.

The experience of embarrassment is related to the emergence of the social self and associated self-consciousness. Some have argued that this occurs at about 7 years of age, an increase in self-conscious awareness then occurring during early adolescence with a peak at around 13 or 14 years of age, followed by a gradual decline. Thus, while children as young as two may show embarrassed behaviors as judged by others whether they personally experience the emotion of embarrassment is a different matter.

Central to age-related changes in felt embarrassment is the extent to which children are aware of how the impression they create is viewed by others. At a young age a child's ability to view things from someone else's perspective is limited. Their behavior is more likely to be directed by what appears to be right to him or her than by what appears to be right to others. Although they may well be aware that certain behaviors provoke ridicule or laughter they may not be aware of why such reactions occur. At this age they are thus likely to experience a fairly 'primitive' form of embarrassment. By the age of 5–7 children are more aware of the way in which the impression they create is viewed by others. They become more concerned with creating an impression appropriate to the circumstances and which will be viewed positively. Thus, for an older child, a social transgression or social accident is likely to result in 'mature' embarrassment, similar to that experienced by adults.

The peak period of embarrassment is during adolescence which parallels the peak of self-presentational concerns and self-consciousness which occurs at this time. Conformity to peer expectations, marked by a need to wear the 'right' clothes and listen to the 'right' music is especially important during adolescence. The desire to win approval from others is an important goal. In addition, adolescence is associated with marked changes in physical and psychological makeup.

No longer being a child, but not yet being an adult, the adolescent has yet to acquire the necessary repertoire of behaviors to play out an adult role. Lack of knowledge can lead to indecisiveness and lack of confidence and hence more likelihood that behaviors will be viewed negatively or have embarrassing consequences.

There is then a gradual decline in self-consciousness after adolescence which is paralleled by both a decrease in experienced embarrassment and a decrease in the tendency to blush. With increased age, novel experiences and hence the potential for embarrassment are likely to decline; this is paralleled by an apparent decrease with age in the propensity for blood vessels in the face to dilate.

Gender

The lay view is that women are more likely to blush and are more readily embarrassed than men. Certainly, within a historical context, coy, shy reactions such as exhibited by the 'blushing bride' were considered appropriate signs of modesty in women. In general, however, such stereotypical differences are not supported by research findings. Although there are some gender differences in relation to circumstances associated with embarrassment and while women in comparison with men do report experiencing more intense embarrassment and a greater propensity to blush there are few differences with regard to actual skin temperature changes in potentially blush-inducing situations. Situational differences in reported embarrassment and blushing no doubt reflect differing socialization experiences while differences in reported embarrassment and propensity to blush may merely reflect the greater propensity for women to express their feelings.

Personality

A number of research studies indicate that some individuals are more prone to experience embarrassment and more likely to report a propensity to blush than others. A central factor is the degree of concern the person has for others' impressions of them. Those concerned with projecting an image which engenders social approval, or at least avoids engendering social disapproval, are more likely to be more readily embarrassed. Furthermore, those who are more readily embarrassed tend to be intensely affected by the slightest social transgression, more likely to report enduring embarrassment even years later at the recall of the event, are more likely to feel empathic embarrassment and are more likely to report a high propensity to blush. Indeed, a proneness to embarrassment is associated with feelings of being observed and a high regard for how one is viewed by others. Indeed, this is a pattern similar to those who experience social anxiety and social phobia. It is thus perhaps not surprising that the degree to which people fear social situations in general is also related to the degree of reported blushing and embarrassment. At the extreme, people troubled by chronic fear of blushing obtain scores on measures of social anxiety similar to those clinically diagnosed as socially phobic; indeed, it is now widely recognized that for a subgroup of social phobics at least fear of blushing is their central concern.

Cultural differences

There seems to be clear evidence that blushing is universal and that embarrassment is expressed in a similar way across cultures. Blacks and other dark-skinned people experience vasodilation in the kinds of social situations that provoke blushing in whites. However, blushing in the former appears to be marked by a further darkening of the skin rather than the reddening which occurs in lighter skinned people. The occurrence of blushing is reported with greater frequency in some cultures (e.g., the United Kingdom) than in others, while averting eye contact and laughter which is reported as frequently occurring in some cultures is reported as occurring less frequently in others (e.g., Italy). These apparent differences tend to be derived from self-reports, rather than from actual observations or direct measures in the cultures concerned, and hence any variations may simply reflect reporting differences. However, if the differences are real, they may involve variations across cultures in the meaning attributed to embarrassing events. Thus, embarrassment might be a more serious matter in certain cultures and hence laughter or smiling would be less likely to occur. There may also be variations in skin thickness across cultures and hence variability in the visibility of blushing. It is also important to bear in mind that different situations are likely to elicit embarrassment and blushing across cultures.

Face Saving and Embarrassment

Because of its aversive and disruptive nature, people generally attempt to avoid embarrassing situations when possible. However, as complete avoidance is rarely possible, we often make attempts to redress the situation in order to maintain face, regain social approval, and restore the interaction following an embarrassing event. In dealing with embarrassing events four main face-saving strategies are recognized: apologies, accounts, avoidance/escape (evasive facework), and the use of humor. Two additional strategies, referred to as remediation and hostility, have also been discussed. Remediation involves offers or requests of help or comfort, expressions of concern, or offers to correct the problem, for example, clearing up after an accident. In contrast to situations inviting remediation, there are some circumstances in which anger or hostility is used as a method of coping with embarrassment. In general, however, the latter reaction is restricted to circumstances in which the person has been criticized or teased by others with the deliberate intent of causing embarrassment. In this context, the goal of intentional embarrassment is to negatively sanction the other's behavior, to establish power, or simply self-satisfaction. The embarrassed person may respond with hostility in an effort to keep the same behavior from occurring again.

The simplest way of dealing with embarrassment is to offer an apology, such as 'I'm sorry' or 'pardon me.' This serves to acknowledge blameworthiness for the undesired behavior in the hope that a minor discretion can be passed over quickly and forgotten by those concerned. Indeed, the very act of being embarrassed can itself serve as an apology, the visual sign of blushing indicating that the person accepts responsibility for the untoward act. Several theorists have stressed the functional properties of expressing embarrassment and have argued that

these expressions may help restore the person's public image after a mishap or transgression. That is, blushing or publicly conveying other signs of embarrassment can show that the person recognizes that they have committed a social or moral transgression, and that they regret having done so. Accordingly, it has been argued that blushing has appeasement-related properties which can actually positively influence observers' judgments. An interpretation of a sign of embarrassment as an apology is most likely in a situation in which the person's undesired behavior may have caused discomfort to someone else who was present. Brazening out the situation may serve to increase both parties' embarrassment, while a display of embarrassment accompanied by laughter may diffuse the situation.

While an apology offers an admission of responsibility, an account is an attempt to explain the undesired behavior. Accounts can take two forms: excuses and justifications. The former consists of attempts to play down one's own contribution to the event while at the same time admitting that the behavior was wrong. A justification similarly admits some responsibility for the event while at the same time containing an element of denial that there are any negative consequences of the behavior. Categories of accounts involve appeals to environmental circumstances, lack of intent, highlighting personal characteristics, or scapegoating. Thus, if we embarrass ourselves by tripping in front of others, we might comment 'that's the trouble with slippery floors' (environmental circumstances), 'I didn't mean to do that' (lack of intent), 'that's typical, I seem to have two left feet' (personal characteristics), 'the cleaners have polished the floor again' (scapegoating).

Categories of justification include 'self-fulfilment,' which justifies the action on the grounds that it leads to some form of enlightenment, and 'effect misrepresented,' which justifies the action because the consequences were trivial or because no harm was done. Because they add to excuses and attempt to minimize or deny the undesirability of the event, justifications may be too strong for dealing with minor transgression associated with embarrassment. An attempt to justify one's actions may serve to prolong, heighten, and add to the implications of the embarrassing event.

Although a verbal apology or account may be used frequently to deal with embarrassing events, there are occasions when they may be inappropriate or may fail to deal adequately with the situation. In addition, the person concerned may feel unable to offer a verbal apology or account for their action. In such circumstances, avoidance may be a common reaction. This may take the form of either withdrawal subsequent to the embarrassing event (escape) or attempts to avoid encounters in which embarrassment might occur (avoidance). However, physically retreating from the situation, rather than achieving the goal of averting attention, is likely to draw further attention to the embarrassed person. There are occasions, however, when averting an awkward event can be achieved by changing the topic or remaining silent rather than by escape per se. It is also clear that some people will go to extreme lengths to avoid social situation due to a fear that they will behave in a way which is embarrassing. This is particularly true for people with a chronic fear of blushing. Avoidance in this case is more an attempt to avoid *losing face* through blushing inappropriately rather than an attempt to *save face*.

A further strategy involved in coping with embarrassment involves the use of humor or laughter. Laughter serves to reduce the tension, while joking can turn a potential loss of social approval into a gain in social approval.

In order for a face-saving strategy to be successful, it must be acceptable, reasonable, and adequate. In the case of minor, nonserious events, humor and laughter may be appropriate. As events increase in their significance, the likelihood that apologies and excuses will be used with greater frequency also increases. In general, however, apologizing is the most appropriate response regardless of the type of embarrassing situation. Excuses and justifications tend to be used infrequently, except in social situations involving forgetfulness or awkwardness. In addition, research findings tend to indicate that the face-saving strategy used will depend not only on the type of embarrassing event, but also the gender and status of those involved. In terms of gender differences, women are more likely than men to offer an apology or excuses outlining mitigating circumstances. In addition, women are more likely to offer help and more likely to act on such offers, if their embarrassing actions have caused potential distress to others. When the embarrassing event is not serious, people of higher status, in comparison to those of lower status, are less likely to acknowledge responsibility for the event or to attempt to account for their actions.

Interestingly, there seems to be little variation across cultures in the type of face-saving strategy used. Both avoidance and a simple expression of embarrassment are common reactions to all types of embarrassing events across cultures. The main variation seems to be in the use of humor, which may be almost absent in those cultures which have stronger sanctions for social rule-breaking.

Observer Reactions

When someone is embarrassed, others present are likely to react to and become involved in that person's embarrassment. Each may affect the other so that embarrassment can either spiral or be mutually controlled. In seeking to offer assistance, observers may excuse or explain the embarrassed person's behavior, 'playing along' with them, for example, by the use of humor or an offer of support or empathy. Such reactions may be used alone or in combination, and seem to be relatively constant across cultures.

The most frequently reported reactions from observers are support and empathy. Indeed, these may often be used in combination, most usually with a supportive comment followed by a sign of empathy. Support includes any comment or nonverbal expression intended to reassure the person that they are still viewed positively despite the embarrassing event. A typical comment might be 'don't worry, it's not important,' while typical gestures include a warm smile or friendly touch. Empathic reactions involve comments intended to assure the embarrassed person that the event that occurred could have happened to anyone. A typical comment might be 'I know how you feel, I'm always doing the same thing.' Such a reaction can also be a useful way for the observer to show that they accept an apology offered by the embarrassed person.

Humor is also used by observers with moderate frequency. However, humor and laughter will clearly have different meaning dependent upon whether the observer laughs alone or whether both the observer and embarrassment person laugh together. There is a fine dividing line between 'laughing with,' and 'laughing at' someone. If the embarrassed person fails to join in with the observer in their attempt to help, they may well end up being the butt of the joke rather than helping to make light of the event. In such circumstances embarrassment is likely to be intensified.

A similar intensification of embarrassment is likely to occur if the observer fails to respond or responds in a manner which is interpreted negatively by the embarrassed person. As with humor, a lack of response can be interpreted as a sign of lack of support. The difference between a positive or negative reaction is often signaled by subtle behaviors such as a fleeting smile or facial expression acknowledging the event, or even an appearance of embarrassment from the observer. Assuming that the observer wishes to provide assistance in remedying the situation, their attempts can fail either because they do not know how to respond or because their attempts backfire.

There are also occasions when an observer may seek to intentionally increase another's embarrassment. For example, if they feel that the embarrassed person has not shown sufficient 'remorse,' if the embarrassing behavior has disturbed others present, or if the embarrassed person was apparently responsible for the event. Such deliberate intensification of another's embarrassment may be achieved either by drawing attention to the event or by expressing reproach. The latter may involve criticism or correction. Clearly, such reactions may well serve to further disrupt social interaction.

As well as instances when an observer may seek to intensify another's embarrassment, there are occasions when an observer may seek to intentionally initiate embarrassment in others. Intentional embarrassment is frequently used as a sanction to teach children correct or tactful behavior. Men, in comparison to women, are more likely to intentionally embarrass children and subordinates. This may reflect the fact that males are stereotypically more competitive and more likely to engage in controlling behaviors. Intentional embarrassment also occurs frequently among same sex friends, often as part of a 'game' to test each other's social poise.

Coping with Blushing

While embarrassment is a common but uncomfortable state which can disrupt social interaction, chronic blushing or fear of blushing can severely disrupt the lives of those concerned.

Blushing seems to cause most distress when it occurs in the absence of a clearly defined embarrassing event, for example, when someone fears that their red face will be taken as a sign of shyness or social anxiety. Chronic blushers are characterized by two facets of self-consciousness, they are over-concerned with both their internal sensations and thoughts, as well as observers' subsequent reactions to their blushing. Blushing causes a particular problem in social situations because we imagine others can see the blush which we assume we are displaying but which we are unable to see for ourselves. In some instances, the fear of blushing can be psychologically debilitating. For many

people such fear of blushing can have devastating effects leading to social withdrawal, friendship, and work related difficulties and a state of panic when faced with what are to other people quite ordinary social encounters. Many chronic blushers are unable to cope with their difficulty, resorting to medication or surgery. A number of authors have noted that fear of blushing is one of the core concerns for at least a subgroup of those who are socially phobic.

One of the key findings from a number of different research studies is that there does not seem to be a perfect relationship between the extent to which people report blushing or fear of blushing with actual measured changes in skin temperature or facial blood flow. In other words, fear of blushing is not necessarily to do with external signs that are visible to others but seems rather more related to our thoughts and evaluations. Thus, a fear of the prospect of blushing provokes anticipatory anxiety thereby increasing the possibility that other signs of anxiety (trembling, shaking, stammering, sweating) will be displayed during the ensuing social encounter. This further increases feelings of discomfort and anxiety which in turn is further fuelled by the assumption that others present can see the signs of our anxiety and in particular our red face. Such fears can lead to increasing avoidance of social situations.

Such findings have clear implications for treatment. If fear of blushing, or a feeling that you are blushing intensely or frequently is not necessarily related to actual blushing, then the focus of treatment should not be actual blushing but the underlying psychological parameter, that is, fear or anxiety about blushing. Appropriate cognitive behavior therapy aimed at helping the person cope more effectively with their anxiety is thus the key and has been shown to be effective. Because the negative pattern of thinking associated with blushing is sufficient to cause embarrassment in the absence of a clearly defined embarrassing event, the most effective strategy for dealing with blushing is for the person to modify their thinking pattern. This can be achieved by reevaluating and redirecting attention away from oneself and blushing.

Thus, while everyday social embarrassment may be a common but uncomfortable psychological state which can disrupt social interaction, a chronic fear of blushing can severely disrupt the lives of those concerned. While a number of strategies can be used to cope with social embarrassment, the more significant the situation and the more concern we have about our reaction the more difficult the embarrassment is to deal with. At the extreme end of the continuum are those who live in a constant fear of blushing and/or being seen as behaving in an embarrassing manner. For such people seeking appropriate therapeutic help may be the most appropriate course of action.

See also: Bullying; Facial Expression of Emotion; Self-Esteem; Social Anxiety Disorder.

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Empathy

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Glossary

Affective empathy A class of feeling states evoked by the real, implied, or imagined experiences of another person.

Altruism A motivational state with the ultimate goal of protecting or promoting the welfare of another individual.

Attitude An individual's relatively stable positive or negative evaluation of an object (e.g., person, place, or worldview).

Cognitive empathy A class of cognitive-perceptual processes oriented toward understanding the perspectives, feelings, or situations of others.

Egoism A motivational state with the ultimate goal of increasing one's own welfare.

Empathy burnout Distress and psychological distancing that result from prolonged exposure to the suffering of others.

External attribution An inference that a behavior was caused by situational factors rather than personality factors.

Internal attribution An inference that a behavior was caused by personality factors rather than situational factors.

The term empathy has been used as a label for a number of distinct psychological processes and related consequences over the past century. Most psychologists agree that understanding empathy (however it may be defined) is crucial to understanding human social behavior, yet there is much disagreement and, consequently, much confusion about what it is. Adding to the confusion is the related concept of sympathy. Although some psychologists use the terms empathy and sympathy interchangeably, others use each to refer to a distinct phenomenon. Even when each term is used to refer to a distinct phenomenon, there is little consistency among researchers in their application. At the most basic level, empathy (or sympathy) may be said to encompass processes that are responsible for, or that result from, (1) understanding what another person is thinking and feeling; (2) a broad range of perceptual, cognitive, and affective responses to negative and positive events in the lives of others; or (3) both. The term empathy may also be used to describe individual differences or a stable personality characteristic. To make sense of the many uses of the term empathy and, more importantly, to understand the role that it plays in human behavior, it is useful to differentiate the various cognitive and affective processes involved and to differentiate these processes from their effects.

Empathy as Knowing or Understanding Another's Internal States

The term empathy was coined by Titchener in the early 1900s as a translation of Lipps' concept, *emföhlung*. Both terms referred to the process by which an individual actively projects or intuitively his or her way into another person or object, thereby experiencing a situation from the other's point of view. This early conceptualization of empathy emphasized the process whereby a person deliberately steps outside of himself or herself to acquire an accurate understanding of another's psychological world.

In this respect, empathy is quite similar to the process that is sometimes labeled role taking or perspective taking.

However, there are a number of variations on this view of empathy. For example, one may actively imagine what another is thinking and feeling as a consequence of his or her situation, based solely on the perception of that person's current values, goals, resources, and the like. Alternatively, one may instead imagine how one would feel in the other's situation, given one's own current values, goals, resources, and the like. The former cognitive activity has been labeled an imagine-other perspective, and the latter, an imagine-self perspective. Although these two approaches to understanding another's internal states appear to be quite similar at first blush, research suggests that these two perspective-taking strategies have different emotional, motivational, and behavioral consequences and, as such, should remain conceptually distinct.

Further complicating the distinction between imagine-self and imagine-other perspectives are distinctions in the different aspects of another's perspective that one may seek to understand. Specifically, when attempting to understand another's perspective one may seek to understand his or her visual perspective, cognitive perspective, or affective perspective.

Visual Perspective Taking

Visual perspective taking has been defined as the ability to understand what another can visually perceive. A prototypical investigation of this form of perspective taking was provided by Piaget's Three Mountains Task. In this task, the child is seated at one of four chairs situated around a table containing three mountain-shaped objects. The child is asked to verbally describe or to select a pictorial representation of what another person, seated at a different chair, would see of these mountains.

Piaget assumed that correctly indicating what the other person could and could not see suggests an appreciation of different points of view of a visual stimulus and, by extension, a rudimentary form of decentering, an awareness that others may have access to different information about, or interpretations of, stimuli. Flavell and his colleagues extended this research by examining the active suppression of one's own

visual or conceptual perspective as a means of facilitating communication with others. Visual perspective taking is likely the initial developmental manifestation of the capacity to empathize with another person, but at least two other manifestations of this skill emerge within the first few years of life.

Cognitive Perspective Taking

Cognitive perspective taking has been defined as the ability to identify or understand what another is thinking in a specific situation. There is clearly some degree of conceptual overlap between the visual and cognitive manifestations of perspective taking in the sense that both involve the recognition of differing points of view. However, researchers tend to separate these in terms of both the focus of each skill (*viz.*, visual vs. conceptual content of the other's psychological experience of a situation) and, as noted below, the nature of the research protocols used to study them.

Building on Piaget's work, Flavell and colleagues' apple-dog story is the prototype for much of the early research on cognitive perspective taking. In this task, children are presented with a cartoon depicting a boy climbing an apple tree after being chased by a dog. The section of the story in which the dog chases the boy is removed and the child is asked to indicate what a naïve participant would think is happening in the story (*i.e.*, what caused the boy to climb the apple tree). The child's ability to suppress the privileged knowledge of the dog chase scene and to construct a story based only on the information that is physically or psychologically available to the other is taken as evidence of cognitive perspective taking.

Researchers working in the Piagetian tradition have also investigated more complex instances of cognitive perspective taking. For example, in Flavell and colleagues' nickel-dime task, one child is asked to trick a second child into choosing one of the two cups that contains the lesser amount of money (nickel) so that the first child can keep the cup that contains the greater amount of money (dime). It is assumed that successful completion of the task requires the child to engage in recursive cognitive perspective taking, whereby the child makes an inference about the other's cognitions and then adjusts his or her own in order to manipulate the other's cognitions (*e.g.*, she will believe B if I do C, so I should do Y in order to trick her into believing Z). This research has demonstrated that cognitive perspective taking is a skill that emerges relatively early in life, but one that develops and becomes more complex and flexible with age and experience.

Affective Perspective Taking

Affective perspective taking has been defined as the ability to identify and understand what another feels in a particular situation. Borke's Interpersonal Perception Test is prototypical of research on one aspect of affective perspective taking. In this task, the child is asked to indicate a hypothetical person's likely emotional responses to a series of emotion-relevant situations (*e.g.*, losing a pet). The child is typically asked to either describe or to select a pictorial depiction of the target's emotional state. Research on this aspect of affective perspective taking tends to follow the same logic as research on cognitive perspective

taking and shares its emphasis on generalized inferential strategies and cognitive processing.

A second aspect of affective perspective taking was investigated by researchers interested in participants' ability to decode a target's emotional response either in terms of feeling or displaying the same emotion that the target is depicting, or in terms of supplying the appropriate emotion label for the target's emotion expression. Thus, affective perspective taking has been conceptualized as both (1) the process of making inferences about how a generic person would feel in a certain hypothetical situation, and (2) the cognitive capacity to infer what a specific person is feeling by decoding (or feeling) the other's displayed emotion as a consequence of the other's situation. It has also been treated as a consequence of the discrepancy between the other's displayed emotion and the emotion that would be expected, given the other's situation (*e.g.*, if someone is sad at his or her birthday party).

Empathy as Feeling What Another is Feeling

Empathy has been defined as feeling the same thing that another is feeling by a number of neuropsychologists, psychologists, and philosophers. However, it was more common for research conducted prior to the 1950s to employ the term sympathy rather than empathy to describe this shared emotional response. Since that time, researchers have coined a number of phrases to emphasize the unique characteristics of this process, such as emotional contagion, or parallel emotional responding.

This view of empathy is potentially problematic in that it is unclear whether an observer must experience an emotional response that, when compared to the emotion of the other, is of either exactly the same tone, the same valence, the same intensity, or some combination of the three to qualify as empathy. For example, one researcher may define empathy as experiencing an emotional response that is similar to the emotional response of the other on one of these dimensions whereas another researcher may require similarity on all three dimensions. It is also unclear whether the observer must experience *only* the emotional response of the other, or if experiencing it in addition to other, different emotional responses still qualifies as empathy.

Empathy as Being Upset by Another's Situation

Witnessing another individual's suffering can, under certain circumstances, produce feelings of distress or anxiety. Such feelings have been labeled empathy by a number of researchers, especially in light of the strong statistical association between measures of empathy and measures of distress in certain circumstances. However, this label becomes problematic when the other's suffering is either graphic or extreme. In such cases, traditional measures of empathy and distress do not appear to assess different aspects of a unified emotional response. To be sure, distress or anxiety can be caused by witnessing another suffer, but this emotional response is not experienced for the other. Rather, it is experienced for oneself. Given the difference in focus of empathy and distress, recent

research on the topic maintains a conceptual distinction between empathy and feelings of distress that may also be produced by the same situation. This research also suggests that each of these emotional responses has distinct motivational and behavioral consequences, further highlighting the need to conceptually separate empathy from the distress that may accompany it.

Empathy as Feeling for Another

Perhaps the most common definition of empathy in modern psychology is feeling a vicarious emotion that is congruent with, but not necessarily identical to, the welfare of another. This view of empathy highlights the distinction noted above regarding distress – empathy is felt for another whereas, in some circumstances, distress is felt for oneself. Another important feature of this view of empathy is that it broadens the scope of potential empathic emotions. Specifically, empathy is typically construed as an emotion experienced when witnessing another suffering or experiencing a negative situation. However, it is also possible to respond with empathic joy when the other is experiencing positive states, with empathic anger when the other has been dealt an injustice, with empathic embarrassment when a cherished other commits a public faux pas, and so on. Thus, it may be more appropriate to view empathy as a category of emotional responses or as a way of responding emotionally rather than as a unitary, prototypical emotion.

Empathy as Matching Another's Overt Responses

Another variation on the concept of empathy views it as the process by which one matches another's overt responses to his or her current situation. Researchers have focused on various aspects of the other's responses that are to be matched, including his or her posture, emotional expressions, physiological state, and physical activities. This view of empathy has also been labeled motor mimicry or imitation to reflect its primary characteristic, some form of behavioral matching.

More recently, neuropsychological research suggests that matching in empathy goes well beyond motor mimicry or imitation. According to the Perception–Action Model of empathy, matching at the level of neural representations is central to the experience of empathy. Specifically, due to the automatic link between perception and action (*viz.*, involving the dorso-lateral prefrontal cortex and left inferior parietal region), simply perceiving another's physical activities results in a pattern of neural activation similar to what would occur if the observer were engaging in the same physical activities himself or herself. It is important to note, however, that the neural matching is far from complete, and that empathy involves a decoupling mechanism (*viz.*, involving the insula and right inferior parietal cortex) that differentiates one's own experiences and physical activities from those of the observed other.

It is important to note that response matching does not necessarily lead to an accurate understanding of the other. In many cases, matching is a goal-directed act that serves to communicate support for the other rather than an automatic and unavoidable imitative act. And it is, of course, possible that another's overt physical activities or emotional expressions

are intentionally inaccurate, so mimicking those actions or expressions would lead to an inaccurate understanding of the other. Above all, one need not match or imitate another's responses in order to understand them. Humans are quite adept at communicating what they are thinking and feeling, and one often needs to simply listen carefully to the other in a nonjudgmental manner to gain accurate knowledge of his or her internal states.

Summary

The various processes outlined above bear some conceptual overlap, but it is important to note the differences between them. The first (empathy as perspective taking) is primarily a cognitive account of empathy. In contrast, the second, third, and fourth accounts (empathy as feeling what another is feeling, empathy as feeling upset by another's situation, and empathy as feeling for another) are affective accounts of empathy, and the fifth account (empathy as matching another's overt responses) is a behavioral account of empathy.

Although the various processes labeled as empathy share similarities, it is important to note that the antecedents and consequences of these different views of empathy are not identical. Interestingly, important distinctions among these processes often result from their differential links to one another. For example, research suggests that adopting an imagine-self perspective toward another in need results in feeling a similar emotion to what one expects the other to feel, whereas adopting an imagine-other perspective toward a person in need has been shown to result in feeling for the other.

These two forms of affective empathy in turn can result in different motivational outcomes. Feeling a similar negative emotion as the other has been shown to evoke a selfish motive to reduce the emotion, resulting in attempts to escape the emotion by either escaping the situation or avoiding the other in need, both of which are involved in eliciting the unpleasant negative emotion. In contrast, feeling for the other evokes an altruistic motive to help the other, resulting in offering direct help to the other or attempting to get someone else to help him or her. The link between these two perspectives and their distinct emotional, motivational, and behavior consequences has been demonstrated numerous times in scientific literature, particularly by social psychologists. The link between being upset by another's situation and specific motivational and behavioral consequences is, however, less clear and is in need of further study.

As a further layer of complexity, research suggests that empathy as matching another's overt responses sometimes leads to cognitive empathy, affective empathy, or both. But, cognitive and affective empathy can also lead to a matching of overt responses. Thus, it is not surprising that the distinctions in various forms of empathy are often lost in the literature, given their interrelated and reciprocal nature.

Empathy as a Personality Characteristic

The research described above has sought to understand the cognitive and affective processes that have been referred to as empathy. However, other scholars have sought to describe

individual differences in either the capacity for experiencing empathy or in the tendency to use this capacity. That is, instead of thinking of empathy as a process, some scholars think of empathy as a distinct and stable aspect of one's personality that transcends situations and potential eliciting stimuli.

To this end, researchers have worked to develop valid and reliable measures of individual differences in the capacity or tendency to experience empathy for others, be it understanding what another is thinking and feeling, feeling what the other is feeling, or feeling for the other. Most of these measures are self-report in nature and, consequently, require that respondents have accurate insight into their empathic capacities or tendencies, have the means for communicating these capacities or tendencies, and are not motivated to present a distorted view of these capacities or tendencies. It is important to note that these preconditions are unlikely to be met at all times in all studies. As such, when considering various individual difference measures of empathy, one should keep in mind these potential limitations. Examples of individual difference measures of empathy include the Interpersonal Reactivity Index (IRI), developed by Davis, the Questionnaire Measure of Emotional Empathy (QMEE), developed by Mehrabian and Epstein, and the Emotional Contagion Scale (ECS) developed by Doherty.

The Interpersonal Reactivity Index

The structure of the IRI is based on the assumption that empathy consists of four related, but conceptually distinct, constructs. Specifically, the IRI consists of four subscales: perspective taking, empathic concern, personal distress, and fantasy. Taking these in turn, the perspective taking subscale measures an individual's tendency to spontaneously adopt other people's points of view. The empathic concern subscale measures an individual's tendency to feel sympathy and compassion for those in need. The personal distress subscale measures an individual's tendency to experience discomfort when in the presence of those in need. The fantasy subscale measures an individual's tendency to imagine himself or herself in fictional situations (e.g., in the scene of a movie or as a character in a book). Taken together, the IRI subscales measure empathy as various types of both cognitive processes (perspective taking and fantasy subscales) and affective processes (empathic concern and personal distress subscales).

Questionnaire Measure of Emotional Empathy

The QMEE is designed to measure a person's tendency to become emotionally aroused in response to the emotional behavior or situations of others. It includes items that measure feeling the same emotion as another, feeling upset about the situation of another, and feeling for another. Consequently, the QMEE is probably best conceptualized as a general measure of empathy as an affective process.

Emotional Contagion Scale

The ECS is a measure of one's tendency to feel the same emotions as others. It consists of five subscales that measure tendencies to 'catch' the experiences of happiness, sadness, anger,

fear, and love. Alternatively one can combine scores on all five subscales to create a general measure of the tendency to feel the emotions of others.

Sex Differences in Empathy

A commonly held belief is that women are more empathic than men, particularly in response to the needs of others. Indeed, an analysis of existing empathy research by Eisenberg and her colleagues suggests that women *report* more emotional reactivity to the plight of others in need than do men. However, a closer look across studies reveals there is little evidence of a gender difference when physiological measures of emotional intensity are used to measure empathy. This suggests that the differences found in research that employs self-report methodologies may be due to self-presentation concerns and gender role-based expectancies rather than to biological gender differences. Thus, (1) women may overreport their genuine feelings of empathy because of what they think is expected of them, (2) men may underreport their genuine feelings of empathy because of what they think is expected of them, or (3) both.

Research does suggest that women are slightly better than men at decoding visual and auditory cues from others (i.e., adopting the perspective of another individual to understand what he or she is thinking and feeling) when self-report measures of empathic accuracy are used; however, no gender differences are found when this aspect of empathy is measured using objective measures. Ironically, this difference on self-report measures of perspective taking may be due to the same self-presentation concerns and gender-role expectations as the differences found using self-report measures of affective empathy (which do not appear to reflect actual differences in the intensity of emotional response to others).

Summary

Much like the theoretical literature, studies on individual differences in the capacity or tendency to be empathic have treated the empathy concept in a variety of different ways. There are also gender-based differences in the tendency to be empathic when empathy is conceptualized as the ability to correctly infer what another person is thinking or feeling (even though objective measures do not detect this difference). Yet, there is little evidence of gender differences when physiological measures are used to assess affective empathy (even though self-report methodologies often mistakenly suggest that gender differences in affective empathy do exist).

Intrapersonal and Interpersonal Consequences of Empathy

Empathy, Prosocial Behavior, and Antisocial Behavior

One of the most widely studied consequences of empathy is its effect on prosocial behavior. The relation between empathy for a victim and an increased tendency to help him or her has been well known for several decades. However, disagreement over

the reasons for this relation has garnered much research attention of late.

According to the Empathy–Altruism Hypothesis, empathy evokes an altruistic motive with the ultimate goal of protecting or promoting the welfare of the person for whom empathy is felt. Note that, as they are used here, the term empathy refers to another-oriented emotional response to the victim’s welfare (feeling for the other), and the term altruism refers to a motivation rather than to any specific form of helping behavior. The claim that humans are capable of genuine altruism is somewhat controversial and, as a consequence, a number of egoistic explanations for the empathy–helping association have been proposed. The term egoism refers to a motivational state with the ultimate goal of protecting or promoting one’s own welfare. Among the more popular egoistic explanations for empathy-based helping are (1) the Aversive-Arousal Reduction Hypothesis, which claims that empathy is aversive and that empathically aroused individuals help in order to rid themselves of the unpleasant feeling; (2) punishment-avoidance explanations, which claim that empathically aroused individuals help because they anticipate negative social evaluations or shame and guilt for failing to help; and (3) reward-seeking explanations, which claim that empathically aroused individuals help because they anticipate praise or positive mood for helping those for whom empathy is felt. Although each of these explanations has some degree of empirical support, the Empathy–Altruism Hypothesis is considered by many researchers to have the weight of evidence on its side.

In contrast to the large body of work on the causal relation between empathy and prosocial behavior, there is relatively little research on the causal relation between empathy and antisocial behavior. Of the research that has been done, most has focused on the behaviors of deviant populations or young children, has assessed empathy as a general personality disposition rather than as a cognitive or emotional process, or used methodological designs that make it difficult to determine the causal direction of the relation (i.e., does empathy decrease antisocial behavior or does antisocial behavior decrease empathy?). As such, evidence for a negative relation between empathy and aggression has been reported, but it is largely inconsistent across populations, research paradigms, techniques for conceptualizing and measuring empathy, and for different forms of antisocial behavior. Consequently, it is difficult to generalize beyond the samples and methods employed in existing research.

Empathy, Accuracy, and Social Relationships

Empathy has long been acknowledged as an important component of social relationships. When defined as a cognitive process, empathy has been linked to conflict avoidance or management, improved communication among relationship partners, increased relationship satisfaction, and a tendency to be considerate of the partner’s wants and needs. However, research suggests a number of potential barriers to accurate perception of what another is thinking and feeling, which can mitigate the positive effects of empathy. For example, it is common for individuals to use themselves as a basis for assessing how and why another individual will react to a given

situation. Making judgments from an egocentric perspective (viz., that self and other are similar) can be useful in many cases, but accuracy is impaired when the empathizer and the other are dissimilar on situation-relevant domains. Accuracy is also impaired when the empathizer is currently experiencing strong emotion or is in a state of need, both of which tend to be unconsciously incorporated into his or her judgment of the other’s thoughts and feelings.

The role that empathy plays within the context of close relationships is even more complex. Research suggests an interesting paradox: empathic accuracy increases relationship satisfaction in certain situations, but decreases relationship satisfaction in others. Specifically, in nonthreatening contexts (e.g., discussing mundane events or planning a night out), a moderate-to-high level of motivation to accurately understand what a partner is thinking and feeling increases relationship satisfaction and stability. However, in relationship-threatening contexts (e.g., potential infidelity or disappointment with the partner’s performance), individuals tend to be motivated toward empathic inaccuracy – that is, to intentionally distort his or her perception of what the partner is thinking and feeling. In such cases, empathic inaccuracy actually increases relationship satisfaction and stability. In contrast, when the motive to be empathically accurate is strong in relationship-threatening contexts, the relationship is likely to suffer. Thus, empathy is important in social relationships in general, but inaccuracy is a common (and occasionally useful) exception, especially in close relationships when dealing with potentially threatening contexts.

Empathy and Attributions

Attributions are beliefs about the cause of an individual’s behavior. According to past research, there is a pronounced actor–observer difference when making attributions. Specifically, individuals tend to explain their own behavior as a consequence of the situation (an external attribution) whereas they tend to explain the behavior of others as a consequence of personality traits or dispositions (an internal attribution), especially when the behavior is negative or otherwise results in failure. Although the actor–observer difference is found primarily when the actor is highly idiosyncratic or when the actor and observer are in a close relationship, the effect can be reversed by simply instructing the observer to empathize with the actor. As a consequence of empathizing with the actor, the observer makes external attributions for the actor’s behavior, just as he or she would make external attributions for himself or herself. Thus, empathy promotes the evaluation of others in a relatively self-like (i.e., generous) manner.

Empathy and Attitudes

Empathy has also been shown to increase valuing of, and attitudes toward, individuals for whom empathy is felt. This is, at least in part, due to the reversal of the attributional biases noted above, especially in situations that involve some form of victimization, in that viewing another’s suffering as a result of situational factors rather than as a result of dispositional

factors reduces the likelihood that derogation and blaming the victim will occur.

The effects of empathy on valuing have important consequences for attitudes toward members of stigmatized groups (e.g., minorities or people with HIV/AIDS) and for attitudes toward social causes (e.g., animal rights or the environment). Research suggests the following three-step model of how empathy can be used strategically to improve attitudes toward such groups: (1) actively trying to understand what a stigmatized person is thinking and feeling will increase empathic feelings for him or her, (2) feeling empathy for him or her will increase valuing of his or her welfare, and (3) valuing this person will generalize to valuing the stigmatized group as a whole. Initial tests of this model demonstrated the success of this strategy by improving attitudes toward a broad range of stigmatized individuals and groups (e.g., people with AIDS, homeless individuals, and convicted murderers). Subsequent research has demonstrated the power of empathy to reduce prejudice and discrimination against members of racial or ethnic minorities, and homosexuals, and to improve attitudes toward protecting the natural environment and its nonhuman inhabitants.

Implications and Future Directions

The term empathy has been used to describe a broad range of cognitive-perceptual and emotional processes, all of which play an important role in human behavior. As noted above, empathy is potentially a powerful force not only in personal relationships, but also in an individual's interaction with social groups and with the world more generally. However, much is left to be discovered about the processes and consequences of this class of phenomena.

Perhaps the most pressing need at present is the theoretical integration of the cognitive and emotional processes involved in empathy. There is much disagreement and little consistency among researchers on exactly what empathy is, which has almost certainly slowed progress toward understanding its causes and consequences. Second, a number of important issues pertaining to empathy have received little or no empirical attention. For example, research on the neurological bases of empathy has emerged only within the last few years and much is left to be learnt about which brain processes are responsible for the various empathy phenomena and how organic brain damage can affect an individual's capacity to understand and respond to the thoughts and feelings of others. Similarly, little is known about the genetic basis or evolutionary history of empathy. Given its importance in human social functioning, it is remarkable that this topic has received so little empirical attention.

Also, much research has been conducted to understand the relation between empathy and antisocial behavior, yet the results are largely inconsistent from study to study. Future research may benefit from adopting a broader purview of the topic and by employing (1) measures of empathy as a process rather than as a general personality disposition; (2) a

representative range of antisocial behaviors rather than focusing exclusively on physical or verbal retaliation; (3) diverse populations, including normal, physically healthy adults; and (4) experimental methodology so that the causal direction of an association can be determined. A broader purview would also be useful when investigating other, socially relevant consequences of empathy, such as volunteerism and a related phenomenon, empathy burnout. Empathy burnout is an involuntary process by which empathy is transformed into feelings of distress after prolonged exposure to the suffering of others that causes caregivers (e.g., spouses, nurses, volunteers, social workers, etc.) to become callous and, potentially, disengaged from service to the victims. The majority of research on empathy and prosocial behavior has focused on single-instance forms of helping and, as a consequence, little is known about the effects of empathy in long-term care situations. Future research on these and related issues could advance both theoretical understanding and real-world application of this important and complex class of phenomena.

See also: Altruism and Helping Behavior; Attitude Change; Moral Development.

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Empirical Challenges to Conventional Mind–Brain Theory

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Glossary

Automatism Motor activity not initiated consciously.

Eidetic imagery Mental images that are almost photographically exact.

Mediumship The ability of some persons, usually in a trance or other altered state, to produce information relating to a deceased person, which they have not learned normally.

Psi A theory-neutral term designating phenomena that seem not to derive from ordinary sensorimotor processes, including phenomena such as extrasensory perception (telepathy or clairvoyance), psychokinesis ('mind over matter'), or precognition.

Introduction

Nearly all contemporary psychologists, neuroscientists, and philosophers subscribe – explicitly or implicitly – to some version of physicalism. Physicalist conceptions of the human mind and personality, contrary to traditional and everyday notions, run along roughly the following lines: We human beings are nothing but extremely complicated biological machines. Everything we are and do is in principle causally explainable from the bottom up in terms of our biology, chemistry, and physics – ultimately, that is, in terms of local contact interactions among bits of matter moving in accordance with mechanical laws under the influence of fields of force. Some of what we know and the substrate of our general capacities to learn more are built-in genetically as complex resultants of biological evolution. Everything else comes to us directly or indirectly by way of our sensory systems, through energetic exchanges with the environment of types already largely understood. Mind and consciousness are generated by – or in some mysterious way identical with – neurophysiological events and processes in the brain. Mental causation, free will, and the 'self' do not really exist; they are mere illusions, ineffectual by-products of the grinding of our neural machinery. And since mind and personality are entirely products of our bodily machinery, they are necessarily extinguished, totally and finally, by the demise and dissolution of that body.

Views of this sort unquestionably hold sway over the vast majority of contemporary scientists and they have also percolated widely through the public at large. We believe, however, that they are at best seriously incomplete, and at certain critical points, demonstrably false, empirically. In this article, we will briefly catalogue a variety of interrelated empirical phenomena that appear difficult or impossible to explain in conventional physicalist terms. We emphasize from the outset that these phenomena must be considered collectively, not piecemeal; they not only challenge the conventional physicalist picture individually, but converge in pointing to the need for a radically novel way of understanding the intimate relationship of mind and brain. We also emphasize that we are presenting here only a skeletal outline of the kinds of phenomena to which we wish to direct readers' attention. More detailed treatments of relevant empirical evidence and the issues raised can be found in works given in the Further Reading.

Extreme Psychophysiological Influence

We begin with a variety of phenomena especially suggestive of the involvement of direct mental agency in the production of physiological effects not fully explainable in terms of physiological mechanisms alone. The following examples will serve to capture their flavor.

Placebo effects and related kinds of psychosomatic phenomena have long been informally recognized and are now widely accepted, but they were accepted by modern biomedical science only grudgingly, as new mechanisms of brain–body interaction that seemed potentially capable of explaining them came to light. In particular, psychoneuroimmunology has demonstrated the existence, previously unknown, of interactions between the central nervous system and the immune system. Nevertheless, the adequacy of such explanations to account even for placebo effects remains in question, and there are many types of kindred phenomena that pose progressively greater challenges to explanation in such terms.

For example, Sigmund Freud and F. W. H. Myers were impressed by hysterical 'glove anesthetics,' in which a patient loses sensation from the skin of a hand in the absence of organic lesion, in a way that typically corresponds only to the patient's idea, in complete disregard of the underlying anatomical organization. Related phenomena have often been reported in the context of hypnosis. For example, highly suggestible persons who can vividly imagine undergoing an injurious circumstance such as receiving a burn to the skin sometimes suffer effects closely analogous to those that the physical injury itself would produce, such as a blister. More rarely, the correspondence between the hypnotic blister and its imagined source extends even to minute details of geometric shape, details too specific to account for in terms of known mechanisms of brain–body interaction. A closely related and well-documented phenomenon is that of 'stigmata,' in which fervently devout or pious believers in Christ develop wounds analogous to those inflicted during the crucifixion. The injuries are again localized and specific in form, vary in locus and character in accordance with their subjects' differing conceptions of Christ's own injuries, and appear and disappear, often suddenly and regularly, also in accordance with the subject's expectations. Similarly, dramatic phenomena have occasionally

been documented in psychiatric patients in connection with their recall of prior physical trauma.

The conventional hope, of course, is that even the most extreme of the phenomena just mentioned might ultimately be explained in terms of brain processes. Continuing allegiance to this hope, despite the indicated explanatory difficulties, is undoubtedly encouraged by the fact that the phenomena described so far all involve effects of a person's mental states on that person's own body. Still more drastic explanatory challenges are posed, however, by cases in which one person's mental state seems to have directly influenced another person's body. Such phenomena include 'maternal impressions' (birthmarks or birth defects on a newborn that correspond to an unusual and intense experience of the mother during the pregnancy), distant healing (including experimental studies of effects of prayer on healing), experimental studies of distant mental influence on living systems, and cases in which a child who claims to have memories of the life of a deceased person also displays extremely unusual birthmarks or birth defects corresponding closely with marks (usually fatal wounds) on the body of that person. In addition, there has been a considerable accumulation of spontaneous cases and experimental evidence demonstrating the reality of psychokinesis (PK), which by definition involves direct mental influence on the physical environment (see section '[Psi Phenomena](#)').

Extremes of Informational Capacity and Precision

A number of well-documented psychological phenomena involve levels of detail and precision difficult to account for in terms of a brain operating in statistical fashion with neural components of low intrinsic precision and reliability. Here are some examples.

The first involves a case of 'automatic writing' observed by William James. The subject wrote with his extended right arm on large sheets of paper, his face meanwhile buried in the crook of his left elbow. For him to see what he was doing was 'a physical impossibility.' Nevertheless, James continues: "Two or three times in my presence on one evening, after covering a sheet with writing (the pencil never being raised, so that the words ran into each other), he returned to the top of the sheet and proceeded downwards, dotting each *i* and crossing each *t* with absolute precision and great rapidity."

This episode illustrates two features that have often appeared together in the large but neglected scientific literature dealing with automatic writing: The subject is in an altered state of consciousness, and the motor performance, itself remarkable, is apparently guided by an extremely detailed memory record, an essentially photographic representation of the uncompleted page.

The latter property relates to the phenomenon of eidetic imagery, the second example, the most dramatic demonstration of which has been provided by Charles Stromeyer using Julesz stereograms. These are essentially pairs of computer-generated pictures, each of which by itself looks like a matrix of randomly placed dots, but is constructed in such a way that when viewed simultaneously (by presentation to the two eyes separately) a visual form emerges in depth. Stromeyer presented pictures of this type to the eyes of his single subject, a

gifted female eidetiker, at different times, ultimately as much as 3 days apart. Under these conditions, the subject could extract the hidden form only if she could fuse current input to one eye with an extremely detailed memory image of previous input to the other eye. Remarkably, she was able to succeed under a wide variety of increasingly demanding conditions. The original stereograms, for example, were 100×100 arrays, but she ultimately succeeded under double-blind conditions with arrays as large as 1000×1000 , or a million 'bits,' viewed up to 4 h apart.

These results were understandably shocking to many psychologists, who sought to escape their force by pointing to the dependence on a single subject and the absence of replications. At least one successful replication has subsequently occurred, however. Moreover, the literature already contains many additional examples of prodigious memory. Stromeyer mentions Luria's famous mnemonist and the case of the 'Shass Pollaks,' who memorized all 12 volumes of the Babylonian Talmud, and Oliver Sacks has reported a similar case of a person who among other things knew by heart all nine volumes and 6000 pages of Grove's *Dictionary of Music and Musicians*. Other examples could easily be cited. Prodigious memory of this sort is a real psychological phenomenon.

Third in this group is the family of 'calculating prodigies.' Of special interest is the 'savant syndrome,' often associated with autistic disorders, in which islands of spectacular ability appear in the midst of generalized mental disability. The abilities are of many types, but almost invariably involve prodigious memory. The depth of the problems they pose for brain theory is exemplified by the case of 'The Twins,' also described by Sacks. These profoundly impaired individuals, unable to perform even simple additions and subtractions with any accuracy, nonetheless proved able to generate and test prime numbers in their heads. Sacks was able to verify the primacy up to 10 digits, but only by means of published tables, while the twins themselves went on exchanging numbers of steadily greater length, eventually reaching 20 digits. Sacks makes the intriguing suggestion that they may not literally be calculating these enormous numbers, but discovering them by navigating through some vast inner iconic landscape in which the relevant numerical relations are somehow represented pictorially. The twins themselves of course cannot say how they do it.

Phenomena of these sorts look hard to explain in terms of brain processes. The most serious attempt to do so that is known to us is in fact devoid of specific neural mechanisms. Its central argument is rather that early-stage brain processes like those subserving visual perception, for example, must also be savant-like in terms of their speed, precision, and informational capacity; what is unusual about savants, therefore, may consist merely in their access to these mechanisms. This explanation of course presupposes a positive answer to the fundamental question at issue, whether the brain alone can accomplish any of these things including perceptual synthesis itself (see section '[The Unity of Conscious Experience](#)').

As proved long ago by mathematician John von Neumann, the only practical way to get increased arithmetical precision out of individually unreliable neurons is to use more of them. This biocomputational perspective clearly implies that calculating prodigies must use large portions of their brains in very abnormal ways to achieve the observed effects. The cognitive

deficits that often accompany savant-type skills could conceivably reflect such substitutions, but we must remember that comparable skills sometimes also occur in geniuses such as the mathematicians Gauss and Ampère.

Memory

The previous section focused on phenomena such as high-precision calculations and prodigious memory that appear incompatible with the physical properties of the brain considered as a kind of computing device. Problems also arise, however, in regard to memory in its more familiar and everyday forms. Here we briefly sketch some relevant issues.

Memory is central to all human cognitive and perceptual functions, yet we remain largely ignorant of where and in what forms our past experience is stored and by what means it is brought to bear upon the present. Generations of psychologists and neurobiologists have taken it as axiomatic that all stored memories must exist in the form of ‘traces,’ physical changes produced in the brain by experience, but there has been little real progress toward scientific consensus on the details of these mechanisms despite many decades of intensive research.

Significant progress has recently been made, to be sure, in regard to ‘learning’ and ‘memory’ in simple creatures such as the sea slug (*Aplysia*), and more generally in regard to what might be called ‘habit memory,’ the automatic adjustments of organisms to their physical environments. But these discoveries fall far short of providing satisfactory explanations of the most central and important characteristics of the human memory system, including in particular our supplies of general knowledge (semantic memory) and our ability to recall voluntarily and explicitly our own past experience (autobiographical or episodic memory). Furthermore, recent functional neuroimaging studies, although generating vast amounts of data, have yielded little, if any, progress toward a comprehensive and coherent account of memory based on trace theory.

Meanwhile, deep conceptual problems have been identified in trace theory itself. For example, autobiographical memory clearly involves something more than mere revival of traces of past experiences, something that allows us to interpret what is experienced now as a representation of our own past rather than a contemporary perception, dream, or hallucination. That is, traces as such only provide memory aids rather than memories per se, and it has proved extremely difficult to specify in conventional physicalist terms what that extra something is, without falling into regressive forms of explanation that presuppose and hence cannot explain the phenomenon of memory itself. Similarly, the content of a concept or semantic memory typically transcends any finite set of experienced circumstances that can plausibly be imagined as having deposited corresponding ‘traces’ in a form capable of explaining its effective deployment in an unlimited variety of novel contexts.

These conceptual problems regarding trace theories of memory have deep connections with issues discussed in section ‘The Heart of the Mind,’ and similar issues arise in relation to allied components of current cognitive theory such as ‘information’ and ‘representation.’ See also section ‘Psi Phenomena’ for an additional empirical problem.

Psychological Automatism and Secondary Centers of Consciousness

Phenomena catalogued under this heading involve what looks like multiple concurrent engagement, in potentially incompatible ways, of major cognitive skills (linguistic skills, for example) and the corresponding brain systems.

Current cognitive neuroscience pictures the mind or ‘cognitive system’ as a hierarchically ordered network of subprocessors or ‘modules,’ each specialized for some particular task and corresponding (it is hoped) to some particular brain region or regions. Leaving aside major issues regarding the details of its specification, this picture seems broadly consistent with the overall manner in which our minds normally seem to operate. That is, our basic way of consciously doing things is essentially one at a time in serial fashion. Although psychologists recognize that with suitable training people can do more things in parallel than they customarily suppose, this generalization applies mainly to relatively divergent things, and conspicuously fails as the simultaneous tasks become more complex and more similar.

Nevertheless, a large body of credible evidence, some dating back to the late nineteenth century, demonstrates that additional ‘cognitive systems,’ dissociated psychological entities indistinguishable from full-fledged conscious minds or personalities as we normally understand these terms, can sometimes occupy the same organism simultaneously, carrying on their varied existences as it were in parallel, and largely outside the awareness of the primary, everyday consciousness. In essence, the structure that cognitive psychology conventionally pictures as unitary, as instantiated within and identified with a particular organization of brain systems, can be functionally divided – divided, moreover, not ‘side to side,’ leading to isolation of the normal cognitive capacities from each other, but ‘top to bottom,’ leading to the appearance and concurrent – not alternating – operation of what seem to be two or more complete cognitive systems, each of which includes all of the relevant capacities. Emergent ‘multiple’ or ‘alter’ personalities can also differ widely, not only in demeanor, interests, and knowledge but even in regard to nonvoluntary physiological characteristics such as visual defects and susceptibilities to allergies. Even worse, it sometimes happens that one of these personalities appears to have direct access to the conscious mental activity of one or more others, but not vice versa.

Two brief examples, drawn from an enormous literature, may help convey a more concrete sense of the character of these phenomena.

The first comes from a report by Oxford philosopher F. C. S. Schiller on automatic writing produced by his brother. As is characteristic of this genre of automatism, the writer was typically unaware of the content of his writing, which went on continuously while he was fully and consciously engaged in some other activity such as reading a book or telling a story. Of particular relevance here, however, were occasions on which he wrote simultaneously with both hands and on completely different subjects, one or the other of these streams of writing also sometimes taking mirror-image form.

The second example is the case of Anna Winsor, described by William James in his report on automatic writing. The case

was protracted and bizarre, but only superficially resembles the neurological ‘alien hand’ (Dr. Strangelove) syndrome. Its central feature is that the patient, Anna, at a certain point lost voluntary control of her right arm, which was taken over by a distinctive secondary personality. This personality, whom Anna herself named ‘Old Stump,’ was benign, often protecting Anna from her pronounced tendencies toward self-injury. As in the case of Schiller’s brother, Stump typically wrote or drew while Anna was occupied with other matters. But Stump also continued writing and drawing even when Anna was asleep, and sometimes in total darkness. This secondary personality also remained calm and rational during periods when Anna was feverish and delusional, and it manifested knowledge and skills which Anna herself did not possess.

Psi Phenomena

Here we refer to experimental and field observations systematically adduced in the course of over a century of effort by workers in ‘psychical research’ and its modern descendent, ‘parapsychology.’ The phenomena in question involve, by definition, correlations occurring across physical barriers that should be sufficient, on presently accepted physicalist principles, to prevent their formation. This occurs, for example, when person A spontaneously experiences an apparition of his friend B, as B unknown to A lies dying from a fatal accident. Over a thousand detailed cases of this sort – carefully documented experiences that are not dismissible en masse as mere ‘anecdotes’ – have been published in the peer-reviewed literature. It also occurs when an experimental subject consistently succeeds in identifying randomly selected forced-choice targets displayed in a remote location. It is not difficult to set up controlled experiments of this sort and to evaluate their outcomes using rigorous statistical procedures. A large amount of careful experimental work has been carried out along these lines, with results more than sufficient, in our opinion, to demonstrate beyond reasonable doubt to open-minded persons that the sheer existence of the basic input–output phenomena – ‘extrasensory perception’ (ESP) and ‘psychokinesis’ (PK) in the popular vocabulary, or in more theory-neutral terminology, ‘psi’ – is a fact of nature with which we must somehow come to scientific terms.

Psi phenomena in general are important because they provide examples of human behavioral capacities that appear impossible to account for in terms of presently recognized computational, biological, or classical physics principles. Even more important for our purposes, however, is a further body of evidence suggestive of postmortem survival, the persistence of elements of mind and personality following bodily death. It is simply not true, as most scientists presume, that we possess no such evidence. We in fact possess a lot of such evidence, much of it of very high quality, deriving, for example, from studies of veridical apparitions, trance mediumship, and ‘cases of the reincarnation type,’ in which young children spontaneously report verifiable events from the lives of distant and ordinary persons now deceased. Ironically, the primary threat to a survivalist interpretation of this accumulated evidence arises not from considerations of evidential quality, but from the difficulty of excluding

alternative explanations based upon psi interactions involving only living persons.

Quite apart from any personal or theological interests readers may bring to this subject, it should be evident that postmortem survival, if it occurs, demonstrates dramatically the limitations of present-day reductive physicalism. If it is the case, for example, as much evidence indicates, that autobiographical, semantic, and procedural (skill) memories can survive bodily death, then memory in living persons must presumably exist at least in part outside the brain and body as conventionally understood.

Either horn of this interpretive dilemma – postmortem survival or psi among the living – is lethal to current physicalist orthodoxy, which undoubtedly explains the widespread scientific resistance to both. But as we are arguing here, and have argued in much more detail elsewhere, these phenomena cannot be isolated and quarantined, because similarly difficult explanatory challenges are posed by many other well-evidenced psychological phenomena. Evidence for the occurrence of psi phenomena in general and postmortem survival in particular must, we believe, play an important role in the formulation of an empirically adequate mind–brain theory, and our efforts here will be amply rewarded if they lead scientifically minded readers to examine these subjects more seriously than they otherwise might.

Genius-Level Creativity

Any scientific theory of personality and cognition truly worthy of the name surely must help us to understand this humanly vital topic, but by this standard we have so far made distressingly little progress. The reason, in our opinion, is that for the most part we have tried to understand the exceptional – real genius, in its fullest expressions – as an amplification of the commonplace – ‘creativity,’ as found in convenience samples of undergraduates and the like.

All of the challenging phenomena catalogued in this article – including extreme psychophysiological influence, psychological automatism and secondary centers of consciousness, flashes of inspiration involving unusual forms of thinking and symbolism, prodigious memory, spontaneous psi phenomena, and altered states of consciousness verging on the mystical realm – are inescapably bound up with genius in its fullest expressions, but these connections go virtually unmentioned in contemporary mainstream discussions. A particularly dramatic case which exemplifies our central point is that of the Indian mathematical genius Ramanujan, rated by his distinguished discoverer Hardy as standing alone at 100 atop a scale of mathematical ability on which most of us lie at or near zero, while the magnificent David Hilbert rated 80 and Hardy himself a mere 25. Replete with examples of prodigious memory, psychological automatism, mathematical discoveries presented in the form of dreams, and profound and beautiful intuitions of hidden but ultimately verifiable properties of the physical world, this astonishing case fairly beggars the theoretical apparatus currently available to cognitive science and hence could well serve as a kind of reality check and navigational aid for further investigations of genius.

Mystical Experience

Experiences of this type lie at the core of the world's major religious traditions and have continued to occur throughout history and across cultures. Their existence as a distinctive and important class of psychological phenomena can scarcely be denied, yet they have largely been ignored by mainstream psychology and neuroscience, and generations of clinical psychologists, psychiatrists, and neuroscientists have tended, with few exceptions, to devalue and pathologize them, treating them as products of malfunctioning brains. Even when acknowledging that such experiences are typically life-transforming and self-validating for those who have them, the historically standard epistemological approaches in psychology and philosophy – beginning with William James in his *Varieties of Religious Experience* – treat them as purely subjective events having authority only for those who experience them, and thus deny their objective significance and the testability of the associated truth claims. However, a large though scattered literature testifies to the common occurrence in connection with such experiences, or in individuals who have them, of genius-level creativity, spontaneous psi-type events, and many other unusual but verifiable empirical phenomena of the sorts described in this article. Mystical-type states of consciousness are also at least partially reproducible by pharmacological (psychedelic) means, and they can be induced by protracted self-discipline involving transformative practices such as the various forms of meditation. An objective and informed appraisal of mystical experience thus finds within it much additional support for an enlarged conception of human personality and many new opportunities for empirical research.

The Unity of Conscious Experience

Under this heading we briefly address two interrelated problems. The first and narrower is the so-called 'binding' problem, which emerged as a consequence of the success of contemporary neuroscientists in analyzing sensory mechanisms, particularly in the visual system. It turns out that different properties of a visual object such as its form, color, and motion in depth are handled individually by largely separate regions or mechanisms within the brain. But once the stimulus has been thus dismembered, so to speak, how does it get back together again as a unit of visual experience?

Only one thing is certain: The unification of experience is not achieved anatomically. There are no privileged places or structures in the brain where everything comes together, either for the visual system itself or for the sensory systems altogether. Some early theorists such as James and McDougall argued that the evident disparity between the multiplicity of physiological processes in the brain and the felt unity of conscious experience could only be resolved in materialist terms by anatomical convergence, and since there is no such convergence, materialism must be false. This argument, although ingenious, relied upon the faulty premise that the only possible physical means of unification must be anatomical in nature. All current neurophysiological proposals for solving the binding problem are instead functional in nature; the essential concept common to

all of them is that oscillatory electrical activity in widely distributed neural populations can be rapidly and reversibly synchronized, particularly in the 'gamma' band of EEG frequencies (roughly 30–70 Hz), thereby providing a possible mechanistic solution to the binding problem.

A great deal of sophisticated experimental and theoretical work over the past 20 years has demonstrated that such mechanisms do in fact exist in the nervous system, and that they are active in conjunction with normal perceptual synthesis. Indeed, contemporary physicalism has crystallized neurophysiologically in the form of a family of 'global workspace' theories, all of which make the central claim that conscious experience occurs specifically – and only – in conjunction with large-scale patterns of gamma-band oscillatory activity linking widely separated regions of the brain.

The neurophysiological global workspace, however, cannot be the whole story, because a large body of recent evidence demonstrates that elaborate, vivid, and life-transforming conscious experience sometimes occurs under extreme physiological conditions, such as deep general anesthesia and cardiac arrest, that categorically preclude workspace operation. In short, it appears to us that the early theorists were right after all, albeit for the wrong reason. In effect, we believe, recent progress in theoretical neuroscience, coupled with advances in our capacity to retrieve patients from the borderland of death, has provided new means for the falsification of physicalist theories of mind–brain relations.

Availability of this emerging evidence emboldens us to make some further and more speculative remarks regarding the larger problem of perceptual synthesis, and the direction in which things seem to us to be moving.

It is an historical fact that mainstream psychology has always tended on the whole to try to solve its problems in minimalist fashion and with as little reference as possible to what all of us experience every day as central features of our conscious mental life. The early workers in 'mechanical translation,' for example, imagined that they could do a decent job simply by constructing a large dictionary that would enable substitution of words in one language for words in the other. This approach failed miserably, and we were slowly driven, failed step by failed step, to the recognition that truly adequate translation presupposes understanding, or in short a full appreciation of the capacities underlying the human use of language.

A similar evolution is underway in regard to perceptual theory. Most of the work to date has taken a strongly 'bottom-up' approach, which views perceptual synthesis as a kind of exhaustive calculation from the totality of input currently present at our sensory surfaces. Machine vision and robotics, for example, necessarily took this approach, and even in neuroscience it seemed to make sense to start with the most accessible parts of the perceptual systems – the end organs and their peripheral connections – and work our way inward. The great sensory systems themselves – vision, audition, somatosensation, and so on – were also presumed to operate more or less independently, and were in fact typically studied in isolation.

A separate tradition dating back at least to Kant and the early Gestalt theorists, and carried forward into the modern era by psychologists such as Ulric Neisser and Jerome Bruner, has been sensitive to the presence of 'top-down' influences, both

within and between sensory modalities. Although a few perceptual subsystems (such as those that produce incorrigible visual illusions) may be truly autonomous or ‘cognitively impenetrable,’ these seem to be isolated and special cases. A very different overall picture of perceptual synthesis is currently emerging in which top-down influences predominate. On this view perceptual synthesis is achieved not from the input, but with its aid. This is necessarily the case for example in regard to ambiguous figures such as the Necker cube, where the stimulus information itself is insufficient to determine a uniquely correct interpretation. More generally, we routinely ignore information that is present in the input and supply information that is not, speed reading providing a characteristic example. Something within us, a sort of world-generating or virtual-reality system, is continuously updating and projecting an overall model of the perceptual environment and our position within it, guided by limited samplings of the available sensory information.

As in the case of understanding spoken or written language, an enormous amount of general knowledge is constantly mobilized in the service of this projective activity, which freely utilizes whatever information it finds relevant. Top-down and cross-modal sensory interactions have recently been recognized as the rule rather than the exception in perception, and neuroscientist Rodolfo Llinás and his coworkers have advanced the view, which we believe is profoundly correct, that dreaming, far from being an odd and incidental part of our mental life, represents the fundamental form of this world-creating activity. Ordinary perceptual synthesis, on this inverted view of things, amounts to oneiric (dreamlike) activity constrained by sensory input. Psychoanalyst Ernest Hartmann has proposed similar ideas in regard to hallucinatory activity more generally, with dreaming included. In his view such activity is again a ubiquitous and fundamental feature of our mental life, and the critical question is not ‘why do we sometimes hallucinate?’ but rather ‘what keeps us from hallucinating most of the time?’ The answer, he suggests, lies in inhibitory influences exerted by the brain activity that accompanies ongoing perceptual and cognitive functions of the ordinary waking sorts.

So far so good, but where exactly is the ‘top,’ the ultimate source of this top-down world-creating activity? The mainstream neuroscientists who have already recognized its existence invariably presume that it arises entirely within the brain itself, but evidence such as that of near-death experiences occurring under extreme physiological conditions and the more direct evidence of postmortem survival suggest that it may originate outside the brain as conventionally understood.

The Heart of the Mind

In this section we comment briefly on a hornet’s nest of issues lying at the core of mental life as all of us routinely experience it, every day. These issues have been the focus of extensive recent debates, especially in the philosophical literature, precisely because of their resistance to understanding in conventional physicalist terms. The issues are deep, individually complex, and densely interconnected, and what we can say here will necessarily amount to little more than a summary of

our own opinions. Our central point is that the prevailing a priori commitment to physicalism has rendered us systematically incapable of dealing adequately with the mind’s most central and characteristic properties. We should rethink that commitment.

Consider first the issue of semantic content, the ‘meaning’ of words and other forms of representation. Throughout our history, we have tried unsuccessfully to deal with this by ‘naturalizing’ it, reducing it to something else that seems potentially more tractable. An old favorite among psychologists was that representations work by resembling what they represent, by virtue of some sort of built-in similarity or structural isomorphism, but any hope along these lines was long ago exploded by philosophical arguments. The central move subsequently made by classical cognitive psychology is essentially the semantic counterpart of the prevailing ‘functionalist’ doctrine in the philosophy of mind: Meanings are not to be conceived as intrinsic to words or concepts, but rather as deriving from and defined by the functional role those words or concepts play in the overall linguistic system. Currently there is great interest in ‘externalist’ causal accounts of this functionalist type; in connectionism, dynamic systems theory, and neuroscience, for example, the ‘meaning’ of a given response, such as the settling of a network into one of its ‘attractors’ or firing off a volley of spikes by a neuron in the visual cortex, is typically identified with whatever it is in the organism’s environment that produces that response. But this simply cannot be right: How can such an account deal with abstract things, for example, or nonexistent things? Responses do not qualify *ipso facto* as representations, nor signs as symbols. Something essential is being left out. That something, as John Searle has so effectively argued, is precisely what matters, the semantic or mental content.

Closely related to this is the more general and abstract philosophical problem of intentionality, the ability of any and all representational forms to be ‘about’ things, events, and states of affairs in the world. Mainstream psychologists and philosophers have struggled to find ways of making intentionality intrinsic to the representations themselves, but again it just does not and cannot work, because something essential is left out. That something is the user of the representations. Intentionality is inherently a three-way relation involving users, symbols, and things symbolized, and the user cannot be eliminated. As Searle puts it in various places, the intentionality of language is secondary and derives from the intrinsic intentionality of the mind. Searle thus agrees in part with the nineteenth-century philosopher Franz Brentano, for whom intentionality was the primary distinguishing mark of the mental. At the same time, however, Searle ignores the other and more fundamental part of Brentano’s thesis, which is that intentionality cannot be obtained from any kind of purely physical system, including brains.

Talk of ‘users’ and the like raises for many contemporary psychologists and philosophers the terrifying specter of the self as a homunculus, a little being within, who embodies all the capacities we sought to explain in the first place. Such a result would clearly be disastrous, because that being would evidently need a similar though smaller being within itself, and so on without end. Cognitive modelers seeking to provide strictly physicalist accounts of mental functions must therefore

do so without invoking a homunculus, but in attempting this they routinely fail. Often the homuncular aspect is hidden, slipped into a model by its designers or builders and covertly enlisting the semantic and intentional capacities of its users or observers. Much contemporary work on computational modeling of memory, metaphor, and semantics harbors subtle problems of this sort. Sometimes, however, the homunculus is more brazenly evident. One example is David Marr's account of vision, which applies computations to the two-dimensional array of retinal input to generate a 'description' of the three-dimensional world that provided that input, but then needs someone to interpret the description. Another is Stephen Kosslyn's model of visual imagery, which essentially puts up an image on a sort of internal TV screen, but then needs somebody else to view the image.

Cognitive models cannot function without a homunculus, we believe, precisely because they lack what we have – minds, with their capacities for semantics, intentionality, and all the rest built in. No homunculus problem, however, is posed by the structure of our conscious experience itself. The efforts of Daniel Dennett and other physicalists to claim that there is such a problem, and use that to ridicule any residue of dualism, rely upon the deeply flawed metaphor of the 'Cartesian theater,' a place where mental contents get displayed and we pop in separately to view them. Descartes himself, James, and Searle, among others, all have this right; conscious experience comes to us whole and undivided, with the qualitative feels, phenomenological content, unity, and subjective point of view all built-in, intrinsic features. We and our experience cannot be separated in this way.

Finally, we wish simply to record our own deepest intuition as to where these issues lead. All of the great unsolved mysteries of the mind – semantics, intentionality, volition, the self, and consciousness – seem to us inextricably interconnected, with consciousness somehow at the root of all.

The consciousness we have in mind, however, is emphatically not that of people such as David Chalmers, irreducible but ineffectual, consisting merely of phenomenological properties or 'qualia' arbitrarily tacked on to some sort of computational intelligence that supposedly does all the cognitive work. Ordinary perception, memory, and action are saturated with conceptual understanding, and conceptual understanding is saturated with phenomenological content. Volition too has an intentionality aspect, for as Nietzsche somewhere remarked, one cannot just will, one must will something. And as William James so forcibly argued at the dawn of our science, all of this perceptual, cognitive, and volitional activity somehow emanates from a mysterious and elusive 'spiritual self,' which can often be sensed at the innermost subjective pole of our ongoing conscious experience.

We find it astonishing, and predict that it will be found so by our intellectual descendants as well, that so much of twentieth-century psychology and philosophy sought – consciously! – to slight or ignore these first-person realities of the mind, and sometimes even to deny their existence. There is perhaps no better example of the power of preexisting theoretical commitments to blind able persons to countervailing facts. The gloomy and counterintuitive modern conclusions summarized in section 'Introduction' about mind, consciousness, free will, and the self really do follow – inexorably – from the physicalism that prevails

today. But as we will next briefly explain, that kind of physicalism is itself incompatible with our deepest physical science.

Conclusion: Toward an Expanded Scientific Psychology

It cannot be emphasized too strongly that these unresolved explanatory problems concerning consciousness, the heart of the mind, and the other empirical phenomena surveyed in this article all have a common source in the narrow physicalist consensus which undergirds practically everything now going on in mainstream psychology, neuroscience, and philosophy of mind. But that consensus rests ultimately upon a classical physics-based conception of nature, deriving from people such as Descartes, Galileo, Newton, Laplace, and Kelvin, that began its career by deliberately banishing conscious human minds from its purview! Given that historical background, it should occasion little surprise that William James – like Newton and Leibniz before him, and like increasing numbers of philosophers and scientists today – clearly recognized the inherent impossibility of explaining consciousness and allied phenomena within that Procrustean framework. James himself cautioned that the physical science concepts underlying classical physicalism were 'provisional and revisable things,' but he had no good alternatives in sight. As he correctly anticipated, however, that conception of nature was soon radically undermined by a tectonic shift in the foundations of physics itself, associated especially with the rise of quantum mechanics.

The founders of quantum mechanics discovered to their horror that the fundamental ideas of classical physics were not just limited but wrong, leading repeatedly to predictions falsified by experiment. The theory they were driven to in response, quantum theory, is a more fundamental and better physical theory that explains everything explainable in classical terms and a host of additional things as well, often to extraordinary levels of accuracy. No outcome predicted by it has ever been experimentally falsified. Furthermore, in at least some of its various interpretations, quantum mechanics appears able to accommodate phenomena of the sorts surveyed here. Mathematical physicist Henry Stapp in particular has shown that a strictly orthodox interpretation derived from the mathematical formalization achieved by von Neumann leads naturally to a non-Cartesian form of dualism in which the human mind with its powers of attention and decision making plays a necessary and fundamental role in completing the quantum dynamics. As a corollary, the classical doctrine of 'causal closure of the physical,' which underlies most contemporary physicalist denials of free will, is specifically rejected. And although details remain to be supplied, many of the challenging behavioral phenomena cited above, from stigmata and hypnotic blisters to psi phenomena and even postmortem survival, seem potentially understandable within this broader framework.

The empirical challenges briefly surveyed here should be sufficient in themselves, we believe, to compel and to some extent foreshadow a radical reworking of central parts of our science of the mind. But it is also important to recognize that a scientific psychology enlarged in these ways will likely prove more compatible than present-day physicalist psychology both with everyday human experience and with our most fundamental physical science.

See also: Creative and Imaginative Thinking; Creativity; Drugs, the Brain, and Behavior; Electroencephalography; Free Will; Genius, Eminence, and Giftedness; Hypnosis; Meditation: The Science and the Art; Memory; The Mind–Body Problem; Near-Death Experiences; Psychology and Religion; Savant Syndrome; Visual Perception.

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Environmental Cognition

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Glossary

Affective map Affective mapping as being the opportunity to plot on maps the feelings that particular places evoke. Feelings are shown by symbols, possibly supplemented with annotation. Where patterns of feelings can be identified on maps then areas can be shaded accordingly on drawings of the cognitive map.

Allocentric frame of reference Frameworks that are fixed to the environment itself or to the individual object.

Being lost Lost is defined as being unable to identify or orient present one's location with respect to known locations; and having no effective method for reorientating oneself. Note: one can have little accurate knowledge of where one is, but not be lost.

Cognitive map A construct which enables a person to predict the environment which is too large to be perceived at once, and to establish a matrix of environmental experience into which a new experience can be integrated, simplifying and ordering the complexity of human–environment transactions. Investigators often capture the individual's cognitive map by asking for a sketch map to be drawn.

Dead reckoning (or path integration) The process which enables a traveler to constantly update their current position

with respect to their starting point without recording details of the path already followed.

Egocentric spatial frameworks Frameworks that move with the body as it moves through the environment.

Environmental grammar The terms of reference acquired by an individual in relation to the spaces and settings around them, from which they develop the appropriate expectancies and hence, the corresponding search strategies.

Legibility The legibility of a city as "... the ease with which its parts may be recognised and can be organised into a coherent pattern" (Kevin Lynch).

Space syntax The general idea is that spaces can be broken down into components, analyzed as networks of choices, then represented as maps and graphs that describe the relative connectivity and integration of those spaces: (Originally conceived by Professor Bill Hillier, Julienne Hanson and their colleagues at The Bartlett, University College London in the late 1970s to early 1980s as a tool to help architects simulate the likely effects of their designs.)

Wayfinding The process of determining and following a path or route between an origin and a destination, as a purposive, directed, and motivated activity.

Introduction

Environmental cognition concerns the way we acquire, organize, store, and recall information about locations, distances, and arrangements in the physical environment. Other aspects of perception and cognition receive their own entries elsewhere in the encyclopedia: Why then is there an entry specific to the perception and cognition of the environment?

Most of the perception and cognition research in psychology concerns isolated objects, often studied within a laboratory, and without a broader meaningful context. In contrast, we are often surrounded by and are moving through the (hugely complex) environments that are the focus of study within environmental cognition. Theories of perception and cognition have always been central to psychology as a whole, and this is true of the relatively recent area of environmental psychology (qv), as individuals perceive, interpret, and respond appropriately to their surroundings.

Throughout our daily lives, literally hundreds of spatial decisions are made each day. These rely not on formal reference systems such as maps, but on previously gained spatial representations of the environment. Environmental psychologists define these as cognitive maps. As a result, the environment has a profound effect on human cognition, action, and well-being.

The Nature of Stored Spatial Information: Analog, Propositional, or Both?

We encode and manipulate environmental information in numerous ways. Evidence exists for two kinds of coding: propositional and analog, as in a Conventional Map. The propositional storage of environmental information, in lists and associated networks, is based on abstract representations of meaning. Analog codes, however, parallel the physical structure of information in the world, emphasizing continuity over space. Neither is sufficient alone: both are used according to need and preference.

People are able to convert propositional into analog: for example, the verbal descriptions of configurations or routes into mental representations. Thus, cognitive maps must be in effect both analog and propositional in nature.

Is configuration (or survey) knowledge metric or topological?

A metric representation would imply that distances and directions are directly encoded between environmental locations. Alternatively, if it is topological, then only the relative spatial relationships would be encoded.

Challenging any theory is the seemingly instantaneous development of configuration knowledge in certain situations as opposed to other cases where it does not seem to develop at all, even after extremely long periods of exposure.

The debate continues as to what constitutes configural knowledge as opposed to route knowledge. Most describe configural knowledge as a well-connected network of locations (or landmarks) with multiple potential paths between them. However, reasonable estimations as to the direction and distance of a remote location can often be made without creating a clear route plan.

The Way the Brain Acquires, Stores, and Handles Environmental Information. Can We Identify Key Structures?

The representation of space may be distinct from other forms of conceptual and perceptual knowledge. In many species of mammals, there have been identified specific behavioral mechanisms for locating objects, for dead reckoning, and for constructing cognitive maps. Such mechanisms probably also form the basis of human spatial cognition.

So what are the neural mechanisms supporting spatial cognition, orientation, and wayfinding? The discovery of place neurons in the hippocampus, and other evidence for the cognitive map theory of hippocampal functioning, suggest that this brain structure is the core of an extensive neural system for representing and using information about the spatial environment.

Evidence comes from lesion studies (damage invariably impairs place learning and navigation) and from neurophysiological recording studies, which show that neurons in this system code for location, direction, and distance, which are the elements needed for a mapping system.

A second brain structure involved in spatial cognition is the posterior parietal cortex, where multimodal sensory systems converge, and link to the motor cortex.

Evidence from lesion, human functional brain imaging, and human functional brain interference studies indicate that distinct areas within the posterior parietal cortex have different functional contributions.

But the core function of the parietal cortex in spatial cognition is the constitution of 'egocentric' spatial frameworks: that is, frameworks that move with the body as it moves through the environment.

In contrast, the hippocampus not only plays an important role in episodic and spatial memory but also provides a neural substrate for the representation of spatial location within an 'allocentric' frame of reference (i.e., frameworks that are fixed to the environment itself or to the individual object).

Thus, the hippocampus and the posterior parietal cortex would act differently by handling topological and metric information, respectively.

Only a close cooperation of both systems would enable the individual to 'overlay' and integrate the relevant egocentric and allocentric frameworks. This is the most important prerequisite for performing many of the complex spatial tasks successfully.

Cognitive Maps in Animals and Humans as Drivers of Action

Early psychology's account of a maze-running rat would be of a sequence of several stimulus-response connections

that formed a route to the goal. Success at getting there could not be taken as evidence that the rat had an image or cognitive map of the whole area: it might only be recalling a series of learned responses to the various choice-points in the maze.

But observations of a rat escaping from a maze and running direct to the goal (i.e., being able to integrate the various subroutes within the maze into a single direction) lead Tolman in 1948 to use the term Cognitive Map in explaining this ability.

Rather than state that animals, particularly the rats that took short cuts across his mazes, stored spatial information as a map, Tolman used the term Cognitive Map metaphorically. In other words, he suggested that the animals used in his studies appeared to be able to use spatial information as though the places they remembered were recorded in a map-like manner.

Much debate has since taken place on whether animals do have cognitive maps, or whether for example they use dead reckoning, or path integration, the process which enables a traveler to constantly update their current position with respect to their starting point without recording details of the path already followed. Without a memory trace of the path taken, exact route retrace might not be possible; but it would still be possible to return home directly with foraged food, or in the case of an emergency.

Much subsequent research has shown that birds and flying insects variously use landmarks, star and sun compasses, and magnetic compasses for their local, longer distance, and migratory travel. Are these landmarks, etc. used as a memorized sequence indicating a route to be followed or represented as a layout or survey overview? Careful and ingenious studies are needed to answer such questions.

The term cognitive maps had to wait until the early 1970s until it received wide usage in the literature about human spatial decision-making. Environmental and developmental psychologists, human geographers, and others have used the term with slightly differing implications, the broadest definition being the cognitive apparatus that underlies spatial behavior. More specifically it has been defined as a construct which enables a person to predict the environment which is too large to be perceived at once, and to establish a matrix of environmental experience into which a new experience can be integrated, simplifying and ordering the complexity of human-environment transactions.

To talk of a cognitive map is to imply that a human or animal cognizes the familiar environment as a system of interconnected places; is able to apply a set of transformation rules to this system, optimizing goal-directed movements; and is able to pilot and perform novel routes within it.

Decisions about action are not, however, purely based on knowing where resources and routes are: that is, the factual aspects of the cognitive map. They must also relate to the attributes, meanings, and values that shape behavior: we should thus talk of an affective map.

Therefore, we should see cognitive-affective maps as integrating images, information, and attitudes about an environment.

They are not isolated and contextless entities: they are formed during purposive and social activity in the person's

everyday world. Wayfinding (see below) relies on landmarks imbued with meaning.

Cognitive maps are in effect a series of knowledge (and feeling) structures which consist of different levels of detail and integration. These knowledge structures develop with age, education and experience, thus increasing the information and associations held. We in effect extract and combine information according to the task in hand: that is, there is no one cognitive map in memory but rather we construct them for specific events.

In this respect cognitive maps are dynamic, and are far from a standard cartographer's map, in that they are schematic, incomplete, distorted, simplified and idiosyncratic. The metaphor of a map in the head is so persuasive that we are tempted to believe that there is no metaphor, but rather a real 'thing.'

The main argument against such a cognitive map construct is the non-Euclidean properties discovered by some methods of investigating our knowledge structures, and the fact that we have incomplete knowledge not integrated into one single 'map' but rather disconnected components.

People's behavior in large-scale environments can be explained more completely through recourse to internal, subjective factors than by more traditional external, 'objective' factors. Ask people to plan a shopping trip round town with a map in front of them, and you may get a 'rational route'; but plot an actual trip that they make, and immediately these more subjective factors are seen to come into play.

The capacity to act and move intelligently through space may well occur before, and possibly in the absence of, the capacity to represent that space.

Very young infants can navigate in ways that demonstrate detailed spatial knowledge well before they could attempt any public representation of that knowledge by, for instance, drawing a sketch-map of a familiar area.

Sketch-mapping has nonetheless been a technique widely used by researchers trying to elicit the elusive cognitive map, despite the obvious limitations imposed by people's general ability to draw. Systematic distortions can be demonstrated in such external representations: distances become exaggerated in areas which have many features of interest, and correspondingly telescoped in less-featured areas; angles are misremembered, such that the map does not fit together; whole areas are neglected.

Some researchers have preferred instead to ask subjects to estimate a series of relative distances and angles, and thence to use multidimensional scaling to reconstruct an underlying cognitive map, thereby avoiding individual differences in drawing abilities. Other techniques have included locating points on a base map; recognizing features on aerial photographs; and obtaining think-aloud protocols.

Even within the sketch-map technique, very different impressions of the presumed underlying cognitive map can be obtained according to the particular demand that the researcher's question imposes; and how much prior spatial cueing is offered. No single test is best.

And some may indeed be misleading: consider that if humans conceive of space as collections of familiar landmarks, then the spatial representation of landmarks is thus

qualitative in the sense that it is imprecise: it does not depend on precise metric information, and therefore should not be elicited as if it were.

Direct and Indirect Sources of Information About the Person's Environment

All senses can be involved in one's direct learning about the environment; but the sense most studied is vision, justifiably so, as this sense affords one the most immediate, complete, detailed relational information about the surrounding environment. Whatever the scale, whether it be at the moment one enters an unfamiliar room, or one has a 360° view from a mountain top, vision provides an instant ordering of the elements of the room-scape or landscape, in a way that tactile exploration of a room could only slowly and partially allow. (In section 'Environmental Cognition Without Sight; and Devices for the Blind,' cognition of space without vision will be further considered, along with measures to afford the blind better awareness of space.)

Visual exploration of the space around the newborn starts from the earliest; and as soon as the infant is capable of active movement, investigation of the immediate environment leads to the integration and interrelating of multiple viewpoints when moving through. These integrative skills in developing a cognitive map of the layout of a room and then a house will be used in wider and wider contexts, from immediate neighborhood up to whole township, district, and region.

Perfect integration, however, is not easily achieved: people find it difficult to interrelate places on different floors of even a familiar house; and can often be surprised to see how close two places in different sections of town are when they are separately known from different habitual journeys, especially if they cannot be both seen at the same time. (The aerial view of a familiar place often affords surprised discoveries.)

Such an overview can also be provided by a surrogate: a map, whose *raison d'être* is to show these interrelationships and locations. We can learn relative distances and locations via such a representation, and plan efficient journeys with their aid. (As section 'Communicating and Sharing Environmental Information' will claim, there is evidence that the act of mapping is a cultural universal.)

In many cases, our knowledge of a particular area derives from both direct and indirect inputs, from exploration and map-use; and the interrelationship of these two in the cognitive map is fascinating but as yet understudied.

Cognition of more distant environments may be predominantly or entirely from indirect sources: not only maps but also television, film, photos, textbooks, travelers' tales, etc. Such sources must inevitably offer only a partial and selective view of a place and its people, and may indeed be a source of prejudices or of over-optimistic expectations.

Even the very names of distant places may convey information (sometimes misleading: think of Erik the Red's propagandizing naming of Greenland as a good place to settle and farm).

Maps may be our primary graphic source of information at the global scale, and information and impressions drawn can be influenced by the map-projection selected.

Communicating and Sharing Environmental Information

How do we communicate our environmental information to others: for example, in sharing information about the location of resources, or directing others to a destination?

Whether this is given via spoken instructions, or in graphic form, the process involves selecting a subset of the stored information, selected partly as a result of the sender's articulatory or graphicacy, and partly with regard to an appreciation of any shared understandings with the receiver of the message. An interesting insight into the selection process can be given by this simple comparison: first ask for verbal instructions; and then on another occasion, ask for them to be given graphically: subtly different subsets of information will be received.

How successful can we be in communicating route knowledge verbally? Studies indicate that remembering and following route directions can be facilitated by presenting the receiver with directions in the correct temporal-spatial order; concentrating information in statements concerned with choice points; suppressing irrelevant (decorative) detail; and by offering referents with which the listener will be familiar. Not surprisingly, navigation from good descriptions results in fewer mistakes than navigation from poor descriptions.

It has been claimed by the geographer Blaut that mapping is a universal in human culture; that it is an important ecological adaptation in all cultures (and the supportive evidence from the anthropological literature is strong); that map-like models of one sort or another have been made in all cultures since prehistoric times (again, there is strong support from the archaeological record); and that mapping ability emerges naturally (without training) in very young children of all cultures, a proposition hotly contested by conventional Piagetians.

The Piagetian position maintains that children younger than seven are 'preoperational' and therefore cannot handle or interpret the conventions involved in maps: of change of size, aerial perspective, symbolism, etc. However, many studies with much younger children show them capable of understanding such conventions and being able to use relatively simple maps to guide their own behavior.

Thus for example, 3- and 4-year-olds can use a simple map of a maze to reach their goal (i.e., a local area map); and cannot only understand that an aerial photograph can represent a familiar larger scale area, but can use it to navigate to 'hidden treasure.' At a larger scale again, young preschoolers can use an aerial photograph of a city to tell a story about imaginative journeys across it, demonstrating clear understanding that the size-reduced, aerial-perspective features on the photograph stand for real, full-scale buildings, roads, trees, etc.

These untaught (hence 'natural') mapping abilities of preschool-age children have been studied in many cultures. And confirmatory evidence comes from toy play, in which many young children have been able to use elements of a map (schematic roads, houses etc.) to describe imaginary places and journeys.

So, instead of the restricted, Piagetian, view of young children's environmental cognitive abilities, the evidence from many such studies using aerial photographs and simple maps would seem to indicate that the cognitive modeling of the environment may be an ecological necessity. Young children in every culture seem capable of modeling, in two or three dimensions, the landscape as through viewed from overhead and reduced in scale; and this is prominently assisted by toy-play and by constructing imaginary maps of what the world may look like from overhead. Do not children everywhere make model landscapes with toys on the floor or markings on the ground?

The Development of Environmental Competence

In early childhood, we have to develop our general competence in understanding and navigating environments: this will take a period of years (though probably not as many as early developmental psychologists believed). As competent individuals, we still have to develop competence with respect to places newly encountered: this will start immediately, with our first impressions, and we will rapidly acquire a survey structure, to which extra information will be added as our travels through the place continue.

The first, the development in early childhood of the basic competence, can be called the Ontogenesis of competence. The second, the application to a new place, can be called Microgenesis. Some theorists have suggested that the stages in microgenesis recapitulate those seen in the ontogenesis of competence.

Perhaps the trend in developmental psychology to stress the lack of early competence in many areas, including spatial, can be mainly attributed to Piaget. Famously, in considering the young child's failure on the 'Three Mountains' experiment, (describing what a toy figure would see in a model landscape as being what the child was seeing, regardless of the toy's position), Piaget generalized this as evidence of an inevitable egocentricity before 7 years or so.

Critics have suggested that young children find the instructions in these classic experiments confusing; and that with more careful testing, we can see nonegocentric thought evident in much younger children.

But it is clear that the youngest children are not fully competent, and do go through a number of stages in acquiring it. The account given, by Siegal and White, has become the predominant (but not unchallenged) one.

They suggest that initially, knowledge is structured around landmarks. The second stage is where such locations are linked as route knowledge; and only at the third stage can the individual be said to have survey knowledge. At first, the space between the known points or landmarks is 'empty'; and the individual cannot relate them to each other. Developing knowledge of set routes gives the individual the beginnings of a structure, but to start with it will consist of a series of local directions at decision points, with little accurate idea of distances. Survey knowledge encodes both distances and directions between landmarks, and allows more innovative route discovery.

The attractiveness of the Siegal and White sequence is that it can describe both the slow build up of the general skill during

early childhood, and the rapid acquisition of knowledge about a newly encountered place by a skilled older individual.

The original account of ontogenesis does not specify how long it takes the young child to progress through the stages, but implies early incompetence lasts several years. Does the empirical evidence bear this out? As we saw in section 'Communicating and Sharing Environmental Information,' Blaut and colleagues suggest not.

Similarly, the account of microgenesis, suggesting that the survey is dependent on accurate estimates of distances along routes and between landmarks is open to empirical challenge; and Montello has recently shown that spatial knowledge, including this metric knowledge is acquired gradually through continuing experience of the new place. And the eventual 'map' may well still include inconsistent data: a geometry of estimates which do not fully match up.

When investigators ask respondents to draw a sketch map to represent the individual's survey knowledge, the very demands of the task may produce apparent consistencies which are not borne out by that individual's actual behavior in the real world. Only a very few studies have taken the time and care to study the actual process of microgenesis over the days and weeks that it may take to develop survey knowledge of a new place; and although they give some support to the landmark-route-survey sequence, it is clear that the resultant 'map' is highly individual, relates to the pattern of the individual's exploration and interests, and will contain both highly detailed and completely ignored subareas. Adults learn some key landmarks very quickly, and start anchoring new knowledge to major, features routes and boundaries. Direction and distance estimates can develop rapidly, and then level off as habitual local travel patterns are established.

But do adults integrate newly learned routes into metrically accurate map-like survey knowledge? Could they demonstrate this by, for example, accurately navigating a novel short-cut? Experimental studies of microgenesis show that people make these short-cuts in roughly the right direction and distance; but only at a low level of accuracy, and that the implied cognitive map is not fully Euclidian. People making short-cuts are highly dependent upon visible landmarks.

Returning to the studies of ontogenesis, there are only a few studies with the time to follow the whole process through; and most are reliant on tests of the young child's competency at particular ages. These latter would be carefully controlled tests of spatial problem solving (often at table-top level) and spatial cognition, rather than studying what children are actually doing within their real world. Developmental psychology's study of children's cognition in general has placed little emphasis on the ecological or sociocultural factors supporting and developing the competencies. In contrast, from the start, environmental psychology has sought ecological validity for its studies, and sees the individual and their environment in transactions right from the start of life.

If one tests children with unfamiliar materials and in strange contexts, then they are less likely to demonstrate the skills they have developed in their everyday transactions with the world. Culturally aware field studies of children's spatial behavior by Hart, for example, have shown how independence of travel by the young directly relates to their levels of local knowledge and thence their basic spatial competences.

Wayfinding, Becoming Lost, and Signage

Environmental cognition, it could be argued, has its main role in supporting wayfinding: in the planning and carrying out of routes through the environment, in locating resources and avoiding dangers, and having an awareness of possible novel routes were the need to arise.

This involves long-term spatial memory of places and their attributes, survey knowledge of spatial interrelationships, and accessible place-tagged lists of resources: in other words, a way of linking survey with listed knowledge.

Individual differences in success in wayfinding are often anecdotally recounted, but can be borne out in part by research: factors involved include people's spatial processing abilities, as well as lifetime experience with spatial problem solving in full scale environments (often related to an individual's drive to explore and to seek novelty). Other, more situation-specific factors can include: familiarity with a particular setting (and previous experience of similar types, developing an 'environmental grammar'); the density and salience of landmarks, and the complexity and ambiguity of the layout.

All models of wayfinding distinguish between the processes of the planning of a route, and its execution via actions that are time- and place-appropriate. There will be a hierarchy of processes which unfold as route-following progresses: for example, there will be a sequence of expectancies, to find particular landmarks (maybe personal markers) at expected places. Where such expectancies are not met, the traveler will have to formulate a new plan. Where this does not work, the person may react as being lost (see below).

Routes to distant places may be planned only at a coarse level, but closer to target the planning will become much finer-detailed (in the same way that migrating birds' strategies shift from the general directional to the specific when arriving close to the familiar end of route).

Wayfinding strategies have been studied using a range of techniques. Verbal report protocols, whether given en route or in retrospect, may be vivid, but can only tell us of the processes people are aware of and can articulate. They can, however, demonstrate this two-stage process of an initial plan-formulation stage and a detailed plan execution, in which new and possibly unexpected features can be reacted to. Analysis of such protocols can also show that initially rational plans are often subverted by chance events and sightings en route.

Eye-tracking techniques will pick these attentional patterns as people travel a real or indeed a virtual route; and can be used in conjunction with protocols. Recent studies have added fMRI to this range of investigative tools; and together, they can track the moment-to-moment changes in the way environmental cognitions direct responsive wayfinding, adding to the stock of place-located knowledge as they go.

Such studies highlight individual differences in route planning and following. A small proportion of people report using cardinal directions; more use an egocentric frame of reference. Occasional individuals report planning the route back from the goal; more often, the plan is assembled from well-rehearsed segments, even if a novel route might have been more efficient. Studies of specialist wayfinders, such

as taxi-drivers, have used the full range of investigative techniques: their ability to produce highly detailed accounts of what they had been thinking during wayfinding can be corroborated by eye-tracking data.

Study of human spatial cognition should contribute to the design of buildings and local layouts which are more easily understood. Complex buildings such as hospitals and airports, which are multilevel and perhaps counter-intuitive, are likely to lead to wayfinding difficulties which good signage can only go part way to resolve, particularly if individuals are stressed or anxious at the time. Design guidelines might include architecturally unambiguous entry-points, after which there could be early open areas which enable users to survey the possible routes forward. Transitions between floors and areas should be clearly signaled, and distinctiveness planned in with a view to developing the newcomer's cognitive map of the area, perhaps with the aid of a well-designed and orientated 'You are here' map, to shape a new local cognitive map. Signage must then support and develop this information, be consistent, frequent, and comprehensible. There are implications for the signage of emergency exit routes: research indicates that under stress people do not so much panic as resort to more basic route-following strategies; and could well be better guided to safety by vocal instructions over a loud-speaker system.

'Being lost' has been studied by environmental psychologists advising police and rescue services, using case studies to show how people of different ages (and skills) are likely to react; and thereby psychology can suggest optimal search strategies. If the missing person is a child under 3-years-old in open country, for example, they may not even think of this as being lost: after a brief exploration of a small area, they are likely to find a local place in which to shelter, thus becoming hidden from searchers. In contrast, a more confident older child or adult is likely to travel much larger distances in attempting to return home, perhaps using faulty search strategies in their increasing alarm. During the preceding travel in a novel area, the landmarks may have only been sketchily encoded, and so the would-be returner may use falsely remembered cues, and travel considerable distances from their start.

The Legibility of Places

This section considers the concept of legibility and interpretability of buildings, areas, whole townscapes; and whether legibility can be a key link to the aesthetics of buildings and places.

Some environments are easier to cognize than others: the concept of legibility was introduced by the planner Kevin Lynch to describe this ease with which one can form a cognitive map of a city. Asking what makes a place legible, and analyzing the sketch maps drawn by residents, he suggested that legibility is facilitated by the presence and organization of five main elements:

Paths: the travel corridors of the city

Edges: features which limit or enclose districts (e.g., rivers)

Districts: subareas with common, distinctive features (e.g., architectural, functional)

Nodes: points of intersection of key paths

Landmarks: visible and distinct features (e.g., tall buildings)

The presence of such elements helps one to organize observations and knowledge of a city: by chunking it into districts, one can cope with possible information overload.

Cities that have a clear spatial structure and physical distinctiveness are easy to 'read,' enabling clear cognitive maps. But what of the link to aesthetic appreciation of places? Many places which are famed for their beauty do indeed have high legibility.

But there can be townscapes that are highly legible, yet which fail to engage our aesthetic or emotional response. In addition to Lynch's list, the architectural quality of the elements, the balance between simplicity and surprise, the level of visual and actual 'clutter,' and the presence of natural features, including water, have all been shown to contribute to the judgment of environmental quality. Level of upkeep, maintenance, and indications of care also contribute to the positive impression.

As an example of simplicity and surprise, a town which reveals itself straightway to the newcomer is adjudged less interesting than one which unfolds as one travels inwards; but beyond a certain level of complexity, this can become aversive and confusing. Similarly, the most positive aesthetic judgments of individual buildings can be shown to relate to an optimal middle range of complexity.

Formal aesthetics includes the idea of order and variables such as rhythm, complexity, and proportion. Symbolic aesthetics has been defined as "pleasurable connotative meanings associated with the content of the formal organization".

Many studies have shown that the presence of natural elements in a scene can evoke positive emotions, induce positive physiological conditions, facilitate cognitive functioning, evoke positive and prosocial behaviors, and help restore the individual. This is true whether the scene is experienced directly (walking through an area) or indirectly (viewed through a window, or even seen in a picture).

Restorative environments and scenic beauty may be linked. Kaplan's Attention Restoration theory states that exposure to restorative environments engages fascination or low-effort attention, promoting recovery and the opportunity to rest and reflect. In contrast, exposure to nonrestorative environments engages directed effortful attention and negatively affects mood, performance, and psychophysical well-being.

Eye movements are a way to measure attention when viewing a scene: they are unconscious adjustments to the demands of attention during visual experience.

Eye movements related to photographs low on fascination were characterized by greater exploration and a greater number of fixations compared to those rated high on fascination, though the viewing time was the same. Scenes high on fascination were viewed without really focusing on particular features. Differences in eye movements suggest that less effort is required to view nature than urban scenes, which is consistent with Kaplan's description of 'soft fascination'; which itself derives from William James' distinction between involuntary and voluntary attention.

Environmental Cognition Without Sight; and Devices for the Blind

Vision must be accepted as the most important spatial sense, for developing the cognitive map and for updating it as the individual travels. Yet blind and visually impaired people can become accomplished independent travelers using the other senses, sometimes supported by traditional and modern technological aids.

Some 30% of adults with visual impairments make no independent journeys out from their home; and many others only use a few set routes. Hence studying the cognitive maps of the blind, and their development, can have a social as well as academic purpose.

Early theories stressed Deficiency: stating that the congenitally blind would be unable to develop a general spatial understanding because they would never have experienced the necessary perceptual process: this has been experimentally discredited.

In contrast, Inefficiency theory argues that awareness from auditory and haptic cues will be less efficient than that from sight; and as a result, the blind will depend upon route-based rather than survey or map-like ideas for travel.

Much empirical evidence now supports the Difference theory, which proposes that visually impaired people possess the same abilities to process and understand spatial concepts, and that although functionally equivalent to the sighted, they are carried out in a different albeit often slower manner. Their spatial reasoning, like an internalized geographical information system, may combine image-based cognitions, which will hold relative positions of places within a frame; and language-based cognitions, which will code place a set of propositions.

For the sighted, much exploration is done visually, and a whole new scene generates a new local cognitive map, with all its implications for action. For the blind, usually much more exploration will be needed to gain information about a new place.

Mobility teachers working with blind children have described them as 'movement recallers' who have movement memories, rather than visual image memories. Their cognitive maps include the relative positions of objects (which act as local landmarks), and the routes leading to, around, or away from landmarks, are composed of movement memories.

Some individuals develop skills which enable them to achieve very accurate independent travel, using, for example, careful sensing of the position of walls. Others will rely on supports such as canes and guide dogs for their mobility. A whole range of higher technology devices are being developed: some of which are located out in the environment (e.g. acoustic beacons and 'talking signs'), others of which are handheld devices providing updatable local information. Attempts have also been made to translate visual information into haptic, to simulate the visual overview.

And tactile maps have been used for many years with great success to develop the blind traveler's spatial expectations of a new area; these can afford perhaps the most immediate sense of the layout and features of a place yet to be explored.

Individual, Specialist, and Cultural Differences in Environmental Cognition

Popular beliefs abound about differences between the sexes in spatial awareness and skills; similarly, claims have been made for special awareness among specialist groups (taxi drivers, orienteers, etc.); and for different cultural groups. What is the empirical evidence?

The most controversial is the issue of sex differences: there is evidence to support the contention that there is a relationship between some measures of spatial ability and the accuracy of cognitive maps. Males may frequently outscore females on spatial tasks which involve the mental rotation of abstract figures (and thus visualization), and on some table-top scale manipulations. But these may not translate into a real-world advantage, where wayfinding, map use, and place learning are involved. There are many spatial tasks where the sexes do not differ, or so substantially overlap that personal styles in learning and recall become more important.

How could we assess individual differences or gender differences? We should differentiate between wayfinding tasks and wayfinding means. Tasks include traveling to a previously known destination, exploration with the purpose of returning home, and traveling to a novel destination.

Means include oriented search, following a continuously marked trail, piloting (between landmarks), habitual locomotion, path integration, and reference to a cognitive map.

Truly individual differences do exist: there are a few people who perform at astonishingly high levels, and who can acquire surprisingly accurate metric knowledge relatively quickly, including relational knowledge about places between which they have not directly traveled. Could we train other people to gain a better cognitive map of the environment? What are good strategies adapted to people's existing strengths and experience?

For strategies seem to be key to understanding the acquisition of the exceptional spatial knowledge of a city by its taxi drivers and other specialists; and the heightened awareness of environmental cues developed by groups as various as prospectors, hunters, police, rescuers, hang-gliders, and divers.

The whole of the anthropological literature attests to similar sensitivities being developed in support of living in particular settings. Where these settings are especially challenging, then again a heightened awareness of subtle cues for wayfinding and resource-location can be seen as vital to survival. There are, for example, well-attested accounts of the sensitivity of Aboriginal peoples to individual rocks and plants as cues when traveling through the Outback of Australia; and of the Polynesian voyagers' heightened awareness of the significance of cues in the sea and the stars.

Electronic and Other Devices for Storing and Using Environmental Information

What impact upon the individual's environmental cognition have the various electronic devices for storing and presenting information? In-car satellite navigation and pedestrian

navigation assistance systems for wayfinding provide route-based information, generally without any survey context, and demonstrably reduce the user's spatial information processing to a minimum. Driving simulators and virtual travel via a computer screen are likely to offer something closer to real-world exploration; but still here, knowledge acquisition and the development of survey-understanding of places will be inferior, and indeed the less-realistic conventional map of a place will afford better survey and route knowledge.

Navigational assistance systems are nonetheless helpful and supportive for the newcomer, often providing a sequence of view-based (i.e., egocentric) visual images together with directions for travel. Maps, in contrast, offer an allocentric perspective, giving a survey model of place by requiring more active spatial information processing.

Navigating real spaces using devices, or navigating large virtual environments, will be optimized if we can link them to 'normal' human processing of environmental information and be aware of its limitations: virtual information environments that offer 3D representations, etc. can overwhelm many users' abilities to filter and represent. As a result, users frequently experience disorientation in navigating large digital spaces to locate and use information.

Conclusion: As we have seen, the cognition of the environment differs from the perception and cognition of objects, the usual focus of studies within psychology, in more than scale. It guides decision making about movement through space; it is linked with feelings and aesthetics, which in turn may be associated with personal well-being. Research in this area has potential benefits for professions as diverse as architecture, the design of virtual worlds, and the mobility instruction of the blind.

See also: Ecological Psychology; Environmental Psychology; Our Cognitive Map; Perceptual Development; Spatial Orientation; Spatial Perception.

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Environmental Psychology

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Glossary

Behavior setting A location that consistently evokes certain patterns of behavior in those who are present.

Crowding The experience of insufficient space; to be distinguished from density.

Density A physical measure of persons per unit area.

Personal space or interpersonal distance The physical distance component of interpersonal relations.

Place attachment, place identity A strong person–place bond that develops through long or intense association; the place becomes part of the self.

Privacy The process of regulating the amount of social interaction in which one is involved; can mean solitude-seeking but can also mean seeking company.

Programming (architectural) Planning buildings to meet the behavioral and psychological needs of those who will use them.

Postoccupancy evaluation Evaluating buildings to determine whether and how well the architectural program was executed.

Social design Architectural design that emphasizes inclusive, grassroots, democratic participation by those who will use the building; interior function and meaning are more important than exterior aesthetics and ornament.

Social dilemma A situation in which group and individual interests are in conflict, often applied to resource management situations; individuals are rewarded more for self-interest behavior than for group-interest behavior, but if most individuals choose self-interest, the resource is extinguished.

Territoriality (human) A pattern of attitudes and behaviors related to the perceived or actual control of a physical space, object, or idea; acts as a mechanism for the peaceful regulation of space use much more often than as a source of aggression.

Environmental psychology is the study of transactions between individuals and their built and natural settings. It assumes that the actions of persons change the environment and that their behavior, experience, and well-being are changed in turn by the environment. Environmental psychology includes basic scientific research aimed at understanding person–environment transactions and practice that applies this knowledge to improve human settings.

Background, Theory, and Method

As an organized discipline, environmental psychology originated in the late 1960s, but some social scientists had studied person–environment transactions for decades before that. Considering the enormous investment society makes in the construction and maintenance of the physical environment, including buildings, parks, and public outdoor settings, and its massive use of natural resources, the long delay before person–environment relations received adequate attention seems odd. However, many studies have dealt with the major topics within environmental psychology since the late 1960s. Much of this work has been stimulated by the recognition of environmental problems such as climate change, crowding, pollution, energy shortages, and unsuitable buildings.

Theories in environmental psychology are diverse. Some emphasize central psychological processes such as stimulation and control. The common occurrence of too much or too little stimulation is the focus of adaptation-level, arousal, overload, underload, and stress theories, which predict that a wide range of behaviors and experiences will be affected by one's level of stimulation. Other theories emphasize the importance of the

individual's real or perceived control over the environment (e.g., personal control, reactance, learned helplessness, and boundary regulation theories). The ecological approach asserts the importance of the behavior setting, a naturally occurring small-scale social–physical unit consisting of regular patterns of person–environment behavior (e.g., a household or a sporting event). Integral or holistic approaches (e.g., interactionism, transactionalism, and organismic theory) describe the complete interrelationship of persons and setting. Finally, the operant approach downplays abstract principles and prefers a direct problem-solving approach that employs behavior modification techniques to deal with problematic environmental behaviors.

Environmental psychologists recognize that person–environment transactions are influenced by many different factors, which has led to multiple paradigms for studying them. A strong preference for performing research in the everyday world means that field studies are common. Sometimes, laboratories and simulated settings are used, primarily when a field study is not possible. True experiments occasionally are conducted; they are desirable when a researcher seeks to isolate particular causes and effects. However, quasiexperimental research designs are much more common.

Environmental Perception

Environmental psychologists prefer to study the perception of whole, everyday scenes. In doing so, they sometimes must sacrifice a degree of experimental control, but in return they obtain data on the perception of real, complex settings through which the persons may move and feel a real connection. Perceivers select certain cues from scenes and ignore many others.

Unfortunately, some cues they ignore may be important, at least in the long run (e.g., air pollution's effect on health). Environmental perception has been studied using verbal reports, time-sampling, behavioral inference, phenomenological methods, and combinations of these.

The available evidence suggests that perceptions of qualities such as length and distance are largely dependent on the physical elements in the scene and how these elements are arranged. However, personal factors such as perceptual ability, finding a setting pleasing, culture (such as being raised in a 'carpentered' world), and training (e.g., in architecture) also affect the very way a person sees the world.

The theories of Egon Brunswik, James Gibson, and Donald Berlyne each have had major effects on the study of environmental perception. Each began as a traditional (nonenvironmental) theory, but contained the necessary seed to be fruitful for environmental psychology: an emphasis on properties of stimuli. They have provoked considerable basic research into the nature of environmental perception, but they have also been extended into the practical domains of city planning, park planning, and architecture.

Environmental Cognition

How do people think about and find their way around the space around them? They do not acquire, store, and recall information about locations, distances, and arrangements like cameras or copy machines. Yet, our ways of doing so usually are effective and rule-governed. Spatial cognition – the way we acquire, process, store, and recall information about everyday settings – is studied by examining sketch maps, model construction or manipulation, distance estimation, and naturalistic observation. It is affected by one's stage of life, familiarity or experience with the setting, and several cognitive biases. Two common biases are to envision places as more grid-like or Euclidean than they actually are, and to mistakenly employ larger geographical entities in placing smaller ones (e.g., Reno is thought to be east of Los Angeles because it is in Nevada, which is generally east of California, but Reno is west of Los Angeles).

The study of cognitive maps reveals that legible places are easier to comprehend: they have clear paths and distinct edges, districts, nodes, and landmarks. The spatial cognition of children generally develops in a sequence that progresses from egocentric to projective to abstract. The spatial cognition of older people often is limited by lowered mobility or sensory abilities, and they may perform less well. However, their memories of the environment are more personalized and are, in some respects, better than those of younger people.

Experience in a setting gives one a richer, better organized cognitive image of it. Both landmarks and paths facilitate the growth of place knowledge. Where one of these elements is more common than the other, examples of it will be learned first. Male-female differences in spatial cognition exist, but may largely reflect the different travel experiences of men and women. The environmental cognition of urban forms is improved by clear paths and visible landmarks. At the architectural level, buildings that are tall, free-standing, distinctively shaped, and used often are better recalled than others.

Environmental Appraisal

Environmental appraisals are personal, subjective judgments of places; they may or may not be consistent with most other people's assessments of the same places. Environmental appraisals take six forms: description, evaluation, aesthetics, emotional, meaning, and concern. First, environments may be verbally described in many ways; a talented writer probably is best able to describe any particular setting. However, researchers have tried to develop standard sets of descriptors to assist the average person to describe places.

Second, environmental appraisals take the form of evaluations. These are influenced by such personal factors as age, sex, and familiarity with the place and by such objective features as room design, congruity, contrast, and complexity affect evaluations.

Third, the aesthetics of environments may be appraised. Environmental beauty is the concern of activists, planners, experimentalists, and humanists. Landscape beauty has been shown to be largely a function of the prevalence of certain elements in a scene, such as bodies of water, types of vegetation, and mountains, and the apparent distance to and the placement of these elements in the scene.

Fourth, emotional response to the environment is another form of appraisal. Emotional responses to environments are usually mild, persistent, and cumulative rather than sharp and brief. Nevertheless, they are a complex mix of behavioral, cognitive, and physiological responses.

A fifth form of appraisal is the meaning assigned by a person to a place. Two kinds of this meaning are the building's communication of an architectural or philosophical concept and the communication of its purpose or function. Some buildings communicate, in this sense, to observers, more than others.

Finally, people appraise places in terms of their concern (or lack of it) for the place or the place's potential risk to themselves. This is a form of appraisal for which behavioral consequences are of particular importance.

Environmental Assessment

Environmental assessments are measurements of a place's qualities that aspire to objectivity; that is, they attempt to measure the way an entire population segment, such as visitors to a national park, experiences a place. Environmental assessments may measure a setting's physical and spatial properties, artifacts and objects, traits, behavioral occurrences, or social climate. For example, do visitors to a park as a group find the park 'natural' or 'beautiful' or 'a good place to fish'? In contrast to environmental appraisals, they are place-centered (rather than person-centered), aim to measure physical properties (rather than psychological properties), are more often policy-oriented (rather than oriented to the understanding of perceivers), and more often employ observers with an expert or frequent-user relationship to the place being assessed.

Environmental assessments may use technical or human means of observations. Each has its place; neither is necessarily more reliable or valid; each employs a variety of instruments (machines for technical environmental assessments, or TEAs), questionnaires, or rating forms for human observers.

Observer-based environmental assessments (OBEAs) have at least five purposes. They allow for comparisons between TEAs and OBEAs, assist in the development of physical measures of environmental quality, provide data on environmental quality trends from the human perspective, provide assessments of quality along dimensions with particular human relevance, and educate the staff of the assessed setting as to its strengths and weaknesses.

Environmental Personality

The study of personality may seem antithetical to environmental psychology if one assumes that environmental psychology emphasizes the effects of settings on persons. However, personality is part of environmental psychology.

Two early personality theorists are important for environmental psychology: Henry Murray and Kurt Lewin. Murray's personology introduced the concepts of alpha and beta press (the actual and perceived power of the environment to affect one's welfare), and internal and external proceedings (subjective and objective accounts of the initiation and completion of a behavior sequence). Lewin's field theory, which conceptualized persons as actively interacting with their environments in their life spaces, produced the famous formula $B = f(P, E)$. One's representation of the physical environment and some elements of the unrepresented physical environment (the foreign hull) affect one's behavior and experience. Lewin's action research concept, in which theory and application are fused, guides many environmental psychologists today.

Numerous modern systems for conceptualizing environmental personality have been described, but the most developed is the Environmental Response Inventory, created by George McKechnie. It assesses eight dispositions: pastoralism, urbanism, environmental adaptation, antiquarianism, stimulus-seeking, environmental trust, need for privacy, and mechanical orientation.

Some traditional personality measures also assist in the understanding of behavior that has environmental significance. For example, extraverts generally prefer smaller interpersonal distances and may experience less stress in higher density situations. Persons with an internal locus of control also prefer smaller interpersonal distances and tolerate high density better than those with an external locus of control.

Personal Space

Personal space refers to the interpersonal distance chosen during social interaction. It varies with and reflects the rise, current status, and decline of relationships. Alpha personal space is the objective distance between interacting individuals and beta personal space refers to the experience of that distance. Edward Hall described four zones of increasing distance that depend on the closeness of the relation between the two persons.

Personal space may be predicted in part from knowing an individual's characteristics. Males typically use larger distances than females. Young adults typically use more personal space than children. Interpersonally warm and nonanxious individuals probably have smaller personal spaces than others.

Psychological disturbance often leads to more variable or inappropriate personal space. These personal influences on personal space also have interactive effects: to predict a person's personal space choices accurately, one must know the person's age, sex, race, culture, and personality.

Social and physical features of the situation also affect interpersonal distance. Attraction, cooperation, and equal status are associated with smaller personal space; stigma and unequal status lead to larger personal space. People seem to prefer more space when the physical environment offers less room. These factors combine to produce interpersonal distances that are different from what would be expected from the consideration of each influence by itself.

Culture is a major modifier of interpersonal distance. Some evidence exists for a continuum that ranges from the closeness of Arabs and Latin Americans to the distance of English and Germans. But differences within these groups, occasional results that do not fit this neat pattern, and other factors such as the language one speaks during a particular interaction, all affect personal space.

The individual's acquisition of the rules concerning interpersonal distance are probably well characterized by social learning theory. The functions of personal space are described by numerous minimodels based on concepts such as comfort, protection, communication, stress, optimal stimulation, and affiliative equilibrium. The social penetration model emphasizes the role of personal space in the rise and fall of relationships. The limits-of-compensation model highlights the outer limits of interpersonal distance, showing that as discomfort grows, interaction becomes more difficult. The approach-avoidance model hypothesizes differences between the desire to draw close to someone and the desire to keep one's distance.

Human Territoriality

Territoriality is a pattern of behavior and attitudes held by an individual or group that is based on perceived, attempted, or actual control of a definable physical space, object, or idea. It may involve habitual occupation, defense, personalization, and marking of that space. Environmental psychologists recognize seven types of territory: primary, secondary, public, interactional, body, object, and idea. The seven types of territory may be infringed upon in at least three ways: invasion, violation, and contamination. In turn, territory-holders may utilize preventative, reaction, or social boundary defenses.

Personal factors, physical and social aspects of situations, and culture can lead to territoriality. For example, males generally manifest more territoriality than females. Defensible space theory argues that physical arrangements increase territoriality feelings and behavior and that this increase leads to a decline in territorial invasions. These physical arrangements may be at the block or neighborhood level (e.g., altering traffic flow) or at the house level (e.g., fences and plantings).

Territoriality appears to increase with three social factors: ownership compared to renting, positive social climate, and greater competition for resources. Cultures differ in their expression of territoriality, although the question whether some cultures are *more* territorial than others has not been clearly answered. Territoriality is associated with a variety of

behaviors and experiences: personalization, aggression, dominance, control, and attachment. Personalization and marking are very common, may occur with or without awareness, signal ownership but do not always lead to active defense, and seem to offer psychological benefits to the territory-holder beyond merely informing the world of a territorial claim. Popular writers have exaggerated the relation between overt aggression and territoriality in humans. Territoriality does facilitate control of spaces, but this is usually accomplished through passive means that do not involve overt bullying of others.

Place attachment is the experience of belonging to a setting. Place attachment is an important process involving some of the closest person–environment bonds that humans experience.

Theories of human territoriality remain diverse, speculative, and largely untested. Ethology, organizational behavior, behavior settings, brain structure, and conflict resolution are some of the disparate concepts that underpin theories of human territoriality. The main function of human territoriality probably is the maintenance of order and identity in everyday life.

Crowding and Population Density

Crowding is the unpleasant experience of spatial restriction, whereas density is a physical ratio of persons per unit area. Crowding and density are not always correlated with one another. The notions of social versus spatial density, indoor versus outdoor density, and proximity have been advanced as ways to refine the density ratio into a variable with more predictive power.

At the personal level, personality, expectations, and preference influence whether an individual experiences a given situation as crowded or not. Internal locus of control, high affiliative tendency, a tendency to screen unwanted stimuli, a preference for high density, and an expectation for low density upon entering a place predispose individuals to experience less crowding when density is high.

Social influences can worsen or ease crowding. Sheer numbers of others will sometimes, but not always, produce more crowding. If others are watching or touching an individual (particularly a male), or one is engaged in disliked activities, crowding is worse even when density is equivalent. Being left out produces more crowding stress than sharing space with another person who is compatible. Objective, accurate information about high-density settings reduces crowding.

Crowding is also affected by the physical surroundings. It is likely to be worse when density is higher, the building is higher, the corridors are longer, the ceiling is lower, the walls darker, and when sunlight rarely finds its way in.

High indoor density usually leads to physiological and psychological stress, at least for those who prefer larger interpersonal distances or are socially isolated. Performance may be harmed under high density when the task is complex, when others are watching, and when performers must physically interact to accomplish a task. When a person's expectations about density are unfulfilled, performance may suffer: performance may even be worse in low density if a person expected high density.

High density often has negative effects, but under some conditions – perhaps when individuals perform activities in which they are already competent – it may improve

performance, through social facilitation. Inescapable high inside density harms a wide range of social behaviors, particularly for men. Except in prison, those effects take more passive forms (e.g., lack of helpfulness) than active forms (e.g., aggression). High density may enhance humor, but it almost always creates negative emotion. High density reduces one's sense of control; as a result, a variety of coping mechanisms are used.

Privacy

A major goal of human social behavior is to regulate the amount of contact one has with others to suit one's current need for interaction, which may be high or low. Privacy essentially is about the regulation of access to oneself. This access may be interactional, as in control over who is allowed to be with whom, or informational, as in who is allowed access to archival information about whom. Privacy has four faces: solitude, intimacy, anonymity, and reserve. Conceptually, privacy may be considered as a preference, an expectation, a value, or a behavior.

Privacy is influenced by personal characteristics. For example, city-raised individuals prefer more anonymity and intimacy. Women seem to manage privacy in close groups by discussing more interpersonal and intimate matters and men often achieve privacy by removing themselves from the setting and talking less about delicate matters. Individuals who have greater-than-average privacy needs are less sure of themselves and more anxious. Members of different cultures are believed to have similar privacy needs but, depending on how the environment supports those needs, may fulfill those needs in different ways.

The physical setting also has important effects on privacy preferences, expectations, and satisfaction. For example, open space at work often breeds dissatisfaction, whereas at home it is usually preferred. Its physical influences are both immediate, such as the doors and partitions surrounding people, and less immediate, such as the distance between houses and the number of neighbors visible from one's house. Privacy attitudes and behaviors vary from setting to setting.

Those who know how to use the environment to successfully regulate their privacy may be more successful in areas of life beyond the social realm. Some individuals adapt to or accept situations that would seem to offer too much or too little social contact. Others faced with a shortage of traditional mechanisms of regulating social interaction develop creative solutions to the problem. As a key process in our dealings with others, privacy is inextricably linked to communication, autonomy, identity, emotional release, and growing up.

Irwin Altman's model of privacy as an optimizing boundary-control process dominates, but other theorists have contributed ideas. John Archea, for example, reminded us that privacy has a strong environmental component. Maxine Wolfe and her colleagues note that privacy preferences, expectations, and satisfaction vary over the life cycle. Eric Sundstrom observes that privacy needs vary as a function of status.

Home and Community Settings

'Home' is a rich personal experience that may develop in a residence, which is the physical setting. Residential satisfaction

is a function of person and residence characteristics. The more congruent the residence is with one's stage in the life cycle and role in the family, the more satisfied one is likely to be.

Moving house is one outcome of residential dissatisfaction; it is a source of stress in itself. Individuals who have little residential choice or do not enjoy new settings experience even more mobility stress. Privacy and crowding are the biggest problems, primarily as they harm child development. High-rises seem inappropriate for children.

Resident lifestyle is reflected in the physical organization of the home. Home is an important place to experience the growth and relaxation that leisure can provide. Neighborhood satisfaction is related to such physical factors as the availability of nearby green space, general upkeep, and noise. Yet, these factors interact to some extent with personal characteristics (e.g., screening tendency, perception of control, and one's residence type). Neighborhood social ties may be less important than they used to be, except for a few determined groups such as religious enclaves.

Cities are stimulating, but their impact does not constitute an overload for everyone. Individuals apparently adapt to some stressors (e.g., air pollution) more than others (e.g., noise), in the sense of no longer noticing them, although their health may suffer in the long term. Vandalism and street art are different in motive and expression: vandals destroy settings out of a sense of revenge, whereas artists enhance settings while expressing social concerns. Crime and fear of crime are also important urban problems that may be eased in part through the application of defensible space design principles.

Aggression increases with air pollution and with temperature. Sunshine combined with moderate temperatures seems to increase helping. Noise in the community reduces helping, unless the other's need is serious. Interaction among strangers on the street generally follows a minimax principle: minimize interaction, maximize order. Frequent exposure to the same strangers, however, leads to a kind of distant affection.

Environmental factors in shopping include store location and layout, the display of goods, ambient music and noise, lighting, and shopper density. Research in the retail environment has been slow to emerge. This may be because its commercial value means that researchers report their findings to corporate sponsors rather than to public-domain journals.

Most homes are threatened by one or more environmental hazards, some natural and others technological. In the precalamity phase, governments attempt to reduce risk through engineering and education, but when neither of these is effective, many lives are lost. Specific warnings and awareness-raising simulations can help, but effective personal action is often blunted by the human tendency to bounded (i.e., limited) rationality: underpreparation for impending disasters, hasty, sometimes inappropriate responses to hazard mitigation once the disaster occurs, and misperception of hazard risks.

During most disasters, individuals generally interact in relatively rational and cooperative ways; the exception is a disaster that traps people in a confined setting. The outcome of disaster is stress in many forms. Some forms of coping reduce some forms of stress better than others. Community attachment and economic factors often prevent residents from vacating high-risk areas; they would rather see governments engage in massive public works to protect their homes than leave.

Work and Travel Settings

Work begins with getting to it. Most research on this has been concerned with encouraging commuters to help save energy. Environmental psychologists have created demographic profiles of car and urban transit riders, devised models of commuter preference, provided positive information about urban transit, evaluated existing transit systems, and studied the effect of reducing fares. This research has not yet had a very large effect on society's automobile addiction, but the more promising approaches are being sorted out from the less promising ones.

Once at work, physical influences play many roles. Noise has many effects. In industrial settings, it can cause serious hearing loss. Loud noise is particularly dangerous when employees do not realize that deafness comes slowly and almost imperceptibly. Despite conventional wisdom that noise interferes with performance, research in natural settings shows how complex the issue is and that performance decrements depend on the task, the person, and the type of noise. Noise does harm performance under certain combinations of these, but not under others. For certain tasks, noise may even arouse a person enough to improve performance.

Noise is a serious problem in open-plan offices. Employees find sound a problem both coming and going: sound entering their workspace is annoying and when their own words escape over partitions too easily, their privacy is compromised. Office noise may even affect important interpersonal behavior, from mere impressions of others to important judgments regarding them. Music may improve performance of well-learned cognitively simple tasks. Employees naturally dislike noise but, for the most part, they like music on the job.

The effects of temperature are also usually moderated by access to heavier or lighter clothing. The amazing variety of temperature effects reported are due to these measurement and clothing factors, as well as many others, including the degree of acclimatization, a knowledge of coping strategies, motivation, and the type of work. Engineers have described precise 'comfort envelopes,' but environmental psychologists have discovered that comfort depends on perception as well as actual effective temperature and that optimal performance may be found outside the comfort envelope. Stress occurs when individuals are initially subjected to effective temperatures farther outside the comfort envelope, but many persons can adapt to these more extreme temperatures after a long-term exposure to them.

Lighting affects work behavior primarily when it is insufficient (leading to low productivity, accidents and eyestrain) or improperly placed (leading to glare and eyestrain). Lighting often is excessive in North American offices and many individuals dislike the newer forms of lighting, some of which distort color. European lighting standards call for lower levels of illumination. Carefully placed local lighting could resolve some of these problems. Access to natural light and views is psychologically important.

Employees are very sensitive to space and unhappy with many existing arrangements. Many open-plan arrangements reduce desirable communication and increase undesirable communication. Office arrangements lead visitors to form impressions of the office-holder's character and status.

Yet, many organizations restrict the degree to which employees may arrange or personalize their offices and fail to consult with employees when offices are planned.

The environmental psychology of travel is a new but growing area. Travelers affect destinations and are, in turn, affected by them. Anticipation, travel itself, and the recollection of travel involve environmental perception and cognition. Recreational travel is a trade-off between familiarity and risk, and between economic growth and environmental degradation, but as society is able to provide employees with more disposable incomes and time, it is a trade-off many are pursuing.

Some destinations bring relief from anxiety, others throw travelers into 'environment shock.' Travelers ruin some physical settings and enhance almost none. 'Romantic' tourism (i.e., the search for more and more unspoiled destinations) may be an undesirable luxury. A more careful planning of destination sites might spread the impact of visitors, offer more authentic experiences, and educate travelers while offering them solace from the working world.

Learning Environments

Both macro (e.g., school and campus design) and micro (e.g., desk and room design) physical features of learning settings affect learning and related activities. Students in large schools have a slight advantage in the variety of topics they can learn about but, partly because time at school is limited, students in large schools do not actually participate in more activities than students in small schools. Students in large schools more often learn and enjoy as spectators; students in small schools more often learn and enjoy as participants. In most areas of learning, students in small schools achieve more as a result of developing competence through direct involvement in activities.

If satisfied teachers are better teachers, then sensitive construction or renovations of their workplace (the classroom) should be undertaken when necessary. Students often perform better in the room where they learned the material. Noise interferes with learning both while it occurs and, if the learner is subjected to noise for long periods, even after the noise is gone. Noisy classrooms may impair the performance of girls more than boys, that of autistic children more than hyperactive children, and that of most children when the task is difficult. Noise may hinder performance by interfering with information processing, lowering the student's perception of control, and increasing blood pressure. To combat noise, instructors have changed their methods – sometimes sacrificing an otherwise good method for a quiet one – and successfully employed behavior modification techniques such as sound-activated electrical relays that control reinforcers such as radio music and extra recess time.

Incandescent lighting is preferred by many, but it is more expensive than fluorescent lighting. Fluorescent lighting has not been shown to have dramatic negative effects on the performance or health of most students, despite some claims to the contrary. As with noise, light's effects may be on specific subgroups of individuals; when studies of whole classes or schools are done, large effects on a few learners may be obscured by an absence of effects on most learners.

A few simple, direct relations exist between indoor climate and educational behavior; some combination of person and setting variables may enhance or reduce the influence of climate. Perhaps the best-supported conclusion is that student performance is best in slightly cool but not humid classrooms. Preferred environmental conditions may not be the same as conditions that facilitate performance.

The amount and arrangement of space in educational settings is important for classroom performance and behavior. High density may affect learning when the activity involves physical movement around the classroom, when learning is dependent on some classroom resource that is not increasing as fast as the number of learners, when a particular situation appears crowded to a particular learner, and when the concept to be learned is complex. Among preschoolers, high density alters the child's choice of activities. Educational benefits appear to accrue in classrooms that have the teacher's desk in a corner, carefully arrange and separate different kinds of activities, possess library corners, and are carpeted. Action zone seating (the front and central area of the room) benefits some students. All these findings depend in part on grade level and teaching style. Space in classrooms affects student and teacher feelings. Most students and teachers prefer lower density classrooms, because lower densities usually feel less crowded.

Increased social density leads to increased aggression and withdrawal when other resources, architectural features, and teaching style do not counteract it. Classroom arrangements should provide optimal stimulation. The proper amount in any given situation cannot yet be specified, but the student's need for stimulation, the type of activity, and the length of time spent in the activity must be considered.

Environmental competence involves learning about the environment. Three varieties of it include (a) one's personal style, attitudes, and awareness of physical settings, (b) knowledge of physical settings, including technical knowledge, how to unearth new information, knowledge about how social systems control space, knowledge of person–environment relations, and (c) practical environmental skills such as scouting, matching, personalization, and creative custodianship. Programs in and out of school teach many different facets of environmental competence, from basic environmental ethics to campfire starting to architectural design.

Architectural Psychology

One main purpose of environmental psychology is to use the foregoing knowledge to create more humane buildings. Some buildings are human disasters while others are merely persistent nuisances to those who occupy or use them. As described by Robert Sommer, social design is a way of creating buildings that fit occupants and users better by involving them in the planning process. It is needed in societies that have splintered the building creation process into many specialist roles. Social design is a remedy for the malady in which architects see themselves primarily as artists, ignoring the basic needs and activities of occupants. This malady is now widely recognized, yet many buildings are still constructed or renovated without significant user involvement. Social design aims to match settings to their occupants, to satisfy a variety of principal player

needs, to promote personal control in the building, and to encourage social support.

The design process includes programming, design, construction, use and adaptation, and postoccupancy evaluation. Programming consists of three phases: understanding the needs of users, involving them in the possibilities of design, and translating their needs into design guidelines, goals the actual design should achieve.

Turning these guidelines into plans and reality is the job of architects and construction companies. Later, the environmental psychologist returns to monitor user behavior and adaptation of the new building. Postoccupancy evaluation examines the effectiveness of the program and design, using a variety of social science tools. Together with programming, postoccupancy evaluation is perhaps the major activity of practicing environmental psychologists.

Resource Management

A major application of environmental psychology is to improve the management of nature and its many essential but limited resources. Each person on the planet manages a steady supply of natural resources that have been converted into products. Some of these resources come from limited sources called commons, that is, a pool of desirable materials that may be harvested by a number of individuals or organizations that share access to it. Commons *dilemmas* occur when harvesting of natural resources may proceed faster than the resource can regenerate; individuals must decide whether to maximize their own gain or the gain of the group, including themselves. The idea may sound abstract, but it applies to so many everyday situations (e.g., recycling, littering, energy conservation, endangered species, lumbering, fishing, pollution, etc.) that it is useful as a powerful general concept.

The quality of resource management depends on the resource itself, characteristics of the managers, and the rules governing the harvest. Cooperation seems to decline as the importance of the resource increases and to improve as the resource is depleted – two ominous signs.

The results of many studies suggest that when a commons dilemma exists, part of the resource should be allocated to each participant to manage, that friendship and trust should be encouraged among the harvesters, that the number of harvesters should be kept small, and that harvesters should communicate, make public choices, and be subject to punishment for selfish decisions, although positive incentives for cooperation are even more effective. Further, harvesters should be given experience operating the commons, be required to make minimal contributions where they are suitable (e.g., in commons dilemmas where the harvesters must donate to keep the resource alive), and have the altruism in the commons pointed out to them. Last but certainly not the least, payoffs for cooperation should be increased as much as possible.

Several theories of social dilemmas have been described. Limited processing theory postulates that most individuals act

selfishly, not because they are evil but because the dangers of defection simply do not occur to them. Tragic choice theory maintains that self-interest cannot be overcome except by the creation of a very strong central authority; this is unpleasant but necessary for the survival of the commons. Social trap theory applies a reinforcement perspective to social dilemmas, suggesting that better management of the commons would follow from a restructuring of reinforcements. Equity theory emphasizes the importance of perceived equity in resource allocation. Cooperation may increase if participants believe others are receiving goods in proportion to the effort invested, no more and no less. But this can still lead to the extinction of a commons: if everyone works hard and harvests equally hard, depletion will occur, so equity alone is not enough.

Two social dilemmas are pollution and energy use. Pollution is a 'give-some' form of social dilemma: individuals or organizations profit by using resources, but degrade the commons with the by-products. Energy use is a social dilemma when it is easier to waste energy, particularly from nonrenewable sources, in the service of a short-term goal than to conserve it for the future. Important savings could be achieved in ideal conditions, which would include an integration of psychological, economic, and engineering contributions. Conservers include those with enough money to purchase energy-saving devices so they can save over the long haul, those who must conserve because they cannot afford much gasoline, air conditioning, or fuel oil, those who have adopted a voluntary simplicity lifestyle and feel a personal responsibility for energy problems, those who are willing to make moderate public commitments toward energy conservation, and those whose energy use is monitored and frequently fed back to them.

Conservation may be enhanced by some appeals from authorities. Educational campaigns seem to change attitudes, priming individuals for changing behavior, but do little to change behavior by themselves. Feedback and goal-setting approaches have achieved significant savings. A housing development that integrated several design innovations with a group of ecologically oriented residents will approach the upper limit of 50% energy savings.

See also: [Crowding: Effects on Health and Behavior](#); [Environmental Cognition](#); [Evolutionary Social Psychology](#).

Further Reading

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Episodic and Semantic Systems of Autobiographical Memory

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Glossary

Coherence The motivation for specific autobiographical memories to fit with abstract beliefs about the self.

Conjunction errors Memory errors in which one or a few details have mistakenly been confused with details from the memory of a different incident.

Correspondence The motivation to recollect accurate autobiographical memories that actually reflect the real state of the world.

False memory A memory that feels veridical but represents an incident that the rememberer did not in fact personally experience.

Flashbulb memory When an incident that is unexpected and highly emotional produces a memory that the rememberer feels is unusually detailed and accurate despite the passage of time.

General (or semantic) autobiographical memory A memory for either a personally experienced event that extended over several days or longer, or of a number of similar experiences summarized.

Hyperthymesia A memory syndrome characterized by extraordinary ability to recall specific incidents from one's personal experience and a tendency to spend large amounts of time thinking about such experiences.

Involuntary (intrusive) memories Specific life event memories that come to mind without volition; if their occurrence is bothersome, they are called intrusive memories.

Overgeneral memory A tendency to recall general multiday memories in response to a cue or request to produce a specific memory lasting 1 day or less.

Specific (or episodic) autobiographical memory A memory for a discrete, personally experienced event that lasted 1 day or less.

Specific autobiographical memories are memories of discrete life experiences that occurred in a specific time and place, usually lasting 1 day or less. Recollection of autobiographical memory involves a sense of reliving the experience, known as mental time travel. Autobiographical memory is used to establish a sense of personal continuity and identity, to form social bonds, to solve problems, and as the basis for projections of one's future. General knowledge of the self and acts of remembering are inextricably intertwined. This article considers both the structure of autobiographical memory as well as the processes involved in recalling them. In the first section, two theoretical frameworks for autobiographical memory structure are discussed. Second, basic memory phenomena which occur within this underlying memory structure are discussed. Third, the manner in which general knowledge about the self is maintained and updated is discussed. And finally, the failures of both general self-knowledge and specific autobiographical memories to accurately depict reality are discussed.

Episodic Versus Semantic Autobiographical Memories

Autobiographical memories and self-knowledge are two types of remembered information about the self. Most theories of autobiographical memory make reference to both of these types of self-relevant memory; that is, not only the memory for specific discrete episodes, but also larger units of self-knowledge. Two popular theories for the structural organization of broad self-knowledge and discrete autobiographical memories are addressed here.

The first theoretical approach, proposed by Endel Tulving, makes a clear distinction between semantic and episodic memories. General self-knowledge (e.g., being an introvert) is

abstracted from numerous specific memories to form a semantic memory about oneself. This semantic self-knowledge is represented in much the same way as semantic knowledge of the Civil War, which of course we never personally experienced. The recollection of semantic self-knowledge is accompanied by the experience of noetic awareness, a sense of knowing the information. Specific autobiographical memory, on the other hand, is represented with a high degree of detail as an episodic memory. The recollection of episodic memories is accompanied by the experience of autonoetic awareness, a sense of remembering in the sense of mentally reenacting the experience.

However, semantic self-knowledge might be stored in an independent semantic system or could be 'computed' from episodic memories during the recall process. Although this has been a controversial topic within certain scientific circles, research evidence has accumulated in support of the former option, showing that semantic and episodic self-knowledge are independent systems. Evidence for two independent memory systems has been provided in two veins of research: priming studies and case studies of amnesics. Klein and Loftus have demonstrated that the semantic system can be primed without affecting the episodic system and vice versa. Additionally, their research with a particular temporarily amnesic patient demonstrated that complete loss of episodic memory functioning does not impair memory for semantic self-knowledge.

In fact, this theory of distinct semantic and episodic systems is consistent with findings from multiple case studies in which patients with severe amnesia cannot remember detailed events at all, yet remain aware of general self-knowledge. Case studies with humans experiencing hippocampal damage, as well as studies with hippocampal lesions in rats, have demonstrated that the hippocampus plays a necessary role in memory.

Although memories are not actually stored in the hippocampus, it provides a sort of road map of other regions in the neocortex that must be activated to reexperience an event. Therefore, the hippocampus activates other regions to provide retrieval. Some researchers have suggested that semantic memory can be intact following hippocampal lesions because much of the information 'mapped' in the hippocampus has been overlearned and therefore represented in other brain regions surrounding the hippocampus. In short, semantic self-knowledge may be abstracted from episodic memories in the hippocampus.

Despite being distinct, these systems are believed to interact in normal memory functioning. When unique events are remembered they are stored in the episodic memory system, but as these unique event memories are joined by similar memories they may be abstracted into semantic self-knowledge. Therefore, when trying to recall an instance of behavior consistent with the self-concept, participants will often recall a broad semantic memory (e.g., 'I was always introverted in high school'). Conversely, when recalling an instance of behavior inconsistent with the self-concept, participants will often recall a detailed episodic memory (e.g., 'I remember going to a party on Halloween and being more extroverted than normal'). In theory, these separate yet interacting memory systems have evolved to allow fast, efficient recall of traits while also allowing this trait knowledge to be modified as new events demonstrate a consistent theme.

The second popular theory of autobiographical memory called the self-memory system is composed of the *working self* and the *autobiographical memory knowledge base*. The *working self* is a temporary activation of current goals which constrain the search for elements to be bound up in the memory. For example, a person trying to recollect his final exam in chemistry to help him study for an upcoming exam may be likely to include behavioral elements about his preparation before the exam. But a person trying to recollect the same memory to help him remember where he left his pen may be likely to include spatial elements about the location of the room. The self-memory system acts to construct memories consistent with current goals and the current sense of self, and to inhibit memories that are inconsistent.

These autobiographical memories are constructed by drawing from episodic (*event-specific knowledge*) and semantic (*long-term self*) components. Event-specific knowledge contains records of the microdetails of everyday experiences, which are quickly lost and become unorganized without ties to the long-term self. The long-term self is composed of a *conceptual self*, abstract beliefs about and traits of the self, and the autobiographical knowledge base, consisting of lifetime periods and general events. Unlike Klein and Loftus' distinction, however, the self-memory system posits a hierarchical arrangement of these episodic and semantic components, with lifetime periods (such as 'school years') at the most general level, general events (such as 'taking exams') at the intermediate level, and specific memories (such as 'final exam in chemistry 101') at the most specific level. Accordingly, the hierarchical arrangement must be navigated every time a specific autobiographical memory is recalled.

Based on the self-memory system theory, researchers have distinguished specific autobiographical memories, defined

as an event which occurred in a single day, from general autobiographical memories, which include events lasting longer than a day and categories of repeated types of events. Specific autobiographical memories are the result of successful generative retrieval, while general autobiographical memories are the result of a failed hierarchical progression from general memory traces to specific memories. For example, when asked to recollect a specific life experience involving the words 'ice cream,' a person may respond with 'I used to eat ice cream a lot after soccer practice' rather than the more specific 'I ate an ice cream cone during the fireworks display last fourth of July.'

The tendency to fail in attempts to recollect specific memories is known as *overgeneral memory*, and it is found in clinical populations (including those with major depressive disorder, posttraumatic stress disorder, and Parkinson's disease). However, some research has applied the same definition of specific and general autobiographical memory to the nonclinical population. Among other factors, a lack of executive resources has been shown to impede the hierarchical progression from general lifetime periods to specific autobiographical memories. In theory, people experiencing overgeneral memory are cognitively unable to move beyond the initial stages of autobiographical memory construction and therefore fail to proceed from the working self and abstract self-knowledge about lifetime periods to the specific details that will be bound to form a memory.

Therefore, one theory considers general self-knowledge to be stored independent of specific autobiographical memories, while the other considers general self-knowledge to be the first step in ultimately recalling a specific autobiographical memory. Despite the differences in terminology and research method, the need to distinguish specific autobiographical memories from some more general representations is a common thread among many theories. The conditions under which and the ways in which these two systems interact are explored. However, the basic features of remembering specific autobiographical experiences are first delineated.

Basic Phenomena in Autobiographical Remembering

Process of Construction

Like all forms of long-term memory, autobiographical memory is reconstructive rather than reproductive. The rememberer constructs a memory anew each time rather than reproducing a static representation. In the case of autobiographical memory, the process of construction involves a large number of brain areas and can extend up to 20 s in time. Most instances of autobiographical remembering begin with a voluntary search based on a cue or probe (e.g., 'When was the first time you saw your current favorite movie?'). People often begin by identifying a time period in their life during which the sought-for memory may have taken place (lifetime period, such as 'high school'), then they find generic examples of similar memories (general event memory, such as 'going to the cinema with friends'), and finally identify specific episodic memory traces that contain the elements of the desired memory (specific event memory, such as 'seeing *Titanic* with Belinda and crying at the end').

Indeed, studies using a think-aloud protocol demonstrate that people usually begin their search for a specific autobiographical memory by identifying a lifetime period or a general event type first. Brain imaging studies also verify the involvement of different regions of activation over time. The construction process begins with what appears to be the working self's activation in the left frontal lobe. The working self generates retrieval cues, then begins to activate relevant elements of the memory in the posterior temporal lobes and occipital lobes, which contain the specific features of relevant episodic memories. The elements of the autobiographical memory can include sensory (especially visual), spatial, emotional, linguistic, and narrative components. The initially activated areas in the frontal lobes and the activated sensory areas in more posterior portions of the brain are then bound together by the medial temporal (hippocampal) area. This precise pattern of neural activation is marked by the subjective experience of autobiographical recall.

Moreover, the search for elements to bind into a memory often begins by identifying an abstractly represented lifetime period in which to search. Frequent rehearsal of semantic and episodic memories is used to maintain *coherence* of the *long-term self*. Furthermore, the constant retelling of stories about the self is often biased and can lead to memory errors. Thus, both temporary and more permanent notions of the self guide autobiographical memory construction.

Amnesia and Hyperthymesia

Although virtually everyone develops the ability to recollect life experiences, there are extreme cases of those who can recollect almost nothing (amnesics) and those who can recollect almost everything (hyperthymesics) of their life experiences. The noted patient HM (Henry Molaison), for example, was unable to record any new memories of life experiences after the surgery that removed his hippocampi as well as his amygdalae and parts of the surrounding temporal cortex. Moreover, Henry Molaison was unable to recollect any autobiographical memories from several years before the surgery. Clive Wearing, who suffered hippocampal damage due to a viral infection, has similarly been unable to record memories of life experiences since his illness, and has few or no autobiographical memories from before his illness. Yet both Henry Molaison and Clive Wearing retained their knowledge, intelligence, working memory ability, and implicit memory skills, demonstrating the separation of autobiographical memory from other forms of memory.

At the opposite end of the spectrum are those whose lives are overfull of autobiographical memory. Jill Price contacted memory researchers for help understanding her inability to forget her life experiences and her obsession with remembering past events. Extensive testing revealed Price's virtually perfect autobiographical memory, but fallible memory for other types of information. Price's autobiographical memories come to mind unbidden and dominate her internal mental world. A handful of others with virtually perfect autobiographical memory have been identified, including Brad Williams, who can also provide detailed memories of his experiences for any given date. The two qualities of superior recall of autobiographical events and a great deal of time spent thinking about them define *hyperthymestic syndrome*.

Like amnesics, hyperthymesics show a disjunction in their ability to remember individual life events as compared to other forms of memory; they usually have average or even below-average working memory, memory for word lists, and so on. Moreover, there is some evidence of larger-than-average structures in the prefrontal cortex of hyperthymesics. Episodic autobiographical memory therefore seems to be distinct from other memory systems.

Involuntary Autobiographical Memories

In addition to the deliberate hierarchical process of autobiographical memory construction described earlier, there is also an unintentional and automatic process of autobiographical remembering. These *involuntary memories* tend to be more specific and more highly emotional than voluntarily retrieved memories. The best-known type of involuntary memories consists of flashbacks or *intrusive memories*, which occur in people who have experienced a traumatic event. Although bothersome intrusive memories are associated with psychopathology, most involuntary autobiographical memories are benign. They occur several times per day in the general population of adults and are twice as likely to be positive as negative in content. For example, a glance at a pond on the side of the road while driving to work might trigger an involuntary memory of swimming in a pond as a child. Such involuntary memories are especially likely during episodes of mind wandering.

Lifespan Distribution of Autobiographical Memories

The complex process of autobiographical remembering develops rather late compared to other types of memory. Infants and toddlers remember facts and procedures, but autobiographical memory ability has a later onset around age 3 or 4. The inability to remember life experiences before this age is called *childhood amnesia*. Adults do not explicitly remember life experiences that happened before age 3 or 4, even if those experiences were explicitly remembered at that time in childhood.

Autobiographical memory assumes its full adult-like form much later in adolescence, when a more complete life narrative develops. A life narrative includes themes and key scenes that express concerns central to a person's sense of self and therefore provides a sense of a coherent and unified life. The adolescent period of life during which the life story develops retains a psychological importance throughout adult life, as revealed in the *reminiscence bump*. For people of middle adulthood age or older, the retention curve for autobiographical memory is a nonmonotonic function, with no memories until about age 3, a small number of memories of the childhood years, a large number of memories from the adolescent years (the *reminiscence bump*), a moderate number of memories from the rest of adulthood, and the greatest number of memories from the most recent year of life.

Maintaining and Updating Semantic Self-Knowledge

We may gain self-knowledge by reflecting on the meaning of behaviors and experiences stored in memory. People indeed report using autobiographical memories in this way

to establish and maintain identity. Yet general autobiographical memories are more directly linked to the self than are specific autobiographical memories. For instance, those motivated to think of the self as introverted will bring to mind more general than specific memories of introversion. Therefore, general autobiographical memories and semantic self-knowledge seem to involve the same system. Specific autobiographical memories, on the other hand, may or may not feed into one's sense of self and therefore represent a separate system of knowledge.

The independence of the episodic and semantic autobiographical memory systems allows for recollection of specific autobiographical memories that may be seen as having little or no relationship to what one is like in general. After all, if one's concept of the self shifted every time a specific autobiographical memory came to mind, the results would be an unstable and therefore potentially unhealthy self-concept. One way of allowing stability in the self is to cordon off particular autobiographical memories as irrelevant for the self. A number of memory and narrative mechanisms are used to make a memory feel less central to the self. For example, the rememberer may make the memory feel distant from the self by assigning to the experience a feeling of subjective temporal distance, or a subjective sense of psychological closure, or no prominent place in his or her life story. To provide stability in the sense of self, such mechanisms may be employed regularly, or self-irrelevant memories may simply be recollected infrequently. Such 'cording off' processes do not represent an unhealthy repression; the information is explicitly remembered, but simply seen as irrelevant for the self.

When autobiographical memories do influence self-knowledge, they do so through one of two processes. One is a conscious decision process of *self-perception*. Sometimes people examine individual event or behavior memories and consider the situation in which they occurred, to come to a conclusion about what they are like in general. Such a self-perception process may explain the effectiveness of the foot-in-the-door influence technique. Starting with a small request, to which an unknowing target agrees, leads to a greater tendency to acquiesce to a large request. The target seems to reflect on his or her earlier decision to comply with the small request and to infer that he or she must be the type of person who likes such things. Thus, the large request is seen as consistent with the new view of the self.

In fact, this self-perception process may build upon itself, as memories can influence not just inferences but also behavior. For example, recollecting an autobiographical memory about donating to charity led to a greater number of charity donation behaviors than a no-memory control condition. The specific memory not only suggests an inference about the self, but may also direct behavior toward a similar inference that serves to confirm the conclusion about the self.

In addition to this conscious self-perception process, people also acquire general self-knowledge through a second process in an online fashion as informative experiences occur. Instead of a constant process of conscious self-perception, a gradual updating of self-knowledge may occur automatically with each additional episodic memory of an experience. This process feeds into an implicit rather than explicit view of the

self. Implicit self-knowledge influences behavior, but it tends to be related to specific emotional autobiographical memories that may or may not be related to explicit self-knowledge. In this way, people may maintain a fairly accurate view of the self implicitly, which may or may not accord with the way they describe the self explicitly.

Although autobiographical memory allows both conscious and automatic updating of self-knowledge, self-knowledge can survive to some degree in the absence of autobiographical memory. Amnesics usually maintain a sense of self over time, although certain aspects of it are disrupted. For example, one amnesic man claimed to be 19 years old when he was actually 49, because his brain injury occurred when he was 19 and he could not properly update his sense of self in terms of his age. Still, amnesics feel they are the same person from moment to moment rather than being in a constant state of self-redefinition. Indeed, general self-knowledge is retained despite an inability to access the specific episodes that may have originally defined that belief about the self.

On the other hand, those with a surplus of autobiographical memories may have difficulty maintaining a stable sense of self. The hyperthymic Jill Price describes her concept of herself not as a unitary and persisting entity, but as a series of separate selves nested inside one another like Russian dolls. Rather than seeing oneself as being a slightly different person in different roles and situations like most people do, Jill Price seems to see herself as being a slightly different person with each episodic memory experience. Perhaps when episodic self-knowledge is abundant and highly accessible, it overrides the usual tendency to defer to semantic self-knowledge. In summary, autobiographical memory serves as an input to self-knowledge, but only under certain conditions. In order for explicit self-knowledge to be altered by recollecting an autobiographical memory, it appears necessary for the rememberer to make a conscious inductive inference that the memory exemplifies something larger about the self. The pressure toward stability in the self makes such inferences unlikely. It is telling that people report using autobiographical memory to maintain a continuous sense of self rather than to learn new information about the self.

Coincidental and Motivated Autobiographical Memory Errors

As independent but interacting systems, episodic and semantic autobiographical memory often influence each other. As previously mentioned, the memory construction process can be biased and lead to distortions. The pressure toward *coherence* might therefore introduce error into either or both types of self-relevant memory. Indeed, research has demonstrated that semantic self-knowledge is not entirely accurate. Attempts to test the accuracy of self-knowledge have compared self-knowledge to objective behavior, self-knowledge to the perceptions of others, and perceptions of others to predictions of others' perceptions. A moderate correlation between self-reports of personality and objective real-time measures of behavior indicates that people are somewhat accurate in their self-knowledge. In fact, people's perceptions of some types of behaviors can be quite accurate, while their perceptions of

other types of behaviors are often inaccurate. For instance, people are quite accurate at reporting their behavioral patterns involving watching television and listening to music, but are relatively inaccurate at reporting their behavioral patterns involving attending class and spending time alone.

Relative to the perceptions of others, semantic self-knowledge is fairly accurate. The correlation between others' perceptions and self-knowledge is especially high for close acquaintances. Interestingly, people are quite accurate in guessing what other people think of them. Their estimates of others' perceptions accord more with reality than do their judgments of themselves.

In comparison to the evidence for accuracy of semantic self-knowledge, evidence for the accuracy of specific or episodic autobiographical memories is more impressive. In one study, 90% of small details such as location and people who were present during everyday events were accurately recalled after 3 months. In another study, 95% of everyday events recorded in a diary were recognized 6 years later, and all of them were remembered when additional prompts were given by others who were present at the time of the events. In other words, relatively few life experiences appear to be forgotten entirely, especially when reminders are provided.

But being able to remember everyday experiences does not imply that specific autobiographical memory is without errors. Because the construction process occurs anew at each time of recollection, it is not uncommon for elements that do not actually belong to that life experience to be bound into the memory. These are known as *conjunction errors*. For example, a rememberer may mistakenly bind memory features about Santa Fe into her memory of a conversation she had with her husband because she is convinced that it occurred during a vacation in that city, when in reality the conversation in question occurred in a different city entirely. Conjunction errors probably occur frequently; in one study, 44% of descriptions of events from participants' own diaries, altered to include details from other events, were accepted as true after only a month's delay.

Moreover, pressures toward coherence of memories with beliefs about the self can lead to distortions in and motivated forgetting of specific autobiographical memory. People preferentially forget and distort their memories such that individual events are seen as more positive in outcome, or events with unflattering implications for the self are poorly remembered. For instance, people remember feedback about their performance to be more flattering than it was, or may simply have a difficult time recalling such feedback. Due to shallow processing at the time of encoding, self-enhancing memories come to mind more quickly and easily than self-deprecating memories. People also report more difficulty in bringing to mind memories of incidents inconsistent with a momentarily desired view of the self. Furthermore, people psychologically push away negative memories and pull forward positive memories, by remembering them as occurring relatively further or closer in subjective time.

Memories of experiences that threaten the desired view of the self may be subject to motivated forgetting. Laboratory evidence shows that people may choose to cease retrieval of unwanted memories; with sufficient practice, this retrieval suppression leads to the desired forgetting. The mechanism

involved is similar to that used to inhibit motor responses, but is directed toward the hippocampus and amygdala. In short, knowledge of the self constrains each act of autobiographical remembering such that memories congruent with semantic self-knowledge (especially desired self-knowledge) are more accessible.

A more serious type of inaccuracy than a memory with some inaccurate details or even a forgotten experience is a *false memory*, meaning a memory that exists in the absence of an underlying actual experience. False memories are unlikely to be detected in studies of everyday autobiographical memory because researchers cannot know which of an infinite possible number of experiences that did not happen to a person might be falsely remembered. False memories may develop due to suggestions of other people. For example, one friend may convince another that he was present at a party he in fact never attended but only heard about afterward. With enough prompting, the friend may eventually come to hold a fully detailed false memory that is difficult to distinguish from a real memory.

False memories may also develop due to confusion of fictional experiences with reality. For example, former US President Ronald Reagan misremembered having made films of Nazi concentration camps during World War II, apparently confusing in memory his work on similarly themed films with a real experience. Self-knowledge derived from false autobiographical memories or from memories containing flagrant conjunction errors is therefore likely to be inaccurate. Fortunately, few autobiographical memories are completely out of line with actual experiences; instead, most exhibit a good degree of *correspondence* with objective facts.

Sources of Inaccuracy in Episodic and Semantic Autobiographical Memory

How, then, can semantic self-knowledge be only moderately accurate, but autobiographical memory be quite accurate? One answer is that semantic self-knowledge comes from sources other than autobiographical memory, some of which may be more biased than autobiographical memory (e.g., feedback from others). A second answer is that even semantic self-knowledge derived from the most factually accurate specific autobiographical memory is subject to bias and inaccuracy. Three potential sources of inaccuracy in inferring semantic self-knowledge from episodic autobiographical memory are considered here.

One source of inaccuracy is that any given autobiographical memory is but a single exemplar that occurred in a given context. Thus, it may be more a product of the situation than of the person (oneself). If the perceiver fails to acknowledge the role of the situation, he or she will come to an erroneous conclusion about the self. People sometimes simply lack information about the cause of their behavior. For example, male participants unconsciously primed to have a goal of affiliation with females were more likely to choose a female than a male tutor, but they mistakenly inferred a greater dispositional interest in the topic being taught by the female tutor rather than accurately inferring that they chose her due to a motivation to affiliate.

Another source of inaccuracy is that a rememberer may not take into account the degree of representativeness of a given autobiographical memory of the general trend of one's behavior. All of us have moments of joy and moments of sorrow, memories of success and memories of failure, and times we were in control and times we fell apart under pressure. Focusing on only one memory and using it to draw an inference about the self in general may represent a failed inductive inference. A rememberer would need to search for multiple memories of, say, a particular personality characteristic and its opposite, to determine the representativeness of a particular memory of her behavior repertoire in general. When making inductive inferences, people are unlikely to be even-handed in this way. In fact, they are influenced by the subjective ease with which autobiographical memories implying a particular trait come to mind rather than the absolute or relative number of memories they can generate. Ease of retrieval is biased by factors other than the actual frequency of memories, such as the vividness of the memory or the demands of the recall task, leading to biased interpretations of the meaning of a given memory of the self.

A final source of inaccuracy is that an autobiographical memory may be over- or underweighted as a source of self-knowledge, depending upon a variety of memory-based factors that may have little to do with its actual diagnostic value. For example, an autobiographical memory visualized from the third-person or observer perspective, in which one can see oneself in the image, is seen as more revelatory about the self than a memory visualized from the first-person or actor perspective. Yet it is not difficult to switch from one vantage point to the other in memory, and it is arguably irrelevant for the implications of that memory for the self. Is a person truly more dishonest if he visualizes himself in a memory of having lied to a coworker than if he visualizes that memory from his original first-person viewpoint? The behavior is the same, so it should be seen as having the same implications. But a structural alteration in the momentary construction of an autobiographical memory may cause a shift in self-knowledge (appropriately or inappropriately).

Are self-relevant memories immune to the distortions and errors discussed above? Generally, self-relevance increases the likelihood that information will be retained, but it also provides motivation to distort that information toward the desired view of self. Research on memory for everyday events suggests that those that involve the self to a greater degree are better remembered months later. But few such everyday events are sufficiently important or threatening to produce distortion or forgetting.

Memory for important and highly emotion-evoking life experiences has been studied in a number of different guises. One type of such memories is a *self-defining memory*, considered central to the sense of self and crucial to one's identity. Given the central role of self-defining memories in identity, one would expect them to remain fairly stable over time. However, the set of memories considered self-defining changes over time. Even across a 2-week interval, two-thirds of the participants in a particular study chose a different memory as self-defining. Moreover, the affective and motivational effects of recalling a self-defining memory are only moderately consistent over the course of several weeks to months, suggesting

some degree of flux in the components and potentially in the accuracy of such self-defining memories.

Another line of research about self-relevant experiences is that on *flashbulb memories* for surprising and upsetting major events, such as the 9/11 terrorist attacks. Flashbulb memories are vivid and feel accurate and unchanging to the rememberer. However, research on flashbulb memories demonstrates that these feelings are illusory; such memories are no more accurate or consistent over time than ordinary memories. In fact, compared to other memories, memories stored under conditions of intense emotion have been found to be more accurate in their central details but less accurate in their peripheral details. These 'tunnel memories' occur for intensely negative but not intensely positive experiences. But if an important, emotion-evoking life experience is not just negative but actually traumatic, the memory for that trauma may be more consistent over time than memories for positive experiences. Thus, it remains unclear whether autobiographical memories for self-relevant experiences would generally be more or less accurate than those for nonself-relevant experiences.

In summary, semantic self-knowledge and vivid episodic memories are relatively accurate, but are far from perfect copies of reality. Additionally, the motivation for coherence between self-knowledge and autobiographical memory tends to impair memory for experiences that challenge one's view of the self, and may distort memories toward consistency with deeply held beliefs about the self. Moreover, even perfectly accurate individual memories may not provide accurate self-knowledge, as such memories may be incorrectly recognized as unrepresentative or underweighted due to an incidental first-person perspective in the memory. More accurate self-knowledge may be gained by considering additional sources of information beyond autobiographical memories, especially the knowledge of others who know us as individuals and of psychological scientists who strive to understand us collectively as human beings.

Conclusion

The story of one's life is central to the experience of most adults. As we move through life collecting and ordering the life experiences we choose to include in that story, we also struggle to attain and to defend our self-knowledge. The two processes – remembering specific life experiences and having abstract knowledge about oneself and one's life – are tied in many ways. Yet neuropsychological and behavioral evidence demonstrates that the two processes are separable. Major differences in the two systems are that semantic self-knowledge is more stable, more accessible, and more resilient to brain trauma than are episodic autobiographical memories. Episodic autobiographical memories appear to be more veridical than self-knowledge. But it is difficult to remember life experiences without the distorting lens of self-knowledge. Semantic self-knowledge intrudes into autobiographical remembering to provide a sense of coherence between the two. However, there is a countervailing need for correspondence: accurate knowledge of the world. The two systems of autobiographical memory operate to fulfill both needs simultaneously.

See also: Amnesia and the Brain; Autobiographical Remembering and the Self; Episodic Memory; Memory, Neural Substrates; Memory; Semantic Memory.

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Episodic Memory

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Glossary

Anoetic Not knowing. One is not aware that memory is being used. Associated with implicit memory.

Autobiographical memory Memory of the self.

Autobiographical memory is thought to overlap with episodic memory, but it additionally contains knowledge and skills related to the self which fall outside the realm of episodic memory.

Autonoetic Self-knowing. An awareness that what is being remembered has happened to the self at an earlier point in time.

Context The spatial and temporal information that is present when material is learned or remembered. The context includes both environmental and internal information.

Episodic memory A memory system that allows one to reexperience personal events.

Flashbulb memory Memory of a very emotional and surprising event.

Hemispheric encoding/retrieval asymmetry (HERA) A neurocognitive model that postulates that the right frontal lobe is used primarily for episodic retrieval and the left frontal lobe for episodic encoding.

Implicit memory Memory for how to perform skills and activities.

Noetic Knowing. The experience of knowing a fact. The type of awareness associated with semantic memory.

Semantic memory The memory system involved in the storage and retrieval of facts and general knowledge.

Source amnesia An inability to remember where one encountered or learned some information.

Working memory Immediate memory for information currently being processed.

The Episodic Memory System

The term episodic memory was coined by Endel Tulving in 1972 to refer to memory of personal experiences (i.e., episodes). Since that time, the concept has developed considerably. Although the term continues to be used to describe the contents of certain kinds of memories and certain types of memory tasks, episodic memory is also used in a theoretical sense to refer to a specific memory system, distinct from other memory systems.

The episodic memory system is designed to allow us to reexperience personal events from the past. Episodic memory is thought to be organized in brain regions that, although involved in other memory systems, are in some ways unique to this system. Retrieval of information from the episodic memory system results in a form of self-awareness. People report a sort of reexperiencing of an event.

Episodic memory is often best understood by comparison with other memory systems. The semantic memory system deals with factual information and general knowledge.

Semantic memories do not contain contextual information, unlike episodic memories. Retrieval of information from the semantic memory system results in a different subjective experience than the one experienced when retrieving from episodic memory. People *know* facts rather than remember them. The sense of self-involvement that occurs with episodic memory is replaced with a sense of knowing something, but not necessarily knowing how it was learned, where it was learned, when it was learned, or knowing how the information is related to the self. Semantic memories may result from the accumulation of episodic memories. Repeatedly learning the fact that George Washington was the first president of the United States may

result in a fact that is stored in memory distinct from the several episodes in which it was encountered.

Implicit memory is the memory system responsible for our ability to remember how to perform certain behaviors or skills. We often have no awareness of actually retrieving information from the implicit memory system. Instead, we simply perform an activity.

Episodic, semantic, and implicit memories are all thought to be forms of long-term memory. They all are capable of holding information over long periods of time. In contrast, working memory is a kind of short-term memory. The working memory system is designed to hold, rehearse, integrate, and otherwise work on information until it can be transferred to the long-term system.

Personal experiences are sometimes labeled autobiographical memories. Although autobiographical memory is often used interchangeably with episodic memory, most researchers distinguish between the two concepts. Autobiographical memory is defined as memory of the self. As such, episodic memories make up many of our autobiographical memories. However, autobiographical memories occasionally contain information that appears to be accurately described as knowledge or skills, and thus are much like semantic and implicit memories. Memory for a friend's cell phone number may be a part of one's personal history, but it may also be considered a fact. Similarly, learning to drive a car is an event in many personal histories, but driving a car is also a skill. There are reports of patients with episodic memory system impairments who remember some personal *knowledge*. One patient, K.M., could remember that his brother had died but he was not aware of when or where he had heard about the death. His personal memory in this case is autobiographical, but

it is better described as semantic memory than episodic memory. Autobiographical memory is best thought of as a variety of memories rather than a distinct memory system in and of itself.

Because episodic memory is thought to be a unique system, it is thought to differ from other systems in a variety of ways. Some of those distinctions are highlighted below.

Episodic Memory Tasks

Episodic memory is often used in a heuristic sense to refer to tasks that ask participants to retrieve personal experiences and specific events that occurred at a particular place and at a particular time. A typical episodic memory task is one in which accurate performance depends on access to the context in which an event occurred. Episodic memory is typically studied in the lab with a study phase in which a set of words would be presented to people and they would be told to try to learn them. The participants would be tested for their memory of the material with a recall or recognition test after a short break or an intervening task to allow the material to be removed from working memory. The task is called an episodic memory test because participants must retrieve a specific episode that occurred in a specific place and at a particular time. That is, they cannot recall just any words; they must recall words that were personally experienced at a particular place and at a particular time if they are to be accurate.

It is interesting to note that the typical 'episodic task' emphasizes the content, and often the semantic content of memory. That is, it emphasizes the 'what' of episodic memory. This is only a small portion of the contents of episodic memory and, theoretically, it may not be the most important component of episodic memory. Two additional important components of episodic memories have to do with the time and location of an experienced event; the when and where of memory. The role of these factors in episodic memory has often been studied under the term context.

Context is a general term that has been used in the literature to refer to factors as varied as the physical surroundings in which a set of material is studied and tested, internal moods, and drug states. A classic design for these sorts of experiments is depicted in Table 1. In an experiment such as this, a set of material is present in one of two contexts (with word A or word B, in room A or in room B, on land [A] or in water [B], while intoxicated [A] or while sober [B], while happy [A] or while sad [B], etc.). Half the participants study the material in Context A and half in Context B. Then, after a delay, half of the participants in each study condition are tested in the same context and the other half of the participants change contexts for the

test. The general finding of these studies with free recall tests is that maintaining the same context during study and test leads to better performance than changing context between study and test. Although there are exceptions to this finding, it has been replicated enough times under enough conditions that it is clear that context is associated with new material when it is learned and context plays an important role as a retrieval cue when episodic memory is probed.

It is interesting that context effects are much less robust when recognition is used as a test than when recall is used as a test. This presumably results because recognition tests include other good cues (i.e., the to-be-remembered item itself is presented and participants are simply asked whether it was previously studied or not) that are not available during free recall, where participants are simply asked to try to remember as much as they can. Context plays a bigger role when other cues are not available.

Context effects are less consistent when emotions or drug states are used as the context. These results can be at least partially explained by the difficulties in inducing emotions and by the additional effects of the drugs and emotions on cognitive functions. As an example, both depression and alcohol slow down performance on a variety of cognitive tasks and the slowed processing may make context effects more difficult to detect.

Source memory is a topic closely related to context. Poor source memory, called source amnesia in extreme cases, is indicated when a person can recognize having seen some material before (i.e., the *what* of an event is remembered) but not where or when material was originally presented. That is, memory for the source of the information is lost. If the source of the information is considered a kind of context, then this is an example of a loss of memory for context information. It is interesting that individuals who have poor memory for the source of information, such as older adults, typically also show poor episodic memory performance. In fact, older adults typically show poorer source memory than memory for items or individual events.

Outside of the psychology laboratory, episodic memory is evidenced in one's ability to answer questions such as: What did you have for dinner last night? Whom did you see at the meeting yesterday? Where were you when you received the emergency telephone call? Again, correct performance depends on one's ability to reexperience, in some sense, a personal episode that occurred at a particular place and time.

Episodic memory tasks can be contrasted with semantic tasks. A typical semantic memory task is one in which participants are asked to recall facts and definitions. How would you define 'justice'? Who was the first president of the United States? Successful performance on these questions and similar tasks does not require the recollection of a personal experience or access to a particular time and place in which the facts and definitions were encountered. In fact, such information is typically not available.

Episodic memory tasks can also be compared to implicit memory tasks. An implicit memory task rarely requires one to explicitly recall an event or fact. Instead, implicit memory is exhibited by performing a task or exhibiting a skill. Memory is shown by improved performance on the task for those who

Table 1 Typical design for a study that examines the effect of context on episodic memory

Test context	Study context	
	Context A	Context B
Context A	Context match	Context mismatch
Context B	Context mismatch	Context match

have performed the task before compared to those who have not. For example, implicit memory for riding a bicycle would be assessed by how well one rides a bicycle after a certain amount of practice. Improvement would indicate implicit memory of the task.

The sorts of tasks that are labeled as episodic are rarely purely episodic. Most of these tasks also require some access to general knowledge and facts, for example. This raises the important point that memory systems must surely interact and specifying how they interact is an important goal for any comprehensive memory theory. The fact that it is difficult to disentangle one memory system from another on the basis of the type of task employed has led to the search for other differences between systems, including the type of awareness associated with each system.

Episodic Memory Processes and Subjective Awareness

Fundamentally different operations are thought to be used by different memory systems. Each system has a unique set of processes to store, organize, and retrieve information. Episodic memory is thought to be temporally organized. In some ways it can be thought of as a movie of one's own life. Portions of one's life are organized along a temporal dimension when stored. Accurate retrieval of that information requires access to the temporal dimension. In contrast, semantic memory is stored more like a library in which related topics are stored together. Implicit memories are stored as scripts, analogous to prescriptions or recipes, for how to perform activities.

The processes used within the episodic memory system give rise to a unique subjective experience. According to Tulving, one of the most important characteristics of episodic memory is that it is associated with a reexperiencing of an event. When people recall information from episodic memory, they often report an 'I remember' sort of experience. That is, they often report experiences like 'I remember eating pizza at the party.' Tulving labels this kind of subjective experience as *autonoetic awareness*. It is a self-knowing awareness. The awareness is of a personally experienced event as having occurred. More correctly, it is a reexperiencing of a certain event.

In contrast to the reexperiencing of events associated with episodic memory, semantic memory is associated with a feeling of knowing. People are much more likely to report that they *know* that Abraham Lincoln was the 16th president of the United States than they are to report that *I remember* that Abraham Lincoln was the 16th president of the United States. The awareness associated with retrieval from semantic memory is labeled as *noetic* or 'knowing' awareness. Interestingly, retrieval from implicit memory rarely gives rise to any form of awareness at all. We are often unable to describe how we hold a pen when we write or exactly how we maintain our balance when riding a bicycle. We just do these things. Tulving labels this *anoetic awareness*, where *anoetic* is taken to mean 'not knowing.'

The type of awareness associated with episodic memory has become an important area of research partly because of the question of whether nonhuman animals have episodic memory. When Tulving first proposed the episodic memory system, it was thought that only humans had episodic memory. Over

the years, researchers have been able to demonstrate that many species can store and retrieve the *what* and *where* of experiences. More recently, several studies have shown that certain birds, for example, can retrieve the *when* of experiences. At this point in time, it is impossible to determine whether nonhumans share the *autonoetic awareness* that humans experience when retrieving episodic memories. Therefore, the question of whether nonhuman animals possess episodic memory remains open.

Although the forms of awareness associated with the episodic memory system is thought to be a defining feature of the system, little research has been conducted on this aspect of the memory system. Some researchers have used a *remember/know* procedure to address this issue. With this procedure, participants are asked at recall to indicate whether the information they recalled is known or remembered. Although interesting results have been obtained, the interpretation of the results is far from clear. A few additional studies have tried to address this issue by studying brain-damaged individuals with impaired levels of awareness/consciousness, for example, but again the results from these individuals are not clear-cut.

The Past Orientation of Episodic Memory

The episodic memory system, according to Tulving, is the only memory system whose orientation is towards the past. As has been stated above, retrieval of episodic memories is best described as a reexperiencing of one's own past. Episodic memory allows for mental time travel. It allows us to reminisce with family and recount stories of past events at reunions. Such memories surely provide a richness to our lives.

It might seem that all memories are similarly directed toward the past. Semantic and implicit memories are acquired at a certain point in time. However, their use does not depend on the fact that they were acquired at a particular time in the past. In fact, much of what we have stored in semantic and procedural memory functions to allow us to make decisions and act appropriately in the present or in the future. For example, the memory for the ability to ride a bicycle, stored in implicit memory, primarily serves us by allowing us to ride a bicycle now or in the future. Similarly, knowledge of the rules of mathematics are most useful when they allow us to solve current or future problems.

The effective use of semantic and implicit memory does not give rise to a sense of time travel. We typically do not experience a movement back in time when we use those memories. Episodic memory does involve mental time travel. It is that sense of traveling back in time that, partly, gives rise to the *autonoetic awareness*.

Emotions

Emotions are among the factors that make experiences meaningful to us. Because emotions are a meaningful part of the events we experience, they are thought to be a part of the episodic memory system. Although cognitive scientists have been slow to include the study of emotion in their memory studies, research indicates that emotions play an important role in the episodic memory system.

One's emotions can serve as a retrieval cue to access memories. Generally speaking, the more overlap between one's current emotional state and the emotional state when an event was experienced, the better the retrieval. In a general sense, emotions can be thought of as a part of context as described above. As a result, emotions, or moods, are important retrieval cues.

Other evidence suggests that emotional events are generally easier to retrieve than nonemotional events. Flashbulb memories are memories for very emotional events. People report very clear and distinct memories for events such as the Challenger explosion or the downing of the Twin Towers in New York in 2001. Although some research has indicated that such memories are not as accurate as they appear to be subjectively, the point that emotions are part of the reexperiencing of the event is indisputable.

In the case of the extremely emotional experiences that are part of traumatic events, the associated memories are often difficult to forget. Severe traumatic events such as those associated with war or severe accidents are often difficult to forget. It is not uncommon for survivors of such trauma to reexperience the events in the form of a flashback. Again, it is clear that emotions are an important component of at least some episodic memories.

Dissociations among Memory Systems

Theories of episodic memory in particular, and theories of multiple memory systems generally, have generated thousands of empirical studies. These studies have taken many forms, but among the most important studies are those that show that the characteristics of the episodic memory system are different from those of other proposed memory systems. A dissociation is said to occur when one variable influences memory systems differentially.

The stage of development is one factor that appears to dissociate episodic memory from other memory systems. Older adults typically perform much more poorly on episodic memory tasks, such as recall of a recently presented set of words, than younger adults. These same older adults often perform as well as, or better than, younger adults on semantic memory tasks such as general knowledge or vocabulary tests. Episodic memory seems to develop after semantic memory in childhood.

Similar patterns of results have been found while comparing younger and older adults on episodic and implicit memory tasks. That is, older and younger adults perform at approximately similar levels on implicit memory tasks, but older adults perform relatively poorly on episodic memory tasks. We typically show a steady decline in episodic memory as we age, starting at age 30 or even younger. The pattern is much different for semantic memory. Semantic memory performance tends to remain stable or even improve through middle age. Only in late adulthood (after age 75 or so) are declines in semantic memory substantial, and even then the declines tend to be gradual. Similarly, performance on implicit memory tasks tends to show little or no decline with increasing age.

These sorts of dissociations can be found for many variables. However, the interpretation of such dissociations is not

always clear. For example, it is possible to show dissociations within a memory system. Recall and recognition tests for episodic memory are sensitive to different variables. Therefore, a dissociation does not require the postulation of distinct memory systems. All that is required for a dissociation is that one process differs on any two tasks.

At one point in time it was thought that one could find support for the episodic memory system, as distinct from other memory systems, by examining the levels of performance across memory systems. The idea behind these studies was that memory performance based on the episodic memory system should be relatively independent of performance on tasks that primarily tap the semantic memory system, for example. That is the two tasks should show stochastic independence. A number of studies have revealed stochastic independence on episodic and semantic memory tasks. Other studies have found relatively high correlations on the two types of tasks. Because most tasks make use of more than one memory system and because in normal circumstances we would expect the memory systems to interact, it is not clear how to interpret these results. Recent attempts to show that episodic memory is distinct from other memory systems have focused on differences in the brain among the various systems.

The Neuroscience of Episodic Memory

Perhaps the most exciting research on episodic memory in the past 15 years has come from neuroscience literature. This research has attempted to find the neural correlates of the episodic memory system.

Brain-damaged individuals provide interesting case studies of the neuroscience of episodic memory. Damage to the hippocampus and surrounding areas in the medial temporal lobe can result in the loss of episodic memory. Such patients typically find it difficult to encode or store new experiences. Some old episodic memories seem to be present, but patients do not have the self-knowing or reexperiencing awareness that comes from typical episodic retrieval. Such patients have relatively intact semantic and procedural memories. It is interesting that cases of semantic amnesia can also be found. In these cases, patients lose the ability to find word meanings, but their episodic memory seems relatively intact.

The problem with studying brain-damaged individuals is that the damage is rarely neat and confined to one functional area of the brain. Careful study of brain-damaged individuals often indicates that both semantic and episodic memories are impaired to some extent.

Many imaging studies (i.e., PET and fMRI images) have suggested an important role for the hippocampus and related areas in episodic memory. Several of these studies have revealed that the hippocampus is more active during episodic memory tasks than semantic memory tasks. Studies with non-human animals have also shown that memory of location, time, and context is related to hippocampal function. Of course, the animal research has not addressed the issue of autonoetic awareness and so labeling this kind of memory performance as episodic memory must remain tentative.

The role of the hippocampus in episodic memory has become much more complicated as research has continued in

this area. Although it seems that the hippocampus plays an important role in the episodic memory system (perhaps in consolidation, forming associations, and spatial memory), it is clear that the hippocampus is just one of many structures that are important for an effective episodic memory system. Large portions of the medial temporal lobe appear to be important for a functioning episodic memory system. The hippocampus also seems to play some role in acquiring semantic memories. In addition, the hippocampus is part of several neural pathways and it may be that it is best to think about the pathways as being the seat of episodic memory.

Tulving and others have argued that there is hemispheric specialization with regard to episodic memory. Based largely on PET and fMRI studies, a consistent pattern of results has been obtained that show hemispheric specialization for episodic encoding (moving information into the system) and episodic retrieval (recovering stored information). The results indicate that the right hemisphere, and especially the right frontal lobe, is especially active during episodic retrieval. The left frontal lobe, in particular, is associated with episodic encoding. Retrieval from semantic memory is most closely associated with activation in the left frontal lobe. This pattern of results, referred to as the hemispheric encoding/retrieval asymmetry (HERA) theory, nicely isolates different areas of the brain with episodic encoding and retrieval and differentiates episodic from semantic memory.

Conclusions

Episodic memory has played, and continues to play, an important role in memory research. Over time, the emphasis in research has expanded from an emphasis on the content of personal experiences to include tasks that assess the context and awareness associated with memory retrieval. Episodic

memory continues to be used in a heuristic sense to refer to certain kinds of tasks, but the more important use of the term is theoretical, where episodic memory refers to a type of memory system. Although a good deal of cognitive research continues to explore the nature of episodic memory, the newest areas of research have added the study of the brain to cognitive tasks.

See also: Autobiographical Remembering and the Self; Memory, Neural Substrates; Memory; Semantic Memory.

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Equity Theory

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Glossary

Cross-cultural psychology The scientific study of culture's impact on human cognition, language and meaning, affect, and behavior. Cultural themes – such as the theories of mind, psychological constructs and explanatory models employed in various cultures – are investigated in order to determine the universality of various concepts.

Equity theory A theory that proposes that people are concerned about both profit and fairness in all of their relationships – from the most intimate to the most casual of interactions.

Ethnology The comparative study of the behavior of animals and humankind, typically in their natural habitats but sometimes involving experiments in both the field and in captivity.

Evolutionary psychology The field wherein human cognition, emotion, and behavior are studied in a Darwinian context. Evolutionary psychologists attempt

to explain psychological traits – such as perception, memory, or language – as the consequence of natural selection or sexual selection.

Neuroscience The scientific study of the brain and the central nervous system. This includes disciplines concerned with the structure, function, chemistry, pharmacology, and development of various attitudinal and emotional behaviors.

Primatology The branch of psychology and zoology that examines primate behavior. Generally, research involves the study of monkeys, apes, and other nonhuman primates, but sometimes nonhuman primate behavior is compared to that of humans.

Socialpsychophysiology That branch of social psychology which looks at the way that personality and situation interact in shaping physiological processes. Many scholars study the way various cognitive and emotional reactions are reflected in the subtle activity of the facial muscles.

The Nature of Equity

Saint Anselm of Canterbury (1033–1109 ACE) argued that the will is influenced by two competing inclinations: an affection for what works to a person's own advantage and an affection for justice. The first inclination is more powerful, but the second matters, too. Equity Theory, too, posits that in relationships, two concerns stand out: first, how rewarding are people's social, family, and work relationships? Second, how fair, just, and equitable are those relationships? According to Equity Theory, people feel most comfortable when their relationships are maximally profitable and they are getting exactly what they deserve from those relationships – no more but certainly no less. (People perceive a relationship to be fair and equitable when the rewards they reap from a relationship are commensurate with their contributions to that relationship.) In contrasting profit versus equity, *profit* (i.e., rewards minus costs) is generally found to be a more important determinant of satisfaction than is *equity*. In this entry, we will discuss the logic on which Equity Theory is based, discuss techniques for assessing how equitable a relationship is, and discuss the consequences of fairness (or unfairness) in both personal and work relationships.

In the past 25 years or so, social psychologists have become interested in the cognitive and emotional underpinnings of humanity's concern with social justice, fairness, and equity. Evolutionary theorists, for example, argue that for several million years, our ancestors engaged in complex social exchanges. They contend that a concern with both reward and fairness are ancient and universal concerns – wired in as part of the architecture of the human mind. Currently, most cross-cultural

investigators, neuroscientists, primatologists, ethologists, and evolutionary psychologists agree that although social definitions of equity may vary, a concern with profit, fairness and equity may, indeed, be common in many animal groups.

Equity Theory

Equity Theory as posited by Hatfield, Walster, and Berscheid (1978) consists of four propositions.

Proposition I Men and women are wired up to try to maximize pleasure and minimize pain. It follows, then, that people are concerned with the rewards and punishments they receive in their close relationships.

Proposition II Society, however, has a vested interest in persuading people to behave fairly and equitably. Groups will generally reward members who treat others equitably and punish those who treat others inequitably.

Proposition III Given societal pressures, people are most comfortable when they perceive that they are receiving roughly what they deserve from life, love, and work. If people feel overbenefited, they tend to experience pity, guilt, and shame; if underbenefited, they tend to experience anger, sadness, and resentment.

Proposition IV People in inequitable relationships will attempt to reduce their distress via a variety of techniques – namely, by restoring psychological equity (convincing themselves that an inequitable relationship is indeed fair), by restoring actual equity, or by abandoning the relationship.

A corrupt stock broker, who feels guilty about cheating his clients, may restore psychological equity by convincing himself that in business it's survival of the fittest. A woman who feels guilty about the fact that convention dictates that her poverty-stricken date ought to pay for dinner, concerts, and transportation may attempt to set things right by inviting him to dinner or pretending someone has given her free tickets to a play – thus restoring actual equity. Finally, a philanthropist who decides his charity cases are ingrates may elect to discontinue his generous gifts (and thus terminate the frustrating relationship).

Historically, different cultures and societies have possessed very different visions of what constitutes social justice. Equity, it seems, is in the eye of the beholder. Participants themselves may disagree about the equitability of their relationships; outsider observers might yet have a third view as to what is fair or unfair. In defining equity, people may focus on a wide variety of decision rules and a plethora of inputs and outcomes. Some dominant views: 'All men are created equal' (Equality). 'The more people invest in a project, the more profit they deserve to reap' (Capitalism). 'To each according to his need' (Communism). 'Winner take all' (Dog-eat-dog capitalism). 'It's a man's world' (Traditional social hierarchy). Whatever the cultural rules, social justice, fairness, and equity are deemed important in all cultures.

Social psychologists have developed a variety of scales designed to assess people's perceptions of equity. In practice, however, people's perceptions are often measured by asking: 'Considering what you put into your (dating, marital, or work) relationship (compared to what you get out of it) and what your partner puts in (compared to what he or she gets out of it), how does your relationship "stack up"?' On the basis of their answers, peoples are classified as perceiving themselves to be overbenefited (receiving more than they deserve), equitably treated (receiving exactly what they deserve), or underbenefited (receiving less than they deserve, *considering their partner's inputs and outcomes*) from a given relationship. Naturally, other scales designed to assess perceived equity exist, as well (Figure 1). In one detailed measure, for example, researchers asked men and women who were dating, living together, or married to indicate (via a 22-item scale) how fair and equitable they considered their relationships to be. The areas of interest included such personal qualities as appearance, intelligence, and social grace; emotional concerns, such as physical affection and understanding and concern, and day-

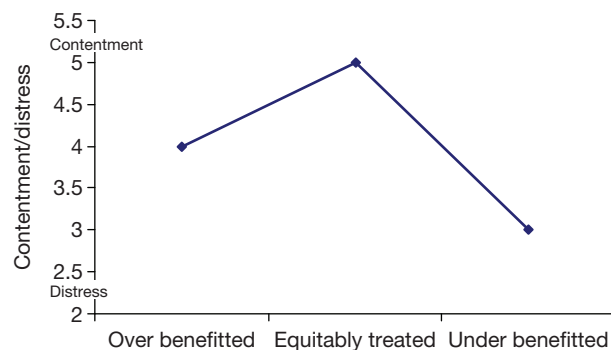


Figure 1 The relationship between perceived equity and contentment/distress.

to-day concerns, such as contributing to household expenses and helping around the house. Other scholars have developed measures to assess how fair employers/employees consider their relationships to be.

Other researchers have created 'Exchange Orientation' scales, designed to assess the concern of individuals with justice, fairness, and equity. They argue that some people are especially concerned about giving their partners and associates all that they deserve, whereas other people are primarily concerned with 'Am I getting my fair share?' Depending on their different personalities, people are predicted to respond with varying degrees of upset to injustice.

Regardless of societal definitions or one's own concern with fairness, considerations of equity have been found to be important in a wide variety of cultures and relationship types – social relationships, romantic and family relationships, friendships, helping relationships, and work relationships.

Current Research: A Multidisciplinary Approach

Currently, some of the most interesting research into the nature of social justice emanates from scholars of three different intellectual traditions (1) primatologists and evolutionary psychologists, who argue that a concern for justice arose early in humankind's evolutionary history, and who speculate about how this ancient wiring affects visions of social justice of contemporary men and women; (2) cultural researchers interested in different societal definitions as to what is fair and equitable; and (3) social psychologists, who have explored people's definitions of fairness and justice and have studied the impact of perceived fairness and equity on people's thoughts, feelings, and behaviors.

Equity: The Evolution of a Cultural Universal

In the past 25 years or so, social psychologists have become interested in the evolutionary underpinnings of a societal desire for social justice. As Cosmides and Tooby (1992) observed:

It is likely that our ancestors have engaged in social exchange for at least several million years ... Social exchange behavior is both universal and highly elaborated across all human cultures – including hunter-gatherer cultures ... as would be expected if it were an ancient and central part of human life (p. 164).

Today, paleoanthropological evidence supports the view that notions of social justice and equity are extremely ancient. Ravens, for example, have been observed to attack those who violate social norms. Dogs get jealous if their playmates get treats and they do not. Wolves who do not play fair are often ostracized – a penalty that may well lead to the wolves' death.

Primatologists have also amassed considerable evidence that primates and other animals do care about fairness. In a study with brown *Cebus apella* monkeys, researchers rewarded female monkeys with tokens after completing tasks. These tokens could be exchanged for grapes, a desired treat. However, after several trials in which completed tasks brought a grape, suddenly the situation changed. The 'fairly treated' monkeys were indeed rewarded with the expected treat – grapes. But some monkeys were deprived of their just reward: they

were given cucumbers, a nondesired food, instead. Female monkeys who were denied the grapes, that is, the rewards they deserved, became furious. They refused to 'play the game' (refused to exchange tokens for a cucumber) and disdained to eat their 'prize' – holding out for the grapes they thought they deserved. If severely provoked (the other monkeys did nothing and still got the highly prized grapes instead of the cucumber) capuchins grew so angry that they began to scream, beat their breasts, and hurl food at the experimenter. Interestingly, in a later study, the authors found that chimpanzees (*Pan troglodytes*) were most upset by injustice in casual relationships. In *chimps'* close, intimate relationships, injustice caused barely a ripple. We see, then, that different species, in different settings, may respond differently to injustice.

Potentially, this fascinating animal research may provide some insights into three questions that have intrigued equity researchers (1) when, in primates' long prehistory, did animals begin to feel guilty about receiving too much, as well as begin to feel outraged when they were deprived of their just deserts? (2) are animals more (or less) concerned about fairness in despotic, hierarchical societies than in relatively egalitarian ones? (3) are primates and other animals more (or less) concerned about inequities in close kin relationships than in more distant encounters?

Equity: Cultural Considerations

Cross-cultural theorists have long been interested in the impact of culture on perceptions of social justice. They contend that culture exerts a profound impact on how fairness is defined, how concerned men and women are with fairness, and how fair and equitable various types of relationships are judged to be.

Cultural critics point out that until very recently, social psychology was primarily 'Made in America.' Theories conceived by Western psychologists were tested in the West with Western participants and disseminated in Western scientific publications. Such ethnocentrism is a mistake, culture theorists argue, as culture exerts a profound impact on the ways in which people conceptualize the world around them, the meaning they ascribe to common life events, and the manner in which they react to those events.

Cross-cultural researchers ask: 'Is equity theory applicable to all people in all cultures and in all historical eras?' Many would say 'No.' Any number of researchers have studied cultural differences in perceptions of who ought to get what, where, when, and how. They have also studied how valuable resources are distributed within and between various societies. Some researchers argue that in individualistic cultures (such as the United States, Britain, Australia, Canada, and the countries of northern and western Europe) people tend to focus on personal goals. No surprise, then, that in such societies, people are primarily concerned with how rewarding (or punishing) their relationships are and how fairly (unfairly) they are treated. Collectivist cultures (such as China, many African and Latin American nations, Greece, southern Italy, and the Pacific Islands), on the other hand, insist that their members subordinate personal goals to those of the group: be that the family, the clan, or the tribe. It is tradition, duty, and deference to elders that matters. No surprise, then, that in such societies people are primarily concerned with fostering

good relationships with ingroup members. Along similar lines, other researchers claim that equity is of more importance in individualistic than in collectivist societies and there is some evidence that this is so.

Equity in Love Relationships

Scholars have discovered that the degree to which couples are concerned with reward and equity depends on relationship stage. When couples are first dating, they participate in a kind of dating and marriage marketplace, in which considerations of reward, fairness, and equity loom large. Once they are deeply committed to one another, however, they become less concerned about day-to-day reward and equity. Should a relationship deteriorate, however, couples – knowing (perhaps) that they will soon be back on the market – may begin to worry about 'What's in it for me?' and to ask: 'Do I deserve better?'

Mate Selection

In fairy tales, Prince Charming often falls in love with the scullery maid. In real life, however, men and women generally seek out partners who are deemed to be suitable. There is considerable evidence that when young people are attempting to decide whether or not to date or mate with someone (whether it is an arranged marriage or a love match), potential reward and equity matter. Specifically, researchers find (1) the more socially desirable men and women are – be they gay, lesbian, or heterosexual – the more social assets they will demand in a 'suitable' potential date or mate; (2) men and women tend to fall in love with partners who possess similar assets and liabilities; (3) market considerations affect men's and women's romantic and sexual choices. Dating couples generally end up with partners similar to themselves in self-esteem, attractiveness, intelligence, education, and mental and physical health (or disability), among other things; (4) profitable and equitable dating relationships are satisfying and comfortable relationships. Inequity is associated with distress, guilt, anger, and anxiety; (5) profitable and equitable dating relationships appear to be more stable (and more likely to lead to more serious relationships) than are inequitable relationships.

In conclusion, research indicates that in the early stages of a dating relationship, considerations of the marketplace prevail. Men and women will attempt to attract a socially attractive partner and they are profoundly concerned with how rewarding and how equitable their budding relationships appear to be.

Close, Intimate Relationships

Casual and intimate relationships are very different from one another. In close, intimate relationships, for example, couples feel more intensely about one another, share more of their lives, have (and expect to have) a longer time to spend together than do couples in fleeting affairs. Married and other committed couples, who assume that they will be together for a lifetime, are more likely to be sanguine about momentary injustices, confident that it will all work out in the end than are uncommitted couples. Then too, it may be difficult for

married couples to calculate whether or not relationships are fair and rewarding. (They may settle for a rough and ready definition of fair outcomes.) Only the most egregious injustices may be noticed.

Researchers argue that people participate in two kinds of relationships – exchange relationships and communal relationships – and that social norms differ markedly between these two relationships. In casual acquaintances or business relationships, exchange norms prevail. People need not feel special responsibility for others' welfare. They may invest ideas, time, and money, but it is with the expectation of receiving their fair share in return. In close, committed, intimate relationships, on the other hand, communal norms prevail. Ideally, men and women are committed to the other's welfare. They wish to please their partners, to care for and nurture them, and reject such crass considerations as score-keeping or a concern for *quid pro quo*. Such differences suggest that couples in close, intimate relationships will be less concerned about day-to-day rewards, costs, and equity than they would be in more casual friendships and work relationships.

Yet, in the end, reward (and costs) and equity do seem to matter in even the closest of relationships. This is the case for most couples – be they casually dating, living together, or married; affluent or poor; married for a few weeks or for a half-century. As we have said, people are generally far more concerned with how rewarding their relationships are than with how fair and equitable they are. Yet, in all of these groups, the degree of reward, fairness, and equity have been found to be linked to marital happiness, contentment, satisfaction, sexual satisfaction, and marital stability. Couples in fair and equitable relationships are also less likely to risk extramarital affairs than their underbenefited peers. They are also more confident that their marriages will last, and (in fact) their relationships are longer lasting than those of couples who feel less fairly treated.

In recent years, social scientists have begun to explore the perceptions of women and men concerning who does the most household work (such as preparing meals, shopping for groceries, cleaning the house, caring for children, and caring for needy or elderly relatives). They have also investigated the impact of fair or unfair divisions of labor on marital satisfaction and stability. Scholars find that for many couples, perceived fairness (in the division of housework) has a positive impact on psychological well-being and relationship happiness and stability.

Endings

Scholars agree that perceived unfairness and misery are linked. They disagree, however, as to the nature of the causal relationship: Does perceived injustice cause dissatisfaction or is the causal order reversed? Equity theorists point out that men and women who are unfairly treated for a prolonged period will begin to wonder: 'Does my partner love me? If so, why would he (she) treat me so unfairly?' They begin to ask: 'What's in it for me?' and 'Am I getting all I deserve in this relationship?' Other researchers take the opposite view, arguing that in communal relationships, couples do not keep score; they simply do not think in terms of reward and justice. Thus, if couples are concerned with such issues, it is a sure sign that their

marriages are in trouble. Misery, then, is the cause, not the consequence of perceived injustice. Regardless of the causal direction of the relationship, when men and women are at the point of separation or divorce, they sometimes become consumed with issues of fairness and equity.

A year-long longitudinal study set out to clarify this question. Researchers interviewed Dutch couples who had been married for various lengths of time. At Time 1, those who rated their marriages as inequitable were more dissatisfied than their peers. By Time 2 (a year later), these inequitable relationships were often faltering. Thus the authors concluded that inequity leads to relationship dissatisfaction and dissolution – and not the reverse. It is possible, of course, that in failing marriages, appraisal might lead to loss of commitment, separation, and then reappraisal ... the two spiraling down together.

In sum, scientists have continued to explore the impact of perceived equity on men and women's marital happiness and stability. It appears that although the concern with fairness may wax and wane during the course of a marriage, such concerns always remain there, sometimes just beneath the surface, guiding people's perceptions, happiness, and marital choices.

Equity in Work Settings

Industrial/organizational psychologists have investigated the applicability of Equity Theory to a wide variety of organizational and work settings and in a wide array of supervisor, worker, and customer relationships.

Differences in Sensitivity to Justice in Work Settings

Scholars contend that in the world of work, people differ in their 'Equity Sensitivity.' They classify people into three groups: the Benevolents (who are more concerned with what they contribute to an enterprise than with the rewards they reap), the Equity Sensitives (who are sensitive to issues of fairness, justice, and equity), and the Entitleds (who insist on extravagant rewards, regardless of their own contributions.)

The Neuroscience of a Concern with Fairness

Recently, neuroscientists have begun to explore the way that people's brains and central nervous systems respond when they are asked to make moral judgments and when they confront fairness or unfairness in the workplace. Neuroscientists have studied moral decision making, specifically moral sensitivity – the ability to detect and evaluate moral issues – major components of morality. Using fMRI (functional magnetic resonance imagery) techniques, the scientists demonstrated that sensitivity to moral issues is associated with activation of the polar medial prefrontal cortex, dorsal posterior cingulate cortex, and posterior superior temporal sulcus (STS).

In one experiment, the authors asked: Are people primarily motivated by the assumption that they will 'do well (for themselves) by doing good' or by a real, unselfish desire to 'Do unto others?' To test people's emotional reactions to various types of moral dilemmas, the scholars placed participants in an fMRI scanner. This high-tech scanner constructs an image

of the brain in which changes in blood flow (induced by brain activity) are represented as color-coded pixels. The authors then asked participants to play a series of games with real monetary stakes. How much of their own economic payoff were players willing to sacrifice to increase the payoffs of others? To find out, the authors digitally compared the scans taken while the participants decided whether to act selfishly or altruistically, to trust (or mistrust) others, to treat others fairly or unfairly, and/or to punish partners who betrayed them (by cheating them out of the outcomes they deserved from the games or to let the infraction slide). They found that people's brains were activated by the anticipation of reward, by a desire to behave fairly, and by a strong negative reaction to partners who betrayed them. Other neuroscientists and social psychophysicists have attempted to link people's self-reports of their reactions to (1) various kinds of justice or injustice; (2) various kinds of justice restoration (say, restorative justice, retributive justice (revenge), or no justice restoration); and (3) to forgiveness or a refusal to forgive, a desire for revenge, and a willingness to forgive exploiters – to their cognitive reactions to such dilemmas, as measured by patterns of fMRI responses.

Equity in Organizational and Work Settings

Scholars agree that a concern with fairness is a cultural universal and in many of the social sciences – including anthropology, psychology, sociology, politics, history, or economics – there are scholars who are primarily concerned with matters of who gets what, when, where, and how. Equity theorists, too, have focused on what participants in social exchanges perceive to be a just distribution of status and privilege, social costs and benefits, and material rewards and costs in organizational or work settings. As we observed earlier, people care about how rewarding and how fair, just, and equitable their treatment is in organizational and work settings – be they hunting and gathering societies or modern day industrial organizations.

Researchers have addressed a series of questions. Among the most important are (1) do employers and employees care about fairness and equity? (2) what do individuals and collectivities consider to be just and why? (3) is procedural justice as important as actual justice? (does it matter if the procedure for allocating reward is fair?) (4) what are considered to be valuable inputs and outcomes in work settings? (5) what are the social and behavioral consequences of perceived injustice in work settings?

There is considerable evidence that both employers and employees care deeply about equity

Researchers find that most business owners and managers are motivated to behave in an equitable way. A few follow equity rules because they are committed to abstract ideas of justice. More, however, find that they reap several payoffs from equitable behavior. In other words, it is profitable for them to conform to business world norms. Fairness allows them to attract superior workers and weed out inferior ones. They wish to motivate workers to produce, and to avoid conflict.

A more interesting question is how workers themselves feel about inequitable treatment. It is understandable that

those who feel cheated would be angry and resentful about the injustice of their situation, but what about those who are paid too much? Is it possible that those discovering they are overbenefited could really be unhappy with their good fortune? The evidence suggests they might be. Researchers find that underpaid workers show an active sense of grievance, the desire to complain, actual complaints, and an active desire to change jobs. But, more interestingly, they also find that overpaid workers are distressed too; they show a strong awareness of preferential treatment with underlying feelings of unease. More recent research has documented that justice is associated with well-being, work satisfaction, positive interpersonal and intergroup relationships, and decision acceptance. Conversely, the experience of injustice may have serious negative consequences on the individual, group, organizational, and societal levels. When faced with injustice, even the overbenefited generally feel a sense of disquiet.

Of course, this only holds true if workers perceive they are overbenefited. Humans are a creative lot and research documents that although the overbenefited might feel uneasy about their good fortune at first, it does not take long before they come up with rationalizations to justify their privileged state.

Procedural versus distributive justice

There are two general types of justice – procedural justice (i.e., the perceived fairness of the decision making process) and distributive justice (i.e., the perceived fairness of final outcomes). Researchers point out that people care about the fairness of the procedures used in allocating rewards, as well as the fairness of the rewards themselves. If the system for allocating rewards is corrupt or unjust, people feel uncomfortable, even if the actual rewards they receive are just what they deserve. In addition, the knowledge that others are receiving too much or too little is in itself unsettling.

Valuable inputs and outcomes in work settings

When considering how equitable or fair a workplace is, men and women consider a number of things to be valuable inputs in work settings. These include demographic characteristics (such as gender, age, and race), loyalty, commitment, intelligence, skill, seniority, degree of responsibility, hard work, support of colleagues, personal sacrifice, and the like. They consider a wide variety of outcomes relevant as well. These include such things as praise, recognition, a sense of achievement, respectful supervisors, friendly coworkers, opportunities for promotion, financial rewards (high pay, perks, valuable benefits), flexible scheduling, health insurance, appealing work environment, a retirement program, and the like.

Responses to perceived injustice in work settings

When faced with inequity, people try a number of techniques to set things right. These include complaining to the management, asking for a raise, and attempting to do a better (or worse) job. If all else fails, they may become absentee workers, try to sabotage production, search for better jobs, or quit their jobs.

In one classic experiment, researchers proposed the (then) unthinkable: that capitalistic American workers would be uncomfortable earning too much (as well as too little) (compared to their peers) and would actively seek to behave so as to

bring their wages in line with those of their peers. To test this notion, the researchers conducted an ingenious experiment. Logically, employees who are paid a far bigger salary than their peers versus those who are vastly overpaid on a piece-rate basis (again, compared to their peers), must utilize very different strategies if they are to restore actual equity – and end up with a ‘fair’ salary or a wage. Overpaid salary workers, for example, can restore equity by working harder or attempting to do better work than their peers. Underpaid salary workers can restore equity by doing exactly the opposite; they can take revenge on their stingy employer by slacking off (producing less work or lower quality work). Workers who are paid on a piece-rate basis, however, must follow the opposite strategy if they are to set things right. Overpaid piece-rate worker can only restore equity if they produce less work (and thus decrease their pay) or higher quality work (justifying their high pay). Underpaid piece-rate worker can restore equity by doing just the opposite; they can produce more work (thus making more) or shoddier quality work (thus justifying their poor pay). The researchers tested this notion in a real-life work setting and found that they were right. Workers did indeed vary their production as the researchers suggested they would.

Of course, as we observed earlier, individuals may respond to inequitable payment not by actually working to make things fairer but by a mental sleight of hand: they can distort reality and convince themselves that they deserve what they are getting. There is considerable evidence that, given adequate time, workers do tend to convince themselves that what is, is right.

Finally, people who are offered a wage that is inappropriate can ‘leave the field.’ Applicants can refuse to accept a job that they think is providing inappropriate rewards. Employees who feel unfairly treated can take up a job that pays more fairly. Naturally, this strategy is preferred by those who are cheated rather than those who are offered a windfall. As we observed earlier, given time, it is usually fairly easy for the overbenefited to alter reality and convince themselves that they deserve to make far more than their peers, given their intelligence, productivity, or charm.

Conclusions

It appears that people in all cultures, settings, and relationships are concerned with being treated fairly. However, what is considered equitable, how considerations are made, and how individuals attempt to restore equity does vary by location, setting and relationship type. Even across these different situations four trends emerge. First, people everywhere are concerned with the punishments and rewards they receive. Second, societies use punishments and rewards to encourage people to behave equitably. Third, people feel uncomfortable when they

receive more or less than they deserve, and feel best when they receive no more and no less than they deserve; and fourth, individuals who overbenefit or underbenefit will to restore the balance somehow. As such, equity remains an interesting and important research topic.

See also: Friendship; Group Dynamics; Personal Relationships in Everyday Life; Social Exchange.

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Event-Related Potentials (ERPs)

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Glossary

Cerebral cortex The outermost layer of the brain (1.5–5 mm thick in humans), often called ‘gray matter’ because it contains nerve cells (neurons) that lack the white-looking insulating layers of myelin.

Component A deflection in the brain electric waveform that can be reliably related to a specific experimental manipulation, paradigm, or task.

Dipole In electrical systems, a separation of positive and negative charges.

Electroencephalography (EEG) The measurement of the ongoing electrical activity of the human brain using scalp electrodes. The electroencephalogram reflects the synchronized electric activity of hundreds of thousands of nerve cells.

Event-related potential (ERP) The sequence of voltage deflections from the EEG that are time-locked to the beginning (or end) of a specific event, such as a stimulus presentation or behavioral action.

Microvolt The millionth part of a volt; abbreviated as μV . The range of the ERP voltages is typically between 1 μV and tens of microvolts.

Pyramidal cells Neurons in the cerebral cortex with a cell body (soma) that is roughly shaped like a pyramid with two distinct structures of dendrites, which are the tree-like projections through which the cell body receives information.

Scalp topography The spatial distribution of the ERP voltage at a specific time, often illustrated using color maps to code the amplitude of voltages at different locations.

Introduction

Measuring brain activity in humans is critical to answering questions regarding the relationship between brain and behavior. Neural activity originates in specialized cells in the brain called neurons that have electrical properties. When neurons fire, a change occurs in their electric status, which generates voltages that can be measured on the scalp as negative and positive voltage deflections. Measuring the electrical activity of the brain by placing sensors on the scalp is referred to as electroencephalography (EEG). During both waking and sleep states, the ongoing EEG results in waveforms with distinct frequency characteristics, including slow wave activity during some sleep stages and fast oscillations during mental work. EEG is usually measured at very fine temporal resolution, typically sampling the voltage measured at the scalp every thousandth of a second (i.e., 1 ms).

Event-related potentials (ERPs) are derived from the ongoing EEG activity, and specifically measure neural activity following (or preceding) the onset of a target event – a word, picture, sound, or other visual, auditory, or somatosensory sensory stimulus; following the onset of a stimulus that cues preparation for, or execution of, motor activity; and even following a cue to perform covert mental operations (e.g., imagery, retrieval, anticipation). Historically, ERPs have been used as indices of psychological phenomena ranging from perception and attention to emotion, action, and memory.

An ERP is typically obtained by averaging several temporal segments (trials) extracted from the ongoing scalp-recorded EEG. Each trial is defined with respect to the event of interest, containing a baseline segment (prior to the event) and a post-event segment. By averaging the EEG activity over many trials, a representative temporal waveform of brain voltage changes is obtained, which characterizes the event of interest. Trial averaging is essential both because the ongoing EEG is noisy and

because the amplitude of changes to specific events are normally on the scale of several microvolts (μV), whereas the EEG involves voltage fluctuations that can be hundreds of volts in magnitude.

The peaks and troughs in the averaged ERP are presumed to reflect latent components or mental processes that contribute to its shape, and the sequence of observed components that characterizes an ERP for a given event is often divided into early mandatory components and later components. Early ‘evoked’ deflections are strongly affected by physical stimulus properties, such as stimulus intensity or duration. Researchers often referred to these early deflections as ‘exogenous’ or ‘evoked potentials’ in order to describe neural activity strongly tied to stimulus properties, compared to ‘endogenous’ psychological processes, which more strongly affect later ERP components. Currently, rather than making a strong distinction between exogenous and endogenous potentials, ERPs are taken to reflect processes that can occur from early to late in the processing cascade that follows the onset of a critical event.

Because ERPs reflect the activity of a large set of synchronously active neurons and can be measured in near-real time, they are often informative when testing hypotheses about the timing of neural activity in behavior and cognition. For instance, studies of visual selective attention to locations in space have shown that attending to a particular area in the visual field will lead to an ERP enhancement as early as 80 ms after the presentation of a stimulus in the attended, compared to a nonattended, location. This information was instrumental in the testing theories of early versus late models of selective attention. Given the versatility of the ERP, which can be measured in almost every experimental or clinical research context, there are a plethora of applications for ERPs and the reader is directed to the bibliography at the end of this article for excellent recent review articles on the topic.

The Neurophysiological and Physical Origins of ERPs

Because ERPs are based on EEG recordings, it is helpful to consider what is known about the neurophysiological and physical processes that underlie the scalp-recorded EEG. Most neurophysiological studies concur in the supposition that EEG reflects the synchronized activity of millions of cortical pyramidal cells. Pyramidal cells make up the majority (80–90%) of cortical neurons, with some differences in their density in different cortical regions. Their elongated shape and parallel orientation within the cerebral cortex, the outermost mantle of brain cells, makes them ideal generators of well-oriented electric fields: although electric field changes of a single pyramidal neuron cannot be detected through the layers of cerebral spinal fluid, skin, and scalp that separate the neural tissue from the electrodes, it is possible to measure the electric activity that is evoked at a given point in time by millions of such pyramidal neurons if they are oriented in the same direction. Thus, the dipolar (i.e., positive or negative) voltage changes induced by either excitatory or inhibitory postsynaptic activity at the apical dendrites are measurable outside the brain. This implies that the EEG measures neural activity in large areas of tissue.

In order to arrive at the scalp electrodes, currents generated by the cortical processes need to travel through the tissue of the human head. Thus, relatively strong currents traveling smaller distances on their way to the sensor electrode are well represented in the human EEG. This favors electrocortical activity in near-surface cortical neurons that are oriented parallel to the scalp, rather than deep brain regions with less favorable orientation. Because the different types of tissue through which the current passes (e.g., brain, cerebrospinal fluid, skull, skin) have different electric properties, volume conduction leads to blurring and distortion of the original electric field. Effects of volume conduction can also vary across the recording period, thus posing constraints on the spatial specificity of the voltage measured by EEG electrodes.

Measurement and Analysis of ERPs

ERP measurements are usually performed in an experimental chamber or room that is shielded from outer electrical fields. During the recording procedure, participants are encouraged to avoid ocular and body movements, as these lead to large nuisance signals (artifacts). A typical recording session involves the following steps: (1) a participant gives informed consent to being part of the study; (2) sensors are then placed on the scalp, and impedances (a measure of the resistance between the sensor and the neural activity) measured; (3) parameters are chosen for the filtering, digitization, and, ultimately, recording of the data; (4) artifacts are removed offline (i.e., after the recording session) from the data; (5) meaningful time segments are chosen from the data and averaged to yield ERPs.

Information critical to these steps include the following.

Sensors and Recording Reference

EEG is a safe and noninvasive procedure with minimum discomfort to the human participant. Over the last few decades,

the application of sensors on the scalp has become more comfortable with technical innovations such as all-in-one electrode caps, which can hold hundreds of sensors and are placed on the head using a cap or net structure (**Figure 1(a)**). In general, specialized sensors (electrodes) that are able to monitor voltage changes are placed over different scalp locations. The most frequently used sensors involve a silver–silver chloride contact that is filled with conductive paste, but other technologies are now available that provide excellent electric contact between the scalp and the amplifier. For instance, **Figure 1(a)** illustrates a dense-array net in which the sensors consist of an electrical contact that is placed in a sponge and is able to conduct current if it is dipped in a saline solution prior to recording.

Originally, the use of a three-sensor montage (sensor array) to measure voltage changes over midline frontal (Fz), central (Cz), and parietal (Pz) sites was common, but larger arrays were soon developed, prompting the formalization of a method for describing and applying sensors on the scalp called the 10–20 system (**Figure 1(b)**). This system labels sensors that are placed over the frontal pole (Fp), frontal (F), central (C), temporal (T), parietal (P), or occipital (O) cortex, with even numbers labeling sensors over the right hemisphere and odd numbers labeling sensors over the left hemisphere; ‘z’ labels midline locations. The numbers attached to sensors provide information regarding their distance from specific landmarks. The 10–20 system provides a common terminology for describing sensor locations across different researchers and laboratory sites and has been expanded to describe sensor locations for up to 257 sensors.

Because voltage is only a relative measure, that is, a difference in electrical potential that exists between two sites, EEG voltage at any specific sensor is always measured with respect to a reference site. One reference montage often used in ERP research is the common reference, in which each of the recording electrodes measures the voltage gradient against a common reference electrode. The location of the common reference electrode is critical to the interpretation of the resulting scalp distribution of the measured voltage, with normal recommendation to place the reference at a site that is electrocortically silent, allowing an estimate of the neural activity at each of the recorded sensor locations. Thus, distant and presumably electrically ‘quiet’ regions have been used as reference sites, such as a sensor mounted on the tip of the nose, the front of the forehead, or on the earlobes. Nonetheless, both cranial currents and extracranial sources (e.g., muscle activity) can affect flow at those sites and distort the measured voltage. Alternatively, the EEG may be recorded using one of the sensors on the scalp itself (for instance the vertex electrode at the top of the head) as the reference site during recording, and then computing an average reference offline (i.e., after recording) as the mean differences across all electrodes. Use of this reference avoids biases due to the specific reference location, but requires extensive coverage over the entire head for accurate estimates. Whichever reference is used, it is important to realize that it can greatly affect the timing and shape of the final ERP waveform, which will always represent the voltage measured over a particular sensor with regard to the reference montage.

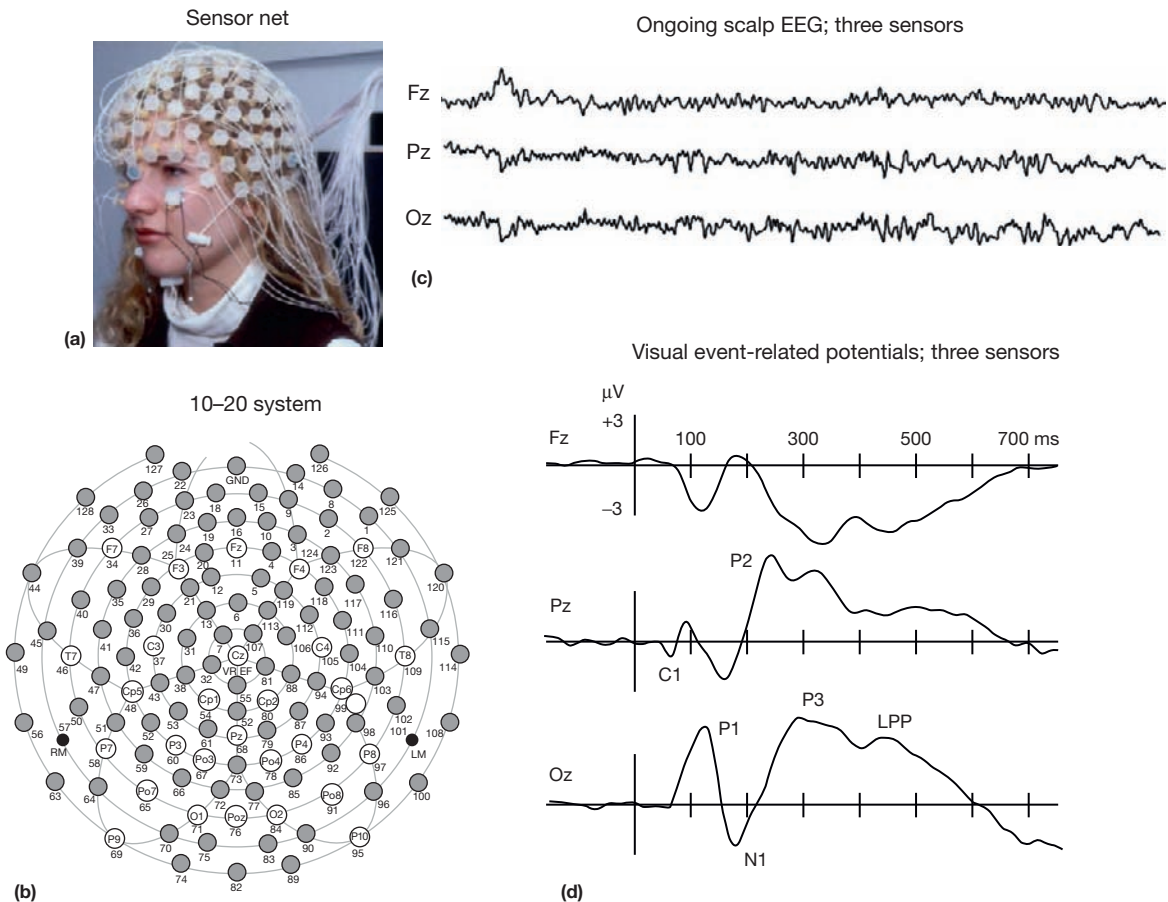


Figure 1 (a) An example of a dense sensor array used to measure EEG. (b) Layout of the 10–20 system and labeling of other sensors in a dense sensor array. (c) Ongoing EEG measured over a frontal (Fz), parietal (Pz), or occipital (Oz) midline sensor. (d) When the EEG in (c) is averaged across trials and deviated from the baseline, an event-related potential with peaks and troughs is produced for each sensor.

Amplifiers, Filters, and Sampling Rate

In addition to the selection of a reference site, other variables affect the quality and appearance of ERP during (and after) recording. The measured voltage at each sensor is typically amplified by appropriate hardware which can increase the amplitude of the EEG by factors of several thousands, making it highly sensitive to both scalp noise and high impedance, which is a measure of the factors that impede the flow of current. Traditional recordings of EEG have attempted to keep the scalp impedance below 5000Ω , which can be measured after the sensors are applied to the head. Recent developments in EEG technology include the creation of very high-input-impedance amplifiers, which allow clean recordings even when scalp impedances are ten times higher than the traditional threshold.

Filters are also used (both during recording and after recording) to further suppress unwanted noise that is not eliminated by signal averaging. Filtering is particularly effective if the desired (or the unwanted) signals are characterized by a certain frequency, for example, AC line noise at 60 Hz. The selection of filters for reducing noise in specific frequency bands will greatly affect the resulting ERP, as low-pass filters (e.g., those that pass frequencies below a certain level) will allow slow changes to remain in the EEG recording, and

high-pass (e.g., those that pass frequencies above a certain value) filters will allow fast changes to remain in the signal. Thus, filters that constrain the spectral content of the signal affect the resulting presence or absence of slow- or fast-going deflections in the final ERP.

The sampling rate at which the analog voltage fluctuations at the scalp are digitized into a numeric representation (using an analog-to-digital converter) will also influence to what extent slow- or fast-going deflections are visible in the averaged ERP. For most applications, sample rates of 250 Hz (i.e., 250 samples per second) will allow veridical reconstruction of the ERP. Using a sample rate of 250 Hz also means that the brain process under consideration will be monitored every 4 ms, affording exquisite time resolution.

Artifact Control and Rejection

After the EEG is recorded, several sources of noise may still be present in the signal, regardless of filtering. Extraneous electrical activity that leads to artifacts in the measured EEG include eyeblinks, eye movements, muscular activity, external electromagnetic noise, sweating, and heart rate potentials. Such artifacts can often be identified in a process of visual inspection, and

discarded or corrected by appropriate algorithms. In traditional approaches to artifact correction, EEG segments (or sensors) containing artifacts or contaminated sensors were completely removed from the data, leading to data attrition.

More recent methods try to retain as much of the recorded data as possible by mathematically modeling certain types of artifacts (e.g., eye blinks), and then correcting (i.e., recalculating) a version of the original EEG that estimates the true signal without the targeted artifact. Often borrowing from methods used in geophysics, signal detection, and engineering, these computational algorithms use advanced interpolation and artifact correction techniques, in which bad data segments or sensors are estimated using statistically weighted spherical interpolation from the full sensor set. To result in accurate estimates, these techniques rely on the use of a moderate to large sensor montage at recording.

Segmenting and Averaging

The positive and negative deflections associated with a specific ERP are typically quite small, and are embedded in ongoing EEG activity that is not time-locked to the event of interest (**Figure 1(c)**). As noted earlier, a simple way of reducing the contribution of nonrelated EEG activity is by averaging activity that is time-locked to the event of interest (**Figure 1(d)**). Random activity not related to the event will cancel out (i.e., positive and negative deflections that occur randomly in time) as the number of trials included in the average increases, leading to greater suppression of the nonstimulus-related EEG activity. Depending on the size of the ERP of interest, recommendations for the number of trials necessary for extracting meaningful ERPs range between 15 and 20 trials (e.g., for extracting large responses to salient visual target stimuli) to thousands of trials (e.g., for extracting the brainstem's response to specific sounds).

When averaging trials, the selected segments from the EEG typically includes a baseline period that occurs just before the event of interest (e.g., often 100–200 ms) and a variable amount of time following event onset (e.g., 1000–2000 ms is fairly typical postbaseline interval). After averaging over multiple trials, the ERP represents the part of the signal in each trial that is time-locked and phase-locked to the event, which means that the peaks and troughs in the resulting waveform tend to occur at the same time and with the same voltage (positive or negative) on most trials. Once the baseline is subtracted from each timepoint following event onset, the resulting ERP waveform will typically consist of a sequence of positive- and negative-going voltage deflections, which vary in their latency, amplitude, and topographical distribution across the scalp.

ERP Components

The pronounced positive and negative deflections in the ERP that are reliably present in a specific experimental context are often called components, and are typically labeled by letter-number pairs indicating their polarity and temporal position in the sequence of deflections. For instance, N1 refers to the first negative deflection, whereas P2 is the second positive deflection. Historically, the numerical index reflected the

temporal latency of a component in milliseconds rather than its temporal position but in recent years labeling an ERP component by its temporal position (e.g., 1, 2, 3) is preferred, as the specific timing of a component can vary broadly, depending upon the experimental context. Thus, for instance a classical ERP component originally labeled 'P300' (i.e., a positive deflection at 300 ms after stimulus onset) is often also referred to as a 'P3' component. Whereas the P3 typically tends to be the third positive peak in studies of visual attention and perception, its temporal maximum is not always at 300 ms. Slower components in the ERP are longer lasting deflections that often lack a clear peak, and are typically labeled, depending upon their polarity, as positive or negative slow waves or potentials. Occasionally, an ERP component that occurs very reliably in a specific paradigm is named, such as the LRP – the lateralized readiness potential – which is an ERP that is maximal over contralateral sensors when preparing to make a motor movement on one side of the body.

Statistical Analysis and Interpretation

Positive and negative components are generally taken as indices of neural activation that reflect underlying latent processes, with a greater amplitude suggesting stronger neural activity at the time point selected. In general, extraction of dependent variable from a spatial-temporal array such as the ERP waveform recorded at many electrode sites is nontrivial. Multivariate statistical approaches such as principal component analysis (PCA) have been used to reduce the many time points included in the averaged waveform to specific time intervals and scalp regions that are sensitive to the experimental question. Then, either averaging over the specified time interval or scoring the peak activity in that time interval results in the dependent measure of interest. PCA can also be used to reduce the spatial information and combine electrodes into groups showing similar time course and/or sensitivity to the experimental manipulations. Difference waveforms between two experimental conditions are also sometimes used to highlight a neural difference between experimental events that are identical except for a variable of interest that was manipulated in the experiment.

In addition to amplitude measures, the latency at which specific components occur is of interest in some experimental studies. Although determining component latency (the point in time at which the peak of the deflection occurs) can be used as an estimate for the point in time at which neural activation occurs, its implementation is variable and, because analysis of single trials is difficult in ERP studies, relies on the average latency across all the trials going into the average.

In addition to the amplitude and latency of different ERP components, ERP studies also result in topographical information that specifies the sensor locations at which selected positive and negative voltage deflections are maximal. Because the EEG records activity from large cell assemblies whose original locus is spatially smeared by conductance properties of the scalp and other brain matter, the topographical information associated with a measured ERP component does not specify the original source of the neural activity. Moreover, because any specific scalp topography can be generated by many different configurations of potential sources of neural activity, the

topography of any voltage distribution measured at the scalp does not uniquely identify the underlying sources. Thus, the topographical information in an ERP study primarily allows more precise labeling of the ERP component, which is useful both for comparison across paradigms as well as for differentiation from other components that may occur in the same time interval but measured at other sites.

Statistical analyses of ERP amplitude, for instance, will often include not only the key experimental manipulations, but also the electrode site (as a factor) to statistically identify its topography (e.g., larger over parietal than frontal; larger left than right, etc.). Depending upon the size of the sensor array, this can lead to conducting a very large number of statistical tests, particularly when dense arrays (e.g., up to 256 sensors) are used, prompting problems associated with alpha error accumulation: How many of the significant test results can be attributed to chance, given that a high number of statistical tests were conducted? Recently, procedures to control alpha error accumulation have been newly developed or adopted from neuroimaging work, in which this issue also arises.

ERPs and Psychological Processes

ERPs are a powerful tool in identifying neural correlates of mental processes associated with information processing and behavior in human participants, as well as in understanding individual differences due to psychopathology, brain insult, aging, and other clinically relevant phenomena. They are used to make inferences about the presence or absence of processes in a specific experimental context, as well to draw conclusions about the timing and ordering of these processes. Nonetheless, it is important to emphasize that an ERP component does not exist independently of the specific experimental context in which it is measured. For example, a 'P1' obtained during visual perception does not necessarily identify the same underlying process as a possible 'P1' that might be measured in olfaction. The interpretation of specific ERP components (either punctate deflections or slow waves) always needs to be tied, at least initially, to the experimental context in which they arise. When an ERP component with a similar timing and topography is found in a different experimental context, careful experimentation is needed to conclude that the same latent process is responsible. Such experimentation will involve systematic comparisons of the contexts prompting that ERP component within the same participants.

Secondly, even when an ERP component appears to consistently vary with a specific experimental manipulation, this does not confirm that the inferred process was actually measured by that component. For instance, if a study finds that the amplitude of a visual P1 component is enhanced in a study of spatial selective attention, this cannot be taken to conclude that an increase in P1 amplitude always indicates that spatial attention was paid to a stimulus. Rather, P1 amplitude can be affected by whether the stimulus is brighter, closer, or more salient in a context, have greater spatial frequency, or has other properties that may lead to the observed change. Again, careful experimental scrutiny is needed to strongly infer that a specific ERP component indexes a specific mental activity.

The critical dependence of the interpretation of ERPs on the specific paradigm of its investigation can be demonstrated for the P3 component, one of the most investigated ERP deflections in psychological research. As its name implies, the P3 is a positive ERP component, often occurring as the third positive deflection in the ERP. It was originally measured in the context of an 'oddball' task in which a tone of the same frequency was played over and over (i.e., 'the standard') and subjects were instructed to count or otherwise respond to rare presentations of a different tone (i.e., the 'oddball'). A P3 component (often occurring 300 ms after stimulus presentation) was larger (over parietal sensors) for the oddball, compared to the standard stimulus, and later studies found that P3 amplitude was generally heightened for any task-relevant stimulus.

Extensive work using both visual and auditory stimuli in the oddball task has yielded a complex database regarding this ERP component, which suggests that the P3 consists of several overlapping subcomponents that depend both on features of the stimulus (e.g., a novel or rare stimulus) and features of the task. For instance, a more frontally oriented and somewhat earlier P3 component, often called the novelty P3 or P3a, describes P3 amplitude enhancement over frontal sensors when novel stimuli appear as nontargets in a stream of events. Task relevance is not critical for measuring this component. In a similar but slightly longer time range, a P3 enhancement over posterior regions has been observed for stimuli that are task-relevant, even if they are not novel, often called P3b. Experiments have investigated the contribution of active motor responses, type of task, modality of target and nontarget, probability, and frequency to the amplitude of the P3 component. Current theoretical interpretations of the P3 suggest that it indexes allocation of attentional resources during perception and mentation.

The database of ERP research is dense, comprised of many thousands of studies conducted since the technology first became widely used in the 1960s. Consistent with the goal of psychological science, certain reliable components have been identified and hypotheses regarding their functional significance advanced. Because both vision and hearing are critical in human information processing, much of the research has measured ERPs in experimental contexts which prompt perception, attention, and action following visual or acoustic stimulation, which is briefly reviewed below.

Visual ERPs

The presentation of a visual stimulus, or even the induction of a simple brightness change in the environment, leads to a characteristic ERP waveform whose components are maximal over sensors located on the posterior part of the scalp. Because the visual system in humans is highly parallel and complex as well as widespread, visual ERPs tend to extend over longer time ranges than auditory or somatosensory potentials. [Table 1](#) (top panel) lists a sequence of potentials together with their latency, neurophysiological interpretation, and factors that impact their amplitude.

Auditory ERPs

The human auditory system is more confined in space and more time sensitive than the visual system. Most auditory

Table 1 Common ERPs measured when processing visual and acoustic events

	<i>Peak latency (ms)</i>	<i>Neurophysiology</i>	<i>Varies with</i>
Visual ERP			
C1	40–80	Response in the calcarine fissure (= lower tier visual cortex)	Physical stimulus features, some forms of spatial selective attention
P1	80–120	Arrival of cortical activation in extrastriate cortex	Spatial selective attention, some forms of feature-based attention
N1	140–190	Spread across the visual system, reentry from frontal cortices	Feature-based attention, match or mismatch with expected semantic content, priming, face processing
P2/N2	200–280	Engagement of wide cortical areas, occipitoparietal focus of activity	Perceptual novelty; stimulus mismatch; response inhibition
P3	300–500	Contributions from widely distributed cortical and subcortical regions	Stimulus probability; attention allocation; task relevance
Late positive potential (LPP)	>400	Contributions from widely distributed cortical and subcortical regions	Sustained attention; motivational relevance; memory retrieval
Auditory ERP			
Brain stem auditory evoked potential (AEP)	1–10	Responses in the deep nuclei in the brain stem; require thousands of averages (stimulus repetitions). Labeled I, II, III, IV, V	Physical stimulus features; temporal properties of the acoustic sequence
Middle latency components: No, Po, Na, Pa, Nb, and P1, Pb, P50	10–40	Subcortical and primary auditory cortical neural activity; require several hundreds of averages	Physical stimulus features; temporal properties of the acoustic sequence
N1	50	First pronounced response of (primary) auditory cortex	Stimulus detection and encoding
	70–110	Primary and secondary auditory cortex	Interstimulus interval; changes in stimulus frequency; rate of presentation; predictability
P2	120–200	Contributions from widely distributed cortical and subcortical regions	Similar to N1
N2, N2a, N2b, N2c	200–250	Contributions from widely distributed cortical and subcortical regions	Stimulus deviance; novelty; task relevance
P3	>250	Contributions from widely distributed cortical and subcortical regions	Stimulus probability, attention allocation, task difficulty

ERP components are generated in the temporal lobe of the cerebral cortex, located bilaterally above the ears and are best recorded from the top of the scalp. A particular feature of auditory recordings is a very early response to sound that can be recorded from the brainstem, if sufficient numbers of trials are available (see [Table 1](#), bottom panel).

Source Analysis

As noted previously, knowing the topography of a specific ERP component does not provide specific information regarding the original sources of the electrical activity that have been measured over the scalp. Nonetheless, there have been several computational efforts in recent years that attempt to estimate the sources contributing to the ERP measured over the scalp. A number of issues are critical in this work.

The Inverse Problem

Both the size of the sensor arrays and their location outside the brain limit the ability to spatially sample the neural generators presumed to underlie the measured scalp voltage. EEG provides a two-dimensional (2D) projection of a three-dimensional (3D) reality, and it has long been known that an infinite number of

3D source configurations exist that can produce a given 2D projection. This is referred to as the inverse problem: It is difficult to go backwards from the 2D signal to generate the sources in 3D space. In practice, this means that there is no mathematically unambiguous way to calculate the neural sources of an ERP voltage distribution. Nonetheless, several methods have been developed that use additional knowledge to constrain the infinite solution space, or to infer gross source configurations by means of simple data transformations.

Mapping Techniques

The extent of the spatial sampling of scalp voltages affects the ability of researchers to use topographical information of the ERP distribution over the scalp to infer sources. With the advent of dense-array EEG/ERP recordings (with up to 257 sensors), the possibility of more accurate source localization of the underlying the scalp-recorded EEG has dramatically risen. By taking into account the physics of current flow in a conducting volume together with sufficient spatial sampling, transformations of the topographical map are available that highlight the current flow on the scalp and allow one to infer possible sources of brain-electric activity. Among the most widely used techniques is the current source density (CSD) mapping approach, which is mathematically based on

the Laplace operator. The Laplacian can be conceived of as the second spatial derivative of the voltage map, thus showing the change of the voltage gradient across the scalp. Assuming no sources in the scalp, the CSD map will be proportional to the radial current flow in or out of the skull at a given site. Because it is reasonable to assume that most generators of the ERP are located in near-surface cortex, this type of measure allows a first approximation of the underlying electrocortical sources.

Source Estimation Techniques

A more elaborate source analysis technique harnesses the spatial information inherent in multichannel ERP recordings using appropriate algorithms to guide estimates as to their cerebral origin. Historically, one of the first techniques used tried to fit the surface potential distribution by assuming it was generated by a single equivalent current dipole. In this procedure, the assumption is that the voltage map at the scalp reflects the activity of a single neural source with a positive and negative pole. The procedure uses knowledge about the possible distortion of this signal together with the current flow in the head to systematically fit a source dipole that is most similar to the measured voltage distribution. To this end, a forward calculation is performed many times, which generates various voltage distributions based on many different dipole locations and orientations, and the one location, strength, and orientation that leads to the distribution most similar to the measured signal is assumed to be the source. This procedure is called inverse modeling.

An alternative distributed source modeling procedure has been proposed as a means for enhancing the resolution of electrophysiological data without constraining the inferred

electric activity to point sources or single dipoles. In this procedure, hundreds of potential dipoles at various locations in a 3D volume are included in the model which estimates the scalp voltage distribution. Several different procedures have been suggested and are in current use. Efforts are also under way to obtain more accurate 3D representations of voltage sources in the brain, although the basic issues inherent in the inverse problem remain to be solved.

See also: [Electroencephalography](#); [Neurotechnologies](#); [Visual Perception](#).

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Evidence-Based Practice

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Glossary

Empirically supported treatments A term used by psychologists to designate behavioral health interventions that are supported by evidence from either clinical trials or single case experimental designs.

Evidence-based behavioral practice (EBBP) EBBP applies the concepts and methods of EBP to behavioral health practices that address mental health and health risk behaviors.

Evidence-based practice (EBP) EBP is both a conceptual model and a process. The conceptual model, depicts 'three circles' or data streams to be integrated via decision making: research, client characteristics (including values and preferences), and resources (including practitioner expertise or skills). Performing the EBP process entails carrying out a sequence of five steps. After assessing the presenting problem, the practitioner: (1) asks key questions, (2) acquires evidence to answer them, (3) appraises its quality and contextual relevance, (4) applies the evidence via shared decision making that integrates client characteristics and

resources, and, after reassessing, (5) analyzes outcomes and adjusts practice accordingly.

Evidence consumers Those who apply evidence, usually for the purposes of implementing clinical or public health practice or policy, or for educational purposes.

Evidence creators Researchers who perform studies to produce data that tests a hypothesis or answers a question.

Randomized controlled trial (RCT) A study in which participants are assigned to different intervention conditions at random and the groups' outcomes are compared for the purpose of determining whether one intervention is more effective than another.

Systematic evidence review A structured review of research that addresses a well-formulated question and applies comprehensive, rigorous, systematic, and transparent methods to minimize bias in the results. The review protocol follows predetermined inclusion and exclusion criteria, critical appraisal of the relevant research, and extraction and synthesis of data from the evidence to formulate findings.

Introduction

Evidence-based practice (EBP) is both a conceptual model and a process of patient-centered decision making. Originally introduced in medicine, the EBP framework has now been endorsed by all major health professions. Here we describe how the concepts and methods of EBP can be understood and implemented by mental and behavioral health care professionals in support of integrated patient care. The conceptual model, elaborated below, depicts 'three circles' or data streams to be integrated when making practical decisions to promote health. One circle represents best available research evidence; the second is client characteristics (including preferences and values); the third is resources (including practitioner expertise or skills). Performing the EBP process entails carrying out a sequence of steps. The practitioner frames clinical questions, locates and contextualizes evidence to answer them, assesses outcomes, and adjusts practice accordingly. By understanding the EBP framework, behavioral health care providers are better able to communicate with other health professionals in a manner that integrates care for mental and physical health.

Terminology, Rationale, and Tools for EBP

Since its first emergence in medicine a century ago, the evidence-based movement has been about finding ways to distinguish quackery from valid health practices. EBP now has become recognized as a core competence for all health professions. Here we address EBP's implications for psychologists, social

workers, physicians, nurses, public health practitioners, and others who implement nonmedical interventions to address the mental health needs and health risk behaviors of clients.

We call the relevant class of interventions behavioral health treatments, while acknowledging that this phrase is sometimes used more narrowly to designate only mental health interventions. In our usage, behavioral health treatments are non-medical interventions that address psychosocial or behavioral problems such as depression, anxiety, obesity, and substance abuse that have documented adverse effects on health and health care costs. Relevant research-supported treatments are sometimes called evidence-based *behavioral* practices (EBBP) because they do not entail medical components: drugs, surgery, medical devices. Psychologists in the United States sometimes call behavioral health interventions empirically supported treatments (EST) if they are supported by results from one or more clinical trials or single case experimental studies. Ironically, though, usage of the phrase 'empirically supported' can cause confusion when used in the context of an interprofessional team. EST connotes positive features to psychologists by suggesting that a treatment has research support. In medicine, by contrast, the phrase 'empirically supported treatment' has negative connotations. The wording suggests use of an intervention in a trial-and-error, exploratory fashion to see if a good effect can be produced, despite the fact that the treatment lacks a basis in clinical trial evidence or pathophysiology.

Many date the onset of the evidence-based movement to the 1910 publication of the Flexner report that challenged the quality of that era's medical training. The Flexner report, a work commissioned by the American Medical Association and

the Carnegie Foundation, set out to ground medical education on a firm scientific foundation.

The EBP movement has continued to press for rational, systematic provision of high-quality care. To achieve that objective, the first problem that needed to be resolved was to find a basis on which to judge the quality of alternative care options. Randomized controlled trials (RCTs), first championed by Archibald Cochrane in the early 1970s, have become accepted as the most valid method to determine treatment effectiveness. Cochrane proposed that the value of a treatment should be determined by high-quality RCTs because this method provides the most valid, least biased estimate of treatment effectiveness. However, it is widely recognized that uptake of best practices supported by RCTs is abysmally slow and incomplete and that many clinical practices have little or no research support. To address these criticisms, it was necessary to develop concise and far-reaching ways to disseminate findings about EBP.

The systematic review is one tool that was introduced to help bridge the research to practice gap. Systematic reviews are literature reviews that employ rigorous, thorough, and transparent methods to minimize bias in the results. Systematic reviews provide a vehicle to synthesize evidence across numerous clinical trials. The Cochrane Collaboration, founded in 1992 and now grown into an international network, prioritizes, performs, and regularly updates systematic reviews, and disseminates them to end users via the worldwide web.

Practice guidelines are sets of recommendations or principles to help health professionals and patients make decisions about screening, prevention, and treatment of specific health conditions. Federal agencies or professional organizations are usually the entities that undertake preparation of practice guidelines. To be considered evidence-based, a guideline must be demonstrably derived from a systematic literature search and review of existing scientific evidence published in peer reviewed journals. However, the systematic review itself only summarizes the evidence; it is silent about practical applications. The job of extrapolating from evidence to clinical recommendations is the task of guidelines creation.

High-quality guidelines explain very explicitly the logic that was applied to derive recommendations from the evidence. The guidelines created by the United Kingdom's (UK) National Institute of Clinical Excellence (NICE) offer an excellent example. NICE guidelines serve as a link in the chain of the UK's EBP policy. They are formulated on the basis of systematic evidence reviews that the National Health Service (NHS) commissions in order to determine which health care procedures to fund. Other evidence-based guidelines can be found by searching the National Guidelines Clearinghouse website. Sponsored by the US Agency for Health Research and Quality, the National Guideline Clearinghouse posts more than 2000 evidence-based guidelines.

Growth of the Evidence Base

One of the greatest challenges EBP faces stems from gaps in the research literature. Insufficiencies are especially stark in the areas of nonpharmacological treatments for mental health conditions and for health promotion, preventive care. On the one hand, there is a great abundance of high-quality evidence

demonstrating adverse effects of poor behavioral health on quality of life, chronic disease risk, and costs. On the other hand, the evidence base evaluating the efficacy and cost impact of interventions to modify behavioral risk factors is relatively meager and of modest quality.

A consequence is that policy makers often find too little high-quality evidence to recommend for or against the delivery of many behavioral health interventions. Of course, absence of evidence is not the same as evidence of absence of an effect. Nevertheless, guideline panels are often compelled to assign a grade of 'I' ('insufficient evidence') for behavioral health interventions. A grade of 'I' renders a policy-making body unable to advise for or against the intervention because the available evidence is of insufficient quality or quantity to support a recommendation.

There is a critical need for a high-quality base of clinical trials that evaluate behavioral health treatments. The fact that creators of evidence-based guidelines apply the same evaluative criteria to trials of medical and nonmedical treatments levels the playing field for psychological and psychosocial interventions. Patients often express a preference for nondrug treatments. Strengthening and disseminating the evidence base for behavioral health interventions supports patient-centered care by helping the public to access and benefit from all effective health treatments. To strengthen the needed evidence base, the US Congress recently authorized new research on comparative effectiveness. In a comparative effectiveness trial, two or more efficacious treatments are contrasted in a head-to-head comparison that tests which one works best and at what relative costs. It is to be hoped that a body of evidence comparing alternative behavioral health treatments to each other and to medical alternatives will support evidence-based policies that expand the effective behavioral health treatments available to patients.

Transdisciplinary collaboration

The start of the twenty-first century has ushered in calls for increased collaboration and teamwork among scientists from different disciplines and practitioners from different professions. Scientific funding agencies encourage transdisciplinary collaboration based on recognition that scientific progress is often made at the interface of preexisting disciplines. Thought leaders and policy makers call for greater collaboration in the education of health professionals based on the expectation that future health care teams will be increasingly interprofessional. The US Institute of Medicine endorses cross-training among the health professions to help care delivery transition toward a 'patient-centered health home' that provides coordinated, accessible team-based care that addresses all of an individual's health care needs.

Yet, despite the advantages that accompany professional boundary spanning, vast differences between disciplines in vocabularies and frames of reference can impede progress. That EBP has come to provide a shared vocabulary and perspective across health disciplines offers tremendous advantages for communication. Learning EBP vocabulary and methods affords behavioral interventionists invaluable opportunities to participate in interprofessional collaboration. The shared EBP framework supports jointly held foundational assumptions, vocabulary, and practice principles for behavioral health practitioners who participate in interprofessional teams.

Lifelong learning

The methods of evidence-based behavioral practice were developed as a way to close the research to practice gap and foster lifelong learning. A well-documented chasm exists between what research shows to be effective and what is done in usual clinical practice. Often, practitioners continue to implement practices they learned during training, even when few of those practices were ever based upon evidence and some have been supplanted by new evidence.

The research evidence base relevant to health professionals proliferates at an astonishing rate. There exist ~23 000 clinical journals that publish more than 2 million articles annually. It is difficult to imagine how a practitioner could keep up-to-date with this primary literature.

At McMaster University in Canada in the early 1980s, there developed a critical mass of faculty with an ambitious agenda to close the research to practice gap. The group wrote many journal articles and books about how to keep up with and understand the research literature. They wanted to develop a method that let practitioners find and apply evidence that answered their questions in real time, during the actual clinical encounter. The idea was to make it a habit to routinely ask questions, consult research, and integrate knowledge from three data strands (research, clinical experience, and the patient) when making clinical decisions. The rationale was that routinely performing such integration would overcome old, automatic, decision-making biases and cultivate new learning. Gordon Guyatt coined the phrase 'evidence-based medicine' to describe the EBP process. The new name represented a departure from the older term, 'scientific medicine,' which omitted the clinician's and patient's contribution to decision making and overemphasized making inferences based on pathophysiology. The basic premise of EBP is that there should be no learning disjuncture between graduate school and subsequent professional life. While in school, just as afterward, engaging in evidence-based behavioral practice involves finding and implementing the practices that are supported by best available current research evidence. It is to be hoped that scientific progress supplants older best practices with newer and better ones, and that the evidence-based practitioner will continue to find the best evidence and upgrade respectively.

One can only marvel at the McMaster group's audacity. Just imagine trying to train practitioners to do library searching and critical appraisal of research at the bedside in real time before the advent of the internet. Having rapid access to the research evidence base at the point of care became critically important. Such access became feasible as the emergence of large electronic data sets brought library resources to the desktop. Perhaps not surprisingly, the McMaster group has played a key role in developing the health informatics that are needed to store, retrieve, manage, and use health information at the time and place that decisions need to be made.

The science of informatics addresses resources, devices, and structures (e.g., treatment algorithms, practice guidelines, systematic evidence reviews, and electronic medical records) that are needed to store, retrieve, manage, and use evidence at the point of care. A growing set of databases of secondary, synthesized literature has evolved to meet practitioners' needs. One important resource already mentioned is the Cochrane Collaboration's online database of Systematic Reviews of

health care practices. Other more clinically oriented resources to address practical questions are available online and/or on a hand-held device. These tools, based upon continually updated evidence reviews, offer pithy evidence synopses, clinical practice guidelines, and structured abstracts. Examples of online resources are UpToDate, MD Consult, ACP Journal Club, Clinical Evidence, InfoPOEMS, and Clin-eguide. The phrase, 'evidence-based capitulation' is sometimes used pejoratively to describe practitioner reliance on filtered, synthesized evidence resources rather than primary research studies. However, use of such infrastructure is in keeping with the voluminous realities of contemporary science and practice.

Conceptual Model of EBP: Three Circles

The root conceptual model for evidence-based behavioral practice depicts three interlinked circles (i.e., data strands) that need to be integrated in order to determine optimal client care. Research evidence has consistently remained a circle as EBP models evolved over time. In 2006, the National Institutes of Health's Office of Behavioral and Social Science Research commissioned the first author to undertake a 5-year project to create 'Resources for Training in EBBP' that harmonize the EBP approach to behavioral health interventions and support communication and collaboration across health disciplines. The resulting interprofessional Council and Scientific and Practitioner Advisory Boards for Training in Evidence-Based Behavioral Practice, include EBP experts from medicine, nursing, psychology, social work, public health, and library sciences. The Council's transdisciplinary model of EBP, depicted in [Figure 1](#), incorporates the most important conceptual advances made by each profession and reflects an emphasis on shared decision making. Additional information and online tutorials about EBP can be accessed free of charge or for continuing education credits via the EBBP Project website.

The transdisciplinary EBP model depicts three data streams to be integrated when deciding upon a course of action: evidence, client characteristics, and resources. Best available scientific evidence remains one of the three circles. Client values, preferences, and characteristics remain a second circle. Reflecting a conceptual advance from public health, the third circle is resources, which includes practitioner skills. Decision making is the central concept of the model and the action that ties the three data streams together in EBP. The interprofessional EBP model is grounded in an ecological framework that suggests a need to understand a problem in context and address influences at multiple levels. Consequently, the model depicts decision making in the environmental and institutional surrounding context that frames it.

Best Research Evidence

Evidence comprises research findings derived from the systematic collection of data through observation and experiment and the formulation of questions and testing of hypotheses. What constitutes best research evidence depends upon the question needing to be addressed. For example, for questions about etiology or prognosis, the optimum research design is often a longitudinal cohort study. For questions concerning the efficacy and effectiveness of treatments, the research design least prone to bias or error is the RCT. Topping the evidence

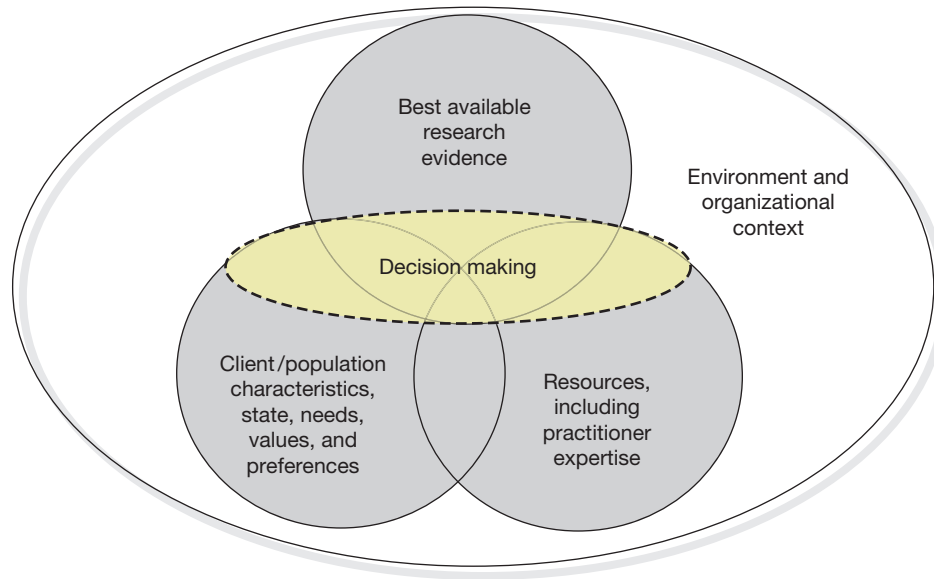


Figure 1 Elements that need integration in EBP. Reprinted with permission from Spring B and Hitchcock K (2009) Evidence-based practice in psychology. In: Weiner IB and Craighead WE (eds.) *Corsini's Encyclopedia of Psychology*, 4th edn., pp. 603–607. New York: Wiley.

pyramid for a question about treatment is the systematic review, which synthesizes the findings from many treatment trials. Recently there have been renewed calls for contextualized research evidence that is directly relevant to the specific patient and practice context. Accordingly, some presentations of the evidence hierarchy place at the apex of the evidence pyramid an $N = 1$, single case study using an experimental design that tests the treatment of interest with the target patient.

Resources

The resources circle depicts the skills and infrastructure support that are needed to offer EBPs. Resources include the physical, technological, personnel, and financial assets needed to deliver treatments (e.g., space, time, technological support, finances including insurance reimbursement, and expert practitioners trained in the EBP). Unless they are fully automated (e.g., internet delivered treatments), all evidence-based behavioral health interventions require practitioner competence in communication, assessment, and counseling skills (e.g., building a therapeutic alliance). Many evidence-based behavioral health treatments also require that the interventionist possess complex clinical skills that require substantial supervised training to develop. Other needed resources may involve institutional endorsement by higher administration and agreement from other system components.

Universally, resources are a variable that factors into evidence-based decisions. The most efficacious treatment is irrelevant to any but theoretical EBP if there is no trained practitioner accessible to deliver treatment or no resources to pay. The creation of resource-sensitive practice guidelines is a new development in EBP. Such guidelines review the quality of evidence supporting alternative practice recommendations that fit the resources available. Decision makers can use the guideline to gage the level of intervention intensity that makes best use of accessible infrastructure, human capital, and financial wherewithal.

The transdisciplinary EBP model incorporates practitioner expertise within the broader circle that depicts needed resources. In earlier models of EBP, the circle named practitioner expertise generated the greatest controversy and underwent several revisions. The problem, in part, reflected ambiguity in medicine's original EBP model, which sometimes led practitioner expertise to be misconstrued as opinion or unquestioned intuition. Later versions of the EBP model in medicine operationalized expertise as skill in performing the steps of the EBP process (e.g., asking questions, acquiring evidence, critically appraising research), etc. In the transdisciplinary EBP model, practitioner expertise entails four categories of skills: (1) assessment skills; (2) EBP practice process skills; (3) communication and collaboration skills; and (4) engagement and intervention skills.

Client Characteristics, State, Needs, Values, and Preferences

Except for single case studies, research evidence describes the average responses of individuals or groups. The core challenge addressed by EBP is how to apply the averaged data to a particular individual or community. The evidence needs to be appraised in relation to the particular circumstances at hand. Client characteristics are one key set of contextualizing factors that need to be taken into account. Relevant client attributes include state and trait variation in condition, needs, history of treatment response, values, and preferences. To decide whether available research evidence is truly relevant to the client, a judgment needs to be made about the comparability between the study population and the client. Some tailoring (e.g., literacy level of materials) can often enhance treatment feasibility and acceptability, without undermining fidelity to the core treatment elements that make a treatment effective.

Client preferences warrant special mention as a contextualizing variable. Patient preferences are the lynchpin of shared decision making, but are also the least developed aspect of the

EBP model. The rationale for shared decision making is to engage patients more fully in self-managing their own wellness and health care. For shared decision making to become a reality, there are two needed preconditions. One is departure from an authoritarian model of care in which the provider makes decisions on the patient's behalf. The other is progress toward a more culturally informed shared model of care. The idea is for providers to respect and help patients clarify their own values and treatment preferences so that patients can behave in ways that will enhance their personal health and well-being.

The need to systematize an approach to client preferences is inescapable and complex. How individuals weigh out the relative risks and benefits of treatment alternatives is personally distinctive, subjective, and often not previously considered by the patient. The issues are no less complex when a community deliberates how to invest resources in order to curtail a public health problem. Effective deliberation also requires information that may be unknown to the clients, such as the range of intervention alternatives, including watchful waiting, and their potential inconveniences and risks. For many psychological conditions, patients need to determine whether they prefer

to be treated pharmacologically, psychosocially, or both. The availability of insurance coverage for specific treatments factors in, as do such logistical considerations as geographic access to trained therapists, scheduling, transportation, and child care. For public health problems (e.g., obesity), there may be trade-offs between investing resources in prevention or treatment, physical infrastructure, program staffing, or policy outreach.

EBP has done much to highlight the importance of shared decision making in the health service delivery process. Engaging clients in decision making that acknowledges their preferences is justifiable on sociopolitical grounds of equity. Shared decision making is also justified on evidentiary grounds because shared decision making has been found to be associated with improved health outcomes.

Roles in EBP

As depicted in [Figure 2](#), behavioral health professionals have three main roles in relation to EBP. First, as primary researchers, behavioral health professionals contribute directly

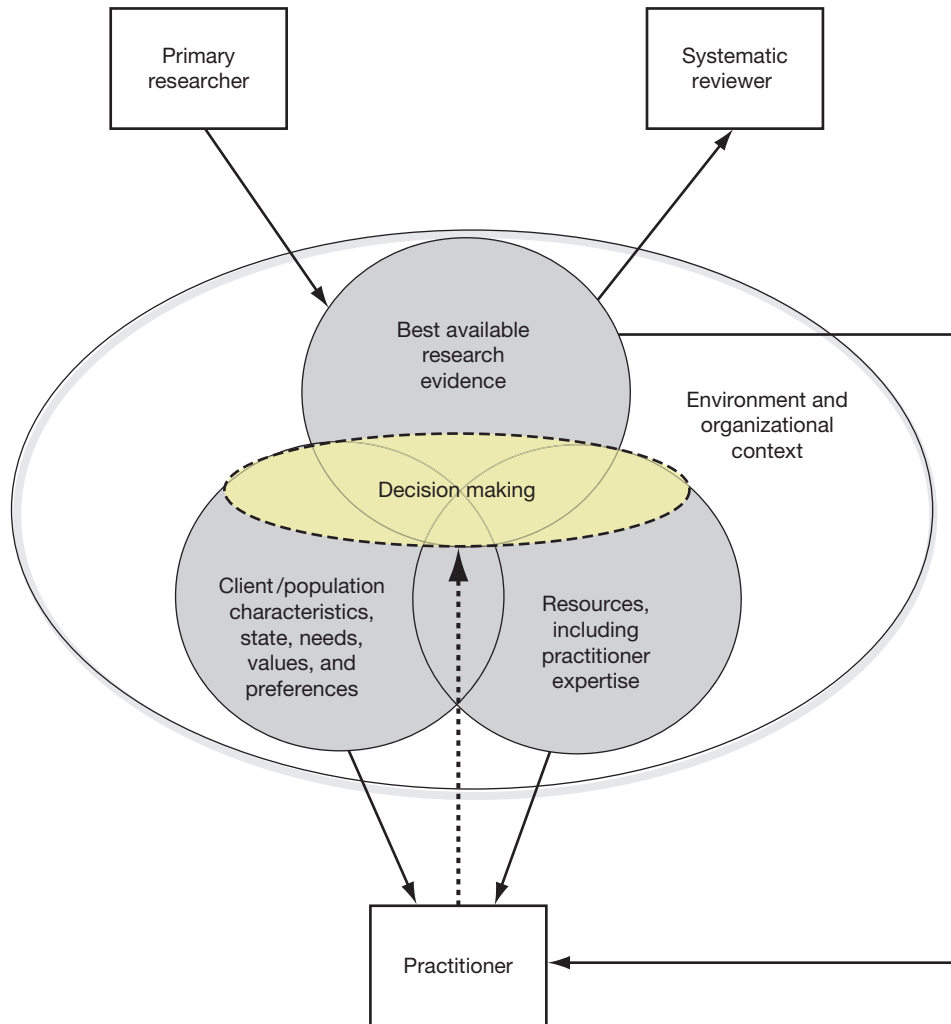


Figure 2 Practitioners' roles in evidence-based practice. Reprinted from Oxford University Press. Spring B and Neville K (2010) Evidence-based practice in clinical psychology. In: Barlow D (ed.) *The Oxford Handbook of Clinical Psychology*. New York: Oxford University Press, with permission from Oxford University Press.

to creating the evidence base. They design, conduct, analyze, and report research that characterizes the risk factors, course, and causal influences on a wide range of mental health problems and health risk behaviors. They validate instruments to assess mental health conditions and unhealthy behaviors, and they develop and test interventions to improve behavioral health outcomes. The evidence that primary researchers create is used by both systematic reviewers and practitioners.

Second, as systematic reviewers, behavioral health professionals use primary research that has been created by others in order to create syntheses that are used by practitioners and policy makers. They locate the primary research that addresses a practical question, and they critically appraise, extract, and synthesize the information to provide an answer. Systematic reviewing is itself a sophisticated and evolving form of research methodology that is increasingly becoming the basis for health policies.

Finally, as practitioners, behavioral health professionals have the most challenging role in EBP. The practitioner extracts and uses data from each of the three circles of EBP. In the assessor role, the clinician acquires and parses data about client characteristics, including developmental course, response to prior interventions, needs, core values, and treatment preferences. She or he collaborates with the client to identify the most pressing behavioral health problem that needs to be addressed. Next the clinician assumes the role of a research consumer, formulating the clinical question in a manner that will efficiently cull the best relevant research. Having found the literature, the clinician turns to critical appraisal, evaluating the research's quality and relevance for the client and context. Then the clinician engages in shared decision making with the client. In that process, the clinician is the authority on best practices; the client is the authority on personal preferences; and both collaborate to determine available resources. Part of the practitioner's resource assessment concerns her own personal training and skill in delivering the optimal evidence-based behavioral health practice and that of other clinicians in her referral network.

The EBP Process

The five steps of the EBP process are depicted in [Table 1](#). After assessing the problem, the practitioner performs the following sequence: (1) Ask a question, (2) Acquire the evidence, (3) Appraise the evidence, (4) Apply the evidence, and (5) Analyze and Adjust practice. Each step, described in greater detail below, is an integral component of the EBP process and represents a competency or skill to be mastered by the practitioner. Note that, rather than being considered a formal step in the EBP process, assessment is assumed to precede the onset of the process and to recur throughout it.

Ask: Asking Questions

After assessing the client, the practitioner poses key questions about optimal management of the presenting condition. Asking effective practical questions involves formulating them in a manner that allows them to be readily answerable. Skill at framing 'well-built' questions is an acquired competency.

Table 1 Steps in the EBP process

Step 1	Ask client-oriented, relevant, answerable questions about the health status and context of individuals or communities
Step 2	Acquire the best available evidence to answer the question
Step 3	Appraise the evidence critically for validity and applicability to the problem at hand
Step 4	Apply the evidence by engaging in collaborative health decision making with the affected client(s). Appropriate decision making integrates the context, values and preferences of the recipient of the health intervention, as well as consideration of available resources, including professional expertise. Implement the health practice
Step 5	Analyze the effects of the health practice and adjust practice. Evaluate implications for future decision making, disseminate the results, and identify new informational needs

Reprinted with permission from Satterfield JM, Spring B, Brownson RC, et al. (2009) Toward a Transdisciplinary Model of Evidence-Based Practice. *Milbank Quarterly*, 87(2): 368–390. © Milbank Memorial Fund.

Numerous important questions arise in practice. The major kinds concern: (1) assessment – questions about best ways of measuring, describing, or diagnosing a condition; (2) treatment – questions that address interventions to prevent, contain, or improve biopsychosocial or socioecological difficulties; (3) etiology – questions about influences that cause or contribute to the onset of a health problem; (4) prognosis – questions about the probable course and outcome of a health condition; (5) harm – questions that concern potential adverse effects of interventions; and (6) cost-effectiveness – questions about the expenditures relative to outcomes yielded by alternative courses of action. Because many questions will be generated for each client, prioritization of the most important ones needs to proceed in an efficient fashion. Criteria for prioritization usually concerns the impact of potential courses of action on the client's functioning or quality of life, or the perceived significance of an issue to the client.

Trainees learning to practice EBP are taught to differentiate two formats of question: background (general) and foreground (specific). Background questions aim to acquire general information about a condition, class of treatments, etc. A well-formulated background question comprises two parts: (1) a question root (What, Who, How, etc.) including a verb and (2) a disorder, treatment, or other health issue. Training in evidence-based medicine devotes almost no attention to background questions. Such questions are too diffuse and yield too many citations to be used efficiently in the very brief time that the physician has available for each patient. Behavioral health interventionists usually have longer to spend with each client. The authors' experience is that many psychologists, psychiatrists, or social workers ask background questions in order to update their knowledge when first preparing to see a client. Subsequently, after having assessed the client in context, the clinician proceeds to pose more focused and efficient foreground questions.

An example of a background question is: 'What are effective treatments for binge eating disorder (BED)?' A clinical psychologist preparing to see a new client with BED might pose such a question in order to ensure that her knowledge of current best treatment options is up to date. A subsequent foreground question takes the PICOT format because the query specifies

the Patient population, Intervention, Comparison condition, Outcome, and Time frame of interest. An example might be, 'In adults with BED (*P*), does interpersonal therapy (*I*) compared to cognitive-behavioral therapy (*C*) reduce the frequency of binge episodes (*O*) at 1-year follow-up (*T*). The better focused foreground question will yield citations that specifically inform a decision about whether to proceed with interpersonal or cognitive-behavioral therapy, assuming the clinician is trained to provide both and both are acceptable to the client.

Acquire: Acquisition of Evidence

Once a well-built question has been formulated, the next step is to acquire the evidence to answer it. This step requires the practitioner to translate the question into an efficient search plan. Help can be found in the EBBP project's online learning module about searching, or via consultation from a librarian or other information scientist. Navigating the sheer bulk of existing primary research can be daunting and time-consuming. Consequently, it is expected and advantageous that busy practitioners will turn first to the secondary synthesized literature to answer their questions. Practice guidelines based on systematic reviews can be found online via the US Government's National Guidelines Clearinghouse or the UK's NICE. Useful search strategies for retrieving systematic reviews have also been published. The authors of a systematic review or evidence-based guideline will already have compiled and critically appraised the quality of the primary research literature to answer many frequently asked questions. However, the clinician will still need to appraise the quality and relevance of the secondary resource.

Appraise: Critical Appraisal of Quality and Relevance

The next step in the EBP process is to critically appraise two aspects of the obtained evidence: its quality and its applicability to the client and circumstances at hand. In evaluating research on interventions, the key parameter to be appraised is internal validity: whether the research was designed and conducted in a manner that allows behavioral change to be attributed causally to the intervention rather than to extraneous influences. Applicability or relevance refers to the practitioner's judgment about whether the research results can be generalized to the specific client, interventionist, and circumstances at hand.

The appraisal of relevance is challenging. Applying either overly stringent or overly lax criteria to judge applicability may have adverse consequences. If the body of evidence is seen as having no relevance to new groups and circumstances, then old, untested practices could continue to constitute usual care for understudied and underserved populations. On the other hand, if interventions are assumed to be universally applicable, then the need to adapt treatment to attain client acceptance may be ignored. Given the limited body of research for psychosocial and behavioral interventions, few interventions have been evaluated fully to determine their efficacy across demographic and cultural groups.

What should the practitioner do when considering the prospect of delivering a well-established intervention to a client from a demographic subgroup whose response to the intervention has not been fully characterized? One possibility

is to search the primary research literature for evidence of subgroup interactions indicative of differential benefit or harm. Finding no evidence of interaction and assuming the client finds the treatment acceptable, the best available evidence suggests going ahead to implement the intervention. Of course, the essential next step is to assess the results and adjust treatment accordingly. That 'analyze and adjust' step, to be discussed shortly, is no less necessary when treating someone from a well-studied population (because no individual or community's responsivity can be assumed).

Apply: Decision Making and Action

The apply step is at the heart of the EBP process. Apply is also the most complex and least-described step in the EBP process model. During the apply phase, the practitioner integrates knowledge from best available, relevant research with consideration of client characteristics and resources to arrive at an action decision. After finding and appraising the evidence, the interventionist assesses the resources available to offer what research shows to be the intervention best supported by evidence. The considered resources include finances, linguistically appropriate materials, trained practitioners, client's ability to access the intervention, etc. The practitioner also considers the likely acceptability and uptake of the best supported treatment by the client. She proactively engages the client, and in some instances other stakeholders (e.g., family members), in a process of collaborative decision making because the hardest work of changing behavior will fall squarely on the client's shoulders. Resource appraisal usually requires the practitioner to self-assess whether locally available training and skills are adequate to implement best practices. A challenge for EBP in behavioral health interventions is that once an evidence-based treatment is identified, practitioners may not have the skills needed to implement the intervention. A decision then needs to be made, collaboratively, about whether to implement an alternative EBP in which the clinician is trained, or whether to refer (if a clinician skilled in the best practice is available and amenable).

For EBPs to be disseminated and implemented, practitioners need to know how to search for training resources. In addition to supervised training offered by a skilled professional, in-person trainings are offered at professional conferences. Some materials are also available on internet sites. For example, kits to support the implementation of evidence-based mental health practices are available from Substance Abuse and Mental Health Services Administration's National Registry of Evidence-Based Practices and Programs. Comparable material to support health promotion and behavioral risk factor reduction are available online at the National Cancer Institute's Cancer Control Planet.

Analyze and Adjust: Evaluation, Dissemination, and Follow-Up

A practitioner engaging in evidence-based behavioral health practice performs continuous practice-based quality improvement. During and after applying an evidence-based intervention, the clinician analyzes outcomes and adjusts practice accordingly. The clinician also engages the client and

sometimes other stakeholders (e.g., family members) in the process of evaluation and quality improvement. Results are then used to refine local decision-making policies, generate new questions, and identify needed research.

The analyze and adjust step makes EBP an iterative process. Performing the step requires ongoing assessment, followed by realignment of intervention based upon local data from the client. It is usually possible to perform such realignments within the scope of an evidence-based behavioral health treatment without compromising the core features integral to the intervention. Analyze and adjust simply reminds the practitioner of the need to monitor progress. In some instances, however, the practice appraised as having highest quality research support and relevance may fail to help a particular client. To continue administering the originally chosen intervention after the client's condition has continued to deteriorate would no longer constitute EBP. The EBP clinician, who would be continuing to assess client outcomes, would analyze the deterioration and adjust course, perhaps by offering an alternative evidence-based intervention.

The EBBP Project website offers a number of online learning modules about EBP. Tutorials are available on systematic evidence reviews, critical appraisal, RCTs, and evidence search strategies. Of particular relevance is the interactive, experiential EBP process module, which presents two cases in which a practitioner addresses tobacco use with a client. In one case, the client is an individual. In the other case, the client is a community. Also valuable are two experiential modules on shared client-centered decision making. In those modules, practitioners encounter scenarios in which best EBPs, client preferences, and available resources are at variance. By making a series of care decisions, the learner is able to detect personal biases toward overemphasizing evidence, client preferences, or resources when making decisions. The learner also can experience and revisit the consequences of choosing to pursue different decisions.

Conclusion

Engaging in EBP entails a process of lifelong learning as the evidence about effective practices continues to evolve. Attaining mastery of the skills needed to perform EBP is a process and not an event with an endpoint. The complexities of real world practice, the proliferation of the research evidence base, the changing sociocultural and healthcare contexts, and rapidly evolving health information technologies require ongoing engagement in the EBP process. Ultimately, the goal of EBP is the provision of best-tested, most effective care to the public in a manner that reflects shared decision making and mutual involvement in continuing to enrich the evidence base.

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See also: Behavior Analysis; Behavioral Medicine; Big Five Model and Personality Disorders; Borderline Personality Disorder; Clinical Assessment; Cognitive Behavior Therapy; Defense Mechanisms; Personality Disorders; Psychotherapy; Social Anxiety Disorder.

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Relevant Websites

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- <http://www.gradeworkinggroup.org/> – Grading of Recommendations Assessment, Development and Evaluation.
- <http://obssr.od.nih.gov/index.aspx> – National Institute of Health's Office of Behavioral and Social Sciences Research.
- <http://www.cochrane.org/> – The Cochrane Collaboration.
- <http://www.ebbp.org> – The Evidence Based Behavioral Practice Project.
- http://www.nice.org.uk/about/nice/howwe_work/how_we_work.jsp – UK's National Institute for Health and Clinical Excellence (NICE).
- <http://www.guidelines.gov> – US Agency for Health Research and Quality, the National Guidelines Clearinghouse website.

Evolutionary Clinical Psychology

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Glossary

Adaptation The result of selection, in this case mental mechanisms evolved to solve survival or reproductive challenges by processing information according to selected mental rules.

Environment of evolutionary adaptedness (EEA) The relevant adaptive challenges and selection forces in the species' evolutionary past that have designed the specific adaptation one is studying.

Evolutionary function The increased inclusive fitness generated by the adaptation in the EEA.

Harmful dysfunction Wakefield's definition of psychopathology, a state that both is considered by evolutionary psychology to not be functioning as selected.

Mismatch theory As the current environment may deviate significantly from the EEA, this may cause maladaptive behavior or detrimental environmental effects.

Schizophrenia paradox The question of how a disorder that seems to reduce inclusive fitness has not been selected out of the gene pool, given that it probably has been around since before the human species migrated from North East Africa 70 000 years ago.

Introduction

Our species' phylogeny has influenced our mental health, not just our mental capacities. While mainstream evolutionary psychology approaches the species' universal normal psychology, evolutionary psychopathology focuses on the breakdown of normal mental function. These two approaches provide important complimentary approaches to the study of human nature.

One of the earliest evolutionary approaches to psychopathology was offered by Sigmund Freud – whose fundamental Oedipal conflict was based on evolutionary (albeit flawed) reasoning. Although Bowlby's attachment theory was explicitly evolutionary and most phobia theory has acknowledged an evolutionary logic, the evolutionary perspective has generally not been focused explicitly on, within clinical psychology. Despite this, the last decades have seen a surge of new interest in evolutionary, biological, and genetic insights within many different disciplines of psychology – including clinical psychology.

The major contribution of evolutionary approaches to clinical psychology, psychiatry, and mental health care in general is often thought to be a conceptual tool. The evolutionary approach is systemic, ecological, multilevel of analysis oriented. It is a truly biopsychosocial, integrative, and multidisciplinary approach. But it would be most strange if an understanding of function or an analysis of dysfunction did not provide clinical theorists with insights that may lead to treatment interventions.

This article will attempt to describe some of the most important contributions within evolutionary clinical psychology thus far. Despite being a part of clinical thinking since the dawn of psychotherapy, evolutionary approaches have never become very common, and there is a limit to how much empirical data and treatment interventions the evolutionary approach has been able to offer so far.

Defining Psychopathology

There is currently no general definition of psychopathology. Many different approaches based on theories of mental health

(e.g., psychodynamic theory, humanistic-existential theory, neurotransmitter theory) focus on different aspects of what constitutes mental health or mental well-being, and also suggest what may be considered pathology. Further, there is a more descriptive tradition of the diagnostic manuals, with a continuous attempt to remove theoretical and mere expert consensus, and move toward an empirical scientific description. But even this approach begs the question of what to actually describe; dustbowl empiricism will never answer that question.

Troisi and McGuire have pointed out that it is not possible to define mental disorder merely due to sequelae, statistical deviancy, or subjective suffering. They claim that a definition of psychopathology must be based on an analysis of the individual's ability to achieve biological goals in the individual's specific environment (lack of such would constitute biological dysfunction).

Kennair suggested that we have three categories of disorder in current diagnostic manuals: (a) The fundamental biological disorder category: mechanism dysfunction, that is, breakdown of the adaptation. (b) Subjective suffering caused by evolved mechanisms that are evolved to produce mental pain. (c) Socially undesirable behavior, caused yet again by mechanisms evolved through selection to produce that behavior. But all of these categories would not typically be considered pathological from an evolutionary perspective. To understand further how these three categories still are the focus of clinicians, we need to consider two analyses: harmful dysfunction and treatable conditions.

Harmful Dysfunction

One of the most debated and influential general definitions of psychopathology is Jerome Wakefield's harmful dysfunction analysis of psychopathology. According to Wakefield, harmful dysfunction analysis considers psychopathology on the basis of two concepts. (1) Harmful is a value term. This means that a category of psychopathology will be defined based upon social and cultural values – there has to be a perception of the state as

harmful. (2) Dysfunction is a scientific factual term. The basis of identifying dysfunction needs to be that the mental mechanism is not functioning the way it evolved to function through selection.

There is broad consensus among evolutionists that a dysfunction – a nonfunctioning adaptation – may be considered a hallmark of pathology. Many natural scientists would similarly disagree with the addition of a value term, and would prefer to see that one could base the whole definition on dysfunction. The phenomenon of mental disorder is not that simple, though. We have a tendency to define conditions that we deem harmful as disorder, thus dysfunctions that are not perceived to be harmful will not be considered necessary to treat or as signs of disorder. A lot of our modern mental functioning is not similar to that of our pleistocene ancestors. If any part of our mind not functioning as it was selected to function was defined to be pathological, then we would have a strange perspective on modern human culture.

But the fascinating aspect of the harmful dysfunction analysis from an evolutionary psychology perspective is that it demands a catalog of research from a functional, modular, evolutionary perspective on the normal mind. We need a taxonomy of functions to be able to develop the nosology of harmful dysfunction.

A last important point is that the dysfunction analysis defines many undesirable behaviors out of pathology. Many mental states and behaviors that may be considered pathological are actually the result of mental mechanisms functioning exactly as they evolved to function through selection. Thus, it would be unreasonable to call those states pathological. Despite this, one might want to treat these conditions, which may be considered harmful functions.

Treatable Conditions

Cosmides and Tooby introduced the concept ‘treatable conditions.’ While not really defining psychopathology, this concept is an insightful specification of a large portion of mainstream clinical practice. Rather than consider whether a condition really is harmful or a dysfunction, clinicians in general treat what is believed treatable. Thus, one treats what is considered to be a nuisance from either a societal, theoretical, or individual perspective without concern for potential function.

The fact that treatment may be desirable even for functioning adaptations suggests that there may be reason to know when this is the case. If we are naïve about the fact that we are attempting to subdue a functioning aspect of human nature, this ought to call for both ethical reflection as well as limited optimism about the ease with which the behavior may be modulated. But an important question is also what the systemic consequences of altering the mental mechanisms workings will be.

Potential Iatrogenic Consequences

Nesse and Williams warn against the iatrogenic consequences of not understanding the evolved organisms’ adaptive defenses. Treating the defense as if it were the symptom of a disorder, and not the body’s attempt to combat the disorder, may create further problems – quite simply because one is attacking the

organism, not the disorder. This is why we need to understand the functions, dysfunctions, and evolution of disorders.

Imagine a depressive state that actually is not a brain disorder but a condition that is meant to help solve a specific problem, by regulating mood. This is the case for most emotions we have. The fact that it is painful is not a convincing argument for this state being unhelpful. Not having physical pain receptors is a lot less helpful than having them – as individuals without pain receptors may have a shortened life span, and endure continuous injuries due to not receiving feedback from their bodies when they are being compromised in a harmful manner. Anyone who has bitten themselves after being to the dentist knows this.

Several functions of adaptive depressive states have been suggested (see below) – but in this instance, let us hypothesize that the function of low mood merely is a signal to both the organism and to kin that one is suffering. If this is the case, then treating the low mood, rather than changing behavior or social conditions, might actually cause the organism more suffering, by reducing the motivational forces for both her close kin and herself.

If symptoms of fear are supposed to make us avoid a potential real threat, merely reducing fear might be lethal. This has been Nesse’s most important message, from a Darwinian Medicine approach, to health professionals in general: we need to understand the nature of disorder, as well as evolved defenses, so that we do not aid the pathological agent by attacking the organism’s defense mechanisms.

Etiology of Psychopathology

We do not really know the etiology of any disorder – all of the explanations in this volume are at best considered tentative. The same holds for the development of personality traits and almost all normal development. The general finding from behavioral genetics is that environments cause differences between members of the same family, while genes cause similarities – and that both genes and environments influence the development of most phenotypes. All human traits, abilities, symptoms, and behaviors seem to be influenced by both genes and environmental input – even though we currently may claim that random effects are more likely than any specific environmental explanation. Currently, only very few genes seem to provide relatively replicable connections with disorder phenotypes and almost no specific environmental stimuli are known.

Etiological research needs not only theories of development, individual differences, and genetic influences but also function and selection. Evolutionary psychology focuses on what we know about relevant features of the species’ evolutionary past, and combining this with middle-level evolutionary theories, to suggest hypotheses of functions that probably evolved, and then testing these in empirical studies.

Principles such as the Belsky–Draper hypothesis (an observation and theory of how the lack of paternal investment in early years may shape specific features of girls’ physical maturation and sexual behavior; specifically, increasing likelihood of early menarche, sexual debut, and pregnancy) may help us understand the etiology of specific disorders. Perhaps other relevant childhood contexts would have specific evolutionary

predictions of later life functioning based on functional analysis of ecological demands.

But before addressing the questions of 'how?' evolutionary approaches start by addressing questions of 'why?'

Why Does Psychopathology Exist?

Evolution does not design perfect organisms, and the process is often more comparable to tinkering rather than industrial design. Our vision has blind spots, we can develop cancer, and we do not live forever. Obviously, there also are arms races between different pathogens and us, which cause infectious diseases. At the same time, this does not answer why a disorder such as social anxiety or schizophrenia may exist in all human populations. Both of these disorders will seemingly cause reduced fitness. The schizophrenia paradox points out that a clearly debilitating disorder is similarly prevalent in all human cultures, and must therefore have been present since the species migrated in different directions from North East Africa. Why has not the disorder been selected out of the gene pool? This and several other questions concerning other disorders need to be addressed.

From an adaptive perspective, it is obviously tempting to suggest that what clinicians consider to be maladaptive really is adaptive. In some cases, this may be true; in many cases, this is an original perspective that at least challenges clinical consensus. At the same time, it is important to note that few disorders are clearly due to proven dysfunction.

Why Do Individual Differences Exist?

An even more fundamental question is why individual differences exist at all. Evolutionary personality psychology and evolutionary clinical psychology both struggle with this – and both address both adaptive and maladaptive variation. Typically, sources of individual differences are considered to be genetic, developmental, and cultural–environmental. Some of these are considered to calibrate mechanisms differently; a few may cause adaptive variation; others will damage the organism in some manner. It is important to add random effects as an explanation, as we currently cannot provide evidence that the individual differences are due to systematic effects of the environment: on the basis of data from behavioral genetics, most psychological theories of such systematic effects have been ruled false or unlikely.

Mismatch: An Important Evolutionary 'How?'

A general idea – even before the invention of evolutionary theory, and even as early as the brink of the industrial revolution – has been to suggest that our modern style of living has a detrimental effect on our well-being, including our mental health. From an evolutionary perspective, one would contrast our modern lifestyle and ecology with that of our Pleistocene (or earlier) ancestors.

This would, for example, be relevant in an analysis of our current increased intake of calories, our lower levels of physical activity and dental caries, diabetes II in children, obesity, heart and coronary disorders, and other lifestyle disorders. We probably evolved to be interested in consuming sugar

and fat – which is probably why livestock has higher levels of fat than game and why we produce large amounts of sugar. And why supermarkets are designed so that the counters – where we stand waiting – are stocked with brightly colored wrappings containing nothing but empty calories waiting to be purchased by primates acting on impulse.

Typically, evolutionary analysis considers whether a specific state or trait could have been adaptive in our species' past. Thus, if something seems maladaptive in a modern setting, it might still be due to an adaptation functioning exactly as it was selected to do in the environment of evolutionary adaptedness (EEA, i.e., the adaptation's relevant past evolutionary ecology, consisting of the selection forces that caused the design of the specific mechanism).

Mismatch may cause negative interactions between the modern environment (toxins, nutrition, technology, social systems, etc.) and our adaptations, resulting in poor mental and somatic health for the individual. This may be due to the adaptation functioning, and the stimulation being excessive and thus harmful. Or it may be due to mismatch causing an adaptation to dysfunction.

Some mismatch, such as easy access to calories and individualizing child rearing practices, may also cause some benefits – such as a better social functioning in western societies, and the Flynn effect (the rise, until recently, of general IQ scores through the last 100 years), which may be due to more stable brain growth (and maybe a result of the increased intake of sugar). Most types of mismatch would cause the developing adaptations to be stimulated in incompatible manners, or cause adaptations to dysfunction. But our omnivore nature and general behavioral flexibility have made us very versatile organisms. Also, our most important ecological feature – other people – has been kept in the form of relatively closely knit small bands until very recently.

A cautionary note is needed: we do not really have as much evidence for mental disorder as for tooth decay, obesity, and diabetes being results of mismatch. Although some studies show an increase in depression or other mental disorders, not all studies point in that direction.

Examples of mental disorders resulting from mismatch are therefore few. Some disorders such as anorexia seem to increase consistently in Westernized, that is, modernized, cultures – including the most modernized subcultures or urban areas in developing nations. Despite the seemingly clear pattern of this disorder, we are still not certain of what causes the disorder. Young women seem to be the group with the greatest increase of depression. Life history-relevant changes (lack of close extended family, less support around pregnancy, and relationship instability) in their ecology *might* be a cause. I would argue that some anxiety disorders may be on the rise due to less stimulation and possibilities for experiencing coping with hazardous environmental features during development, due to modern society's fear of harm, and our safety regulations and lack of experience with nonurban environments. It is also suggested the dietary changes, especially a lack of fish and fatty acids, will influence rates of attention deficit hypersensitivity disorder (ADHD), depression, and schizophrenia. The problem with all of these explanations is that there is very little evidence to back them up. Despite this, mismatch needs to be considered.

A specific type of 'mismatch' warrants further note: what Cosmides and Tooby call Value-Condition Divergence. This is the mismatch between what society today finds acceptable or desirable, and the natural function of the evolved mental mechanism. For example, despite the mental mechanism, potentially motivating cuckolded men to wish to avenge themselves, functioning violently as it evolved, such violence is not accepted in many societies and will result in criminal charges against the violent husband. As such, many kinds of behavior may be considered mismatched as different cultures sanction evolved expressions of human nature in different ways, and some of these will describe undesirable behavior as psychopathology (but that only covers the value-half of the Harmful Dysfunction definition).

Evolutionary Constraints on the Mind and Mental Well-Being

The evolutionary process operates with certain constraints – this is true. Despite this, most modern evolutionists are wary of placing too much emphasis on this limitation of evolution's potential for design. But in considering different design aspects of our bodies, we will soon notice that there are parts and mechanisms that could have been safer and more efficient. But evolution is more a process of tinkering than engineering.

Further, an important reminder, the evolutionary process is based on reproductive success, not happiness, well-being, or painlessness. But this must not be taken to mean that poor mental health would not have been selected against – if poor mental health is taken to mean that the function of the individual is compromised due to suffering, or if the mental health causes a reduction of inclusive fitness.

Many mainstream psychological theories of etiology have described humans as such frail organisms that a normal life in the EEA would have caused poorly functioning bands (if indeed the individuals still could form bands) huddled quivering together riddled with psychosis, posttraumatic stress disorder, and every other disorder of the diagnostic manuals. This frail species would not have conquered the world. Resilience had to be part of our nature. And mostly, we must have been functioning well enough to survive and reproduce, and our mental well-being and mental disturbances had to be limited to a level that did not end in extinction.

Psychological Theories of Etiology

Poulton, Menzies, and coworkers have challenged the existing knowledge of how anxiety disorders develop. Further, Kendler and coworkers have challenged the stress–diathesis model of phobia acquisition. In many of this volume's articles, the most typical psychological explanations are learning-based or stress–diathesis-type explanations. These have for a long time been considered the most scientific – not least because exposure and habituation models of treatment have proven efficacious. Two important cautions need mentioning: (a) there is some disagreement within clinical psychology that habituation really is the mechanism that brings about change, and (b) even though a condition appears due to maturational processes (rather than environmental conditioning), an environmental conditioning intervention may change the condition.

The challenges to mainstream clinical consensus mentioned above suggest that evolutionary, innate, or genetic

models are better explanations than many of the environmental or stress models of etiology. A simple example: I work and teach in Norway, where there are no harmful spiders, and one would have to go abroad to have a painful conditioning experience with a spider. Despite this, I have patients with spider phobias, and I can always rely on someone in the audience having this condition in order to demonstrate the swift effect of exposure and cognitive behavioral therapy for phobias.

Less scientific theories of etiology and development have come under fire from behavioral genetics. It would seem that to understand the causes of mental disorder, one needs to consider our species' evolutionary history. If psychopathology is defined as harmful dysfunction, we further need to understand the functions of the mechanisms that are dysfunctioning. This calls for a general evolutionary psychology of the function of mental mechanisms, of individual differences, and of development.

Viral Causes, Environmental and Nutritional Causes

Work by sociologist Roger Masters and coworkers has provided us with insights on the importance of environmental toxins (e.g., lead) and metabolic, nutritional, ethnic, and social interactions and aggression. Evolutionary biologist Paul Ewald has championed the role of viral agents in almost all conditions. Horrobin and coworkers advocated the effects of nutritional shifts through our species' evolution – and the effects of modern diets on brain function.

One has to agree that a purely psychosocial approach to mental health and mental disorder is too limited and not fully in the spirit of evolutionary psychology. Despite being a psychological discipline, evolutionary psychology is based on an anti-dualistic foundation. But it is also important to analyze critically all suggestions – and thus many of these viral and nutritional ideas have not garnered enough support to be considered mainstream or very relevant for our understanding or treatment. At this point, it is important to keep both an open and a critical mind as we continue to consider these causes.

Biopsychosocial Integration

Many explanations of the etiology of mental disorders are offered as universal – they are supposedly the explanation of all cases, and are therefore considered to be competing explanations. This is obviously a rather premature position to take for any of these explanations. The lack of understanding of how to define psychopathology creates some problems, but as mentioned below the mere uncertainty of what phenotypes are relevant causes problems for any explanation.

It is important to consider how several different causes may be integrated, and how many explanations might be relevant for subcategories of disorders. Multidisciplinary, integrative meta-theories should be exceptionally well suited for multi-causal phenomena such as psychopathology.

Specific Disorders

The following section will attempt to highlight different evolutionary approaches to the specific disorders. It is important to

point out that a comprehensive evolutionary approach would have to start by critiquing the phenotypes of the diagnostic manuals – as these to a large degree are the result of traditional theory and dustbowl empiricist description, with little evolutionary functional analysis or basic biological knowledge. Thus, most conditions are extremely heterogeneous, and any attempt to explain a condition will probably not be able to cover all facets. Despite these shortcomings, the following section will consider major diagnostic categories, as these are how we currently categorize the relevant states.

Anxiety

It may be helpful to first differentiate between fear and anxiety disorders. Fear is an adaptive emotional response to real threats – and the fight, flight, or freeze responses that this emotional state causes will help the organism avoid or prevent danger in a manner that increases fitness through the species' evolutionary past. Within the domain of fear, one will have species-specific defenses of different types – from defensive burying in rats and freeze behavior in grouse to species-specific avoidance behavior. Anxiety is defined by having a fear response when there is no real present threat or danger. Anxiety is therefore an exaggerated or maladaptive fear response, in which none of the safety behaviors that the individual uses to defend himself with is necessary – as no catastrophe or harm would come about even if the safety behavior was discontinued.

One may also differ between what Marks and Nesse call hypophobia – a maladaptive lack of fear – and hyperphobia, maladaptive hypervigilance, or fear activation. But what seems to be maladaptive needs to be considered in terms of mismatch. Also, we need to consider whether what seems to be maladaptive due to discomfort or limitations for an individual might be adaptive for the individual's genes in the long run. Thus, hypophobia, as in the young male syndrome described by Daly and Wilson, might cause an increase in deaths among young males, as found by Nesse, but at the same time the males that are chosen by females due to displays of recklessness would have increased their fitness. Currently, hypophobia is not considered a disorder, although lack of consideration of consequences might be a symptom of manic disorders.

The anxiety disorders have benefited from the functional (and evolutionary) understanding of fear. This approach suggests that anxiety attempts to protect, or at least that the underlying fear mechanism is activated in a general attempt to protect the organism. Considering what the individual is attempting to protect from or avoid therefore informs the clinician of cognitive, emotional, and behavioral processes. It also differentiates between different anxiety disorders.

Panic disorder and agoraphobia

These two conditions co-occur to such a degree that they usually are considered together. Agoraphobia is often due to a fear of having a panic attack and not being able to return home to 'safety.' There are two points worth considering about this: (a) the panic attacks occur at home as well, so the patient is not really escaping the panic, but is seeking surroundings in which the patient feels safer, usually due to freely being able to perform safety behaviors; and (b) the panic attack is not dangerous. Usually, panic attacks are considered to indicate one

(or more) of four major catastrophes: that one is going mad, that one is having a heart attack, that one is choking, or that one is going to faint. These are due to misinterpretations of anxiety symptoms such as: depersonalization or a sense of unreality or other cognitive anxiety symptoms (giving a sense of going mad), increased heart rate and blood pressure and other bodily sensations (interpreted as symptoms of heart attack), tightening of the chest and sensation of a lump in the throat (a choking sensation), and dizziness and hyperventilation (interpreted as precursors of fainting). But none of these will occur due to anxiety – increased blood pressure and fainting are simply incompatible, so even the most 'likely' event in the opinion of many clinicians is actually not possible. Thus, there are problems when considering these conditions from an adaptive perspective – panic does not make you flee danger, it makes you focus on the nonreal threat of the anxiety symptoms. Actually, there seems to be a necessary higher level conceptualization in order to develop panic disorder. In some cultures, the patient rather than believing that one is choking, believes that an evil entity is sitting on one's chest, a djinn. This interpretation of bodily sensations suggests that panic has no evolved function, and is merely due to our increased intelligence and attributions (often cultural) about bodily sensations.

Social anxiety disorder

Social anxiety disorder (SAD) is often conceptualized, from an evolutionary, perspective to be a fully understandable condition. Baumeister's seminal works on the normal need for social belonging of humans, the obvious threats to fitness of being ostracized, group processes such as conformity, and the fitness benefits of being considered attractive all suggest that we *should* fear negative evaluations from others. The major problem is to explain what socially anxious patients specifically are threatened by – because what they fear is that intermediate acquaintances (rather than close family and friends – the group from which being ostracized is most relevant) should notice that they are anxious. For example, they fear blushing in public, and due to introception (perceiving the heat on their cheeks to be an indicator of degree of blushing) they often have an exaggerated belief about the degree of blushing. But there are no typical negative appraisals of or sanctions toward people who blush. Males witnessing blushing females might even find them more attractive. Actually, the most typical fitness-reducing consequence of SAD is the patient's own safety behaviors – which include social avoidance, and in some cases more noticeable deviant behavior (in attempts to not show signs of anxiety – and these signs are often not perceived by onlookers). In general, patients with SAD are less likely to seek promotions or extra attention in the workplace, less likely to enter romantic relationships, and thus the disorder itself is causing what many believe is the threat that the anxiety is protecting against. The very good reasons for caring about social evaluation suggest that an evolutionary approach is very relevant – although the conceptualization needs to consider the actual negative consequences of SAD.

Specific phobias

It is quite obvious to anyone working with phobias how stimuli such as heights, darkness, strangers, water, snakes,

spiders, rodents, insects, germs, and social settings are the typical sources of anxiety. But to most people in the Western world, these stimuli (apart from maybe the social setting) are not dangerous. At the same time, modern societies attempt to install fear in populations: fear of smoking, driving too fast, drugs, not using seat belts, getting STDs, getting pregnant, sugar, fat, exposure to too much sun. Generally this has little or no effect. Teaching someone to fear truly dangerous or culturally undesirable phenomena is much harder than any learning theory or psychosocial theory of anxiety acquisition suggests. Without an evolutionary understanding of the evolved susceptibility of specific evolutionary relevant stimuli, we would not have understood the nature of specific phobias.

Blood phobia

This very specific and different phobia is the only anxiety disorder where the patient may faint. Marks pointed out the adaptive logic: in all the other anxiety disorders, the fear mechanisms motivate the organism for a fight-or-flight response – with an increased need for energy, and therefore increased adrenalin and blood pressure. In the case of severe bleeding, a sudden drop in blood pressure would be a lot more helpful to the organism.

Generalized anxiety disorder and health anxiety

These seem to be specific human conditions. While one may consider social anxiousness and even specific phobias in other species, it would seem that the verbal problem-solving cognition involved in worry suggests a very species-typical disorder. In health anxiety, the worry is mainly focused on different threats to health – and mostly lethal diseases known from media. In GAD, it is a diagnostic criterion that the patient worries about more than one topic. An important question is whether this continued anticipation of catastrophes is beneficial in any way. In our current society, the loss of function due to generalized anxiety disorder (GAD) is obviously maladaptive. But everyone worries – thus the ability to plan for contingencies and imagine situations where bad things may happen might be beneficial in some way. Even if this maybe true, although something that needs investigation, such positive metacognitions (worry keeps me prepared/worry protects me) are exaggerated in GAD patients, where continuous worry about catastrophes that do not occur is causing them distress and limiting function. Changing these metacognitions is often the focus of treatment.

It would seem reasonable to claim that anxiety in general is not currently adaptive – and that the disorders do not have specific adaptive functions. On the other hand, it is relevant to note that hypophobia – too little fear of real threats and dangers – also is maladaptive to the individual. Fear of specific features of our past ecology was adaptive, and some psychological mechanisms involved in these processes are present in current anxiety disorders. Understanding the functions of fear and other emotional responses and evolved psychological mechanisms may further improve our ability to prevent the development of anxiety disorders. (*Note: treatment of anxiety disorders with CBT and exposure is currently that effective that the aim is not presently improved treatment for anxiety disorders, with the possible exception of GAD.*)

Autism

Autism is usually not considered a mental health condition – rather it is, together with most examples of mechanism failure, typically considered a neuropsychological disorder. Despite this, it warrants mention in this article. There are two reasons: it is a prime example of mental mechanism failure. Further, it is an example of how a modular adaptive evolutionary psychology framework may inform researchers seeking to understand both normal and pathological development.

Baron-Cohen's research into theory of mind (ToM) and the evolved ability for 'mindreading' has informed us of many of the mental mechanisms that are involved in both normal mental processing of social interactions as well as autism. This has been a prime case of how the lack of specific abilities, such as taking the intentional stance, as Dennett calls it, toward other humans when attempting to understand their behavior impairs behavior in a specific set of ways. This research has thus highlighted the role of mechanisms for theory of mind both in autism and also in schizophrenia.

Depression

Depression is one of the most debilitating health conditions worldwide. The anhedonia, lack of energy, low mood, and negative appraisal of oneself and the future, has obvious consequences for fitness and function. At the same time, it is one of the most common disorders. How can something as widespread and debilitating as depression exist? An evolutionary approach is necessary to address the nature of depression.

There are two basic views within evolutionary perspectives to unipolar depression: (a) the involuntary behavior inhibition approach and (b) the social bargaining or social problem-solving approach.

The involuntary behavior inhibition approach may be formulated from foraging theory and social hierarchy theory. In both cases, the inhibition is involuntary or elicited by ecological cues. From a foraging perspective, there is a more general consideration of when spending energy ought to be suspended. Focusing primarily on the demotivating aspects of depression, this approach predicts that depression will occur in any context where increased effort would have been fitness reducing in the EEA. The social hierarchy perspective is more specific, suggesting that under socially threatening conditions, subordinate behavior may reduce threats. Thus, the behavior that is inhibited would be subdominant challenges toward dominants.

These approaches, formulated by both Nesse and Gilbert, focus mainly on the processes and mechanisms behind depression being adaptive. The syndrome of major depressive disorder is not considered to be adaptive. Rather, this is a condition that occurs due to the adaptive processes being disturbed in some manner. This is probably the most accepted approach among clinicians with an interest in evolutionary theory.

On the other hand, more adaptationist approaches draw on the possibility that just because we subjectively deem depression undesirable, does not mean it is maladaptive. Watson and Andrews suggest that depression in general improves social cognitive problem-solving. The depressed state of mind will

be less vulnerable to the biases of a nondepressed mind, and focus more on specific social information. While many clinicians are critical of this approach, it is a highly original and thus interesting contribution to the investigation of possible facets of depression.

Hagen suggests that depression is functional, and uses a specific subtype of depression, postpartum depression (depression with an onset tied to childbirth), as a model of how depression in general may have been adaptive in our past. The parents are codependent of each other's investment in the child. Therefore, a suboptimal investment by the father may elicit a depressive response in the mother, which reduces her caretaking behavior, which in turn forces the father to put more effort into parenting.

An extreme example of depression-relevant theorizing from an adaptationist perspective is the work on suicidal ideation by de Catanzaro. There are obvious cases where suicide could be fitness-enhancing – the mathematics of selection predict that if one is a burden to one's family, and thus reducing one's inclusive fitness more than one can hope to compensate by having further offspring, then suicide is adaptive – from a gene/inclusive fitness perspective. Also the functional approaches of Hagen and Watson and Andrews to depression provide evolutionary explanations of suicide and self harm.

Unipolar depression is a prime example of a lack of evolutionary functional analysis of phenotypes considered psychopathology. This category should probably be plural: depressions. Within the same category, one will find certain bipolar conditions; conditions that are better explained by ongoing life stressors or events; deregulated biochemistry of the brains neurotransmitters, but also more endocrinological disruptions or gastrointestinal disturbances; evolved adaptive responses or brain malfunction; agitated, atypical, anxious, physiological, psychological, social, female, or male types, etc. It is clear that this causes a large array of possible explanations – but also it does call for a better analysis of phenotypes, and an integrative approach. Thus, the evolutionary approach is warranted.

While depression is the disorder that has been given most attention within the evolutionary psychopathology literature, too little work has attempted to differentiate different types of depression. A modular approach might be helpful.

The general lack of subdivisions of depression suggests that many evolutionary attempts at explaining 'depression' will fail due to a lack of specificity. Two interesting subdivisions that intuitively make for evolutionary analyses are seasonal affective disorder and postpartum depression. But while seasonal effects on behavior and mood have been found, the diagnosis of 'winter depression' seems less certain. In Norway, there are effects of seasonality and latitude, but the peaks of pathology are found in April, with a smaller peak in October. And while women may get depressed after birth, they may get depressed at other times, too – and there is little to substantiate a specific link between birth and depression. There is therefore a need for more work on specifying phenotypes. Evolutionary clinical psychologists need to ascertain that what one is attempting to analyze from an evolutionary perspective actually is a relevant evolutionary phenomenon and phenotype. This would be a great contribution to mental health science.

Eating Disorders

It is obvious to most of us that we should eat fewer calories (despite the fact that many calories taste delicious); that we eat more fruit, vegetables, and fish (while it is still safe); and that we ought to exercise more (not merely pay the annual gym fee). We have constructed our society and industry in order to save ourselves effort and still provide us with what were scarce resources in the EEA, but which now are found in abundance ripe for the picking in our supermarkets. Obviously, this will cause a general increase of body fat in the general population of all countries that reach a certain standard of living – and for many there does not have to be anything wrong with the metabolism to gain excessive weight. An evolutionary understanding is fundamental to understanding this aspect of our modern health hazards and lifestyle diseases.

Evolutionary approaches have also offered some correction to theories of the puzzling disorders where patients starve themselves. Early psychoanalytical approaches suggested that one of the effects of anorexia – delaying onset of menarche – was the function of the behavior: the sexually repressed girl wishing to put off adulthood and adult sexuality through starving her body.

This creates an interesting reverse image compared with the most empirically researched evolutionary approaches to disordered eating, where different life history strategies and female intrasexual competition is considered to be fundamental. Here initial findings suggest that a slow life history is linked to greater executive control and protects against disordered eating or extreme low weight.

Obsessive Compulsive Disorder

Several different evolutionary approaches to understanding obsessive compulsive disorder (OCD) have been suggested – including general threat monitoring mechanisms, group selection models, and animal models focusing on ritualized behavior. This is one of the disorders where the viral explanation is most often mentioned. Swedo and colleagues suggested that pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS) may explain OCD symptoms. This is still a controversial explanation, and mainly considered an explanation of recurring and remitting cases or sudden onset cases. The treatment of choice of cases where a viral explanation seems relevant is the same as other OCD: cognitive behavior therapy (CBT) and exposure with response prevention. Why this should work for viral throat infections is so unclear that many are critical of the explanation.

OCD is, as the other anxiety and disgust disorders, efficiently treated with CBT and exposure. But the nature of OCD is still not very well understood – and certain subcategories may demand special attention. From an evolutionary and modular perspective, it is important to differ between normal and extreme hygiene and grooming behavior, hoarding, and magical thinking/ritualistic behavior. Yet again, specifying the phenotypes and subcategories of the diagnostic category may currently be important, rather than attempting to explain the whole disorder.

Personality Disorders

Personality disorders are sometimes considered to be extreme versions of normal personality traits, such as the traits of the big-five model of personality (openness, agreeableness, conscientiousness, neuroticism, and extroversion). Linda Mealy had a different approach – as she suggested that lack of empathy could be an adaptation. Thus, dissocial personality disorder (sociopathy or psychopathy) may not merely be a result of normal variation, or a dysfunction, but may indeed be a functioning evolved phenotype: an adaptation.

Thus, personality disorders may not be ‘disorders’ in some cases but can be specific adaptive strategies that have reproductive benefits under certain ecological conditions that the ‘normal’ phenotypes do not fully take advantage of. Frequency dependent selection suggests that minority strategies may be beneficial as a result of interactions with qualities of the typical strategy: Consider a simple two-strategy game consisting of two types, exploiters and cooperators that due to their strategy are able to produce a surplus. There will be a threshold that decides what percentage of the population may be exploiters, and yet be sustained by the cooperators. At a certain point, the exploiter strategy will not be helpful, and the number of exploiters will be regulated.

Schizophrenia

Some evolutionary models of schizophrenia focus on social hierarchy theory. There are also group selectionist explanations. Others focus on changes in our modern nutritional habits, suggesting that a decreased intake of fatty acids has made schizophrenia and related mental states more common. Viral explanations also exist within the evolutionary literature.

One of the most interesting models, suggested by Timothy Crow, considers schizophrenia to be a result of the speciation event – schizophrenia is a result of what made us human. As such this is a by-product explanation. Schizophrenia was not selected for, but our language capabilities and hemispheric lateralization and the necessary genetic evolution underlying these mechanisms made us vulnerable to schizophrenia as a species.

One of the reasons why schizophrenia has been given a lot of attention from an evolutionary perspective is that it poses the schizophrenia paradox: a condition with a known genetic mechanism of transference and also a clear fitness-reducing phenotype. Recent evolutionary genetics research by Crespi and colleagues has discovered that genes that are strongly linked to schizophrenia show signs of selection. This research cannot identify why these genes have been selected but concludes that the by-product theory of schizophrenia is supported by these findings.

Sexual Disorders

One of the most prolific and fruitful fields of evolutionary psychology research has focused on normal human sexual behavior from an evolutionary perspective. As such, it is surprising that the research on sexual disorders from an evolutionary perspective has been rather limited.

Both sexes may experience lack of desire or orgasm – or, in males, erectile dysfunction. Sex differences are more evident

when considering problems such as premature ejaculation in males and pain during intercourse for females. These conditions are obviously partly understandable from sexual strategies theory, life history theory, etc.

The evolutionary functions of sex and sex differences have been addressed by evolutionary psychology. The same theoretical foundations promise to provide clinical sexology with important insights. Some work on excessive and violent jealousy is relevant for a clinical and forensic psychology, as is work on stalking behavior.

Substance Abuse and Dependency

Another of the most debilitating and common groups of mental disorders in the world are disorders of substance abuse and dependency. These are a complex, multicausal disorder – where biochemical, genetic, cultural–historical, social factors need to be considered. Different evolutionary approaches from life history theory to different hypotheses about the EEA (was this a substance-free or substance-rich environment) have been addressed in the literature. The evolutionary perspective has offered both biopsychosocial integration as well as novel hypotheses to the field of addiction research – but despite a promising start in the beginning of the last decade, the last few years have not seen the same interest in this topic.

Evolutionary Informed Psychological Treatments

Both Freud (classical psychoanalysis) and Bowlby (attachment theory, a combination of psychoanalysis and ethology) based their therapeutic theories on contemporary evolutionary insights. Although the biological underpinnings of their theoretical approaches have not been much focused on by the clinical community in general, there has been a rekindled interest in evolutionary explanations within psychodynamic theory and practice as evolutionary and biological approaches have become more popular in general. Freudian, Jungian, and more mainstream psychodynamic theorists have explored possible insights from evolutionary theory, and this has caused a small revival of phylogenetic explanations.

Aaron Beck's cognitive behavioral therapy (CBT) – which is the most evidence-based psychological treatment method – is also explicit about the evolutionary underpinnings of his thinking. Evidence-based and scientific approaches to psychological treatment cannot be at odds with evolutionary theory.

Many of the approaches to anxiety – especially the simple phobias – have always had a functional approach. This understanding has probably been relevant for the subdivision of anxiety disorders, as one has focused on what elicits the fear – that is, what the organism is attempting to protect itself from. This more modular approach has been a benefit for anxiety disorders, and we are today more capable of treating these than, for example, depression – maybe due to a better understanding and general acceptance of the function of fear.

While many researchers and clinicians believe that insights from evolutionary theory may be implemented directly, I would stress the need to perform clinical trials. The scientific foundation of evolutionary theory does not make an

evolutionarily informed intervention scientific. The efficacy of such interventions needs to be compared both with control groups (to check for natural fluctuations of symptoms and spontaneous remission) and with other evidence-based treatments to check for relative efficacy. Nonevolutionary insights might still be more efficacious, and thus be the treatment of choice. Any other approach would turn evolutionary theory into an ideology.

Paul Gilbert has developed a treatment based on an explicit evolutionary approach. Gilbert and coworkers have developed a treatment method – compassion-focused therapy – that combines different ideas but especially draws on ethological work and internalized social hierarchical behavior. Insights from this work have also informed less explicit evolutionary work within mainstream CBT on schizophrenia and other disorders.

Conclusions

The integrative power of the evolutionary psychology meta-theory has been focused on by many authors. The greatest mysteries within mental health care are maybe the following questions:

- What is psychopathology?
- How do we specify specific diagnostic categories?
- Why does psychopathology develop?
- How can we prevent psychopathology?
- How do we most efficiently treat the specific disorders?
- How can we prevent relapse?

The question of treatment is being addressed by more proximate approaches, but for those conditions we have yet to develop efficacious treatment methods, answers to the questions above might be assisted by an understanding of the evolutionary functions of the mental mechanisms involved. Existing approaches have not been able to address these questions satisfactorily.

Evolutionary approaches to the definition of psychopathology have improved our understanding of mental disorder as a phenomenon. Evolutionary analyses of diagnostic categories as phenotypes might further improve our ability to understand disorders – including subtypes of disorders, relevant mental mechanisms and contextual stimuli. For anxiety disorders, the sociopsychological explanations of etiology have been challenged, and evolutionary explanations have got increased attention. Several treatments have been suggested based on evolutionary insights, but a common problem is the lack of studies on the efficacy of these interventions. The prevention question is very important, as it is probably very cost effective at a societal level to reduce the number of people who develop mental disorder – an evolutionary approach may address the

ecological contexts that cause problems. Relapse prevention, especially in disorders such as depression, is a major focus of mainstream treatment research – yet again, ecological contexts might be predicted by evolutionary theory.

An integrative meta-theory will most likely address all relevant questions. Evolutionary clinical psychology is therefore not merely an academic exercise – or a luxury explanation. The evolutionary approach improves our knowledge of the nature of mental disorder and mental health, and thereby promises to have very practical implications for the future of mental health care.

See also: Agoraphobia and Panic Disorder; Anxiety and Fear; Autism and Pervasive Developmental Disorders; Cognitive Behavior Therapy; Depression; Evolutionary Developmental Psychology; Evolutionary Psychology; Phobias; Schizophrenia; Social Anxiety Disorder.

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Evolutionary Developmental Psychology

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Glossary

Distal (ultimate) causation Explanation of an animal's behavior based on changes in the heritable genes of that organism that were favored by natural selection.

Genotype An organism's genetic makeup.

Ontogeny The developmental life history of an organism from conception to death.

Phenotype All of an organism's observable characteristics – which are influenced both by its genotype and by the environment.

Phylogeny The developmental history of a species, genus, or group.

Probabilistic epigenesis A bidirectional process by which an organism's genes, environment, and development all continually affect each other at all stages during the organism's ontogenetic development.

Proximate causation Explanation of an animal's behavior based on an event which is most immediately responsible for its cause. This is in contrast to higher level distal, or ultimate, causes of behavior.

Evolutionary Developmental Psychology

The field of evolutionary developmental psychology (EDP) has garnered interest in recent years as yesterday's critics have begun to embrace the union of developmental psychology and evolutionary biology. The core principles underlying EDP date back to Darwin's theory of evolution by natural selection and its application to the study of human development and, more recently, developmental systems theory (DST). EDP attempts to explain both species-typical universals and adaptive individual differences, and focuses on how proximal factors influence the expression of evolved psychological mechanisms over time. In this context, EDP has been defined by Bjorklund and Pellegrini as "the application of the basic principles of Darwinian evolution, particularly natural selection, to explain contemporary human development. It involves the study of the genetic and environmental mechanisms that underlie the universal development of social and cognitive competencies and the evolved epigenetic (gene-environment interactions) processes that adapt these competencies to local conditions; it assumes that behaviors and cognitions that characterize not only adults but also children are the product of selection pressures operating over the course of evolution." Following this definition, the current article is divided into two parts: (1) species-typical patterns of social and cognitive development that are common to all humans reared in a species-typical environment and their 'real-world' applications, and (2) individual differences among humans as a result of adaptively structured phenotypic plasticity and genetic variation.

Evolutionary Psychology and Developmental Systems Theory

The growing popularity of EP has brought evolutionary perspectives into mainstream developmental science and has even found its way into the media-driven pop-psychology realm. In the past years, developmental psychologists have criticized EP

for neglecting to take into consideration human development and, instead, focusing solely on distal, rather than proximal, causes of adult human behavior.

Although the fields of EP and developmental systems have disparate histories, we believe that each could benefit from the insights of the other. Indeed, EDP attempts to synthesize these two fields of study. On the one hand, studying developmental processes – gene \times environment \times development interactions – without considering the fundamental role of evolution in structuring these interactions necessarily paints an incomplete picture of the developing organism and its adult phenotype. On the other hand, studying the evolved psychological mechanisms and behavioral adaptations of adults without considering their developmental history – the continuous and bidirectional interactions over time between the developing individual and the environment – is equally limited. In this section, we discuss the differences between mainstream evolutionary psychology (EP) and DST and argue that, by integrating the two and forming a new field (EDP), a resolution is afforded which allows researchers to integrate the tenets of each respective field and apply a broader perspective to the study of human development. We then outline relevant applications of the newly synthesized field of EDP before concluding with a discussion of the individual differences between humans resulting from our species' remarkable plasticity and variation.

Evolutionary Psychology

EP is the application of the principles and knowledge of evolutionary biology to psychological theory and research. Its central assumption is that the human brain is comprised of a large number of specialized mechanisms that were shaped by natural selection over vast periods of time to solve recurrent problems associated with survival and reproduction faced by our ancestors. These problems include such things as finding and choosing which foods to eat, negotiating social hierarchies, dividing investment among offspring, and finding and retaining mates.

Evolved cognitive mechanisms

According to Bjorklund and colleagues, the field of EP posits that our cognitive mechanisms were 'shaped by natural selection to (a) detect and encode information associated with recurrent problems of survival and reproduction in ancestral environments and (b) generate physiological activity and manifest behavior directed at solving the specific problem that brought the mechanism online.' In essence, natural selection is operating at the mechanistic level, mediated through environmental interactions, to generate manifest behavior aimed at solving real-world problems. As a field, EP has focused on identifying recurrent adaptive problems faced by our ancestors and the information-processing mechanisms that evolved to solve them. This process has produced species-typical cognitive mechanisms that are shared by all biologically normal members of the species.

Universal features of the human mind

The main focus of EP has been on species-universal characteristics of the mind. Necessarily, the distinction between evolved cognitive mechanisms and individual differences in manifest behavior is of great importance. Proponents of mainstream EP would argue that regardless of individual differences in behavior, all humans possess fundamentally the same set of evolved psychological mechanisms. From this view, individual differences in manifest behavior are due not to differences in evolved psychological mechanisms, but to interactions between the psychological mechanisms and environmental variability. A common example of the universality of evolved cognitive mechanisms is that of language. Environmental input mediates what language a child will learn to speak; but regardless of environmental variation, all children universally acquire language by engaging species-typical cognitive mechanisms to make sense of their surrounding verbal stimuli. While evolutionary theorists recognize the potential importance of variation between people, their primary focus remains on species-universals rather than individual differences.

Historical nature of biological adaptations

An assumption of EP is that the mind comprises highly specialized cognitive mechanisms. In general, genes which have increased the fitness of our ancestors (in terms of survival and reproduction) have been favored by natural selection and have propagated within the population. By contrast, genes which have not been associated with fitness-enhancing benefits have been unlikely to spread throughout the population. This dynamic process, over time, can cause species-level changes. From this perspective, any trait or characteristic described as 'adaptive' is defined as such because it enhanced reproductive success in ancestral environments.

It is important to note, however, that adaptations would have evolved in a very different environment than the one in which we live today. As a result, some adaptations may have at one time conferred fitness benefits to our ancestors while no longer retaining their same adaptive qualities and, indeed, some may actually have detrimental effects in modern society. For example, humans' penchant for sweet and fatty foods was adaptive for our nomadic ancestors living in resource-scarce environments, but is associated in modern times with a host of

general health problems for many people living in developed countries who are inundated with these types of foods.

Modularity of the mind

Another assumption of EP is that most evolved cognitive mechanisms are domain-specific and modular in nature. The concept of domain-specificity stems from the knowledge that these mechanisms evolved in response to specific recurrent problems faced by early humans, making them necessarily 'specific' by nature. Because humans developed domain-specific mechanisms in response to specific problems, a logical extension is that the mind of humans is modular in nature, implying restrictions in human cognition. Tooby and Cosmides argue that the human mind is analogous to a Swiss army knife, comprised of many tools, each designed to 'solve' a specific problem, rather than functioning as a general-purpose problem solver.

Although domain-specificity is a fundamental aspect of EP, others have proposed that in addition to these abilities, domain-general mechanisms may have evolved over time. Because information varies across generations and within lifetimes, these mechanisms would have evolved to solve the more generalized, unique, or novel problems faced by humans and to afford the flexibility of general problem-solving and a high degree of plasticity, both early in development as well as throughout the human life span. Consistent with this idea, David Geary, among others, has posited that the human mind is comprised of multiple modular mechanisms of varying degrees of specificity. From this perspective, higher level executive mechanisms would have evolved to function specifically for integrating information across lower level mechanisms.

A well-studied example of the mind's modularity is the development of theory of mind. Having a *theory of mind* refers to the ability of an individual to attribute mental states to oneself and others; importantly, it requires an individual to understand that the thoughts, beliefs, and intentions of another person do not necessarily reflect, and may in fact contradict, one's own. Although humans are not born with a fully developed theory of mind, development occurs along a continuum and most children exhibit an adult-like theory of mind by about 4 years of age.

Baron-Cohen has argued that theory of mind comprises multiple modules that each solve a specific adaptive problem. For instance, an *intentionality detector* is observed in infants as young as 9 months and serves to interpret moving objects as having some 'intention' toward the individual (e.g., that object may bite – or feed – me). An *eye-direction detector* detects eye-like stimuli and tracks their 'gaze' to determine whether the individual 'sees' something. A *shared-attention mechanism*, developed between 9 and 14 months of age, involves interpreting triadic interactions and representations between the self, another person, and an object (i.e., Mom and I are looking at the same thing). Finally, developing by about 4 years of age is the *theory-of-mind mechanism*, which is essentially a fully functioning belief-desire reasoning ability as described above.

The pattern of development for the modules comprising theory of mind is consistent with that proposed by Geary and Bjorklund regarding the developmental trajectory of evolved cognitive mechanisms, in general. Specifically, they have

asserted that modules should be hierarchical in nature, have sensitive periods for the development of abilities, and be based on implicit knowledge and cognition. As Geary has argued, these abilities are important and may provide the foundation for intelligence because it is likely that they serve as the basis upon which a child's developing cognitive competencies are built.

Developmental Systems Theory

Developmental systems theorists are strong proponents of epigenesis, the continuous bidirectional feedback between an organism and its environment on multiple levels (e.g., biochemical, physical, social) over time. At the core of DST is the idea that an organism, itself, actively influences its own development over the course of ontogeny. In the following section, we outline basic tenets of DST.

Gene–environment interaction (probabilistic epigenesis)

A criticism of EP that is commonly cited by developmentalists is the focus in evolutionary research and literature on adult human behavior and their failure to recognize the significance of environmental variables. Evolutionary psychologists have, in the past, been accused of being genetic determinists because of the importance they place on an animal's genes in explaining its behavior. Although most evolutionists would recoil at the thought of being considered a genetic determinist, developmental systems theorists contend that postulating 'genes for' any given trait, as sometimes occurs in EP, represents a form of genetic determinism.

Instead, developmental systems theorists argue that all development results from interactions between genes and the environment at the genetic, structural, and environmental level. Continuous bidirectional feedback occurs between these adjacent levels and results in an organism's structure and function throughout its life span. From this perspective, genes are not thought of as being encoded with 'instructions' that are in some way carried out during the course of development. Rather, genes are seen as developmentally relevant only within the broader environmental context and should not be studied without considering the organism's developmental history.

Ontogeny of species-typical behavior

DST holds that no behavior is naturally occurring or 'innate.' Furthermore, proponents argue against any structure or function being genetically predisposed, waiting only for specific environmental stimuli for activation. Instead, experience during embryonic development is necessary for animals to display species-typical behaviors. From this perspective, continuous and dynamic interactions between an organism and its environment are responsible for emergent structure and function. As stated by Bjorklund and colleagues, "genetic information is extensively scaffolded by species-typical features of the environment . . . the phenotypic outcome is a predictable, emergent property of the *total* developmental system" (emphasis added).

In terms of developmental timing of species-typical behavior, the sensory systems of all vertebrates mature in a common order. For example, neural areas associated with audition develop before those associated with vision. Given that an

animal develops in a species-typical environment, this developmental pattern will always be the same, thus yielding species-typical behavior throughout ontogeny. Some theorists have argued that the brain develops in part via competition over neurons. Because different groups compete for the same cells, deviations from species-typical patterns of activation during development may result in changes in brain organization. A number of studies have reported alterations in species-typical behavior in precocial birds as a result of early species-atypical experiences. This is presumably because any species-atypical sensory experience (whether the experience is introduced earlier or with greater frequency than is normative) interferes with the animal's species-typical pattern of development, sometimes yielding deleterious patterns of functioning. We will revisit this concept when we discuss applications of EDP.

An Emerging Synthesis

Traditionally, developmental systems theorists have accused evolutionary psychologists of practicing a form of genetic determinism, whereas evolutionary theorists have contended that DST affords a nearly infinite degree of plasticity, with the subsequent result that it lacks the ability to predict species-typical patterns of development. Although these theories appear to be rooted in seeming contradictories, an emerging synthesis between the two has resulted in the new field of EDP. At the crossroad of these theories is the idea that genes and environments interact during an organism's ontogeny to produce competent adult behavior. In the following section, we examine applications of EDP that emerge as a result of the synthesis between EP and DST.

Applications of EDP

Prepared Learning

Although evolutionary developmental psychologists caution against prematurely labeling human traits or characteristics as 'innate,' there are certain instances in which humans show remarkable ease of learning, suggesting that this potential 'prepared learning' stems from an evolutionary history where predictable and recurring environments have prepared the brain to react in certain predictable ways given a species-typical rearing in a species-typical environment.

Predator avoidance

Learning to fear potentially threatening stimuli very quickly is an important ability for survival. Mammals may be 'prepared' to learn to fear predators that were widespread and posed a recurrent threat throughout evolutionary history. Indeed, a fear of snakes and spiders is easily acquired by children via social learning at a young age. A study of infants aged 7–18 months found that when presented with fear-inducing and nonfear-inducing visual stimuli (i.e., moving images of a snake and a nonsnake displayed split screen) and an auditory stimulus (a scary voice or a happy voice), infants associated the fear-inducing sound with the snake, as measured by longer look time.

This selective attention to evolutionarily relevant dangerous animals likely results from an evolved predator-avoidance adaptation. Our ancestors who were able to attend to and avoid potentially threatening stimuli were more likely to reproduce than their conspecifics lacking this ability. Interestingly, past research with nonhuman primates has found that lab-reared rhesus monkeys rapidly learn to fear evolutionarily relevant stimuli (e.g., toy snake or crocodile) even without having any prior exposure, simply by observing a videotape in which a rhesus monkey model responded fearfully in the presence of a toy snake or crocodile. However, upon viewing an identical video in which the model displayed fear of non-evolutionarily relevant fear stimuli (e.g., flowers, toy rabbit) the animal observers did not exhibit the same fear. The acquired fear of evolutionarily relevant stimuli in this experiment was both powerful and potent, with animals displaying distress even while watching the original video with fear responses continuing on posttests up to 3 months after the initial video viewing. Because the fear of snakes and crocodiles was easily and rapidly acquired while the same fear of irrelevant stimuli was not, researchers have posited that this fear is likely driven from phylogenetic rather than ontogenetic factors, suggesting a long evolutionary history.

Nausea associated with food

A similar association that both human and nonhuman animals make with seemingly 'prepared' ease is that of nausea associated with food. Evolutionarily, our ancestors who experienced nausea or vomiting after eating certain unhealthy foods (i.e., rancid meat, etc.) would have benefited from being able to associate the illness with the food previously eaten. The ability to do so would surely have benefited these animals by ensuring they would not continue eating food damaging to their immune system.

Researchers have found that rats quickly and easily associated the consumption of novel food with nausea when they received the novel food paired with an injection intended to make them ill. They did not, however, make the same connection when novel food items were paired with electric shocks, associating the consumption of food with a following aversive stimulus. Interestingly, the rats did learn to avoid the electric shock when it was preceded by light and noise. This may hint at an evolutionary history of learning to avoid environmental hazards like lightening or falling objects, which would have also had significant evolutionary relevance.

In addition to an evolutionary 'preparedness' for pairing illness with consumption of food, many researchers have posited that nausea and illness associated with pregnancy, often referred to as 'morning sickness,' may serve an adaptive function. Cross-cultural analyses of 27 traditional societies have resulted in many findings consistent with this view. First, nausea and vomiting peak when the embryo is most susceptible to chemical effects (6–8 weeks); second, women who experience morning sickness are less likely to miscarry than those who do not experience any illness; third, women who vomit are less likely to have a miscarriage than those who only experience nausea; and finally, many pregnant women have aversions to substances that would be especially harmful to their developing embryo (i.e., alcohol, caffeinated beverages, meats, poultry, and eggs). From this perspective,

morning sickness is adaptive because it causes women to avoid substances that could be potentially dangerous to themselves or their embryos. Interestingly, women from 7 of the 27 societies never experienced morning sickness. Of interest from an evolutionary developmental perspective is the fact that the diets of women in these societies were largely vegetable-based, with corn as one of the main staples. In contrast, the diets of women from the remaining 20 societies who did experience morning sickness were largely meat-based, again providing evidence for environmental interaction in this evolved adaptation.

Species-Typical Development Depends on Species-Typical Environments

Information-processing mechanisms have evolved to solve recurrent problems faced by ancestral populations; however, they are expressed in a probabilistic fashion in each individual in a generation, based on the continuous and bidirectional interaction over time at all levels of organization, from the genetic through the cultural. These mechanisms are universal, in that they will develop in a species-typical manner when an individual experiences a species-typical environment over the course of ontogeny. That is, consistent with Brunswik's theory of probabilistic functionalism, evolved cognitive mechanisms make use of and depend upon systematic information and relations in the ecological–environmental contexts in which development regularly and predictably occurs. However, these mechanisms are subject to modification in any particular individual as a result of perturbations in these contexts.

Visual abilities

As we have already discussed, domain-specific modules have been theorized to have evolved to deal with recurrent and relatively invariant aspects of ancestral environments. Most visual abilities, for example, will develop in all humans living in all but the most deprived conditions. This is because natural selection would have favored domain-specific, modular-like mechanisms, which require only a species-typical environment for their proper development. Importantly, species-atypical environments can actually alter the development of these abilities.

For example, to study the effect of presenting animals with experiences outside the boundaries of species-typical environments, researchers removed part of the eggshell of bobwhite quails prior to hatching and provided chicks with visual stimuli (patterned light) that they would not otherwise have been exposed to until after hatching. A control group of chicks also had part of their shells removed but were not exposed to visual stimuli. After hatching, chicks were presented with the maternal calls of their own species as well as that of a chicken.

Findings indicated that the experimental group of chicks, compared to the control group, could not discriminate between the maternal calls and, thus, showed no preference for one over the other. They did, however, show enhanced visual discrimination, but at the expense of auditory discrimination. This research indicates that providing young animals with stimuli outside the realm of normative species-typical experiences may have negative consequences for development.

Language acquisition

A heavily studied example of 'prepared learning' is that of language acquisition. Although many species communicate in varying, but limited, ways, language is unique only to humans. Although we can only theorize as to when language emerged within the human population, evidence from biological sciences has suggested that the expansion of pathways carrying nerves to intercostal muscles in vertebrates – which occurred 300 000 years ago – helped control the pulmonic pulsing driving human phonation, thus, indicating a developing reliance on vocal communication as far back as 300 000 years ago. Evidence suggests that language produced at that time was limited in structure and lacked the complexity we see in today's languages, but it surely served as support for the development of a linguistic society dating far back into our evolutionary history.

During the 1980s, a set of cognitive developmental psychologists began expanding on *neonativist* theories originally put forth by Noam Chomsky, arguably the world's most well-known linguist. Central to a neonativist perspective is the claim that children are born with *universal grammar*, some basic knowledge about language's structure and syntax. Furthermore, neonativists would argue that children also possess a *language acquisition device*, a mental ability to compare language input from a child's environment with their own universal grammar, and to make modifications as necessary, permitting children to learn the basics of the language spoken in their environment and aiding them in the acquisition of this language.

Support for the universality of language acquisition comes from studies in which children spontaneously 'invent' new languages when isolated from society or exposed to poorly structured verbal codes. One compelling instance of this was studied among deaf children in Nicaragua. Prior to the 1970s, no deaf education was in place in the country, and deaf children were isolated from the rest of their society. However, a group of deaf children spontaneously began creating their own sign language, first studied in 1978, and subsequent generations of deaf children not only learned this rudimentary language but actually modified it from a *protolanguage* (a rudimentary representation of language lacking syntax), to a more complete language.

Interestingly, evidence for a sensitive period of language acquisition suggests that although the acquisition of language is universal for all humans reared in species-typical environments, humans reared in atypical environments may be subjected to a limited period of time within which they are easily able to acquire language. After this sensitive period, any child who has not yet acquired language will have a difficult time mastering even basic linguistic abilities and will be unlikely to ever acquire language comparable to that of the average adult.

Evidence for a sensitive period comes from studies of feral children who have been discovered in late childhood living in conditions presumably without any significant human contact. These children, when not 'discovered' until adolescence, have difficulty acquiring even rudimentary language and fail to achieve language proficiency comparable to most 3-year-olds, even after intensive education. Although there is no definitive cutoff age at which the ability to learn language ceases, studies have generally found that the younger the child at time of

recovery, the greater the likelihood that they will be able to acquire language. Conversely, once children reach adolescence, even intensive instruction may prove futile in attempts to teach a primary language. Similarly, individuals learning second languages benefit greatly from instruction in childhood, during which time they are best able to learn the subtle nuances of a second language. If not exposed to a second language until adolescence or adulthood, people often have trouble mastering the syntax and phonology of the second language and are rarely able to obtain linguistic ability comparable to that of their primary language.

Characteristics of Childhood

Another unique feature of *Homo sapiens* is our extended juvenile period. Having an extended childhood imposes specific costs both to parents and offspring, themselves. In addition to children's physical and sexual immaturity, an extended childhood is also a time of social and cognitive immaturity. For evolution to have favored an extended juvenile period in spite of so many seemingly adverse effects, it must have served adaptive purposes. One explanation for humans' extended childhoods is that it serves to prepare children for adulthood by allowing time with which to learn the social complexities of their environment.

Certain characteristics of childhood are seen cross-culturally and worldwide. Some of these universal characteristics have been hypothesized to occur as preparations for adulthood (*deferred adaptations*) whereas others serve adaptive purposes specifically during childhood, with no relevant benefits to later adulthood (*ontogenetic adaptations*). Because all individuals must survive childhood in order to reach adulthood and pass on their genes, it is not unreasonable to expect that certain selective pressures may only operate during childhood and that, as a result, adaptations that help children to survive would have been selected for throughout the course of human evolution. For example, observed sex differences in children's play provide evidence that an extended childhood may have evolved both for immediate and delayed benefits. An immediate benefit of play is that it serves as a form of exercise. Delayed benefits, which we argue serve as preparations for adulthood, include learning about dominance hierarchies (seen particularly in boys' play) and the establishment and maintenance of social relationships, which foster skills that are undoubtedly relied upon throughout an individual's life span.

Extended childhood

One hallmark of our species is our unusually long childhood and juvenile period, relative to those of other mammals. Because the costs of an extended childhood are likely to be substantial, evolution would only have favored this strategy if it allowed for specific adaptive advantages (in terms of survival and reproduction). Importantly, one benefit of an extended childhood is that it permits children to adjust to variations in social environments and to anticipate future ones. Because a prolonged period of immaturity was (and continues to be) vital for learning the complexities associated with group living, humans are uniquely susceptible to (or able to cope with) environmental variations. In addition to serving as a learning

ground for developing human social competencies, an extended period of immaturity may serve other adaptive benefits, as well.

Although some of the immediate benefits for delaying sexual development are rather intuitive (e.g., delaying reproduction allows a child the time to build their physical and cognitive abilities to make them a 'fit' parent prior to raising offspring), other benefits of an extended childhood may be less obvious. One characteristic of childhood that has been argued to be pivotal for developing social and cognitive competencies is that of child-initiated play. This is because in contrast to 'organized' play, child-initiated play is often person-centered, allowing children to develop important social competencies and to learn about the structure of the physical world.

Examples of the social competencies gained from children's play stem from naturally occurring observable sex differences. For example, boys' play is more likely to be rough in comparison to girls' play. Boys' play, relative to that of girls, focuses on social dominance and group-level competition, which serve as preparations for physically aggressive male-on-male competition that would have served to increase social status and acquire mates for our male ancestors. In contrast, girls' play is more often focused on developing and maintaining social relationships with other girls. It is more likely to be fantastical in nature and to involve make-believe or dress up, helping girls learn how to form and maintain stable social support systems, which surely bolstered the survival of our female ancestors. As a result, play serves an important role for both boys and girls because it can serve as the foundation upon which later innovations and creativity may take root, which are certainly beneficial in adulthood. In addition to the delayed benefits of play, immediate benefits such as those gained through exercise and the establishment and maintenance of social relationships during childhood also serve an adaptive function.

Adaptive Individual Differences

Individual differences in EP have traditionally been viewed as nonadaptive (noise in the system). However, mounting theoretical and empirical evidence (much of it stemming from EDP) suggests that there is not just a species-typical human nature but also diversity within species at the genetic level as well as phenotypic plasticity. Natural environments are often complex and afford more than one way to survive and reproduce. Such multi-niche environments provide the ecological basis for the evolution of adaptive phenotypic variation within species. This adaptive variation can evolve in response to the physical diversity of environments (i.e., ecological niches that vary over time or space) or as alternative solutions to problems of social competition.

Adaptive Phenotypic Plasticity

Whereas the development of all adaptations depends on various regularities in the environment, the development of many adaptations also depends on systematic (structured) variation in the environment. That is, for many adaptations, the types of environmental information that interacts with underlying genes vary substantially within species-typical environments

(e.g., as does diet, quality of parental investment, social competition, and mortality rates). When, over evolutionary time, the fitness of alternative phenotypes is predictable on the basis of observable environmental cues, natural selection tends to favor *phenotypic plasticity*: neural circuits that reliably guide development of alternative phenotypes (anatomical, physiological, behavioral) in response to given ecological or developmental conditions. Adaptive phenotypic plasticity enables matching of the phenotype to conditions where it is expressed.

One form of adaptive phenotypic plasticity is *conditional adaptation*, defined by Boyce and Ellis as "evolved mechanisms that detect and respond to specific features of childhood environments – features that have proven reliable over evolutionary time in predicting the nature of the social and physical world into which children will mature – and entrain developmental pathways that reliably matched those features during a species' natural selective history."

Conditional adaptation in the Arizona caterpillar

According to this view, organisms have evolved to detect and encode information from their environments and develop organized and contingent adaptive phenotypic responses. These responses serve to match the organism to their environment. These responses can be reversible (polyethisms) or permanent (polyphenisms). One example of a polyphenism is the caterpillar *Nemoria arizonaria*, commonly referred to as the Arizona caterpillar. The Arizona caterpillar has evolved an adaptive phenotypic response to the type of food they consume within the first three days of life. Food available during the spring cause the caterpillar to develop a flower-type morph while food consumed during the summer cause the caterpillar to develop a twig-type morph. These different morphs have been found to be contingently responsive to spring and summer food even when they are experimentally administered out of season. Thus, development of one morph over another represents an evolved adaptive predator-avoidance mechanism that matches the caterpillar to their expected environment (floral environment in the spring, a more sparse environment in the summer).

Conditional adaptation in human reproductive strategies

A much studied example of conditional adaptation in humans is adjustment of rates of sexual development and behavior in girls to match conditions in and around the family. This work is based in life history theory, which suggests that early experiences bias reproductive decision (e.g., decisions about how to allocate effort toward mating vs. parenting, or quality vs. quantity of offspring) in adolescence and adulthood. The theory assumes that, in response to specific developmental contexts, individuals adjust reproductive strategies in ways that historically increased reproductive success and thus fitness in those contexts. Accordingly, behavioral profiles or 'strategies' are conditional and responsive to environmental (including social) cues. According to prevailing models of human sexual development, of particular importance is a sensitive period (approximately the first 5–7 years of life) when environmental exposures – cues to the availability and predictability of resources, the trustworthiness of others, the stability of pair bonds, and the endurance of close personal relationships – function to entrain alternative reproductive pathways.

The basic premise of the model, as developed by Jay Belsky and colleagues, is that there are two alternative pathways – fast and slow – underlying variation in reproductive strategies. The fast pathway is characterized by early high-stress environments such as high marital discord, father absences, and/or inadequate resources. This acrimonious family context undermines parenting behavior resulting in harsh, rejecting, insensitive/inconsistent parenting. These parenting behaviors are thought to promote insecure attachment accompanied by a mistrustful internal working model and an orientation toward opportunism in interpersonal relationships. This in turn is hypothesized to accelerate somatic development (e.g., cause earlier puberty) and leads to a faster reproductive strategy (e.g., earlier sexual activity, more sexual partners). The second pathway, the slow path, is very nearly the complement of the fast path. Children whose reproductive trajectory follows the slow path inhabit early environments characterized by adequate resources and low spousal discord, sensitive and supportive parenting behaviors, secure attachment, and trusting internal working models. These children are hypothesized to delay the onset of puberty relative to their peers and have later sexual activity and more enduring relationships.

Empirical research testing this model, much of it conducted by Bruce Ellis and colleagues, has generally found that girls who are reared in homes prone to economic or psychological stress, marital discord, father absence, and unreliable social relationships reach puberty sooner, become sexually active earlier, and reproduce at a younger age than do girls raised in more supportive environments. Consistent with life history theory, these differences in girls' reproductive strategies are hypothesized to reflect adaptive responses to their early environment. Although it may be counterintuitive for girls' best adaptive strategy to include early puberty and sexual activity, this pattern may actually reflect a 'good' strategy (from a Darwinian perspective) for a girl living in a harsh or unpredictable environment. When living in dangerous conditions, girls can increase their inclusive fitness by accelerating reproduction, thus increasing the chance of reproducing at all in a high-mortality environment. Individuals may also be selected to hedge their bets in this context by producing multiple offspring and investing relatively little in each one, rather than investing a lot in a given offspring who might die young. This 'strategy' is, of course, not necessarily conscious but is based on children's sensitivity to early environments and their physical and psychological responses in anticipation of future ones.

Adaptive Genetic Diversity

Despite the apparent advantages to plastic organisms that can alter development to match environments, there are potentially high costs of phenotypic plasticity (e.g., producing and maintaining the appropriate regulatory and assessment mechanisms for alternative development); thus, in some cases, genetically based polymorphisms will be selected for, instead. Such polymorphisms are likely to be favored by selection when advantages of niche specialization are high, when organisms can evaluate and select their niches, and when reliable environmental cues for entraining or switching between alternative phenotypes do not exist. Genetic polymorphisms can also be maintained by an evolutionary history of fluctuating

selection pressures whereby the fitness of alternative genotypes (and their expressed phenotypes) varied depending on their frequency in the population. In this context, the fitness of each genotype changes over time as it becomes more or less frequent. The most common and viable form of frequency-dependent selection is negative, selecting against genotypes as they become more common. For genetic polymorphisms to be maintained by natural selection, they must evolve toward a state of equilibrium in which the average fitness of the alternative alleles (or variants of the same gene within a population) is equal.

Allelic variations can support the development of alternative phenotypes that may have adaptive consequences for the organisms. For example, consider the situation where two gene variants exist at a given locus, *a* and *b*. For diploid species, such as humans, three alternative genotypes are possible, homozygous *aa*, *bb*, and heterozygous *ab*. If one of the genotypes (and corresponding phenotype) confers a selective advantage over the others, then natural selection will tend to favor this genotype. This implies that selection will act to eliminate the other alternative genotypes since they are nonequivalent in terms of their fitness benefits. However, as noted above, alternative genotypes can thrive in multi-niche environments when individuals can choose niches that match their genomes. Consider the example of the dopamine 4 receptor gene (*DRD4*).

Maintenance of adaptive genetic variation in humans: The case of the *DRD4* gene

The *DRD4* gene has two allelic variants that are associated with distinctive phenotypes. The first, *DRD4* 4R (also known as the short allele), is associated with more risk averse behaviors while the *DRD4* 7R (also known as the long allele) is associated with more novelty-seeking and risk-prone behaviors, though the main effects of the 7R allele are relatively small and inconsistent. A possible explanation is that individuals with the 7R allele are generally more susceptible to environmental influence: such individuals display enhanced sensitivity to *both* negative and positive environments, that is, to both risk-promoting and development-enhancing environmental conditions. This enhanced sensitivity increases *developmental* receptivity to the environment. That is, more susceptible individuals are more likely to experience sustained developmental change in response to environmental exposures.

The 4R allele was the most common form of the *DRD4* gene throughout human prehistory. Under conditions of environmental harshness and resource limitation, which are common in preagricultural foraging societies, biparental investment in offspring, durable pairbonds, and strong family ties and cooperation (i.e., slower LH strategies) are generally needed to survive and reproduce successfully. These ancestral conditions may have helped to maintain the 4R allele, which is associated with more risk-averse mating and social behavior.

Whereas the *DRD4* 4R allele appears to have emerged around a half-million years ago and is common in most geographical locations, the *DRD4* 7R allele, which is associated with greater developmental plasticity and, under certain conditions, more impulsive and risk-prone behavior, appears to have been selected for over the last 40 000–50 000 years and has a widely variable and nonrandom global distribution. Based on an analysis of this distribution, some researchers

have concluded that the 7R allele promotes migratory behavior, with bearers of 7R more likely to lead populations far away from their ancient lands of origin (e.g., South American Indians, Pacific Islanders). An alternative explanation, however, is that carriers of the 7R allele are more behaviorally plastic and thus better able to adapt to new environments. Still another explanation is that the 7R allele is favored by selection under conditions of surplus resources. In such luxuriant contexts, where offspring can be successful without intensive biparental investment (as is common in many agricultural and modern societies), higher levels of energetic, impulsive, and noncompliant behavior characteristic of male bearers of the 7R allele may facilitate fast sexual behavior and success in intrasexual competition. Recent increases in the frequency of the 7R allele are consistent with this hypothesis. In total, 7R bearers may not only be more likely to become propagules colonizing new environments (generating between-group variation in reproductive strategies) but may also employ faster reproductive strategies than 4R bearers in well-resourced, multi-niche environments (supporting within-group variation).

Concluding Remarks

An evolutionary perspective can contribute significantly to the study of human development, but a developmental perspective, especially the careful consideration of epigenetic effects, should also be recognized by evolutionists. While most evolutionary psychologists acknowledge the role the environment plays in development, they rarely address the issue in depth and fail to fully explore the implications of probabilistic epigenesis on emerging human social behavior and cognition.

Ultimately, adopting a developmental perspective in EP has the potential to broaden the horizons of mainstream EP by providing a more thorough background of the environmental variations and individual differences that account for the development and expression of evolved human behaviors. Failing to do so can potentially limit the influence of evolutionary theory by failing to take into consideration an adult's ontogenetic history when discussing their current behavior. The two cannot be separated in the natural world and, therefore, must be considered only within the context of each other.

EDP represents an emerging synthesis between species-universal traits and characteristics and those which result from adaptive phenotypic plasticity or genetic diversity. Although the field is still in its infancy, EDP has the power to make its way into mainstream psychology by providing the most complete picture of adaptive human behavior, taking

into consideration our species' rich evolutionary history in conjunction with unique individual experiences in such a way as to explain adaptive human behavior and cognition.

See also: Evolutionary Clinical Psychology; Evolutionary Psychology; Evolutionary Social Psychology; Parent–Offspring Conflict; Social Development (Attachment, Imprinting).

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Evolutionary Personality Psychology

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Glossary

Apparent context The set of apperceived and ordered psychological manifestation of extant adaptive problems.

Assortative mating Preferential assortment between phenotypically similar (if positive) or dissimilar (if negative) sexual partners.

Assortative sociality Preferential association between phenotypically similar (if positive) or dissimilar (if negative) social partners.

Balanced polymorphism An evolutionary stable strategy of multiple behavioral types coexisting within a population.

Behavioral flexibility The temporary, reversible behavioral changes that can occur throughout the life span.

Developmental plasticity The permanent behavioral, anatomical, or physiological changes in the developmental trajectory adopted by an organism during the life span.

Directional selection Changes in gene frequencies within a population that ensue when natural or sexual selection favors a single phenotype over others and shifts the relative allele frequencies continuously in one direction.

Disruptive selection Changes in gene frequencies within a population that simultaneously favor individuals at both extremes of the distribution over those in the middle of the range, also called diversifying selection.

Ecological validity coefficients Correlations, ranging between zero and one, that characterize the predictive validity of ecological cues that signal the presence of particular adaptive problems.

Epigenetic Changes in phenotype caused by mechanisms other than changes in the underlying nucleotide sequence of DNA, such as changes in gene expression.

Frequency-dependent selection A dynamic form of balancing selection that occurs when the fitness of a given phenotype increases or decreases based on its prevalence relative to alternative phenotypes within a population.

Gene–environment correlation An association between an individual's genotype and the environment that it inhabits.

Gene–environment interactions Environmentally induced changes in gene expression.

General factor of personality A certain profile of personality traits that is purportedly both socially and sexually selected for mutually beneficial cooperation and has been associated with a number of cooperative and prosocial traits.

Genetic diversification Increasing the level of heritable variation within and between populations, providing a mechanism for organisms and populations to adapt to changing environments.

Genetic drift Nonadaptive changes in relative frequencies of gene variants (alleles) that occur in a population due to random chance over time.

Heritability The proportion of the variance in phenotype that is attributable to variance in genotype.

Natural selection Changes in gene frequencies favoring phenotypic traits that increase survival and fecundity.

Ontogenetic Referring to the sequence of developmental stages through which the organism passes during its lifetime.

Sexual selection Changes in gene frequencies favoring phenotypic traits that enhance success in obtaining and retaining sexual partners.

Social selection Changes in gene frequencies favoring phenotypic traits that enhance success in obtaining and retaining social partners.

Sociality hypothesis The theory that disruptive selection favors the diversification of personality in social species.

Theoretical evolutionary ecology The mathematical equations and probability distributions that govern the demography and biogeography of species over evolutionary time.

True context The extant subset adaptive problems currently facing an individual organism, independent of origin.

Introduction

Multiple mechanisms of selection shape individual differences in human personality, both within and between different populations. Together, these selective forces operate to change the relative frequencies of the genes influencing the development of personality traits in various ways. All human personality traits are at least partially heritable, with *heritability coefficients*, an index of genetic influence, mostly ranging from 40% to 50%. The way that most genes influence personality development, however, may not be through simple Mendelian inheritance. For example, genetic influence may operate through biologically

prepared mechanisms of phenotypic plasticity. These epigenetic processes consist of systematic changes in the phenotype (observable traits) through ontogenetic shifts at specific points of the life cycle by altering the expression of the genes themselves throughout development. These genetically influenced developmental programs may be guided by adaptively fine-tuned *developmental switches* that are strategically preprogrammed to be contingently activated upon encountering prespecified environmental cues, signaling the presence of the particular *adaptive problems* to be solved at each successive stage of life.

Nevertheless, genetic influences are intimately involved in personality development, one way or the other, making

personality variation a potential target of various forms of selection. Depending on prevailing ecological conditions, one of these selective pressures may be more or less influential at any given time. Although space constrains the provision of an exhaustive overview, the influences of (1) directional social selection, (2) disruptive social selection, (3) genetic diversification, (4) developmental plasticity, and (5) behavioral flexibility upon the evolution of individual differences in personality have been addressed.

Directional Social Selection

The need for *social cooperation* among humans produces directional selective pressures favoring a certain degree of convergence among individuals in behavioral dispositions. Such selective pressures were identified as early as 1871, in Darwin's seminal work *The Descent of Man*. This kind of social selection may act either through contest competition among rival groups, as Darwin maintained, or through social adaptations to better fit individuals to optimize their survival and reproduction within the complex social context of such interacting groups.

Recently, this type of selection has been theorized to promote the evolution of a certain profile of personality traits purportedly best suited for social cooperation. This personality profile has been referred to as the *general factor of personality*. Although it has been derived from a variety of different personality inventories, some measuring different subsets of lower-order personality factors, this higher-order factor is best described as a trait profile consisting of high openness to experience, high conscientiousness, high extraversion, high agreeableness, and low neuroticism.

The general factor of personality appears to be both socially and sexually selected. For example, when asked to rate their *ideal romantic partner* on a standard personality inventory adapted for the purpose, most respondents reliably rate this imaginary partner somewhat higher than themselves on this characteristic profile of personality traits. This indicates both assortative mating (pairing of individuals on similar levels of phenotypic, and perhaps heritable, traits) on individual differences and a population-wide directional preference, at least in romantic aspirations. When people say that they would like someone with a 'great personality' as a sexual or social partner, this is evidently what they generally have in mind.

In addition, the general factor of personality is associated with a number of cooperative and prosocial traits, including altruism, sociability, subjective well-being, satisfaction with life, self-esteem, and emotional intelligence. The profile is so self-evidently socially desirable that it has led some to question whether the entire common factor is not just an artifact of shared evaluative bias. Recent behavioral genetic twin studies, some using multiple raters and not limited to self-reports, however, demonstrate both substantial heritabilities for this higher-order factor as well as genetic correlations with both better overall physical and mental health and slower life history (for more on this reproductive strategy, see section 'Disassortative Mating as a Strategy for Genetic Diversification').

Classical neo-Darwinian theories of sexual selection predict that a population-wide sexual preference for a trait, or for a certain coordinated profile of traits, inevitably becomes

genetically associated with the trait itself over evolutionary time. Therefore, even if the general factor of personality started its evolutionary history as an evaluative bias, it would have quite quickly become a target of both sexual and social selection and would have been shaped into being, even from an assortment of previously uncoordinated personality factors. Thus, some of the methodological criticisms of the higher-order personality factor are psychometrically, but not evolutionarily, informed.

Disruptive Social Selection

Theoretical Evolutionary Ecology

When considering the evolution of a species over time, it becomes apparent that the heterogeneity (nonuniformity) of the spatial habitat alone cannot account for the diversity both between and within species. One must think of species and individuals as existing within the multiple intersections of many different environmental factors. Each factor comprises some aspect of the environment, living or nonliving, to which the species or individual is subjected. For example, domestic dogs have lived in many different habitats. Many other physical and biological factors, such as the temperatures and humidities of their environments, their interactions with humans and their other domesticates, the available prey, and other predators, have influenced their evolution. All of these environmental factors taken together constitute an *ecological niche*. This conception treats an individual within the species as an element within an ecological system influenced by the many environmental factors affecting its survival and reproduction.

Humans have been described as generalists. As a species, humans have a wide range of potential niches that allow for variability in the means of both survival and reproduction. A major contributor to this large niche space is that humans have become molders of their environment, modifying once uninhabitable habitats to become habitable for them. This *ecological dominance* has been dramatically facilitated first through the advent of agriculture and then later through the industrial revolution, both allowing for greater population densities and release from some between-species pressures. These greater population densities, however, foster greater within-species competition.

Release from this within-species competition has come in part through technological revolutions. These technological revolutions allowed for more division of labor (e.g., farming vs. hunting) and a consequent increase in within-species dependencies (e.g., the exchange of grain for meat). New technologies cut down labor requirements and made new resources within the environment more easily attainable, permitting some individuals to specialize in occupations that were not possible before, but some of which became advantageous in the more complex social environment. In essence, these technologies expanded and diversified the ecological ranges of humans to incorporate and create new niches. This labor specialization requires intensified social interactions and within-species dependencies. As the ease of meeting survival and reproductive needs grew, so did the dependency on others in direct proportion.

Thus, in addition to directional selective pressures produced by *social cooperation*, favoring convergence among

individuals, disruptive selective pressures are produced by *social competition*, favoring divergence among individuals in behavioral dispositions. We propose that individual differences in personality evolved in response to these opposing social selective pressures. Within-species competition grows as a function of the number of social interactions. Paradoxically, more cooperative social interactions lead to more competition within species. For a solitary species, a single response disposition might be optimal, where any deviation from this optimum resulted in shortened survival or lower overall reproductive success. Thus, individual differences were not selectively neutral. For a social species, we might also expect a single response disposition to be optimal if it promotes greater social cooperation, as the general factor of personality described earlier evidently does.

For a social species, increased within-species interactions expanded the number of social niches, eliminating a single and invariant species-typical or *global* optimum and replacing it with a divergent set of *local* optimal response dispositions. These disruptive selection pressures shaped the evolution of what became variable personality traits, each contingently optimal in a different social niche. Ecological dominance relieved some of the between-species pressures selecting the formerly species-typical optimal response disposition, allowing the within-species variance around it to grow. Dispersing from this central tendency, individuals partially released themselves from direct competition with other individuals and became better adapted to a social existence. This process is known in the theoretical evolutionary ecology as *within-species niche-splitting*.

Frequency-Dependent Selection

Several theorists argue that, due to the extreme sociality of humans over recent human evolution, frequency-dependent selection offers the best framework for understanding such personality variation. Frequency-dependent selection is a dynamic form of balancing selection that occurs when the fitness of a given phenotype increases, or decreases, based on its prevalence relative to alternative phenotypes within a population. Essentially, the frequency of an alternative phenotype affects the fitness payoff of an individual's traits in that environment. If the alternative phenotype is abundant, making it more costly, a selective pressure working against the alternative may increase the fitness of an individual's phenotype, thus making it more common. This outcome is called *positive frequency dependence*. If the alternative phenotype is less abundant, and less costly, a selective pressure working against the individual's phenotype will make it less fit. This outcome is called *negative frequency dependence*.

Such a process, occurring across evolutionary time, can lead to an *evolutionary stable strategy* of multiple behavioral types coexisting within a population, called a state of *balanced polymorphism*. This evolutionary stable strategy may work at both the between-species level, as with species that coexist within a given environment, and at the within-species level, as with multiple morphs of the same species competing within a population. This latter process is the most applicable to individual differences in human personality. As an illustration, one might examine the universal personality dimension of extraversion/introversion. This personality trait is heritable, tied to

physiology, and predictive of specific behaviors. It is not difficult to envision social niches where extraversion is beneficial. Extraverted individuals are more assertive, social, dominant, active, and sensation seeking than their introverted counterparts. As the number of extraverts increases in the population, however, competition among them would also increase, opening up a niche for the lower-competition solution of introversion.

Some evolutionary models use frequency-dependent selection to explain such variations in human personality traits. Inherent to these models is the understanding that within any given social environment there are multiple niches individuals may exploit, each of which may lead to an increase or decrease in the fitness of a given behavioral phenotype. Population-level variation in personality is a mixture of genetic variation and phenotypic plasticity. Individuals may be ecological specialists (i.e., genetically constrained to fill a particular social niche) or ecological generalists (i.e., who can match their phenotype to respond to their current social niche). As a logical extension of the previous extraversion/introversion example, it has been argued that those who score at the extreme ends of the dimension (highly extraverted or highly introverted) tend to be more strongly consistent across time and context, suggesting a constraint on their behavior, while individuals who score more toward the population average of the dimension are contextually sensitive and flexible in their behavior. This simplified example therefore suggests that frequency dependence acts not only in relation to the frequency of other 'types' in a population, but also in relation to the environmental niche that an individual inhabits.

Both theories rely on the selective pressures produced by social environments. As the sociality of a species increases, so does the within-species competition for access to resources such as food, shelter, mates, and antipredator defenses. Frequency-dependent selection operates to diversify behavioral traits as a means to decrease the likelihood of such costly competition. Social environments are not consistent, and multiple niche spaces exist within each. Within every niche space, there is a balance among alternative phenotypes under the effect of frequency-dependent selection. Thus, within-species variation in personality is predicted to increase as the species becomes more social with prolonged, repeated interactions among individuals; this prediction of the *sociality hypothesis* has generally held true. Nevertheless, while some evolutionary personality theorists argue that this mechanism operates primarily at the group level by decreasing within-group competition and enhancing success in between-group competition, others argue that it is primarily focused at the individual level of selection, conferring the advantages of competitive release upon individual survival and reproduction.

Frequency-dependent selection for alternative niches requires the presence of *gene-environment correlations*, in which an individual's genotype influences the environments that it inhabits. That is to say, genetically different individuals must identify and exploit alternative social niches in any of the various possible ways. This may be done passively through mechanisms such as random genetic drift, or actively through mechanisms such as *selection* (of a social niche), *evocation*, or *manipulation*. Selection of a social niche means that an individual specifically chooses which environment to occupy.

This may be done through conscious appraisal of one's personal attributes in relation to social activities. Evocation refers to the individual seeking to elicit predictable responses from the environment. Manipulation of an environment allows individuals to create a social space that is more suited to their particular phenotype.

Genetic Diversification

Social organisms are especially well suited to adapt in ways that enhance genetic diversification because of the inherent instability of social niches. Sexual recombination, for example, is a common means of genetic diversification even though this behavior comes at an enormous cost, evolutionarily speaking. Offspring of sexually reproducing species carry only half of the parents' genes. Additionally, an asymmetry exists in parental effort such that one sex bears a disproportional cost of sexual reproduction, which produces a selective pressure against this type of reproduction. Given these costs, evolutionary biology struggled to explain why this phenomenon evolved in the first place, and in doing so has produced several possible explanations. Some argue that sexual reproduction thwarts attacks by pathogens by creating a 'moving target'; while others suggest that recombining genetic material increases resistance to environmental fluctuations in general, including the prevalence of parasites. Sexual recombination has been shown to help remove deleterious mutations that would otherwise 'ratchet up' in an asexually reproducing species.

Disassortative Mating as a Strategy for Genetic Diversification

Life history theory predicts different adaptive strategies depending on the stochastic characteristics of the environment. When the environment is unstable and unpredictable, the sources of morbidity and mortality are consequently uncontrollable. These risks are called *extrinsic* sources of morbidity and mortality, because organisms cannot evolve adaptations to avoid them with genetically influenced developmental processes. Instead, they adopt a *fast life history strategy*, characterized by allocating material and bioenergetic (energy flowing through living systems) resources toward mating effort to maximize the production of offspring. In contrast, when the environment is stable and predictable, and when organisms can minimize *intrinsic* sources of morbidity and mortality with genetically influenced (and thus, evolvable) developmental processes, they adopt a *slow life history strategy*, characterized by the allocation of resources toward somatic growth and parental investment to enhance competitive advantage.

The increased mating effort of fast life history strategists also functions to increase the rate of genetic recombination, through the increased number and diversification of sexual partners and hence of offspring, which could serve to enhance survivability of at least some of the resulting offspring in the unpredictable environment by providing more genetic variation and, presumably, phenotypic variation among them to contend with the fluctuating environment. In contrast, slow life history strategists engage in *positive assortative mating*, as well as *positive assortative sociality*, on genetically influenced traits, thereby preserving locally well-adapted and possibly coadapted genomes,

because stable environments select against high rates of genetic recombination that could otherwise split up these adaptive genetic combinations. As predicted by this theory, recent cross-cultural studies have shown that fast life history strategists do assortatively mate less strongly than do slow life history strategists and that the relationship is consistent across several cultures and across both sexual and social relationships.

Developmental Plasticity

Developmental plasticity describes the permanent behavioral, anatomical, or physiological changes in the developmental trajectory adopted by an organism during the life span, influenced by external environmental factors or other internal physiological factors, and that occurs through gene-environment interactions. Developmental plasticity can be contrasted with behavioral flexibility, which describes the temporary, reversible behavioral changes that can occur throughout the life span.

Gene-environment interactions involve environmentally induced changes in gene expression. This is mechanistically possible because environmental factors (including both the external and internal environment) can lead to biochemical modifications of epigenetic processes that function to activate or suppress the production of proteins. The thresholds for these developmental switches influence responses to environmental cues and are genetic in nature. Thus, natural selection can act to adaptively modulate genetically controlled thresholds for environmental influences.

Human pubertal development is an illustrative example of developmental plasticity. This physiological event results in permanent biological change; however, the age of puberty is plastic and depends on the threshold of a developmental switch. Internal (e.g., body fat composition) and external (e.g., stress) factors alter the neuromodulatory system that controls a specific neurotransmitter network that controls puberty in human females. Onset of puberty depends on ecological conditions, such as resource availability and environmental variability, leading to the suggestion that the threshold sensitivity may have evolved to calibrate physical and reproductive development according to the social and ecological circumstances encountered during development. For example, absence of the father accelerates the onset of puberty in females.

Role specialization may represent an additional example of developmental plasticity in humans, such as in *niche-picking* within families. Empirical tests of the theory of birth order as a determinant of personality have provided some support suggesting that this factor is related to attitudes toward family, friends, and sexual fidelity. Underlying these findings is the theoretical proposition that siblings may adopt specialized roles to obtain adequate parental investment. This model of within-family niches may be expanded to describe society as a whole such that the social niche space may be partitioned to reduce competition and maximize individuals' access to resources. Thus, under conditions of high population density or limited resource availability, a selective premium is placed on the evolution of individual differences in personality.

Populations of organisms are expected to evolve traits that enable them to survive and reproduce in their own unique ecological circumstances. If the environment varies such that organisms are facing unpredictable changes over many generations, an adaptive response to these changes is to evolve a plastic phenotype that enables learning during development so that the organism can detect current, relevant environmental cues and respond accordingly. These cues can be conceptualized as *ecological validity coefficients* that range between 0 and 1 and characterize the predictive validity of ecological cues that signal the presence of particular adaptive problems. When there is moderate variability in conditions, organisms will evolve a combination of genetic diversity and developmental plasticity, allowing them to maximize survival while diversifying to fill available ecological niches.

Behavioral Flexibility

A Taxonomy of Ecological Contexts

True contexts

An *environment* can be defined as the full set of adaptive problems an individual organism of a given species faces throughout development, independent of time. A *context* can be defined as the extant subset of adaptive problems currently facing an individual organism, independent of origin. A *setting* can be defined as the subset of adaptive problems currently facing an individual organism, originating from the extant nonliving environment. A *situation* can be defined as the extant subset of adaptive problems an individual organism currently faces, originating from extant biotic sources. A *between-species situation* can be defined as the subset of adaptive problems the organism currently faces, originating from any physically present species other than that of the individual. A *within-species situation* can be defined as the subset of adaptive problems the organism currently faces, originating from any physically present individual of the same species.

Apparent contexts

An individual, by definition, cannot act on unsensed, or 'unrecognized,' adaptive problems. Hence, following Sir Isaac Newton, we contrast an *apparent context* with a *true context* and attempt to analyze how they might systematically, albeit imperfectly, relate to one another.

Whereas the set of actual extant adaptive problems an individual faces defines a true context, setting, or situation, the set of apperceived and ordered psychological manifestations of extant adaptive problems that an individual faces defines an apparent context. This apperceived set of extant adaptive problems appears to depend on the true context, the experiential history with similar adaptive problems an individual has faced, and the current physiological state of the organism (e.g., food deprived, socially deprived, etc.).

Given that the physical, psychological, and behavioral structure of the organism bears traces of the experiential history of the current organism, we call this apperceived and ordered psychological manifestation of extant adaptive problems the perspective the organism takes on its current context. The perspective is the subjective importance of the extant adaptive problems constituting a full context. The current organism

apparently matches behavior to true adaptive problems by sensing, classifying, and differentially responding to apparent adaptive problems.

Relations between true and apparent contexts

Hence, apparent adaptive problems present themselves to an individual, driven by true setting and situation, filtered through genetically, physiologically, developmentally, and experientially determined schemata. These schemata appear causally prior to adaptive behavioral strategies, which in turn may be thought to guide adaptive behavioral tactics. More completely, a schema is an individual conception of how the world works and one's relation to it. A strategy is how one goes about dealing with the world as conceived through the schema. A rational individual activates appropriate tactics, predicated upon what one perceives to be the objective state of the world and one's place within it, which is constrained by one's schema. Although a schema-driven conception of the world may or may not be objectively correct, it is the schema that should logically predate the strategy, which guides the tactics used to solve extant apparent adaptive problems, which, at least in the ideal, are tightly coupled to extant true adaptive problems.

The causal and statistical relations among the true and apparent context, schemata, strategies, and tactics are, however, not strictly unidirectional. Individuals sometimes find that others place them within a situation, or even within various settings, without that individual's choice and independent of one's schema. In contrast, an individual's behaviors, predicated on one's contextually activated strategies, in turn apparently predicated on one's schema, may bring the individual to a greater-than-average number of situations or settings of a given type. Hence, thinking in terms of unidirectional causality, a given individual's behavior may be causally prior to, at least from one perspective, entering a specific context.

One may characterize contexts, especially within-species situations, along a strong-to-weak dimension: in strong contexts, one must solve apparent adaptive problems immediately and efficiently. In this case, there will be little evidence of stable individual differences in overall behavior (traits); instead, one will observe stable context-specific behavioral patterns. In weak contexts, there are few important extant adaptive problems. In this case, there will be consistent evidence of stable individual differences in overall behavior (traits) and few idiosyncratic context-specific behavioral patterns.

This range appears to be partially due to individual differences in specific and temporally persistent behavioral traits that exist and serve as raw material upon which the law of effect (or any other related law) acts. Behavioral genetics and related fields have discovered many of the laws relating genetic contributions to these traits (and hence to both perspective and discrimination), demonstrating that traits exhibited by the current organism produce a tendency for trait absorption in some contexts, trait rebuffing in others, and, if being rebuffed is not an option, activity to change the true context, apparent context, or both in a way that matches the traits and perspectives of the current organism. These forms of *niche-picking* (including niche-rejection and niche-building) appear, as before, to be a joint product of innate behavioral dispositions, preferences, and abilities, the developmentally and

experientially acquired behaviors of the organism, the current physiological (motivational) state of the organism, and the adaptive problems that it encounters in the environment.

With this in mind, consider within-species situations. Four major categories of within-species situations exist – within-sexual situations composed of the adaptive problems that (1) a male presents to another male and (2) a female presents to another female; and between-sex situations composed of the adaptive problems that (3) a male presents to a female and (4) a female presents to a male. These adaptive problems may be competitive, cooperative, or any combination of the two. The form of the adaptive problems offered by within-species situations will be determined by factors such as the degree of perceived relatedness and the developmental stages of the participants. ‘Recognizing’ and responding appropriately to a situational category is called discrimination. Hence, contextual discrimination sets the stage for the activation of various schema, strategies, and behavioral tactics.

Focusing on behavior, a given tactic within any given context may produce conflicting outcomes. For example, certain behaviors within the confines of a within-sexual situation involving two males may reap consequential immediate costs but simultaneously reap consequential benefits in an encompassing within-species situation (e.g., injurious fighting may produce reproductive gains). Conversely, certain behaviors within the confines of, for example, a between-sex situation may reap consequential immediate benefits but simultaneously reap consequential costs in an encompassing context (e.g., immediate sexual activity produces immediate gains but consequential opportunity costs in the long term). Those contexts that involve short-term gains but substantial long-term costs are labeled *contingency traps* and those contexts that involve short-term costs but long-term gains *contingency augmentations*.

Conclusion: An Integrated Overview

The evolution and development of individual differences in personality among human and nonhuman animals therefore depend upon not one but multiple selective pressures, some acting in concert, and others in partial opposition to each other. The ecological conditions prevailing at any given time determine which one of these selective pressures may be more or less influential. Thus, the evolution of individuality in behavioral dispositions cannot be ascribed to any simple, single causal factor.

Directional social selection favors the profile of personality traits that best enhance the prospects for mutually beneficial cooperative interactions within social groups; disruptive social selection favors divergent, frequency-dependent phenotypic variations that provide the most release from within-species competition from other individuals; genetic diversification of offspring can be adaptively upregulated or downregulated in response to the stochastic characteristics of environmental hazards of morbidity and mortality by manipulating the extent of sexual recombination of genetic material achieved through differential degrees of assortative mating and assortative sociality for genetic similarity, as indicated by shared heritable phenotypic traits; developmental plasticity epigenetically directs development adaptively along different alternative pathways,

depending on critical cues signaling relatively enduring states of the environment, presenting differing adaptive problems, and modifies permanent and stable behavioral dispositions to suit these long-term contingencies of survival and reproduction; behavioral flexibility permits the deployment of rapid and reversible short-term adaptive behavioral responses to different classes of transient situations, each presenting its own suite of unique adaptive problems.

These are *not* alternative hypotheses from which we may endeavor to select the one true causal influence shaping the evolution of individual differences in personality. They are all evolutionary mechanisms that demonstrably operate simultaneously, each exerting its own characteristic influence upon personality variation, and both the central tendencies and the dispersions of the behavioral dispositions that have been observed both between and within individuals are the joint product of their synergistic interactions.

See also: Altruism and Helping Behavior; Antisocial and Narcissistic Personality Disorder; Associative Learning; Behavior Analysis; Behavior Genetics of Personality; Behavioral Genetics; The Behavior-Genetics of Intelligence; Big Five Model and Personality Disorders; Cognition and Personality; Competition; Conflict Communication; Ecological Psychology; Empathy; Environmental Cognition; Environmental Psychology; Evolutionary Developmental Psychology; Evolutionary Psychology; Expectation; Extraversion–Introversion; Hormones and Behavior; Human Mating; Individual Differences in Temperament: Definition, Measurement, and Outcomes; Individualism; Language Development; Mate Selection; Molecular Genetics and Human Behavior; Moral Development; Operant Conditioning; Parenting; Parent–Offspring Conflict; Personality Assessment; Sex Differences; The Sense of Touch; Sex Roles; Spatial Perception.

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Evolutionary Psychology

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Glossary

Adaptation A feature of an organism's phenotype, sculpted by the process of natural selection, that performs a function that solved a problem of survival or reproduction in a species' evolutionary history.

Environment of evolutionary adaptedness The set of features of the environment (physical, social, etc.) that generated selection pressures that caused the particular design of a given adaptation.

Modularity The degree to which an information-processing system consists of specialized computational mechanisms.

Natural selection The process by which some genes are retained in a population relative to others by virtue of genes' different causal effects on their own rate of replication, leading to gradual changes in the traits of that population. The only process by which functionally complex traits arise.

Phenotype The physical characteristics of an organism. Its physical traits, as opposed to its genotype, which is the set of genes the organism possesses.

Evolutionary psychology (EP) is an approach to understanding and explaining behavior, especially human behavior. It rests on the foundations of evolutionary biology and cognitive science and has been applied to research questions across the behavioral sciences.

Principles of EP

The assumptions and logic that underpin EP begin with the basic principles of physics. Because the laws of thermodynamics dictate that matter becomes less ordered over time, configurations of matter that show order – as all biological systems do – can only be explained with the single known natural causal principle that gives rise to increasing rather than decreasing order: evolution by natural selection. Even 'simple' life forms such as viruses represent wildly improbable arrangements of atoms and molecules which, absent natural selection, would never exist. For this reason, all such arrangements of matter require explanation beyond the causal principles of physics and chemistry.

Darwin's theory of evolution by natural selection, combined with recent refinements, provides this causal explanation. Once there were entities that caused near-copies of their physical arrangements to come into existence, the ingredients of selection were present. Modern biological forms are descended from those organisms whose physical properties caused the propagation of the information that gave rise to them. The properties of the human mind, whose order represents perhaps the single greatest departure from randomness in the entire corpus of human knowledge, will ultimately need to be explained in terms of evolution.

While the social sciences have historically been – and to a substantial extent continue to be – indifferent to the idea that the phenomenon under study requires an explanation in these terms, EP begins with this idea, and in this sense can be understood as making explicit what is left implicit in other areas of psychology. For example, the precise, systematic, and useful changes to neural tissue that occur in response to information taken in from the environment – that is, 'learning' – are

prototypical departures from disorder which demand an explanation in terms of natural selection. While some have suggested that 'learning' is an alternative to evolutionary explanation, learning is the prototypical phenomenon that requires an evolutionary explanation.

Biological Function

Useful information is preserved in genes by virtue of the genes' contributions, however indirectly, to their own replication. The specific ways in which such contributions are made varies from organism to organism and from trait to trait. Genes, in concert with other genes and the environment (broadly construed) give rise to the organisms' features. The way in which the action of genes contributes to their own replication gives rise to the biological concept of 'function.' The function of a spider's web is to catch flies in the sense that its insect-catching properties – tensile strength, elasticity, bonding properties, etc. – led to the differential success of the genes causally relevant to these properties.

This idea allows a principled way to divide up the phenotypic properties of organisms, with respect to the way they are organized to execute functions in this sense. The anti-entropic process of selection occurs by virtue of the feedback between genes' effects on the world and their own replication rate. This is why organisms have features that are exquisitely well engineered to accomplish goals relevant to survival and reproduction. The engineering has been done by the process of natural selection, with modifications to the existing organization of the organism tested, tried, and sieved over generations.

In the case of the human mind, the way that nervous tissue is organized to contribute to function is by virtue of the way that it processes information. In this sense, EP merges the adaptationist program with cognitive science, locating design in the computational properties of the mind. Natural selection acted on the relationship between various computational mechanisms that developed in concert with the environment in the brains of our ancestors and the reproductive consequences of these mechanisms. The properties of these mechanisms – how they acquired information, changed in response to

this information, and structured behavior contingent on information – caused the underlying genes that gave rise to them to change in frequency by virtue of reproductive outcomes.

To evolve by the process of natural selection, then, computational mechanisms had to discharge adaptively relevant functions. These functions range from low-level perception, including the construction of a rich visual representation from sense data, to high level, including emotional systems, which dynamically activate and deactivate suites of computational mechanisms designed to cope with particular adaptive problems. Importantly, many computational devices gain advantage by virtue of adaptive flexibility, causing behavior that is contingent on local circumstances, recent, and distant history, and the individual's current state.

The central motivating question in EP is to describe the computational mechanisms of the mind.

The Environment of Evolutionary Adaptedness

The complex functional traits of organisms – adaptations – have their properties by virtue of the way their features interacted with the environment of the organism. For instance, because of the specific wavelengths of electromagnetic radiation at the surface of the Earth, photoreceptors are sensitive to particular frequencies of light. Adaptations reflect features of the environment because selection favors designs that successfully exploit the world as faced by the organism.

The set of features of the environment that existed over the course of many generations that were relevant to the function of a particular adaptation is frequently referred to as the 'environment of evolutionary adaptedness' (EEA). Rather than being a specific time or place, the EEA is a collection of properties relevant to a specific adaptation. Different adaptations, then, have different EEA's.

The composition of the EEA of an adaptation is potentially very broad, and can include any feature of the environment that was repeatedly present over the course of a species' evolutionary history and had an effect on selection. The EEA of an adaptation can encompass a wide array of properties. Physical properties, such as light, gravity, and temperature have obvious relevance to traits such as photoreceptors, balance systems, fur, and so on. There are also features of the social world that recur sufficiently frequently that adaptations are sculpted around them, such as, in humans, the presence of kin, allies, potential mates, and so on.

The EEA of adaptations depends exquisitely on how the organism survives and reproduces. Hawks' excellent visual acuity, for example, is causally related to their natural history as a high-flying predator. Adaptations reflect the features of their environment, including the physical world, the social world, and, crucially, other properties of the organism.

Currently, human environments differ in significant ways from the environments that human ancestors inhabited. Population densities are greater, food is in greater supply, technology has provided any number of new tools, and so on. Because adaptations were designed to function in ancestral environments, these environmental differences can have important effects on how they operate. For example, in the past, animal fats were not as readily available as they are today; the evolved appetite for fats – which would have led to good nutritional

outcomes in the past – leads to negative health outcomes in modern environments because of the modern abundance of high fat foods.

However, many features of the world are very much like they were in past environments. The physical properties of the world, including gravity, light, and so on, are more or less the same. The social world similarly has many properties in common with past social world, including phenomena such as kinship, friendship, membership in groups, locally relevant accumulated knowledge, and so on.

Specialization

By virtue of the competitive nature of natural selection, organisms come to have properties that more efficiently and effectively solve adaptive problems relative to alternatives. This makes the criterion by which selection acts fundamentally a matter of engineering.

Physical mechanisms' effectiveness depends on their physical properties: their structure, form, and shape. This idea was a big clue in Darwin's discovery of the principle of natural selection. The beaks of the finches on different Galápagos islands have different forms depending on the foraging problem posed by the environment because different beak shapes are best for solving different mechanical problems.

Selection drives morphological form toward greater specialized functionality. This is the case at every level of description, from cells to tissues to organs. Because of the relentless pressure of selection, better-engineered designs will tend to out-compete poorer designs. Organisms' features, therefore, reflect the principles of engineering. In particular, any given form which solves some problem or problems effectively necessarily cannot solve others: a short, stout beak, good for cracking open nuts with thick shells, is necessarily poor for reaching nuts or seeds at the ends of long, narrow tubes. For this reason, the parts of an organism tend to reflect the engineering advantages of specialization. In turn, as the parts of an organism become specialized to execute their function, they necessarily trade off the ability to execute other functions. A neuron can effectively transmit information, but cannot efficiently store calories, as a fat cell can.

The advantages to specialization inherent in engineering explains why selection, which is sensitive to even small advantages in function, tends to yield specialized structures at all levels. Functional specialization is, for this reason, the hallmark of evolution.

Modularity

Information-processing problems obey the same logic as physical problems. The particular procedures that must be applied to information to generate adaptive responses depend on the adaptive domain in question. This is why photoreceptors are designed to respond to light while hair cells in the ear respond to changes in air pressure. The differences in the transformations that must be computed depend on the function. The same logic applies to other information-processing problems. A computational device that is well designed to process information from the visual world needs to have procedures different from a device designed to process information in the auditory domain.

In the same way that natural selection sifts mutations for improvements to the forms of the organisms' parts, it also sifts for improvements to the computations that execute information-processing functions across the large number of computational tasks the mind executes. Specificity of function in information-processing yields benefits in terms of the efficiency and efficacy in solving adaptive information-processing problems, giving rise to specialization in cognitive function. This is the case for low-level cognitive functions, such as vision, and high-level cognitive functions, such as the mechanisms that underlie social behavior, such as friendship or kin-directed altruism.

Such specialization is obvious among nonhumans. Adaptive cognitive specialization has been well established for such tasks as food caching, navigation, and predator evasion.

Because organisms need to solve many different computational problems, the organisms' brains consist of a large number of specialized information-processing mechanisms. Bundled together, and deployed appropriately in the organism's context, specialized devices together solve adaptive problems effectively.

Many evolutionary psychologists refer to the specialization in function among computational devices as 'modularity.' This term is not used to connote the idea that particular functions are spatially localized in the brain's neural tissue – though it does not exclude this as a logical possibility. Instead, it refers to the idea that the mind's computational mechanisms have describable and empirically discernable functions. This view includes the notion that modules can be composed of sub-modules, and the procedures of some modules might be shared by superordinate modules.

The modular cognitive architecture postulated by evolutionary psychologists shares the advantages enjoyed by modular artificial computational systems. Modularity allows specialization – subroutines can be designed around particular, narrow tasks. This allows information processing to be efficient because the specific procedures required to solve a problem can be deployed for that particular problem.

Second, modularity, because it allows procedures to be used and combined in many ways, allows flexibility. Functionally-specialized menu-driven functions in computer applications provide a useful analogy. The large number of procedures included in modern word-processing software allows users tremendous flexibility in the content and layout of documents. As minds – humans or otherwise – come to include more procedures, these can be deployed in conjunction with others in ways that allow increasing flexibility by virtue of the combination of the functions of the various subroutines.

Similarly, modularity facilitates learning, as incoming information can be used to update variables and procedures in a systematic and useful way. How incoming information should be used depends a great deal on the domain in question. By routing information to a particular subroutine, appropriate information can be extracted, stored, or discarded, as appropriate for the task the module executes. For example, while the meaning of new words needs to be stored, the episodic details of the learning episode need to be discarded. Language learners need to retain what the word 'cow' refers to, but not the circumstances surrounding the acquisition of the meaning of the term.

Finally, modularity – both natural and artificial – allows for changes to be made in one subroutine without affecting many

different processes simultaneously. Such an architecture has an advantage because the odds of a change in one system being useful is vastly larger than the odds of a change that affects multiple systems being advantageous across all of the relevant systems.

Possible Functions

A gene that increases its own rate of replication in one environment relative to an alternative allele will not necessarily do so in another environment. So, to the extent that organisms' environments change in ways that are relevant to different alleles' rates of replication, and the relative advantage genes have over one another varies from one generation to the next, selection might not repeatedly lead to the gradual replacement of one particular allele over others because of fluctuations in the feedback loop on genes' replication.

Selection, therefore, will only lead to the accumulation of genes that fit well, in this sense, with features of the environment that are sufficiently stable to lead to the continuous upward pressure on a gene's frequency. Absent such stability, the process of natural selection will not lead to the accumulation of genes that give rise to functional elements of the organism's phenotype.

So, the only functional organization that will be observed are developmental programs that are well designed to solve adaptive problems faced by a given species' ancestors. Because natural selection is a slow and gradual process that stretches over long periods of time, the human mind consists of developmental programs that aided survival and reproduction in the past. The search for the mind's computational architecture, including the way it changes over the lifespan and in response to information in the environment, according to EP, is the search for information-processing devices that would have solved our ancestor's problems of survival and reproduction.

This view constrains hypothesis generation. The only plausible functions that EP allows are those that would have contributed to our ancestors' reproductive success. Problems that are very recent, such as the problem of over-eating by virtue of an abundant, low-cost food supply, have not been present for a sufficiently large number of generations to allow large numbers of genes to have been selected to give rise to complex, functional arrangements of the human nervous system designed to solve these and similarly recent problems.

Although the genes currently part of the human genome were selected in the past, humans can do many things that our ancestors could not. Every organism is facing an environment that is different, in certain respects, from its ancestors' environment. For example, predator-evasion mechanisms were selected by virtue of these mechanisms' value in causing potential prey to avoid and escape particular predators in the past. Those particular predators are gone, but new instances of them appear in the prey organisms' environments. Although each sea lion, in particular, is one that has not itself tested penguin predator-evasion genes, penguin minds nonetheless direct them away from these novel predators.

In the same way, the human mind interacts with many novel features of the environment. Each face is one that has never before existed, but can be parsed, stored, and recalled with mechanisms designed to do so.

Levels of Explanation

EP seeks to explain behavior at multiple levels of analysis and draws to a substantial extent on the way that researchers such as ethologist Niko Tinbergen have divided up the questions that can be asked to have a complete explanation of behavior. (Note that different research traditions cleave these levels slightly differently.)

1. *Function*: What is the mechanism that gives rise to the behavior in question designed to do so? How did the mechanism in question contribute to survival and reproduction? What was the goal of the mechanism?
2. *Computation*: What are the computations performed by the mechanism? What does the mechanism take as input, what does it generate as output, and how does it transform one to the other?
3. *Implementation*: How are the computations in (2) physically implemented? What neural systems are involved, and how do they give rise to these computations?

These three levels of explanation are not mutually exclusive, but rather mutually informative in both directions. For example, hypotheses about the function of a mechanism give rise to hypotheses about the computations necessary to execute that function. Similarly, knowing what computations a mechanism embodies gives clues about that mechanism's function. Similar logic applies with respect to neural implementation.

Consider a simple mechanism such as a typical thermostat. The function of a thermostat is to regulate temperature (Level 1), and this function explains why it has its particular form and why it carries out the computations that its form embodies. In particular, it performs its function by detecting the surrounding temperature, comparing this to the user's setting, and then causing a heater or air conditioner to turn on or off depending on this comparison (Level 2). These computations are implemented through a small number of parts. One is a mechanism that changes shape depending on the temperature, often a metallic strip that winds or unwinds depending on the surrounding temperature. The movement of this strip causes a mercury switch to move in such a way so as to cause current to flow to the correct circuit, either the circuit going to the air conditioner or the one going to the heater (Level 3).

The emphasis on adaptive function as a source for hypotheses distinguishes EP from other branches of psychology. Research in EP generally considers a hypothesis about a mechanism to be incomplete without some plausible explanation that relates its computational properties to an evolved function.

Researchers in EP often, but not always, begin investigations with an idea about the function of a putative mechanism. These ideas inform the generation of hypotheses about the computational systems that would, in principle, be able to accomplish the putative function. Using the usual techniques available to social scientists (see below), evolutionary psychologists study and measure behavior to evaluate candidate hypotheses about the details of the underlying computations. Such hypotheses are constrained by the functional level of analysis.

Development

EP takes a view of development that is like the view of development found in biology, an explicitly and fundamentally interactionist position, that every aspect of every organism's phenotype is the result of the interaction between the genes and the environment. On this view, genes, in concert with other genes, and the large number of relevant aspects of the organism's environment – chemical, physical, social, etc. – mutually and jointly codetermine the developmental trajectory of the organism.

This view of development fits naturally within the framework of EP because genes act dynamically, during the lifespan, over shorter or longer intervals. Selection, therefore, can be viewed as favoring genes not by virtue of a direct link between a gene and an adult, static phenotype, but rather by virtue of the relationship between a gene and the environment in which it has existed and the changes, in concert with the environment, that it brings about.

In addition, practitioners in the field draw heavily on life history theory. Because the effect that particular traits will have depends on key life history variables – sex, point in reproductive career, size, and so on – genes that influence traits in such a way that they are deployed dynamically and adaptively depending on these variables will tend to have an advantage. The onset of sexual maturation, for example, varies substantially across humans, and research in EP is aimed at understanding what features of the individuals' environments or state might calibrate these maturational mechanisms. For example, recent research suggests that a social factor – the presence or absence of a male parent – influences this developmental program.

For evolutionary psychologists, development includes learning, the particular ways in which incoming information is processed, leading to useful changes in the organization of the mind. A key element of the way research on learning is conducted from an evolutionary perspective mirrors the way it is conducted in biology: different mechanisms underlie different domains. In the same way that jays can store and recall the location of thousands of food caches, requiring dedicated mechanisms to accomplish this feat, human minds have been widely viewed, particularly since Chomsky's famous analysis, as requiring specific learning mechanisms to acquire natural language. Other domains of learning, such as faces, similarly seem to have their own developmental system.

The details of the different learning systems for other domains are a source of ongoing research. Some evolutionary psychologists are exploring the way certain facets of cultural information, such as religious ideas, are generated, stored, and transmitted by human minds. By understanding the functions of learning systems, evolutionary psychologists contribute to the understanding of the details and texture of local, population-specific artifacts, ideas and accumulated knowledge, or 'culture.'

Possibly because evolutionary psychologists believe that genes are, in addition to the environment, a critical causal force in development, researchers in this tradition are sometimes mistakenly taken to assume that genes are the only crucial causal force in development. However, EP does not hold that any feature of the mind is 'innate' in the sense that

it develops independent of the environment. Evolutionary approaches do, however, hold that certain traits tend to develop in similar and reliable fashion, given relatively broad regularities in the developing person's environment. In the same way that every normal human begins as a cell and comes to have four limbs, certain features of the cognitive architecture tend, with appropriate nutrition and input from the (social) world, similarly tend to develop reliably. This occurs by virtue of selection acting on genes that cause these developmental trajectories, preserving those genes that, in normal environments, lead to these (adaptive) outcomes.

Research in EP

EP crosscuts traditional subdisciplinary boundaries, and the approach is applied to areas such as decision-making, development, economics, language, perception, social life, and so on. Researchers in EP, therefore, use methods that vary, making use of the techniques that are most useful given their particular domain of study.

Independent of the domain of study, however, research in EP is not qualitatively different from research in other areas. The same commitment to hypothesis testing, falsification, quantification, and the other details of how science is currently practiced is found in EP.

There are, however, a small number of differences between EP and practices in other areas. Because most branches of the social sciences do not engage with the notion of evolved function, evolutionary psychologists are more constrained in their hypothesis space than are their colleagues in the social sciences, who omit this analysis. This difference explains why the style of explanation for the same phenomenon is often very different in standard social science and evolutionary social science. While standard social science explanations tend to begin with constructs such as 'expected utility' or 'self-esteem,' evolutionary explanations tend to begin with the notion of a goal or a target with implications for survival and successful reproduction.

Standards of Evidence

A difference between EP and subbranches of the social sciences is that evolutionary psychologists develop hypotheses about *function*. In terms of the epistemic commitments of the field in evaluating the evidence for a given function, the field follows the practices used in evolutionary biology as famously laid out in George Williams' seminal work, *Adaptation, and Natural Selection*.

Williams' focal argument is that arrangements of matter that are improbably well organized to bring about beneficial outcomes (with respect to fitness) can have only natural selection as their causal antecedent. This gives guidance in evaluating hypotheses about evolved function. In particular, any given hypothesis about the function of some aspect of an organism's phenotype is supported by evidence that the phenotype has properties that make it particularly – and improbably – useful for executing the function.

In this sense, Williams' analysis is no different from the intuitive analysis that people bring to bear in evaluating

artifacts. A thermostat is recognizable as an artifact designed to maintain the temperature in a room because its properties can be seen to be designed around this function.

Biological forms can be similarly analyzed in the service of distinguishing among putative functional explanations. The eye is frequently used as an example. Of the tremendously large number of forms that cells and tissues can take, the transparency of the lens and the receptivity of the retina to light make it surpassingly unlikely that these structures came about by any process other than selection for the conversion of light from the environment into a representation of the physical world which can be used to guide behavior.

Because we know what nervous tissue is for – processing information and producing useful behavior – it is possible to evaluate the function of the mind's components in the same way. By observing behavior, inferences are possible about the computational mechanisms that give rise to it. By documenting the nature of these mechanisms, putative evolved functions of these component mechanisms can be systematically evaluated.

Just like the transparent lens of the eye – whose soft tissues left no fossil remains – behavior can be evaluated within the framework of adaptationism because of the relationship between complex functional features of the organism and natural selection. Improbably useful computational mechanisms for a particular function lend weight to an explanation in terms of that function in a way that mirrors the improbably useful arrangement of matter that constitutes the eye.

Hypotheses in EP are not about the history of the mechanism in question. To say that the eye is for seeing – that this is its function – is not to commit oneself to any specific hypothesis about the evolutionary history of the eye outside the claim that the current structure of the eye can be understood – and is explained – by virtue of its function of seeing. Hypotheses in EP are about the computational mechanisms of the mind – about cognitive architecture – just like hypotheses in physiology are about the mechanisms of the body, and the same evidentiary criteria apply.

Hypotheses about evolved function are similarly not about how traits contribute to reproductive success in modern environments.

Connections to Other Fields

The principles of EP can be applied to any discipline that studies behavior. For example, economists study human behavior in the context of the exchange of goods and services, as well as other behaviors that fall under the aegis of the discipline as currently constituted. The cognitive mechanisms that give rise to economic transactions are no more or less the product of evolution by natural selection than other mechanisms of the mind, and are therefore just as amenable to the adaptationist analysis developed by evolutionary psychologists.

The same argument holds for the subdisciplines of psychology – cultural, developmental, clinical, etc. – and the other disciplines neighboring psychology that take human behavior and its consequences as the objects of its study, such as anthropology, political science, and sociology.

EP is related to, but distinct from, the field of behavior genetics. Researchers in behavior genetics are interested in the

role that genes play in the development of behavioral traits, and frequently are interested in the heritability of such traits, the extent to which differences among individuals in a particular population are due to differences in the genetic endowment among those individuals compared to differences in those individuals' developmental environments. While evolutionary psychologists are also interested in variation among individuals and the origin of this variation, individual differences are frequently used as a window to help understand how mechanisms are designed to change in functional ways depending on the environment. For example, calluses form as a result of continual friction or pressure on the skin. They reflect the operation of a mechanism designed to protect the skin in the particular areas which are subject to repeated insult. Variation among individuals reflects the operation of a mechanism shared in common across the human species, leading to differences in the phenotype by virtue of the different activities in which individuals engage.

The same is true of computational mechanisms. While every normally developing human has a mechanism that is capable of acquiring language, the details of the developmental environment in which someone grows up will determine which particular language is learned. The language-learning system, like the callus-production system, is designed to lead to a different phenotype depending on the environment in which the organism finds itself.

Controversies in EP

In *The Blind Watchmaker*, Richard Dawkins wrote, "I suppose one trouble with Darwinism is that, as Jacques Monod perceptively remarked, everybody thinks he understands it" (p. xv). A similar remark could be made about EP. The field has been criticized harshly by members of the scholarly community and the lay public. However, while there are of course many issues that are controversial and many active debates in and around the discipline, substantial amounts of controversy surrounding the field are illusory rather than substantive.

Genetic Determinism

Many critics of EP argue that the environment is crucial for understanding human behavior, and that EP ignores this fact. Along similar lines, critics have argued that the brain is flexible, rather than 'hard wired.' However, the evolutionary view holds that every aspect of the phenotype is jointly caused by genes and the environment and that selection will act to give rise to developmental mechanisms that respond contingently and adaptively to the environment. This criticism, therefore, is directed at a position not held by mainstream practitioners in the discipline.

Unfalsifiable Hypotheses

Critics of EP have charged that EP consists of unfalsifiable hypotheses, and so is unscientific. As indicated above, EP follows the usual standards of scientific practice. One source of confusion might have to do with the nature of hypotheses in EP. Critics frequently make the argument that hypotheses

about a particular evolutionary history cannot be falsified or verified because there is no fossil evidence of behavior. Independent of the question of whether one can generate evidence regarding the evolutionary history of computational devices, this argument proceeds from the false premise that hypotheses in EP are about history, rather than design.

Adaptation and Optimality

In some critiques of the field, it has been argued that it is important to realize that evolution gives rise not only to adaptations, but also byproducts – that is, aspects of the phenotype that do not themselves have a function but are simply side-effects of the functional parts of the phenotype. An example of a byproduct is the color of the liver: its hue does not contribute at all to its function, and is merely a side-effect. The argument is that not all aspects of the phenotype, including the computations carried out by the brain, are functional.

This critique represents a correct description of the way that evolution by natural selection operates – it is inevitable that any device that has a function will have properties that do not themselves contribute to that device's function. However, this idea is a crucial component of the discipline. Following George Williams (see above), evolutionary psychologists assume that there are large numbers of byproducts, and take the claim that some mechanism is an adaptation to be a strong claim, requiring design evidence.

A related critique focuses on the fact that evolution does not yield designs that are optimal, perfectly sculpted to execute particular functions. This is indeed the case for well known reasons, such as the possibilities of local fitness maxima, historical and developmental constraints, engineering tradeoffs, rapidly changing environments, continuous mutation pressure, and so on. Evolutionary psychologists do not claim that designs are optimal for such reasons.

Finally, some have critiqued EP by observing that adaptation by natural selection is not the only source of genetic change over time. For example, there is also a genetic drift, a process by which some genes increase or decrease in frequency by virtue of random processes as opposed to the differential retention of alleles by virtue of the effect on reproductive success. While genetic drift can lead to changes in gene frequencies, this process does not cause increasingly functional aspects of the phenotype to arise. Because evolutionary psychologists are interested in the functional architecture of the mind, processes that do not have a causal influence on the object of their study are ignored. Researchers in EP do not often consider genetic drift for this reason.

Modularity

Some critics have taken issue with the idea of modularity, a key element of the discipline as practiced by a number of researchers. The criticism is frequently made that the observation of the many ways in which the human mind shows flexibility undermines the notion of modularity. These criticisms derive from a misunderstanding of the word 'modular.' Critics take the word to mean something like solid blocks or slabs, as if the metaphor were taken from architecture, whereas the term is used in the literature in the field to mean that the mind consists of a

large number of functionally specialized computational mechanisms, in a way that mirrors the use of the term in computer science.

More generally, having a large number of specialized information-processing mechanisms increases, rather than decreases flexibility. This is seen most easily by analogy with modern software. When word-processing programs have more features included, this makes them able to do a larger number of tasks, not a smaller number of tasks.

The debate surrounding modularity, though often derailed because of confusion over the meaning of the term, masks a genuine point of debate. The precise function of any given psychological mechanisms is of course an empirical matter. A good example is the debate in face-recognition: is the mechanism that executes this function designed for faces, in particular, or a larger class of stimuli? Careful experiments have converged on a close specification of the function of this system.

Ongoing research will be needed to identify the functions and computations of the modules of the human mind, a central component of the agenda of EP.

See also: [Evolutionary Clinical Psychology](#); [Evolutionary Developmental Psychology](#); [Evolutionary Social Psychology](#).

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www.hbes.com – Human Behavior and Evolution Society.
<http://evolution.anthro.univie.ac.at/ishe> – The International Society for Human Ethology.

Evolutionary Social Psychology

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Glossary

Domain specificity A theoretical position that presumes that people have evolved separate specialized mechanisms to help them solve different recurring problems, such as how to get a mate or protect oneself from physical harm.

Environment of evolutionary adaptedness (EEA) In evolutionary theory, it is the environment in which the brain evolved. There may be different EEAs for different adaptations.

Inclusive fitness The survival of one's genes in one's own offspring and in any relatives one helps.

Life history theory A theory that suggests that organisms adaptively engage in different behaviors and hold different goals depending on key maturational and

productive characteristics, such as age and reproductive potential.

Natural selection The process by which characteristics that help animals survive and reproduce are passed on to their offspring.

Parental investment Any energy, time, or resource expenditure by the parent for its offspring. Parental investment theory says that the more investing sex (in mammals, this is usually the female) will be the choosier sex in terms of who to mate with. The other sex must then compete for mating opportunities with the choosy sex.

Sexual selection A form of natural selection favoring characteristics that assist animals in attracting mates or in competing with members of their own sex.

Evolutionary Social Psychology

Evolutionary social psychology is based on a straightforward premise: people's interactions with one another are influenced by mental and emotional mechanisms shaped by natural selection. From this perspective, people's thoughts, feelings, and behaviors toward their families, friends, and enemies can be better understood by considering what biologists have learned about other animals and what anthropologists have learned about people in other societies. In a classic example of this approach, Charles Darwin suggested in 1872 that emotional expressions served an adaptive function – to communicate one person's motivations and intentions to others. For example, expressing anger can decrease the odds of a physical conflict, while smiling can increase the odds of cooperation. Along with physical features such as upright stance and opposable thumbs, evolutionary theorists assume humans inherit brains equipped with mechanisms for managing movement through both the physical world (e.g., seeing in color, discriminating sugars from poisonous alkaloids) and the social world (e.g., speaking languages, bonding between mother and infant).

From an evolutionary perspective, all recurrent human social behaviors reflect the influence of physical and psychological predispositions that helped our ancestors survive and reproduce. This is not to say that every individual social behavior is successful in promoting survival and reproduction, and it does not necessarily imply that people (or other social animals) consciously think about survival and reproduction. It does imply, however, that any social animal's brain is composed, in part, of mechanisms that helped its ancestors succeed in interactions with other members of its species. Thus, humans' reactions to other humans are presumed to reflect the influence of mechanisms shaped to solve the kinds of problems and opportunities our ancestors regularly encountered. Human behaviors are not presumed

to be robotically determined by instinctive mechanisms over which we have no conscious control or which are impervious to environmental inputs. People can and often do exercise control over powerful and fundamental emotional and motivational inclinations, including anger, fear, and sexual arousal. Furthermore, most mental mechanisms reflect the operation of flexible trade-offs, determined in interaction with current environmental conditions and past learning experiences. Although flexible, the influences of evolved predispositions (such as hunger, thirst, sexual arousal, and anger) are nevertheless powerful vectors in our decision making.

To understand the importance of evolved mental mechanisms, it helps to step back from our own species and consider the interaction between other animals' bodily features and their environments. Orca whales, for example, though related to cows, would not do well with a cow's brain, since an Orca's brain must control a body that tracks prey in the ocean rather than eating grass in a meadow. Likewise, bats, though also mammals, need brains designed to run tiny bodies that fly around catching insects at high speeds in the dark. Because all organisms' brains are composed of mechanisms evolved to deal with recurrent environmental threats and opportunities, evolutionary theorists ask: What are the implications of human evolutionary history (e.g., living in omnivorous and hierarchical primate groups populated by kin) for the design of the human mind? Evolutionary social psychologists focus on the subset of questions dealing with recurrent social conditions of human life, and their hypotheses reflect anthropological data about social interactions common in societies around the world (e.g., close relationships with family, dominance hierarchies, long-term bonds between parents, common dangers from other groups competing for resources and territory, etc.), as well as general principles derived from placing humans in the context of other species confronting diverse adaptive problems.

Multiple Levels of Causal Analysis

Biological theorists have stressed the importance of differentiating between causal explanations of behavior involving evolutionary history, adaptive function, ontogenetic development, and proximate determinants. For example, consider the question of why human mothers nurse their offspring. This can be addressed at four different levels of analysis. (1) *Historical* explanations consider *ancestral roots* of behaviors. Researchers adopting a historical perspective might consider human nursing in the comparative context of other animal species. Unlike human language, nursing capacity does not pose much of a historical puzzle, since all primate females nurse their offspring, as indeed do all mammals. (2) *Functional* explanations, on the other hand, are concerned with ultimate *adaptive purposes* of behaviors. A functional explanation might suggest that mothers nurse offspring because it increases offspring survival rates. (3) *Developmental* explanations are concerned with *lifespan-specific inputs* that sensitize the organism to particular cues. A developmental explanation might suggest that mothers nurse offspring because pregnancy and childbirth trigger puberty-dependent shifts in hormones and milk production in mammalian females. (4) *Proximate* explanations focus on *immediate triggers* for particular behaviors. A proximate explanation might suggest that nursing occurs because an infant has begun suckling on the female's nipple, which leads to immediate hormonal changes inside the mother which stimulate milk release.

Sometimes, there are obvious connections between the different levels of analysis. In the case of nursing, developmental changes in lactation capacity accompany other changes during pregnancy; the infant, who receives obvious functional benefits from nursing, triggers the proximate release of milk. But connections between different levels of analysis are not always obvious. Consider why birds migrate each year. A proximate explanation is that birds migrate because days are getting shorter – the immediate cue triggering migration. The functional reason for such migration, however, is survival and reproduction: the distribution of desirable food and mating sites varies seasonally. There are two key implications here: (1) animals, including humans, need not be consciously aware of the ultimate functions of their behaviors and (2) the connection between long-term goals and immediate goals is often indirect and unobvious.

An explanation at one level of analysis must be compatible with explanations at other levels. Positing a proximate or developmental mechanism that reliably leads people to make functionally maladaptive decisions (such as Freud's death instinct) is problematic. Evolutionary psychologists typically advance hypotheses about links between proximate mechanisms and adaptive function, not about the historical roots of the mechanism. In deriving those hypotheses, however, psychologists adopting an evolutionary perspective attempt to take into account pertinent findings from evolutionary biology and/or anthropology. Psychologists can derive hypotheses about proximate causes and development without thinking in evolutionary terms, but disregarding evidence and theory derived from research on other cultures and other species can lead to hypotheses incompatible with other levels of analysis.

For example, psychologists during the last century often assumed most sex differences in social behavior (such as differences in violent aggression) were products of 'American culture,' being unaware that similar differences were found in other cultures, and even other species.

Historical Background of Evolutionary Social Psychology

The evolutionary perspective on human social behavior represents the convergence of several streams of influence. One contribution came from the field of ethology – the study of the behavior of animals in their natural habitats. In 1973, three European ethologists (Niko Tinbergen, Karl Von Frisch, and Konrad Lorenz) were awarded a Nobel Prize for their work on the adaptive significance of animal behaviors. Tinbergen studied how stickleback fish respond with complex behavioral displays to other sticklebacks (e.g., males demonstrate an aggressive display on seeing a red underbelly on another male, and the mechanism can be tricked by using 'supernormal stimuli' – fishlike shapes with bright red paint on the underside). Von Frisch demonstrated that bees engage in complex communications – informing other colony members about the location of nectar-bearing flowers. Lorenz conducted research on imprinting, the process by which young geese became attached to their mothers. Each of these lines of research demonstrated an interaction between an innate mechanism and inputs from the social environment.

In humans, language seemed a beautiful example of instinctive preparedness interacting flexibly with environmental inputs. Comparative linguists had uncovered evidence that languages the world over have a similar underlying grammatical structure, developmental psychologists found that children make similar linguistic mistakes, regardless of the language they are learning, and the languages spoken by adults everywhere were found to be equally complex, regardless of the speaker's education level. Paralleling Lorenz's work on animal imprinting, developmental psychologists had found that young children go through predictable phases in their relationships with parents and strangers (such as a fear of strangers that peaks around 9 months) and that infants engage in complex nonverbal mimicry of their mothers. Paralleling Tinbergen's research on fixed action patterns in sticklebacks, research uncovered a sequence of nonverbal flirtation gestures in societies around the world and revealed that children born blind and deaf, nevertheless, demonstrated appropriate facial expressions in appropriate contexts (smiling when tickled, for example).

The ethologists' research made it clear that much so-called instinctive behavior (such as imprinting) involved what biologist Ernst Mayr called 'open instincts' – innate proclivities requiring environmental inputs to be fully operative. Although a fixed sequence of movements is fine for mating rituals, some innate predispositions require flexibility to be useful. For example, animals need a rapid response system for avoiding other dangerous animals and poisonous foods, but exactly which other species in the local environs pose threats is often quite variable over the range in which they might be born

(consider young English sparrows which, like humans, may be born in deserts, forests, farmlands, or cities on several continents). Hence, those avoidance systems need to be calibrated to reflect local threats.

Psychologists studying learning in the laboratory had presumed that mammals possessed only a very few innate drives (such as hunger and thirst, often referred to as 'primary drives') and that experiences after birth led to the development of 'secondary drives' (desires for other stimuli associated with satisfaction of hunger and thirst). The development of secondary drives was believed to depend on two simple forms of learning – classical and operant conditioning, the rules of which presumably applied similarly to many kinds of learning across many species. This view had the advantage of being parsimonious, meaning it could explain much with few assumptions. However, several behavioral psychologists began to uncover findings challenging this view. The rules of conditioning changed depending on what was being learned and which species did the learning. Consider the rules involved in learning to avoid unpleasant experiences. Some learning requires instantaneous feedback (e.g., a jolt of pain immediately after touching a hot stove facilitates learning not to touch it again); however, people and other animals also learn to avoid foods that made them sick many hours after the food was eaten. Food aversion is also unlike many other types of learning in that it requires only one trial and is difficult to extinguish once learned. Furthermore, the types of stimuli that get conditioned to nausea vary in ways consistent with the organism's evolutionary history and typical ecology. For example, rats have poor vision and rely on taste and smell to find food at night, and they easily condition aversions to novel tastes, but not to novel visual stimuli. Quail, on the other hand, have excellent vision and rely on visual cues in food choice, show the opposite bias – conditioning easily to visual cues but not to taste.

Although not many social psychologists were radical behaviorists, most shared the assumption that social behaviors were products of individual learning experiences and not innate mechanisms. However, two other influences at the time began to challenge that simple empiricist worldview. Behavioral geneticists were uncovering evidence that complex human behaviors could be passed on genetically. For example, twins reared separately shared many adult personality traits, including rare forms of psychopathology, whereas adopted children shared surprisingly few such traits with the families in which they were raised. At the same time, advances in cognitive science, including the study of artificial intelligence, were beginning to suggest that complex cognitive processing could be programmed from very simple 'on-off' components. The culmination of these new research directions coincided with the emergence of several key concepts – life history theory, sexual selection theory, and parental investment – that are now cornerstones of evolutionary research. In the next section, we discuss each of these theories in detail.

Life History, Parental Investment, and Sexual Selection

Studying the array of unique adaptations found across the animal kingdom has uncovered several general principles

governing the evolution of diverse traits. One powerful set of principles is embodied in *life history theory* – which assumes that all organisms must resolve a key set of trade-offs throughout their lives. Central trade-offs involve allocating energy to development versus mating versus parenting (effort spent on attracting mates is effort that cannot be spent on caring for young, for example). Depending on ecological factors, different animals allocate effort very differently across their life-spans. Some fish, for instance, change from small drab females into large colorful males if a territory becomes available. Some small mammals start reproducing weeks after they are born, others wait decades. Some animals (such as salmon) reproduce in a single grand effort; others (such as elephants) reproduce repeatedly over their life-spans. Human life history involves a long period of somatic development, earlier sexual maturity in females than in males, and more lifespan mating effort by males than by females.

Why do females and males within species often have different life histories? Part of the answer has to do with *differential parental investment*, which usually involves greater amounts of offspring care by females. In mammals, for example, females carry developing young inside their bodies and nurse them after they are born. Within a species, the sex investing less in offspring tends to compete for mating opportunities with the higher-investing sex. Because mammalian females always pay a high price for reproduction while males may contribute little or nothing to offspring care, females are relatively more selective in their choice of mates. This is linked to *sexual selection*, which refers to the relative success of traits that assist in mating (by helping either to attract the opposite sex or to compete with one's own sex). Darwin developed the idea of sexual selection to address the fact that one sex is often larger, more colorful, and more competitive than the other (sexually dimorphic). A peacock's bright feathers increase his chances of attracting peahens as mates while at the same time making him more susceptible to detection by predators. Females do not need ostentatious ornamentation displays because they make a higher investment in the offspring and are therefore choosier about their mating partners (who must consequently compete with other males to be chosen). These evolutionary concepts can be applied to numerous and diverse aspects of human thought and behavior. In the next section, we consider how an evolutionary framework can shed light on many different types of human relationships.

Evolutionary History and Human Relationships

For most of human evolution, our ancestors lived in groups of about a hundred people who were often related to one another. Thus, human cognitive mechanisms were designed not for life in modern cities but for coexistence in small hunter-gatherer groups. Because hunter-gatherers everywhere faced some similar problems and opportunities, evolutionary theorists expect to find a number of human universals beneath the surface diversity of modern cultures. We consider some of the functions that relationships might have served in ancestral human groups, focusing on six domains of social interaction: affiliation, status, self-protection, mate search,

mate retention, and kin care. Each domain is characterized by different problems and opportunities and each is likely to operate according to slightly different sets of decision-making rules.

Affiliation

Research on hunter–gatherers suggests that social alliances may have been critical to our ancestors' survival and reproduction. Anthropologists studying modern hunter–gatherers, such as the Ache of South America, find that the likelihood of capturing game is often quite low on any given occasion for any given individual. If one individual catches a large fish or a deer, however, it is often too much to consume alone and will rot if not shared. By sharing, individuals help other members of the group survive and accrue credit for the future when their own luck is down. Furthermore, people in cooperative networks can accomplish tasks that none of them could easily do alone (such as hunting large game).

There are costs as well as benefits to alliances: it takes time and resources to help other people, and those people might want to take more than they give in return. Group members also compete with one another for food, status, or mates. How much to cooperate, and with whom, is influenced by two powerful evolutionary principles – *inclusive fitness* and *reciprocity*.

Inclusive fitness refers roughly to an organism's success in getting its genes into future generations. The term 'inclusive' refers to the fact that fitness is measured not simply by the number of offspring an organism produces but also by contributing to the success of relatives. Hence, all living organisms, including humans, are expected to cooperate more readily with close relatives. There are many examples of inclusive fitness in nonhuman animals. For instance, Florida Scrub-Jays often stay at the nest to help their parents raise new offspring for at least 1 year. In human hunter–gatherer societies, individuals tended to be closely related, and even in modern societies, people spend most of their lives in close contact with kin.

Human beings are also cooperative and generous with people who are not related to them. *Reciprocal altruism* involves kindness toward nonrelatives whom one expects to be beneficial to oneself in the future. Unlike relationships with kin, people are more sensitive to violations of reciprocity when unrelated individuals are involved. Indeed, people are exquisitely sensitive to other people's violations of social contracts, to the extent of being able to solve difficult logical problems if those problems are framed as involving potential cheating.

Status

Human beings everywhere arrange themselves into status hierarchies. There are costs associated with achieving status, but high status individuals are compensated with greater access to resources. For males, there are additional benefits in gaining status, since females are more likely to mate with higher status males. Consistently, men around the world are more likely to compete for status, sometimes violently. Such competition is most pronounced among young unmated males and tends to decrease once a male gains social position and a mate.

Self-Protection

Ancestral humans frequently confronted dangers from members of other groups, and occasionally from members of their own groups. A number of cognitive biases suggest that people are especially alert to possible threats from others. Males posed, and continue to pose, greater threats of physical violence. Consistently, people are especially rapid at detecting angry facial expressions on men's, as opposed to women's faces. People are also biased to perceive intentions of threat more readily in members of outgroups and surprisingly good at remembering angry males from threatening outgroups. Consistent with the fact that our ancestors were more defenseless in the dark, ambient darkness increases threat-related prejudices against stereotypically dangerous groups. When feeling threatened, people are more likely to band together with ingroup members.

Mate Search

Differential reproduction is the central driving force of evolution. We are here today because our ancestors were successful at mating. For most mammals, courtship involves mostly males competing for the attention of females. This is because mammalian males usually contribute little beyond sperm to their offspring, making female parental investment (and consequent choosiness) much higher. Humans are mammals, which means (a) women are physiologically equipped to raise offspring without help from men and (b) men could, conversely, father offspring with no investment beyond sperm. Unlike most mammals, however, human offspring are born helpless and require more than the usual amount of parental care. In species with helpless young (such as most birds), a common pattern is for males to contribute to offspring care. Although there are many instances of human females raising offspring without male help (the typical mammalian pattern), more common across human cultures is some degree of paternal investment in the offspring.

When males contribute to offspring, they tend to become more selective in choosing mates. Human beings adopt different mating strategies, which seem to be sensitive to levels of parental investment. For casual sexual relationships, males are relatively unselective about mating, whereas females favor especially symmetrical and healthy males (the more typical mating pattern). For longer-term monogamous relationships, in which men make a high investment, men become similar to women in being relatively more selective about their mates. Nevertheless, because mothers and fathers contribute different resources to the offspring, each sex seeks slightly different characteristics in a mate. Men seek traits that would have been associated with fertility (such as relative youthfulness and low waist-to-hip ratios). Women, on the other hand, are generally attracted to men demonstrating dominance and social status.

Mate Retention

Keeping mates involves a different set of challenges and opportunities than choosing them. Both sexes are expected to be alert to other members of their own sex who might disrupt their

relationships. Women are attentive to other women who are highly attractive, men to other men who are socially dominant. Because fertilization occurs inside the female's body, mothers are always certain that their children are their own, whereas men risk investing resources in other men's offspring. Women are at risk for losing their partner's investment of resources and ought to be relatively more concerned that interloping females might establish a long-term relationship with their partners. Consistently, women are, compared with men, more jealous of their partners' deep affectionate relationships and relatively less jealous about casual sexual contacts. These sex differences are relative rather than absolute – neither sex welcomes either sex or love between their partner and another.

Kin Care

Following principles of inclusive fitness, one expects to find relatively less tit-for-tat exchange and more communal sharing of benefits among close relatives. People are indeed more willing to help others with whom they share genes, and such aid takes into account their relatives' reproductive potential. While a 40-year-old woman is equally related to her 17-year-old daughter and her 70-year-old mother, she would be expected to invest more resources in her daughter (whose reproductive potential is high) than in her elderly mother (who, though capable of providing indirect benefits of grandmothering, has no direct reproductive potential remaining). One study examined the impact of such considerations on grandparental effort, finding relatively more investment by mother's mothers, for whom there are no uncertain paternal links involved. On the other hand, investments in sons' children were relatively high if a grandmother did not have (more certain) grandchildren via a daughter.

Evolution and Social Information Processing

The evolutionary perspective was emerging during the period when the social cognitive perspective came to predominance in social psychology. Cognitive and evolutionary perspectives are not just compatible; a full understanding of human nature requires an *integration* of the two perspectives.

In line with this perspective, recent research suggests that human memory is functionally designed to enhance fitness. For instance, people were better at remembering words when they were related to prototypical survival scenarios than nonfitness-relevant control scenarios. In addition, some gender differences in memory and cognition have been speculated to be the result of the sexual division of labor between hunting and gathering in the environment of evolutionary adaptedness. Specifically, men are speculated to have evolved cognitions suitable for hunting while women evolved parallel processes for foraging.

Harking back to Darwin's evolutionary view of emotional expressions, another person's anger is a very functionally relevant stimulus, foreboding potential harm. If that other person is a male, the dangers are substantially higher: males commit ~90% of homicides; even when females do commit murder, it is often a self-protective response to male harassment. Males are also more likely to do physical damage if they strike someone. Women, on the other hand, are more likely to afford

cooperative opportunities to others. Consistent with functionally derived hypotheses about emotion recognition, people not only identify whether a face is angry or happy in a fraction of a second but are also significantly quicker and more accurate at recognizing anger on a male than a female face and happiness on a female face. Interestingly, the reverse is also true – people can identify a face as male or female in a fraction of a second, but are significantly faster at identifying a face as male if it is angry, and as female if it is happy.

In another series of studies linking attention, encoding, and memory, participants were shown crowds of faces containing attractive and average-looking people of both sexes, and later asked to remember which faces they saw. Findings from an eye tracker study indicated that both sexes looked relatively more at attractive women. When asked to judge the frequency of attractive women in a crowd, both sexes overestimated the number if the crowds were presented rapidly, suggesting that attractive women are more immediately cognitively accessible. Consistently, people of both sexes are good at remembering whether or not they have seen a particular attractive woman before. For attractive male targets, on the other hand, there is an interesting disjunction between different levels of processing. Women (but not men) attend more to good-looking guys, but then neither remember them well nor overestimate their frequency in previously presented crowds. These findings make sense in terms of male and female mating strategies discussed earlier. For men, strange attractive women are mating opportunities. For women, who are typically more inclined toward long-term relationships with familiar men, and who typically do not make advances toward strangers, there is less inclination to devote processing time to strange attractive men.

Another study in this program used functional logic to reconsider a bias in memory linked to 'outgroup homogeneity' and the failure to remember individual members of other racial groups. In functional terms, it makes sense to make finer discriminations between members of one's own group (with whom one has more frequent and more cooperative interactions). However, there are also times when it makes functional sense to pay close attention to, and remember the identity of, members of other groups, for instance, when those individuals might pose threats to one's welfare (members of outgroups often have less motivation to inhibit aggressive inclinations than members of one's own group). Consistent with that logic, the standard outgroup homogeneity effect reverses when White participants are asked to remember faces of angry, but not neutral, Black men. In this section, we have considered cognitions and behavior on the individual level; however, an evolutionary perspective can also help us understand group level behaviors. We touch upon this idea in the following section.

Social Dynamics and the Emergence of Culture: The Mind as a Coloring Book

Evolutionary social psychology is one component of a broader interdisciplinary movement toward integrative science. Dynamical systems theory is another attempt to combine ideas from biology, mathematics, computer science, and cognitive psychology. Two fascinating conclusions have emerged from

research on complex systems ranging from ant colonies to world economies. Dazzling fractal images represent one lesson of dynamical systems theory: awe-inspiring complexity can emerge from a few variables interacting according to a few simple rules. Such emergent processes can be intellectually overwhelming, but there is another side to the story. Complex systems at every level from molecules to genes to neurons to ecosystems often reveal *self-organization* – order emerging out of initial disorder.

Exactly which patterns of self-organization arise in complex systems depends on simple decision rules at the individual level. Combined with ideas from evolutionary domain-specificity, this helps explain why different patterns of social organization arise in different aspects of social life, such as the hierarchies associated with status, dyadic pairings associated with mating, and large aggregations associated with inter-group conflict.

This work has important implications for another area of modern social psychology: the emergence of cultural norms. A dynamical evolutionary approach helps us understand how cultural norms encompass underlying universal biases as well as diverse cultural norms. For example, most human societies involve a greater number of marriages between older men and younger women than the converse, as discussed. There are however, a few societies, such as Tiwi aborigines of Australia, in which older women marry younger men. On closer examination, those societies do not involve exceptions to underlying human nature but a new dynamic emerging from multiple evolved biases. Men in Tiwi society are in fact attracted to younger women and Tiwi women are attracted to older, high status men. The Tiwi arrangement is an accommodation to another general feature of human social life – male competition for status – and emergent patterns of patriarchy. In Tiwi society, older men have all the power, and since they are polygynous, they betroth their daughters to other patriarchs, who reciprocate. This leaves the younger men out of luck. Another norm in Tiwi society, however, is that all women – of all ages – must be married. When an older woman becomes widowed, she must remarry, but the older patriarchs with younger wives do not wish to marry her. Instead, she marries a younger man, who thereby does a favor for her older male relatives and puts himself into the game of acquiring younger wives in the future.

These Tiwi mating arrangements suggest that the mind-culture interaction is neither captured by the Blank Slate metaphor nor by the metaphor of a predetermined blueprint. Instead, we can fruitfully conceptualize the interaction using the metaphor of a coloring book – with some predrawn lines, but a great deal of flexibility within which local colors can be recombined in diverse ways. While a coloring book can, in one sense, be colored in an infinite number of ways, it is not so passively receptive as a Blank Slate, since the outlines in a coloring book strongly suggest (though do not determine) particular palettes of inputs to be used on the different pages. A coloring book is not a blueprint, in which a predetermined design fixes the outcome. It has blank space between the lines, leaving room for unexpected outcomes: a given child could choose to color his giraffe purple and green instead of tan and brown. But most children coloring a giraffe will be inspired to search for tan, brown, and yellow rather than purple, blue, and

green. And there's another benefit of this image – a coloring book gives us an easy-to-understand metaphor for teaching students about the flexible interactions between evolutionary constraints and local cultural norms. Indeed, it is as easy to visualize as a Blank Slate, except it is more colorful, and draws a more complete picture of the mind.

See also: [Evolutionary Clinical Psychology](#); [Evolutionary Psychology](#); [Social Cognition](#).

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Relevant Websites

- <http://www.hbes.com> – Official site for the Human Behavior and Evolution Society.
- <http://evolpsychology.blogspot.com> – Online forum for commentary, discussion, essays, news, and reviews on evolutionary psychology.
- <http://www.psychologytoday.com/blog/sex-murder-and-the-meaning-life> – Psychology Today website for the first author of this entry, describing recent research and ideas linking evolutionary to various aspects of social behavior and cognition.
- <http://www.psych.ucsb.edu/research/cep> – Site for the Center for Evolutionary Psychology at the University of Santa Barbara.
- <http://www.epjournal.net> – Site for the online, open-access peer-reviewed journal Evolutionary Psychology.
- <http://plato.stanford.edu/entries/evolutionary-psychology> – Site for the Stanford Encyclopedia of Philosophy on evolutionary psychology.

Exercise and Sport Psychology

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Glossary

Biofeedback Biofeedback is a patient-guided treatment that teaches an individual to control muscle tension, pain, body temperature, brain waves, and other bodily functions through relaxation, visualization, and other cognitive control techniques. The name biofeedback refers to the biological signals that are fed back, or returned, to the patient in order for the patient to develop techniques of manipulating them.

Biomechanics The study of the mechanics of a living body, especially of the forces exerted by gravity on the skeletal structure.

BIRGing Basking in Reflected Glory, a phenomenon that occurs when things are going well and identification with a team is high.

Clinical psychology The branch of psychology concerned with the diagnosis and treatment of mental disorders.

Counseling psychology A psychological specialty that encompasses research and applied work in several broad domains: counseling process and outcome, supervision and training, career development and counseling, and prevention and health. Some unifying themes among counseling psychologists include a focus on assets and

strengths, person–environment interactions, educational and career development, brief interactions, and a focus on intact personalities.

Kinesiology The study of the anatomy, physiology, and mechanics of body movement, especially in humans; the application of the principles of kinesiology to the evaluation and treatment of muscular imbalance or derangement; also refers to the professional field in which these applications are practiced.

Licensed professional counselor (LPC) LPC is a subdoctoral licensure for mental health professionals. The exact title varies from state to state and LPCs are not psychologists. The LPC licensure provides for master's level professionals to set up an independent practice, not as psychologists but as LPCs.

Motor learning The acquisition of skills or skilled movements as a result of practice. Motor learning involves a set of internal processes associated with practice or experience leading to relatively permanent changes in motor skill. The study of acquisition of skills.

Social facilitation The effect of the presence of others on individual performance.

Introduction

The world is absolutely sports crazy and it begins only a few short years after birth in many cases. Young people are being brought into the action at much earlier ages than ever before as evidenced by the presence of knee-high tykes in pizza parlors after baseball games or soccer matches, all decked out in form-fitting uniforms appropriate to their particular sport. As these children age and gain experience, they are often channeled into playing for one or more highly competitive travel teams that have as their main focus producing the next Albert Pujols, LeBron James, or Peyton Manning. If these kids stay with sports, and many do not for a variety of reasons, they will take part in interscholastic sports where literally millions of teenagers select from a large sports menu provided for them by their school districts. A few of these athletes will have the privilege of going on to play on an intercollegiate team in their chosen sport. Even fewer become professionals, and a select few may get to experience the immense joys and challenges of being an Olympic-caliber athlete. Such is the nature of sports. As a result of all this sports participation, intense competition, and attendant fandom, an ever-increasing array of sport scientists have been employed to help boost sport performance and fitness adherence through improvements in diet, equipment, and psychological and physical training methods. It is in the

context of enhancing sport performance and fitness adherence that the sport psychologist can make a significant contribution. The remainder of this article will be devoted to enhancing our understanding of the history, present status, and future of exercise and sport psychology.

A Definition of Exercise and Sport Psychology

Exercise and sport psychology is a relatively new area of application within the field of psychology, having only come into its own in the past four to five decades. The field is essentially a blend or amalgam of two domains, the broad area of psychology and the narrower domains of exercise and sport, and it is not unusual to see the professionals in the area referred to as sport psychologists, sport and exercise psychologists, and exercise and sport psychologists. The shorter version, sport psychologist, will be used throughout this article in the interest of parsimony, but the reader should always keep in mind that there is no intent whatsoever to diminish the importance of exercise in the total equation. One of the major exercise and sport psychology professional organizations to be discussed later, Division 47 of the American Psychological Association (APA), indicates on its website (<http://www.apa47.org>) that "Exercise and sport psychology is the scientific study of the

psychological factors that are associated with participation and performance in sport, exercise, and other types of physical activity. Sport psychologists are interested in two main areas: (a) helping athletes use psychological principles to achieve optimal mental health and to improve performance (performance enhancement) and (b) understanding how participation in sport, exercise, and physical activity affects an individual's psychological development, health, and well-being throughout the life span."

The Origins of Sport Psychology

In any discussion of sport psychology, there are at least four historical domains to keep in mind: sport, psychology, physical education (now known most popularly as kinesiology), and the subfield of sport psychology. A brief summary of some of the key moments in the history of sport, psychology, physical education, and sport psychology can be seen in [Table 1](#).

Sport History

Sport historians generally agree that the starting point for their area of inquiry is 776 BC with the advent of the first Olympic Games in Athens, Greece. This designation is not to deny the existence of some kinds of sporting activities thousands of years earlier in ancient civilizations such as China, Egypt, and India. There is clear evidence that sport played an important

societal role in times even more ancient than Greece and Rome, but the 776 BC designation is believed by most sport historians to provide the most convenient starting point for a discussion of sport history.

Sport flourished in the Greek Athenian period with its emphasis on grace, beauty, and the human form. Also, sports and fitness played a huge role in the daily life of the more militaristic Spartans who saw these activities as part and parcel of the creation of the perfect warrior. In 146 BC, the Romans came to power in the ancient world and the sporting activities during their rule moved away from the Greek tradition into a more primitive and sometimes ugly realm that appealed to man's baser instincts with chariot races, festivals dedicated to the slaughter of thousands of animals at a time, and the gladiatorial events in which many people died. For example, when the Coliseum in Rome opened in 72 BC, the inauguration was celebrated with the slaughter of 5000 animals and games that lasted for 100 days. The bloodlust of the Romans is well-documented in sport history.

The savagery of the Roman approach to sport, the overall social, political, financial, and moral decline within the Roman Empire, and the increasing influence of Christianity led to the demise of the Olympic Games in AD 394. The Summer Games were resurrected in 1896 and have been held every 4 years since, with the exception of the World War II years of 1940 and 1944. The Winter Games were first formally introduced in 1924 in Antwerp, Belgium and have been held every 4 years since except for the war years, alternating in 2-year cycles with the Summer Games.

Table 1 Key historical events in sport, psychology, physical education and sport

<i>Sport</i>	
776 BC	First Olympics Held in Athens, Greece
AD 392	Ancient Olympics Ended. Reinstated 1602 Years Later
1896	Baron de Coubertin Leads Revival of Modern Olympics in Athens
1905	President T. Roosevelt Holds Meetings on Future of College Football
1939	Little League Baseball Initiated in Williamsport, Pennsylvania
1947	Brooklyn Dodgers Racially Integrate Major League Baseball
1952	President Eisenhower Commissions Study of Youth Fitness in US
<i>Psychology</i>	
1879	Wilhelm Wundt Opens Psychology Laboratory in Leipzig, Germany
1893	French Physiologist Phillippe Tissie Conducts Study of Cyclists
1894	Edward Scripture Studies Reaction Time in Expert Fencers
1898	Norman Triplett Studies Effects of Social Facilitation on Cyclists
1903	T. W. Patrick Publishes Study of Catharsis Among Football Fans
1915	Karl Lashley and John B. Watson Study Skill Acquisition in Archery
<i>Physical Education</i>	
1861	First Men's Physical Education Program at Amherst College
1865	First Women's Physical Education Program at Vassar College
1866	California is First State to Pass Law Requiring PE in Public Schools
1885	American Association for the Advancement of Physical Education Created
1904	R. Tait McKenzie Becomes Leader in PE and Sports Sculpture
1922	Jesse Feiring Williams and Clarke Hetherington Issue Call for American PE to Move Away from Militaristic German Influence
<i>Sport Psychology</i>	
1925	Coleman Griffith Starts Sport Psychology Laboratory at Illinois
1926–1928	Griffith Publishes <i>Psychology of Coaching</i> and <i>Psychology of Athletics</i> , First Two Sport Psychology Books
1965	International Society for Sport Psychology Formed in Rome, Italy
1967	North American Society for the Psychology of Sport and Physical Activity Formed
1986	Association for the Advancement of Applied Sport Psychology (AAASP) Formed. Known Since 2006 as Association for Applied Sport Psychology (AASP)
1986	Division 47, Sport and Exercise Psychology, created within American Psychological Association (APA)

There is plenty of evidence for sport participation in the American colonial period. [Rice et al. \(1969\)](#) and [Struna \(1981\)](#) reported that popular sports at that time included cricket, fives (handball), goff (golf), rounders (a ball game similar to baseball), shinny (hockey), and others too numerous to mention. Participation in sports also took place during the Civil War where something approximating baseball was apparently immensely popular ([Kirsch, 2003](#)).

The middle part of the 1850s ushered in an era in which there was a huge influx of European immigrants into the United States, and they brought their own sporting traditions with them. Of particular importance in this regard were the highly organized, almost mechanistic Germans who exerted a significant influence on American physical education philosophy and practice for much of the eighteenth and early nineteenth centuries. At the same time these European immigrants were making their way to our shores, there was a technological revolution that had a profound impact on the country in general and sport in particular. The development of the railroads and inventions such as the telegraph, incandescent lighting, ball bearings, stopwatch, and sewing machine, to name just a few, allowed for the creation of improvements in the overall conduct of sports.

The reinstitution of the Olympic Games in 1896; the evolution of sports and fitness in social agencies such as the Young Men's Christian Association (YMCA), Young Women's Christian Association (YWCA), Boy Scouts, and Girl Scouts; the creation of Little League baseball in Williamsport, Pennsylvania in 1939; and the landmark pieces of legislation, the Civil Rights Act of 1964 and the Title IX Act in 1972, were instrumental in furthering the integration of minorities and women into sport and were pivotal in shaping sports and fitness as we know them today.

History of Psychology

It is widely accepted among psychologists that the discipline of psychology essentially began in 1879 with the creation of the first research laboratory in Leipzig, Germany. The emergence of psychoanalysis as formulated and practiced by Sigmund Freud in Vienna, Austria, and Carl Gustav Jung in Zurich, Switzerland, in the late 1800s and early 1900s had a huge impact on the development of psychology. The same can be said for the behavioral approach, which traces its roots to the work on classical conditioning by the Russian physiologist, Ivan Pavlov, in the late 1800s. The American psychologist, John B. Watson, conducted related work in his laboratory at Johns Hopkins University in the early part of the twentieth century, and this led to his designation as the 'Father of American Psychology.' A couple of decades later, the Harvard psychologist B. F. Skinner promoted a new view of behavioral psychology known as Skinnerian Psychology or instrumental conditioning, and his work greatly advanced our understanding of the principles of human and animal learning. Finally, the humanistic tradition within psychology was promoted by Abraham Maslow at Brandeis University in Boston, Massachusetts and Carl Rogers, the famous psychotherapist. The resilience and optimism of the humanistic model was a welcome response to the pessimism of the psychoanalysts and the hard-core emphasis on laboratory-generated, sometimes mechanistic truths of the behavioral psychologists.

History of Physical Education

As can be seen in [Table 1](#), physical education was given huge impetus in the nineteenth century with the creation of the first collegiate physical education program for men at Amherst College in 1861 and the one for women at Vassar in 1865. Also, the 1866 legislation in California mandating compulsory physical education activity classes in the public schools was a giant step forward for the discipline. The field evolved almost totally in its earliest years from the field of medicine to a discipline of its own in the early 1900s. Unfortunately, the place of physical education in the quest for youth and, later, adult fitness has been a political football for many years in both our public schools and universities, with critics constantly calling for it to be minimized or discontinued in favor of other academic pursuits.

History of Sport Psychology

There seems to be general agreement that the first research studies conducted with a sport psychology theme were those of the Frenchman Phillipe Tissie (1852–1935) and Americans Norman Triplett (1861–1934) and Edward Scripture (1864–1945), all in the 1890s ([Benjamin and Green, 2009](#); [LeUnes, 2008](#)). In the case of Phillipe Tissie, he wrote two articles that appeared in 1894 describing his work on the physiological and psychological aspects of bicycle racing ([Baumler, 1997](#)). Though more naturalistic than laboratory-based, the Tissie articles are extremely important since they were the first of their kind with a sport psychology focus. However, Norman Triplett is generally accorded the status of having produced the first sport psychology experiment in 1898 for his study of what is now known as social facilitation (i.e., audience effects on individual performance) among sport cyclists. Benjamin and Green surveyed 33 English language sport psychology textbooks published between 1980 and 2002, and found that 19 identified Triplett as the individual who published the first sport psychology research. It is likely that the appearance of Triplett's paper in the highly accessible *American Journal of Psychology* coupled with the more obscure nature of the French journals in which Tissie published his work in great part accounts for the discrepancy. In any event, both Tissie and Triplett made significant contributions to the history of sport psychology, and their status in that regard is guaranteed.

As for Scripture, his work also predated that of Triplett but was published in an in-house journal at Yale that ceased publication in 1902, thus lowering the visibility of his work ([Benjamin and Green, 2009](#)). Scripture's study compared two classes of fencers on reaction time and speed of movement and found no differences between expert fencers and fencing novices on reaction time, but the expert fencers were superior to the less accomplished ones on speed of movement.

Interestingly, Tissie, Triplett, and Scripture never published another paper with a sport psychology theme. As Benjamin and Green indicate, these one-shot studies were typical in the early years of the discipline.

Though there were other studies conducted in several universities with a diverse pool of subjects embracing a number of countries throughout the world, the field made a quantum leap forward with the work of Coleman Roberts Griffith at

the University of Illinois. According to [Green \(2009\)](#), Griffith had established a reputation as a first-rate scholar by 1920 with a research focus on selected aspects of audition in laboratory rats. Griffith published several important scholarly articles and two books prior to 1923 and, in the process, developed a side interest in sport psychology that was to become a passion for two decades of his professional life. It seems that while teaching introductory psychology, he became enamored with trying to understand the psychological makeup of athletes in his classes. As part of this effort, Griffith engaged in an ongoing exchange of letters with the legendary football coach at Notre Dame, Knute Rockne ([LeUnes, 2008](#)).

To further his understanding of the athlete's psyche, Griffith created the first sport psychology laboratory in the United States in 1920. Three years later, he introduced the first university-level sport psychology course and it gave rise to his third book in 1926, entitled *Psychology of Coaching*. He followed that volume with another in 1928, entitled *Psychology of Athletics*. For reasons not clear, the university closed Griffith's laboratory in 1932 and Griffith was reassigned to an administrative position which he held until his retirement. Though he dabbled for a while in the sports area after the closing of the sport psychology laboratory, his interest in the area slowly waned. Griffith published four more books during his tenure as an administrator, none of which focused on sport psychology. For his efforts, however, Griffith is generally considered to be the 'Father of American Sport Psychology.'

Sport Psychology Professional Organizations

Once Griffith moved on to other pursuits, not much happened in sport psychology for essentially three decades. There were smatterings of research with a psychological theme published related to the purported dangers of Little League baseball and a few other topics, but not much really happened in sport psychology until 1967. It was at a meeting of a national organization for physical educators that a splinter group met to form what became the first sport psychology professional organization in this country, the North American Society for the Psychology of Sport and Physical Activity (NASPSPA). Though NASPSPA represented a step forward for sport psychology, the overriding focus of that organization on research and theory, particularly in the area of motor learning, led to the formation in 1986 of the two dominant professional organizations in sport psychology, the Association for the Advancement of Applied Sport Psychology (AAASP) and Division 47, Sport and Exercise Psychology, of the APA.

Association for Applied Sport Psychology

Since its inception in 1986, AAASP has been at the forefront in promoting the discipline of exercise and sport psychology. In 2006, it was decided that the word 'Advancement' was no longer needed in the title, and the organization became known as the Association for Applied Sport Psychology (AASP) instead of AAASP. AASP has now grown to ~1000 members, pretty much equally divided in academic preparation between psychology and kinesiology. To further meet the interests of the membership, 24 Special Interest Groups (SIG) have been

formed and included are such diverse interests as Business Ownership in Sport Psychology, Disability Sport and Exercise, Gay, Lesbian, Bisexual, Transgender, and Intersex, Humanistic Sport Counseling, Soccer, Sport Fandom, and Youth Sport.

Division 47 APA

Also in 1986, the APA Council of Representatives unanimously approved the creation of Division 47, Sport and Exercise Psychology. This interest group began with perhaps two dozen members, and the rolls have grown to around 1000 including student affiliates.

One of the more important initiatives arising from Division 47 occurred in 2003 when the APA Council of Representatives approved what is known as the Sport Psychology Proficiency. In essence, the proficiency is a form of recognition from the APA that serves to lend validity to sport psychology as a post-doctoral specialization area under the larger umbrella of the field of psychology. The academic and applied requirements necessary for achieving the Proficiency read much like those for certification as a consultant with AASP, and thus are thorough and rigorous. The APA Proficiency in Sport Psychology is designed to serve at least two important functions, one of which is to offer protection for the general public and the other to offer guidelines for better training of professionals in the field.

In terms of training within sport psychology, Division 47 has listed on its website some issues to consider when thinking about a career in exercise and sport psychology ([Graduate training, 2010](#)). As part of that discussion, it is suggested that four tracks be available to people with interest in a career in exercise and sport psychology, and they are:

1. *Track I: Teaching/Research in Sport Sciences and Work with Athletes on Performance Enhancement.* This track requires a doctoral degree in Sport Sciences with a Sport Psychology Specialization. Significant course work in Psychology and Counseling is also expected. The primary sources of employment in this track are teaching and/or research positions within colleges and universities, research institutes, or medical research laboratories, or as a Coaching Educator for a collegiate or sport organization.
2. *Track II: Teaching/Research in Psychology and also Interested in Working with Athletes.* This track carries with it an expectancy of a doctoral degree in a psychological field with significant course work in Exercise and Sport Science. It is anticipated that specialization in this track would allow one to work in an academic position in Psychology within a college or university, a research institute, or a medical research laboratory.
3. *Track III: Provide Clinical/Counseling Services to Various Populations, Including Athletes.* The educational requirement to work in this domain is quite strict, requiring that the person be a graduate of an APA-approved doctoral program in either clinical or counseling psychology. It is further expected that this professional would bolster his or her credentials in psychology with additional work in the sport psychology and related sport sciences. Track III might lead to a private practice in psychology or a counseling or clinical psychology position in a university counseling center.

Track IV: Health Promotion and Working with Athletes but not Necessarily Directly in Sport Psychology. Master's level training with specializations in clinical or counseling psychology augmented by significant training in the sport and exercise sciences or, alternately, a master's in the sport sciences with significant course work in psychology. Academic athletic counseling centers, health maintenance organizations (HMOs), and sports medicine clinics represent job possibilities for people trained in Track IV.

Division 47 offers several caveats or issues to consider concerning employment opportunities in all of the tracks, but especially for those in Track III. Jobs are not plentiful and those that exist are almost always filled with professionals possessing years of extensive experience. An additional caveat suggests that staking one's time and reputation on working with elite athletes is a risky proposition, offering little job security and a less than encouraging job market in the foreseeable future.

From time to time, Division 47 confers Fellow status on exercise and sport psychologists who have made significant contributions to the field over the course of their careers. Thus far, 28 distinguished professionals have been designated as Fellows, 10 of whom are also certified as consultants with AASP which will be discussed shortly.

International Society for Sport Psychology

At the international level, the International Society for Sport Psychology (ISSP) is a major player. ISSP was created in Rome, Italy, in 1965 and was the brainchild of Feruccio Antonelli. ISSP sponsors a journal, *International Journal of Sport Psychology* and conducts a world congress every 4 years in which the exercise and sport psychologists from all over the globe congregate to assess the current status and the future of the discipline. Starting in 1965, the world congresses have been held in such exotic locations as Rome, Washington, DC, Madrid, Prague, Ottawa, Copenhagen, Singapore, Lisbon, Israel, Skiathos Island in Greece, Sydney, and Marrakesh, Morocco.

Other active, prominent, and well-organized societies for exercise and sport psychologists are found in Australia, Canada, and England, and are regulated and promoted by sport psychology or psychology organizations within their respective countries.

What Do Sport Psychologists Do?

As was noted in earlier descriptions of the various training tracks, sport psychologists are engaged in three main activities, teaching, research, and practice. Typically, the teaching and research functions take place within a Department of Kinesiology though, in a minority of cases, the functions may fall within the purview of a Department of Psychology. It is fascinating to note that historically, sport psychology has been almost totally a specialty area within Physical Education or Kinesiology, and remains much that way today. At the same time, however, it is becoming more and more necessary to be licensed as a psychologist in order to reap the full benefits associated with being a sport psychologist. The licensure, in turn, necessitates narrowly specified training within a psychology program. This inconsistency has caused much gnashing of

teeth over the years about who can come to be identified professionally as a sport psychologist. But as we shall see shortly, it is not proper to refer to oneself as a psychologist without passing the licensure examinations provided by the states in the United States and the provinces in Canada. Similar issues are being dealt with by professional organizations or statutory bodies in countries such as Australia, England, and Japan.

The first function, teaching, was mentioned briefly earlier and may take place in a variety of settings, but the most traditional of the possibilities is the university classroom. Also, formal or informal sessions focusing on imparting information to athletes, coaches, athletic administrators, and fitness professionals are common and conducted with both individuals and groups. The second function, research, most frequently is conducted within the confines of academia, though field research sometimes yields very important information, too. In the applied function, the sport psychologist works with athletes and coaches on a variety of things most often aimed at enhancing athletic performance. Included in these applied psychological skills are such things as anxiety management, concentration control, communication, goal setting, imagery, visualization, mental practice, positive self-talk, team building, and time management.

Perhaps an expanded treatment of the topic of research is in order to give the reader a better feel for what domains are most popular. Though hardly inclusive, five broad areas stand out as prominent avenues of inquiry, and they are: performance enhancement, social psychology of sport, psychological assessment, youth sport, and exercise.

Research has demonstrated the performance-enhancing properties of a host of techniques including biofeedback, deep muscle relaxation, goal setting, energizing techniques, imagery, and attentional focus. Also, the stress-reducing or performance-enhancing properties associated with systematic desensitization, stress inoculation training, positive psychology, and learned optimism have been strongly supported.

With regard to the social psychology of sport, the focus has largely been on three domains: leadership, group cohesion, and audience effects. The leadership research has focused more on the coach rather than on player leaders, an omission that represents a gap in the sport leadership literature. The cohesion research has focused on levels of attraction and integration among sports teams or fitness groups with regard to task and social cohesion components. The scale of choice for assessing these group characteristics has been the Group Environment Questionnaire (Carron et al., 2002), and the results have been generally robust. Insofar as audience effects are concerned, two interesting phenomena have emerged from the literature, BIRGing (Cialdini et al., 1976) and the home advantage/disadvantage (Baumeister and Steinhilber, 1984). In BIRGing, the tendency to bask in reflected glory (i.e., BIRGing) when things go well with our favorite teams is assessed. When things go less well, the tendency is to (CORF) or cut off reflected failure, through dissociation with the team. As for the home advantage/disadvantage research, the weight of the evidence strongly suggests a clear edge associated with playing on one's home venue in most sport situations. However, there is evidence that the effect weakens or dissipates in critical junctures in the baseball World Series or finals of the National

Basketball Association (NBA) playoffs, where a home disadvantage appears to be in effect (Baumeister and Steinhilber, 1984). It is believed that this disadvantage may be tied to performance anxiety issues associated with performing before the home but sometimes critical home audience. As is often the case in scientific research, there are points of disagreement. For example, critics have taken Baumeister and Steinhilber to task over some methodological and statistical issues, thus casting doubt about the existence of a true team home disadvantage (Schlenker et al., 1995).

The research in psychological assessment in sport has been robust, not unlike that in the broader field of psychology with its rich history of assessing traits such as intelligence, achievement, aptitude, and personality. One example among many in sports and exercise involves the Profile of Mood States (POMS) of McNair et al. (1971). The POMS is a state measure of mood designed 40 years ago to assess progress in counseling and therapy. During its lifetime, the scale has been used in several thousand studies of which around 600 have been in sports and exercise. LeUnes (2002) reported its use in 396 studies through 2002 and an updated compilation (LeUnes et al., 2010) includes another 200. In general, the efficacy of the POMS in assessing the mood states of tension, depression, anger, vigor, fatigue, and confusion as they relate to sports and exercise has been strongly supported.

One important research topic in youth sport research has looked at why young people continue participating or drop out of organized athletics at a young age. It is clear that the number one participation motive is to have fun whereas winning is consistently a low priority for the vast majority of participants. Conversely, not having fun and experiencing bad coaching account for a large proportion of the sports dropouts. A second area of inquiry about youth participation focuses on anxiety and its effects. For example, high trait anxious youth experience more anxiety about poor performance, and they often expect negative emotion and negative evaluation regardless of how well they may perform. In an interesting side note related to this topic, it was demonstrated three decades ago by Simon and Martens (1979) that band solos and other music activities possess far more anxiety-producing properties than do most sports activities. This finding, of course, flies in the face of the assertion that sports are harmful to children due to anxiety and stress. Finally, Ronald Smith and associates at the University of Washington have published a number of articles beginning in the late 1970s (Smith et al., 1977) extolling the virtues of their training program for youth coaches in the Seattle, Washington, area. The recurring theme of their research is that coaches trained using their sport psychology package produce young people who enjoy sports more, are more positive about their coaches, and feel better about themselves than do children playing for coaches who did not receive the training. Interestingly, no differences in win-loss percentages have been noted in comparisons of the two groups of coaches.

A fifth and final area of inquiry has focused on the many nuances of exercise and fitness. For example, a scan of the table of contents of three top journals in the field, the *Journal of Sport & Exercise Psychology* (JSEP), the *Journal of Applied Sport Psychology* (JASP), and the *Journal of Sport Sciences* (JSS), indicates that slightly over 40% of the articles published in the last 3 years were on various aspects of fitness. In the case of JSEP, the figure

was 60%. These data lend credence to the notion that the field of sport and exercise psychology truly takes the exercise challenge seriously.

Why Sport Psychology?

There are a number of factors that have contributed over the past several decades to the continued growth and acceptance of sport psychology among both sports professionals and the general public. An obvious one is the pursuit of excellence on the part of athletes. Seeking the competitive advantage is not new in sports and has taken many forms. For example, elite swimmers now use streamlined swimming apparel. Many athletes have turned to the use of illegal compounds such as the anabolic-androgenic steroids to build muscular strength. Runners and cyclists have resorted to blood doping, a technique in which blood is extracted from an athlete and centrifuged to isolate the red blood cells. In turn, these red blood cells are infused back into the blood stream just prior to competition, thus giving the athlete a super-oxygenated systemic boost.

Only in the past 30–40 years have athletes figured out that they might also gain a competitive edge if they possess more mental toughness than do their opponents. Prominent athletes who have made liberal and effective use of applied sport psychological skills to improve their performance include professional golfers Camilo Villegas, Justin Leonard, Corey Pavin, and Davis Love, boxer Evander Holyfield, and NBA Hall of Famer David ‘The Admiral’ Robinson of Naval Academy and San Antonio Spurs fame. Teams or organizations that have successfully employed sport psychologists include the California Angels of major league baseball, the collegiate champion baseball team from California State-Fullerton, the many times champion women’s collegiate softball team from the University of Arizona, the Department of Athletics at the Ohio State University and the University of Oklahoma, and the championship World Cup soccer team from Spain.

A second force propelling sport psychology to the forefront is closely tied to the desire to improve performance issue, and that is money. The golfer Eldrick ‘Tiger’ Woods parlayed excellence in his sport to become the first sports billionaire. Michael Schumacher, the fabulously successful Formula One race driver from Germany, has won prizes in his career totaling \$80 million. The world-class soccer player Messi is now the highest paid member of his sport, with an annual salary of \$44 million. The total payroll of the New York Yankees in major league baseball and that of the English soccer power Chelsea are roughly equal, with an annual payout of \$200 million each. There are now major league sports franchises that are worth more than a billion dollars. The recitation of the money in sport could go on endlessly, but suffice it to say that there is indeed plenty of it there. And if an athlete, coach, or team can make more money by using the skills of a sport psychologist, they will find one to assist that process.

A third force, and one with substantial historical significance, is using sport of advance a nation’s political agenda. This search for identity through sports most certainly was powerful in the ancient Olympics, with the Athenians and the Spartans jousting, so to speak, for superiority and validation of their individual city-states. The French philosopher,

Jean Jacques Rousseau, wrote at length in the 1800s about using sport as a political tool. More recently, the Russians and their allies in the Communist bloc most certainly sought validation of their political and economic philosophies through the Olympic Games and other sporting events, and the abuses of sportsmanship they perpetrated through use of banned substances and methods in the latter part of the twentieth century are legendary in sports lore. The Communist bloc countries set in motion the substance abuse monster that is plaguing almost all of organized sport today in every corner of the world. Hardly a day passes without the media calling attention to some athlete who has abused a banned substance or method. No doubt, some of this chicanery is aimed at gaining the competitive advantage and validation of some country's political agenda.

Two other forces that have helped sport psychology gain a foothold in sport are spectator interest and the fitness movement. We have increasingly become spectators rather than participants, and anything that sport psychology can do to make the athletes perform better is much appreciated by the sports fans. Bigger, faster, taller, stronger, and mentally tougher athletes who can run faster, jump higher, lift more weight, or hit a baseball farther are what the fans demand.

As for the fitness movement, it seems at times that the movement is more illusory than real, but there are people out there who truly value fitness and work hard at it. As a result of the evolution of fitness centers and a fitness movement, sport psychology has had to broaden its focus and the end result is what is now known as *exercise* and sport psychology. It stands to reason that exercise and sport psychologists would have much to offer the fitness movement in areas such as motivation, goal setting, and exercise adherence.

Major Challenges Within Sport Psychology

There are five major issues within exercise and sport psychology that are of ongoing concern, and they are training, licensure and credentialing, ethics, image, and employment opportunities. The two major exercise and sport psychology professional organizations, AASP and Division 47 of APA, are working hand in hand to address and resolve each of these five concerns. The fact that the membership of the two organizations and the power structure in each are overlapping almost guarantees a certain agreement on how to proceed in addressing the problems within the field.

Training

As noted elsewhere, sport psychology has intertwined roots in both psychology and kinesiology. One important source of information about where training is conducted is the *Directory of Graduate Programs in Applied Sport Psychology* (Sachs et al., 2001). That directory contains a list describing the location of the various graduate programs at both the master's and doctoral level in Australia, Canada, New Zealand, Singapore, South Africa, the United Kingdom, and the United States. As of 2001, there were 88 master's and 44 doctoral programs in Kinesiology departments. In departments of Psychology, the numbers are 13 and 17, respectively. Clearly, the majority of

exercise and sport psychology training is being conducted in Kinesiology departments.

Such a picture is well and good, for the most part. There is one glaring problem, however, and it serves as a segue into a second area of concern: licensure and credentialing.

Licensure and Credentialing

In the mid-1960s, the APA, in response to a growing perception that the field of Psychology was filled with quacks, charlatans, and perhaps some well-meaning incompetents, conducted a study to assess the status of professional training in people who called themselves psychologists. The APA essentially looked into the academic credentials of a random sample of so-called psychologists advertising their services in the phone book yellow pages of a number of large US cities and found a disproportionate number of grossly undertrained psychologists. In an effort to provide consumers of psychological services with protection from quacks, charlatans, and incompetents, each of the states in the United States and the provinces in Canada began to enact licensure laws. Though there were a few rocky moments in getting the licensure ball rolling, the enacting of this legislation has accomplished its purpose for the most part. If one seeks psychological services today, the consumer is pretty much guaranteed a reputable practitioner who has met a solid set of qualifications in order to obtain the license.

It was never anticipated that these new licensure standards would have such a profound impact on the field of exercise and sport psychology, but that is exactly what has happened. Individuals who called themselves 'Psychologists' prior to the passage of the relevant legal strictures suddenly found themselves in violation of the law if they had not passed the assorted state and province licensure exams. This situation was equally applicable to those who might have called themselves 'Sport Psychologists.' Calling oneself a sport psychologist without possessing a license is a violation of the law. What recourse was available to sport psychologists trained within a Kinesiology department who were, as stated earlier, the dominant group numbers-wise?

In time, the recourse took the form of credentialing in addition to or instead of licensure. AASP (AAASP at that time) took up the charge in the late 1980s and put in place a process to credential nonlicensed sport psychology professionals, thus giving them a legal and ethical mechanism to continue working in the field. The credentialing process, begun in 1989, has resulted in what is known today as Certified Consultant, Association for Applied Sport Psychology (CC-AASP). The purpose of this credential is to confer an organizational stamp of approval on professionals in the field who have met strict training and applied requirements. The person seeking certification must possess, among other things, a doctoral degree, be in good standing as an AASP member, and complete 400 h of supervised practical experience. In addition, he or she must demonstrate proficiency in a variety of intellectual domains including intervention, performance enhancement, the social psychology of sports, biomechanics, psychological assessment, biological bases of behavior, and research design and statistics. Of the ~1000 members of the organization, 217 members have been accorded certified consultant status.

In summary, the certification allows talented professionals to work in academic and applied settings minus licensure.

The process thus serves a number of purposes including protecting the public, demonstrating that AASP has a strong commitment to quality control within the field, assuring that a system is in place to promote training, assisting in marketing the services of the consultancy, and serving as a stepping stone to being placed on the US Olympic Committee Registry, thus allowing consultants to work with Olympic athletes, coaches, and teams.

Ethics

Briefly stated, the AASP code of ethics consists of an Introduction, a Preamble, 6 general principles, and 25 standards, and they are largely based on the Ethical Principles of Psychologists set forth by the APA (APA, 1992) and amended where needed to address specific ethical issues related to sport psychology. To the credit of the organization's leadership, it is stated that where the AASP code suggests a higher standard than other ethical guidelines or the law, the AASP member should adhere to the higher code.

There is no time or space to deal with all of the facets of the AASP ethics code, but brief discussion of the six general principles is in order. Of paramount importance in any ethical discussion is the licensure and credentialing issue discussed earlier, and once one is on firm ground there, the other six principles become salient. These principles are Competence, Integrity, Professional and Scientific Responsibility, Respect for People's Rights and Dignity, Concern for the Welfare of Others, and Social Responsibility. Restated, these principles require that one practice within one's training and competence, always operate with the highest level of personal and professional integrity, refrain from engaging in any activity that would shed negative life on the profession, respect client confidentiality and privacy, be sensitive to real and ascribed power differentials between oneself and others, and be respectful at all times with regard to one's obligations to one's community and to society as a whole.

One of the training issues confronting the field at present is the institution and operation of academic courses devoted to ethical practice. For example, Watson et al. (2006) reported that two-thirds of the graduate programs they surveyed required such training, though most often the ethical issues were imbedded in the subject matter of other courses in the curriculum. Producing ethical practitioners might be improved upon if courses specifically addressing the topic were implemented in lieu of the more hit-or-miss approach in place today.

Image of the Profession

As noted elsewhere, the profession of psychology was plagued for a time with the poorly trained, the incompetent, and the charlatans, and to some extent exercise and sport psychology got caught in that same net. Promises were made to professional sports teams that could not possibly be met, the public was fed a steady diet of fads and frills about what the field could do, and the end result of this was slow growth in the acceptance of sport psychology as a valid discipline. Even among academic clinical psychologists, there was some agreement with the sentiment of one respondent to our questionnaire

who stated that "Sport Psychology is a Flash in the Pan, Soon to Die" (LeUnes and Hayward, 1990).

There has been an increasing acceptance in the past decade of what exercise and sport psychologists have to offer. Part of this change is due to greater awareness among the general public of what both psychologists and those who work in the subdiscipline of exercise and sports have to offer. Also, there has been a burgeoning interest among professional athletes, particularly golfers, owners of professional teams, and administrators and coaches within university athletic departments in having the expertise of a licensed psychologist or certified sport consultant available within their domains. Newspaper headlines are increasingly making reference to sport psychology applications in a variety of settings, and most of the publicity has been positive. Overall, there seems to be a substantial and positive change throughout sports operations and the general public in their acceptance of sport psychology principles and practice.

Employment Opportunities

It is not unusual for professors with expertise in sport psychology to be approached by students and athletes wanting to know what they can do to prepare themselves for a career in sport psychology. My standard response is to (1) assure them that it is an exciting profession and (2) make sure they understand that job opportunities are, at best, sparse and that there are two major strategies they can employ to carve out their own niche. One is to earn the Ph.D. degree in a Kinesiology of Psychology program and become a professor. The second approach is to obtain the licensure required to become a psychologist, set up a broad practice geared to having enough paying customers to make the practice flourish, devote a part of that practice to athletes, coaches, and teams, and if all goes well over the years, phase out the clients other than those involved in sports, and devote the remainder of one's career to sport psychology. Both of those proposed routes are long term, demanding, and expensive, but afford the greatest likelihood for a sport psychology practice. State laws that allow for subdoctoral licensure, such as Licensed Professional Counselor (LPC), offer an additional opportunity for master's level graduates to eventually set up an independent practice that is psychological in nature while adhering to state law and good ethical practice.

An interesting outgrowth of training in sport psychology is seen in the entrepreneurial efforts of one-time sport psychology professionals such as Dr. David Cook, Dr. Graham Jones, and Dr. Robert Rotella. These three people come from an assortment of training backgrounds but share common roots in sport psychology coupled with a real entrepreneurial flair. They have branched out into the domain of business and industry, taking their sport psychology mental skills package to work with management in corporations such as Bayer, Chrysler, Coca Cola, Compaq, Deutsche Bank, Ford Motor Company, General Electric, Heinz Foods, and State Farm Insurance. Motivating athletes and young management personnel to excellence in performance, however defined, must have some common threads imbedded in good sport psychology practice.

More and more collegiate athletic departments are making use of sport psychological services, and this is opening up some much-needed positions. A leader in this area is the athletic

department at the University of Oklahoma which employs Dr. Nicki Moore as the Director of Psychological Resources for OU Student-Athletes (PROS). Dr. Moore supervises a staff of three doctoral-level personnel, a postdoctoral fellow, and a registered dietitian. Dr. Moore and her staff provide a wide variety of services to include individual, group, and couple counseling, mental coaching to improve performance, coaching consultation, learning disabilities assessment, crisis intervention, career development, and specialized treatment and medical referral. The success of the OU athletic program is legendary, and part of the reason for their success is that they are forward thinking and innovative, placing emphasis on relatively new initiatives such as sport psychology that many other universities may regard as superfluous, too expensive, or not necessary.

The Future of Sport Psychology

The future of the field rests on improvements in training, mentoring, creating additional job opportunities, maintaining and enhancing the image of the field with the various constituencies (i.e., the public, athletes, coaches, athletic administrators, and the larger field of psychology), and being more inclusive and encouraging broader input on the various challenges facing the discipline. AASP and Division 47 are diligent about assessing the current status of the field and where it should go in the future as evidenced by such initiatives as the twenty-fifth Anniversary Survey.

Care should be exercised to ensure that sport psychology is inclusive rather than exclusive. The field is relatively small and everyone tends to know everyone else, and this can lead to insular narrowness of perspective. Care must be exercised by the leadership to make sure these things do not happen. It is tempting to adopt a self-serving 'You scratch my back, and I'll scratch yours' mentality when it comes to choosing the leadership within the two professional organizations, who gets to publish their research in the top journals in the field, and who are the prime movers and shakers. The field will not thrive in the future if it proceeds in this fashion.

The relative paucity of fundamentally sound sport psychology researchers in areas basic to psychology such as conditioning and learning, physiology, biofeedback, and neuropsychological assessment is problematic. A concerted effort should be made to lure some of the better thinkers and doers in these areas into the field. They could provide a breath of philosophical and experimental fresh air and thus infuse new life into sport psychology. The field is blessed with an abundance of good social psychologists of sport, assessment experts, and capable performance enhancement practitioners, but a few hard-core, well-trained psychologists with alternate areas of expertise would be a most welcome addition.

Sport psychology professionals need to be alert to practitioners purporting to enhance sports performance through exaggerated claims about various applications of biofeedback. Where unfounded claims about the efficacy of biofeedback are made, there should be challenges lodged against them at every turn. It is seductive to hook an athlete up to sophisticated electronic devices with their assortment of wires, sensors, electrodes, monitors, and thermometers, and pass off resulting

observations as proof of the efficacy of biofeedback procedures in promoting athletic success. If a procedure is promoted enthusiastically as hard-core science, looks every bit the part, has an element of mystery to it, is couched in fancy scientific terms that laymen or athletes really cannot understand, and produces glitzy visions on a computer screen or a flashy, multicolored digital printout, it must be good. There are instances in which unwarranted claims are made that simply stretch credibility and are inconsistent with good science and practice.

The field of sport psychology is alive and well. Its image is on the ascent, there is some forward movement in the job market, training models are constantly improving, territorial disputes over who 'owns' sport psychology appear to be subsiding, and athletes, coaches, and organizations are increasingly seeking sport psychology services. The future looks bright.

See also: Behavior Analysis; Cognitive Behavior Therapy; Competition; Drugs, the Brain, and Behavior; Group Dynamics; Hope and Optimism; Personality Assessment; Play; Self-Efficacy; Self-Regulatory Skills and Behavior Change; Sex Roles.

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- <http://www.usoc.org> – United States Olympic Committee.

Expectation

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Glossary

Affective forecasting The prediction of one's future moods and emotions.

Comparative optimism The belief that one's future will be better than the future of other people or of the average individual.

Confirmation bias The tendency to selectively search or focus on information that is consistent with one's prior expectation.

Expectancy-value model A model that describes human motivation as a function of people's beliefs about the likelihood that actions will create outcomes and about the subjective value or utility these people associate with the relevant outcomes.

Expected utility The expected subjective value of an outcome.

Linguistic expectancy bias The tendency to describe expected behaviors in more abstract terms than unexpected behaviors.

Overconfidence effect An unwarrantedly strong confidence in the accuracy of one's own predictions.

Self-defeating prophecy An expectation that affects the holder's behavior in such a manner that this very behavior prevents the expectation from coming true.

Self-fulfilling prophecy An expectation that affects the holder's behavior in such a manner that this very behavior makes the expectation come true.

Stereotype threat The unfavorable effect on an individual's performance of this individual's awareness of a negative stereotype about his or her group in the relevant performance domain.

Subjective probability The perception of the likelihood by which an event or behavior will occur.

Definition and Types of Expectations

An expectation is a belief about events or behaviors that will occur or that will be revealed in the future. The objects of event-related expectations may be identifiable events (specific expectations, e.g., about an economic recession, about good weather), life in general, or the future in general (generalized expectations, e.g., about whether the future will be pleasant or unpleasant, or about whether important outcomes are generally controllable or uncontrollable). The objects of behavioral expectations may be overt behaviors (e.g., giving money to charity, attending a class) or covert behaviors (e.g., feeling happy, needing company) shown by the individuals who hold the expectations themselves or by third persons.

Behavioral expectations about the self need to be distinguished from other types of future-oriented thinking, such as aspirations, wishes, behavioral intentions, and fantasies. Aspirations and wishes are the goals people hope to achieve rather than the goals they believe they will achieve. Behavioral intentions concern the actions people decide they will undertake rather than the actions they believe they will undertake. In fantasies, people pretend that something happens or that they perform some action rather than believe that it will truly happen or that they will perform it.

Expectations may occur in relationship to various aspects of events or behaviors, such as these events' or behaviors' nature, their likelihood (i.e., the events' or behaviors' subjective probability or likelihood), their subjective value (i.e., the events' or behaviors' predicted or expected [subjective] utility), their consequences, or their duration. All these expectations may be either purely descriptive or normative. Descriptive expectations merely state what, according to the individual holding these expectations, will happen or will be revealed. Normative expectations

also state what, according to the individual holding them will happen yet with the prescriptive connotation that for logical, social, or moral reasons it should happen. Normative expectations are therefore closely related to norms.

Role of Expectations in Human Behavior

Expectations are involved in almost any kind of human behavior. They play a particularly important role in learning, motivation, decision-making, affective responding, and social interaction.

Learning

Signal learning, the prototypical form of classical conditioning, implies learning that the occurrence of a mundane stimulus predicts the subsequent occurrence of another, more meaningful stimulus. Instrumental or operant learning implies learning to expect rewards or punishments for specific behaviors. Signal learning also gives rise to generalized expectations about the predictability of important events, while operant learning gives rise to generalized expectations of controllability. Both generalized expectations have even been shown to crucially affect the well-being of both humans and animals. For instance, at the core of the learned helplessness phenomenon lies a generalized expectation of not being able to control important events in the future.

Motivation

The central role of expectations in behavior is also reflected in so-called expectancy-value models of motivation that assume

that people make choices on the basis of the subjective expectancy of attaining (or not attaining) given outcomes through a behavioral choice and of the value they place on attaining (or not attaining) these outcomes. The individual's motivation to show some behavior depends on the multiplication of these two factors. Some famous expectancy-value models of behavior are Tolman's expectancy theory, Eccles' expectancy-value theory of achievement motivation, and Pekrun's control-value model.

Decision-Making

People make decisions based on their expectations both concerning their future preferences, tastes, feelings, and needs and concerning the likelihood of events, situations, and behavioral outcomes. One theory that formalizes the role of expectations in decision-making is prospect theory. This theory states that people choose between behavioral options on the basis of the expected subjective utility of each alternative's outcome weighed by the subjective probability of these outcomes. An outcome is conceived of as a change relative to a reference point (i.e., as a loss or a gain) rather than as a state. The subjective utility of an outcome therefore depends on both the reference point and on the magnitude and the direction of the change. However, not all differences between outcomes are created equal. The further away two outcomes are from the reference point, the smaller the difference in subjective utility between them normally is. For instance, the difference between gaining \$5 and gaining \$10 'feels' larger (in more formal terms: corresponds to a greater difference in subjective utility) than the difference between gaining \$50 and gaining \$55.

The expected subjective utility of a loss or gain is a function of the outcome's subjective utility adjusted for temporal distance. The more distant an outcome seems, the weaker its positive or negative value is (temporal discounting). Having to wait some time for a pleasant outcome renders that outcome less attractive than knowing that the outcome will arrive any moment. Similarly, knowing that an unpleasant outcome will only happen after some time renders it less aversive than knowing that it will arrive any moment. However, temporal discounting is generally steeper for losses than for gains. Postponing an unpleasant outcome reduces its expected aversiveness to a larger extent than postponing a pleasant outcome reduces its expected attractiveness. By consequence, outcomes that carry both advantages and disadvantages (i.e., outcomes that may be viewed as gains in some respects but as losses in other respects) often seem more attractive (or less unattractive) when they are envisioned in the distant future than when they are envisioned in the near future. This phenomenon may give rise to preference reversals, with one option seeming more attractive than another at some point in time (e.g., with the prospect of helping a friend move some weekend next spring seems more attractive than spending that weekend reading on the beach) but becoming less attractive as the relevant event comes nearer (e.g., with the prospect of spending the weekend reading on the beach becoming more attractive than helping the friend move on the Friday before it is all supposed to happen).

Apart from expected utilities, the subjective probabilities or the expected likelihoods of events and behaviors also affect

decision-making. Various biases occur in people's estimation of these likelihoods. For instance, people tend to overestimate small likelihoods and underestimate high likelihoods. They also associate higher likelihoods with desirable outcomes than with undesirable outcomes and lower likelihoods with undesirable outcomes than with desirable outcomes. At the same time, people seem to be quite able to produce accurate estimates of likelihoods. In general, it seems that people are better able to estimate likelihoods when they are allowed to do so in a format that they would spontaneously use (e.g., by estimating frequencies of occurrence) than when they are forced to use a nonspontaneously used format (e.g., by estimating probabilities).

Affect

In the domain of moods and feelings, it is generally believed that affective responses to events and behaviors sometimes depend on people's expectations about how these events or behaviors will make them feel and on how their actual experiences depart from their expectations (cf. the affective expectation model). According to the affective expectation model, both assimilation and contrast effects may occur. People's affective responses to an event or a behavior may be assimilated to these people's prior expectations about how they will feel if the stimulus information they perceive does not differ too much from the stimulus information they expected. In these cases, people's affective reactions resemble the affective reactions they had expected more than they would have done without the relevant expectations. For instance, an audience may have more fun viewing a moderately funny movie when this audience had previously expected to see a funny movie (and hence to have fun) than when the audience had expected to see a not-so-funny movie. If, however, the stimulus information so strongly departs from the expected information that the discrepancy gets noticed, contrast effects occur. In these cases, people's affective reactions differ from the affective reactions they had expected more than they would have done without the relevant expectations. For instance, an audience may have less fun viewing a moderately funny movie when this audience had previously expected to see a wildly funny movie (and hence to have tremendous fun) and when the audience notices that the movie departs from this expectation than when the audience had expected to see a not-so-funny movie.

This view that expectations influence affective reactions is at the basis of various models of consumer satisfaction in which satisfaction is believed to be a function of the confirmation versus disconfirmation of expectations. These models generally indicate that consumer satisfaction is highest when prior expectations are surpassed and lowest when expectations remain unfulfilled. As such, setting rather low expectation standards may, to some extent, enhance consumer satisfaction, whereas setting high expectation standards may reduce it.

Social Interaction

People's behavioral choices in interdependence situations are affected by their expectations about how the others involved will behave. Interdependence situations occur in group settings when the outcomes of group members' behaviors depend on

how the other group members behave so that each group member affects and is affected by others. For instance, when students work together on a group project, each student's efforts may contribute toward a good grade, yet whether or not the effort of this individual student will ultimately prove useful depends on the work of the other students in the group as well. In interdependence situations like these, expectations about the behaviors of others may affect behavior in various directions. When people share a common good, the expectation that others' contributions will be sufficient to build and maintain the common good may lead them to consume from the common good without contributing to it (free riding). Similarly, when people work on a group task, the expectation that others will work sufficiently hard sometimes leads them to invest less effort (social loafing). Ironically, the expectation that others will insufficiently contribute may also inhibit contributions out of fear of being taken advantage of. Only in specific cases (usually implying strong group cohesiveness) will the expectation that others will perform poorly or not contribute induce harder work and larger contributions (social compensation).

Sources

Expectations about events may derive from an individual's previous experiences with the relevant events or with similar events. They may also be based on verbal or numerical information individuals receive about other people's experiences or even on their purely cognitive constructions or intuitive rules-of-thumb (named heuristics). To estimate events' likelihoods, for instance, people may use statistical information to some extent. However, they also apply heuristics such as the availability heuristic (if I can easily remember or imagine examples of it, it must be likely). Moreover, people sometimes judge an event's likelihood on the basis of whether they can figure a mechanism or scenario leading up to the event. One consequence is that when people are able to causally explain why given events might occur, their likelihood estimates for these events may be enhanced. This effect occurs even when people are aware of the fact that the events they have just explained were purely hypothetical.

Similarly, interpersonal behavioral expectations may derive from the observer's previous experience with the actors (the individuals whose behaviors are being predicted) as well as from implicit personality theories, stereotypes (including those associated with social roles), and projection from the observer's own behaviors. For instance, an individual's social values (e.g., individualism, competitiveness, altruism) have been shown to predict the social values according to which he or she expects others to behave in interdependence situations.

Because people possess an unequalled basis of knowledge about their own overt and covert behaviors as compared to what they know about others, it would seem that their expectations about their own behaviors depend on their actual experiences rather than on stereotypes or on intuitive theories of personality and affect. Yet, it seems that even self-related expectations are based on theories and stereotypes. For instance, women may expect to experience mood swings caused by their hormone cycle because they have heard about the emotional effects of hormone-level changes on women.

Even if people process information without any prior expectations to guide them, expectations that arise online (i.e., while people are encoding the incoming information) may affect their interpretation of subsequent information elements. For instance, when people receive a variety of information about some other individual, the behaviors or personal characteristics that they encounter first may create an initial impression. This initial impression then serves as an expectation about the individual's other behaviors and characteristics. The primacy effect (i.e., the phenomenon that initial information weighs relatively heavily on general impressions) is a case in point. One situation in which a primacy effect may occur is when emerging expectations lead people to interpret subsequent elements in a manner that is partial to their first impression.

Measurement

Expectations are typically studied by asking people about them. Participants in studies are invited to verbally describe (either in their own words or, more frequently, using rating scales) what they think will happen or what they or others will do, how pleasant or unpleasant they think these future events or behaviors will be to them or to others, how likely they believe the events or behaviors are, or how long they think events or behaviors will last. The main problem with this approach is that verbal self-descriptions are vulnerable to self-presentation tendencies (including social desirability). When researchers use rating scales to facilitate participants' responding, their approach is also vulnerable to issues surrounding scale interpretation. People may differ in how they interpret specific response alternatives and hence how they view scale ranges. In addition, these interpretations may change over time. The latter problem is particularly troublesome in prospective studies on the accuracy of expectations.

In prospective studies about how well people's expectations match their actual experiences, researchers ask participants about the events or behaviors they expect. Later on, they either ask participants about the events or behaviors that have actually occurred or collect external data concerning the occurrence of these events or behaviors. To the extent that their original ratings differ from their later ratings, the expectation is said to have been inaccurate. Yet, participants' ratings may differ not because their expectations were off the mark but because these participants' scale use has changed. For instance, maturation may have taught them not to use extreme response alternatives lightly.

In retrospective studies about how well people's expectations match their actual experiences, researchers either ask participants about events or behaviors that have actually occurred or collect external data about the occurrence of these events or behaviors. They then ask participants about what they had expected concerning these events or behaviors. The main problem with retrospective studies is that people's ratings of how pleasant or unpleasant they had expected an event to be may resemble how they rate the event after it actually happened not because their expectation was spot on but because the hindsight bias (the tendency to view past or current events as more predictable than they were before they

occurred, also known as the “I knew it all along effect”) affects their reconstruction of their prior expectations.

Cross-sectional studies compare people’s expectations of how they will experience events in the future with how other people actually experience these events at the same time. When researchers use these designs, they ask one group of participants who face a given event about their expectation and another group of participants who have experienced the same or a similar event about their experience. One weakness of cross-sectional designs is that it may be hard to find comparable samples or to optimally match the expected versus experienced events and that error variance due to individual differences may obscure within-individual discrepancies between expectations and experiences.

Accuracy and Biases

In general, accurate expectations help people to prepare for events and to adequately respond to events and other people’s behaviors. As shown by research within a functional perspective of Pavlovian conditioning, for instance, the most important outcome of signal learning is not that learners develop responses to conditioned stimuli but rather that their responses to the unconditioned stimuli are optimized, with aversive stimuli evoking weaker negative responses and appetitive stimuli evoking stronger positive responses.

However, a few notable exceptions to the rule that expectations help prepare for reality have been identified. In academic learning situations, for instance, expecting recognition tasks negatively affects memory performance both on recognition and recall tasks. The most plausible explanation seems to be that people view recognition tasks as easier than recall tasks. Even though this perception is accurate to some extent, the overestimation of the difference leads people to invest less effort on the preparation (i.e., the encoding and subsequent rehearsal of stimulus materials) in recognition tasks than in recall tasks.

The accuracy of people’s expectations obviously depends on the specific characteristics of the objects of these expectations, of the individuals who hold them, and of the context surrounding the events and behaviors. Despite this variability, however, various tendencies have been identified that generally characterize people’s expectations.

One general characteristic of people’s expectations is that in the absence of any information about upcoming experiences, people tend to expect that these experiences will be moderately positive. Ironically, this expectation creates negativity effects. People’s rosy expectations indeed make negative information stand out and seem both more extreme and more informative, thus allowing this information to disproportionately weigh upon their overall evaluations. In the domain of consumer satisfaction, the consequence of the negativity effect is that the mere expectation of having to evaluate products or services renders people’s evaluation more negative by having them focus more than they would spontaneously do on potentially evaluation-relevant information.

Expectations about the subjective utility of future outcomes are often characterized by a so-called projection bias. This bias implies that whereas people do realize that their future tastes,

needs, and circumstances will differ from their present ones, they underestimate the magnitude of this difference. Hence, they overestimate the extent to which future subjective utilities will resemble current subjective utilities. For instance, in a hungry state, people often prefer candy-like snacks (such as chocolate bars and crisps) over fruit snacks (such as apples or bananas). When people choose a snack to consume in a week’s time, their selection therefore depends on whether they expect to consume the snack at a time at which they may reasonably expect to be hungry (e.g., late in the afternoon) versus at a time at which they may reasonably expect not to be hungry (e.g., immediately after lunch). Interestingly, however, people’s predictions also depend on whether they are hungry at the moment they make the choice regardless of whether they may expect to be hungry at the moment of consumption. This finding shows that people project their current situation (and hence the current subjective utility of outcomes) onto the future.

The projection bias is closely related to biases in affective forecasting. To the extent that expected utilities are directly related to affective responses to events, it may even be viewed as an affective forecasting bias. Another of these biases is the overestimation of the emotional impact of future events. This so-called impact bias has various causes. First, people tend to think about future events as if these will happen in a vacuum rather than in the midst of many other events and experiences (focalism or the focusing illusion). Second, people fail to appreciate the essentially comparative nature of human judgment. On the one hand, people fail to appreciate how strongly their standards of evaluation may change under the influence of their previous experiences (neglect of change in adaptation level). On the other hand, they fail to appreciate how strongly their judgments will depend on social comparison. Third, people also ignore the extent to which they will psychologically transform the event into something less extremely positive or less extremely negative after it happened (neglect of ordinization and of psychological immune reactions). It should be noted that people not only overestimate the impact of events as compared to the actual impact events generally have, they also overestimate the impact of events as compared to these events’ impact on others. People generally believe that bad things will make them suffer more and that good things will make them happier than others.

In the domain of behavioral expectations, people generally underestimate how strongly situational factors will affect other people’s behaviors and particularly how these situational factors will affect their own behaviors. Among the situational influences that people generally underestimate are social influences. People underestimate how strongly others will be affected by a unanimous majority (and hence show behavioral conformism), by an authority (and hence show obedient behavior), or by the mere presence of others (and hence show social facilitation and inhibition).

In addition, people’s expectations about future events are generally overoptimistic, both as compared to these events’ objective probabilities (implying that people believe that desirable outcomes are more probable and that undesirable outcomes are less probable than is objectively warranted) and as compared to how they view the probabilities of these events in other people’s future. Apart from expectations about events,

comparative optimism also characterizes behavioral expectations in that most people believe that they are more likely to perform morally desirable actions in the future than others. The planning fallacy, implying that people underestimate the time they will need to complete projects, may be viewed as an example of overoptimism and comparative optimism at the same time. People indeed underestimate the time they will need to complete projects but do not (or to a lesser extent) underestimate the time other people will need to complete their projects.

Despite biases like these, one intriguing characteristic of expectations is that they tend to get validated more frequently than would rationally be warranted. One reason is the confirmation bias (also known as 'positive test strategy') that leads people to focus on, overweigh, and selectively search information that confirms their expectations. In addition, expectations guide the interpretation of vague or ambiguous information. The process of selectively seeking and interpreting information results in the apparent confirmation of expectations, a phenomenon that is known as perceptual confirmation. In addition, interpersonal expectations may lead observers to behave in such a manner that they evoke the expected behaviors in those about whom the expectations exist. This phenomenon is known as behavioral confirmation.

Meta-Characteristics

Expectations are not only characterized by their contents and their validity. People may hold them with varying degrees of confidence and experience them at varying levels of concreteness and elaboration. Studies on such 'meta-characteristics' of expectations have yielded intriguing insights.

Overconfidence and Inferences of Trustworthiness

One characteristic of many expectations is that they are held in an overconfident manner. This overconfidence effect implies that people generally overestimate the accuracy of their expectations. In addition, people infer the trustworthiness of other people's expectations partly from these expectations' preciseness. For instance, they find communicators more trustworthy if these communicators provide point estimations of probability (i.e., one numerical value) than if they provide interval estimations (i.e., a numerical value accompanied by the range of numerical values between which the probability may vary). This is counternormative because the so-called confidence intervals generally provide more information (namely, by acknowledging the degree of uncertainty surrounding the estimation) and are more likely to be accurate than point estimations.

Abstraction and Temporal Distance

One particularly intriguing characteristic of expectations is that their level of abstraction depends on the temporal distance of the expected events or behaviors. The more distant an event or a behavior seems to be in the future the more abstract or high level its construal tends to be in that it includes general, essential, or overarching characteristics. The nearer an event or a

behavior seems to be in the future the more its construal includes contextual, incidental, or concrete details.

This apparently simple idea is at the core of construal-level theory. It carries a variety of implications. One implication has to do with how the expected event or the expected behavior itself is conceived of. Expectations about the distant future tend to be simpler, more prototypical, and less diverse than expectations about the near future.

In the case of behaviors, it is important to note that behaviors may be described at different levels of abstraction, with trait inferences that are based on them representing the highest level and with mere descriptions of directly observable actions representing the lowest level. Reflecting the more abstract nature of expectations for the distant future than for the near future, people expect that other people's behaviors in the distant future will depend on these other people's traits more strongly and hence show a higher cross-situational consistency than other people's behaviors in the near future.

In addition, people's expectations about the subjective utility of temporally distant events and behaviors mostly depend on these events' and behaviors' overarching and central characteristics. In contrast, their expectations about the subjective utility of temporally near events and behaviors also depend on the events' subordinate and noncentral characteristics. By consequence, changes in evaluation and sometimes even preference reversals may occur as distant events come nearer.

A further and counterintuitive implication of the relatively abstract representation of distant events and behaviors has to do with these events' and behaviors' subjective probabilities. People are more convinced that their expectations for the distant future will be borne out than they are about their expectations for the near future. Finally, the relative abstractness of future expectations affects the expected variability in them. People expect less variability in the distant future than in the near future. When predicting other individuals' behaviors, for instance, people expect these others to behave more consistently across situations in the distant future than in the near future.

Cognitive Effects of Expectations

The Identification of Behaviors and Events: Assimilation and Contrast

Expectations affect the interpretation of information. Their effects have mainly been demonstrated in the field of perception and social judgment. For instance, when observers compare suspects to facial composites, they may expect that a given suspect is guilty (e.g., because witnesses have identified him or her). This expectation can lead them to view a greater similarity between the composite and the suspect, even when they deny that it affects their judgment. Expectations' effects also occur in other domains, such as visual perception (with context-based expectations affecting the interpretation of ambiguous patterns), the perception of physical symptoms (with the expectation of a physical symptom leading people to interpret any physical experience in terms of that symptom), and the perception of covariation (with the expectation that two variables covary leading people to perceive a nonexistent association or to overestimate an existing association, better known as illusory correlation).

When expectations affect information processing in such a manner that the cognitive elaboration of (including perception, interpretation, and judgment) events and behaviors or the affective responses to these events and behaviors is distorted in the direction of the expectation, assimilation is said to occur. Assimilation predominantly happens when the incoming information is vague, ambiguous, incomplete, or mixed. In these cases, expectations are used to clarify or disambiguate the information, to fill in the gaps, or to make a choice between conflicting interpretations and conclusions.

Contrast effects are said to occur when the cognitive elaboration of an event or behavior is distorted away from the expectation. Such contrast effects predominantly occur when the incoming information is clear and unambiguous and when observers strongly focus on the incoming information (e.g., when they are driven by a strong need for cognition). Because most information is open to interpretation, contrast effects tend to occur less frequently than assimilation effects. Yet, contrast effects have been demonstrated in affective responses.

People may be (partly) aware of how their expectations affect their interpretation of incoming information. In these cases, they may try to correct their impressions and responses for the biasing effect of expectations. As a consequence, expectation effects typically occur when people have lowered their defense against them, for example, when they believe that the incoming information is rich enough to overcome undue expectations. When people do try to correct for expectations, on the other hand, overcorrection may sometimes take place. The assimilation effects that would normally occur then give way to contrast effects or vice versa.

One consequence of the predominance of assimilation effects is that they help to maintain and even corroborate expectations even in the face of information that objectively contradicts them or that might be construed as contradicting them. For instance, assimilation has been identified as an important factor in stereotype maintenance. When people believe that men are better professors than women, for instance, they may evaluate a lecture given by a man more positively than a lecture given by a woman even if both performed equally well, thus maintaining and even corroborating the stereotype.

Judgment: Expectations as Descriptive and Normative Standards

Expectations may sometimes serve as descriptive comparison standards by which observers judge the new information. As such, they may affect the subjective evaluation of events and behaviors as well as affective responses to them.

In the domain of consumer psychology, buyers' satisfaction with products and services depends on the confirmation versus disconfirmation of prior expectations. It does so in an asymmetrical manner, however, with negative disconfirmations particularly strongly predicting dissatisfaction.

In the domain of person perception, stereotype-based expectations may serve as standards by which individuals' abilities, behaviors, and life circumstances are being judged. When differential expectations lead to different standards being applied to different individuals, these expectations may codetermine the subsequent judgments, for instance, group stereotypes may

give rise to expectations about how group members behave or about the situations in which these members live. Any individual group member's behavior or situation may then be judged by comparing it to the expectation that is associated with his or her group. When women are expected to show low levels of aggressiveness and men are expected to show higher levels of aggressiveness, for instance, any woman's aggressiveness is judged by comparing it to a low-aggression standard and any man's aggressiveness is judged by comparing it to a high-aggression standard. The same behavior may then seem aggressive when shown by a woman (because it is above the normative expectation for women) or as nonaggressive when shown by a man (because it is below the normative expectation for men).

Group-specific expectations may create paradoxical consequences in the comparison of above-average members of a group that is expected to score low on a given dimension and below-average members of a group that is expected to score high on the same dimension. The former individuals may then be judged to score higher on the dimension than the latter individuals do, even if their score is objectively lower. For instance, women who behave more aggressively than expectations for women would predict may be judged as behaving more aggressively than men who behave less aggressively than expectations for men would predict even if by any objective standards the women's behavior is less aggressive than the men's.

Apart from serving as descriptive standards, it should be noted that expectations may also serve as normative comparison standards. This is particularly evident in the case of behavioral expectations, with expectation-confirming behaviors being judged as normal and appropriate and with expectation-disconfirming behaviors meeting with disapproval. For instance, the expectation that women behave less aggressively than men may give rise to the normative prescription that women should behave nonaggressively and that men should behave aggressively. A woman behaving aggressively and a man behaving nonaggressively may then be socially sanctioned.

Causal Attribution

When their expectations are contradicted, people are more likely to engage in causal thinking than when their expectations are met. Unexpected events or behaviors thus evoke more causal attribution than expected events and behaviors. This particularly holds true for events and behaviors that depart from the prior expectations in an undesirable sense. In this case, causal reasoning often takes the form of counterfactual reasoning contrasting alternative series of events to what has actually happened ('what if...').

One implication of the effect of expectations on causal reasoning is that the extent to which people causally explain events or behaviors reveals to some extent whether they had expected these events or behaviors. Within this context, for instance, the notion 'stereotypic explanatory bias' has been coined to describe the relative tendency to explain stereotype-inconsistent behaviors and to leave stereotype-consistent behaviors unexplained. The stereotypic explanatory bias has been at the basis of the development of a measure of stereotypes that does not require asking people about their stereotype-based

expectations (a so-called indirect or implicit measure of expectations). Like other indirect measures, it is particularly useful to avoid the social desirability concerns that often plague self-report measurements.

Recognition and Recall

In apparent contrast with the finding that expectation-inconsistent information tends either to get overlooked or to get distorted, memory is generally better for expectation-inconsistent information than for expectation-consistent information. This finding holds both for recall and recognition measures. The sole exception consists of recognition measures that are not corrected for response tendencies. Probably due to guessing strategies, these measures show an advantage for expectation-consistent information above expectation-inconsistent information. The advantage for expectation-inconsistent information that all other measures reveal seems to be due to expectation-inconsistent information being processed in a deeper or more elaborate manner than expectation-consistent information.

Expectations and Verbal Communication

Apart from affecting the perception of expected and nonexpected events and behaviors, expectations may affect how observers communicate about these events and behaviors. As compared to nonexpected behaviors, people tend to describe expected behaviors in more abstract terms (the linguistic expectancy bias).

One measurement of the abstractness of a description hinges on the verbs and adjectives being used, with descriptive action verbs (describing an observable overt behavior, usually implying an invariant physical element) representing the most concrete level and with adjectives representing the most abstract levels. The intermediate levels are represented by interpretative action verbs (describing a broader semantic category to which an observable overt behavior belongs) and state verbs (describing internal states) and, in some conceptualizations, by mixed types of verbs. Imagine, for instance, that an observer views a female passer-by slap a male soccer hooligan. The observer may describe the incident as 'she slapped him' (descriptive action verb), 'she abused him' (interpretative action verb), 'she hates him' (state verb), or 'she is aggressive' (adjective). Interestingly, the more the observer had expected the behavior the more abstract his or her description generally is. In the example described previously, the observer is more likely to use concrete verbs to describe the scene than if he or she had viewed a male soccer hooligan slapping a female passer-by.

The effect of expectations on verbal communication is important because it facilitates the interindividual spreading of expectations. As compared to concrete descriptions, abstract descriptions do not only communicate that the speaker or writer expected the event. On an implicit level, it also suggests that the listener or reader should in turn expect the behavior.

Interestingly, the more abstract a description is the more evidence it seems to be based on. As compared to communication about unexpected behaviors, therefore, communication

about expected behaviors suggests that it is based on a larger informational basis. In addition, abstract descriptions are harder to verify or to falsify than concrete descriptions are. Whenever a message refers to a directly observable behavior, readers or listeners may easily determine whether it is truthful or not. If, in contrast, a message refers to a broader semantic category of behaviors, nonobservable behaviors, or personality characteristics, it is much more difficult for readers and listeners to prove that it is true or that it is false. Because people generally assume that interpersonal messages are truthful unless proven otherwise, communications about expected behaviors thus get accepted more easily (because it is more difficult to falsify them) than communications about nonexpected behaviors do.

Apart from affecting the verbalization of behaviors, expectations may also affect how listeners or readers decode verbally described events and behaviors. This effect is particularly well documented in the case of natural language quantifiers such as the ones that are used to verbally describe probabilities. A word like 'probable' may be interpreted as denoting different probabilities depending on whether it is used to describe events that *a priori* seem likely versus to describe events that *a priori* seem unlikely. For instance, the statement that 'it will probably rain tomorrow' may be interpreted by listeners or readers as denoting a much higher likelihood when the forecast is about the weather in Belgium than when it is about the weather in California.

Expectations Affect Reality

Perhaps the most intriguing characteristic of expectations is that they may make themselves come true. Among the best known manifestations of this phenomenon is the treatment belief effect (better known as the placebo effect) that is said to occur when the expectation that a treatment will work in itself induces improvement. However, expectations affect reality in a variety of other situations as well. Interpersonal expectations sometimes lead observers to behave in such a manner that they encourage or even evoke the expected behaviors or performances in others. One well-known example of such interpersonal self-fulfilling prophecies is the so-called Pygmalion effect, indicating that individuals about whom high expectations exist do show an improved performance. The Pygmalion effect has been extensively studied in the context of teacher expectations, with the scientific consensus presently being that teacher expectations do affect pupil performance in a robust manner yet to a typically small extent. Yet, self-fulfilling prophecies are also involved in demand effects (also known as experimenter bias, occurring when an experimenter evokes the expected behaviors in participants) in studies with both human and animal participants.

One particularly intriguing manifestation of a self-fulfilling prophecy is stereotype threat. This phenomenon occurs when a negative stereotype evokes a stereotype-consistent bad performance in members of the stereotyped group. In order for it to occur, a set of conditions must be met. First, group members must be aware of the negative stereotype that exists about their social group (e.g., women must be aware of the stereotype saying that women are worse at mathematics than men are).

Second, their group membership must be salient, either because it chronically is or because situational cues draw the group members' attention to it (e.g., women having heard sexist jokes or having seen sexist commercials). Third, group members must be aware of the fact that the task at hand calls on the ability that their group supposedly lacks (e.g., women knowing that a test they take measures mathematical ability). Fourth and finally, the relevant achievement domain must be personally important to them (e.g., women who wish to pursue a career in mathematics). When these conditions are met, group members may underachieve as compared to a situation in which they are not met and as compared to other groups.

The opposite of a self-fulfilling prophecy is a self-defeating prophecy or an expectation that falsifies itself. Self-defeating prophecies have been studied less intensely than self-fulfilling prophecies. One example of how expectations may both validate and falsify themselves is to be found in the domain of affective expectations. These expectations affect actual emotional experience such that either assimilation effects (with the actual experience being more similar to the expected one than if the expectation had not existed) or contrast effects (with the actual experience being more dissimilar to the expected one than if the expectation had not existed) may occur.

Conclusion

Expectations are ubiquitous in human behavior. The frequently occurring impression that one's expectations are borne out may be due, at least in part, to the sometimes distorting effects of expectations on behavioral, affective, and cognitive processes. However, the mere existence of successful instrumental and classical learning processes reveals that people can and do develop adequate expectations.

See also: Classical Conditioning; Hope and Optimism; Intention; Motivation; Operant Conditioning; Planning; Prejudice, Discrimination, and Stereotypes (Racial Bias); Self-Efficacy; Self-Fulfilling Prophecy;

Social Loafing (and Facilitation); Social Values (Influence on Behavior); Surprise; Uncertainty.

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Extraversion–Introversion

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Glossary

Correlation A statistical method for determining the degree and direction of relationship between psychological variables.

Extraversion A major personality dimension that includes measurable traits such as sociability, activity, and dominance.

Factor analysis A statistical technique that combines clusters of correlated variables into broader categories.

Personality A field of study that focuses on describing individual differences in human behavior and identifying the causes that characterize our unique ways of thinking, feeling, and acting across situations.

Traits Relatively consistent and enduring ways of thinking, feeling, and behaving.

Extraversion: An Overview

Alison and Milla are a study in contrasts. Both young women have entered their first year of university and have been assigned to share a room in the university residence. Alison is described as a ‘bubbly’ person, full of charm and wit – a real go-getter. She is active in many campus clubs and can always be found with a group of friends. She enjoys dancing and lively music, plays various team sports, loves to travel, and seems willing to try most things at least once. She is well liked and popular and often at the center of events. She has indicated that she would enjoy work that has lots of action and change to it rather than an office job.

In contrast, Milla is a somewhat shy and retiring person who is much more content to work on her studies in the library or at her desk in the residence. She prefers quiet meals and going to movies or reading a book to the more outgoing activities of her roommate. She is not especially well known by fellow students as she tends to move rather quietly from class to class. She has several close friends whom she knows from her public school days. Her expectation is to major in history and English, and author books or work as an archivist.

Whatever commonalities and differences exist between these two people, one particular personality dimension comes to the fore. The various behaviors, actions, and preferences would suggest that Alison and Milla vary along the personality continuum defined as extraversion–introversion. Extraverts, like Alison, manifest a relatively consistent and stable profile, characterized by such descriptors as sociable, lively, active, carefree, and sensation seeking. Milla more clearly falls toward the other end of the continuum, which defines introverts, people who are quiet, reserved, passive, controlled, and less sociable and outgoing.

Extraversion is seen by many psychologists as a major personality dimension that is very important in formulating a description of human behavior and particularly of individual differences. Psychologists have created numerous concepts in an effort to explain, understand, predict, and even change or modify human behavior. But, in order to understand the nature and relevance of extraversion (E), consideration must be given to a number of basic questions that are of critical importance when examining any personality description. The discussion of E that follows focuses on the following themes: historical perspectives, current views of personality, personality measurement, the biological basis of E, cross-cultural studies, and relationships with other human characteristics.

History

Efforts to describe how we both differ from each other and how we are the same certainly predate the development of psychology as a scientific discipline and a profession. In fact, the term personality is derived from ‘persona,’ the Latin word meaning mask that refers to characterization in early Roman theater. Astute descriptions of personality appear in the works of early Greek and Roman philosophers and writers such as Theophrastus and Cicero. The attempt to explain those differences in personality in a systematic way can also be traced to an early period in Roman history, notably in records of Galen of Pergamum (c130–c200 AD), who was a physician to early Roman emperors. The schema that Galen espoused, the humor theory of temperament, was remarkably influential and resilient over many centuries, and indeed, vestiges of this schema are linked to the modern personality description of extraversion.

For Galen, humors were bodily fluids that influenced the health, physiognomy, and character of man. There were four primary humors, *chore* (bile), *melanchole* (black bile), *sanguis*

[†]Deceased.

(blood), and *flegma* (phlegm). These four humors were understood in the context of a general cosmological theory where fire, earth, air, and water were conceived as the four basic elements of all things. As expressions of bodily processes, psychological characteristics were influenced by the particular blend (L. temperare) of the four humors, that is, temperament. For example, steadiness and solidity was thought to depend on black bile (melancholy), whereas simple mindedness came from blood (sanguine). In the analysis of Galen's work that survives today, it is clear that he mainly addressed medical problems. His observations of character were infrequent and bear little resemblance to the adjectives ascribed to the humor categories by later authors. Further, the humor theory as a framework for understanding health issues was displaced by progress in medical science. Nevertheless, as a descriptive personality classification schema, the four temperament categories prevailed during the eighteenth and nineteenth centuries, notably in the work of German philosophers Immanuel Kant and Wilhelm Wundt.

Both Kant and Wundt developed schemas of personality adjectives that expressed the four temperament categories in terms of two concepts. For Kant, the two concepts were feelings and activity. The sanguine temperament was characterized by strong, short-lasting feelings in contrast to the melancholic temperament characterized by weak, long-lasting feelings. The choleric temperament was characterized by intense, but brief activity in contrast to the phlegmatic temperament that was characterized by weak, but enduring activity. This schema yielded four independent temperament categories based on two dimensions. For Wundt, the two concepts were strength of emotion and changeability. Although the two concepts are similar to those employed by Kant, Wundt shifted the emphasis from four independent categories to a two-dimensional system that encompassed the four types. In this schema, the choleric and melancholic are characterized by strong emotion (unstable) in contrast to the sanguine and phlegmatic that are characterized by weak emotions (stable). The sanguine and choleric are characterized by rapid change in contrast to the melancholic and phlegmatic that are characterized by slow change. In terms of semantics, the unchangeable–changeable dimension and the strong–weak emotion dimension in Wundt's schema clearly resemble the extraversion and neuroticism dimensions, respectively, that were developed by Hans Eysenck using modern statistical methods. The relation between the classical four temperament types from Wundt's depiction and Eysenck's results is illustrated, using modern statistical methods of personality description, in Figure 1.

During the early part of the twentieth century, there were significant advances in the application of mathematical concepts to the study of individual differences, which enabled personality description to move from the insightful categorical association of descriptive personality adjectives as discerned by Kant and Wundt to a rigorous, objective clustering of adjectives, using statistical methods. This advance in statistical methods was pioneered by several significant figures, notably Francis Galton, who developed the correlation statistic and Charles Spearman, who developed a procedure, factor analysis, for grouping correlation statistics into a common factor. During this period, the terms introversion–extraversion emerged in the personality description literature, effectively

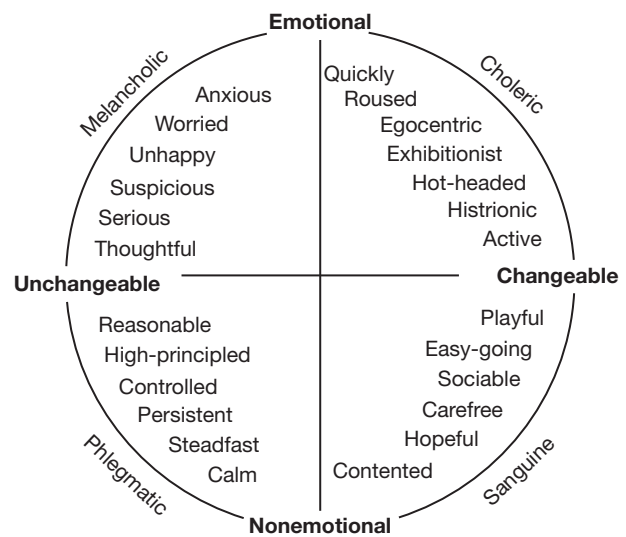


Figure 1 Representation of the four classical temperaments using Wundt's schema and adjectives from modern descriptions of extraversion (changeable–unchangeable) and neuroticism (stable–unstable).

replacing the terms unchangeable–changeable from Wundt's schema. Although the original introduction of introversion–extraversion in psychological literature is obscure, it is clear that the terms were popularized in the hugely successful writing of the Swiss psychoanalyst Carl Jung. This popularity led several investigators (e.g., J. P. Guilford and R. B. Cattell) to develop psychometric tests of introversion–extraversion. This dimension is prominent in all modern personality classification systems.

Neither Kant nor Wundt offered a causal basis or theory of temperament to replace Galen's humor theory. Early in the twentieth century, there were several scientists who suggested physiological processes to account for differences in the temperament categories. Notably, Ivan Pavlov, famed for his contributions to learning and conditioning theory, applied the neurophysiological concepts of excitation and inhibition to explain the four temperament types. Introversion and extraversion types were included in an all-encompassing theory of personality developed by Carl Jung. In his theory, personality was determined by innate dispositions (instincts), culture, and conscious and unconscious processes. In 1929, from current knowledge of the nervous system, William McDougall outlined a hypothetical chemical theory that presaged our contemporary understanding of the biological basis of introversion–extraversion. In his proposal, greater cortical inhibition, mediated by a hypothetical neurochemical factor, effected the behavioral restraint and reticence exhibited by introverts. A similar course of inquiry blossomed in the biological basis of introversion–extraversion proposed by Hans Eysenck in 1967.

Contemporary Views of Extraversion

Psychologists have been and are still actively engaged in the debate as to whether human personality can be best and most meaningfully described with the aid of only a few or many

'words.' One can very quickly create an exhaustive list of personality descriptors commonly found in the lexicon: for example, happy, bright, friendly, kind, assertive, honest, sullen, patient, etc. At the same time, we can accurately and concisely describe individuals along such major dimensions as extraversion-introversion when we recognize that some human characteristics or behaviors share much in common with others (e.g., shy, withdrawn, nonassertive, not talkative, quiet, loner, etc.). Psychologists' attempts to reduce human behavior to a finite set of descriptions are not an attempt to impose an artificial and nonworkable solution onto a truly complex personality description, but rather, an attempt to find the most meaningful and parsimonious means of representing human personality.

As already described, extraversion has its roots in the early Galen-Wundt theory of the four temperaments but has been more recently elaborated by such notable contemporary psychologists as R. B. Cattell, H. J. Eysenck, L. Goldberg, J.A. Gray, J. P. Guilford, J. Wiggins, and P. Costa and R. McCrae. Extraversion is also included in other personality models but under different names. Further, E scales appear on all of the Eysenck personality measures, beginning with the Maudsley Personality Inventory and Eysenck Personality Inventory to the more recent Eysenck Personality Questionnaire series (EPQ and revised scales such as the EPQ-R and Eysenck Personality Profiler, EPP), where it constitutes one of the three major personality variables.

The description of individuals according to a small number of personality dimensions is frequently referred to as the trait approach. Essentially, through the use of sophisticated statistical techniques, such as correlational and factor analysis, psychologists have reduced the large number of behavioral descriptions to a much smaller number of stable and generalizable characteristics that make possible the explanation and prediction of individual differences and similarities possible. This view rests on the assumption that a meaningful model of personality can be based on a smaller but more powerful set of traits that are remarkably stable across time and differing situations.

Very briefly, E appears as a major personality variable in almost all the current trait descriptions, whether by name or as a result of further research investigations stimulated by these theories. An ongoing debate is whether personality is best described, for example, by the 16 primary traits suggested by Cattell, or the 'big 5' trait dimensions emphasized by Goldberg and Costa and McCrae, or by the '3 super factors' described by Eysenck. A consistent finding from the research studies is the emergence of a robust factor that may be called extraversion. Analysis of large numbers of responses to the various personality questionnaires seems to invariably produce an E factor. The two most influential trait theories today agree that E is one of the major dimensions. Eysenck adds two other major personality dimensions labeled neuroticism (N) and psychoticism (P). Costa and McCrae add neuroticism, openness to experience, agreeableness, and conscientiousness to their extraversion factor to produce the 'big 5' trait dimensions of their Five Factor Model.

Some of this confusion may be clarified by examining how Eysenck has developed his personality model with particular reference to E. His system is a hierarchical one and begins with

single acts or thoughts. The second level focuses on more consistently occurring behaviors and cognitions. Next comes the level of traits and finally types that reflect a composite of various correlated traits. Thus, each level is more encompassing and inclusive than the previous level. With respect to E, it is a dimension that encompasses a number of trait descriptors such as happy, cheerful, sociable, lively, assertive, and carefree. It is the observed intercorrelations between these traits that justify our postulating the existence of extraversion. This structure is shown in Figure 2. Similarly, for the other major high-order concept, neuroticism, traits that intercorrelate and thus define it are shown in Figure 3.

How can we justify such a typology? Table 1 shows six questions supposed to measure E, and six questions supposed to measure N. We can collect large numbers of answers from random samples of the population, intercorrelate the answers, and check whether the patterns of intercorrelations and more parsimonious factor analysis results give us two independent factors corresponding to E and N. Should we obtain the results shown in Figure 4, it is obvious that the results support the theory.

We do not have to rely on self-ratings to obtain such evidence. Figure 5 shows the results of such a factor-analytic investigation of the relation between ratings made of thousands of children in a child guidance clinic, using items of behavior. It will be seen that extraverted children demonstrate conduct problems, and introverted children personality problems. Of course, all of these children are essentially high N scorers; children with low N scores would simply be more outgoing behaviorally when extraverted, and unsociable when introverted.

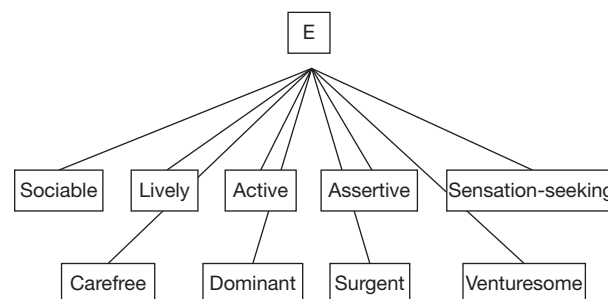


Figure 2 Some traits defining extraversion.

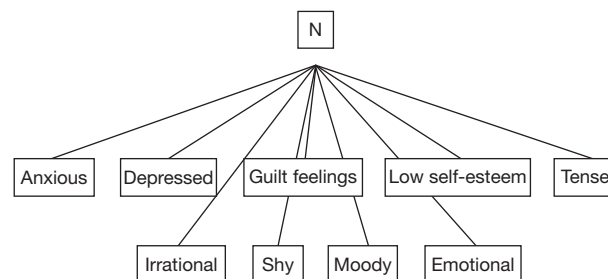
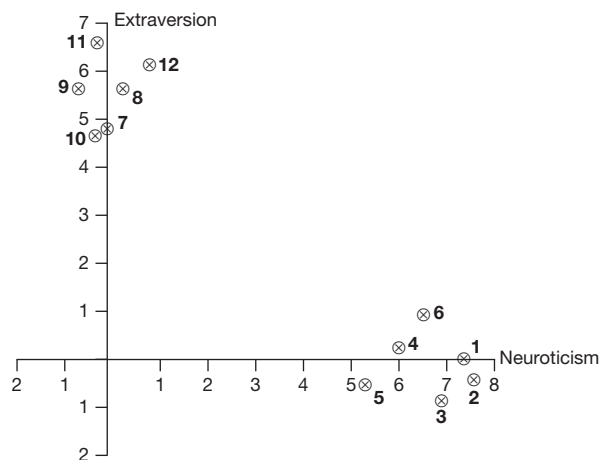


Figure 3 Some traits defining neuroticism.

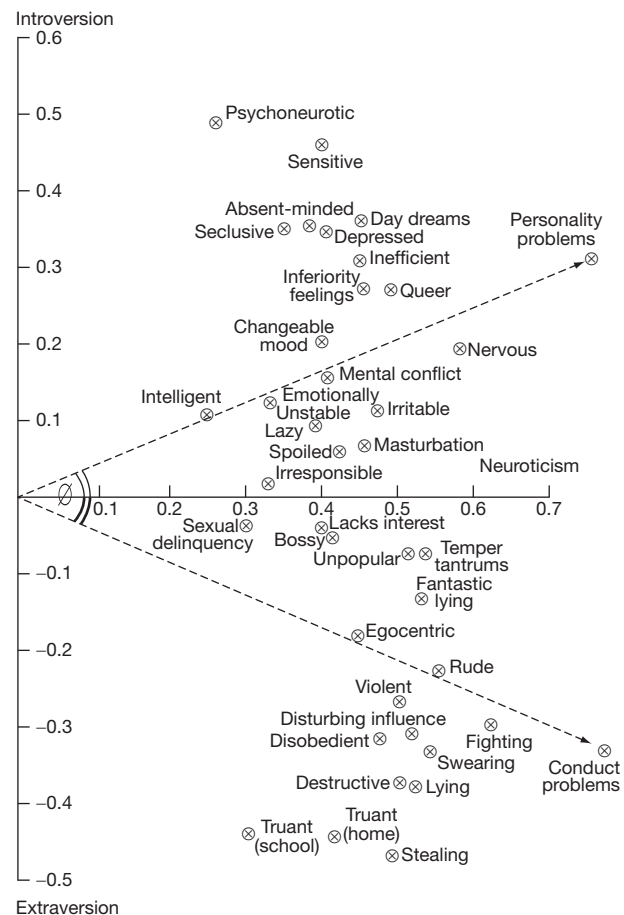
Table 1 Questionnaire items measuring extraversion–introversion

Questions	Key
1. Do you sometimes feel happy, sometimes depressed, without any apparent reason?	N
2. Do you have frequent ups and downs in mood, either with or without apparent cause?	N
3. Do you worry a lot?	N
4. Does your mind often wander while you are trying to concentrate?	N
5. Are you frequently 'lost in thought' even when you are supposed to be taking part in a conversation?	N
6. Are you sometimes bubbling over with energy and sometimes very sluggish?	N
7. Do you like surprises and spontaneous activities?	E
8. Are you happiest when you get involved in some project that calls for rapid action?	E
9. Do you usually take the initiative in making new friends?	E
10. Are you inclined to be quick and sure in your actions?	E
11. Would you rate yourself as a lively individual?	E
12. Would you be very unhappy if you were prevented from making numerous social contacts?	E

**Figure 4** Relative position in two-dimensional space of six neuroticism and six extraversion questionnaire items.

Jung had earlier put forward the hypothesis that introverted neurotics would present with psychasthenic or dysthymic symptoms (anxiety, depression, apathy), while extraverted neurotics would show hysterical symptoms (hysterical attitude, conversion symptoms). A study of the behaviors and attitudes of hundreds of neurotics bore out this theory as shown in [Figure 6](#). These empirical studies will give an idea of the structure of personality.

A discussion of empirical findings that help us to better understand extraversion follows. It is important to know about the theories and models that psychologists have created to account for and explain extraversion. The most thorough and widely accepted is the theory put forward by the late Professor Hans Eysenck (1916–1997), who spent much of his professional career at the Institute of Psychiatry, University of

**Figure 5** Two-factor representation of conduct and personality problems in children, showing breakdown into extraverted and introverted groups.

London. The ensuing discussion draws extensively from the theoretical and research contributions of Professor Eysenck. A question that is frequently asked is how psychologists measure variables such as extraversion. A number of questionnaires have been developed and are mentioned below. While a description of the structure of personality is important, it is equally important to examine its causes. Extraversion would not be a very useful person description if it only served as a summary label for a collection of human behaviors. Of considerable importance are questions related to whether extraversion is learned or whether genetic factors determine a person's position on the extraversion dimension. What are the biological underpinnings of extraversion, and are there certain brain structures or functions that underlie an individual's behavior along the introversion–extraversion dimension? Further points that must be addressed relate to the robustness of extraversion such as: can it be identified cross-culturally? What extraversion, or any other personality factor, tells us about other aspects of human functioning is of relevance. For example, are extraverts more or less prone to certain psychiatric illnesses? Are there differences in various performance indicators between extraverts and introverts?

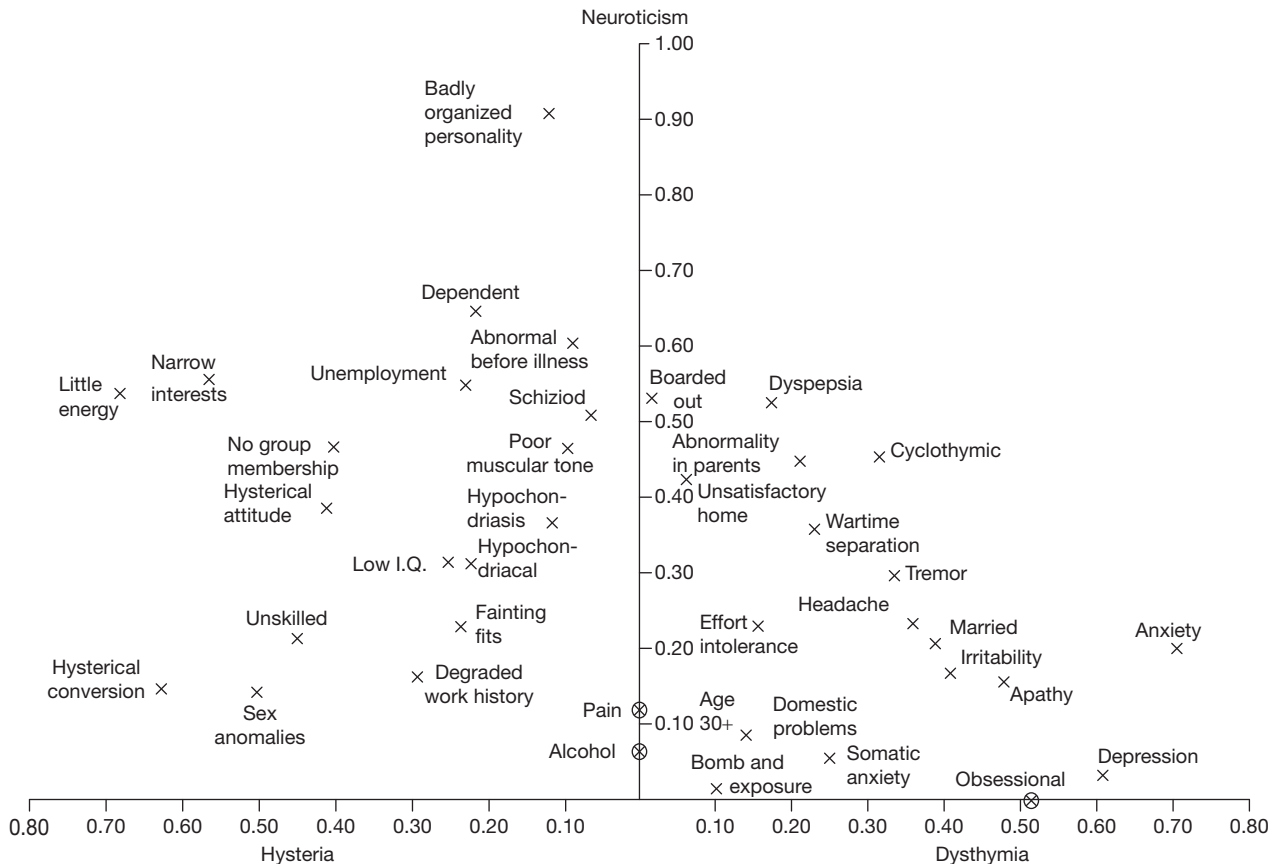


Figure 6 Behaviors and characteristics of introverted and extraverted neurotics.

The Measurement of Extraversion

Psychologists employ various procedures for gathering information about human behavior. We may observe a person in a structured situation or in more natural settings. The person may be interviewed or we can ask others to tell us about the person. Various tests can be conducted to determine, for example, how an individual reacts to stressful situations or responds to tasks that require the learning of new behaviors. In some instances, we gather information that tells about the person's internal condition such as the level of cortical arousal (EEG or MRI scans). Various biochemical influences on personality can be examined by extracting samples of hormones such as testosterone and cortisol, or neurotransmitters including monoamine oxidase, dopamine, or serotonin. We may also assess personality with self-report questionnaires. It is this personality test, inventory, or questionnaire method that is most commonly used to assess variables such as extraversion.

Hans and Sybil Eysenck have developed the most well-known and frequently used personality measures of extraversion. Recent versions include the EPQ-R, for which there are both adult and child forms. This questionnaire contains items that are answered with a 'yes' or 'no' and measure the three superfactors of extraversion, neuroticism, and psychoticism. It also includes another scale that measures untruthfulness, faking, or social desirability (e.g., answering questions in a way that presents a supposedly more 'desirable' profile of the

Table 2 Please respond to the following statements with 'yes' if you agree that they more or less describe you. Answer 'no' if the statement is not a reasonably accurate description of you

1. I like loud music
2. I would much prefer a quiet evening at home to going to a party
3. Driving fast cars would appeal to me
4. I am easily bored
5. I enjoy meeting new people and having lots of friends
6. I make decisions in a very methodical and deliberate way
7. I would not enjoy traveling to new and different places
8. Others see me as an easygoing and carefree person

There are no right or wrong answers.

person). More recently, the EPP has replaced the EPQ in both professional and research use.

Since extraversion, in the main, taps traits and behaviors such as those shown in [Figure 2](#), the kinds of items that might be found on such inventories may look like the example questionnaire shown in [Table 2](#).

While these are not actual items from the EPQ or EPP, they do reflect the kind of content and appearance found in measures of extraversion. If 'yes' were answered to questions 1,3,4,5, and 8 and 'no' to questions 2,6, and 7, then the respondent would likely be more of an extravert than introvert.

Many hundreds of studies have been conducted that focus on how useful and 'good' these questionnaires are at assessing

introversion–extraversion. Interested readers may wish to examine the journal *Personality and Individual Differences*, for research papers reporting results of studies with the EPQ, EPP, and related measures. The Eysenck scales show consistently high reliability (an indication of the test's precision, consistency, and stability) and validity (an indication of whether the test measures what it was intended to measure). Unfortunately, in addition to the Eysenck measures, other scales developed to measure extraversion differ in the relative mixture of the affective, behavioral, cognitive, and goal-seeking components, which has caused some confusion in the research and clinical literature.

The Basis of Extraversion

Trait models of personality are sometimes criticized for apparently claiming to explain differences in behavior by simply postulating the existence of traits based on that behavior. How do we describe social shyness? We correlate a number of questions related to that trait, extract the factor of social shyness, and then describe the observed behaviors by the very trait label based on the analysis of these behaviors! But this criticism is incorrect. In the first place, we carry out the statistical analyses in order to discover whether our original notion was correct, that is, that there was in fact only one factor of social shyness. At first sight, it may seem obvious that this is so, but, in actual fact, it may not. When we take a large sample of items relating to sociability, social shyness, and similar notions, calculate the correlations, and factor analyze the resulting table of correlations, we find, not one factor, but two. There is an introverted social shyness, defined by items that tell us that introverts do not particularly like being with other people and prefer being by themselves most of the time. However, they are not worried about being with other people and can perfectly sustain social interactions. There is also a quite independent type of neurotic social shyness, where people are actually afraid of others and avoid them for that very reason. They would like to socialize with others, but are prevented from doing so by their worries and anxieties about social relations. Thus, a statistical analysis of this kind is carried out in the main to see whether our commonsense beliefs are justified or not, and in many cases what is found is that they are not. In other words, we have to solve the problem of personality description before we can go on to attack the problem of causality. Factor analysis and other correlational methods are not meant to tell us anything about causality, but to act as tools for the discovery of a useful personality taxonomy. Having solved the problem, we may then go on to carry out the more difficult task of discovering why some people are sociable, others quite less so, and why some people are extraverted, others introverted.

Hereditary Influences

The first step in such a causal analysis must be to discover to what extent differences in behavior are determined by heredity, and to what extent they are determined by environmental factors. For many years, personality theorists took it for granted

that environmental factors, and particularly the influence of the family, were the major, if not sole, determinants of individual differences in human behavior. Early studies of identical and fraternal twins seemed to support such a view, but improved research methods have challenged this assertion.

There are several ways of assessing the relative importance of nature and nurture. The first, and probably the most important, is to study identical twins (monozygotic (MZ) twins) who were brought up from birth in different environments, that is, were adopted. Identical twins share 100% heredity, being the product of a single ovum, fertilized by a single sperm, and then separating into two separate entities. MZ twins separated at birth share identical heredity, but have completely different environmental influences determining their behavior. We get an accurate estimate of the importance of heredity by looking at the intercorrelations between such MZ twins; if environment were all-important, there should be no correlation at all. In fact, several studies have shown quite high correlations, suggesting that heredity accounted for at least 50% of the total difference observed.

Similarly, we can compare MZ twins and dizygotic (DZ) twins; that is, fraternal twins who share, on the average, only 50% heredity, and are no more alike than ordinary siblings. If heredity was important, we could expect MZ twins to be much more alike than DZ twins, and this is precisely what is usually found. So here again, we have evidence for the importance of heredity. These and other studies, on topics such as whether adopted children are more alike in personality with their biological or their adoptive parents, leave us in no doubt that heredity is extremely important. They also show that the theory implicating only the family is quite wrong. We can divide the environmental factors determining differences in personality into those between families, emphasizing the importance of family upbringing, and those within family, emphasizing the environmental differences between different children coming from the same family, such as one having a good teacher, the other a poor one, or one marrying a kind and loving person, the other an abusive, unsupportive one.

Several very large-scale studies have now shown that it is the within-family environmental factors that affect individual differences in personality between children, not those between families, a finding that demonstrates that practically all the usual theories of personality are in fact inadequate, and have to be revised or replaced. Most current personality theories have now taken the implications of genetics into account. What is important to remember here, however, is that even very high heritabilities do not imply a lack of malleability; nor do they deny the possibility of changes over the life span. Heritability is a within-cohort measure that increases with a lack of environmental variability; heritability estimates say little about mean changes over time or what happens if the environment is systematically varied.

The Link Between Biology and Extraversion

The compelling evidence from behavioral genetic studies confirms the important contribution of heritable, constitutional factors to the development of personality. This evidence endorses the views of scholars, from Galen to McDougall and

Pavlov, who speculated on the physiological determinants of personality. Only physiological processes, under the control of DNA, are heritable. During the twentieth century, there was considerable research that aimed to identify the psychological processes and neurological mechanisms that mediated individual differences in personality. Foremost in this research enterprise was the leadership provided by Professor Hans Eysenck and his colleagues at the Institute of Psychiatry, University of London, in their studies on introversion–extraversion and individual differences in cortical arousal.

From the 1950s, there was widespread interest in the idea that a continuum of neurophysiological states of arousal, ranging from sleep to alertness and excitement, was important in influencing such psychological processes as attention, motivation, and learning. Importantly, it was shown that low-amplitude, high-frequency EEG activity, associated with wakefulness and attention, and high-amplitude, low-frequency EEG activity, associated with sleep and drowsiness, were modulated by activity in the ascending reticular activation system (ARAS). The ARAS is a diffuse network of neural fibers that are innervated by collaterals from the main sensory pathways and that project to the midbrain and higher cortical centers. The discovery of the ARAS provided a plausible physiological basis for the arousal continuum and for the psychological processes involving modulation of sensory inputs that it served. Several of these psychological processes were known to differ between introverts and extraverts. For example, compared to extraverts, introverts tended to be more alert (as indicated by stronger reactions to stimulus change) and to be more vigilant in situations that demanded sustained attention. It was in this context that Hans Eysenck proposed the arousal hypothesis in 1967 as an explanation for individual differences in introversion and extraversion (Figure 7).

The central hypothesis identified individual differences in behavior between introverts and extraverts, with differential thresholds of excitation and inhibition in the various parts of the ARAS. It was suggested that, compared to extraverts, introverts were characterized by higher levels of activity or lower

levels of excitation in the ARAS. In general, it was expected that the responses of introverts and extraverts would be affected differently in psychological processes and psychophysiological measures that were thought to be sensitive to the stimulus-modulation function of the ARAS. The hypothesis inspired hundreds of experiments and continues to guide research on the topic even as personality theory and ARAS brain physiology advances. From this substantial body of work, some induction of the causal bases of extraversion can be made from the reliable effects that were demonstrated and from research employing different methods and paradigms that converge on common processes.

First, there is considerable research, both in the field and in the laboratory, demonstrating that introverts are more sensitive than extraverts to sensory stimulation. This effect can reasonably account for some social behavior that is displayed by introverts, that is, their preference for quieter environments and solitude and avoidance of noisy environments and intense stimulation, such as partying. For example, one project investigated introversion–extraversion and the area where a person preferred to study in the library. Introverts tended to prefer sitting in quieter corners of the library whereas extraverts seated themselves closer to the noisier, well-traveled areas, although there is the view that an impulsivity effect underlies these reported differences. In another example, when given the opportunity to set the volume on the radio to their preferred listening level, on average, introverts set the volume level 20 decibels lower than did extraverts. In the laboratory, under rigorously controlled conditions, introverts exhibited greater sensitivity to sound and taste stimuli, that is, lower auditory and gustatory thresholds. Similarly, introverts show less tolerance for intense sensory stimulation, as evidenced by lower pain thresholds and noise thresholds.

The behavioral differences in response to sensory stimulation are also evident in psychophysiological indices that gauge the physiological response to sensory stimulation. When small metal electrodes are placed on the finger tips to record minute changes in sweat gland activity, the greater sensitivity of introverts compared to extraverts to brief moderate-intensity tones is evident in their larger skin conductance response, that is, greater sweat gland activity. From electrodes placed on the scalp, introverts exhibit larger electrocortical responses (event-related potentials) to simple auditory stimulation. Similarly, with techniques that measure the speed at which eye blinks are initiated, introverts display faster startle reflex responses than extraverts to moderate-intensity noise bursts. It was also found that introverts are characterized by faster brainstem auditory evoked potentials (BAEP) than extraverts. This effect too is indicative of greater auditory sensitivity for introverts. However, BAEP waves develop very early in the auditory pathway, prior to excitation of the ARAS, and they are relatively independent of descending cortical influences (the waves are unaffected by either sleep or arousal). Thus, the BAEP effects cannot be easily accounted for by differences in the ARAS as originally proposed.

It is also important to note that the described differences between introverts and extraverts reflect differences in response to stimulation rather than tonic or base levels of arousal. This conclusion is drawn from the absence of differences when autonomic nervous system measures of arousal, such as sweat

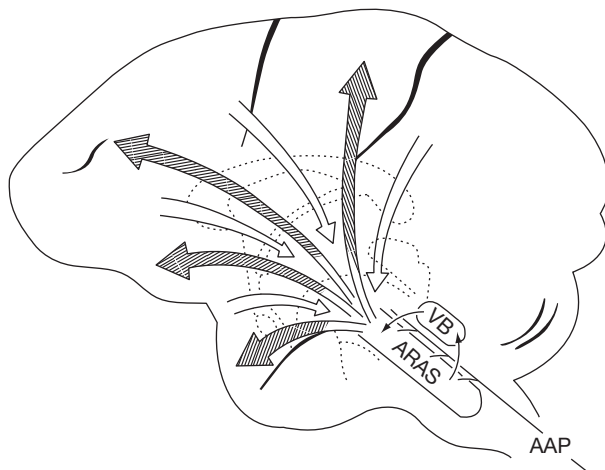


Figure 7 Diagrammatic representation of the interaction between the limbic system (visceral brain) and the reticular–cortical arousal system. Copyright © 1967, H. J. Eysenck.

gland activity (skin conductance), are obtained prior to sensory stimulation and in conditions that have low arousal potential. Notably, differences are seldom reported with EEG measures in low-arousing conditions or during sleep. In effect, it is the reaction to stimulation, rather than endogenous differences in level of physiological activity, that differentiates introverts and extraverts. This conclusion challenges the idea that extraverts seek stimulation in order to achieve an optimum level of arousal.

An important clarification of the arousal hypothesis was the distinction between energetic and tense arousal. Energetic arousal, which contrasts energy versus sleepiness, varies over the day in a clear diurnal rhythm. Tense arousal, reflecting a dimension of tension and worry versus calm and relaxed, varies in response to situational demands. While not differing in their tense arousal, introverts and extraverts do differ in the phase of their energetic arousal. Introverts have a somewhat earlier peak level of energetic arousal than do extraverts. More importantly, high energetic arousal is associated with increased activity and sociability rather than the inverse relationship that would be expected by the arousal-seeking hypothesis.

Introverts and extraverts are also known to differ in a range of social behaviors that can be linked to differences in movement or motor activity. These differences in the expression of motor activity provide a plausible basis for understanding the greater spontaneity, sociability, and liveliness of extraverts. For example, extraverts are more disposed to participate in physical activities and sports than introverts. Extraverts are more talkative and initiate conversation more frequently than do introverts during interview situations, and they are more restless (fidgety) in restricted environments. In controlled laboratory experiments, faster reaction time is commonly observed for extraverts than for introverts. On a task that involves tracking a small target on a revolving disk and requires refined motor control, extraverts show less effective tracking performance than do introverts. In reaction time tasks, where participants are instructed to respond as quickly as possible, extraverts tend to make more false-positive errors than introverts. These effects indicate that extraverts inhibit the initiation and control of movement responses less readily than introverts.

In reaction time tasks, it is understood that the task involves a cognitive decision to respond when a cue to respond is presented and a movement response that typically requires pressing a response button. Decision time and movement time can be separated in reaction time tasks by measuring the time from the onset of the cue to respond to the release of a home button that is, decision time, and by measuring the time from the release of the home button to the press of the response button, that is, movement time. In a series of studies, it was consistently observed that extraverts exhibited faster movement time than introverts, but that there were no differences in decision time. In effect, it was motor activity rather than cognitive activity that was the discriminating factor. Moreover, it was clear that this movement time effect was due to the faster initiation of movement for extraverts than introverts rather than the speed of the ballistic motor response.

The behavioral differences in motor activity between introverts and extraverts were also explored using psychophysiological indices of movement responses. In the recording of electrocortical activity during reaction time tasks, extraverts displayed greater response amplitude than did introverts in

the interval between a warning signal and the cue to respond. This effect is indicative of greater response motor preparation for extraverts than introverts. It has also been observed that extraverts exhibit slower motor-neuronal recovery than introverts following the discharge of motor reflexes, an effect linked to increased dopaminergic activity for extraverts.

Differences in motor activity between introverts and extraverts were also examined with an electrocortical response measure, the lateralized readiness potential (LRP), that directly assesses movement initiation processes following stimulus-related processing. In this procedure, the duration of premotor activity, including stimulus analysis, response preparation, and some aspects of response selection, is distinguished from the duration of motor activity, independent of stimulus processing. With this task, shorter response-linked LRP latencies were found for extraverts than introverts, indicating faster speed of motor processing for extraverts than for introverts. There were no differences between introverts and extraverts, however, for stimulus-linked LRP latencies. Again, it is the motor component of the response process, which favors extraverts, rather than the cognitive analysis component that is the relevant factor in this analysis. Overall, these results indicate that introverts and extraverts are characterized by fundamental differences in the expression of motor activity.

Given the remarkable differences between introverts and extraverts in sensory sensitivity and in the expression of motor activity that were consistently demonstrated, there remains the important question of identifying the neural circuits and neurochemical properties on which these effects depend. The neural generators of psychophysiological response measures have been extensively explored and do provide some insight into the neural pathways that are involved in individual differences in extraversion. Perhaps more importantly, there is good evidence indicating that dopamine, a neurotransmitter that is thought to modulate the probability and strength of behavioral responses to sensory input, may be implicated in variation in extraversion. Dopaminergic activity in the mesolimbic pathway is involved in locomotor activity and reward behavior. Increased dopaminergic activity in the mesostriatal pathway can enhance sensory sensitivity by counteracting the inhibitory effects of the striatum on the thalamus and ARAS. When alpha-methyl-para-tyrosine (AMPT) was used to block the synthesis of dopamine, both decision time and movement time were markedly slower for introverts during a choice reaction time task. However, AMPT had no effect on the response time of extraverts. Similar results were observed when remoxipride, a receptor blocker that selectively inhibits mesolimbic dopaminergic activity, was used. These important experiments pioneered by Thomas Rammsayer at the University of Bern, Switzerland, indicate that the differences between introverts and extraverts in the transmission of sensory input to motor seem to be a clear function of modulation in the dopaminergic system. As an extension to this work, introversion–extraversion differences in dopaminergic activity may also be related to the sensitivity in detecting and learning cues for reward. That is, with more dopaminergic activity, one is able to learn which environmental stimuli lead to future reward. When presented with positively valenced stimuli, extraverts display more brain activation, as measured by fMRI, than do introverts. This is true for reward cues but not true for cues of punishment and nonreward.

Cross-Cultural Research into Extraversion

There are other consequences of the general theory that E and N are determined very largely by heredity, and that their behavior is mediated by biological structures in the central nervous system and the autonomic nervous system. One of these is that E and N should appear not only in those cultures where the original studies were made (essentially the European-North American culture) but should also be equally characteristic of all other countries. What is asserted is not that all these cultures would be equally extraverted, or similar in emotional lability, but rather that the same factors would emerge in these countries as were found in North America, Australia, etc. The experiments were done in over 35 different countries, including a large number of European, Scandinavian, Slavic (e.g., Russia, Hungary), Southeast Asian (e.g., Japan, China), South American, and African (e.g., Uganda, Nigeria) countries. In all these countries, over 500 males and 500 females were administered the EPQ, and the items were then intercorrelated and factor analyzed to see whether the resulting factors would be the same as the ones we found in England and the United States.

It was found that in all these countries, there were practically identical structures of items, verifying the existence of N and E. Of course, not all countries had identical levels of E and N; Japan was very high on N but lower on E. The United States was very extraverted. Thus, the prediction is verified. Identical factors emerged in many different countries and cultures. Of interest is the fact that similar findings have been obtained across large samples of children from different countries such as Canada, Denmark, Greece, Spain, and Singapore.

Drug Studies and Extraversion

There is another way of testing the hypothesis that personality is mediated by biological mechanisms in the central and autonomic nervous systems. If this is true, then it should be possible to shift the person on the various dimensions involved by means of drugs known to be relevant to the hypothetical underlying structures. Thus, stimulant drugs should make people more introverted because they are known to raise the cortical arousal level, while depressant drugs should have the opposite effect, making people more extraverted. It is well known that alcohol, which is a depressant drug, does make people more extraverted (except in excessive doses, of course), while stimulant drugs have the opposite effect. Similarly, adrenergic drugs lead to greater neuroticism, anxiolytic drugs to greater stability. **Figure 8** illustrates these effects. Also shown is the third major personality dimension, psychoticism, which is increased by hallucinogens and diminished by antipsychotic drugs. A great deal of work conducted along these lines has yielded positive results.

Extraversion and Other Personality Factors

E as a dimension of personality is never found in isolation but is always interacting with other dimensions of personality and with intelligence. Thus, an intelligent extravert behaves very

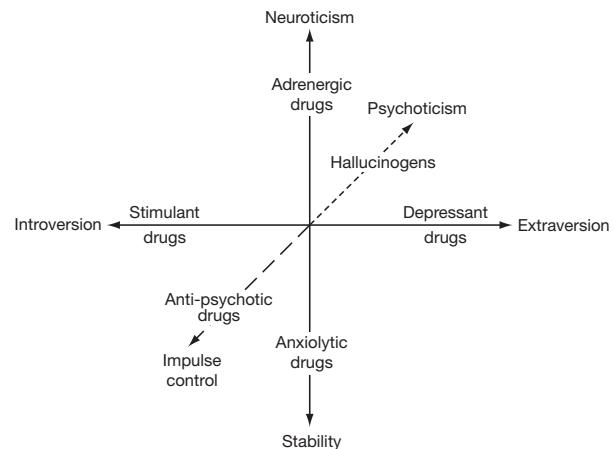


Figure 8 Psychotropic drugs and personality.

differently from a less intelligent one, and a neurotic extravert very differently from a stable one. Furthermore, while extraverts may have the same score on the E scale of the EPP, they nevertheless differ to some extent from each other because they may be characterized in the main by different traits. The sociable extravert is not necessarily assertive, the carefree one not necessarily dominant. These traits are all intercorrelated, but the correlations are far from perfect. Different extraverts may sometimes show different facets, and therefore subtle differences. It should never be assumed that knowing the main dimensions of personality of a given person tells us all there is to know.

The hierarchical system outlined earlier simply tells us that knowing the position of a person on the major dimensions will tell us more about that person than any other similarly restricted data set. If we know a person's IQ score as well as degree of E and N, we will know more about him or her than any other three figures could tell us. This does not mean that there is not a great deal more to be known; if we characterize the person in terms of 40 or 50 traits, we would certainly have a much more detailed picture. But much of this information would be redundant, and we would have great difficulty in absorbing it all. Having a hierarchical theory means that for different purposes, we may choose different levels of analysis. We may be particularly interested in one aspect of E, say sociability, or dominance, and under these conditions, we would obviously prefer to make use of a questionnaire that measures sociability or dominance. Thus, a hierarchical system is very flexible, for it is not committed to working only at the highest level. R. B. Cattell, for instance, preferred to focus on his 16 personality factors, although these are intercorrelated and give rise to higher-order factors very similar to E (which he called 'envia-exvia') and N (which he called 'anxiety'). There is no essential contradiction between the Cattell and Eysenck systems. For all practical purposes, they simply lay emphasis on different levels of analysis; however, the relative weighting of the lower order factors, facets, or aspects does lead to somewhat different conceptualizations of extraversion.

Essentially, what a proper theory of personality must do is look at all the steps, from distal causal factors, such as heredity, to proximal causal factors, such as differences in the

functioning of the limbic system or the ARAS, to the major dimensions of personality like E and N. The theory must then proceed to the study of proximal consequences, such as the study of changeability already mentioned, which is best done in the laboratory. And finally, it must proceed to distal consequences, mainly in the social field, such as sociability or differences in sexual behavior. In the case of E, we have a complete chain, from DNA, through ARAS, to E, to laboratory behaviors, and then on to social behavior. It is not suggested that each element in the chain has been finally located and that no further progress is either required or possible. The concept of cortical arousal presents many difficulties, and there are many anomalies in the experimental analysis of extraverted behavior in those terms. These will be analyzed and solved in future research; at the moment, all we can say is that the theory has much going for it.

Extraversion and Social Behavior

In a complete chain of events, our main interest of course is in the final link, that is, social behavior. An examination of the current research literature implicates E in a wide variety of real-life behaviors including social interactions, sexual activity, work performance, school achievement, psychiatric disturbance, and antisocial and criminal behavior.

For example, it has been shown that traffic accidents are much more frequent in people who are high N and high E. It has also been shown that by using this knowledge in the selection procedure for drivers, the accident rate can be halved. A rather different field is education. There has been a great deal of interest in the last 20 years in the so-called 'discovery learning' or inquiry-based methods, in which students are encouraged to discover basic principles and rules. It has been found, by comparing classes taught by either discovery or reception learning methods, that there is little difference in achievement. This may be due to the fact that both methods are equally good, but it may also be that extraverts learn better by means of discovery methods, and introverts by means of reception methods, as predicted on theoretical grounds. Figure 9 shows the results of one such study, where pupils were taught by one method or the other and then were separated into introverts and extraverts.

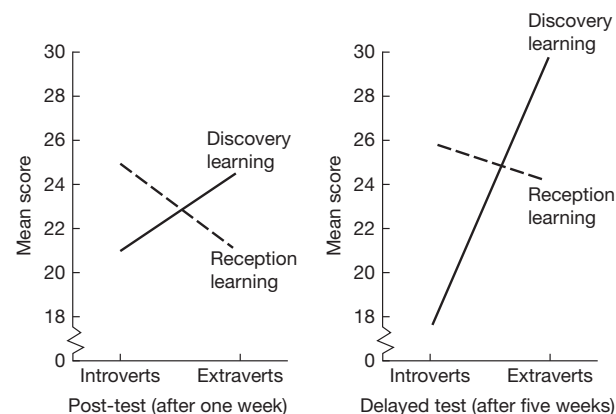


Figure 9 The performance of introverts and extraverts using different learning methods.

The posttest was done after 1 week, and again after 5 weeks. It does show that extraverts do indeed benefit more by discovery learning, and introverts by reception learning.

Conclusion

Most people underestimate the very large individual differences in personality, which heredity has created. We tend to think that most people are like us, just slightly different because of environmental events, particularly events characteristic of a given family. Such a view underestimates the very real differences, which are largely genetic, or, if environmental, have little to do with the way children are brought up in a given family. Theories of personality characteristic of the last 60 years have now been shown to be essentially contradicted by the facts of behavior genetic research. We will have to develop new theories in order to do justice to the facts as described. The above descriptions of extraversion are contemporary. While there is good reason to suggest that E will continue to be recognized as a major personality dimension, the specific findings reported here, ranging from its biological basis to behavioral manifestations, are currently being examined and reexamined.

See also: Behavior Genetics of Personality; Behavioral Genetics; Individual Differences in Temperament: Definition, Measurement, and Outcomes; Temperament and Individual Differences.

Further Reading

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Relevant Websites

- <http://www.personality-arp.org/> – Association for Research in Personality.
- <http://www.issid.org/> – The International Society for the Study of Individual Differences.
- <http://www.smeop.org/> – Society of Multivariate Experimental Psychology.
- <http://www.aaas.org/> – American Association for the Advancement of Science.
- <http://www.apa.org/> – American Psychological Association.
- <http://www.spsp.org/> – Society for Personality and Social Psychology.

Eye Movements

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Glossary

Accommodation Change in focus of the lenses, normally accompanied by a vergence eye movement.

Conjugate Both eyes moving with the same speed and direction at the same time.

Extraocular Outside the eye, usually referring to the six muscles that move the eye.

Fixation Steady gaze at an object or texture in the visual world, maintained by compensatory eye movements.

Fovea The retina's area of best detail and color vision, at the fixation point.

Microsaccade A small, abrupt eye movement taking place during fixation.

Oculomotor Referring to the muscles that move each eye, and the neurological system that controls them.

Pursuit Smooth, conjugate eye movements that track objects on the fovea.

Saccade A rapid change of visual fixation from one point to another, accompanied by a suppression of vision.

Vergence A horizontal rotation of the eyes toward or away from one another, to track targets in the third dimension.

Vestibular The sensory system that detects postures and accelerations of the head, with sensors connected to the inner ear.

Eye movements have two functions – making the eyes jump to a new fixation point and steadying the retinal image between jumps. The jumps are called saccadic eye movements, oculomotor sprints that bring the eyes to a new location as quickly as possible, with vision inhibited during the movement. Thus all vision occurs during steady fixation. The steady fixation periods are necessary because the retina processes visual information relatively slowly, and the information smears out if a visual image moves too fast across the retina.

Functions of Eye Movements

During visual fixation, the eyes are seldom at rest. They are continually compensating for movements of the head, movements of objects in the visual world, or both. A family of reflexes holds the retinal region of sharpest vision, the fovea, steady with respect to the visual image. The fovea is a tiny region, about 1° of arc in size, that gives the eyes their best acuity and their best color discrimination. It almost covers the area of the full moon. Outside this region, acuity and color discrimination rapidly decline, though movement discrimination hardly decreases at all if the moving objects are large enough.

The fovea has a unique role in movement perception as well as in acuity and color discrimination, for despite our constant perceptions of movement, objects hardly ever sweep across the fovea. It is essential to stabilize the image on the fovea because the receptors there are so tightly packed that even a slow drift causes the contours of an image to move across the retina at a rate of many receptors per second. At the same time, the stabilization should not be perfect, because visual receptors that receive a constant stimulation adapt within a few seconds and cease responding. So the image should not move too fast or too slowly across the retina. Usually the problem is to keep the image from shearing too fast. A number of physiological mechanisms cooperate to stabilize the fovea against the world.

Types of Eye Movements

Pursuit

A mechanism specialized for stabilizing the image on the fovea is visual pursuit. As soon as a visual target begins to drift away from the fovea, an involuntary movement (one that cannot be willfully prevented) is generated in ancient subcortical brain centers to move the eyes in a direction that reduces the drift. The delay in initiating this compensatory pursuit movement is about 0.1 s, a significant part of which is due to the time required to transduce the visual signal from light to neural activity in the retina. For about another 0.1 s the pursuit system calculates the direction but not the velocity of the drift, so the system generates a stereotyped movement in the direction of the target, but with a constant velocity. This is called an open-loop movement, because the control loop from retinal drift to visual movement detection to motor compensation is broken. Feedback control closes the loop after this interval, so that tracking responds to the speed and direction of the motion.

The pursuit system has a speed limit, however; it can accurately track image movements only up to about 30° per second relative to the head. Because tracking is never perfect, there is usually some remaining drift that is not compensated for. Above this speed the pursuit system continues to generate compensatory movements, but they fail to keep up with the stimulus. Tracking in this mode can continue up to 80° per second for brief periods, but only if driven by a target that is moving substantially faster than this.

When a target begins moving relative to the eyes, the delay in pursuit means that the eyes are already behind the target by the time pursuit tracking begins. If the error is small, pursuit will be a little faster than the target to catch up. Larger errors are cancelled by a saccadic eye movement that makes the eyes jump to the target location, where error feedback maintains accurate position. To study pursuit movements in isolation from the saccade, a target is first jumped by a small amount in the direction opposite to that of its smooth motion. Smooth

target motion begins immediately after the jump. Then, when the delay in the pursuit system is over, the fovea finds itself fixating the moving target.

In the real world, visual targets seldom move with constant velocity and direction. As a target changes its motion, the pursuit system compensates this with its closed-loop feedback control, but always with a delay. If the movement is repeated and predictable, however, the visual system creates an internal model of the motion and feeds its prediction to the pursuit system. As a result, tracking of a predictable target (such as sinusoidally moving point) can occur without delay. The prediction takes over quickly – tracking a sinusoidal oscillation shows a phase lag initially, but within a few cycles the lag disappears as the predictive controller takes over.

Pursuit movements result in perceived motion of the tracked target. If a small target is tracked in darkness or against a uniform field, the perception of motion corresponds to the motion of the target relative to the head, not to the small and variable errors in the positioning of the target on the fovea. The perception corresponds to the innervation sent to the eye muscles by nuclei in the brainstem, not to the motions on the retina, and thus is due to an extra-retinal signal, a copy of the oculomotor innervation (efference copy or corollary discharge) that is sent to centers controlling visual perception. Similar signals inform perception about head movements. These signals convey a smaller amount of motion than the true head-centric motion, however, so that target motion seems smaller and slower than it really is.

Vergence

Oculomotor function can be seen as directing the point of sight, the place where the lines of sight from the two eyes converge, so that tracking takes place in three dimensions. This requires control over convergence and divergence, collectively termed vergence movements. Vergence has a separate neurological controller from pursuit; it moves the two eyes horizontally in opposite directions. The movements are normally accompanied by accommodation of the lens, and since accommodation involves changing the shape of a highly viscous lens, the process must take place slowly. To maintain clear vision, then, vergence movements need not be any faster than accommodation. They are driven by drift of a target away from the foveas in much the same manner as pursuit, except that the target drifts in opposite directions in the two eyes, indicating a change in depth. Visual stimuli that are not imaged on the fovea have little effect on vergence movements; those stimuli will be blurred in any case because of the poor spatial resolution of the peripheral retina. Vergence and pursuit movements can take place simultaneously while tracking a target in three dimensions. The dynamics of vergence are shown in **Figure 1**; the vergence movement to a sudden target appearance is slower than a saccadic movement, and after the target disappears the eyes gradually diverge again, maintaining the point of sight at a 'dark focus' about 1–2 m from the eyes. Normally there is some 'hunting,' oscillations of vergence to find the optimal eye position.

The effect of vergence movements on perception can be isolated by projecting corresponding images into the two eyes from separate sources, and moving the sources separately.

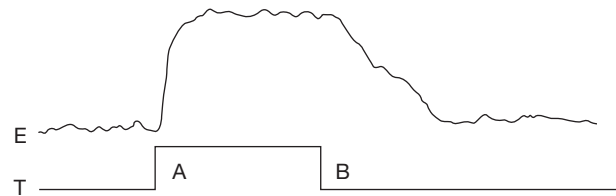


Figure 1 Vergence eye movements (E) in response to a near target (T). The target remains visible for 5 s (A to B).

As the eyes converge and diverge to track these images, the perceived size of the target changes correspondingly.

Vestibular and Optokinetic Systems

Two additional systems supplement pursuit and vergence in maintaining clear vision on the fovea. Whenever the head turns, the vestibular organs connected to the inner ear detect the acceleration of the head and feed a signal forward to the eye muscles to compensate for the predicted slip of the image against the retinas. This reflex is active even in darkness, when vision cannot control corrective movements. It is a feedforward rather than a feedback. In the vertical direction the compensation is called the 'doll reflex' because the eyes, like those of a doll, roll downward when the head tilts back, and roll upward when it tilts forward.

Vestibular reflex compensation functions in all directions, though. Tilt of the head forward and back is the pitch dimension, compensated vertically by the doll reflex. Yaw is rotating the head left and right, compensated by horizontal movements; and roll induces torsional eye movements (the eye rotating about its own line of sight as an axis) to compensate for tilting the head toward one shoulder. An analogous reflex compensates for linear motions of the head by exploiting signals from the vestibular system's gravity receptors, the utricle and saccule. Again these movements are involuntary and cannot be inhibited; most people do not know that the movements exist, though they work almost constantly to stabilize vision. The reflexes are ancient in evolution; they function in sharks in almost the same way as in humans, solving the same problem.

The vestibular reflexes are very quick, sending signals to the eye muscles within 15 ms of the start of a head movement; they rely on hair-cell receptors similar to the auditory receptors. The neural pathway is among the shortest in the brain, a three-neuron arc. The signals adapt quickly, however, because the immediate stimulus for activating the vestibular acceleration receptors is motion of fluid in the three pairs of semicircular canals. When the head starts moving, the fluid remains in place, so that it flows through the semicircular canals and stimulates the vestibular receptor cells. Within less than a second, however, the fluid also begins to move, weakening the stimulus to the hair cells. Once the fluid is moving as fast as the head, stimulation ceases and the vestibular receptors respond as though there were no head movement at all. In this sense the receptors detect acceleration rather than rotation of the head. There is some integration of the acceleration signal, maintaining compensatory eye movements, but eventually the reflex fails to keep up with predicted image movements.

Fortunately another reflex takes over the job of compensating for movements of the entire visual field, the sorts of

movements that are generated by movement of the head and body rather than by movement of objects in the world. This is the optokinetic reflex, a visual feedback that works on the movements of the entire image across the retina. This contrasts with pursuit, that is stimulated only by movements on the fovea. Again it is an ancient system, acting in sharks in much the same way as it acts in humans to compensate for the retinal slip caused by locomotion. The reflex sums up slips of the image across the entire retina, and compensates for the average motion. Thus it is little affected by motions on the tiny fovea, and is dominated by the retinal periphery.

This system too has its limitations, however. Its activity builds up gradually, so that at the start of a movement there is no compensation. Part of the delay is due to the time required to transduce the visual signal, conduct it to the relevant areas of the brain, and generate the appropriate compensations.

For head rotations, the optokinetic and vestibular reflexes work in concert to maintain compensation for the resulting retinal slip. The rapid, feedforward vestibular reflex reaches the eye muscles even before the motion signal leaves the retina. As its contribution declines, the slower optokinetic reflex takes over the job of counterrotating the eyes, resulting in a rapid but continuous compensation.

Though these systems seem primitive, they also show cooperation and adaptation. One complication of compensation is that head turns in the presence of a close target require a larger oculomotor compensation than is needed for distant targets, because turning the head also moves the eyes left and right. The optokinetic system can track this required increase in gain (output/input) because it is controlled by error feedback, but the vestibular system cannot. After extended exposure to a close target while turning the head, though, eye compensation increases even in darkness. This means that the higher optokinetic gain was transferred to the vestibulo-ocular reflex, the only compensation system that functions even in the dark.

These evolutionarily ancient systems are built deeply into all vertebrates, working mostly from the oldest parts of the brain. A conflict arises, however, when the newer pursuit system, functioning only in animals such as humans that have foveas, tracks motion across a fixed background. The pursuit system then drives eye movements, while the optokinetic system works to hold the eyes still. In this case pursuit dominates, but to overcome the optokinetic reflex, it must generate a stronger signal in the presence of a textured background than it would with a uniform background. This is one of the reasons why objects moving against a textured background seem to be moving faster than objects moving across a uniform field. Further, the pursuit signals are registered in perception as object motion while the optokinetic signals are not.

Saccades

If all of these reflexes together constituted the entire oculomotor control system, we would live in a peculiar world, trapped forever by whatever happened to appear on the fovea. To jump to another target, the newer saccadic system suppresses the reflexes briefly to allow a rapid movement to a new fixation point.

The saccadic system is binocular – both eyes move simultaneously to the same extent. During these jumps, the eyes move

so quickly that no useful visual information can be picked up. The shearing image motion is so rapid that the receptors cannot transduce a signal before the next parts of the image interfere. To solve this problem, the visual system actively suppresses vision during saccades. Saccadic suppression is selective – motion is suppressed much more strongly than brightness, because it is apparent motion that must be suppressed, and gross features are preferentially inhibited because fine features will be lost in any case by the rapid retinal image motion.

Saccadic targeting

A saccadic eye movement is ballistic in the sense that once started, it cannot be stopped. Launching a saccade is like throwing a ball; once the ball leaves your hand, its path cannot be altered. Analogously, if you begin a saccade and then change your mind, the movement must be completed anyway, and a second saccade must be planned to reach the new target. During the saccade planning process, you are committed to making a saccade before the eyes begin to move. For example, if you are instructed to simply track a target that jumps away from fixation and then jumps to a new location 0.2 s later, your eyes will remain at their original fixation point when the target jumps, and will still be there when the target jumps again. Just as the target makes its second jump you will execute your saccade to the first target position, because you are already committed to an eye movement. You will wait there for 0.2 s while your brainstem calculates a new saccade, and then fixate the target at its new position (Figure 2).

Since saccades are preprogrammed, they often do not reach their targets exactly. Small saccades tend to overshoot slightly, while saccades of more than about 6° tend to undershoot the target (seen in the first saccade of Figure 2). If the saccade is accurate enough to bring the target into a saccadic ‘dead zone’ less than about 1° from the target, the eyes will simply drift into place, just as pursuit movements can ‘catch up’ to a target when they lag behind. Larger errors are corrected with a second saccade about 170 ms later. People are never aware of this corrective saccade, even if the primary saccade was voluntary.

When both the eyes and the head are free to move, most large saccades are accompanied by a head movement in the

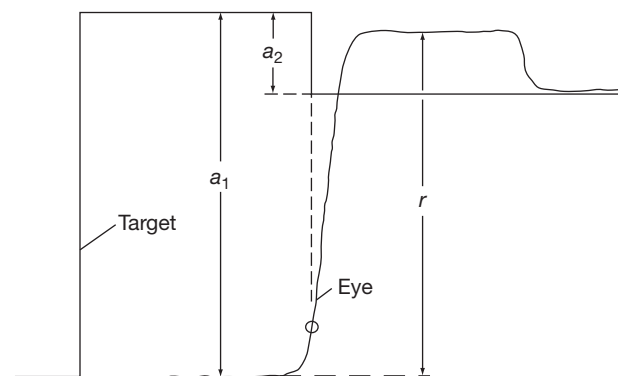


Figure 2 The ballistic nature of saccadic eye movements. The eye must jump to its originally targeted position, even though the fixation target jumps away from the goal location just as the eye begins to move. The target remains at position a_1 for 0.2 s.

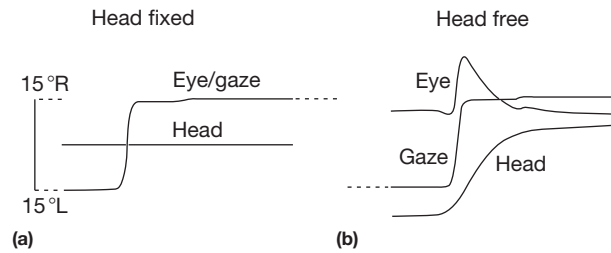


Figure 3 Saccadic eye movements (a) with the head fixed and (b) with the head free to rotate. Gaze is the sum of eye motion and head motion. The small corrective saccade occurs one-sixth of a second after the end of the main saccade.

same direction. Since the head rotates much more slowly than the eyes, there is a quick saccade that brings the eyes to the target just as the head movement is beginning. Then, to keep the eyes fixating on the target, a compensatory eye drift begins in the direction opposite to that of the head movement. As a result the gaze position relative to the target remains stable while the eyes and the head rotate in opposite directions at equal speeds. As the process concludes, the eyes are again centered near their original position in the orbit, but the head is deviated to one side (Figure 3).

Anatomy of Eye Movement Control

As specialized, stereotyped movements, saccades have a fixed relationship between their magnitude and their peak velocity. The eyes are driven as fast as the physics of the oculomotor system allows. At the start of a saccade the agonist eye muscles (the ones pulling in the direction of the movement) receive a pulse of innervation. The magnitude of the pulse is always maximal, even for small saccades; the size of the intended movement affects only the duration of the pulse. About halfway through the movement, the innervation drops back to the level required to hold the eyes in the new position, a pulse-step pattern of innervation. It allows the eyes to accelerate much faster than vergence or pursuit movements. For large saccades, a braking pulse in the antagonist muscles slows the eyes near the end of the movement. This helps to keep the rapidly rotating eyes from overshooting their target.

The strategy of the saccadic system is like an automobile driver's strategy in entering a crowded freeway. To reach the cruising speed as quickly as possible, the driver presses the gas pedal to the floor. The faster he wants to go, the longer the pedal stays on the floor. This is the pulse of the pulse-step strategy. When the cruising speed is reached, the driver lets back on the pedal to maintain a steady speed, corresponding to the step of innervation.

Dual initiation of saccades

Normally only one conscious decision is possible in oculomotor behavior – the initiation of a saccade. Even this is usually automatic, without the owner of the saccadic system thinking about its behavior or even being aware of its actions. Accordingly, two separate brain systems can initiate saccades. One, the superior colliculus, resides in the evolutionarily ancient midbrain. The other is located in the newest part of the brain, in the

dorsolateral frontal lobe of the cerebral cortex. The midbrain branch initiates automatic actions such as the return jumps that must be generated during continuous locomotion; when the optokinetic and vestibular reflexes have moved the eyes as far as they can comfortably go, a saccade is generated to make the eyes jump in the direction opposite to that of the continuous movement. The result is a nystagmus, a continuously repeated pattern of eye movement. The frontal cortex system is responsible for jumping to a new target determined by a motivation for visual exploration. We know that these are the only two saccade initiation areas, because removing both of them causes permanent loss of all saccades even though all of the nuclei containing the motor neurons for the ocular muscles remain intact.

The function of these systems can be observed by recording from tiny electrodes that pick up discharges from single nerve cells. For a long time it was thought that the cells in the frontal cortex played little role in initiating saccades, for most of them fired only after the beginning of a saccade. These recordings were made when a monkey was casually looking about a laboratory. But when the animal made a deliberate saccade, for instance to obtain a reward, many cells in a part of the lateral frontal cortex called the 'frontal eye field' became active just after the change in the visual stimulus but before the eyes began to move. The frontal eye field would be better named the frontal attention field.

Control of the eye muscles

Downstream from the cortical and midbrain saccade initiation centers, eye movements are organized in the brainstem, the oldest part of the vertebrate brain. The eye muscles are innervated by three nerves, the third, fourth, and sixth cranial nerves, with brainstem nuclei driving each of them. A common path to saccade execution begins with 'long-lead burst' neurons, followed by actions of a sequence of more specialized neurons organizing the saccadic pulse and step.

Pursuit, optokinetic reflexes, vestibular reflexes, and vergence each have specialized control centers in the brainstem contributing to the final innervations. The eye muscles are the most finely controlled in the body, with each nerve fiber controlling fewer muscle fibers than in any other muscles. This allows very precise control of eye posture.

Eye Movements and Attention

Scanpaths

When a human observer encounters a new visual scene, the eyes saccade first to the area of greatest interest, where the information density is greatest. Then they jump to another location determined by information content, distance, and one's own interests. A series of such jumps generates a scanpath, a pattern of exploratory eye movements.

The scanpath is the meeting point of oculomotor physiology and cognitive psychology. Decisions about where to move the eyes are made with great rapidity, up to 5 per second during reading, and usually without awareness of the decision process, yet they involve sophisticated use of information. Reading presents highly structured eye movement patterns achieved after extensive practice, but other patterns are less fixed.

After the identity of a scene is established, higher-level questions govern visual scanning patterns. Russian researcher A. L. Yarbus showed subjects a painting, Repin's 'Returning Stranger,' while asking them questions about the people in the painting; the scanpaths depended on the question being asked. When estimating the material circumstances of the people, for example, observers fixated largely on the clothing and furniture in the painting. When asked about their ages, though, they fixated mostly on the faces. Observers still scanned the most information-rich regions of the painting, but the definition of what provides the most information changes with the question being asked.

Attention Shifts

When a person shifts attention from one location to another, the first thing that usually happens is that a saccadic eye movement shifts the eyes to the new location. People seldom look in one place while processing information in another (except in psychologists' laboratories). The shifts are very frequent – the eye normally generates about three to four saccades each second. Even when the eyes are not actively exploring, small drifts in fixation are punctuated by 'microsaccades,' tiny saccadic movements that occur during what seems to the observer to be continuous fixation. This makes saccades, unaccompanied by other behaviors, by far the most frequent of all human behaviors. As such they are of central interest to psychologists who study behavior. During a lifetime, a person generates more saccades than heartbeats.

There are three parts to shifting attention: attention must be disengaged, shifted to a new location, and reengaged. The process is analogous to shifting gears in an automobile with a manual transmission. Stepping on the clutch pedal corresponds to disengaging attention, moving the shift knob is the transfer to the new location, and releasing the clutch is the reengaging. Each step takes time, and has a corresponding process in oculomotor control. The disengagement is the active inhibition of the tracking systems that automatically lock the fixation point to the foveal image. If tracking were not disengaged, the start of a saccade would trigger the fixation reflex and the two systems, tracking and saccadic, would fight against one another. The saccade itself corresponds to the shift of attention, and reestablishing fixation occurs at the end of the saccade. Though vision is inhibited during and just before the saccade, it is more sensitive immediately after the eyes come to rest. If the new fixation target is found within a spatio-temporal window following the saccade, space constancy (the perception of a stable world despite eye movements) is maintained, even if there are small errors in fixation.

The attention shift and the motor execution of the saccade are not simultaneous – attention leads the physical action. Two targets can be briefly flashed to the left and right of fixation, but only the one that is the target of an immediately following saccade can be identified, even though the targets disappear before the eyes actually begin to move.

Reading

One of our most highly practiced oculomotor skills, reading can be considered as a specialized and stereotyped scanpath

made on a particular kind of visual pattern (printed text). Experienced readers normally fixate a new word on each fixation, with a saccade between fixations. Small words such as 'of' or 'but' are frequently skipped. Occasionally a reader will look back to a previously fixated word, especially if the text is difficult (a 'reverse saccade'). At the end of each line, a large saccade returns the eyes to the beginning of the next line. This pattern is called a staircase, since it looks like a staircase in an eye movement record when the position of the eyes is plotted against time.

Since they are exploratory saccades (not driven by an abrupt event in the visual world), eye movements of reading are limited to about 5 per second, with a fixation period of about 0.2 s between them. On average, readers normally make about four saccades per second. With these physical limitations, how can one read faster? The only way is to make larger saccades, skipping more words. Especially if the text is easy or redundant, the reader can often fill in the context even if some words are not picked up by the visual system. This requires extra effort, though. The trick of tracking a finger, advocated by some speed-reading techniques, results in pursuit eye movements that make it difficult to see any of the text. Programs that advocate such methods should be avoided.

Dyslexia, a severe reading deficit in a person who is otherwise normal intellectually, is often accompanied by abnormal saccadic patterns during reading. One symptom is a 'reverse staircase,' repeated eye movements in the wrong direction. The input to the brain from such a sequence must be difficult to interpret.

Evolution and Anatomy of the Eye Movement System

The Shark

The oculomotor system evolved along with the earliest vertebrates. To understand the structure of the eye muscles and the orbits, we can examine the basic vertebrate pattern in sharks, in which each extraocular muscle has a simple job. The six muscles are arranged in three opposing pairs; one member of each pair pulls in one direction, while the other pulls in the opposite direction. One pair of muscles pulls the eye up and down (pitch), another pair turns it left and right (yaw), and a third rotates it like a wheel with the line of sight as the axle (roll). The eyes point in opposite directions from each side of the head. The muscles serve to stabilize the retinal images during a shark's locomotion.

The Human

Humans have the same six muscles as sharks, but their arrangement and functions are more subtle and flexible. Over the course of evolution, the orbits have moved to the front of the head to facilitate binocular vision. The muscles that move the eyes are always activated to some extent. A lateral set pulls the eye left and right; a vertical pair pulls up and down, and a little inward at the same time; and an oblique set twists the eye in a complex motion. All eye movements can be resolved into actions of these three pairs of muscles in each eye.

The three dimensions of space are built into the human eye movement control system. Consider the double-eye as a single

organ, managed by a single neurological control system. The double-eye controls the point of sight. Thus, each direction of visual space is represented by a pair of muscles, operating in various combinations. Rectangular coordinates were not invented by mathematicians; they were there all along in the oculomotor control system.

Eye Movements in Sleep

Slow-Wave Sleep

The eye movements of slow-wave sleep, sleep characterized by large slow waves in the EEG that occurs just after going to sleep, are simply slow drifts of the eyes and a general trend upward. In another phase of sleep, named rapid eye movement (REM) sleep, spectacular eye movement activity appears. REM sleep begins about 1½ h after falling asleep, and has several signs. The body becomes paralyzed, the brain shows signs of intense activity, thermoregulation ceases, and the eyes begin to move vigorously.

Paradoxical Sleep

REM sleep is also dream sleep; sleepers awakened during REM usually report vivid dreams, while those awakened during slow-wave sleep seldom do. Not all dreaming occurs during REM sleep, however; it is now almost certain that some dreams occur in other sleep stages. Toward the end of a night of sleep, the distinction between dream reports from REM and from slow-wave sleep begins to break down, but for most of the night REM dreams are the most common and the most vivid.

Dreams are maddeningly subjective as objects of experimental inquiry. Some techniques have been successful in revealing their characteristics, however. For instance, we can ask whether the subjective impression of time in dreams matches the actual duration of the dream. Because dreaming often starts along with a REM episode, sleepers can be awakened after varying durations of REM sleep and asked to relate their dreams. Later awakenings result in longer dream reports, but the effect peaks about 15 min after REM; awakenings after longer intervals lead to about the same length of dream report. The dreams seem to occupy about as much time as it would have taken to act out the action in real life, but apparently memory for them stretches back only about 15 min.

A further step toward relating the content of dreams to the physiology of sleep is to relate the scanpaths of dreams to their contents. Early studies reported such a relationship, but replication has been inconsistent. Interpreting such studies is difficult: how strong must a relationship be between dream reports and eye movements to have significance?

Another way to examine the relationship between dreams and scanpaths considers not the scanpaths but the eye movements themselves. If the eye movements of REM sleep are exploratory movements driven by visual imagery, they should have the characteristics of normal waking eye movements: saccades, pursuit, and vergence movements. These movements are driven by specialized control systems, permitting only a few kinds of activity. Saccades have a fixed peak velocity for each amplitude of movement. But pursuit movements cannot exceed a velocity of about 80° per second. Convergence

and divergence are even slower. These restrictions create an intermediate 'forbidden zone' for eye movements, consisting of movements that are faster than 80° per second but slower than saccades for the corresponding amplitude of movement. Such movements can be neither saccades nor pursuits.

To learn whether REMs of sleep are exploratory, one can look to the forbidden zone of large eye movements too fast to be pursuits but too slow to be saccades. The electrical method usually used in sleep studies cannot measure the dynamics of movements with the necessary precision, and most other methods require the eyes to be open. One technique, however, fulfills all the requirements. The procedure is to sew a small coil of fine wire into the sclera surrounding the cornea of a monkey's eye, leading the two ends of the wire out to a recording apparatus. Using the same principle as a conventional transformer, alternating currents are induced in this coil with three pairs of huge induction coils surrounding the monkey. Eye movements can be recorded quite accurately, with eyes either closed or open, by measuring the amplitudes of the induced alternating currents.

Sleep studies with implanted search coils show that the fastest REMs of sleep matched the dynamics of waking saccades. This is not surprising, since saccades are the fastest possible movements that the oculomotor muscles can generate. Other movements were slow enough to be pursuits. Many so-called REMs, though, fell into the forbidden zone, movements not related to visual exploration. Cats also have REMs inconsistent with visual exploration, for a different reason: all of the movements are in the same plane.

The eye movements of REM sleep are not continuous, but occur in bursts of a few minutes' duration. A typical burst in humans begins with slow movements, continues with more rapid movements up to saccadic velocity, and concludes with slow movements. All of these observations contradict the idea that REMs are exploratory saccades.

Do dreams help to review the experiences of the day? If this were their main function, we should expect to see less REM in organisms with fewer experiences. REM sleep is seen even in unborn fetuses, however. Shortly before birth, fetuses spend most of their time in this state, perhaps to suppress a maturing thermoregulation system that should not be activated until after birth. If they are dreaming, it is difficult to imagine what they are dreaming about.

If dreams review or consolidate a day's experiences, we should be able to manipulate the amount of eye movement allowed during the day and find a corresponding change in REM that night. In fact the opposite change occurs: people induced to make smaller eye movements during the day make larger ones at night. So the evidence does not support a role of eye movements in dream experiences.

See also: Dyslexia; Motor Control; Psychology of Reading; Sleep, Biological Rhythms, and Performance.

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Eyewitness Identification

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Glossary

Double-blind A research study paradigm wherein the person administering a test or a treatment does not know if the subject is receiving an active treatment or placebo.

Live lineup A procedure where a witness views actual potential suspects, often through a two-way mirror.

Photo lineup A procedure where a witness is shown photos of potential suspects.

Sequential lineup A lineup (photo or live) in which persons are presented to a witness one at a time and a decision as to inclusion or exclusion should be made before moving to the next subject.

Showup The practice of showing a witness only one person. This often occurs shortly after a crime when a suspect has been apprehended.

Simultaneous lineup A lineup (photo or live) in which all persons are viewed at the same time. Such a procedure invites so-called comparison shopping, the tendency of a witness to choose the person who resembles the suspect most closely, whether the suspect is present in the lineup or not.

Weapon focus The phenomenon of a witness concentrating attention on a weapon during the commission of a crime.

Introduction

Eyewitness identification, along the bedrock of legal systems throughout the world, is surprisingly vulnerable to attack, although the courts often shield it from appropriate scrutiny, not unlike the situation with fingerprint evidence. Prior to the introduction of the forensic sciences into the trial arena, eyewitness testimony was often the only evidence introduced at a trial. Clearly, the veracity of the witness must be reliable for a criminal justice system to function fairly. To protect the reliability of trial verdicts, courts can impose sanctions (i.e., perjury charges) against a witness (eyewitness or otherwise) who lies in court. Such prohibition is longstanding and encoded in the Judeo-Christian ethic as *Thou Shalt Not Bear False Witness Against Thy Neighbor*.

The recollections of a (truthful) witness who either observed a crime or was the victim are presumed to be accurate by fact finders. Yet there has been, until the turn of the twentieth century, little research into proving that hypothesis. In fact, even with much current research casting doubt on the reliability of eyewitness memory/testimony, the criminal justice system had preferred, for the most part, to ignore such research until DNA science began to lead to the exoneration of many whose conviction resulted from faulty eyewitness testimony as either contributory evidence or the only evidence presented at trial. Eyewitness identification in a courtroom can lead to a conviction even when the defendant has significant alibi evidence in his or her favor. In spite of research findings that ...

- Witnesses can be less accurate when involved in a stressful situation
- Witnesses have difficulty with cross-racial identifications
- Witnesses tend to focus on a weapon rather than a face
- Memory begins to decay immediately
- Witnesses have memory gaps that are filled through confabulation and/or suggestion
- And that there is no necessary correlation between witness proffer of certainty and accuracy of recollection

... some courts insist that a jury's general knowledge is adequate to determine the probity of eyewitness testimony.

(Melton et al., 2007: 190–192)

The problem with eyewitness testimony is usually not that the witness is lying, but rather a far more insidious issue where the witness is testifying to facts they believe to be true, but which in fact are not. With the advent of DNA exonerations, faulty eyewitness testimony has emerged as the leading cause of wrongful convictions, being a factor in 75% of cases (innocence project).

Memory

Before discussing eyewitness testimony it is important to understand the basics of memory. Memory (and therefore recall) was presumed for some time to operate like a movie camera. An individual observed something and since it was initially recorded in the brain, it could be recalled accurately at a future time. Research from the 1970s to date has shown repeatedly that this is far from true.

While scientists are far from understanding memory in its entirety, some useful paradigms of memory have been developed. In possibly the simplest description, for a person to remember something certain processes must occur. First there must be a stimulus in the environment, such as a car passing close by. Second, the individual must perceive the stimulus. Having perceived it, the person must register it in short-term memory. Third, the perception must be transferred or encoded into long-term memory. Fourth, at some future time the memory will need to be retrieved or brought from long-term memory storage to consciousness. It is likely that different areas of the brain are repositories for different aspects of the memory. For example, one area holds the memory of the sound of the car, one the visual of the car passing by, another

the smell of the exhaust and another the emotion of fear or annoyance that the car was so close. To accurately recall the event all aspects of the memory must be laid down accurately and recalled accurately. There is much room for error.

In addition to room for error in recollection, the mind is quite adept at filling in the blank spaces of a poor memory. This can occur without the awareness of the witness and can be recalled and presented as an accurate recollection when it is not. It is very possible that the witness never saw (perceived) the face of the car's driver. Yet weeks later, shown the driver's photograph, the witness might believe he or she saw the driver's face. If presented with covert or overt coaching, the witness may actually describe the face and exhibit significant certainty (and therefore credibility) in the accuracy of the recall. At times attempts are made to use hypnosis to refresh memories of past events. Research into such hypnotically refreshed memories was able to show that the memories produced (created) were often unreliable due to suggestibility and confabulation. Due to this, some states (as well as the military) have banned hypnotically enhanced memories from the courtroom, while others have insisted on various proffers of reliability or adherence to strict protocols for the use of such testimony (Miller, 2003). It is important to note that focused/ritualized enhancements such as hypnosis are not required to create a false or inaccurate memory. As shown by Loftus and Ketcham (1994), simple suggestion can be enough.

Aside from problems related to faulty recall, with or without enhancements (such as hypnosis), there can be problems in perception of the stimulus in the first place. The witness may not have been paying attention and simply failed to initially perceive the information necessary for a complete memory. The witness may have been experiencing other stimuli (internal or external) that interfered with accurate perception, for example fear, anger, confusion, or distraction. Or the witness may have simply inaccurately perceived an event. For example, it is not uncommon for a car to appear one color under certain lighting conditions and another color under others. Also, observers can be inaccurate when judging speed and distance between vehicles, and these inaccuracies can be enhanced due to weather and lighting parameters. Observing two vehicles ahead on a highway can (due to the angle of observation) make it appear that the two cars are actually much closer than they are. Yet it is very possible for an eyewitness to be certain that their misperception is an accurate recollection of an event in question. Also, the wording of questions can effect the reported recollections and additionally, prescribed medications, as well as illicit substance use, can affect one's ability to accurately perceive environmental stimuli.

General Overview

Problems with eyewitness memory have been recognized for quite some time. At the turn of the twentieth century many studies on recall and witness issues had already been performed. Describing such studies, Hugo Munsterberg spoke of "the treachery of human memory" and the fact that the administration of an oath in court adds to the problem as the "... seriousness and solemnity suggest that the conditions for complete truth are given if the witness is not ready to lie"

(Munsterberg, 1908: 46–47). In his book *Criminal Investigation* (1934), Hans Gross, felt by many to be the father of the field of criminalistics, discussed issues of witness perception of events, recall, and eyewitness reliability. Soderman and O'Connell (1936) noted that any of the stages of forming or retrieving a memory leave opportunity for distortion and further noted that there is also opportunity for others to influence the recollections of a witness. They identified a scenario regarding a 'unanimous statement' in which several witnesses are allowed to spend time together telling each other their recollections of a crime. The witnesses will influence each other and this may lead to a collective statement (given individually) where all the witnesses agree on certain facts, lending the facts a more reliable basis than they may deserve.

Stern (1939: 4) pointed out that little attention had been paid to eyewitness testimony in America, highlighting that a "perfectly correct remembrance is not the rule, but the exception." And, "... subjective sincerity does not guarantee objective truthfulness." (p. 13) He noted that when a witness was allowed to relate his or her story as a free-flowing narrative, the result was more accurate than when the witness was constrained, as by cross-examination.

More recently, probably the most well-known researcher on false memories and eyewitness memory is Elizabeth Loftus a research psychologist (Loftus and Ketcham, 1991). Her work publicized the inherent problems with memory as evidence. A problem with most research related to eyewitness memory/testimony is that it is not 'field' based and usually relies on simulated crimes that do not replicate the actual levels of witness and/or victim involvement, stress, and motivation present in actual crimes. Interestingly, *Criminal Interrogation and Confessions*, 4th edn (2001), the most widely used text to teach interrogation, while discussing problems inherent in eyewitness testimony, fails to mention potential contamination of the witness by law enforcement personnel. This is striking, considering that law enforcement is the presumed target audience of the text.

What follows is a review of modern research on the subjects of weapon focus, effect of stress on eyewitness memory, malleability of witness recall, confidence in recall, facial recognition, line up issues, and the inadequate court remedy available. Clearly, these areas of research will overlap.

Weapon Focus

When an offender confronts a victim or witness with a weapon, especially a firearm, accurate recall of the events decreases. It appears the witness selectively focuses on the weapon to the detriment of other pertinent details (Loftus et al., 1987; Loftus, 1996a,b). A 1992 meta-analysis of 12 studies (Steblyay) found a small effect related to lineup identifications and a moderate effect for feature accuracy, for example, clothing and/or facial features.

Stress

Research seems to indicate that the relationship between stress and memory is nonlinear, but results often vary from study to

study, with confounding variables difficult to control for. It seems that, allowing for individual variations, up to a certain point stress enhances memory, but once a certain level of stress is experienced, memory subsequently declines. Yuille and Cutshall (1986) were able to conduct a real life study, whose findings differed from laboratory-style studies. After interviewing 13 witnesses 4–5 months after a homicide, they found that stress levels at the time of the incident did not have a negative effect on memory and, importantly, that the witnesses resisted leading questions.

Valentine and Mesout (2008) produced anxiety artificially (in the Tower of London), but measured it accurately and found that as anxiety increased, accuracy of descriptions and lineup identifications decreased. A 2004 (Deffenbacher et al.) meta-analysis of 24 studies, including 27 tests of the effect of stress on eyewitness recall and 36 tests of crime detail recall, found ‘considerable support’ for the hypothesis that high stress levels negatively affect both eyewitness identification and memory for crime details. Interestingly, it was found (similar to Munsterberg’s commentary noted above) that stress affected interrogative recall much more than it did narrative or free recall. It was noted that a confounding variable (in most studies) is the conflation of findings related to ‘neurotic’ (i.e., more anxious at baseline) individuals with those who do not tend to experience anxiety unnecessarily. This could tend to make it appear that nonneurotics perform more poorly than they actually do.

Confidence/Malleability

It is generally accepted that eyewitness confidence in recall of events and identification often has no clear relationship to accuracy (Odinot et al., 2009) and is subject to overt and covert influence. Yet, the one thing that is likely to impress the trier of fact is the confidence an eyewitness places on his or her identification and testimony (Cutler et al., 1988, 1990). Research has shown that older adults are more prone than younger adults to either remember an event that never occurred, or to recall an event that occurred, but to do so inaccurately (Dodson and Kreuger, 2006) and maintain confidence in the misremembered recollection.

Eyewitness confidence in identification of a suspect is quite malleable. Luus and Wells (1994) staged a theft for 70 pairs of eyewitnesses who then were subjected to a photo-lineup. After an initial identification, witnesses’ confidence was easily manipulated by either telling the witness another witness made the same identification or did not. Surprisingly, one study found that immediate recall after an event did not protect from later incorporation of false details into a recollection. This so-called reversed testing effect is significant to understand in regard to eyewitness testimony and though already recognized, the malleability of eyewitness testimony may be even greater than previously suspected (Chan et al., 2009). In a real life crime scenario (Wright and Skagerberg, 2007) post-identification feedback had a significant effect on eyewitness confidence. This underscores the need to assess witness confidence after identification before they give any further information.

One concern regarding witness confidence in identifications is the confounding factor of a confession. Hasel and

Kassin (2009) conducted a staged theft and later gave information to subjects regarding confessions or denials of guilt, after an identification had or had not been made. More than 60% of subjects changed their identification when told a different lineup member had confessed. Just as problematic, 50% of subjects who had not made an identification chose the lineup confessor when his identity became known to them. Identifications were clearly affected by this information, which highlights the problem with presenting witnesses with such information not only before lineup identification, but also after.

Facial Recognition

It is presumed by many that a human’s ability to recognize a face seen at a prior time and to accurately recall the parameters of the original event are good. What is often misunderstood is that while our ability to recognize a known face may be good, the ability to recognize an unfamiliar face is actually not impressive. Megreya and Burton (2009) performed three experiments designed to test the ability to recall (identify) unfamiliar faces. Performance was poor across the testing paradigms, indicating that witness ability to recall faces is both generally poor and independent of the usual eyewitness memory problems. Both live and still videos were used. Performance under both conditions was poor. When the target was present, a correct choice was made 70% of the time, meaning three out of ten identifications were wrong. When the target was absent, a wrong match was chosen 35% of the time. This was across both photo and live presentation. As expected, there were large variations in performance among subjects.

Also of interest is the fact that interracial facial recognition tends to be poorer than intraracial facial recognition (Marcon et al., 2008) and that women seem to have better ability to recognize female faces than men (Lewin and Herlitz, 2002), although they may not recognize more faces in general than men and men may be better at opposite sex facial recognition (Winters, 2009).

Lineups

Lineups have been problematic from the time they entered use in law enforcement and are subject to contamination at several junctions in the lineup process. Except for rare circumstances, law enforcement personnel want to identify and charge the person or persons whom they believe committed a crime being investigated. In light of this, one would expect law enforcement to eagerly adopt procedures to minimize false identifications as such errors not only can result in conviction of innocents, but also because such errors allow guilty persons to remain in the community, capable of committing new crimes. Yet it has taken considerable time for some jurisdictions to recommend standard procedures for lineups.

A lineup is the presentation of a suspect to an eyewitness for the purpose of determining whether the witness can identify the suspect. Witnesses can receive potentially contaminating information overtly or covertly before, during or after a lineup. A live lineup can be performed after a photo identification, or a photo lineup can be used alone. At any step of the process it is

possible for a false identification to occur. Even when lineup administrators give unbiased instructions to witnesses, influence is measurable and most witnesses do not realize the extent to which they have been influenced (Clark et al., 2009). This is compounded by the fact that humans are not particularly good at identifying unknown faces in the first place.

Several lineup guidelines were offered since 1957, but all suffered various weaknesses. In 1998 Wells et al. reviewed prior guidelines and offered their own. These included double-blind lineups (lineup administrator does not know who the suspect is), advising witnesses that the suspect may not be present, distracters chosen according to eyewitness descriptions, and documentation of confidence at the time of the identification. Several states (most notably New Jersey) have issued guidelines for lineups with mixed acceptance, although most jurisdictions that have adopted recommendations have been happy with the results.

Current recommendations (The Justice Project, 2006) endorse the following:

1. Standard instructions to eyewitnesses
2. Double-blind administration of lineup
3. Random sequential presentation
4. Appropriate use of decoys
5. Immediate documentation of witness confidence and procedure for lineup

Standard instructions are important so that each eyewitness is told the same thing regarding what they will be doing, how it will be done, and what the expectations are. For example, part of protocol would be advising the witness that the suspect may or may not be in the photo array or the live lineup. The potential witness must feel comfortable not making an identification. Investigators may not realize how much a potential witness may want to help solve a crime, leading the witness to override doubt in an effort to avoid disappointing an investigator. Also, using standard instructions minimizes subtle cues that could inadvertently be given to a witness. All investigators must warn against comments that might be overheard during a lineup, such as 'he' or 'she' has been arrested for similar crimes in the past.

The importance of a double-blind presentation cannot be overemphasized. The officer or personnel administering the lineup should not know who the suspect is. Tone of voice, body language, even rate of breathing, can subtly influence a witness to what the desired response is. If it is not possible to use a double-blind technique (due to staffing or other issues) the lineup administrator should take every precaution to avoid seeing what the witness is seeing. For example, in a photo lineup the suspect and decoy photos can be placed in folders (one to a folder) and the folders shuffled. The folders are then given to the witness to look through without the administrator seeing the photos. Also, it should be possible to set up a computer program that can randomly show photos to a witness, and record identifications and witness confidence.

Random sequential presentation is important for two reasons. First, when presentations are random the (blind) lineup administrator will not know which photo or person is the suspect. Second, presenting all individuals together invites so-called comparison shopping by the witness. A witness will be more inclined to pick the person who appears closest to the

perpetrator, regardless of whether that person is in the lineup. With a true sequential presentation the witness must offer a yes or no to each photo or individual before the next person is shown.

Important for the integrity of the process is that any decoys (also known as distracters, fillers, foils, etc.) used must resemble the suspect, especially as to witness reported features. If the witness said the offender had a certain hat or clothing on, then all persons presented in a lineup must have the same hat or clothes on. If the witness reported that the offender was bald, then all persons in the lineup must be bald. The same goes for any type of facial hair or feature, as well as height, weight, and general body build. It would not be fair if a witness reported the perpetrator was very muscular and all the decoys resembled Barney Fife.

Documentation of lineup protocol is important to allow subsequent evaluation of the adequacy of the protocol. Video-taping of the entire process would be a gold standard, but unlikely to be implemented to any significant degree. At a minimum a record should be kept of what was said to the potential witness and how the lineup was conducted. In addition, documentation of witness confidence at the time of an identification is crucial to avoid later bolstering of the confidence level due to information the eyewitness may later learn that can affect confidence, such as the suspect has been arrested for similar crimes, a confession was obtained, etc. The identification must stand on its own. To allow otherwise invites error.

Complicating the picture is a field study conducted in Illinois (Mecklenburg, 2006). The study was a year-long pilot study completed with the cooperation of the Illinois State Police and three local police departments (Chicago, Joliet and Evanston) to assess the sequential double-blind lineup procedure under real life conditions. Results of the study did not support the belief that such a paradigm would result in decreased false identifications, with lower rates of false identifications found in the simultaneous lineups.

But there has been much criticism of the study structure. Wells (2006) states that the study cannot draw any clear conclusions due to the fact that the sequential lineups always used a double-blind structure, while the simultaneous lineups never used one, leaving unanswered whether simultaneous lineup administrators could have suppressed false identifications. Schacter et al. (2008) conclude that this design essentially negates its findings. Also, behind the scenes were such issues as at least one participant (Chicago Police Department) having publicly opposed testing the sequential lineups. Another confounding issue is that the very people opposed to sequential lineups were trained on the nature and purpose of the research (O'Toole, 2006) putting them in an excellent position to bias the study. Interestingly, as pointed out by Schacter et al. (2008), if the Mecklenburg (2006) study had found that sequential double-blind lineup administration decreased false identifications we would not know if it was because of the double-blind or the sequential administration.

One type of lineup is what is known as a showup. Only one photo or individual is presented to the witness. This is a very suggestive procedure. An example would be a suspect apprehended near a crime scene and brought in the back of a police car for viewing. Another example is walking the witness past the suspect at the police station, or asking a witness if he or she

recognizes 'the man sitting over there.' While such a practice may be of some utility immediately after a crime, the more time that passes, the more suggestive it can become.

Court Remedies

Courts have generally been reluctant to allow expert testimony on the problems inherent in eyewitness testimony, framing it as invading the province of the jury. What is unspoken is the practical issue of harm to the ability of prosecutors to try cases. This issue is not to be ignored as many court decisions regarding the use of various types of evidence, although legally framed, are designed to protect the prosecutorial side of the court equation. If eyewitness testimony were allowed to be scientifically challenged at trial it would create a significant barrier to prosecutorial efforts. Expectations that legal safeguards, such as suppression hearings and cross examination, are adequate to protect the defendant from miscarriages of justice are naïve.

In *Neil v. Biggers* (1972) the US Supreme Court offered criteria to assess the reliability of eyewitness identification even when it could be shown that the identification procedure was suggestive of an individual's guilt. Apparently loath to exclude suggestive identifications, the Court offered an examination considering the 'totality of the circumstances' which could include:

- The apparent opportunity of a witness to see the offender during the commission of the crime
- The degree of attention the witness was able to maintain
- The accuracy of the witness' original description of the offender
- Witness proffer of certainty when identifying the suspect
- The length of time that had passed from the occurrence of the crime to the identification

Subsequent research has shown that this paradigm is inadequate to protect against false identifications, if only because there is no reliable correlation between witness confidence and witness reliability.

In spite of an accumulating research body highlighting the problems with eyewitness testimony, the US Supreme Court revisited the issue in 1972 (*Manson v. Braithwaite*) and reaffirmed and clarified the *Neil v. Biggers* decision. The Court reiterated the 'totality of the circumstances' paradigm with the same criteria, but made it clear that if the identification was not unnecessarily suggestive, no further inquiry was required. In other words, unless it could be shown that the identification process was unduly suggestive, the defendant couldn't even take advantage of the flawed criteria offered from the *Neil v. Biggers* decision. The US Supreme Court has yet to revisit the issue of suggestive eyewitness testimony. What the Court failed to appreciate is the inherent unreliability of eyewitness testimony, regardless of whether the police were openly suggestive or not.

In April 2001 the New Jersey Attorney General (Farmer) sent guidelines for suspect identifications to state law enforcement and prosecutors. While a major step in the right direction, the guidelines allowed for both sequential and simultaneous lineups, inviting comparison shopping, as noted above. Since then,

some states, but not all, have adopted similar guidelines. In June of 2010 a Special Master (Gaulkin), assigned by the New Jersey Supreme Court to review eyewitness testimony issues, released his report. It has yet to be acted upon. After reviewing case law and hundreds of research articles, the Special Master advised that the State's proffer that juries can sort out the good from the bad identifications is not accurate. He recommends the State require pretrial hearings to evaluate the reliability of all eyewitness identifications with the burden of proof on the prosecution to establish the reliability of the identification. He further recommended that steps should be taken to ensure that judges and juries are both informed of and guided by the available scientific research.

Summary

Along the presumed bedrock of the Criminal Justice System, eyewitness identification has been shown to be often unreliable. Both at the time of initial identification and later in the legal process, eyewitness testimony is subject to influence. Legal safeguards currently in place are inadequate to protect against miscarriages of justice. In spite of the known problems with eyewitness evidence, it enjoys an unwarranted currency in the courtroom, similar to that of uncorroborated confession evidence.

The best-informed research suggests that minimally, the following procedures should be adhered to when conducting lineups: standard instructions to eyewitness; double-blind lineup administration; random sequential presentation; appropriate use of lineup decoys; and immediate documentation of witness confidence, as well as documentation of the overall procedure.

See also: Forensic Psychology in Contemporary Society; Homicide; Jury Psychology; Memory.

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Facial Expression of Emotion

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Glossary

Culture A set of meanings, attitudes, and behaviors specific to a given cultural group.

Emotion Spontaneous and intense neuropsychological reaction which makes the organism produce an action.

Facial expression Neuromuscular activity via which messages and signals are emitted.

Nonverbal communication The expression and perception of nonlinguistic signs between individuals.

Introduction

The face is the most visible part of the body. Hence, it has vital importance in the psychosocial development of an individual. The face is a complex and many-dimensional system, which has been extensively studied over the years. It is capable of expressing over 10 000 different emotions. Early research on facial expression of emotion concentrated on identifying and characterizing the structural nature of facial movements. Later, attention shifted to identifying and characterizing the functional nature of these same facial movements. Researchers in the field of facial expression of emotion have now turned their attention to the implications and applications of facial expressions in diverse social contexts (e.g., healthcare, justice, and education). Every face is unique, the stamp of the individual, and no two faces are identical. However, many patterns of facial behavior are shared and passed from one generation to another. Facial expression functions as a form of adaptation. So, is the face like a genetic code which we gradually decipher in our social exchanges over the course of our lives? That is a question which continues to provoke scientific debate. Current scientific research on the facial expression of emotion owes much to the work of researchers like Bell, Darwin, Duchenne, Schlosberg, Landis, Hjortsjö, Tomkins, Ekman, Fridja, Izard, Osgood, Fridlund, Russell, and Camras. The identification and recognition of a facial 'program,' with consequent measurability, have preoccupied many researchers over the years. For example, Bruce and Young analyzed face processing as a set of seven types of information code. It is a theoretical model that involves neuropsychological dissociations to access specific semantic information on facial expression recognition. Other theoretical approaches (i.e., of Burton) suggest the involvement of artificial neural networks derived from complex systems. Emotion may or may not provoke a facial expression and facial expression may or may not be prompted by emotion. This is why it is so important for us to understand the brain–emotion–face process. Each emotion (and its accompanying perception) has its own associated neural circuits. It is essential, therefore, to understand the traits on the human face put there by the emotions generated in the brain. Human facial expressions are the result of muscular movements, which express emotional states or signals. Behaviorist and geneticist approaches examine the use and meaning of the muscular movements of the face – eyes, nose, mouth, eyelids, eyebrows, forehead, and neck. Reading the map of the face remains a

challenge to modern science. Facial expression of emotion can have a contagious effect among individuals in their social interaction. The debate on facial feedback and learning, their cerebral, physiological, and situational aspects, is well documented in the literature. The face has always been seen as a mechanism of adaptation and survival, a view borne out by empirical research. Of the various theories on the facial expression of emotion, the holistic approach, which postulates that facial expression is the result of diverse and complex moderating variables, currently has the most followers.

Emotion: A Complex and Multidimensional Phenomenon

Over two centuries have passed since Bell published his anatomical groundwork of facial expression, a work which was to form the foundations for later scientific research and even today is frequently cited. Bell was the first researcher to offer a definition, albeit tenuous, for emotion. The definition of emotion is not consensual, as it is a complex and multidisciplinary phenomenon. For example, some feelings are associated with emotions. But even if all emotions generate feelings, not all feelings derive from emotions. The difference lies in duration, intensity, and frequency. Despite the difficulties in arriving at a consensual definition of emotion, the literature does agree on the importance of neuron, motor, and experiential processes. Emotion is an automatic, intense, and rapid response – either conscious or unconscious – to the world around us, and a neuronal impulse, which induces the organism to perform an action. The functions of emotion are associated with adaptation and expression. Emotion functions as a catalyst between conduct and the environment, and is a prelude to action. Emotion plays a crucial role in the learning process. Experiencing emotion allows us to learn emotionally, so we can deal with future situations, and emotion is a means of preparing us for action. Emotion manifests itself in the form of kinesic and kinetic processes in the scope of the repertoire of nonverbal communication. It contributes to the expression of feelings and may also reflect social status and power in terms of facial configuration. The different types of emotion help make communication more fluent and also assist in the identification and comprehension of defense mechanisms and rules of interaction. The components of emotion are *conscious experience* (sensation), *physiological reactions* (organs and

systems of emotional activity), and *expressive behavior*. Emotional systems have been extensively discussed in the literature and include cognition, facial expression, and the activity of the autonomous nervous system (ANS). The universal recognition of facial expressions derives from an innate program for each of the basic emotions. However, changes in expressivity change what is felt. The characteristics of emotion spread the distinctive pancultural signal for each emotion, universal facial expressions being determined phylogenetically with the involvement of various signals, the duration of which is limited; facial expression reflects aspects of emotional experience; with the different degrees of intensity for measuring the subjectivity of experience, facial expressions can be inhibited, and expressions can be faked; each emotion has its own aspects, and each activates an alteration pattern on the level of the ANS and central nervous system (CNS).

From the Brain to the Face: An Emotional Journey

The general theory is based on the premise that emotion has evolved in accordance with everyday activity; its adaptation implies differentiated patterns for each emotion and that cognition and physiology play a part in the activation of emotion. Emotion is activated in the brain circuits and involves *lateralization*; positive emotions are governed by the left hemisphere and negative emotions by the right hemisphere; *efferece*, the emotion program, implies distinct expression via movement of the facial muscles; and *facial feedback* that relates to the proprioceptive, cutaneous, and vascular dimensions of facial expression is influenced by emotion. Facial expression of emotion lasts from 1 to 5 s. The vascular theory holds that emotion and cognition functions operate via different mechanisms and that changes in facial expression change what we feel, creating or influencing emotional experience. Emotion causes physiological alterations which prepare us for action and which, over the years, evolve on the adaptive and expressive levels. Emotion is a brief reaction, but it can form the basis for the formation of feelings or other conducts. Emotion is a neurophysiological reaction to stimuli which mediate situations of danger and satisfaction. Not all of the emotions occurring in the cerebral structures are conscious. There is an extensive literature attesting that emotion develops in the limbic system, a set of structures located below the cortex and related with the cortical zones. The interaction between the limbic system and the cortex makes us aware of emotion, which may then act as a moderating variable. Emotional processing activates different cerebral structures, such as the hypothalamus and the pituitary gland, whose primary physiological functions are to regulate cardiac and muscle movements. Over the years, the emotional system has evolved to place greater emphasis on the consciousness of emotion. However, no significant evolution has occurred in the primary *pulsions*. Take, for example, the processing of fear: in the first place, the amygdala registers the stimulus almost automatically, without any interference from conscious mechanisms. The amygdala then notifies the hypothalamus, which triggers a set of physiological reactions. This process occurs almost instantaneously, with interaction between unconscious reaction and conscious response which is not fully understood. Studies have clearly shown that the

amygdala is one of the key centers for the processing of emotion, for it is the amygdala that issues instructions to other brain areas for the appropriate emotional response to be made. The brain functions, therefore, as a kind of dressing room for the expression of emotions which subsequently appear on the *stage*, that is, the face. The amygdala plays a crucial role in the emotions, and damage to it can cause selective deficits in the recognition of facial expressions of fear and also other emotions. The amygdala comprises the nuclei, which are responsible for differentiated reactions. For example, while the central nucleus triggers the immobilization reaction in the presence of a phobic situation, the basal nucleus stimulates the flight response. The different ways in which men and women react can be explained by the way these nuclei are affected by the sex hormones. The amygdala is a repository of experience. It operates unconsciously, involving various brain structures (e.g., the thalamus, hypothalamus, hippocampus, cerebral cortex, etc.). This is one reason why it is difficult to treat phobias in a clinical context. However, we can – and should – learn how to deal with the stimuli and in this way mitigate the intensity of phobic reactions. In the case in point, the amygdala captures the facial expression and produces a certain reaction. Scientific discussion continues on the issue of whether the activation of emotional reactions is a conscious or unconscious process. Much literature contends that emotion is initially a physiological reaction to, for example, a threat to the integrity of the system. Once the amygdala has relayed the signal, conscious feeling, involving the orbitofrontal and cingulate cortex, emerges.

Facial Expression: From Universality to Cultural Influences

The research of Ekman and Friesen just over half a century ago made a considerable contribution to our knowledge of the facial expression of emotion. Until then, the study of facial expressions had enjoyed little prestige among psychologists, despite the contributions of Allport et al. At this time, the work of Schlosberg on the representation of the information exhibited by the face drew most attention. Still, very little extended research was dedicated to it. The much needed paradigm shift came with the work of Tomkins, for whom nonverbal communication – namely facial expression – was a superlatively rich source for the study of human behavior. Ekman and Izard were influenced by Tomkins' work, particularly with regard to the planning and execution of intercultural studies, in their examination of questions such as the following: Do facial expressions convey universal emotions? How do we interpret facial expressions? The work of Ekman in New Guinea in the late 1960s reinforced the view that, contradicting Mead, spontaneous expressions are universal, while also showing that facial expressions can be influenced by the so-called *rules of exhibition*, which are specific to a given culture or social context. Ekman's findings were backed up by the evidence gathered in anthropological studies. Psychologists such as Fridlund and Russell, however, have questioned this evidence as well as the methods used in arriving at judgments on the display of facial expressions. Expressions of fear, anger, disgust, sadness, and joy register values of intercultural

congruence. Discovery of the universality of facial expression triggered the need to devise methods and techniques of scientific measurement for the evaluation of facial movement. Thus, in the 1970s, there emerged the Facial Action Coding System (FACS) for the classification of muscular movements, and the Maximally Descriptive Facial Movement Coding System (MAX) for the verification of the most important muscular movements in the identification and recognition of a given emotion. Also, at this time the first scientific findings on the measurement of the electrical impulses associated with movements of the facial muscles began to appear. Measurement of the facial expression of emotion continued to be a challenge for researchers. And the principal problem affecting measurement methods already devised was how accurately and objectively these methods could measure. The identification and recognition of facial movements and their association with certain emotions have provoked extensive and heated scientific debate. The techniques and methods devised by Izard, Ekman, and Friesen (the FACS was updated in 2002) in the late 1970s were based on the research of Hjortsjö into the workings of the facial anatomy. The identifying Affect Expression (AFFEX) by holistic judgment, the Facial Affect Scoring Technique (FAST), the Facial Expression Coding System (FACES) and EMFACS (which converts action units (AUs) into emotional states), the FACS Affect Interpretation Dictionary (FACSAID), electromyography (EMG), functional magnetic resonance imaging (fMRI), and baby FACS and FACEM (which measures facial movements in terms of a dozen basic states) are some of the instruments now used in measuring the meaning of facial movements. Current research also draws on databases (e.g., F-M Portuguese Face (F-MPF) and pictures of Facial Affect and Karolinska Directed Emotional Faces) and software (e.g., Micro Expression Training Tool (METT), Subtle Expression Training Tool (SETT), FaceReader, FaceXpress, i-Brain, i-Emotions, i-Smiles).

Facial Expression: Its Contribution to the Study of the Emotions

The evidence for the universality of facial expressions has led research to extend into other areas, such as healthcare, justice, and education. The scientific community now sees facial expression as a psychobiological phenomenon of considerable interest to the comprehension of human attitudes. Given that each expression is associated with a particular physiological activity in turn associated with a particular emotion, the idea of interaction between a given emotion and the CNS gained increasing numbers of supporters, especially in the early 1990s with the work of Davidson and Cacioppo among others. Spontaneous facial expressions are the result of a subjective emotional experience. Typical emotions appear in response to given situations, which bears out the claim that events precede emotions. Facial expression is the mirror of our ontogeny. The ability to give facial expression to our emotions appears at an early stage of infancy. Thus, the face is a fulcrum element in human interaction from a very tender age – and indeed is the first means of communication from which we can draw. Emotions occur according to a special process. There are various expressions for each emotion. For example, Ekman catalogued over 60 expressions of fear, which reflects the intensity

of this emotion. Each emotion is comprised of specific affective states, and it is the composite nature of these states which determines the differences between the emotions. Facial expressions are seen as evidencing subtly positive or negative states. Emotions may vary in terms of vocal expression, but not in terms of facial expression. And some expressions, such as smiling, are used in various states.

Positive Emotions and Negative Emotions

Negative emotions trigger serious problems, which may take the form of, for example, phobias, anxiety disorders, aggression, violence, depression, suicide, and eating disorders. For Tomkins, negative emotions produce a specific signal. However, research conducted in the 1990s failed to confirm this theory, pointing instead to the existence of various templates, which supports the differential theory of emotion. Positive emotions represent the satisfaction of the individual. The limbic system is related with sensations of pleasure, diminishing other types of activity which may influence the normal course of satisfaction. According to the literature, there is an association between emotional states of pleasure and zygomatic muscular activity. It also shows that happiness is not always signaled by a smile. For example, the smile of a child is more evident in the context of social interaction than in situations of happiness and can also be observed more in situations of discomfort. The smile is coordinated by the ocular function and success in a sports competition is not evidenced when receiving the prize. The smile is in fact a specific phenomenon of the facial expression of emotion and one of the paradigmatic features of the study of facial expression of emotion, as a multidimensional phenomenon which is at the source of much disagreement among researchers with regard to its causes and functions. One type of smile which has attracted much scientific attention – and yet elicited little agreement – is the so-called Duchenne smile, which is characterized by zygomatic activity in combination with the orbicularis oculi.

Basic Emotions

The human face exhibits basic universal emotions with a muscular configuration specific to each: joy (corners of the mouth raised), disgust (cheeks raised, nose puckered, upper lip curled), anger (eyebrows lowered, eyes narrowed, lips compressed), contempt (chin raised, part of corner of mouth raised slightly), fear (eyebrows raised, eyes wide open, mouth open), surprise (eyebrows arched, eyes wide open, jawbone slack), and sadness (eyebrows slanting from center to edge, mouth slack).

What Does the Face Show?

Facial expressions are the reflection of the experiences and messages of the endogroup (the group of belonging) and the exogroup (the comparison group). The terms we use to describe emotions are not unique or unequivocal. Once again the intercultural question comes into play. The message generated by an emotion has to be captured instantaneously. The start, duration, and end of the movement are the stages that have to be taken into account. Involuntary and momentary expressions activate a particular muscular contraction, giving

indications on the type of associated emotion. Positive emotions share a particular expression (e.g., the smile), which can be observed in terms of time, intensity, and context. Negative emotions (e.g., sadness) also exhibit a particular morphology of expression (e.g., corners of the mouth, eyebrows) characteristic of unhappy states. Some emotions are given no expression on the human face. This means we are unable to identify a facial expression, vocal expression, or bodily behavior associated with them – no discernible pattern or sign of distinction exists. This is a legacy of ontogeny and phylogeny. There is a template at the CNS level which is unique for the emotions. The fact that an emotion is not linguistically coded does not mean that the emotion does not exist. There can be emotion without facial expression. Research using EMG has detected alterations in the pattern of facial activity. This would seem to contradict Tomkins, who asserts that facial expression is always part of emotion, even when it is not visible. Voice and posture (e.g., head and hand movements) also contribute to the configuration of the emotions. Isolated head movements do not by themselves communicate emotions. It may be possible that emotion can be characterized by vocal expression but not facial expression. Ekman agrees with Tomkins in contending that each emotion has its facial expression and its vocal expression too. The existence of emotions with no expressive or auditory signal has occupied many contemporary researchers. Ekman maintains that we must bear in mind certain discrepancies in the mode of facial expression of emotion (e.g., anger as a result of irritability), emotional state (anger as a result of hostility), and affective disorders (sadness as a result of depression).

Facial Expression Without Emotion

People can fabricate and feign the facial expression of emotion, but this occurs when they are not in any emotional state. The literature attests to the distinction between genuine and false expressions. Some muscular movements cannot be made voluntarily. In the latter half of the nineteenth century, Duchenne identified the orbicularis oculi, the muscle which surrounds the eyes. This muscle contracts in involuntary smiles but not in voluntary smiles. The orbicularis oculi comprises two portions: the central and the lateral. The first portion can be contracted voluntarily, but the second cannot; and it is the contraction of this second portion which is absent in 'false' smiles. Duchenne's theory now enjoys global consensus. Expressions such as anger, fear, and sadness also involve specific muscular configurations that cannot be exhibited voluntarily.

A Special Phenomenon: The Human Smile

Not all smiles are the same. Laboratory analysis of the human smile has established a reference framework which distinguishes between true and false smiles, and which involves identical asymmetry and different amplitude and duration. Distinctions are established between true smiles and false smiles, spontaneous smiles and intentional smiles, as well as Duchenne smiles and non-Duchenne smiles. The Duchenne smile and the social smile are extensively documented in the literature. The first is spontaneous; the second intentional. The Duchenne smile – named after the French neurologist Guillaume Duchenne, who was the first to identify it – involves

muscles activated by an unconscious cerebral process. With the Duchenne smile, the lower eyelids dilate and the corners of the eye wrinkle. The smile is an indicator of what its wearer is feeling and reveals the emotional state ascribed to it. Forced smiles point to low levels of happiness. The smile is controlled by emotion. A true smile, which involves activation of the muscles around the mouth and the eyes, reveals joy and involves the motor cortex, the muscle around the eye (which controls movement of the eyelids), and the amygdala. A false smile, however, involves conscious brain structures and the motor and premotor cortices, with the eyes averted and deliberate contraction of the muscles around the mouth drawing the lips outwards, and also involves the premotor and motor cortices, the frontal cortex, and the lesser and greater zygomatic muscles.

Gender and Age: Differences and Implications

Women are more attracted by faces exhibiting positive emotions in men than in women, regardless of age, while men are more attracted by negative emotions without distinction of gender. This is one of the conclusions of research into facial attraction and the effects of the emotions. The procedure consisted of displaying images of faces exhibiting basic and secondary emotions and judgments on identity and attractiveness made by individuals. The findings suggest that women feel more attracted by the faces of men exhibiting positive emotions and belonging to the 18–25 age group, with levels of attractiveness decreasing as age increased. Men feel more attracted by negative emotions in the 18–25 age group, and again the level of attractiveness decreases with age. The findings also suggest that distinct perceptions of attractiveness vary according to the type of emotion exhibited on the face, and that such perceptions vary also according to gender and age. The conclusions also suggest that facial expressions reflect and determine how emotions are expressed. They confirm the principal effect of the facial muscles in the representation and determination of the emotions, while differences according to age and gender were observed. Women claim to feel emotion more intensely than men. Individuals in the 40–60 age group also claim to feel emotion with greater intensity. The findings corroborate the facial feedback theory, according to which the facial expressions exhibit not only emotional experience but also determine the way the basic emotions are lived and labeled.

Emotion Manifested on the Face: Some Theories Compared

The new scientific approach accepts some associations between facial expression and emotion, but insists that the central question is not the associations themselves but their nature. This is the real core of the debate on the facial expression of emotion. The facial expression of emotion is influenced by culture, age, and gender. It makes reference to multiple standards within the scope of nonverbal communication, which reinforces the behavioral ecology view of the emotions. Spontaneous expressions are rather the reflection of phylogenetic criteria. The smile, according to this theory, appears from the

experience of an affective state. It is not an intention of friendship, but a positive feeling. The emotions do have social intentionality, as rational behavior does, but we must take into account a behavioral disposition characteristic of a certain receptor. Facial expressions can occur when the emitter is alone. With regard to facial expression and the effect of the intensity with which the basic emotions are exhibited, the literature observes that the human face is incapable of displaying two emotions at the same time. The research procedure consisted in collecting information on the intensity of the seven basic emotions (joy, sadness, anger, fear, surprise, disgust, and contempt) exhibited by individuals. Muscular-skeletal movements were measured in terms of microexpressions in fractions of a second. Participants were unable to exhibit two basic emotions (e.g., joy and anger) on their face at the same time when asked to do so. The findings show that the brain processes the exhibition of the basic emotions sequentially. The findings also suggest that women exhibit the basic emotions quicker and more intensively than men, regardless of age. Surprise and fear are the basic emotions that both women and men are quickest to exhibit, while contempt and disgust are those which take most time to appear on the face. The literature also shows that the right hemisphere is more associated with negative emotion than the left hemisphere. For example, the identification and recognition of the basic emotions of fear and sadness tends to activate the structures of the right hemisphere more than the left, while the signals produced are received and processed by the left hemisphere. These signals must circulate in that order if we are to be conscious of the emotions. Facial expression of emotion also activates the right frontal cortex. Emotional information is processed in neuronal circuits and the reaction and response to them depends on the type of stimulus. For example, the positive emotions follow a different path from the negative emotions, for they are intimately linked to the cerebral artery which segregates dopamine, the neurotransmitter responsible for feelings of satisfaction and pleasure. The consciousness and evaluation of the intensity of emotion is the responsibility of the thalamus. fMRI enables us to identify the course of the reaction and response of brain structures. The literature attests that the facial expression we know as the smile is more rapidly identified and recognized (i.e., consciously) than a neutral expression, and that the brain needs only 350 ms for the global perception of emotional interpretation. Emotion is characterized by duration and intensity. It is a guide for adaptive behavior. It is consensually described as a neuronal impulse which causes the organism to produce an action. Modern evolutionary theories are concerned with the identification of the functional axis of the emotions, arguing that just as emotion can be the cause of facial expression, the latter can be the cause of emotion. And the recognition of discreet or subtle emotions is a fundamental question in the evaluation of this process. Approaches toward the facial expression of emotion have changed since the late 1970s. Traditionally, expressions such as the smile have been considered as facial expressions. But this is where a range of differences begins to emerge. The new approaches focus on the expression-emotion pairing. The facial movements are called signals. Facial expression is viewed as a heterogeneous phenomenon and the point of analysis is the emotional state of who is emitting and who is receiving the message associated with a given facial expression. The communication process is considered, and analyzed, in its

entirety. The modern era of the study of the facial expression of emotion began in the 1960s with the work of Tomkins, which was later an influence on Izard and Ekman, among others. Tomkins's theory holds that each basic emotion is associated with a unique cerebral emotional process. The basic emotions vary in their degrees of intensity. This theory of the basic emotions has received criticism, however. The new approach to the facial expression of emotion stresses the multidimensional character of the emotions, paying particular attention to the components underlying emotional processes. One of the criticisms leveled at the theory has to do with the fact that research into the facial expression of emotion is centered exclusively on the judgments made by the receiver of messages. The momentary emotional state of the receiver of these messages is not taken into account. And the judgments made by the receiver do not necessarily correspond with the emotion as lived. This view of the facial expression of emotion stresses the idea that the receiver does more than merely receive and decode the expressed message. The facial expression of emotion involves the emitter in a range of effects. For example, when detecting a lie, the receiver is not merely detecting the lie but also verifying a standard of truth. For the person receiving the message, more than merely verifying the traces of the lie, he/she verifies the truth-framing process. Can the facial expression of emotion predict human behavior? The traditional theory of the basic emotions is now being reexamined in the light of new approaches, which stress the dynamic processes of the various components involved, with particular emphasis on the social context and its relationship with cognition and activation. Social learning is a dimension which must be taken into account in the process of construction and exhibition of the facial expression of emotion, as the communication process involves both sender and receiver and it is not essential that an emotion be attributed to the message. What is at stake is the universality of this process. In the traditional view, facial expression is always a particular signal of emotion, with the consequent process of decoding on the part of the receiver, regardless of gender and age variables. The process is innate and immediate. It is precisely in regard to the processing of the comprehension of facial expression that the debate and the different approaches emerge. According to the traditional view, the facial expression of emotion occurs according to an innate standard shared by all cultures. According to the modern view, social influence has a considerable effect on this process. In other words, the signal manifested on the human face is interpreted according to different perspectives, as a range of facial traits can be observed for each emotion. No rational evidence for the existence of such a range is known. The research is extensive and the findings are not consensual, principally with regard to the facial expression of spontaneous emotion. And this is a result of the components involved in the cognition process. For example, some emotions are more easily recognized than others. The basic premise is that this process requires that the emotion is part of the stimulus and as such must be immediately recognized, as if it were part of a congenital standard. Now the attribution depends not only on the genetic process but also on the cultural background of the individual processing and emitting, and the individual receiving and perceiving. For example, the literature observes that a smile is not always a sign of happiness, and that the ways we recognize a smile are not in fact consensual. Hence, modern theory on the facial expression of emotion argues for

the existence of what it calls a minimum universality, pointing to the fact that facial expression can occur in any place at the instancing of a psychological process, that is, people make inferences based on facial traits. However, judgments reveal discrepancies with regard to identification and recognition. The judgment that the receiver makes of facial traits is summarily expressed as a specific emotion. Yet, this process is influenced by our surroundings. The judgment of a given facial expression of emotion is not as simple as it might at first glance appear to be. The process – often the immediate identification of a signal – involves complex variables such as gender, age, affective state, and social context. The idea is that the recognition of the facial expression of emotion is not just the recognition of a signal but the result of a learning process of the utility of such a signal in the dyadic process of human communication. In the light of the above, and despite previous research, further intercultural investigation is required, for the effects of the facial expression of emotion are diverse.

Macroexpression and Microexpression

The analysis of the facial expression of emotion, spontaneous or intentional, addresses amplitude, asymmetry, duration, onset, offset, intensity, and head movements. Macroexpressions last between half a second to 4 s and can be observed in everyday conditions. Microexpressions last less than half a second and occur when the individual is concealing or repressing his/her feelings. Microexpressions are not immediately detected by the observer. However, with a little training, we can learn to express and recognize microexpressions. ‘Subtle’ expressions are related with the intensity of the emotion and occur only when an individual is undergoing the onset of an emotion. They also appear in response to another individual in contexts of reduced emotional intensity. We can observe a strong correlation between the degree of identification and recognition of subtle expressions and the degree of detection of falsehood or deception. The time taken for macroexpressions to appear and disappear varies between 0.5 and 4.5 s, and occurs as part of a normal process of the exhibition of the emotions. The time taken for microexpressions to appear and disappear is less than half a second, and frequently as short as 1/5 or 1/15 of a second. Some expressions involve the whole face, that is, enlist all the facial muscles at the service of a certain pattern, including the forehead, eyes, cheeks, and lower jaw. Facial expressions that involve all the associated components are observed only in the eyebrows or eyes and cheeks or lower jaw. Analysis can be made in terms of angles (frontal, whole face frontal; 3/4 angle where the face is seen from an angle of 45°, and in profile, where the face is seen from the side, at an angle of 90°). The intensity of macroexpressions can be moderate or strong, corresponding to codes C to E of the FACS. Microexpressions are of low intensity, corresponding to codes A and B of the FACS. Facial expression is also measured in terms of distance (short, as in social interaction between close friends or family members; medium, as in social interaction among known and unknown individuals; and long, as in the identification of a face in the crowd or at a considerable distance). Recent research has revealed that subtle expressions, but not microexpressions, are a more accurate and

useful tool for the detection of falsehood and deception. Thus, learning how to identify and recognize subtle expressions helps us learn how to detect lies. Subtle expressions occur only when an individual is beginning to feel a given emotion and in low-intensity contexts. When we identify and recognize a subtle expression, we are identifying the emotion that our interlocutor exhibits and the subtle variations in its expression. To identify and recognize a microexpression, we need to be able to verify an expression visibly replete with emotion in a short space of time (1/2 s or less). In the laboratory analysis of facial expression, a range of methods and techniques are used. For example, Psy7Faces is a method devised for detecting subtle expressions and microexpressions. The METT, SETT, and SubX are computer programs designed to train us in identifying the basic emotions. The most commonly used instrument for measuring facial expression is the FACS, which provides a scientifically rigorous method of classifying the movements of the facial muscles. Current research suggests that traits can be identified and recognized for lie detection purposes. The basic premise is simple enough: if there are different ways of expressing the content of the basic emotions, then profiles for psychophysiological alterations can be devised. The research manual, published in 2002, lists 44 AUs for evaluating facial expression via combinations. For example, the expression of joy maps to AUs 6 and 12. The intensity is measured on a scale of a (trace) to e (maximum evidence). Onset, apex, and offset mark the stages during the muscular movement evaluation process.

Neuromuscular Structure and Facial Expression

The way the brain constructs emotion has been the subject of much in-depth research in recent years. The brain is divided into two hemispheres, and processes information cross-wise: each hemisphere controls the opposite side of the body. Each half of the cerebral cortex has four lobes (frontal, parietal, occipital, and temporal), each with a specific function. The temporal lobe regulates certain emotions (joy and anger); the frontal lobe regulates movement and reasoning; the parietal lobe regulates touch, sensations of heat, cold, and pressure; and the occipital lobe interprets the information sent it by the optical nerve. As for the nervous system, of the 12 pairs of cranial nerves it is the facial nerve (VII) which controls the movements of face and neck, as well as the sense of taste. The motor fibers drive the facial muscles and in this way allow us, for example, to move our eyebrows, open and close our eyelids, narrow our nostrils, smile, pull faces, and kiss. The muscle around the eye allows us to close our eyes (voluntarily, when we want to sleep, and involuntarily, to blink); the muscle around the mouth allows us to close our mouth or stick our lips out (e.g., to give a kiss); the frontal muscle allows us to raise our eyebrows and frown our forehead; the masseter muscle allows us to chew; the nasal muscle allows us to open and close our nostrils; and the temporal muscle allows us to move our temples. Another example of the differentiated movement of the muscles is that the expressions made by humans are not exactly the same as those found in the chimpanzee (humans configure joy differently from chimpanzees; when the latter show their teeth they are revealing fear).

The Face: Moderating Variables

The Effect of Visual and Auditory Stimuli

Visual stimuli exercise more influence on emotional perception than auditory stimuli, and there are gender and age differences in emotional reactivity when the neuropsychophysiology of the emotions is examined via the verification of the visual and auditory effects of positive and negative emotions. The effects of visual stimuli are more visible than those of auditory stimuli both in positive and negative emotional reactions. Regardless of their age, women are more influenced by the visual stimuli of the basic emotions of joy, sadness, and surprise. Men are more influenced by visual stimuli of the basic emotions of anger and joy, decreasing in intensity from age 45 onward. Research has revealed that visual stimuli of fear and sadness are mentioned by participants aged 65 and over.

Effect of Skin Color

According to the literature, skin color affects the psychological perception of the smile. The expressiveness of the smile reveals that women are more influenced by skin color when they see a smile. Research has demonstrated that our perception of smiles in individuals of a different color of skin reinforce attachment to the endogroup in relation to the exogroup and facial stereotypes in the context of the rules of social exhibition and theories on the facial expression of emotion. The Smile Perception Scale (SPS), devised by this author in 2003, comprises 19 opposing pairs and measures the factors evaluation (Ev) and expressive movement (EM) in two types of facial expression: the broad-type smile (lips apart, corners raised, both rows of teeth on show, the whole face exhibiting significant physiological alterations, accompanied by muscular movements) and the neutral or unsmiling face (lips together, corners not raised, teeth not displayed, no physiological alterations of face, and no muscular movement).

Facial Feedback

The facial expressions reflect and determine how emotions are expressed, that is, the psychological construction of the emotions and the effect of the movement of the facial muscles. The research procedure involved asking participants to use their facial muscles to express the basic emotions. One of the examples used was fear ('Raise your eyebrows and knit them'; 'Stretch your lips horizontally toward the ears'). The participants later noted whether they had felt the emotion represented, and with what intensity. The findings confirm the principal effect of the facial muscles in the representation and determination of the emotions, and age and gender differences were observed. Women say they feel emotions more intensely than men. Participants in the 40–60 age group also claimed to feel emotion with greater intensity. These findings corroborate the facial feedback theory.

The Effect of Stereotypes

Facial expression and the effect of the smile on the psychological perception of stereotypes show that an individual who smiles is perceived as intelligent and attractive. Smiling people

were perceived as happier than those with a neutral expression. The broader the smile, the happier its wearer. Women were perceived as more intelligent and attractive when wearing a superior or closed smile than when with a neutral expression. There were no significant differences in perceived intelligence in men. The findings suggest that smiles affect men's perception of beauty. A smile makes a woman more attractive, and attractiveness increases in linear fashion from a neutral face to a broad smile. The 60–70 age group makes no significant distinction in its perception of the different types of smile and associated psychological characteristics. But this difference is significant in the 18–25 age group. Women tend to underestimate the effect of a smile in other women, attaching greater value to the smile of a man. A smile in itself is the expression neither of intelligence nor beauty – its effect depends on variables such as the gender and age of its wearer and observer.

The Smile of Criminals

Criminals who smile are more favorably perceived, and seen as less responsible for the crimes they have committed, than criminals with a neutral expression, especially among women. Analysis of facial expression and the effect of the smile in psychological perceptions of criminals revealed the same. The conclusion is that women and male criminals are perceived more favorably, and seen as less responsible, by women, while men only make such a distinction in relation to women. Research has also revealed that the age effect is operative in men aged between 18 and 50, for whom there are no significant differences in their perceptions of the facial expressions of criminals. The more serious the crime committed, the less the importance attached to the smile, both by men and women. The findings reveal that this significant reduction in the smile effect is more pronounced in men.

Activation and Perception

Findings on the psychophysiology of the smile and the construction and effect of the emotions reveal that the smile not only reflects certain emotional states but can also help to produce them. Women and men attest to experiencing positive emotions when they smile, and this experience varies according to gender and the type of smile exhibited: women say they feel happier when they wear a broad smile and men when they wear a superior smile, as the literature records. For example, the muscles which are activated when we smile send a message to the brain informing it of the experience of happiness, even when context and circumstance have not actually produced this particular emotion. This is the premise on which the theory of facial retroaction is based. Conversely, neither women nor men say they feel any emotion when they wear a neutral expression. A closed smile is the first indicator of the feeling of happiness, although it has little intensity either in men or women. None of the participants said they felt any kind of negative emotion when exhibiting one of the smile types studied. The findings suggest that wearing a smile has strong therapeutic effects in the induction of positive emotions in diverse social contexts. The smile has been classified into four different types: the broad-type smile (lips apart, corners of mouth raised, both rows of teeth on show, the whole face exhibiting significant

physiological alterations, and accompanied by muscular movements), the superior smile (lips apart, corners of mouth raised, upper teeth on show, the whole face exhibiting significant physiological alterations, and accompanied by less intense muscular movements), the closed smile (lips together, corners of mouth raised, teeth not on show, no significant physiological alterations to the face as a whole, and limited muscular movement), and the neutral or unsmiling face (lips together, corners of mouth not raised, teeth not displayed, no physiological alterations of face, and no muscular movement).

The Effect of Visual Memory

Women reveal better visual memory in the identification and recognition of human faces, as shown by research into the effect of memory on the psychological perception of the face over different periods of time (5, 10, and 30 min). The ability to remember a face decreases significantly as more time elapses between exhibition of the face and the request to identify and recognize it at a later stage. The eyes, mouth, nose, and facial shape are the elements most cited as facial identifiers. Regardless of their age, women are more assertive in the identification and recognition of faces, but especially in the 45–65 age group.

The Effect of Facial Deformation

There is a pattern of construction of facial expression associated with each basic emotion, as discovered by recent research into the effect of facial deformation in the psychological perception of the basic emotions. The research procedure consisted in the identification and recognition of the basic emotions (joy, sadness, surprise, fear, anger, disgust, and contempt) via the exhibition of purposely deformed faces extracted from F-MPF, a database compiled by this author in 2003 and spanning ages ranging from 18 to 80 years. Degree of assertiveness in the identification and recognition of the facial expression of emotion diminishes as movement decreases and deformity increases. Sadness and contempt, two emotions that require little muscular movement in a subject of purposeful deformation, are the emotions that register the lowest identification and recognition ratings. Joy, anger, disgust, fear, and surprise were more assertively perceived, and in the order given. Regardless of their age, women are more assertive in the identification and recognition of the basic emotions in deformed faces, especially in the 45–65 age group.

The Effect of Tears

Research into the psychophysiology of weeping and the effect of tears on emotional experience has found that women on average cry two or three times a week and more frequently show their tears than men. The procedure consisted in the gathering of information (via questionnaire) on the frequency and intensity of weeping and the emotional and physical circumstances in which weeping occurs. The findings suggest that while women cry more than men, the latter cry more intensely when they do. Age differences were observed in the manifestation of tears: women in the 18–30 and over 60 age groups cry more frequently, but more intensely in the 35–55 age group. With men, weeping is more common in the 18–30 and over 60 age groups, but more intense in the 35–50 age group.

Women tend to cry in their bedrooms and with their female friends, while men claim not to choose the location and place the emphasis on the circumstances which incite their tears. Both sexes are in agreement with regard to the reactive nature of tears, that is, weeping is provoked by external factors; however, women also noted that sometimes they cry without knowing why. The death of kin, family breakups, loss of employment, and the detection/treatment of illness are the most important causes for the production and manifestation of tears. The findings also indicate that women have (or claim to have) no shame about crying in public, while men are more withdrawn and only cry in public in exceptional circumstances. Both sexes see weeping as a reactive mechanism, a compensatory phenomenon which offsets the tribulations of life.

Facial Symmetry

The classification of faces as ‘more masculine’ or ‘more feminine’ depends on the degree of symmetry they present, a phenomenon related with the mechanisms of attraction. According to research, symmetry is related to biological processes, where it functions as an indicator of attraction and the genetic suitability of a prospective partner. According to the findings of research into facial expressions and the recognition of the basic emotions, women can more readily and more consistently identify the basic emotions via facial expression – a faculty they retain over the course of their lives. Research involved individuals aged from 18 to 70. Joy, anger, sadness, surprise, disgust, and fear were the emotions studied. In women, the standard for the perception of the basic emotion of joy is in the 18–25, 40–50, and 60–70 age groups. Women perceive this emotion more spontaneously, frequently, and rapidly than men. No homogeneous pattern can be identified for men, although anger and disgust are the emotions they identify most frequently and rapidly. Research revealed that men in the 60–70 age group identify sadness and fear more frequently and spontaneously. Women in the 18–25 age group perceive joy and sadness more frequently and spontaneously, while men more readily identify anger and rejection. Men in the 40–50 age group perceive sadness and surprise more frequently and spontaneously, while women more readily identify joy. While women frequently and spontaneously identify all the emotions, regardless of the age or gender of the individual exhibiting them, men more frequently and spontaneously identify the emotions exhibited by females. Perceptions are not linear across all age groups: the 60–70 age group had difficulty in correctly identifying the emotions expressed. The METT and the SETT, devised by Ekman in 2003, were the instruments used in the collection of empirical data. The facial expression of emotion was exhibited for only one quarter of a second, with participants subsequently asked to identify the emotion exhibited.

Expression and Twins

The smile and its effect on the psychological perception of twins. The objective of this research was to determine whether, in controlling the face variable by the presentation of twins, people are perceived differently because of their gender. The broad smile was the smile type which exerts most influence on the psychological perception of the person, followed by the superior smile, closed smile, and neutral expression. A gender

effect is also observed in the comparison of smiles in twins: women identify more with a smile by the female twin, while men make no distinction.

Perception of Facial Expression in Babies

Women are more spontaneous and consistent than men in the perception of the basic emotions conveyed by the facial expressions of babies aged 1 year, as research into the facial expressions and the recognition of emotions has shown. Joy, anger, sadness, surprise, disgust, and fear were the basic emotions studied. The findings merely confirm that the identification by women of the basic emotions is the result of bonding interaction from the first 3 months of life, intensifying from 8 months without gender distinction. Men are less spontaneous and less consistent in their identification, manifesting errors of emotional perception in babies of both sexes between 5 and 6 months of age. Women are also better able to spontaneously identify positive emotions than negative emotions. Gestational age is a moderating variable in emotional perception. The 18–35 age group registers the least discrepancies in emotional perception, regardless of gender, while the 35–50 age group exhibits alterations, inaccuracies, and errors in its emotional perceptions, a phenomenon especially marked in men.

Truth and Falsehood in Facial Expression

Expressing and reading the emotions on the human face are two verbs which should be conjugated in the present, as they contribute to healthy interaction. Expressions are not merely signals – they are also freighted with emotional content. Persons who are blind from birth never change their facial expression. Learning seems to have little influence. Observation of the expression of the emitter presupposes that the receiver gets it immediately. Inhibition, via intentional muscular configuration, is performed consciously. The literature shows that individuals unable to imitate facial expressions after cerebral stimulation are unable to identify and recognize them to the same extent as those able to imitate. Facial expressions can be false, and this falsity can be detected. When we express an emotion we are creating that emotion, so when we attempt to fake an emotion we fall prey to emotional conflict because of overlapping emotions. This process involves the secondary motor cortex (responsible for the alternative expression), the upper temporal sulcus (responsible for evaluating the effect of the forced expression), and the orbitofrontal cortex (responsible for inhibiting the natural expression). When we attempt to display an emotion which we do not feel, diverse cerebral structures are involved. With true expressions, the left hemisphere controls movement on the right side of the face, while the right hemisphere, more emotional, controls the left side. Take for example the eyes and the importance of their movement. The eyes can be a major giveaway in lie detection, and women are more assertive in this procedure, according to the conclusions of research into the effect of the eyes in lie detection. The procedure consisted in the identification and recognition of falsehood via true and false stories with which a certain look was associated (direct, evasive, objective, right, left, straight ahead, profile, miosis, mydriasis, normal, upwards,

downwards, or/and level). The standard for identification of falsehood was the more frequent exhibition, in this order, of intensity (mydriasis and miosis), incidence (averting the eyes), inclination (up, down), and laterality (profile). Regardless of their age, women are more assertive in the identification and recognition of falsehood, especially in the 25–45 age group. Research has also shown variations in the types of look associated with falsehood from 45 years of age onward.

Psychosocial Implications and Applications

The facial expression of emotion has diverse psychosocial implications and applications, for example, in the fields of healthcare and justice. In healthcare, the applications are in physiognomy and pathognomony, that is, verification that the patient is transmitting a true emotion: subtle expressions and microexpressions in the context of clinical supervision, emotional expressiveness as an indicator of psychological state and social cooperation, and the study of pain via detailed mapping of facial expressions. Some current lines of research are examining pain in terms of its facial manifestations. Identifying and recognizing the neuro-anatomical features of the expression of pain facilitate productive interaction between patients and doctors in healthcare settings. Mapping the features of pain allows us to immediately detect discomfort and to take more assertive action, as the face is like a fingerprint of suffering. The neurophysiological mechanisms of pain give us valuable information about the face and its ability to convey the state of health of an individual, and this information is of great value in the prevention and treatment of pain. Meanwhile, technology is also making its contribution to the study of the human face, with attention focusing on sufferers of, for example, Alzheimer's and Parkinson's diseases. The objective here is to allow sufferers of degenerative diseases of the brain to improve their ability to identify and recognize faces, thus improving their quality of life. Memory loss is the principal symptom of such diseases as Alzheimer's, so the challenge is to create signals which assist memory, and the human face is a reactive mechanism which can play a decisive role in this process. As for Parkinson's disease, the strategy is to give patients the chance to identify and recognize faces with the objective of facilitating interaction via the mapping of facial movements. Loss of the expressive faculties is a recurrent symptom of this disease, so the challenge is to create signals which assist memory, and again the human face is a reactive mechanism which can play a decisive role in this process. All aspects of the expressive powers of sufferers of Parkinson's disease are worthy of scientific analysis, for knowledge of the facial movements is a valuable asset in the development of a healthy society, as it clarifies the mechanisms of communicative interaction. In addition to four-dimensional imaging technology for the verification and evaluation of the muscular movements, other techniques can be used for scientifically verifying the functionality of facial expression in sufferers of Parkinson's disease.

The Smile and Its Therapeutic Effects

The literature confirms that the broad smile and superior smile are the two types of smile which exert the greatest therapeutic effect. The effect of these two types of smiles is more

frequent and more intense in women than in men. It was also observed that the therapeutic effect of the smile varies according to age group: members of the 45–60 age group registered clear improvement in their mental health in relation to the 25–44 age group, and participants attached increasing importance to positive thoughts when exposed to broad and superior smiles.

Forensic Psychology: The Value of Facial Expressions

The adoption of methods and techniques for the analysis of the facial expression of emotion within the legal system. Analysis of the effect of the smile in lie detection represents one more attempt to raise awareness in legal circles of the need to adopt scientific procedures for the analysis of the facial expression of emotion. The lines of research have shown that the legal system stands only to gain by using facial expression analysis techniques. One example is questioning by police and legal representatives, during which the use of scientific methods for interpreting facial movements and facial language can be decisive in determining the truth, and one more contribution, therefore, to the body of evidence. Like DNA analysis, the science of the human face also employs the concept of markers of trust in analysis of facial expressions. Training police agents to detect emotional incongruities using scientifically proven techniques and methods is one potential application. The ‘autopsy’ of facial expressions could prove decisive in solving certain crimes, as some muscular movements are totally involuntary and as such escape the control of an individual who might, during questioning, attempt to conceal them. The face is a laboratory of scientific analysis which could be put to the service, in this case, of justice.

Emotion and Psychopathy

Research has examined the relationship between psychopathy and the emotions. The objective is to understand the cerebral processes involved in the neuropsychophysiological reactions of the facial expression of emotion and to establish a standard which facilitates treatment and the prevention of crime. The ability to identify a psychopathic state is a vital predictor for treatment and the prevention of violence. Science has suggested that psychopaths process emotions in a different way from normal persons, and therefore the manifestation of emotions in the form of facial expressions is likely to be different too. The ability to identify and recognize emotions and the frequency of their manifestation could form the basis for the creation of a database for forensic use. To verify and analyze the brains of psychopaths and the relationship with facial expression, research laboratories use fMRI, neurofunctional psychometry, and computer programs which stimulate the cerebral systems, especially the limbic system.

Conclusions

Debate on the facial expression of emotion continues to revolve around the questions of universality and cultural specificity. This involves determining whether expressions of emotion really are expressions, and the emotions are not an easy subject to study. Research continues. The different aspects of facial expression are universal or culturally specific. The facial expression of emotion

is a complex and multidisciplinary domain, which requires, after verification of the structural and functional axes, refinement of analysis methods and techniques. Computer programs will play a decisive role in the future, as the science of facial expressions finds more and more applications in a range of psychosocial contexts. The emotions play essential roles in human development. For example, they prepare individuals for action and help mold behavior. The emotions are a mechanism of social interaction, promoting development in the scope of the neurocultural theory advanced by Ekman. No one will dispute that the human face is a rich repository of information and communication. However, analyzing the face is not as easy as it might sometimes appear. Superficial analysis of the face leads us into error, and this error can become a serious one in cases where the information emitted is incorrectly assimilated and interpreted – or where the information in question is actually false. Interpreting the signals put out by the human face is a line of research which has occupied many scientists in the last two decades. But what is the ultimate objective of this research? To answer this question, we have to identify and understand the psychological states that underlie the facial expressions; however, these expressions are configured. The codification of such work is the next step in the construction of a theoretical groundwork for the development of a reliable and workable scientific technique for the mapping of the human face. In psychology, the study of the human face is now a wide-ranging field which occupies large numbers of researchers. Review of the literature is vital, given the countless studies carried out and their greater or lesser practical feasibility. The study of the face, insofar as it is a measurable and quantifiable phenomenon, is now a vital condition for research in the domain of the facial expression of emotion. In early studies, the face was seen, and studied, as an independent variable. The objective was simply to study the effect of the face on other associated variables. Nowadays, however, the face is seen and studied as a dependent variable in its relationship with other variables in the context of human systems of communication. From situations of social confrontation (e.g., embarrassment) to the study of facial expressions in forensic, healthcare, school, etc. contexts, the face is a constantly changing repository of information which requires refined theoretical and practical analysis if the scientific interpretation of it is to be put at the service of society at large. Over the course of history, basic research on the emotions has involved the analysis of emotional experience, the neurological control centers of facial expression, and the difference between voluntary and involuntary expression. Meanwhile, applied research has shown how useful it can be to identify and recognize movements of expression and has pointed to the social implications of such knowledge – for the brain, not the face, is the actor.

See also: [Interpersonal Perception and Communication](#); [Nonverbal Communication](#); [Socioemotional Development](#).

Further Reading

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Family Systems

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Glossary

Cybernetics The study of systems that change themselves, or the science of self-regulating systems – that is, systems that attain or maintain a particular endpoint or goal, despite changing conditions, through a process of feedback, thereby permitting self-correction. An interdisciplinary field that began in the 1940s. Norbert Wiener, one of several founders of the field, coined the term, coauthored seminal papers, and authored a best-selling book, *The Human Use of Human Beings: Cybernetics and Society*, which applied the concepts of cybernetics to human systems.

Double bind A verbal command or request that is contradicted nonverbally such that regardless of response, a failure occurs. For example, a mother tells her son to give her a hug, tensing when he draws near. A father insists that his son become a basketball star yet becomes furious whenever his son beats him. Double binds are said to have a pathological impact if the relationship is important and the recipient is not permitted to comment on the contradiction.

Genogram A family tree that includes information about significant events in the family history, qualities of relationships (e.g., enmeshed, close, cutoff), emotional triangles, unresolved conflicts, etc. Such mapping can highlight relational imbalances in the extended family, transitional conflicts, repeating patterns across generations, and also allows consideration of the entire family at one glance.

Reactivity Internal reactions driven by unresolved emotional issues, disguising themselves as reasonable responses justified by circumstances. Overreaction occurs usually when an area of vulnerability or sensitivity is touched.

Second-order cybernetics The study of systems that change how they change themselves. Also referred to as learning systems, these systems change the feedback loops themselves based on feedback about how well those loops are helping the system maintain its desired goal.

Family Systems Theory

Family systems theory is an approach to understand human functioning that focuses on interactions between people in a family and between the family and the context(s) in which that family is embedded. Family systems theory has been applied to a wide variety of areas including psychotherapy in general and family therapy in particular (working from a systems framework with emotional, behavioral, or relational symptoms in individual, couples, and families); school systems; community problems (e.g., working with polarized disputes and facilitating ‘difficult conversations’ as in the Public Conversations Project, peace studies, nonviolence training); organizations (consulting, leadership training, coaching); and health care (medical family therapy – tracking the emotional dynamics of illness and facilitating collaboration among patients, families, providers, and health care systems).

According to a family systems perspective, an individual’s functioning is determined not so much by intrapsychic factors as by a person’s place in the system(s) in which he or she finds himself or herself, subject to the pushes and pulls of the system, including competing emotional demands, role definitions and expectations, boundary and hierarchy issues, coalitions and collusions, loyalty conflicts, family and institutional culture and belief systems, double binds, projective identifications, and systemic anxiety. In addition, self-correcting and self-reinforcing feedback loops in a system can either facilitate or hinder pathology or health, breakdown or resilience.

A thorough understanding of family systems theory requires an elucidation of the foundational contributions of systems theory itself.

Systems theory is a field that informed and inspired the founders of the family therapy field and upon which family systems theory is based in many important respects. Unfortunately, as the field of family therapy has developed, the important contributions of systems theory to the theoretical foundations of the field have too often been neglected, undervalued, or only dimly understood. The following discussion will review the key concepts of systems theory that are most relevant to family systems theory and family therapy, followed by a description of the primary schools of family therapy and enduring family systems concepts and family therapy techniques. The concepts throughout will be illustrated with both actual and hypothetical clinical case examples.

Systems Theory

Systems theory is an interdisciplinary area of study that developed around the same time as family therapy, in the 1950s, with particular roots in biology. (An allied field, cybernetics, developed out of engineering around the same time and focused on how mechanical systems control and change themselves. Cybernetics has also had a major impact in family systems theory and therapy.) Systems theory seeks to understand the dynamic behavior of complex systems, including how components of a system interact to affect the behavior of the system in often unexpected, nonlinear ways.

There are actually many schools of systems theory, each with its own focus, methods, and applications. This discussion will focus on concepts common to most. Important contributors to the development of systems theory include

economist Kenneth E. Boulding and biologists Anatol Rapoport and Ludwig von Bertalanffy (general systems theory); mathematician Norbert Wiener, psychiatrist Ross Ashby, and anthropologist Gregory Bateson (cybernetics); computer engineer Jay Forrester (systems dynamics); and others. Systems theorists whose work has found particular application to family systems theory and family therapy include Gregory Bateson, biologist Humberto Maturana and Francisco Varela, and chemist Ilya Prigogine.

Initial proponents argued that system theory could be used to understand any type of system (hence, *general* systems theory), be it biological, physical, electrical, ecological, conceptual, social, or psychological. Systems theory has been applied to various disciplines such as engineering, physics, biology, computer science, ecology, and the social sciences to study a wide variety of systems, including ecological systems, industrial systems (e.g., the oil industry, or coal, fishing, agriculture), monetary systems, stock markets, business cycles (economic models), local and global climate systems (climate modeling), political systems, population systems, corporations and organizations, (organizational theory, management science), society (sociological theory and sociocybernetics), communities (community ecosystemic models, urban dynamics), and families (family systems theory and therapy, systems psychology).

The Nature of a System

A system is a collection of parts – people, cells, organizations, planets – that are interconnected in such a manner that they produce their own pattern of behavior over time. Systems are self-organizing. When perturbed by external forces, the resulting behavior of a system is determined by the structure of the system. To a significant extent, a system causes its own behavior. A system is more than the sum of its parts, and so the properties of a system cannot be predicted from an analysis of its constituent members. A pile of wood chips is not a system. A tree is a system. A collection of books is not a system. A library is a system. Systems can be biological or nonliving – frogs, families, factories, clocks, guided missiles, the water cycle. From a systems perspective, the world is a continuum; there are no ‘separate’ systems. All systems interconnect. Where to draw a boundary around a system and what to include as its constituent elements depends on the purpose of the discussion. A family is a system. A family is also a part of multiple larger systems – neighborhoods, schools, religious institutions, medical, workplace – with which it interacts in significant ways.

There are three components to any system, including family systems: (1) elements – the roots, branches, and leaves of a tree; the components of a TV; the people in an organization or a family, (2) interconnections – the flow of water through the trunk, the flow of electrons through circuits in a TV, the flow of information in an organization, the flow of emotional information in a family, and (3) a function or purpose – of a tree to grow and reproduce, of a TV to inform and entertain with moving images and sound, of an organization to provide a specific product or service, to make money and/or contribute to the social good, and of a family (usually) to nurture and protect its members.

It is easier to spot the elements of a system than it is to see the interconnections among the elements. The difficulty in recognizing interconnections in a system can lead to misattribution of the causes of behavior of the elements of the system, or faulty prediction about probable outcomes of interventions in a system. It is harder still to grasp the function or purpose of a system – the best way to do so is to observe its operation over time. Purposes of a system are inferred from behavior, not from the system’s professed goals or intent. This point is especially relevant to family systems. A family systems analysis of any presenting problem begins with the assessment of both how the system organizes itself and what its underlying purposes are. The latter is best assessed by examining the results of the system’s behavior rather than the professed intent of any of the system’s members. An adolescent may protest that he wants his parents to let him make his own decisions, yet behaves in such a provocative way as to make that impossible, suggesting that his behavior is organized by a wish to remain dependent. This wish, in turn, may derive from the parents’ deep anxiety about the prospect of his leaving home (contrary to their professed wish to grant him independence once he begins behaving responsibly). The purpose of such a system can be understood as keeping everyone safe by preventing members from leaving.

Systems are self-organizing and are often self-repairing and resilient, at least to a point. Systems are often composed of various subsystems, which may compete and pull in opposite directions from each other or from the purpose of the larger system. Sometimes this competition can benefit the larger system, as is intended in our governmental system of checks and balances, or in the capitalist theory of competing self-interest adding up to maximum prosperity for the greatest number. Other times, subsystem competition can result in disorganization and undermine the purpose of the larger system, as when departments in a university wage war over limited resources, eroding morale and encouraging talented people to leave or stay away.

Due to the interplay of the parts of a complex system, understanding the system structure and predicting a system’s behavior can be anything but straightforward. Attempts to alter a system’s behavior may lead to unanticipated consequences. A classic example of such unintended results is the introduction of cats to Australia to control the rabbit population (rabbits having been introduced as a food source by sailors in the 1800s) with the result that the cats have become pests, decimated native fauna, and had little appreciable impact on the rabbit population. The field of ecology now involves the modeling of complex, interconnected environmental systems in an attempt to understand more completely the factors involved in managing the structure and predicting the behavior of ecosystems, including national parks, agricultural systems, forests, and other important natural resources.

Feedback Loops

The fundamental control mechanism in systems – the way a system runs itself – is the feedback loop. In human terms, a feedback loop is a systemic process whereby one’s behavior is influenced by the system’s reaction to one’s behavior. When A is friendly toward B because of B’s warmth, and B is warm

toward A because of A's friendliness, a reinforcing feedback loop is set in motion that encourages more of the same, and is resilient over time. If A is having a bad day, B's expectation of A's friendliness pulls warm behavior from B and tends to elicit friendly behavior from A anyway. Thus, self-reinforcing feedback loops, which increase a given behavior in an individual or system in response to that same behavior (friendliness begets more friendliness), may eventually trigger self-correcting feedback loops, which counter a given behavior if it strays too far from the norm or goal of the system (unfriendliness begets its opposite, as when a sudden absence of friendliness in a resilient system prompts greater warmth in the rest of the system in an effort to restore the balance of friendliness). Likewise, when pushed past a certain point of vulnerability, a self-correcting feedback loop may reach its limit and give way to a self-reinforcing feedback loop – if A's absence of warmth is not changed by B's increase in friendliness, B may give up and angrily withdraw, reinforcing A's unfriendliness, which further reinforces B's withdrawal.

In general terms, a feedback loop is the mechanism by which any system alters the flow of resources depending on the level of the resources available, or alters the behavior of the system in response to feedback about the state of the system relative to the goals of the system. A feedback loop is formed when changes in the supply of resources in a system affect the flow into or out of those same resources through a set of operations based on a rule, decision, emotion, physical law, or action relating to the level of resources.

Balancing and reinforcing feedback loops

Feedback loops can be either balancing (negative, stabilizing, or goal seeking) or reinforcing (positive, amplifying, self-multiplying, escalating, runaway, snowballing). A balancing feedback loop reduces change to keep levels in check around a specified system state or goal. A reinforcing feedback loop magnifies change – rising levels increase the ability of the system to raise levels still more, and falling levels not only decrease the levels of resource but result in ever accelerating outflows.

A balancing (or negative) feedback loop is in operation whenever a system is able to maintain a steady state despite changing outside conditions. The process of a system maintaining a steady state in the face of changing conditions as a result balancing feedback loops is known homeostasis. An example of a balancing feedback loop is a home heating system. The thermostat monitors the changes in the level of heat in the room and alters the output of the furnace in order to maintain room temperature within a certain range. When system resources fall above or below a certain level, the system tries to change the level of resources in the opposite direction. For this reason, balancing feedback is also called negative feedback; it negates change, reducing the discrepancy (error) between the state of the system and the goal of the system.

A reinforcing (or positive) feedback loop amplifies the direction of change in a system, either positive or negative, so that the more the system changes, the more rapidly or forcefully it changes, resulting in vicious cycles or virtuous circles. Any system that behaves in an escalating fashion contains a reinforcing feedback loop. An avalanche is one example. Upward mobility is another – success begets additional

resources that increases chances of still more success. Warming global temperatures melt arctic tundra, releasing trapped CO₂, increasing greenhouse gasses, and escalating global warming which melts exponentially more tundra. The distancing of the husband makes the wife anxious so she pursues contact to feel better, he feels intruded upon and increases his distance (and her anxiety) until the escalation results in a system locked into a rigid distance or tumultuous contact. Reinforcing feedback is also known as positive feedback because it responds to whatever changes occur in a system by adding to it.

All systems exist as elements within larger systems and coexist with complementary and competing subsystems, so all systems are surrounded by limitations and by other feedback loops. Escalating feedback loops often trigger balancing feedback loops in the larger system, so 'trees don't grow to the sky' – swelling populations trigger increase in predators or exhaust the food supply; stock market bubbles burst; banks fail or new system-protective regulations are imposed; successful companies reach the limits of growth when they have recruited all potentially available customers; escalating conflict in families often leads to divorce or cutoff, ending the escalation.

Feedback loops are ubiquitous in nature, in human functioning, and at all levels of the biopsychosocial continuum, from the cellular and physiological (balancing feedback loops – blood sugar levels, body temperature; reinforcing feedback loops – tumor growth), to the intrapsychic (mood levels, perceived happiness; addiction, impulse control problems) and the social/interpersonal (levels of intimacy and independence in a couple; mutual criticism, self-fulfilling prophecies, prejudice) to the ecosystemic (P/E ratios of stocks, employment levels, diplomacy; capital investment, arms races).

Feedback loops in human systems often function through the flow of information – for example, about the state of the system, along with some 'rule' about how to alter the behavior of the system accordingly to change the state of the system. When one shifts one's weight to maintain one's balance, one does so in response to information fed back into the body about the location of the body in space. When deprived of visual feedback, maintenance of balance becomes far more difficult, as can be observed by standing on one leg and then closing one's eyes.

Systems Thinking and Family Assessment

Appreciating the operation of feedback loops is critical to becoming a family systems thinker – someone who understands the unexpected, counterintuitive ways all systems, including family systems, function. Effecting change in a system is rarely simple or straightforward. An intervention can have unanticipated consequences and may even reinforce the problem it intends to correct, or set in motion cascades of behavioral reactions that lead to new problems. Systemic change is often slow and/or nonlinear – if some intervention produces one result, twice the intervention may produce half the result or 100 times the result, the opposite result, or no result at all.

Due to the interconnecting nature of feedback loops in a system, causality in systems is said to be circular rather than linear. While mother's overinvolvement with the children may

put father on the periphery, it is also true that father's retreat to the periphery pushes mother toward overinvolvement with the children. If A causes B, it is often just as true that B causes A, or the effect of A on B and of B on A in turn may influence, and be influenced by, a third element, C. A child's oppositional behavior may be 'caused' by the parents' controlling behavior, or the parents may become controlling in response to an oppositional child, or the child may be aligned with a grandparent who is critical of the parents and gratified by the child's demonstration of the parents' 'incompetence' – the reactions of each person exacerbates the corresponding reactions of the other.

Since a system causes its own behavior by the operation of feedback loops, the cause of the behavior can never be determined to have an originating point – or rather, the originating point becomes irrelevant once the self-maintaining cycle has begun. The relevant point is the cycle itself: system behavior → feedback → change in system behavior → feedback → change... If a system, including a family system, causes its own behavior, then solving problematic system behavior must first begin with analysis of the structure of the system itself rather than searching for some internal or external cause. When systems thinkers encounter any particular symptom or behavior in a system, they automatically seek the interconnections with other elements in the system that may be influencing that behavior, and also look to understand how that behavior may be influencing itself or generating supportive or opposing feedback from other parts of the system. If outside elements are deemed relevant to the system's behavior, the boundaries of the system under consideration must be redrawn to include that element and its reciprocal interaction with the family. An example of this would be considering the impact on families of the larger contexts of community, schools, health care systems, social service systems, employment systems, etc.

The Development of Family Systems Theory

Unlike traditional psychoanalytic or behavioral approaches to therapy, family system theory drew intellectual inspiration from a wide variety of fields in addition to clinical psychology and psychoanalysis, including social psychology, anthropology, communication theory, hypnotherapy, linguistics, philosophy, mathematics, biology, zoology, and particularly cybernetics and systems theory. Like systems theory itself, family therapy developed initially in the 1950s as an interdisciplinary field with psychiatrists, psychologists, social workers, and other clinicians and scientists in various parts of the country experimenting with seeing families together in contravention to the then-prevailing psychoanalytic orthodoxy that dictated that therapists should have minimal contact with family members of the patient lest the transference relationship become irrevocably tainted. Also, in contradistinction to the traditional psychoanalytic focus on internal processes and psychopathology seen as arising from repressed drives and maladaptive defense mechanisms, the family systems perspective focused on interpersonal processes, developing models for how interactions among family members give rise to or maintain pathological behavior. A family systems perspective even led to the question of whether such problematic behavior, if understood

as arising from systemic attempts at adaptation, could rightly be termed pathological, especially considering the potential of labels such as 'pathological' to affect the behavior of others in the system through reinforcing feedback loops in such a way as to call forth more pathological behavior.

The development of new theories regarding human functioning based on a family systems perspective suggested new approaches to therapeutic intervention, whether one worked with individuals, couples, or families. The 'patient' was not the source of the difficulty; the problem was in the system. The word 'patient' was put in quotes, and the terms 'identified patient' and 'symptom bearer' came into use, reflecting the belief that a patient was merely the person in the system who was the most vulnerable to system pressures and therefore the first to develop emotional, behavioral, or relational symptoms as stress in the system increased. Therapeutic change therefore became a matter of changing the system rather than changing the patient, or rather, seeking to change the patient through bringing about change in the system.

Schools of Family Therapy

Various schools of family therapy developed in the latter half of the twentieth century. Over time the distinctions among different approaches became less important and integrated models of family therapy were developed. Some of the major family therapy approaches will be briefly described below, followed by consideration of the enduring family therapy concepts and techniques common to various approaches.

Structural family therapy

One of family therapy's most influential approaches, structural family therapy was developed by Salvador Minuchin and colleagues at the Philadelphia Child Guidance Center at the University of Pennsylvania, which Minuchin directed for many years. Structural family therapy draws from systems theory the idea that the behavior of a system is a result of the structure of that system, and that a system's structure is gleaned from observation of the behavior of the system over time. Structural family therapy looks for misalignments in the structure of the system as reflected in the nature of the boundaries, hierarchies, and cross-generational coalitions in the family. How all family members respond to events in the system is also carefully tracked. Minuchin posited that healthy families have a clear hierarchy with the parents in charge (neither anxiously seeking guidance from the children nor rigidly commanding them), and with clear but flexible boundaries demarcating the family as a whole, the parental and sibling subsystems, and the personal boundaries of individual family members, promoting flexible interdependence and autonomy rather than an over-involved, emotionally fused enmeshment or a disconnected, underinvolved disengagement.

Strategic family therapy

Strategic and brief therapy approaches grew out of the influential work in the 1950s and 1960s of a group in Palo Alto, CA, led by Gregory Bateson, an anthropologist, and including Jay Haley (communications theorist), John Weakland (engineer turned anthropologist), Don Jackson (psychiatrist), and Paul Watzlawick (philosopher and Jungian therapist), among

others. The group applied communications theory, systems theory, and cybernetics to the understanding of schizophrenic communication, family interaction, and therapeutic communication. Don Jackson and others formed the Mental Research Institute in Palo Alto in 1959, to develop treatment approaches based on the theoretical formulations and findings of the Bateson project, including concepts deriving from their study of the creative, unconventional hypnotherapeutic approaches of psychiatrist Milton Erickson. Landmark articles from this collaboration include 'Toward a theory of schizophrenia', which introduced the concept of the double bind, and 'The question of family homeostasis'. Both strategic family therapy and brief therapy approaches emphasize a here-and-now, problem-centered focus and development of strategies that interrupt the problem-maintaining interactions in the family system. Dramatically brief and counterintuitive interventions became the hallmark of this approach, which is one of the more theory driven of all the schools of family therapy with the notable exception of Bowen family systems therapy.

Bowen family systems therapy

Murray Bowen, a psychiatrist who worked initially with schizophrenic families at NIMH and eventually settled at Georgetown University, developed a comprehensive theory of emotional functioning in biological systems, including family systems and organizations. At the center of his theory is the concept of differentiation of self, which refers to an individual's ability to maintain a self-directed, principle-driven course of action while maintaining contact with emotionally significant others. Lack of differentiation is reflected in a tendency when anxious either to give up self to maintain togetherness (e.g., emotional fusion, placating, conflict avoidance), or to give up togetherness to maintain sense of self (emotional or geographical distance, disengagement, stonewalling). Differentiation also has an internal aspect: the ability to distinguish in oneself thought (reflection) from feeling (emotional reactivity). Lack of differentiation is reflected by an inability to recognize when one is overreacting, and a corresponding conviction of the reasonableness of one's behavior. The emotional dynamics of a relational system – family or organization – is a function of the level of differentiation of the systems' members, especially of the leadership. Bowen contends that working on one's own level of differentiation is key to resolving problems in the family system. He argues that this can be best accomplished by working through unresolved emotional issues with one's family of origin, particularly with one's parents, and improving one's ability to maintain a sense of self while in contact with the family emotional system. Michael Kerr, a student and close associate of Bowen, has taken up the mantle at the Bowen Center since Bowen's death in 1990.

Experiential family therapy

This approach is most closely associated with the work of psychiatrist Carl Whitaker (symbolic-experiential family therapy), but also includes others who emphasize the importance of working directly with emotional experience of the family in the here-and-now: Virginia Satir (humanistic), Walter Kempler (gestalt experiential), Leslie Greenberg, and Susan Johnson (emotionally focused couples therapy). Hallmarks of experiential approaches include a reverence for authenticity,

directness, awareness (of emotions, cognitions, and physical sensations) and attention to nonverbals as clues to what is being left unsaid, use of nonverbal techniques with the family to capture systems dynamics, including sculpture, role play, empty chair work, visualization, and imagery.

Narrative family therapy

The rise of postmodernism as an intellectual force in virtually all academic disciplines has found expression in the field of family therapy in the development of narrative/hermeneutic/language-based models, which are seen as an antidote to the mechanistic metaphors of cybernetics and systems theory, metaphors that omit much that is uniquely human. Narrative therapy focuses on how all people assemble internal narratives of their lives, summarizing and compressing the richness of lived experience into dominant themes deriving feedback from family, culture, and society. These dominant narratives go on to impact the individual in countless ways and become self-reinforcing. Narrative therapy seeks to assist people in breaking this self-reinforcing loop by reauthoring the stories of their lives through the integration into their narrative of formerly overlooked truths about themselves (unique outcomes) that could not have been predicted by the dominant narrative. Narrative therapy returns meaning and a focus on the experience of the individual to the center of psychotherapy, all of which, ironically, are hallmarks of insight-oriented therapies of all stripes, from psychoanalytic to Jungian to existential-phenomenological, from which family therapy initially distinguished itself. Michael White is the most well-recognized developer of this approach, though many others have also contributed including David Epston, Jill Freedman, and Gene Combs.

Enduring Family Systems Concepts

As the family therapy field matured, a number of key concepts and interventions became widely recognized as core family systems theory ideas and techniques. Most were originally associated with a certain school of family therapy but over time have become recognized as having merit independent of any particular theoretical formulation.

Biopsychosocial model

The biopsychosocial model is a broad framework for understanding the interaction of all levels of life, from the most simple (molecule) to the most complex (biosphere), developed by George Engel at the University of Rochester as an antidote to the reductionism inherent in the prevailing biomedical model, which omitted psychosocial factors from consideration in analysis of the etiology and course of physical illness. In the biopsychosocial model, all levels of biologic complexity are organized on a continuum from the somatic to the intrapsychic to the interpersonal. When arranged vertically, each of these levels can be seen as embedded in the ones above and containing the ones below, from the level of the molecule, cell, and organ system to the level of individual, dyad, family, community, culture, nation, and biosphere. Events at any one level in the hierarchy are influenced by interactions with those levels above and below. The biopsychosocial model provides a systemic framework for integrating biological, psychological, and social domains of human functioning by affirming the

centrality of each. The biopsychosocial model continues to play an important role in family systems approaches as a foundational framework for the field of medical family therapy, which is an application of family systems theory to the psychotherapeutic treatment of chronically and terminally ill patients and their families.

Circular causality

Circular causality refers to the idea that causes of behavior in a system cannot be located in any one person or interaction but instead occur as a function of recursive feedback loops in the system, in contrast to the typical human preference to see causality as linear (A causes B causes C...). Circular causality refers to the understanding that A's impact on B is affected by B's impact on A, so that an individual in a system unwittingly tends to bring about the very behaviors which he or she finds problematic. The following case example illustrates how an undesired behavior in Person A can be unwittingly triggered by family members who seek to 'fix' the behavior: The family of an autistic young man was referred to me because his highly agitated reaction whenever his parents (with whom he lived) went on vacation was becoming increasingly disruptive to his day treatment program. All attempts by his parents and the program staff to correct this problem over several years had been unsuccessful. In our first session, I asked the parents about their understanding of the problem. They suspected he was becoming upset whenever they left town because it made him think of their 'abandonment' of him as an adolescent when they had, at the advice of his doctors and with deep reservations, put him in a residential facility for a year, which had proved to be extremely painful for them all. The parents were asked if they themselves had associations to that painful time whenever they were planning and packing for their trips. They tearfully agreed, noting that their anxiety level increased significantly before every trip. It became clear that their son was reacting to their anxiety and becoming agitated in turn, which further worried the parents, increasing their guilt and further increasing his agitation. Targeting the parents' anxiety for intervention proved far more successful than targeting the son's.

Once a cycle of interactions has become self-sustaining, any attempt to define 'cause' in terms of one part of the system's impact on another is an arbitrary punctuation of only part of the cycle and is therefore incomplete. This can often lead to causal misattribution and misguided interventions. Each interaction is dependent on and caused by the interlocking interactions in the rest of the system: father criticizes mother as incompetent, mother deflates and withdraws, daughter comforts mother and acts out against father, who blames daughter's behavior on mother's incompetence, etc. The 'cause' of this cycle cannot be said to originate in any single member of the system, or any single interaction. A therapeutic implication of circular causality is that strategic intervention at any point in a system can lead to change in the entire cycle of interaction since the change ripples through the entire system, each part in turn.

Emotional cutoff

Emotional cutoff is the refusal to have any contact with a family member(s), often for years or decades, typically with the perception that the other person is impossible to deal with, toxic, or dangerous. Cutoffs tend to be replicated in families

across the generations. Cutoffs rarely succeed in resolving relational difficulties as it makes future cutoffs more likely and permits both parties to avoid the hard work of reconciliation, boundary management, definition of self, differentiation, and tolerance of difference. Resolution of a cutoff is facilitated if at least one of the parties makes genuine ongoing attempts at reconnection without the demand for capitulation or apology. Major emotional events in families' lives such as births, marriages, funerals, and catastrophes often provide openings for reestablishing contact and resolving cutoffs as a result of the significant changes in the emotional states and proximity of estranged family members that such events often provide.

Family life cycle

The family life cycle is a model of the stages family systems go through in their course of development: marriage → childbirth → children starting school → entering adolescence → children leaving home → caring for aging parents → the arrival of in-laws and grandchildren → retirement → death. Transitions between stages are inherently stressful as they require shifting previously stable routines, roles, and expectations from the former stage to adapt to the requirements of the new stage. Symptoms often develop at these transition points, especially if there was an unsuccessful adaptation to a previous stage of the life cycle. For example, if a husband was unable to adjust to the idea of marriage, the arrival of the first child may intensify the problem and result in depression, substance abuse, or an affair. If parents were unable to adjust to the increasing capabilities of their school-aged children, the children's entry into adolescence can become highly problematic as the children press for greater age-appropriate independence and the parents are unprepared to allow it. Symptoms can also develop if there was an unsuccessful adaptation to the same stage of the life cycle in a previous generation. For example, symptomatic behavior in an adolescent getting ready to leave home often matches an analogous difficulty one or both parents had when they were leaving home, with fears of abandonment or dependency conflicts rippling down through the generations at similar developmental junctures.

Function of the symptom/communication value of the symptom

Symptoms can be understood as the system's attempts to solve a problem or send a message. The function of the symptom can best be discerned by carefully inquiring about how family members respond to the symptom or by looking at the pragmatic impact of the symptom over time. For example, an adolescent girl had significant anxiety and difficulty sleeping, prompting her parents to bring her to see me for therapy. The initial interview revealed that, as a result of the symptom, mother soothed daughter by lying down with her at night so she could fall asleep, with the result that mother herself often fell asleep in daughter's room. Husband complained that his wife no longer sleeps with him since this problem began. I observed that the symptom functions to keep mother from the marital bed, and inquired about the quality of the marital relationship, which was highly (though quietly) conflictual, something the couple avoided facing. Another example, drawn from my practice: A young woman's suicide attempt, of which she is deeply ashamed, is reframed in a family therapy session as her way of communicating to herself and her family

the intensity of her distress as well as her recognition of the hidden distress in her parents' lives – all difficulties which the loving but minimizing family had been loath to recognize.

Homeostasis

Literally 'standing in the same place,' homeostasis is the process by which a system maintains stability (and so resists change) by making internal adjustments in response to changing external conditions through the operation of balancing feedback loops. In family therapy, homeostasis is the term for 'resistance,' or the process by which a family or other human system will tend to return to any established way of functioning even if that functioning is problematic to the participants. A family may respond to an alcoholic member's sobriety with behavior designed to encourage return to alcohol abuse. Relief over a decrease in chronic fighting in a couple may be accompanied by increased anxiety as they struggle with the unfamiliarity of warm intimacy and so find themselves reverting to the former hostility, a territory with which they are intimately familiar. Elimination of a symptom in the family scapegoat may be followed by development of a symptom in the formerly 'perfect' child.

Identified patient/symptom bearer

The symptomatic member of a family can be understood as expressing the stress or pathology in the system, sometimes on behalf of others. Consequently, he or she is identified by the family as the sick one, though the entire system is responsible. In this sense, the patient is bearing the stress for the rest of the family through the development of symptoms. This systemic understanding of symptom development stands in marked contrast to an intrapsychic perspective, which understands symptoms as arising from within the individual due to individual psychopathology. Illustrative case examples: A conflict-avoidant mother who could never stand up to her ex-husband brought her son to see me because he had become highly conflictual and unmanageable at father's house, alarming both parents, who see him as the patient. I point out that he is fighting mother's battles with father on her behalf, something she could never bring herself to do. Mother's willingness to assume more responsibility for her feelings about her ex-husband allows her son to stop arguing on her behalf and the tension subsides markedly. A 7-year-old was brought to me for therapy because he had developed severe obsessive preoccupations at bedtime and at the end of school breaks. His mother, a self-sacrificing woman with obsessive tendencies, had three young children at home. His father had recently begun graduate school and was increasingly unavailable in the evenings to help with the children. The child's symptoms quickly remitted when the parents were coached about (1) dealing with personal and family stress more effectively, (2) not reinforcing the identified patient's anxiety by anxiously overreacting to it, and (3) providing extra contact with the child when he is not exhibiting symptoms rather than when he is.

Isomorphism

Literally 'same shape,' isomorphism refers to the tendency of interlocking levels of a system to mirror each other, or take on similar characteristics. The supervisor criticizes the therapist for criticizing the mother for criticizing the child for criticizing the

younger sibling. These behaviors are isomorphic. Intense alliances and dramatic battles between an adolescent and her parents are mirrored by alliances and battles in the extended family, and then between the family and various providers, and then among the providers themselves. Isomorphisms multiply through a system, including biological systems – for example, roots, branches, and leaf veins of a tree have similar branching forms.

More of the same solution

According to strategic family therapy, people come to therapy not because they are stuck with an insoluble problem, but because they are stuck in escalating attempts to apply a solution that is not working and that they cannot stop using, which elicits more of the same problem in a reinforcing feedback loop. Therapeutic interventions in such situations should focus on finding ways to get people to stop using their unhelpful solutions so that a new solution might emerge.

Polarity

A polarity is a tension between two extremes of a continuum. A central polarity in therapy is between the need to change/grow and the need for stability/safety. Any system seeks a balance between these two poles. Too much of either will threaten the viability of the system. People will usually respond to a pull toward either end of any continuum by moving in the opposite direction, and will tend to move away from an extreme position in response to someone advocating an even more extreme version of the same position. A therapist advocating for change more strongly than the family desires will arouse their anxiety about loss of stability and change will slow down; conversely, a therapist pushing for the status quo beyond the family's comfort level will enhance their desire for change.

Triangles

Triangles is a concept common to many schools of family therapy but developed most fully by Murray Bowen, who defines the triangle as the most stable unit of relationship. Dyads become unstable as stress rises in the relationship, so one or both members of a dyad will triangle in a third person to reduce the relational stress, with the third person functioning either as a mutual focus of concern (as when enemies cease hostilities to deal with a mutual threat, or parents put aside differences to deal with a symptomatic child) or as a new alliance for one member of the dyad (as when A gossips to C about his problems with B, creating a sense of pseudocloseness with C based on their mutual dislike of B, and fostering increased distance between B and C).

Relational triangles are ubiquitous and can even be useful, as when a couple presents for marital therapy. Triangles become problematic if they enable avoidance of responsibility or rigidly keep the conflict on one side of the triangle (e.g., the scapegoat) rather than distributing it around the system. The various triangles in a system interlock so that change in any one of them is made more difficult by how others in the system are thrown off balance by, and resist, any change.

Bowen and one of his disciples, Ed Friedman, developed a number of principles of emotional triangles, including the following: (1) a person cannot fix how two people relate to

each other. (2) Attempts to do so will likely have the opposite effect. (3) If anyone attempts to take responsibility for how two other people relate, that person will end up carrying the stress for the relationship. For example, if a mother takes responsibility for ending the fighting between her children, she enables the combatants to avoid the responsibility for dealing with their conflict, thereby encouraging continued fighting and increasing her stress. If a father seeks to end the relationship between his daughter and her irresponsible boyfriend, he is likely to only make the boyfriend seem more alluring, enable the daughter to avoid awareness of her own dissatisfaction with her boyfriend, and push the two closer together. (4) One can only change a relationship of which one is a member. (5) The way to positively affect how two people relate to each other is to try to maintain a well-defined relationship with each, and to avoid the responsibility for their relationship with one another. ALANON illustrates this principle in their recommendations for how a spouse of an alcoholic might step out of the triangle of 'alcoholic-bottle-spouse.' They tell spouses 'you didn't cause it, you can't control it, you can't cure it.' Spouses must stop taking responsibility for, or trying to influence, what the alcoholic does and focus instead on taking responsibility for their own relationship with alcohol and for their relationship with their alcoholic spouse – for example, "I love you and want you in my life. I do not like alcohol's impact and do not want alcohol in my life. You are free to choose what to do with alcohol. However, I will no longer stay in your presence when you have been drinking. I will not cover for you with work when you are hung over, nor will I lie to our parents if they ask."

Enduring Techniques of Family Systems Therapies

Joining

Joining refers to the process of establishing a therapeutic relationship with the family; making the family comfortable in one's presence; forming a safe context, and allowing oneself to be sufficiently subject to the emotional dynamics of the family group that one can appreciate and spot the relevant emotional exchanges that reflect the family structure.

Strength orientation

An attunement to that which is genuinely positive, resilient, admirable, impressive, pleasantly surprising, or delightfully unexpected and a readiness to notice and celebrate strengths and solutions as much as to ferret out hidden problems, impasses, and failures are hallmarks of a strength orientation in therapy. It is the opposite of pathologizing, problem-dominated descriptions. Having listed their problems and concerns, the family may be asked to delineate what they admire or appreciate about other family members, especially the identified patient, for it is out of such resources that solutions will be built. Stories of success are elicited and amplified. If necessary, a drift back to problem talk is interrupted and redirected. Setting treatment in such a context of explicit appreciation and affirmation is like providing anesthesia before surgery; it makes an otherwise anxiety-provoking process much more bearable. A strength orientation is not naïve optimism, and is not incompatible with recognizing pathology, injury, dysfunction, or pain, but resists letting those be the whole story, insisting

instead on the importance of both sides of the coin, with neither obscuring the other.

A strength orientation is reflected in an ability to appreciate how the abusive mother is doing a far better job parenting than her sadistic father did; to see the love and commitment of the black sheep of the family when he is the only one of the siblings to step up when mother is terminally ill; knowing to interrupt the story of yesterday's conflict to have the family amplify on their passing comment that it had been a very good week until yesterday. What made it a good week? When was the last time they had had such a good week? How did they pull that off this week in light of all the challenges? Narrative therapists talk about strengths in terms of 'unique outcomes,' – occurrences that could not have been predicted by the dominant story (e.g., of failure) and that reflect other truths that, if included in a rewritten narrative, would change the outcome of the story.

Solution-focused interventions

Solution-focused therapy is a school of family therapy in its own right, developed by students of strategic therapy and the Mental Research Institute. Solution-focused interventions are based on the presumption that solutions to complex problems can be fairly simple, and that knowing where one wants to go in the future is more important than knowing how one got to the present predicament. The presenting problem was not always present in the client's life, and typically is not invariably present in the here-and-now either, but varies and sometimes is absent altogether. Solution-oriented approaches ask about what has worked in the past, or what makes the problem absent at times in the present, or keeps it from getting even worse, and about what would represent improvement or success. "If you woke up tomorrow and a miracle had occurred overnight and this problem was solved, how would you know the problem was gone? What would be different?" This question encourages people to define what they want most rather than what they do not want. This deeply felt desire is often bigger or different than mere elimination of the problem, and may be readily achievable even if the problem itself is never fully resolved.

Reframing

Reframing is the process of providing an alternate definition or perspective of the symptom (or of the system dynamic), one that often suggests a radically different response. "Jimmy's demands that you stay off his back are actually a plea for you to take control, which is why giving in to them isn't working," or, "Jessica appears to have taken it into her head that you are depressed and unable to function without her and therefore is refusing to attend school," or, "Your husband's silence may mean he feels too much rather than that he is unfeeling. Like the person who has to wear sunglasses because of sensitivity to even mild sunlight, his distance helps him keep his feelings from overwhelming him." An artful reframe is not arbitrary but has an inherent plausibility or emotional resonance that fits with the feedback loops and dynamics of the system.

Positive connotation

Describing a 'negative' behavior or attitude in terms of its positive, adaptive, or helpful aspects – "I can see the deep

love and commitment you have for your daughter in how much you fight with her when you think she is doing something harmful to herself." "Your son's provocative behavior may be his way of helping you face your difficulty expressing anger and setting limits effectively."

Paradoxical intervention

1. Paradoxical interventions are designed to alter the self-sustaining nature of a symptom by interrupting the reinforcing feedback loops that maintain it through engaging in opposite behavior. The 'paradox' derives from the counter-intuitive nature of the intervention in which the route toward a destination appears to lie in going away from it. A therapist working with a young man paralyzed by fear of failure and unable to finish his dissertation directs him to intentionally make a minor, embarrassing mistake in public in the coming week in order to practice recovery from failure. The focus is 'reframed' from avoiding failure to recovering from failure, and from loss of control (unintentional error) to gaining control (intentional error). Avoidance of failure keeps him from discovering that failure is manageable. The intervention is repeated over several weeks, changing client's experience of failure, and the paralysis dissipates. Sex therapists rely on a similar dynamic when prohibiting couples with performance anxiety from having intercourse, directing them to focus instead on giving and receiving pleasure, replacing a vicious cycle of mounting anxiety with a virtuous circle of mounting arousal.
2. An additional form of paradoxical intervention, also known as a therapeutic double bind or counterparadox, is one in which the client is 'blessed if she does, blessed if she doesn't.' Such interventions are a way to respond to the double bind presented by the family: 'we have a problem, help us change – we are afraid to change, don't make us change' (either way, the therapist loses). A group therapist asks a client who sees herself as unable to set limits to look intently at each group member in turn and firmly say 'No.' Appalled, she refuses. The therapist increases the pressure, she refuses more forcefully, setting a firm limit, which the therapist then highlights, celebrates, and explores. Whether she complies with or resists the directive, she succeeds in setting a limit.

The 'go-slow' prescription is a commonly used (though far from the only version of) paradoxical intervention. When encountering a treatment-resistant family, a therapist may direct them to make no improvements, suggesting they are not yet ready for the turmoil change will bring. The family will either comply with this recommendation, thereby becoming more cooperative with the therapist, or they will resist the therapist and become less symptomatic. Either way they win.

Reframing and positive connotation are commonly used when delivering paradoxical interventions in order to sidestep the family's defenses. It is difficult to resist a comment from the therapist that contains a compliment. In this sense, positive connotation represents a therapeutic double bind: If you reject this definition, you reject my positive assessment of you. Case example: A teenage girl was brought to me for therapy by her mother who was concerned about the girl's reaction to the parents' divorce, including restrictive eating and weight loss.

The girl was very worried about her father, who she described as quite lonely, withdrawn, and refusing to adequately care for himself since the divorce. It came out that the daughter's symptomatic behavior had the effect of prompting the worried parents to speak with each other quite frequently. I complimented the girl (positively connoting) for being willing to sacrifice her normal adolescent freedoms, including the freedom to eat when hungry, in order to ensure that her desperately lonely father had an ongoing connection with mother. This was delivered as a statement; the girl was not asked for a response to this idea. Not only was no change suggested, the implication hung in the air that she should continue to do so lest her father have a miserable life. On the way home, the daughter asked her mother to stop at Burger King so she could order a Whopper. The restrictive behavior ceased immediately, though a number of other issues remained for us to resolve in ongoing sessions.

A variation of the go-slow prescription is a paradoxical technique known as 'prescribing the symptom.' The therapist asks the patient or family to make the symptom worse rather than better, perhaps because they need to better understand the dynamics giving rise to the symptom, or because a relapse will allow the family to see if there is anything from that experience they wish to carry forward with them into the future.

Successful use of paradoxical interventions requires a skillful, sensitive hand and a nuanced understanding of the systemic feedback loops maintaining the symptom as well as those connecting therapist and family. Like any powerful tool, paradoxical interventions, if misapplied, have the potential to do significant damage.

Taking a 1-down position

This is the opposite of trying to get '1-up' on the other person; being willing to lose the battle to win the war. Originally associated with strategic and brief approaches to family therapy, 'going 1-down' means giving ground to the other, elevating them in importance, letting them save face – the bumbling TV detective Columbo being a classic example of this maneuver. Taking a 1-down position can serve (1) to disarm the other and sidestep a symmetrical battle for dominance with those threatened by loss of dominance – for example, taking an interest in the concerns of the dismissive, hostile individual therapist of a family member by asking how the family therapy might help with what that therapist feels is the central issue, or how the therapy should be structured to avoid injury to their client, or (2) to avoid stepping into an ambush when invited into a battle for control – for example, when difficult in-laws seek to demonstrate the inadequacy of the young couple by constantly offering unsolicited advice, the couple gives up trying to prove themselves, which never succeeds anyway, and instead go 1-down by asking the parents for advice in excruciatingly long phone conversations until the parents protest that it is time for the young couple to figure things out on their own, ending their advice-giving, or (3) in the case of those taking a submissive position of asking to be told what to do, to show oneself to be even more inadequate than the other in order to provoke the other to take more control, responsibility, and authority for their situation – for example, when a 'help-rejecting complainer' asks repeatedly what he should do and repeatedly

ignores the advice, the therapist 'goes 1-down' by professing (or, as Carl Whitaker would have it, simply admitting) impotence and strategically giving up, yet continuing the therapy, letting the patient or family retain ownership of their anxiety.

Enactment

With enactment, the problem is brought into the room behaviorally rather than via description. For example, a couple is asked to actually have a typical argument in session, or to show how they are unable to communicate. Enactment permits clarification of aspects of the problem that are outside the awareness of the participants, and hence are not reflected in their descriptions of the difficulty.

Circular questioning

Circular questioning is a technique developed by Boscolo and Cecchin of the Milan group to encourage family members to develop a systemic perspective regarding the cycles (or circles) of interaction giving rise to their problems, and to see their relationships from the perspective of others. There are a variety of types of circular questions, including (1) questions that ask family members what they can do to provoke undesirable behavior in another, usually asked of parties that are unaware of their own contribution to an interaction or outcome, for example, "What would you have to do to get your wife to criticize everything you did after you arrived home from work?" "If you wanted to really make your parents suspicious and intrusive, how might you do that?" "When your sister and brother fight, how could you make it worse?" (2) Questions that ask the family to rank order family members (or others) along some continuum of interest to the therapist, useful for eliciting relational connections, loyalties, and feelings, for example, "Who in the family was most interested in coming to today's meeting? Who least?" "Who would be most disappointed to see the fighting stop? Who after that?" "Who in the extended family is most involved in the conflict between dad and Sean?" "Who is the most interested in changing this problem?" (3) Questions that ask family members to describe or comment on a relationship to which they do not belong, useful for obtaining additional information about family dynamics – for example, "If your father could ever bring himself to speak openly, how would he explain your brother's persistent belief that your father never approved of him?"

Use of self

Many schools of family therapy (with the notable exception of strategic family therapy approaches) speak of the therapist's

use of self in therapy as central to the 'art' of therapy and as a corrective to a superficial overfocus on technique. Therapists' skillful use of self is often seen as accompanying and enhancing the development of self in family members. Murray Bowen speaks of the need for the therapist (and anyone who is working on self-differentiation) to develop an ability to observe self – to regard one's own reactions and behaviors with curiosity and interest rather than judgment, and to become a 'non-anxious presence' and, just by virtue of being nonanxious, automatically foster change in anxious systems. Carl Whitaker speaks of the need for the therapist to be an authentic self – open to and comfortable with one's own 'gut' (unconscious process), suspicious of life-draining 'head trips' (intellectualization) – and able to invite others to make friends with their own craziness. Salvador Minuchin speaks of the need for therapists to transcend technique and develop self-acceptance, spontaneity, creativity, openness, and finally, in deep appreciation of the interconnectedness of all things, wisdom.

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Forensic Psychology in Contemporary Society

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Glossary

Civil (involuntary) commitments The process whereby the state commits an individual to a psychiatric facility.

Forensic psychology The interface of psychology and law.

Police psychology A specialty of forensic psychology in which psychologists work with police departments.

Psychological evaluations A process whereby psychologists administer special tests to clients (i.e., intelligence tests, personality tests, etc.).

Voluntary The process whereby a person voluntarily requests admission to a psychiatric facility.

Forensic Psychology: Background and Contributions

Forensic psychologists are uniquely qualified to contribute psychological expertise to the legal process. Typically trained at a postdoctoral level, including a Ph.D., Ed.D., or Psy.D., in Clinical Psychology, Counseling Psychology, School Psychology, or Forensic Psychology, and with a Postdoctoral Residency, forensic psychologists bring specialty training in applied psychology to a variety of legal situations. In fact, with the legal system confronted by a growing array of complex psychological issues, the forensic psychologist's specialized training can provide the legal system with in-depth psychological insights on matters ranging from the prediction of dangerousness to situations involving involuntary hospitalization and children's development, and help educate the courts on various psychological issues impacting behaviors interfacing with legal systems.

The expertise of the forensic psychologist's specialized knowledge can, ideally, enhance the wisdom of the legal community and provide judges, attorneys, juries, police departments, psychiatric forensic unit staff, and the public with information to make better-informed decisions. Certainly, the courts are faced by a challenging array of cases where psychological participation can be useful. At present, for example, more than 2000 youth have been committed to life without parole and more than 600 000 adults are reported as incarcerated in correctional programs. Equally distressing, there has been an increase in psychiatric admissions for adolescents. Particularly noteworthy about these groups, it has been estimated that approximately 80–90% of psychiatric and correctional populations have a history of physical, sexual, or psychological abuse. In all these cases, a forensic psychologist can help educate interested parties on key psychological issues impacting the behaviors that led to such placements and help to better understand the way behaviors can change from such a trajectory.

Selecting from a growing roster of problems facing children, approximately 270 000 children are reported in foster care in the United States. Removed from homes for such problems as abuse and neglect, the court system plays a critical role in the placement of such children, but court personnel are not typically trained in the mental health issues facing children or families. The forensic psychologist brings this expertise to these professionals and can help inform the system in ways which might change future behaviors and guide new intervention models.

These data, then, buttressed by information on such matters as violence in the home (reported to occur in 1 in 14 marriages) or sexual abuse (by the age of 18, 1 in 3 women have been reported to be a victim of sexual abuse), lead to the conclusion that for the legal system, the forensic psychologist can be a useful resource. That is, the forensic psychologist can answer questions and provide information helpful to judges, attorneys, juries, parole officers, and juvenile justice personnel. For example, a person who hears voices and who cannot tell what is real from what is not would not be expected to generally understand their rights if arrested. In such a case, a forensic psychologist can provide clarifying testimony about the client's reasoning and understanding. In another example, a forensic psychologist can provide testimony on the background of a defendant who was sexually abused and violently sodomized by a parent prior to murdering that parent.

Given the importance of the issues faced by the legal system, then, the forensic psychologist can serve an educative role in clarifying psychological dynamics and providing rich details and information through the use of psychological assessment instruments. In addition, the forensic psychologist can provide direct services through the completion of psychological evaluations, as example, and also serve as a consultant to multiple parties. Clearly, the courts face difficult cases in which psychological factors influence behavior. The forensic psychologist helps serve as a bridge in the interaction between psychology and the law.

Professional Training

The psychologist invited to provide the court with psychological expertise must be appropriately trained and credentialed to provide such services. In view of the importance of psychological testimony in the judicial system, alone, it is important to understand the depth and extent of training required of psychologists for licensure/certification: psychologists providing services to the public are required to hold licensure/certification by their respective states.

To be eligible for licensure or certification (a designation that varies by individual state statutes), psychologists must have typically completed an undergraduate baccalaureate degree of approximately 4 years duration followed by graduate

training leading to a doctoral degree in applied psychology which would include practicum and internship training. Appropriately, forensic psychologists must earn their doctoral degrees in a designated area of professional psychology (e.g., clinical psychology, school psychology, counseling psychology, or possibly, forensic psychology) and may hold the Ph.D. (Doctor of Philosophy), Ed.D. (Doctor of Education), or Psy.D. (Doctor of Psychology). Doctoral training must involve a balanced program of training as outlined by the licensing boards for psychologists of each state.

Following receipt of the doctorate, candidates for licensure typically complete 1–2 years of postdoctoral experience under the supervision of a licensed psychologist and prior to conducting independent practice complete the requisite state and national examinations for practice. This leads to credentialing as a licensed psychologist.

Forensic psychology, as a unique area of practice of psychology, involves specific areas of expertise separate from that typically learned during graduate school. Therefore, just as physicians complete specialty training following medical school, so too, forensic psychologists typically (with the exception of those who complete programs offering integrated training with a law school) acquire specialty training following receipt of their doctorate.

Through postdoctoral specialty training, often augmented by participation in workshops and symposia involving specific areas of forensic practice, psychologists acquire the necessary training for forensic work. For clients, attorneys, and the public, as in selecting a physician, it is worthwhile to make specific inquiry about each psychologist's background, training, and professional credentials. Ultimately, the best fit between client's needs and psychologist's background requires careful attention. Of growing interest, a number of licensed psychologists acquire Board Certification through the American Board of Professional Psychology and acquire the designation of Diplomate in Professional Psychology [A.B.P.P.].

The Role of the Forensic Psychologist

Forensic psychologists typically use their knowledge of human behavior and various psychological assessment instruments to provide the legal system with an assessment, diagnosis, and recommendations for a range of clients. As examples, forensic psychologists may be asked to provide a psychological assessment to aid in the disposition of a case for a convicted child molester, rapist, or murderer, or they may be asked to conduct a comprehensive psychological evaluation to aid in the determination of placement for a child in a custody hearing.

A forensic psychologist may also be involved in a subsection of forensic psychology called police psychology which can involve such areas as police selection, hostage negotiation, or stress reduction. The demands of involvement in screening police candidates versus intervention as a psychotherapist for a police officer who shot a criminal in the line of duty can represent two extremes for the forensic psychologist.

Forensic psychologists, then, are often asked to offer testimony, expertise, and guidance in a wide array of cases. Today, a sampling of cases that the forensic psychologist might be involved with might include arson, murder, rape, foster care, drug addiction, sexual abuse, child welfare, or a psychiatric

commitment. Indeed, the legal system can present a wide array of cases to the forensic psychologist. Still, while the actual cases vary, in a general way the role of forensic psychologists can be construed to involve the general areas of practice which characterize professional psychology: assessment, intervention, consultation, and research. Each is discussed briefly in the following paragraphs.

Assessment

The unique role of psychological testing (i.e., psychological assessment) has remained an important area of practice for forensic psychologists. Psychological testing provides the court with both quantitative and qualitative data which can encompass intellectual abilities, cognitive reasoning, personality strengths and weaknesses, competency data, mental status information, and data pertaining to neuropsychological functioning. Although specific tests chosen for forensic practice vary greatly, selected psychological tests often used include the Minnesota Multiphasic Personality Inventory, Wechsler Intelligence Scales, California Psychological Inventory, 16 Personality Factor Questionnaire, Myers–Brigg Type Indicator, Rorschach, Thematic Apperception Test, Bender–Gestalt, and Projective Drawings. Certainly, though, there are literally hundreds of assessment instruments commonly used by forensic psychologists in order to systematically evaluate, diagnose, and gather material on clients.

For many professionals in the court system, psychological testing is truly an integral aspect of the testimony of the forensic psychologist. The expectation, generally, is that psychological test results provide objective, impartial, psychological information which can inform the testimony of the forensic psychologist. However, psychological tests provide data only about current functioning and do not accurately predict future behavior. Nonetheless, psychological testing can provide comparisons with the normative sample on which the test was developed and provide indications of psychological and psychiatric disorders which can be invaluable for court systems.

Of no surprise, the questions often asked of the forensic psychologist in a court situation, or in a referral, often relate directly to the results of the psychological evaluation. What is the intellectual level of the defendant? Is the client suicidal? Is the client dangerous? Will the client benefit from counseling and/or psychotherapy? Indeed, all the data compiled from the psychological testing ideally must be integrated into a comprehensive picture which can be presented to the court. Ultimately, in providing testimony, the forensic psychologist may be presented with additional questions, and the psychologist must present findings which can help the court system render a decision.

Intervention

Forensic psychologists are confronted by a wide range of challenges since the services to be provided can vary widely from client to client. A police officer referred for counseling because of depression or stress will require a different treatment, for instance, than a psychiatric patient committed to a forensic psychiatric hospital unit to restore competency for trial. As such, forensic psychologists must be knowledgeable about the advantages and disadvantages of different interventions and treatments and may utilize individual, group, or family treatment as deemed appropriate.

Certainly, not all clients seen by the forensic psychologist are willing participants in the treatment process. In fact, the court may require treatment for clients when the client is not interested in such a path. One client, for example, may be ordered to receive treatment to restore competency while another may be ordered to receive treatment as a condition of parole. Thus, the contours of psychological treatment are often governed by the court rather than by either the psychologist or the defendant, and the treatment atmosphere for a client, who may or may not believe they need intervention, but must participate because of a court mandate, can dramatically affect the process of treatment as well as the outcomes.

In a basic way, the inherent problems of designing an effective treatment program for a police officer ordered by a department to participate in counseling, a client mandated by the court to receive treatment because of violent episodes, or a patient committed to a forensic psychiatric hospital for treatment can vary markedly. In effect, a treatment plan may vary in design if designed for a police officer seeking to voluntarily address some issue or if designed for a parolee, for instance, who involuntarily is ordered to participate in psychotherapy as a condition of that parole. In short, one especially challenging aspect to forensic psychology is the fact that while there *are* clients who will voluntarily desire psychological services, the forensic psychologist will also encounter many clients who participate in treatment only because of the court.

The forensic psychologist, then, draws from a wide array of treatment modalities and models, and may select and recommend intervention including but not necessarily limited to individual, group, or family approaches which can each blend and mix a wide array of therapeutic theories. Fundamentally, counseling and psychotherapy interventions can be challenging when embedded within this forensic framework. In addition, it is not uncommon that client reports may, legally or administratively, be required for review by various individuals. As such, a forensic psychologist may actually provide treatment to an individual while not able to maintain confidentiality. In addition, because of such court-ordered disclosure issues, a forensic psychologist might conceivably view a prison or court system, for instance, as the client rather than the patient.

Consultation

Consultation is the area of practice for forensic psychology in which psychologists provide information to many different agencies. Consultation with courts, police departments, judges, attorneys, court personnel, and staff in correctional and forensic psychiatric settings illustrates agencies and individuals with whom forensic psychologists may work.

The forensic psychologist must possess strong communication skills, both written and oral, and be able to explain psychological terminology to many individuals not familiar with the language of psychological practice. The forensic psychologist who is asked to provide an evaluation of a client as to whether they are competent to stand trial must be able to explain relevant findings to the judge, trial attorneys, and the jury. Because of the need to effectively communicate psychological data to so many different individuals, consultation skills are critical for the forensic psychologist.

Certainly, the forensic psychologist working with a police department to construct a psychological battery of tests to aid in police selection procedures will present different information and utilize different consultation strategies than the forensic psychologist asked to provide a psychological consultation in a child custody case. As consultants, then, forensic psychologists must effectively choose the techniques most germane to each case and strive to present psychological expertise in a fashion that can most effectively meet the needs of each client. For the forensic psychologist, consultation skills are often a routine part of daily practice.

Research

Psychological research may ultimately provide definitive answers for questions which cannot at present be fully understood. What intervention is most effective with sexual offenders? What are the implications of long-standing sexual and/or physical abuse? What are the effects of witnessing repeated acts of violence in the home versus living in a neighborhood characterized by street violence? What differences exist between individuals who commit different crimes, including arson, rape, or murder? What factors affect juries? What behavioral characteristics affect court deliberations?

Clearly, there is a large area of research where the forensic psychologist may ultimately help the court. Research involving eyewitness testimony is one area which has already begun to yield important information. Other areas include advances in the understanding of neuropsychological deficits of adolescents who commit violent crimes ranging from murder to arson.

The utility of psychological research is undeniable. Even so, there remains a great dearth of knowledge. In general, greater research attention is needed on the predictors of dangerousness, on the developmental characteristics of different types of offenders, and on the effectiveness of different treatment interventions with children, adolescents, and adults. In short, psychological research conducted by forensic psychologists can be of tremendous value to the courts and society by offering greater scientific precision and understanding about the most effective ways the courts can intervene in cases involving psychological dynamics. Of course, the full range of knowledge and information which can potentially be learned through psychological research endeavors involving forensic psychology has yet to be fully ascertained.

Predictions of Dangerousness

Testimony surrounding the prediction of dangerousness remains one of the more frequently asked questions of the forensic psychologist. Whether involved in the civil (involuntary) commitment of the mentally ill to psychiatric hospitals or providing a psychological evaluation involving the possible confinement of a defendant to a correctional facility, the concern for potential for dangerous behavior endures as one of the more problematic issues for the forensic psychologist.

You might ask, then, *can* forensic psychologists predict dangerousness?

Regardless of theoretical position or quality of training, from a psychometric standpoint, any psychological prediction

involves a degree of error. In psychological terms, the forensic psychologist can err in two ways. The first way is to suggest that a person will be dangerous when they will not (false positive). Basically, this involves overpredictions of dangerousness. The second way is to suggest that the person is not likely to be dangerous when they will (false negative). This involves under predictions of dangerousness.

More false positive errors are made than false negative errors. This means that forensic psychologists overpredict dangerous behavior and suggest imprisonment or involuntary psychiatric hospitalization when it is not necessary. However, even with the fact that psychologists predict dangerous behavior more times than actually occurs, this does not reduce the fact that there still exists a group who are seen as not dangerous and who are. That means that while the error is reduced, it is not eliminated.

Over the past 25 years, research involving predictions of dangerousness leads to the unavoidable conclusion that there is a high incidence of error involving the prediction of dangerousness. Some studies report that more than 80% of individuals were *inaccurately* predicted to be violent! In other words, these individuals did not display the violent behavior which was predicted.

Empirically, it is important to remember that the science of human behavior is not sufficiently well developed to allow reliable predictions to be made about future behavior. Thus, while courts are pressing for determinations and predictions surrounding the possibility of future violence, forensic psychologists know that such predictions cannot be made without error. At present, this means that psychological determinations risk either the release of clients who may act violently or confining clients who will not be violent.

Over the long run, we have yet to know whether forensic psychologists will someday be able to make such predictions with ideal accuracy. This may indeed, come to pass. It is not, however, a reality at this point in time. Mostly, we can expect that the forensic psychologist can provide considerable psychological information about how a client is functioning during the examination itself. And a psychological evaluation can be helpful in clarifying whether the client understands their behavior. This type of information can be quite helpful and can help the judge, attorneys, and jury in rendering a decision.

In short, while the prediction of dangerousness remains a commonly asked question for the forensic psychologist, the ability to predict future behavior remains a murky issue at best. Still, the forensic psychologist can be helpful in clarifying present behavior. However, the available research indicates that the prediction of future dangerousness, while potentially invaluable to the court system, cannot be reliably predicted.

Commitment

Commitment to psychiatric hospitals can be either voluntary or involuntary. In the United States, civil (involuntary) psychiatric hospitalization – civil commitment – has loomed as one of the critical areas where forensic psychologists must effectively interface with the courts. The ability to hospitalize a patient, whether the patient wishes it or not, is the basis for involuntary commitments. Historically, the basis of civil

commitment has rested in the concept of the ‘*parens patriae*’ power of the state to act as a guardian on behalf of those in need. Thus, commitment was not viewed as punishment. Rather, it was viewed as a way to protect the welfare of the individual.

Unquestionably, our history is filled with instances where commitment has been inappropriate, including instances where a parent sought hospitalization for children and husbands sought psychiatric commitments for wives because of disagreements far removed from the need for psychiatric care. Fortunately, civil commitment laws have been altered and rewritten in order to more effectively protect patient rights. However, for forensic psychologists, involuntary commitment remains a critical area of practice. In fact, most psychologists employed in psychiatric hospitals today routinely complete psychological evaluations used, at least partially, to determine whether certain patients require commitment.

As previously stated, psychiatric commitments are of two types: (1) voluntary commitments and (2) involuntary commitments. Each is described in brief subsequently.

Voluntary Commitments

Voluntary commitments involve the willing, ‘voluntary’ agreement by a patient to undergo psychiatric treatment. The fact that an individual voluntarily is admitted for psychiatric treatment, though, does not necessarily indicate that the patient will necessarily be released on request. Voluntarily committed patients must request their release in writing. When this discharge request is received, the hospital is obligated to subsequently either release the patient or file for involuntary commitment.

Generally, then, even if a patient voluntarily requests psychiatric treatment initially, there is no guarantee that the patient will subsequently be released on their request. When appropriate – when the treatment team believes that a patient is in need of further treatment – the hospital may petition the court for a civil commitment. If the court agrees with the hospital that the patient meets the statutory requirements for a civil (involuntary) commitment, the patient may subsequently be ordered to remain hospitalized. On the other hand, if the court rules that the patient does not meet the criteria for an involuntary period of hospitalization, the hospital will be ordered to release the patient. What is striking about this, then, is the fact that not all ‘voluntary’ patients remain voluntary and not all patients voluntarily admitted for psychiatric treatment will necessarily be discharged simply by virtue of their requesting such a release.

Involuntary Commitments

Involuntary commitments are characterized by the ability to hospitalize a patient, whether the ‘*patriae*’ power of the state, which is to act as guardian of those in need.

From a historical standpoint, the Supreme Court addressed the status of civil commitments in the 1975 case of *O'Connor v. Donaldson*. This case involved a patient, Donaldson, who spent approximately 14 years hospitalized. The Supreme Court ruled that civil commitment was unconstitutional based solely on mental illness and that the patient must be dangerous to either self or others: Donaldson was not dangerous and was ordered released.

Addressing standards and guidelines for commitment, it is noteworthy that the commitment guidelines that follow are general inasmuch as civil commitment laws vary from state to state. As a result, the interested reader will want to refer to individual state laws for specific details. Generally, the criteria which follow are provided to serve as an introduction to the area of civil commitment. Those confined for forensic evaluation or for reasons involving criminal justice may be confined under different standards.

Patients who meet the commitment criteria generally: (a) demonstrate a mental disorder, (b) are considered dangerous to either themselves or others, (c) are committed consonant with the principle of the least restrictive placement, and (d) lack the ability to make an informed decision involving treatment.

Procedurally, an individual can be committed for up to 6 months duration, with renewals. State statutes vary from state to state, with varying lengths of time allowed relative to placement and the lapses of time after which hearings must be held. The latter is noteworthy as admissions can come from a variety of referral sources. For instance, if a patient is admitted from an emergency room, hearings must be scheduled within certain time parameters – generally 48 hours. On the other hand, court-ordered commitments may possess a longer time parameter.

It is during the initial examination and admission period that the patient undergoes an assortment of examinations, one of which is often a psychological evaluation (i.e., psychological testing) completed by the forensic psychologist. The forensic psychologist is not the sole person completing examinations, but lawyers and judges often place great weight on the opinion of the forensic psychologist and on the results of the psychological examination.

Today, the psychiatric commitment of individuals to psychiatric facilities remains an area of considerable discussion, despite changes and refinements in the various laws governing the process of commitment. For forensic psychologists, the ability to make contributions involving civil commitment is of considerable importance as psychological evaluations offer an important vehicle for interviewing and examining patients. Indeed, although exact predictions about the need for psychiatric commitments can appear as much art as science, the use of a psychological evaluation serves as a useful adjunct to the clinical interviewing typically completed by the psychiatric (M.D.) and psychiatric social worker (M.S.W.).

Conclusion

How many clients interacting with the legal system display psychological issues of sufficient magnitude to warrant the involvement and expertise of a psychologist? How many court decisions are made without the necessary input of experts in mental health? Because of the divergent number of cases confronting the judicial system, it is unknown how many individual cases are adjudicated without the expertise of the forensic psychologist.

As a general rule, the courts are faced with difficult if not seemingly impossible questions. Because many cases involve psychological dynamics – cases ranging from child custody disputes to cases involving the necessity for psychiatric

hospitalization – forensic psychologists who blend specialized knowledge of psychology and the law provide valuable inputs for attorneys, judges, juries, and families. In addition, forensic psychologists are actively working with staff, administrators, and families in the correctional system, in psychiatric settings, in police departments, and are providing valuable inputs in legal matters involving many differing cases involving the interaction of psychology and the law.

Unfortunately, the compendium of questions facing both psychologists and the courts remains too voluminous and complex to yet be completely unraveled. Should an adolescent murderer with severe neuropsychological disorders be put to death? What are the best predictors of dangerousness? What differences exist between someone who murders a stranger versus a family member? Clearly, the questions are many. Fortunately, forensic psychologists are working to provide society with responsible information in which to better understand these and related issues. For although the judicial decisions are rendered by the court, the psychological input of the forensic psychologist can be an invaluable aid to the court system. As has been noted in this article, the forensic psychologist brings to the court specialized knowledge about psychology and the law. And it is this expertise which can help the court face a wide array of challenging cases.

In general, forensic psychology is still a young science, which has yet to completely unravel many of the questions posed by the courts and society. At the same time, forensic psychologists are active contributors to the court system and are providing expertise in highly specialized matters. It is safe to say that some day we may yet unravel mental illness and criminal behavior. In the meantime, the challenge for the forensic psychologist, the courts, and society, is tremendous.

See also: [Eyewitness Identification](#); [Jury Psychology](#).

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Free Will

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Glossary

Compatibilism The view that even though all behavior of organisms originates in principle in genes and environment, the concept of free will (the distinction between voluntary and involuntary behavior) is nevertheless meaningful.

Determinism The view that because all behavior of organisms is in principle predictable as the outcome of prior

causes originating in genes and environment, there is no room in psychology for the concept of free will.

Libertarianism The view that at least some important actions by some organisms are not predictable on the basis of genes and environment. These actions are held to be due to free will, an autonomous internal cause.

Philosophers have bequeathed to psychologists three fundamental positions on the question of free will: libertarianism, determinism, and compatibilism. Libertarianism (not necessarily the same as political libertarianism) says that at least some interesting or important actions of people and maybe even some actions of nonhuman animals are truly free. These actions are vitally important for the organisms in which they originate but they are unpredictable on the basis of innate structure, experience, past behavior, or anything else. Such actions, libertarianism implies, are outside the realm of scientific study. According to libertarians, psychology can at best vaguely predict free behavior perhaps through empathy or some other undefined process. But a psychology of purely voluntary behavior can never be scientific.

Determinism says that all interesting or important behavior – of humans, of organisms in general, and that of inorganic objects – is in principle predictable on the basis of prior states and events. Therefore, say the determinists, there is no such thing as free will. Determinism implies that the concept of free will is useless in psychology or, worse than useless, a cloak for ignorance of the true causes of behavior.

Libertarians and determinists agree that if one is right, the other must be wrong.

Compatibilism, on the other hand, says that some acts may be both determined and free at the same time – depending on how you look at those acts. Compatibilism implies that the distinction between voluntary and involuntary behavior is a useful and meaningful distinction even while a scientific psychology is possible.

Libertarianism

Humanistic, phenomenological, existential, and hermeneutical branches of psychology take the position that, although psychology can never be scientific, a nonscientific psychology is nevertheless possible within a libertarian framework. Existential psychology, for instance, holds that the fundamental psychological reality ('being') consists of immediate phenomenal appearances. Our perception of objects in the world, as well as our mental representations of those objects, contains more or less 'nothingness' (like jigsaw puzzles with more or fewer pieces missing). The essential function of our wills is to

construct: (a) our physical and (b) our mental worlds ('essence') from appearances ('existence'). Thus, the concept of free will plays a very important part in existential psychology. It is the basic process by which an abstraction (a chair, for instance) arises from particulars (appearances of chairs). This primary function of the will determines in turn the distinctly secondary function of controlling overt behavior. Behavior is uncontrollable and unpredictable according to existential psychology because (absent physical constraint) individuals might always have behaved otherwise than they did. Two individuals with identical genes and experiences may nevertheless see the world differently, see themselves differently, and behave differently because of different innate, and free, wills. Psychologists today are mostly determinists or compatibilists because to be a libertarian is to confess that much of what is usually considered the domain of psychology (the areas of motivation, choice, rational thought, and so forth) is crucially important in human existence and at the same time beyond systematic understanding.

Determinism

Those modern psychologists who are determinists are usually reductionists of one sort or another. They say that while the mind (and the will) is crucially important it is nothing but ... (and here they specify some deterministic system). The most common sort of reductionism is physiological reductionism. In modern philosophical psychology, physiological reductionists are also called 'materialists.' Modern materialists hold that the mind is nothing but the workings of the brain (or the wider central and peripheral nervous systems combined). The creed of modern physiological reductionists was perhaps nowhere better argued than by the Russian reflexologist Ivan Michailovich Sechenov, in 1863. Sechenov said:

All the endless diversity of the external manifestations of the activity of the brain can be finally regarded as one phenomenon – that of muscular movement. Be it a child laughing at the sight of toys, or Garibaldi smiling when he is persecuted for his excessive love for his fatherland; a girl trembling at the first thought of love, or Newton enunciating universal laws and writing them on paper – everywhere the final manifestation is muscular movement. In order to help the reader to reconcile himself with this thought more readily, I will

remind him of the frame-work created by the mind of humanity to include all manifestations of brain activity; this frame-work is *word and deed*. Under *deed*, the popular mind conceives, without question, every external mechanical activity of man based exclusively on the use of muscles. And under *word*, as the educated reader will realize, is understood a certain combination of sounds produced in the larynx and the cavity of the mouth, again by means of muscular movements.

From the strict materialistic point of view, animals including humans are machines explicable by physical and chemical principles; it is the job of the psychological determinist to uncover the workings of these machines. What seems like voluntary behavior is just involuntary behavior of a more complex kind. For Sechenov, Newton enunciating universal laws is just a more complex version of Newton kicking his leg when his knee is struck by a hammer. From this viewpoint, physiological psychology is the only truly scientific psychology. Other forms of psychology would be mere holding actions, rough classifications with which we make do until our knowledge of the physiological basis of behavior catches up. The recent development of magnetic resonance imagery (MRI) machinery has tended to support the materialistic view. Complex psychological states have been shown to be accompanied by corresponding activity in specific brain locations.

But not all modern determinists are materialists of this physiological sort. The deterministic system inserted in the blank space of 'The mind is nothing but ...' need not be a strictly physiological system. B. F. Skinner, a modern radical behaviorist, believed that an animal's apparently voluntary actions are caused by what he called its 'history of reinforcement,' the pattern of prior rewards and punishments for classes of acts (called operants) defined by common consequences. For Skinner, an operant's consequences determine its subsequent occurrences. It is this characteristic of operants that, according to Skinner, makes them seem (but not really be) voluntary. For example, a rat may press a lever with its left paw, its right paw, its nose, etc. All constitute the same operant, the rate of which is predicted by the theory. Since operants are what Skinner's theory predicts, the rat is within the theory 'free' to press the bar as it may – with any particular movement. But according to Skinner this sort of freedom is unimportant. Therefore Skinner was right to declare himself a determinist. In *Beyond Freedom and Dignity*, Skinner claimed that free will is a myth and that people's desire for freedom is nothing but a desire to replace control of operants by aversive consequences with, equally deterministic and ultimately more precise, control by reward.

A similar kind of determinism is claimed by modern cognitive scientists. The sort of behavior these scientists are interested in predicting is largely verbal or informational – the sort that could go into or come out of a computer. A successful theory, according to cognitive science, is one that can be translated into a program that passes the 'Turing test.' A computer program held to embody a theory of the mind may be tested by human observers who feed questions into the computer and receive answers from it. To the extent that the machine's answers are indistinguishable from those given by a real human being, the computer's program is an adequate model of the mind. Any program that passes this test will necessarily be highly complex, perhaps involving probabilistic neural

networks, perhaps not. It is that complexity of our actual minds, a complexity not generally available to our conscious introspection, which according to the cognitivist creates in us the illusion that our behavior is free. When the true program by which our minds are governed is uncovered we will see, says the cognitivist, that our behavior was never really free.

The cognitive scientist's theory of the mind is nothing but the program itself. But a given program may be instantiated in many ways – by transistors, vacuum tubes, relays, analog circuits, a number of connected abacuses, and so forth. For the cognitive scientist, however, the particular mechanism by which the program is instantiated, while 'free' to vary within the system, is held to be unimportant, not the aspect of behavior that makes it seem voluntary. Thus, modern cognitive science, like modern neuroscience, is generally deterministic. In cognitive neuroscience, cognitive psychology and neuroscience collaborate in abstracting from the behavior of humans and nonhuman animals the part that is computer-like – cognitive psychology studying the software and neuroscience the hardware of the computer.

Compatibilism

If there are several conceivable kinds of determinism there is an even greater conceivable multiplicity of kinds of compatibilism. Compatibilism implies a dualistic approach to scientific activity (if not to existence in general). To understand the compatibilist point of view, it might be easiest to go all the way back to the founder of philosophical dualism, the ancient Greek philosopher, Plato. In the famous Allegory of The Cave in his dialog, *The Republic*, Plato asked us to conceive a group of prisoners in a cave, chained so that they can see only shadows on the wall. The shadows are two-dimensional projections of a three-dimensional world consisting of objects, other people and even themselves; the prisoners cannot even perceive themselves in three dimensions. Then one prisoner is freed and exposed to the three-dimensional world, first the world in the cave behind the prisoners (where a fire projects the shadows), then the real world outside the cave in the sunlight. The main difference between the free man and the prisoners is that the free man has gained knowledge of the three-dimensional world while the prisoners remain ignorant. When in the allegory the free man is returned to the cave the prisoners do not believe his stories of the three-dimensional world and either laugh at him or, worse still, persecute him (a reference to the behavior of the Athenians to Plato's teacher Socrates). In the allegory, the prisoners' chains correspond to our own ignorance of reality. Plato sees us as being bound by our own ignorance.

The prisoners' two-dimensional world is analogous to our three-dimensional world, the world of our perceptions, our pleasures, and our pains. This world, a world of illusions, is contrasted with a multidimensional real world of what Plato called 'Forms.' The sun, in the allegory, is compared to The Good; what is seen in the full light of the sun is the real world of Forms. The benefit of behaving in accordance with our pleasures and pains (seeking pleasure) is illusory and temporary as contrasted with the benefit of behaving in accordance with the Forms (seeking goodness) which is true and

permanent. A person whose behavior is guided by mere pleasure and pain is supposed by Plato to be like the prisoners in the cave while a person whose behavior is guided by the Forms is said to be free. According to Plato, everyone wants to behave in accordance with the Forms; none of us would willingly trade a better for a worse alternative given that we could accurately weigh worse and better alternatives. The problem is that we are blinded by our pleasures; only the most intelligent of us are capable of accurately weighing all our alternatives; therefore, only the most intelligent of us are capable of true freedom of behavior.

Plato thus packed freedom, knowledge, and goodness into one package. We would necessarily have all three of these virtues if our behavior were determined by the Forms. What are the Forms? Where are they located relative to us? How can we bring our behavior into line with them? How can we know if we are succeeding or not? All these questions were discussed at length in Plato's philosophy and taken up in interpretations and extensions of Plato from Aristotle to present-day philosophers and psychologists. Let us consider three interpretations: strict dualism, internal/external dualism, and molar/molecular dualism.

Strict Dualism

The Forms are to be found not in this world but in another world located somewhere else, perhaps in heaven. We have access to this other world only by revelation from God. This sort of mystical dualism has had little effect on modern psychology. We will therefore not discuss it further.

Internal/External Dualism

The Forms are to be found not in the outer world but inside of us. We have access to the inner world of Forms only through deliberate insight exercised by our free wills. This view was formalized in the neoplatonic philosophy of St. Augustine (fourth century AD). It separates what he considered to be an illusory external freedom of the sort Skinner referred to as freedom from aversive contingencies from true internal freedom (freedom of the will). According to Augustine, our souls are naturally directed outward to the chaotic world with its random pleasures and pains; our behavior naturally follows this chaotic pattern; when our souls face outward we are like leaves in the wind. However, by an effort of the will (aided by the Christian religion), we can turn from the outer world to an inner world where we can find direction of another kind – from God (equivalent to the world of the Forms). Obeying God is thus a consequence of turning inward, away from the world, an action we do of our own free will. Even if every move we make is strictly determined by God, our wills are said to be free because by an internal effort of will we freely chose this form of control rather than control by essentially random pleasures and pains.

Leaving aside the question of God's foreknowledge of our behavior, Augustine's distinction between behavior controlled by rewards and punishments in the external world (living in 'The City of Man') and behavior controlled from the internal world (living in 'The City of God') is a kind of compatibilism: looked at one way, behavior is controlled – either by rewards

and punishments or by God. Looked at another way, we are free to determine the source of control – from without or within. For Augustine, this internal freedom is God's greatest gift to human beings and is also the reason why evil exists in the world. If there were no evil, we could only do what was good; we would never have to choose; God, not us, would be responsible for our good behavior. But, because we may do evil, we are responsible for our own good behavior (at the cost of also being responsible for our own evil behavior). Augustine's compatibilism, like those of Plato and Aristotle, ties free will to responsibility – a link that persists to this day in compatibilist thought.

The difference between Augustine and Plato is that for Plato the effort a person has to make to be guided by the Forms is (in modern terms) a cognitive effort. For the Forms to guide our behavior, we have to calculate, said Plato. Plato's true Forms are thus accessible only to an intelligent elite. For Augustine, the City of God is available not to a cognitive elite but to a motivational elite – those who have the spiritual strength (foreknown by God) to turn inward for direction. Once we do turn inward, we will automatically do the right thing (our souls will be at peace).

Ironically, while Augustine's conception of an inner world has had a very strong influence on modern psychology, his compatibilism has not. Augustine viewed everyone's inner world as one world; for Augustine, when two individuals both turn inward for direction, they both turn to a common God, common principles, common social rules such as the Ten Commandments. Their behavior in such a case would be in synchrony due to this common control. For Augustine, we all inwardly see the same thing although if we turn outward we see different things – our individual versions of a chaotic world.

More than 1000 years later, during the Renaissance, the French philosopher and mathematician, René Descartes, was to turn Augustine's conception inside out. For Descartes, the outer world was the source of common control; renaissance physics had just begun to find remarkable regularity in that world. The human commonality of Augustine's inner world, on the other hand, was replaced by the concept of an isolated (and 'free') individual inner soul, identical with the individual mind, with which we are familiar today. Descartes believed that the individual human soul is absolutely free. Although he conceived of people's bodies as just machines and all non-human behavior and some human behavior (like the knee jerk and pupillary dilation) as controlled by machinelike reflexes, hence strictly determined, Descartes claimed that the most important human actions are controlled by the free, individual mind working through the body (the 'ghost in the machine'). Descartes thus abandoned Augustine's compatibilism for libertarianism.

As indicated previously, libertarianism denies the validity of scientific psychology, because it exempts the most important human actions from scientific understanding. Descartes' philosophy has therefore been modified by modern psychologists via two routes, both of them deterministic. One route, that of Sechenov and his modern followers in neuropsychology, expands the territory of the bodily machine from simple reflexes to more and more complex ones – from Newton's knee jerk to 'Newton enunciating universal laws.' This form

of determinism simply banishes the ghost from the machine – or threatens to do so once physiology has developed to the point where it can explain complex human behavior.

The other route to a scientific psychology, psychic determinism, retains the ghost alongside the machine but claims that the ghost itself is not free; the ghost's operations, like the machine's, are said to be lawful. This second route led from Descartes to the beginnings of experimental psychology. The initial impetus of experimental psychology was to discover the 'laws of the mind' and to give them causal status equivalent to that of physical laws. Once the 'laws of the mind' were discovered it would be seen that all behavior of all organisms is as involuntary as the behavior of a leaf in the wind. The German philosopher Gottfried Wilhelm Leibnitz (late seventeenth century) compared the individual mind and the physical world to two clocks (originally set by God) running in parallel, both reading the same time. The workings of the mind were no less clocklike (no less lawful) than the workings of the body – different but corresponding in form.

A common characteristic of this branch of determinism from Gustave Fechner, the founder of psychophysics, to Wilhelm Wundt, the founder of the first psychology laboratory (at Leipzig, Germany, mid-nineteenth century), through Wundt's student, Edward Bradford Titchener, the founder of the first American Psychology Laboratory (at Cornell University, at the turn of the twentieth century), to modern-day cognitive psychology, is the desire to get past 'mere' overt behavior to understand the inner laws of the mind. For Wundt and Titchener, these laws were structural and associationistic: elementary sensations combined in more complex perceptions combined in turn in still more complex cognitions – all strictly determined, none free in any way.

The antistructuralists of the early twentieth century, the Gestalt psychologists, differed from the structuralists on the nature of the mental laws. Gestalt psychologists believed that the laws of the mind worked more like electrical fields than like discrete circuits. But for them, the laws of the mind were just as deterministic as the laws of those electrical fields. The deterministic computer model of modern cognitive psychology discussed previously is a continuation of early experimental psychology's search for the laws of the mind.

All psychologies of inner dualism have in common the hope of eventually coordinating the laws of the mind with the laws of the body (coordinating one of Leibnitz's clocks with the other). The eighteenth century British associationist philosopher and physician, David Hartley, divided his book, *Observations on Man, His Frame, His Duty, and His Expectations*, into alternate chapters on physical and mental explanation of all human behavior, including moral behavior. Modern cognitive neuroscience is a much more sophisticated, more rigorous, and more experimentally based endeavor than was Hartley's but it rests upon a corresponding parallelistic determinism – a functional organization of the nervous system running parallel to a functional organization of the mind.

A common feature of parallelistic determinism from Wundt to the present day is its focus on internal causal systems – interactions between one part of the body and another or one part of the mind and another. If the body and the mind are each machines then psychology must be fundamentally

directed at discovering the workings of those machines. What are the units of the mind? How are they connected? How do they operate? These are the questions that parallelistic determinism substitutes for Plato's questions about the Forms. The cognitive mechanism is seen as a mechanism for transforming the particulars of everyday experience into abstract conceptions. Trying to understand human behavior (the sort of understanding sought by Plato's wise man who journeyed out of the cave) is for cognitive determinists like trying to understand the program of a computer by analyzing its inputs and outputs. According to some modern cognitivists, understanding of the human mind will be obtained when we can build a computer that successfully simulates it.

Thus, while strict dualism leads to libertarianism, internal dualism has led to the sort of determinism characterized by modern cognitive psychology. We now turn to a third interpretation of Plato's distinction between particulars and abstract Forms – molar dualism. This form of dualism leads, as we will see, to modern compatibilism.

Molar/Molecular Dualism

The interpretation of Plato's Forms that has led to modern compatibilism is that of his immediate follower and the other great ancient Greek philosopher, Aristotle. For Aristotle (and perhaps for Plato himself), the Forms, as abstract conceptions of objects in the world (objects including other people and ourselves), exist not in another world (as strict dualism says) and not inside us (as internal/external dualism says) but in the world itself. Aristotle saw the dimension of particular-versus-abstract as a dimension of functional interaction with one natural world. Thus, although Aristotle was a monist in the sense that he believed in the existence of a single world, he was a pluralist as regards our understanding of the world. Consider a modern example. When we watch a movie, we see only one thing – the movie. Our understanding of the movie is usually at the level of character and plot. But in some sense, the movie is nothing but colored shadows on a screen. In the usual case, we see through the many particular shadows, the many particular 'projections' that represent a character in the movie so that we recognize the character immediately each time he or she appears on the screen. In that sense, the lights and shadows on the screen may be said to be 'perceptually transparent.' But we understand this phrasing as a metaphor. The characters do not exist in a room behind the screen – they exist on the screen. It would be wrong (Aristotle would have said) to think that only the particular shadows exist on the screen but the characters exist in our heads. Shadows and characters are just two ways of looking at the screen (and of course both exist in our eyes and brains as well as on the screen but, as Aristotle insisted, we see the world, we do not see our eyes. Nor do we see our brains).

With some effort, we can look at a movie as pure shadow and light – that is, we can see the movie in terms of particulars, and with some effort (plus some considerable experience), we can see the movie at a still more abstract level than characters and plot; a critic, for instance, might see the movie in terms of the director's style or might even be able to discern the school where the director was trained.

Understanding the Forms, Aristotle said, is just an abstract way of perceiving the world. Aristotle agreed with Plato that the more abstract our vision of the world is, the better we will be able to deal with it. Why? For the same reason Plato gave – because abstract conceptions of the world are relatively permanent while particular conceptions are relatively temporary. Since Aristotle lived and died 300 years prior to the birth of Christianity and more than 600 years prior to St. Augustine, he did not conceive freedom as an internal attempt to turn away from the particulars in the world but rather as an external attempt to see through them and to conceive the world abstractly.

A person who does this is, according to Aristotle, free from particular influences in the same sense that an ocean liner is free from the influence of small waves. A modern concept of self-control (inherited from St. Augustine) would view a person on a diet who eats an extra hot dog as externally controlled by the smell and taste of the hot dog; the same person refusing the hot dog would be viewed as internally controlled, as self-controlled (hence as free). Aristotle, on the other hand, would have seen the eating of the hot dog as caused by the particular qualities of the hot dog, its particular taste, its particular smell, while the refusal of the hot dog is caused by its abstract qualities: the hot dog as part of an unhealthy diet. Both goals (good taste, good health) are what Aristotle called final causes, rather than efficient causes in the sense that they are consequences rather than antecedents of acts. But the good taste is a final cause of the particular act of eating the hot dog while the good health comes from no particular act but rather an extended pattern of acts over time. Looked at one way, eaters who respond to the most abstract features of their diets, like viewers who respond to the most abstract features of a movie, are free: free from (in some sense normal or typical) influence by particulars, by immediate forces, and by temporary pleasures and pains. Looked at another way their behavior is controlled: controlled by abstractions.

The more complex an organism's behavior is, the more abstract are the principles that explain it. The life of the philosopher, Aristotle said, is the most abstract, and therefore the best and freest life. For Aristotle, even though all of a person's actions are caused (by both efficient and final causes) it is still meaningful to talk of better and worse acts; it is still meaningful to talk of free acts and unfree acts: final causes of free acts are consequences that are beneficial in the long run (to society as well as the individual) while final causes of unfree acts are consequences that may be beneficial only in the short run and possibly harmful in the long run. Thus, Aristotle was a compatibilist.

The influence of this point of view on modern psychology has come through studies of self-control or delay of gratification discussed elsewhere in this volume. Nevertheless, it will be instructive to briefly summarize one procedure that epitomizes the conflict between particular and abstract. The procedure is a game originally designed for a single player but extended also to groups. In its group form, it is a version of the famous prisoners' dilemma of game theory and is easiest to understand in that form.

The instructions to a group (of 10 members, for example) are as follows:

Each of you is asked to choose alternative A or alternative B. If you choose alternative A you will get $\$N$. If you choose alternative B you will get $\$(N + 4)$. N will equal the number of members of the group who choose A. (No other member of the group will know what you chose.)

In this game, if all 10 members choose A, each gets \$10. If all 10 members choose B, each gets \$4 ($N = 0$). However, any individual will get almost \$4 more (actually \$3.90 more in a group of 10 members) by choosing B than by choosing A, regardless of what the rest choose.

With this game some people choose A and some choose B depending on a host of factors. But the central question the game asks is how do people perceive themselves in relation to the group? Choice of A benefits the group as a whole but hurts the particular individual (relative to choice of B) while choice of B does the reverse.

In its original, within individual, form the game treats the individual from time to time (or trial to trial) as analogous to a group of individuals. Thus, an individual chooses repeatedly between A and B, and is rewarded with N points for choosing A and $N + 4$ points for choosing B. But N is equal to the number of A-choices made by the individual over the past 10 trials. As trials go on, N for the present trial is determined by a running count of the subject's choice on the previous 10 trials (while the 11th-trial ago is dropped out). Clearly it is better for the individual over time to always choose A, since the person will then average 10 points per trial, than to always choose B (averaging 4 points). Even a single choice of B will lose points on the average.

Again, the degree to which people choose A or B is a measure of the degree to which they see their choices as particular events or as abstract patterns over time because in this game those two perceptions are made to conflict with each other (much like the figure-ground conflicts constructed by Gestalt psychologists).

The only conception of free will that remains meaningful in modern scientific psychology is this originally Platonic conception: when people act for the long-term good of themselves and their society, in cases where such acts conflict with their immediate and individual pleasures, they may meaningfully be said to be acting freely; they are not constrained by pleasures and pains. This freedom is compatible with a determinism that sees even their choice of abstract good over particular pleasure as in principle predictable. The reason for making this distinction between free and unfree behavior is not Platonic but pragmatic; such a distinction has proved to be useful in developing a science of behavior.

See also: Cognition and Personality; Gestalt Psychology and the Development of Perceptual Organization; Personality, Structure.

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Friendship

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Friendship has been described as the neglected, 'understudied' relationship. However, when people are asked what gives their lives happiness, joy, and meaning, friendships appear at the top, or near the top, of the list. In a study that tracked the day-to-day interactions of teenagers and adults, it was found that the greatest enjoyment and excitement was reported when in the presence of friends – more so than when alone or in the presence of spouse or family. Thus, although other kinds of relationships (e.g., dating, marriage) have received much more research attention, there is evidence that friendships are of great importance in people's lives.

The purpose of this article is to chart the life cycle of friendship, beginning with the initiation and formation stage, followed by the maintenance stage. Some friendships are not maintained, but rather enter into the deterioration stage. Deterioration can lead to dissolution, which is the final, terminal stage of friendship, unless efforts are taken to restore the relationship. Given that the vast majority of people's friendships are same-sex, the focus will be on same-sex friendships.

Friendship Formation

Friendship formation is a complex process in which a number of factors must converge. Four major factors have been identified in the literature: environmental, situational, individual, and dyadic.

Environmental Factors

Day-to-day contact is conducive to the formation of friendships. A classic study revealed that friendships develop when individuals come into contact with one another through residential proximity. The researchers asked residents of a married students' housing complex to name the three people in the complex with whom they socialized most. The person who lived next door was named most frequently, followed by the person who lived two doors down, and so on. It was also found that residents were more likely to develop friendships with those who lived on the same floor, rather than on different floors – even when the physical distance between the living units was the same. The additional effort required to walk up and down stairs was a deterrent to friendship formation. These findings have been replicated in studies of students living in dormitory residences, residents of a condominium complex, residents of a public housing complex, and new recruits on naval bases.

The workplace is another avenue through which potential friends are brought into contact with one another. A survey of nearly 1000 men found that the workplace was the most common source of friendships, followed by the neighborhood. Within the workplace, physical proximity enhances the probability of friendship formation. For example, a study of state

police trainees who had been assigned to dorm rooms and classroom seats alphabetically by surnames found that friendships were most likely to form between those whose surnames began with the same, or nearby, letter of the alphabet. In research along the same lines, university students were randomly assigned seats during their first class. Friendships were most likely to form between students who were seated next to each other, followed by those who sat in neighboring seats and so on.

The role of the workplace in the formation of women's friendships is less clear. For women who have family responsibilities, the demands of combining paid work with domestic work may leave little room for the cultivation of friendships in the workplace. For women who are not employed outside of the home, there is some evidence that the neighborhood may play the same role in friendship formation as the workplace does for men.

Finally, other friends and relatives are an important source of new friendships. For example, in one study, high school and university students were asked to name a same-sex friend and to list the friend's 12 closest social network members. The respondents were then asked to indicate how many of these network members they had met prior to meeting their friend. Approximately two-thirds of the participants had been acquainted with at least one person in their friend's social network before meeting their friend. Thus, people's existing network of family and friends can provide links to new friendships.

In summary, the seeds of friendship are sown when people are in physical proximity. Although proximity was once regarded as a necessary precondition for friendship formation, computer-mediated communication (electronic mail, computer networks) is enabling people to form friendships in the absence of face-to-face contact. So far it is unclear whether online friendships are replacing 'real-world' friendships or whether online friendships develop into offline friendships. What can be said is that computer-mediated communication has opened another avenue for friendship formation. However, the people with whom one crosses paths in daily life continue to be an important source of potential friendships.

Situational Factors

A number of situational factors determine whether or not friendships develop. These include the frequency of interactions and how available each person is for a new friendship.

Frequency of interaction

Hundreds of studies have shown that the greater the frequency of exposure to another person (or even photographs of him or her), the greater the attraction, even if no actual interaction ever occurs. (If a person is initially disliked, however, repeated exposure may lead to decreased, rather than increased, liking).

This phenomenon is known as the *mere exposure effect*. One reason why it occurs is that the more familiar people become with someone, the more likely they are to assume that they are similar to him or her. (As is discussed in the section on Dyadic Factors, similarity is a major determinant of attraction).

Availability

Even if two people have pleasant, frequent contact, they have to weigh whether they have sufficient time, energy, and other resources to devote to a new friendship. Commitments to family, a spouse or romantic partner, existing friendships, and work or studies may limit each person's availability for a new friendship. For example, one study found that the middle-aged women they interviewed perceived practical limitations on the number of friendships they could develop. A respondent's 'friendship budget' depended on the number of friends she wanted, as well as the number of friends she felt could be maintained, given her existing relationships and other commitments such as work.

Thus, the situations in which people find themselves can either hinder or facilitate the development of friendships. If two people come into frequent contact with each other, the probability of friendship formation is increased. This probability is further increased if each person's 'friendship budget' can accommodate another friend.

Individual Factors

External factors such as physical proximity are important in bringing potential friends into contact with one another. However, in order for a friendship to develop, each person must be attracted to certain qualities in the other. Research has shown that physical attractiveness, social skills, responsiveness, and shyness are among the individual characteristics that influence friendship formation.

Physical attractiveness

Although physical attractiveness receives greater emphasis in romantic relationships than in friendships, beauty, nevertheless, plays a role in friendship formation. Studies using photographs, laboratory interactions between people varying in attractiveness, and actual face-to-face interactions confirm that people express greater liking and are more likely to pursue friendships with those who are physically attractive than those who are not.

Social skills

There is considerable evidence that people with well-developed social skills are more likely to successfully initiate friendships than those with poor social skills. For example, in one study, it was found that socially skilled university students had a greater number of acquaintances and close friends than did less skilled students. In a follow-up laboratory study, participants engaged in a brief conversation with two confederates. The confederates reported the greatest liking for the most socially skilled participants. Other research has shown that social skills are a particularly valuable asset in the early stages of friendship formation. Once a friendship has been established, the link between social skills and friendship satisfaction becomes weaker – "instead, competence in providing warmth and support becomes important" (Buhrmester et al., 1988: 1006).

Responsiveness

People who are responsive (e.g., show interest and concern during interactions) also are more likely to develop friendships. Researchers conducted a series of studies in which participants interacted with confederates who had been trained to behave responsively (answering questions, giving replies that were on topic) or unresponsively (refusing to answer questions, giving unrelated replies). In all studies, participants reported greater liking for the responsive confederates. In addition, participants thought that they were liked by responsive confederates and believed that they could become close friends.

Shyness

People who are shy tend to experience greater difficulty with forming friendships than those who are less shy. Shy people tend to initiate fewer conversations, make less eye contact, smile less, are slower to reply to their interaction partner's statements, and generally behave less responsively than people who are not shy. These behaviors have the effect of communicating that a friendship is not desired. Not surprisingly, shy people form fewer friendships than those who are less shy. For example, in one study, the researchers assessed the social relationships of university students during their first week of classes and again 2 months later. Shyness was correlated with having fewer friends, overall, and with having developed fewer new friendships on campus.

In summary, people are most likely to cultivate friendships with those who are physically attractive, socially skilled, responsive, and not shy. However, even if a potential friend possesses all of these qualities, this does not ensure that a friendship will develop. The situational influences that are operating on each person must be considered as well.

Dyadic Factors

Another important class of variables concerns the nature of the relationship between prospective friends. Research suggests that a friendship will be formed if two people are similar, like one another, and if self-disclosures become more personal and intimate over time.

Similarity

The bulk of the research on friendship formation has focused on the role of similarity. Byrne (1971; Byrne and Clore, 1970) developed an experimental paradigm to test his similarity-attraction model. Specifically, participants were led to believe that their interaction partner held attitudes that were either similar or dissimilar to their own and then reported on their degree of attraction. This research revealed that the greater the proportion of similar attitudes, the greater the attraction to another person. (Conversely, the greater the proportion of dissimilar attitudes, the greater the dislike.) Subsequently, researchers examined similarity in many other domains. By now there is considerable evidence that people become friends with those who are similar to them in terms of demographic variables (e.g., age, physical health, education, religion, race, ethnicity, income). People are also attracted to, and form friendships with, those who hold similar leisure or activity preferences and who are similar in terms of social skills and

communication skills. In research conducted with students, friends are found to be similar in terms of academic interests, academic achievement, and attitudes toward school.

Interestingly, there is little evidence that friends are more similar overall in terms of personality than nonfriends, even though friends believe that their personalities are similar. However, research on personal construct similarity shows that people who view the world in a similar way are more likely to become friends. Similarity effects also have been found for the construct of value similarity.

It has been suggested that superficial kinds of similarity (e.g., demographic characteristics) may be used as a criterion for selecting (or rejecting) friends. However, in order for a friendship to become close, two people must be similar in deeper and more meaningful ways (e.g., similarity in important values, similarity in how the world is construed).

In conclusion, there is substantial evidence that similarity in many domains leads to the formation of friendships. The most common explanation is that when people interact with similar others, their opinions and views are validated. According to the rewards-of-interaction explanation, another reason is that interactions are smoother and more enjoyable when people are matched, rather than mismatched, in terms of their attitudes and interests. It should also be noted that not only do two people form a friendship because they are similar, but they also become more similar as the friendship develops. This increase in similarity may serve to further solidify the relationship. Finally, given that people find similarity so rewarding, it is perhaps not surprising that friends tend to perceive greater similarity between them than actually exists.

Reciprocity of liking

Simply put, we like people who like us. In a classic experiment, groups of same-sex strangers participated in weekly discussion groups over a 6-week period. Before the first meeting, each person was told which group members the researchers expected would like him or her, based on information gathered earlier. (The experimenters actually randomly selected names.) Participants reported the greatest liking for the group members they believed liked them. Interestingly, when people believe that they are liked by another person, they may behave in ways that confirm that expectation. For example, in one study, participants were led to believe that they were either liked or disliked by their interaction partner. Those who thought that they were liked showed fewer distancing behaviors, were more pleasant, and engaged in more intimate self-disclosure than those who thought that they were disliked. These behaviors had the effect of inducing liking in their interaction partners.

Self-disclosure

According to social penetration theory, when two people first meet, they generally disclose nonpersonal, superficial information. If that level of interaction is enjoyable, disclosures gradually will increase in breadth (the number of topics discussed) and depth (the information that is disclosed becomes more personal and intimate). Research has confirmed that people are more attracted to someone who begins with relatively nonpersonal disclosure and progresses to more intimate disclosure later in the interaction. In studies specifically on

friendships, it has been found that friends disclose more intimate, personal information than do acquaintances.

Before leaving this topic, it should be noted that in the early stages of a relationship, it is important that disclosures are reciprocated. The reason is that disclosing personal information engenders feelings of vulnerability. If each person is taking similar risks, feelings of vulnerability are reduced and a sense of trust can be established. Once this occurs, strict tit-for-tat reciprocity is no longer necessary.

In conclusion, the formation of a friendship is a complex process in which a number of factors – both external and internal to the relationship – must converge. External factors such as physical proximity (an environmental factor) and frequency of exposure (a situational factor) serve to bring potential friends into contact with one another. Internal factors such as a person's social competence (an individual factor) and whether the two people are similar in important ways (a dyadic factor) determine whether a friendship actually will be formed.

Maintaining Friendships

There are two paths to relationship maintenance: One is deliberate, strategic planning for the continuation of the relationship; the other is “the breezy allowance of the relationship to continue by means of the routine everyday interactions and conversations that make the relationship what it is” (Duck, 1994: 46). Put another way, people use both explicit and implicit strategies to maintain friendships.

Explicit Maintenance Strategies

In one study, the researchers asked a large sample of undergraduates to list strategies (behavioral examples) that they used to maintain romantic, friendship, and familial relationships. The most frequent strategy reported was “direct discussions and listening to one another” (p. 9). This strategy was labeled *openness* and was exemplified by self-disclosure. The second most frequent strategy, termed *assurance*, involved communicating that the relationship was important. The most common behavioral manifestation of this strategy was supportiveness. The third strategy listed was spending time together (labeled *joint activities*). Other strategies included *positivity* (trying to make interactions pleasant), *cards/letters/calls*, and *avoidance* (of relationship issues or the partner). Most of these strategies were more likely to be used in romantic or familial relationships than in friendships.

Research that has focused exclusively on the maintenance of friendships underscores the importance of the three most frequent responses in this earlier research, namely self-disclosure, provision of support, and spending time together. With regard to the former, several studies have found that friends use self-disclosure as a maintenance strategy. According to Rosenfeld and Kendrick (1984), “the primary motivation to engage in self-disclosure with a friend is to help the relationship solidify and grow” (p. 337). Similarly, in another study, “attempt to strengthen and improve the relationship” was one of the reasons given by women and men for having self-disclosed to their best friend. Other research has found that women are particularly likely to endorse self-disclosure as a strategy for maintaining same-sex friendships.

Canary et al. also found that the provision of assurance and support was important in maintaining relationship. This finding, too, has emerged in other friendship maintenance studies. It should be noted that the form that social support takes tends to differ by gender. Women are more likely to provide emotional support (a listening ear; a shoulder to cry on) to their same-sex friends; men are more likely to provide practical support (e.g., help repairing a vehicle or building a deck).

Finally, the original study on explicit maintenance pointed to the importance of making the effort to stay in contact and spend time together. This strategy also has been confirmed in other research on friendship maintenance. Based on extensive interviews with middle-aged adults, Rawlins (1994) concluded that "the primary culprit cited for problems with friends was a lack of time. Consequently, keeping friendships alive... involved 'taking,' 'making,' or 'finding the time'" (p. 290).

Implicit Maintenance Strategies

Friendships are maintained by the everyday interactions that people naturally have with friends, even though these interactions may not be motivated by the explicit goal of relationship maintenance. The literature on implicit friendship maintenance again underscores the importance of self-disclosure (especially for women), the provision of support, and the importance of simply spending time together. Implicit friendship maintenance tends to take a different form for women and men. It is well documented that when women interact with same-sex friends, the focus is on talking, whereas men prefer to engage in activities, such as participating in sports. For example, when undergraduates were asked whether they would prefer to do an activity or 'just talk' with a same-sex friend, more than three times as many women as men chose talking; nearly twice as many men as women chose the activity. Topics of conversation also vary by gender. Women tend to talk about personal and relationship matters, whereas men tend to talk about the activities they engage in (e.g., sports, vehicles, work, computers). Regardless of the form that activities and conversation take for each gender, these kinds of everyday interactions serve to maintain and sustain friendship for both women and men. Hare (1977), for example, discussed friendship maintenance in terms of shared mundane activities such as socializing over food and drink, giving rides, and so on. Similarly, Duck (1994) argued that everyday talk is the essence of relationship maintenance. In his view, the mere occurrence of talk, regardless of its content, signifies that the relationship exists and is important. In support of this view, Duck and colleagues (1991) found that for both men and women, having a conversation with a friend was considered more important than the actual topics discussed.

Social support also can be conceptualized as an implicit maintenance strategy. It has been noted that close friends are the primary source of social support for most young adults, which has implications for the maintenance of friendships: "To maintain a close friendship, partners are thus obligated to provide comfort, help solve problems... celebrate victories, offer encouragement... and so on" (Burleson and Samter, 1994: 74). The authors suggest that such support is frequently given without deliberate maintenance in mind. Rather, there is

a tacit understanding that the provision of support is simply 'what friends do.' As discussed earlier, sometimes friends will provide support out of an explicit motivation to maintain the friendship (e.g., someone who dislikes dogs might nevertheless agree to take care of a friend's dog while she is away for the sake of maintaining the friendship). However, much of the time support is given automatically, without a lot of conscious deliberation about friendship maintenance.

In summary, the literature on the maintenance of friendships points to a number of strategies – both explicit and implicit – that facilitate the maintenance of friendships. Of these, three seem particularly important: self-disclosure, supportiveness, and spending time together. Thus, people self-disclose to friends, support their friends, and make the effort to spend time with friends with the deliberate goal of maintaining and strengthening the relationship. It is also the case that relationship maintenance is a by-product of the kinds of conversations and activities that naturally occur in friendships. In conclusion, in order for a friendship to thrive, it is important for friends to engage in personal self-disclosure, provide social support to one another, and simply spend time together.

Deterioration and Dissolution of Friendships

In the section on formation of friendships, the central theme was that four categories of variables must converge in order for a friendship to develop: environmental, individual, situational, and dyadic. As shall be seen, each of these factors also plays a role in the deterioration and possible dissolution of friendships.

Environmental Factors

In order for a friendship to develop, the individuals must have frequent contact with one another. Conversely, the loss of proximity is associated with friendship dissolution. Loss of proximity occurs when people attend different schools, change jobs, retire, or move away. According to one researcher, the majority of friendships do not survive significant changes such as geographic mobility. In one study of college students, more than half of the participants (57.4%) reported the dissolution of a close friendship within the last year. For the majority, the loss had occurred during the transition to college. Thus, an environmental factor such as reduced proximity can contribute to the termination of friendships. It is possible that technological developments such as electronic mail now mitigate these effects. However, so far the benefits of computer-mediated communication for friendship maintenance have not been examined empirically.

Situational Factors

The situational factors that play a role in friendship formation, namely, frequency of exposure and availability, also have been implicated in the deterioration and dissolution of friendships. For example, when researchers asked participants to report on reasons for the decline of relationships, the most common response was a reduction of interaction or involvement (e.g., spending less time together, sharing fewer activities). Friendships also may dissolve when one or both people become less

available for this kind of relationship. Availability may be reduced by many different changes in life circumstances, such as the transition to parenthood, increased work demands for one or both friends, or the formation of new relationships. The development of new friendships is frequently accompanied by casualties in established friendships, as people discover they lack the resources (e.g., time, energy) to maintain a roster of preexisting and new friendships. Romantic relationships pose an even greater threat to friendships. It is well established that the greater the involvement with a romantic partner, the lesser the involvement with friends. For example, in one study, it was found that the number of friends decreased from an average of 4.13 for occasional daters to 1.06 for married respondents. Moreover, romantic involvement was associated with a reduction in the quality and quantity of interactions with the few friends who were retained.

In short, situational factors that result in decreased interactions between friends are likely to put the relationship in peril. This point is underscored in an interview study with middle-aged adults. A striking finding was that “the interviews were riddled with accounts of how vulnerable friendships were to altered circumstances . . . shifting schedules, changing jobs, moving away, developing new interests. It felt like valued friendships were continually slipping away from these adults, in most cases due to events that transcended the friendships” (Rawlins, 1994: 287).

Individual Factors

Earlier, research was presented showing that friendships are more likely to develop when potential friends possess positive qualities (e.g., social skills, responsiveness). Unfortunately, negative characteristics such as being demanding, moody, possessive, or boring may only become apparent once a friendship is established. The discovery of such characteristics can jeopardize a friendship. Based on her study of serious problems in friendships, Wiseman (1986) concluded that, “the discovery of just one undesirable trait can cause the recasting of the character of a friend” (p. 199). Similarly, in a program of research on adolescents’ friendships, the most frequent reason given for the dissolution of a friendship was disloyalty/lack of commitment, followed by the discovery of character flaws that undermined admiration for the friend. In a study of women’s friendships, participants reported that some of their friendships had ended because the friend behaved in ways that triggered a complete reassessment of his or her character. Betrayal of trust was especially likely to result in a friend receiving a negative evaluation. Indeed, other research has confirmed that friendships are likely to deteriorate and dissolve when betrayal of trust occurs. In conclusion, as Duck (1982) observed, “new, surprising, and significantly negatively charged information about the other can hasten the relationship’s death” (p. 7).

Dyadic Factors

The dyadic factors that lead to friendship formation (i.e., similarity, reciprocity of liking, self-disclosure) also play a role in the deterioration of friendships. In addition, once friendships are formed, conflicts may arise. When friends fail to engage in constructive conflict resolution, the relationship becomes vulnerable to dissolution.

Similarity

One of the best predictors of friendship formation and maintenance is similarity. It follows that if friends change in ways that create dissimilarities between them, the relationship may be threatened. Indeed, when asked why a friendship ended, a typical response is that the two people followed different life paths and no longer had anything in common. One study compared the amount and type of similarity between college roommates who remained friends versus those who did not. Those whose friendship ended were less similar in terms of psychological, intimate constructs than those whose friendship remained intact.

Reciprocity of liking

Reciprocity of liking was another factor identified as important in the formation of friendships. Conversely, decreased liking is associated with the dissolution of friendships.

Self-disclosure

Self-disclosure was identified as a key strategy for forming, as well as maintaining, friendships. Perhaps not surprisingly, when a friendship begins to deteriorate, the decline is reflected in the friends’ self-disclosure. According to one program of research, friends tend to avoid personal, intimate self-disclosure when their relationship is deteriorating. For example, in one of study, participants recorded their interactions with a friend over a 2-week period. Disengaging friendships were characterized by less effective and less personal communication than growing friendships. It is unclear whether the avoidance of intimate self-disclosure is a cause of friendship decline or whether friendship deterioration causes people to restrict the intimacy of their disclosures. This is an issue that can only be addressed by longitudinal data in which patterns of self-disclosure and reports of deterioration are tracked over time.

Conflict

As a friendship develops and becomes more intimate, there is an increase in the reported benefits of the relationship. However, reports of anger, conflict, and hurt feelings also increase. Unfortunately, when conflict does arise, the research suggests that the most common response is passive avoidance, as opposed to strategies that involve explicit discussion of problematic issues. For example, in one research program on conflict in friendships, integrative strategies (explicit, constructive discussions) were least likely to be used, even though they were most likely to produce a satisfactory resolution. Moreover, the use of integrative tactics was negatively correlated with both the frequency and duration of conflicts. Thus, when faced with conflict issues in friendships, people generally respond with avoidance, even though this response is least likely to lead to a satisfactory resolution.

To summarize, in the same way that environmental, individual, situational, and dyadic factors must converge in order for friendships to develop, friendships are likely to dissolve when these factors conspire against them. The importance of these four factors in friendship dissolution is underscored in Rose’s (1984; Rose and Serafica, 1986) program of research. When college students were asked to describe the decline of a closest, same-sex friendship, nearly half (47%) mentioned an

environmental factor, namely physical separation (e.g., moving to another city, attending different schools; Rose, 1984). The situational factor of reduced availability also was apparent in these responses: 18% of participants reported that old friends had been replaced by new friends; 12% attributed friendship dissolution to one or both friends' romantic involvement (i.e., dating or marriage). The individual-level factor of dislike also emerged; 22% of the respondents named attitudes and behaviors that undermined liking for the friend. Rose and Serafica (1986) subsequently conducted a finger-grained analysis by soliciting dissolution accounts for different kinds of friendship: best, close, and casual. Participants' responses were coded using a five-category scheme: less proximity (e.g., friend moved), less affection (decrease in liking, commitment, acceptance), less interaction (decrease in quantity or quality of time spent together), and interference (romantic involvement). Interestingly, different causes were identified for the dissolution of the different kinds of friendships. For example, casual friendships were more likely to end because of reduced proximity, whereas close and best friendships were more likely to end because of interference or decreased interaction. These findings raise the intriguing possibility that environmental, individual, situational, and dyadic factors may have a differential impact on friendship dissolution, depending on the stage of the relationship. The bottom line is that numerous factors conspire against the continuation of friendships.

Restoring Friendships

It has been argued that no other social relationship is as fragile as friendship. Unlike institutionalized relationships such as marriage, when a friendship deteriorates, there are no societal supports in place to assist in reconciliation and repair. Instead, people are left to their own devices. Are people able to resuscitate ailing friendships? Researchers asked respondents to describe the decline of a relationship (friendship, romantic, marital, or familial) and the turning points that resulted in its rejuvenation. For friendships, the most common rejuvenation event (reported by 33% of participants) was a change in the behavior of one or both friends, including giving the other more 'space,' spending more time together, being more independent, talking more, and so on. The second most frequent rejuvenation event (31%) was labeled 'have big relationship talk.' These talks entailed apologies, arguments, acknowledging the importance of the relationship, setting ground rules, and the like. They differed from other conversations in that they served the explicit function of restoring the relationship. The third rejuvenation event (19%) included gestures of reconciliation (e.g., initiating a joint activity, directly expressing a desire to reconcile). This was followed by reassessment of the importance of the relationship (8%) and accepting or forgiving the other (8%). Finally, a mere 2% of respondents reported that they had restored a friendship by seeking third-party help (e.g., seeing a counselor, talking to other social network members; Wilmot and Stevens (1994)). (Note these numbers add up to more than 100% because participants tended to report more than one rejuvenation strategy.)

When the researchers compared the different types of relationships, they found that the rejuvenation events were endorsed much less frequently for friendships than for other

kinds of relationships. This suggests that when friendships deteriorate, people may not take active steps to restore it. As discussed earlier, research on conflict has shown that in friendships, people are most likely to respond with passive avoidance, as opposed to open, explicit discussion of problem issues. Passivity is also the *modus operandi* when people terminate friendships. In one study, 72% of the termination strategies that participants had used to end a friendship were classified as indirect. This passivity is also reflected in the language that people use to describe the dissolution of their friendships – 'drifting apart' or 'fading away,' rather than 'breaking up.'

Although the passive approach to conflict management has deleterious effects, ironically, this same approach to friendship termination may have beneficial consequences for friendship restoration. Research has found that faded friendships are seen as relationships that could be revived. Reconciliation is perceived as much more difficult if a friendship has been explicitly terminated.

Conclusion

In conclusion, despite its status as the 'neglected' relationship, there is sufficient research on friendship to paint a portrait of the life cycle of this kind of relationship. Friendships are formed when environmental factors bring people together, when the situation permits for ongoing, frequent interaction, when the individuals involved possess qualities that facilitate the formation of relationships (e.g., social skills), and when the interactions between the two people flow smoothly. Friendships are maintained and strengthened when friends engage in personal self-disclosure, support one another, and make the effort to spend time together. Not all friendships survive. Friendships deteriorate and dissolve when the factors that facilitated the formation of the relationship are negated (e.g., reduced proximity, the discovery of disliked qualities in the other). Given the benefits of this kind of relationship in terms of physical and emotional well-being, it is encouraging that people have knowledge of the kinds of strategies that can result in the rejuvenation of lapsed friendships.

See also: The Clinical and Cognitive Psychology of Conflict; Conflict Communication; Impression Formation; Interpersonal Perception and Communication; Personal Relationships in Everyday Life; Sex Differences; Social Support.

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Relevant Website

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Generalized Anxiety Disorder

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Glossary

Avoidance theory of worry Another cognitive model that focuses on how individuals with generalized anxiety disorder cognitively avoid facing anxiety-laden fears by verbal-linguistic thought, rather than imagery in the form of worry.

Cognitive-behavioral therapy A form of 'talk therapy,' based on the principle that our thoughts mediate feelings and behaviors. The approach is commonly used, effectively, in the treatment of generalized anxiety disorder.

Experiential avoidance A type of avoidance common in generalized anxiety disorder, where anxious individuals attempt to circumvent experiencing and facing their anxiety and rely on worry as a coping technique. A psychological approach called acceptance-based behavior therapy has been developed that addresses this concept of experiential avoidance and its treatment.

Intolerance of uncertainty It is both a generic term for chronically anxious/worried patients' difficulty in

facing the uncertainties of daily living and a psychological approach aimed at helping them address this fear of uncertainty.

Looming vulnerability A cognitive model that defines the concept of threat in dynamic terms, where images and thoughts are rapidly rising in risk, thereby increasingly intensifying appraisals of threat and danger.

Generalized anxiety disorder An anxiety disorder characterized by excessive anxiety and worry across multiple content domains that is experienced as uncontrollable by the person. The anxiety and worry interfere with functioning in important roles and areas of daily living.

Metacognitive model A cognitive model that focuses on the nonadaptive beliefs anxious individuals have about the uncontrollability and danger of worry.

Worry A type of cognitive activity marked by negative affect and chains of apprehensive thought processes aimed at the problem solving of issues where the outcomes are often uncertain.

Generalized Anxiety Disorder: An Overview

Diagnostic Definition of Generalized Anxiety Disorder

Generalized anxiety disorder (GAD) is a condition characterized by chronic, persistent, and excessive anxiety or uncontrollable worry associated with three or more accompanying symptoms such as restlessness, difficulty in concentrating, fatigue, muscle tension, disturbed sleep, and irritability. The worry that occurs is often focused on multiple content areas (e.g., job performance, finances, health, and safety of self, children, or family members). It is frequently about 'minor' and remote things. The anxiety and worry contribute to occupational impairment and barriers in other important areas of function. The symptoms of anxiety and worry in GAD are not the result of any medical conditions such as hyperthyroidism, or because of medication, substance abuse, or any other disorder such as a mood disturbance.

Clinical Picture

Unlike a phobia, which is cued by a specific object or situation, GAD has a far more diffuse, unrelenting quality to its presentation. Many GAD sufferers report being in poor health and medical concerns bring them to primary care providers complaining of somatic symptoms. Patients often have a long history of physical complaints before health professionals identify that chronic and unrelenting worry/anxiety may be the underlying cause of their symptoms.

There is no fixed clinical picture for GAD and it presents with considerable heterogeneity. Many GAD sufferers experience

gastrointestinal distress, acid reflux disease, hypertension, and autonomic hyperarousal. As compared to nonpathological worry, the anxiety and worry are more pervasive, pronounced, distressing and protracted in duration. The excessive worry often arises from minor concerns and may appear to surface with little apparent overt reason for its onset. It is perceived as difficult to stop and uncontrollable. Some research suggests that there is a 'generalized tension subtype' and a 'generalized worry subtype.' Some view GAD as a 'dysphoric disorder' more similar to depressive illnesses, while others feel that GAD and depression share a trait called, 'negative affectivity.' These hypotheses about the various clinical presentations of GAD may lead to changes in the much anticipated DSM-V and other classification systems.

Case Example

Carol is a 38-year-old, Caucasian, married mother of three children. She has been 'happily' married for 10 years and her husband and three children (ages 9, 8, and 6) are in good health and doing well. She is a registered nurse and works for her husband – an accomplished radiologist – and his practice. She reports no conflict in her personal and professional relationships and that she and her husband are financially secure and have many friends.

When 18 years old, she reported to her physician that she was troubled by childhood worries that seemed to worsen as she got older. Although unable to verbalize all worries, she reported frequent headaches, stomach aches, difficulty in

sleeping, and feelings of tension in her back and neck. She reported fears of going to college, worries that something horrible might happen to her parents while she was away, and could not decide what she wanted to study in college. She did well academically but was worried about her grades, whether her parents could afford her tuition, and the welfare of her parents and siblings. She developed a frequent need to use the bathroom that would flare up for hours at a time and believed that she had irritable bowel syndrome. She also suffered from depression and began missing classes. After several months, her parents visited and found her 15 pounds thinner, looking strained and fatigued. She began to see a psychologist who diagnosed her with comorbid GAD and depression and recommended that she be evaluated by a psychiatrist who prescribed an antidepressant and benzodiazepine. Although she noticed improvement, her worry and somatic symptoms did not fully leave her even after a year of medication and therapy.

She reported that she saw herself as living a 'picture perfect' life after her marriage and attainment of a nursing degree – but her symptoms never fully abated. She continued to worry and be somatically preoccupied, and was bothered by back and neck tension. Her husband noticed her seeming irritability, restlessness, 'worry about everything,' and spending an unusual amount of time in the bathroom and worrying about 'everything.' She resumed treatment with medication – not having perceived benefit from her supportive psychotherapy. A combination of antidepressants and benzodiazepine helped her to achieve symptomatic relief. However, with each new stressor, responsibility, and developmental challenge – for example, birth of children, the children starting school, aging parents, etc. – her worry and somatic anxiety intensified. She resisted suggestions that she should try a more evidence-based psychosocial approach than the supportive treatments received in the past. However, she has resisted further psychotherapy – arguing that her schedule is too hectic and therapy too costly and will take forever. Although medication compliant, she still suffers from debilitating symptoms when facing stressful events or transitions.

Carol exemplifies a case of comorbid GAD with dysthymia (low-grade and persistent depression) where the person has had GAD, most likely since late adolescence, combined with depression (low self-esteem, depressed mood, poor appetite, decreased libido, and some loss of pleasure in things). She appears to undergo exacerbations of her lower level and chronic anxiety around increased internal/external demands (called 'double anxiety' – anxiety episodes superimposed on a lower level of severity, but persistent course of GAD). Her preference is pharmacotherapy, but she has now pursued a course of evidence-based therapy where she saw that it might help her to maintain her recovery. As with some people who have GAD, others do not fully appreciate the level of her distress. She maintains a reasonably intimate relationship, raises children, and works part-time. However, she often feels disconnected from others, is preoccupied with fluctuating domains of worry, and is fixated on her health, the welfare of others, and finances. She has no close friends, little time for leisure, and minimal peace of mind. This is true despite the lack of any evident reasons for her GAD symptoms – no history of loss/abuse, solid relationships with family growing up, current financial stability, and good health.

Phenomenology of GAD

Prevalence

GAD is one of the most common and debilitating anxiety disorders, but often symptoms are at a subthreshold level and do not always result in sufficient distress or impairment to warrant a diagnosis. It is frequently seen in primary care settings without being properly diagnosed. Lifetime prevalence rates for GAD range from approximately 3% to 7% in adults, and 12-month rates are in the 1–4% range. The prevalence rates are higher in anxiety disorder clinics, where up to a quarter of the individuals have GAD as a presenting or comorbid diagnosis.

Once considered rare among children, GAD occurs in this population at around 2–4% and at even higher rates in specialty child psychiatry clinics and in adolescents. Anxieties and worries in children often center on performance in sports, school, or on social and environmental catastrophes. GAD may be most common in middle age (45–55 years old), while in older adults, subclinical GAD (not meeting full diagnostic criteria) is typical.

Age of Onset

GAD can develop at any age, but most commonly develops in the late teens and early twenties. Although earlier onset (which can occur in childhood) is marked by the absence of a specific precipitating event, crisis, or challenge, later onset GAD is often characterized by precipitating life stressors.

Gender Differences

Women have GAD in a ratio of 2 or 3:1 compared to men. Explanations for the greater prevalence in women have been proposed in terms of hormonal factors, greater openness about feelings and treatment seeking, and societal/cultural pressures associated with raising children and responsibility for their safety (a frequent focus of worry in GAD), and having to work full time. Gender divergence begins in adolescence and women in their forties are particularly vulnerable and overrepresented in clinical settings.

Course and Prognosis

GAD is typically chronic and an unremitting lifetime condition, but can also exhibit a more episodic-like course with periods of relative latency. The course is particularly poor when GAD is comorbid with another disorder such as major depressive disorder (MDD), another anxiety disorder, or a personality disorder. Comorbidity for GAD is approximately 85–90% with another disorder – the most common being MDD and then social anxiety disorder. Co-occurring personality disorders happen in around 60% of GAD cases. Pure GAD is rare. The course of GAD involves frequent use of medical services and contributes to approximately 6.3 missed days of work per month and broad impairments in social, marital, vocational, and academic life.

Conceptual Models of GAD

Psychodynamic Model

According to contemporary psychodynamic models, GAD develops as a result of unresolved 'core conflictual relational

themes' (CCRTs) that are associated with the particular symptoms expressed by the individual sufferer of GAD. For example, modern day psychodynamic thinkers have proposed that by focusing on the therapeutic alliance, therapists are able to use this relationship as a 'corrective experience' to offset the hypothesized damage done by insecure attachments and traumatic experiences that have occurred during earlier periods in life. Some individuals develop GAD because of these earlier interpersonal conflicts and traumas with significant others. Psychodynamic therapists help individuals with chronic anxiety face similar feared situations and people – similar to the idea of facing a phobic object. If an individual is unable to approach those things he or she fears, the anxiety associated with these unresolved relational/interpersonal conflicts persists and can become chronic, as in GAD. Anxiety is then manifest psychologically and behaviorally.

Beck's Cognitive Theory

Beck's cognitive formulation of anxiety disorders has been one of the most influential and supported contemporary models. According to Beck, GAD is related to the continuous activation of maladaptive danger schemas that guide information processing (e.g., attention, interpretation, and memory for threat stimuli). Such danger schemas – internal frameworks developed from past experience – contain distorted beliefs in individuals who have GAD and lead them to overestimate the magnitude and severity of threat and underestimate the extent of their coping resources in even neutral or mundane situations. For example, individuals with GAD exhibit overactive threat processing and cognitive biases that serve to maintain the disorder. For instance, they overestimate the probability of threat and consequences of harm, scan the environment for potential threats, and interpret ambiguous situations as likely leading to catastrophic worst-case scenarios. Individuals who suffer from GAD are seen as suffering from a continual stream of threatening 'automatic' thoughts and disturbing threat-related visual images across multiple content areas that elicit anxiety, worry, and tension. A great deal of evidence has supported Beck's cognitive model of anxiety and GAD in particular. However, one criticism of the model is that it does not take metacognitive factors – beliefs about worry – the cognitive activity in worry, and emotional experience sufficiently into account.

Barlow's Model of Anxious Apprehension

In contrast to Beck's model, Barlow's model focuses more on emotion and behavior than cognition in the concept of anxious apprehension (negative affect). Barlow assumes that GAD is the basic anxiety disorder and so it shares anxious apprehension with all other anxiety disorders. That is, anxious apprehension is a broad-based phenomenon common in anxiety. However, in spite of its universal presence in anxiety, the presence of this negative affect is both distinct and unique to GAD, just like fear is more central to panic disorder. Barlow goes on to propose that the synergy between biological (genetics) and psychological vulnerability (decreased loss of control) combined with environmental factors (early adverse developmental experiences) leads to attempts to cope with anxious apprehension via behavioral avoidance and worry. These early developmental experiences are critical factors, in this

model, as to whether a young person will bring a sense of control over his or her life with him or her into adulthood or a low sense of control that contributes to heightened arousal, lack of predictability over events, and increased somatic output. This latter perception of decreased control interacts with the other mentioned factors becoming a precursor for the emergence of an anxiety disorder, such as GAD.

Avoidance Model of Worry

Borkovec's cognitive avoidance model of pathological worry has stimulated one of the most effective of current treatment interventions. His model proposes that pathological worry – a central process in GAD – is a maladaptive cognitive response to threat stimuli that consists primarily of abstract lexical activity. Such lexical activity functions to help the worrier to avoid painful affect in response to the threat. In this view, worry has a short-term benefit for the worrier in facilitating escape from disturbing mental imagery, negative emotions, and bodily sensations. Evidence confirms that worry is primarily lexical and that verbal thoughts elicit far less cardiovascular arousal than images of the same emotional stimuli. The short-term benefit of worry, however, is thought to come with a long-term cost. In specific, it reinforces and thus maintains a pathological worrisome thought activity in GAD – and lack of extinction of these fear-based cues and aversive imagery. Evidence confirms that worry is associated not only with a dampening of somatic activity, but also with the decreasing of emotional processing and increasing of anxious meanings. Evidence suggests that pathological worry activity in GAD can serve the unhealthy purpose for sufferers to not confront more painful issues and interpersonal issues. Borkovec's model has been highly influential on recent approaches to cognitive, emotional, and acceptance-based perspectives of avoidance in GAD.

Looming Vulnerability Model

The looming vulnerability model of Riskind and his collaborators holds that individuals worry, experience anxiety, fear, and engage in self-protective strategies to the extent that they appraise danger as dynamically developing and approaching in relation to the self. What sets this model apart from others is its emphasis on threats as dynamic unfolding events – such as deadlines, oncoming injuries, or failures. Thus, threatening stimuli are not static but rapidly rise in risk as they approach and expand in space and time. Thus, the threatening stimuli that initiate anxiety, worry, and cognitive avoidance are defined by the perceived dynamic aspects of threat and not just defined in terms of the probability and severity of aversive events. Evidence supports that looming vulnerability is elevated in GAD, that it predicts vulnerability to anxiety, worry, and emotional avoidance, and that it influences information processing biases. However, it has received less research than some of the other models on GAD and has only recently been explored as a source of intervention strategies.

Intolerance of Uncertainty Model

According to Dugas, intolerance for uncertainty is a key mechanism that is implicated in GAD. It is defined as a cognitive

bias that is reflected in an excessive tendency to find uncertain situations stressful and upsetting, to believe that unexpected events are negative and should be avoided, and to think that being uncertain about the future is unfair. Furthermore, intolerance of uncertainty leads to the inability to act when faced with an uncertain situation. According to the intolerance of uncertain model of Dugas and collaborators, GAD sufferers, when confronted with ambiguity and uncertain events/situations, become highly distressed and upset. In this model, intolerance of uncertainty precedes and produces the onset of worry. Worry then serves as a way to cope with uncertainty about an unpredictable future. The model suggests that GAD sufferers have dysfunctional beliefs about worry (e.g., worry is motivating, worry assists in problem solving, and worry means that they care), poor problem orientation (e.g., problems cannot be solved, problems are a threat), and cognitive avoidance (e.g., not wanting to think about distressing thoughts and images). There is substantial support for this model and treatment trials have examined and found evidence of associations between intolerance of uncertainty and GAD and the usefulness of targeting this in treatment.

Metacognitive Model

Wells has proposed a metacognitive theory of GAD that distinguishes two categories of worry – Type 1 and Type 2. Type 1 worries are what people ordinarily think of when they refer to worry, and concern events and physical problems they may face in everyday life. Type 2 worry, in contrast, concerns the phenomenon of ‘worry about worry.’ Metacognitive beliefs and appraisals lead to metaworry which is a key feature of pathological worry that distinguishes people with GAD from others. People with GAD may simultaneously have positive beliefs about worry and its usefulness in helping them to solve problems and negative beliefs about its harmful effects. In particular, GAD is associated with beliefs and appraisals of the uncontrollability and dangerousness of worry. For example, people with GAD may believe that their worry is damaging their health. The beliefs in Type 2 worries are about both the uncontrollability of worry and its danger to survival. Positive metacognitions are generally adaptive and use worry to actually cope, while negative metacognitions focus on lack of control and threat which lead to deleterious effects and the development and maintenance of GAD. At this point, a host of ineffective strategies such as checking behaviors, reassurance seeking, avoidance, and suppression come into play, further reinforcing negative metacognitions. Some aspects of the model seem better supported than others, but overall it has proven to be an important conceptual contribution on GAD.

Emotion Dysregulation Model

The emotion dysregulation model of Mennin and colleagues draws heavily on emotion theory and the regulation of emotional states, rather than just increased cognitive control and mastery. This model focuses on four main components that are central in GAD. GAD sufferers share the following: (1) they experience emotions more intensely than others (positive and negative), (2) there is a poorer understanding of emotions, (3) attitudes about emotions are viewed as more aversive and

threatening, and (4) emotion regulation strategies are largely ineffective. For example, raw emotional experiences often go unprocessed, according to this model, and in many cases are viewed in GAD as aversive in nature. This in turn creates a challenge in learning new skills, in order to solve problems that are now impaired in GAD. Worry and cognitive control strategies are once again used to confront this dysregulation, as is the suppression of emotions and emotional reactivity. Initial evidence for the model is well supported with most of its premises. Although this approach is promising, some findings suggest that GAD sufferers are in reality well equipped to identify their emotions and are not nearly as fearful of their emotions as once thought compared to others with certain psychiatric disorders.

Acceptance-Based Behavior Model

Roemer and Orsillo’s acceptance-based model contends that experiential avoidance (e.g., aversive affect, avoidance of internal experiences) is the most prominent feature of GAD. Experiential avoidance refers to GAD sufferers avoiding unpleasant internal experiences. In other words, to diminish internal distress and somatization, they suggest, like Borkovec, that worrying is one way to accomplish this goal. However, they further postulate that worrying reinforces more problems than it solves, ultimately leading to a repetitive cycle of more worrying and behavioral restriction. For example, in the long run, individuals with GAD end up not pursuing valued goals, are too future oriented, lack a mindful, present-oriented focus, and become even more behaviorally rigid over time. Thus, experiential avoidance impedes effective problem solving and the broadening of more adaptive and flexible solutions to reduce internal distress and decrease somatic activity. Ultimately, this leads to increased distress and more unpleasant internal experiences.

The Biological Model

There is no one biological model on GAD, but a number of theories that offer insights about how biology and genetics play a role in this disorder. These theories run the gamut from neurotransmitter deficits and surplus, to hypersensitivity/overactivation in the amygdala, anterior cingulate, and dorsal medial prefrontal cortex regions of the brain. New technologies such as functional magnetic resonance imaging (fMRI) have made it possible to look closely at these areas and make predictions about how neural correlates of worry compare in GAD subjects versus controls.

Genetics seem to suggest a moderate degree of heritability in GAD with best estimates ranging around 30%. These rates are almost exactly the same for MDD and lower than in panic disorder. GAD and MDD have been viewed as sharing similar genetic, but different environmental, influences. Individuals with GAD are more likely to have first degree relatives with GAD compared to controls, and twin studies have found higher rates of GAD in monozygotic twins, than in dizygotic twins. In the end, it may still prove to be an interaction of factors that range along the spectrum of heritable traits such as neuroticism, negative affectivity, plus environmental correlates that influence the emergence of anxiety disorders more broadly and GAD in particular.

Treatment of GAD

Cognitive–Behavioral Approaches

Cognitive–behavioral therapy (CBT) has proven itself in multiple controlled trials to be an effective first-line treatment for GAD. Borkovec's approach is particularly supported. There is no single CBT approach, yet they all share the assumption that distortions in thinking and their modification bring about change – that is, the particular cognitions and beliefs needing to be targeted – has become more precise and better delineated in the newer approaches, than earlier, more traditional and generalized treatments that address more globally dangerous threats and anxious apprehension. In Beck's cognitive therapy, the focus is on helping patients with GAD to recognize, refute, and cope with the continual stream of threatening automatic thoughts and images, while at the same time, modify or change dysfunctional attitudes that compose underlying maladaptive danger schemas. This in turn leads to increased self-mastery and general coping skills. In Borkovec's approach, worry exposure is critical.

Metacognitive therapy, in contrast to the more traditional model of Beck, does not focus on the contents of worry *per se*, but rather negative beliefs about worry (metaworry). Interventions in this approach are aimed at challenging Type 2 worries concerning the uncontrollability and dangerous effects of worry. Various interventions such as worry postponement, decreasing reassurance and thought suppression are employed to change these negative beliefs about worry. Positive beliefs about worry that are erroneous, such as an overreliance on worry as beneficial, are also challenged. An open trial and recent randomized-controlled study has provided support for the metacognitive approach.

The intolerance of uncertainty approach aims to help GAD sufferers better tolerate uncertainty, and not decrease its intensity. Psychoeducation, worry awareness training, uncertainty recognition, behavior exposure, reevaluation of the usefulness of worry, problem solving training, imaginal exposure, and relapse prevention are distinct modules in the treatment process. The processing of core fears also helps to soften cognitive avoidance which maintains worry. A series of randomized-controlled trials (RCT) have largely validated the efficacy of this approach in the treatment of GAD.

Emotion-Focused Approaches

Two recent approaches focus on dysregulation of emotional states and experiential avoidance of them in the treatment of GAD. Emotion regulation therapy attempts to help individuals with GAD better self-regulate their emotions to decrease their worrying using elements to increase emotional awareness and decrease emotional avoidance.

Acceptance-based behavior therapy focuses on experiential avoidance which is common in GAD. The goal of treatment is to enhance confronting internal experiences to help decrease worrying and avoidance as viable coping techniques. Key treatment strategies in this approach include techniques that enhance present-focus living, a nonjudgmental acceptance of internal/external sensations, and decrease behaviorally restricted and restless unfocused activities by enhancing mindful action of

desired values. Acceptance-based behavior therapy has conducted an open trial and recent RCT with promising results in improving worry, depression, and anxiety. A future RCT with a control group is in process.

Psychodynamic Approaches

Crits-Christoph and colleagues have developed a supportive-expressive psychodynamic approach that is a brief interpersonally oriented therapy for GAD. It focuses on worry and interpersonal problems within the context of a relational psychodynamic model. Their main premise is that worry is a defense mechanism and the effects of trauma lead to interpersonal/relational challenges. The goal of the treatment is to alter 'CCRT' via the creation of a strong therapeutic alliance. The approach has produced mixed results with it being helpful in reducing rates of symptoms of anxiety leading to improvements in remission in GAD patients, but not being of benefit in decreasing interpersonal issues (the main goal of the treatment). However, newer research lends support for this type of short-term dynamic treatment. This has been demonstrated in a similar, but modified version of Crits-Christoph's approach in a recent RCT comparing supportive-expressive psychodynamic therapy versus CBT. Results showed that both therapies were effective in the treatment of anxiety and depression in GAD. Yet, CBT was more efficacious in reducing worry. Interpersonal challenges improved with both treatments.

Integrative Approaches

Integrative approaches have become popular in the treatment of GAD and other psychiatric disorders. Borkovec and colleagues have developed an approach that combines a cognitive-behavioral treatment package with interpersonal/experiential processing. The treatment incorporates CBT components (self-monitoring, relaxation training, cognitive therapy, rehearsal of coping responses, scheduling of pleasant activities, stimulus control techniques, establishing worry periods, and decreasing intolerance of uncertainty). In addition, targeting nonadaptive relationships, building the therapeutic alliance, and helping GAD sufferers experience a deepening of their emotions by expressing them, rather than avoiding them, are key strategies in this treatment. The results have shown that the additive piece of interpersonal/emotional processing to CBT showed some early promise, but other recent research produced more modest outcomes and the added benefits of integrative approach are still being determined.

Pharmacological Approaches

Multiple agents have been tried and tested in the pharmacotherapy of GAD. First-line agents are still the selective serotonin reuptake inhibitors (SSRIs) such as paroxetine, sertraline, and escitalopram and the selective serotonin norepinephrine reuptake inhibitors which include venlafaxine and duloxetine. Benzodiazepines can be used for short-term control of somatic symptoms selectively as monotherapy and in long-term use because of intolerance to other classes of medications. Other medications that are more second line are buspirone, hydroxyzine, and imipramine. Pregabalin, a novel anxiolytic, may

prove to be a first-line given its efficacy, but has not achieved FDA approval in America. Tiagabine has not proven to be effective in GAD. Beta blockers also have limited use and should ideally be avoided as they may contribute to emergent depression. The same can be said about herbal/alternative compounds where empirical support is lacking. Other medications requiring more research that may have a future in the pharmacological treatment of GAD are bupropion, gepidone, opipramol, agomelatine, abecernail, and riluzole. Many RCTs have been conducted on the first-line treatments, as have been effective relapse treatment studies to support their maintenance use (long-term treatment). Pharmacotherapy is a mainstay in the therapy of GAD and has proven to be of equal efficacy to the psychosocial approaches mentioned throughout this article.

Treatment Refractory GAD

There is no consensus among the experts on how best to manage those GAD sufferers who remain symptomatic after receiving full courses of evidence-based protocols. Given the modest clinical outcomes for therapeutic and pharmacologic treatment of GAD (40–60% response range), novel interventions in both areas need to be used to help those sufferers who are often refractory to first-line approaches such as CBT and SSRIs/SNRIs. There has been some growing research suggesting that if a tried and tested approach does not work, it is well advised to try another empirically validated approach (Beck, personal communication, 2009). The plethora of psychosocial and pharmacological modalities leaves the clinician with many more options than in the past. Identifying the core worry domains and associated symptoms (psychic vs. somatic) can assist in this process. The mechanisms of change inherent in the various therapies such as intolerance of uncertainty, cognitive/experiential avoidance, negative metacognitions about worry, emotional regulation, interpersonal conflict, and looming vulnerability, for example, can be assessed in the early stages of treatment making it possible to match the treatment to the varied clinical presentations and target-specific areas in need of change with GAD patients.

In regard to pharmacotherapy, different pharmaceuticals will work for some patients rather than others in spite of FDA approval. Optimization of doses, switching from one class to another, and polypharmacy in the form of augmenting antidepressants with atypical antipsychotics such as risperidone, olanzapine, and quetiapine have proven in some research to be effective in the GAD refractory patient. Mood stabilizers such as depakote may also be of benefit. For some patients with somatic impairment, monotherapy with benzodiazepines, perhaps with antidepressants, may prove to be a viable option, despite dependency and withdrawal concerns. Finally combining CBT with medication or trying one when the other fails is also a possibility to enhance response rates. In the end, clinical

acumen, patient preference, building the therapeutic alliance, and just plain trial and error, in some cases, until something takes hold may be the missing ingredients.

Conclusion and Future Directions

GAD is a common anxiety disorder characterized by pervasive anxiety and worry that is excessive and experienced as uncontrollable. A variety of theoretical models have been developed to account for the onset and maintenance of GAD, including those that emphasize overactive processing of threat information, worrying, emotion dysregulation, and genetics. CBT and pharmacotherapy are currently considered the most effective approaches. GAD is considered a treatable disorder but many treatment refractory cases exist and efforts continue to enhance treatment for this condition.

See also: [Anxiety Disorders](#); [Cognitive Behavior Therapy](#); [Psychodynamic Psychotherapy: Theory and Practice](#); [Uncertainty](#).

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Genius, Eminence, and Giftedness

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Glossary

Convergent thinking The ability to think analytically in one direction in order to converge on a single answer to a problem.

Creative productive giftedness The ability to develop innovative products, solutions, or ideas that become valued by their targeted audiences.

Divergent thinking The ability to think flexibly in a variety of different directions in order to generate multiple solutions or strategies for solving a problem.

Eminence Distinction within a domain, society, or historical time period, typically for one or more outstanding achievements.

Genius Exceptional intellectual ability; original and exemplary achievement that significantly alters a domain or creates a new one.

Giftedness Outstanding performance or capability in comparison with others of the same age, environment, or experience. Areas of high performance or potential include general intelligence, specific academic disciplines, leadership, creative, and/or artistic.

Historiometrics The statistical analysis of historical and biographical information.

Intelligence An internal, fairly stable ability that accounts for individual differences on mental ability tests; the ability to comprehend and adapt.

Intelligence quotient (IQ) A score derived from a standardized intelligence test where the average is set at 100.

Psychometrics The design and use of psychological tests and measurement.

Schoolhouse giftedness High IQ or aptitude scores and rapid adaptation to the academic environment.

Genius, eminence, and giftedness are highly related in that each involves extraordinary abilities valued by members of a society. Where they differ is in the average age of their identification and their degree of impact on a particular discipline. Giftedness typically is recognized in an individual's childhood achievements, while genius and eminence tend to be adult phenomena requiring major creative breakthroughs or distinction in one's field of endeavor. Although these intangible constructs are difficult to define and explain, the aim is a worthy one. Understanding giftedness, genius, and eminence means that a culture can benefit from their identification and development; scientific knowledge about the workings of the human mind is also advanced. After presenting the historical context that continues to affect current practices, this article describes the characteristics, theories, and cultivation of giftedness, genius, and eminence. The connections and disparities between these three constructs are highlighted.

Historical Legacies

A society's values largely determine which of its members are recognized as geniuses, eminent, or gifted. As values and beliefs change, so do the definitions of these three constructs. In Ancient Rome, for example, genius was a divine spirit commonly bestowed upon people and places to protect them. In the eighteenth century, the term adopted a more secular and exclusive meaning when it began to signify the innate and exceptional creative abilities of relatively few individuals. Interestingly, in Western cultures, genius became associated with insanity because of the belief that the 'creative force' could drive one mad.

During the mid-nineteenth century, the British aristocrat Sir Francis Galton conducted some of the first scientific

measurements of genius. Galton defined genius in terms of eminence (i.e., reputation achieved through widely acclaimed accomplishments), domain-specific passion, and hard work. Results from his historiometric analyses of family lineages, physical tests of intelligence (e.g., auditory acuity), and twin studies confirmed his belief that genius is an innate ability that runs in families (including his own of course). Although his physical measurements of 'natural' ability were eventually deemed inadequate, Galton successfully focused scientific attention on the connection between eminence and genius. He also laid the groundwork for later historiometric and psychometric measurement of genius and giftedness.

Lewis Terman, a twentieth century pioneer of intelligence testing in the United States, adopted Galton's view of genius as genetically inherited, stable throughout one's lifespan, and psychometrically measurable. However, unlike Galton, Terman simply defined a genius as any person with an intelligence quotient (IQ) of at least 140. Moreover, he believed that eminence in adulthood could be predicted from a child's high IQ. To test this belief and to learn more about the nature of giftedness, Terman initiated an extensive longitudinal study of 1528 intellectually gifted children in California. These participants, affectionately nicknamed the 'Termites,' were selected on the basis of teacher nominations and high IQ scores. Contrary to the popular belief that gifted children have poor physical and mental health, Terman's results showed that they were superior to their peers in motor coordination, physical condition, social adjustment, and school achievement.

Results from Terman's ongoing longitudinal research have been published in multiple volumes titled *Genetic Studies of Genius*. Did the Termites actually become adult geniuses? Overall, they were certainly successful experts in their disciplines. For example, the male participants received more college degrees, higher salaries, and more awards than the national

average. Many of them were also highly represented in honorary societies and *Who's Who in America*. The 672 female participants showed a similar pattern of midlife success except that, like most women of this era, they were less likely than the men to have advanced degrees and professional careers. However, despite their high levels of expertise, none of the male or female participants had groundbreaking discoveries, extraordinary artistic achievements, or other signs of creative greatness. (Ironically, even though none of the Termites won a Nobel Prize, two children who reportedly failed the study's psychometric screening did grow up to become genius-level Nobel Laureates.) Terman eventually acknowledged that childhood IQ scores of 140 or above did not accurately predict genius in adulthood. Furthermore, IQ did not even distinguish participants with the most successful professional careers from those who had been the least successful. Instead, factors related to their parents' education and child rearing involvement appeared to play an important role in the degree of career success these gifted children obtained as adults.

Galton and Terman left behind a powerful legacy. Their work helped pave the way for the psychometric measurement of creativity and personality. In addition, their views and methodologies are visible in current approaches to giftedness, genius, and eminence. For example, IQ tests have dominated the measurement of giftedness; childhood giftedness is no longer equated with adult genius; and genius is viewed as intertwined with eminence. Similarly, Galton's and Terman's groundbreaking research methods – historiometrics, psychometrics, twin studies, and longitudinal research – are commonly used today to examine giftedness, genius, and eminence.

Childhood Giftedness

Common Characteristics of Giftedness

Giftedness is democratic, in that it appears in all ethnicities, all socioeconomic statuses, and in equal proportions for females and males. In addition, it is typically identified in childhood and takes a variety of forms. Some children are schoolhouse or globally gifted, which means they excel in a wide range of academic disciplines. This category represents the type of giftedness studied by Terman. More common are children who display extraordinary performance in one specific domain, while showing average or below average ability in others. According to the US Department of Education, children can be gifted or talented in any academic discipline, leadership capacity, or the visual or performing arts. A subset of this population is known as 'twice exceptional' because they demonstrate extraordinary achievement in one area and are diagnosed with a learning disability in another. For example, gifted children can have extraordinary artistic or mathematical abilities and also dyslexia.

Despite the heterogeneity of giftedness, numerous studies indicate that gifted children typically differ from their same-age peers in several respects. First, these children are often precocious and tend to acquire information in certain domains earlier and at a more rapid rate than others their age. Giftedness is frequently demonstrated in the preschool years through such behaviors as precocious reading, advanced use of language, mastery of complex tasks, and extraordinary memory.

In general, precocity usually occurs in domains with a limited and well-defined body of knowledge that can be acquired through methodical study. For example, a young gifted child is more likely to excel at musical performance or mathematics than at musical composition or creative writing.

In addition, gifted children tend to process information in ways that differ qualitatively from other children's processing. For instance, the gifted are more likely than their same-age peers to use divergent, flexible strategies to combine materials and solve problems. They also tend to learn independently and create novel methods for acquiring relevant information. These qualitative differences in information processing are usually obvious by early adolescence.

Perhaps the most striking characteristic of extremely gifted children is that they are intensely and intrinsically motivated to master their domains of interest. Often beginning in the early years of their lives, they become obsessed with certain activities and types of information. They can spend endless hours immersed in drawing or reading books about reptiles. Sometimes their obsession is triggered by a crystallizing experience that exposes them to features of a domain related to their latent abilities. For example, hearing the harmonies in Wagner's music ignited Claude Debussy's interest in composing.

However, children who are gifted are more likely than other children to develop unevenly. In other words, their intellectual, socioemotional, and physical development typically occur at different rates. Their emotional maturity, in particular, often lags behind their advanced cognitive abilities and interests. For example, a 10-year-old gifted child might read at the college level, have age-appropriate physical abilities, and the emotional skills of a 9-year-old child. This means that it is not uncommon for extremely gifted children to have difficulty making friends and regulating their feelings. Furthermore, they recognize that they differ from their peers and are not treated the same. Although this sense of being atypical can lead to pride, popularity, and high self-esteem, it often results in low self-concept, depression, and feelings of isolation. Some gifted students, particularly girls, purposely underachieve in an attempt to be socially accepted by their peers. Level of exceptionality can be a contributing factor to a gifted child's poor social adjustment. For example, from her study of a small sample of children with extremely high IQs (i.e., above 180), Leta Stetter Hollingworth concluded that profoundly gifted children do not relate well to their peers as a result of dissimilar abilities, interests, and intensity of emotions.

Common attributes of gifted children's families are also worthy of mention, although these attributes do not necessarily cause giftedness. Parents of the gifted, for the most part, are highly responsive to their children's need to be intellectually challenged and absorbed. These parents tend to allow their progeny higher than normal amounts of independence, while providing them with strong support, relevant opportunities, and discipline. In short, they are child centered and have high expectations for themselves and their offspring. They are also likely to have moderate to high levels of education and socioeconomic status.

These characteristics illustrate the qualitative and quantitative differences between children who are gifted and those who are not. Many of these differences appear early in life and continue throughout adolescence.

Theories of Giftedness

Theories of giftedness are valuable because they guide both research and practice. However, they have an exceedingly difficult task, which is to describe, explain, and predict the various characteristics and forms of giftedness. With this mission in mind, current theories were developed in response to the evolving recognition within science and society that giftedness is more than what standardized intelligence tests measure. More specifically, these views propose that creativity, domain-specific strengths, and personal characteristics interact with high cognitive ability and motivation to produce giftedness.

Creativity plays a central role in most contemporary models of giftedness. However, these models differ in whether creativity is viewed as a necessary or an optional component. For example, Joseph Renzulli, director of the National Research Center on the Gifted and Talented at the University of Connecticut, developed his 'three-ring' conception of giftedness with creative, productive giftedness in mind. According to this theory, the three main interactive components (or rings) of giftedness are high levels of creativity, higher than average general or domain-specific abilities, and strong commitment to a specific area of interest. Other models propose that creativity is an option rather than a requirement. For example, the Munich model of giftedness (MMG) portrays creativity as one of many potential and independent competencies that predict later performance in language, the arts, and other domains. Personality characteristics and environmental factors play a role in determining which of a child's competencies actually develop and result in gifted performance.

As the above examples indicate, most current theories define giftedness as largely domain-specific. For example, some views propose that giftedness is neither more nor less than expertise in a particular domain. Exceptional performance is simply the result of extended training, deliberate practice, and commitment. Another example of domain specificity is Howard Gardner's theory of multiple intelligences, which proposes that individuals can be gifted in one or more of eight independent intelligences. These intelligences differ in their developmental courses and the areas of the brain they employ. Three of them – linguistic, logical–mathematical, and spatial – are related to abilities typically assessed by intelligence tests. The remaining five – bodily kinesthetic, musical, intrapersonal, interpersonal, and naturalistic – are not measured by intelligence tests but are valued in most cultures. In short, theories no longer view giftedness simply as a global trait or a general ability.

Not surprisingly, theories of giftedness reflect behaviors and potentials that a society values and hopes to foster. One recent societal concern involves a perceived decrease in social capital or civic actions. Therefore, some contemporary frameworks include characteristics that allow individuals to use their gifts to advance the greater good of others. More specifically, one's personal qualities, such as optimism, courage, passion for a particular topic, and wisdom, interact with his or her above average cognitive ability and creativity. This interaction increases the likelihood that the gifted individual will effectively address collective needs in one or more domains.

Finally, theories of giftedness need to explain how the construct originates. The expertise explanation mentioned earlier proposes that exceptional behavior stems primarily from

environmental factors, such as practice and training. According to this view, labeling some individuals as gifted is misleading because the term incorrectly implies genetic endowment. In contrast, most theories of giftedness propose that giftedness is dependent on both genetic make-up (nature) and appropriate opportunities in the environment (nurture). For example, Gardner claims that individuals become gifted in one or more intelligences through genetic inheritance, environmental opportunities, and socialization of cultural values.

Overall, theories of giftedness present a multidimensional conception that captures its variety and complexity. In addition, they explain how potential evolves into exceptional achievement. Many of the theories also provide practical guidance for how to identify and cultivate giftedness in ways that can benefit society.

Cultivating Giftedness

In order to reach their full potential, children need a stimulating and challenging educational environment. The characteristics of childhood giftedness described earlier imply that conventional methods of instruction are unlikely to promote the gifts of children who learn more independently, quickly, and differently than their age-related peers. Unfortunately, given the multidimensionality of giftedness, it is not entirely obvious how these children should be selected for educational programs that meet their needs. Identification of gifted students currently depends, in large part, on how a school district defines giftedness.

Some schools in the United States apply Terman's definition of exceptional general intelligence; therefore, they require children to have some combination of high scores on achievement or IQ tests (e.g., an IQ of 130 or above), strong teacher recommendations, and good grades. When creativity is included in a school's definition of giftedness, traditional psychometric measures of creativity are often administered, even though these measures do not predict significant creative productivity in adulthood. Similarly, aptitude tests are sometimes used to identify domain-specific giftedness. The Center for Talented Youth (CTY) at Johns Hopkins University conducts national and international talent searches, where math and verbal scores on the Scholastic Reasoning Test (SAT I) or the American College Test (ACT) are used to identify mathematically and verbally precocious seventh and eighth graders.

As views of giftedness become broader, less traditional forms of assessment are used more frequently. These methods of identification are derived from some of the theories of giftedness described earlier. For example, a number of schools select children according to Renzulli's three-ring conception of giftedness, while others use Gardner's theory of multiple intelligences. Nontraditional forms of selection include portfolios, auditions, behavioral checklists, performance-based assessment, and peer recommendations.

Once children are identified as gifted, a decision must be made about how best to educate them. The two most common options are enrichment and acceleration. With enrichment, gifted children remain at a grade level consistent with their chronological age and their curriculum is supplemented with advanced material and activities. Depending on a student's form of giftedness, more depth is provided either in all

academic disciplines or only in particular ones. Furthermore, this supplementation can occur within the regular classroom or as part of a 'pull-out' program where gifted children leave their regular classrooms at least 1 h per week to work with other gifted children on content specific projects and activities. School-based enrichment programs are usually not implemented until the third grade but they have been known to begin as early as the first grade. However, as noted earlier, schools are not the only source of enrichment. Parents typically provide their gifted children with responsive surroundings and stimulating opportunities.

In contrast, acceleration allows intellectually gifted children to enroll in advanced courses or enter grades that are consistent with their mental abilities. For example, the CTY and the Study of Mathematically Precocious Youth provide intensive summer programs that cover a 1-year curriculum in 3 weeks. These programs allow precocious youth to interact with each other, learn advanced material, and sometimes enroll in college early. Acceleration typically results in greater academic achievement than does nonacceleration; it has not been found to harm social competency skills. In general, current research indicates that acceleration is more effective than enrichment in promoting gifted development.

Adulthood Genius

Common Characteristics of Genius

As noted earlier, childhood giftedness does not guarantee, or even predict, adult genius. Although there is overlap between the two constructs in terms of intelligence, creativity, and intrinsic motivation, it is not surprising that most gifted children do not attain genius status in adulthood. Although individuals can have what is sometimes referred to as a genius-level IQ, true genius requires certain personal and environmental characteristics not needed for giftedness. Several of these distinguishing characteristics will be reviewed here.

Most importantly, geniuses must demonstrate creative greatness (or Big-C creativity) in order to transform a broadly valued domain or create a new one. Obviously, this high level of originality and usefulness is not required for childhood giftedness. Creative greatness is associated with reasonable risk taking or rebelliousness in order to change the status quo, the willingness to make considerable personal sacrifices for the sake of one's work, and above average intelligence. Interestingly, extremely high IQ scores (i.e., 180 or above) are not better predictors of Big-C creativity than are IQ scores of 130. The characteristics described below are related to creative greatness.

To become a genius, an individual must have sufficient drive and persistence to acquire domain-relevant knowledge, overcome obstacles, and persevere in the face of multiple impasses. As Leonardo da Vinci reportedly stated, "It had long since come to my attention that people of accomplishment rarely sat back and let things happen to them. They went out and happened to things." However, persistence is crucial because ~10 years of intense training in at least one discipline typically precedes a major breakthrough. Put simply, genius begins with expertise. For example, Picasso needed to master realism before moving beyond it. Furthermore, major insights

and innovations are more likely to occur when expertise is gained in more than one domain. Darwin assimilated knowledge from zoology, botany, anthropology, economics, and other disciplines. Persistence is also important because the right creative approaches are usually far from obvious, which means that many failed attempts occur before a successful breakthrough. Geniuses are extremely productive, with more failures and successes than the norm.

Closely related to persistence is the ability to maintain intense concentration while working on a major problem or project. Mihaly Csikszentmihalyi refers to this highly focused state of consciousness and undivided attention as flow. Individuals who experience flow often report losing track of time or forgetting to eat because they are wholly immersed in what they are doing. Flow happens most frequently when individuals are working in domains that match their abilities and passion. This state of effortless concentration increases the likelihood that material will be mastered and major insights will occur.

Finding significant problems often precedes noteworthy innovations. Whereas giftedness typically involves solving problems that other people have already identified, genius often entails discovering previously unknown ones. Put another way, forming relevant questions is at least as important as answering them. For example, Isaac Newton's curiosity about why an apple would fall perpendicularly to the ground resulted in his theory of universal gravitation. According to Csikszentmihalyi, finding significant problems and then solving them requires a relatively extended preparation or training period, immersion in a field that utilizes this training, the synthesis of information from different domains, and insight into a new configuration that helps solve the problem. This entire process usually takes longer than the one for solving already identified problems but the results are usually more revolutionary.

However, problem finding and significant discoveries are embedded within an important social context. Even though geniuses are frequently alone when they have their breakthroughs, the training, evaluation, and verification stages surrounding their insights depend on productive social interactions with colleagues. The link between collaboration and genius may seem counterintuitive because geniuses often spend a great deal of time working alone. However, they need to be extroverted at critical times. Working with others exposes them to unfamiliar concepts and viewpoints, thus making it more likely that they will eventually combine relevant information in unusual ways. During this collaborative process, colleagues contribute ideas and feedback. These ideas are then modified and creatively merged, resulting in a new context for problem solving. In addition, social interaction can foster group flow, which is comparable to an individual's intense periods of concentration described earlier. According to Keith Sawyer, group flow happens when dissimilar individuals work well together to accomplish a common goal. In general, collaborative improvisation improves each person's performance and increases the likelihood that problem finding insights will occur.

Perhaps the most intriguing characteristic associated with genius has to do with mental illness. Overall, geniuses show higher quantities and greater intensity of psychopathological symptoms than does the general population. Depression and bipolar disorder are the most common psychopathologies

found in geniuses; schizophrenia is relatively uncommon. However, these mental disorders are more likely to be found in geniuses working in some domains than in others. More specifically, affective disorders and alcoholism occur more frequently among geniuses who are creative writers and artists than those who are scientists. Furthermore, mental illness occurs more frequently in the family lineages of geniuses than it does in other families. In other words, geniuses both with and without psychopathologies are likely to have family members who do have them.

Similarly, studies of twentieth century artists and scientists have shown that geniuses were more likely than other individuals to have been raised in stress-filled family situations. Many had experienced death of a parent, poverty, abuse, or other childhood traumas. As with mental disorders, childhood trauma was more common for geniuses who were writers, musicians, artists, and actors than for those who became scientists or political leaders. One explanation is that childhood stress predisposes certain individuals to create as a form of therapy and the experience of suffering provides the subject for works of art, music, and literature. It has also been found that families of future geniuses often provide intellectual stimulation but little emotional support. One popular view is that this type of upbringing fosters rebelliousness and the willingness later in life to challenge conventional practices within one's domain of work.

The characteristics described here help explain why only a small minority of gifted children become adult geniuses. As Terman's participants illustrate, most gifted children accomplish the first step toward genius, which is to become adult experts in a well-established domain of interest. However, genius requires a crucial second step that involves transforming the practices and rules of one's domain. Each of these two steps utilizes a different form of thought. The first relies heavily on convergent thinking for mastering knowledge and techniques. The second predominately involves divergent thinking in order to overcome impasses and envision new groundbreaking approaches. In addition, genius is associated with certain personality traits that giftedness is not. For example, geniuses tend to be dissatisfied with the status quo, both introverted and extroverted depending on the stage of problem solving, extremely productive, and willing to take risks with their work and reputations.

Theories of Genius

Psychological theories of genius, compared with those of giftedness, are small in number, largely focused on creative greatness, and not aimed at providing guidance for practical applications. Instead, they concentrate primarily on the internal and external contexts in which genius occurs. Two widely cited examples will be described here.

Mihaly Csikszentmihalyi proposes a systems model that takes into account cognitive, social, and cultural factors related to significant discoveries or inventions. According to this view, creative greatness does not reside within the creator. Instead, it involves positive interactions between three systems: an individual, a domain, and a field. An individual's talents, motivation, knowledge, and interests must be a good match for the particular domain to which he or she contributes. The domain

plays the important cultural role of transmitting its rules, procedures, and practices to the individual. When a creator produces something innovative that potentially transforms the domain, knowledgeable judges (or gatekeepers) in the larger field evaluate the contribution and decide whether it should be accepted. If approved, the modification is incorporated into the domain and then transmitted from generation to generation. Put simply, creative greatness or genius has not occurred if relevant members of a society have not recognized, accepted, and dispersed it. Csikszentmihalyi's theory explains how individuals can become geniuses long after they have died. According to this intriguing view, it is not simply that their creative greatness went unrecognized during their lifetimes. Instead, genius literally did not occur until their contributions had an impact on society.

In contrast to the systems model, Dean Simonton takes an evolutionary approach to genius by elaborating on Darwinian theory. According to Simonton's view, genius-level creativity occurs through the process of blind variation and selective retention (BVSR). More specifically, creative individuals randomly generate variations on ideas in hopes of producing ones that are original and useful. Some of these blind variations involve combinations of separate ideas, while others are mutations of old ideas. After ideas are produced, they are subjected to cognitive and sociocultural selection, with the ones most likely to survive and reproduce being retained. Through this process of random generation and careful selection, geniuses are able to leave behind important work that will influence future generations. However, the degree of blindness (or randomness) in the variation of ideas tends to vary across domains of work. For example, the generation of ideas is often more blind in artistic domains, where remote associations and trial-and-error approaches are used, than it is in the natural sciences, where variations are typically based on logic, data, and algorithms. Domain-related differences in the blindness of ideas potentially explain the domain-related psychopathology and family characteristics described earlier. A higher than normal rate of mental illness and traumatic family backgrounds are not liabilities for geniuses working in artistic or literary domains where variations in ideas are fairly blind and unrestricted. Oddly enough, psychopathologies and childhood trauma can be assets. In contrast, low rates of mental illness and stable childhoods are conducive to the less blind, logical variations found in the natural sciences.

Simonton uses the BVSR theory and historiometric data to derive and test mathematical models that explain and predict various aspects of creative greatness. For example, one of his models predicts when creators in various domains will make their first, last, and best major contribution. Again, one's domain of genius makes a difference. For example, the length of time needed to learn a domain, generate ideas, and turn these ideas into significant products is typically shorter for poets than it is for geologists. Consequently, distinguished poets tend to do their best work at an earlier age than do scientists. For all domains, however, data indicate that productivity changes as a function of career age rather than chronological age. More specifically, output increases for approximately the first 20 years of one's career, reaches its peaks, and then declines. Although overall productivity is much higher for geniuses than for nongeniuses, this curvilinear course for output

is the same for both groups. Other mathematical models based on BSVR and historiometric data explain the characteristics, backgrounds, mental processes, and environmental circumstances of geniuses.

Cultivating Genius

Unlike giftedness, there are no official guidelines for identifying genius in individuals of above average intelligence or special programs devoted to its cultivation. However, geniuses are not randomly distributed across time and place, which implies that some historical periods and environments have been more favorable for creative greatness than others. More specifically, genius tends to form cultural configurations that are chronological. In other words, geniuses are clustered together for certain time periods within a culture, often followed by decades with relatively few geniuses. The political, economic, and social factors that appear to inhibit or foster these cultural configurations will briefly be described.

In general, a culture's politics influence the development and expression of genius. For example, aversive events that heighten emotional arousal tend to interfere with originality and creative greatness. This means that genius is less likely to be manifested during times of war, terrorism, or other conditions that threaten human survival. In contrast, cultures conducive to genius generally have the peaceful coexistence of heterogeneous ethnic groups and ideologies. Diverse perspectives and experiences increase the cross-fertilization of ideas and stimulate divergent thinking.

Economic growth also tends to foster genius. Some disciplines, such as architecture and science, require considerable monetary support. Yet even relatively inexpensive endeavors, such as literature and poetry, thrive in a rising economy. Prosperity typically precedes the social change and intellectual receptiveness required for genius to emerge. In contrast, economic depression and stagnation tend to result in rigidity and dogmatism, which are counterproductive for creative greatness.

In any given domain, the number of geniuses in the preceding generation positively influences how many are in the current one. These cultural configurations provide mentors, role models, and colleagues who transmit knowledge, guidance, and diverse perspectives. However, these configurations are meaningless to potential geniuses not given access to formal training, mentors, resources, and opportunities. Discrimination based on gender, ethnicity, socioeconomic status, or other factors limits the range of individuals who are able to become geniuses.

Furthermore, social systems need to value originality and change. As Csikszentmihalyi's systems theory indicates, genius manifests itself only when a field recognizes and legitimizes novel contributions. Journal editors, sources of funding, and other gatekeepers must be receptive to innovative change.

To summarize, certain environmental factors promote genius. Whereas cultivation of childhood giftedness typically occurs in families and schools, particular features of a domain, field, and surrounding culture foster adulthood genius. A society can cultivate genius by providing resources, diversity, and receptiveness to change.

Adulthood Eminence

Common Characteristics of Eminence

Eminence occurs when individuals become widely known for their sustained, outstanding achievements. This construct is frequently assessed through number of biographies, length of biographical entries in standard reference works, nominations or citations by experts, or other documented signs that someone has attained significant professional influence in a socially valued discipline. Although some researchers consider eminence to be synonymous with genius, the view taken here and elsewhere is that there are more eminent individuals in a society than there are geniuses. More specifically, eminence has degrees, with geniuses receiving greater and broader recognition than outstanding experts. For example, some of Terman's participants met the criteria for eminence based on expertise by being listed in *Who's Who in America* and other reputable sources, without reaching the elevated status of recognized genius. Consequently, the characteristics of eminence incorporate the ones of genius described earlier, which in turn build on those of expertise. These attributes include above average intelligence, deliberate practice, extended training, persistence, problem finding, and risk taking.

An additional characteristic of eminent individuals is that they typically start their productive careers much earlier than their peers. Beginning lifetime work at a relatively young chronological age is a reliable indicator of high overall productivity. In short, considerable output often leads to high impact on a domain, which results in eminence.

Achieving a strong sense of personal identity by early adulthood helps an individual start a career as early as possible. By their mid-twenties, for example, many of Terman's least successful participants had not explored their career options or formed a relatively firm vocational commitment. The most eminent participants had already achieved their occupational identities. Self-knowledge about one's strengths, weaknesses, interests, and values predicts later motivation, goal orientation, and vocational success.

Finally, eminence typically requires self-confidence and the ability to promote one's accomplishments. Some studies have identified the personality traits of eminent individuals as aggressive, competitive, independent, nonconforming, and domineering. In other words, one need not be agreeable or likeable to become eminent.

A Theory of Eminence

The two theories related to genius that were described earlier also apply to the type of eminence that is achieved through creative greatness. In addition, Robert Albert's developmental theory of eminence explains why some gifted children achieve distinction in adulthood, while many do not. Albert proposes a systems model where interactions between personal experiences, maturation, learning, and the people in a child's life result in particular developmental outcomes. The child's abilities, emergent sense of self, temperament, and other factors organize and shape these ongoing interactions. How well the various systems collaborate during sensitive developmental periods influences later eminence.

According to Albert's model, adolescence is the stage at which personal identity and the capacity for creative behavior develop simultaneously. For highly creative individuals, their identities and creative abilities merge together so that their career aspirations and innovative accomplishments define who they are. However, many gifted children are at risk of having their identities scripted for them by their families or other influential people. This foreclosure of identity means that during adolescence or early adulthood they are not in a position fully to explore and select options that best fit their strengths and interests. The end result is that they never reach their full potential or achieve eminence. However, some gifted children are given the opportunities and support to discover their strengths, weaknesses, passions, and real-life opportunities. This period of exploration allows them to make firm occupational, moral, and personal commitments. In turn, their achieved identities lead to the independence, intrinsic motivation, and self-assertiveness required for creative behavior and later eminence.

Cultivating Eminence

It is not clear that eminence needs to be cultivated. However, the programs that advance giftedness and the environmental factors that foster genius indirectly promote eminence. Mentors, resources, intellectual receptiveness, and opportunities to develop expertise and creative potential increase the chances that outstanding achievements will occur and be recognized.

Furthermore, helping, or at least permitting, gifted adolescents to achieve their personal identities makes it more likely that they will choose the best vocations for their talents. This also allows them to start their productive careers early, increasing the likelihood of eminence. In addition, acceleration can shorten time in school and improve the chances of increasing individuals' overall productivity in a career. In particular, young children who have a combination of schoolhouse and creative productive giftedness will be more likely to achieve eminence if they are given advanced overall instruction and ample opportunities to develop their expertise and creative talents.

Putting the Pieces Together

Current conceptions of giftedness and genius have moved beyond narrow, IQ-based definitions toward broader views. For example, many theories and practices now recognize that there are numerous ways to be gifted; high performance on intelligence tests is only one of these ways. Similarly, genius involves domain-transforming creativity in addition to above average intelligence. Despite their broader definitions, giftedness and genius are more different than alike. Although both

constructs involve superior abilities and intrinsic motivation, adulthood genius typically requires Big-C creativity, problem finding, high productivity, a desire to change the status quo, and recognition by members of one's field. In contrast, childhood giftedness usually entails precocity and proficiency in one or more domains. Although a small number of gifted children do become adult geniuses, the differences between these two constructs make it more likely that giftedness will result in expertise-related eminence rather than genius-related eminence. Both types of distinction reflect valuable contributions to a society.

See also: Academic Achievement; Bipolar Disorder; The Behavior-Genetics of Intelligence; Childhood Mental Disorders; Creative and Imaginative Thinking; Depression; Dyslexia; Human Intelligence; Personality Disorders; Problem Solving.

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Gerotechnology

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Glossary

Aging in place The preference of growing numbers of older adults and new policy paradigm for long-term care. Involves provision of additional community-based services, assistive technology and home modification to maintain seniors in their homes rather than moving to age-segregated housing in 'active adult' communities, or accepting institution-based long-term care in the event of becoming frail or in need of assistance.

Biopsychosocial model The currently prevalent theoretical paradigm in gerontology that proposes a holistic, dialectic, or contextual understanding of the influence of biological, psychological, sociological, and history-graded variables in human development.

Convergence Trend in technology development whereby diverse technologies (e.g., telecommunication, computer/internet, sensors/controls, are integrated and coordinated. Convergence of the NBIC Fields (Nanotechnology, Biotechnology, Information technology, and the Cognitive sciences) holds significant long-term promise.

Ergonomics/human factors The scientific discipline concerned with understanding the interactions among humans and other elements of a system; the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance.

Excess disability Behavioral, cognitive, or emotional inability or disability experienced by an individual that exceed those predicted by a disease process alone, and which are a direct result of contextual/environmental factors, such as flawed design, inappropriate expectations, etc.

Gerotechnology/gerontechnology A multidisciplinary field which considers the intersections of biopsychosocial aspects of aging with multiple forms of technology, primarily information/communication technology, assistive devices, home modification, and medical devices.

Information processing A useful conceptual model in psychology drawn from computer systems, which recognizes discrete steps involved when processing information from the environment. Some aspects of sensation, perception, cognition, attention, and other processing elements show predictable decline with age. Design of technologies must respond to these changes, and may be utilized to compensate for, slow, or reverse them.

Telehealth/telemedicine Use of computer/telecommunications technology to allow medical practitioners to provide health care information and services to patients at a distance, in their homes, etc. Also allows for telemetry and monitoring of patients' vital signs.

Ubiquitous computers/technology Comprehensive and often invisible and nonobtrusive integration of information technology into human environments, social systems, and labor (care provision, including self-care). For example, behavioral monitoring/tracking of automobile and pedestrian traffic in order to time traffic signals, or SmartHouse applications of monitors, sensors, or effectors in residential settings.

Universal design An approach to design of buildings and devices that encourages unimpeded usability for individuals with a wide variety of abilities and impairments. Similar to the concept of 'Barrier-Free Design.'

Introduction

Gerontology, the interdisciplinary study of older adulthood and aging, embraces a biopsychosocial model that encourages researchers, educators, providers, and policy-makers to consider jointly the complex, interconnected, and reciprocal influences involved in individual and population aging.

With advanced age, humans experience the natural process of 'senescence' – reduced viability and increased vulnerability – and are less able to respond effectively to a variety of environmental demands. Aging brings notable changes in biological, psychological, and social functioning. Predictable changes occur in bodily function (i.e., cardiovascular, nervous system, endocrine system, musculoskeletal system, etc.). Sensory, perceptual, and cognitive abilities also undergo inevitable changes (many, *but not all*, *negative*), which have significant behavioral ramifications for older adults. For example, an older adult with atrophied musculature, coupled with proprioceptive and balance difficulties may fall, or develop an exaggerated fear of

falling. Either may lead to reduced activity and mobility, further exacerbating the problem and leading to a precipitous deterioration in well-being and life-satisfaction. Many of these changes can be mitigated, reversed, or slowed with appropriate nutrition, exercise, and other interventions. Appropriate environmental design coupled with advanced technologies may also mitigate these declines and their ramifications.

Yet, scientific studies and anecdotal evidence demonstrate that many older adults maintain and enhance their various capabilities well into their very late years, most wish to continue to live full and meaningful lives, and many are becoming increasingly empowered to take necessary steps to make these goals a reality. This is particularly important because the life expectancy at age 65 is currently nearly 20 additional years. Steps are needed to assist older adults to maintain well-being mentally, physically, socially, and spiritually. Technologies can assist with this goal in a wide and expanding variety of ways.

Population aging is transforming global populations, primarily in Europe and North America. In the United States, for

example, those over 65 will comprise nearly 20% of the population by 2030 (they currently comprise 13%). Moreover, the aged population itself is aging, with significantly increased proportions and numbers over age 85. The number of centenarians in developed countries is expected to grow exponentially, doubling each decade in the near future. The United Nations estimated approximately 180 000 centenarians worldwide in 2000 and projects an 18-fold increase to 3.2 million by 2050.

We can expect both positive and negative consequences of population aging for societies and individuals; Dychtwald suggests it will transform many social institutions. Secular changes in employment, education, leisure, political, social, and spiritual engagements and other domains will occur, perhaps leaving older cohorts with obsolete knowledge and skills. Cohort membership is often a better predictor than age and this is certainly the case in the context of changing technologies.

The intersection of these 'megatrends' (population aging, technological innovations, and other secular trends) provides opportunities and perils for individuals and society. These intersections most interest those studying technology and aging. With increasingly deliberate actions, technologies are being applied to the needs and interests of older adults. Careful and deliberate use of technologies can enhance the likelihood of successful aging by providing fulfilling opportunities and mitigating many common age-related declines. Technologies may reduce costs and burdens associated with age-related maladies; however, careless and insensitive development, deployment, and use of technologies may do significant harm and increase costs.

Gerontechnology Defined

The study of technology and aging is referred to as gerontechnology (or gerontechnology). Jim Fozard (a longtime leader in psychology, human factors, and gerontology) suggests that "gerontechnology provides a systematic way to organize and understand research and education related to technology and aging." A major genesis of this study comes from within the field of human factors and ergonomics. Core concerns of this field include several *microlevel* interactions of individual persons (or their component systems – sensory, perceptual, cognitive, or motor) with specific technological interventions and interfaces that are part of the environment. For example, what screen resolutions and font sizes and types improve readability for the average older user? Which evolutions in graphic user interfaces create excess disability among users?

Gerontechnology also considers *many* macrolevel and social variables studied by various other disciplines. For example, a Spring 2010 special monograph issue of the *Sociology of Health and Illness* considered "how old people, healthcare professionals, and technology designers create, use, and modify science and technology to negotiate and define health and illness." Related questions might include what kinds of useful information can seniors find on the Internet and to what end.

By linking advances from the multidisciplinary study of gerontology with work in rehabilitation engineering, architectural design, human factors and ergonomics, and the

computer and telecommunications fields, there is currently a significant increase in the number and nature of successful interactions of aging humans with technology at the micro-, mesa-, and macrolevels. These interactions have begun to positively influence health, well-being, and life-satisfaction, and show promise to reduce costs associated with traditional delivery of long-term care.

Technologies are variously defined as 'tools' or 'artifacts,' which when properly designed and utilized, simplify daily living, enhance efficiencies, extend capacities, or lengthen life span. A culturally based sociohistorical understanding of technology considers how they are embedded in complex social and labor systems (e.g., in the provision of care, including self-care). Technologies are classified in several ways; for example, as high, medium, and low (e.g., embedded nanochips, broadband, POTS – plain old telephone service), or as hard versus soft (as in hardware or software). Technologies may have a positive impact on seniors, but negative impacts are as likely when technologies are poorly designed, if instruction/training is flawed, or if maintenance and adaptability are absent. What has emerged in recent years is a clear priority to promote positive outcomes. The current notion of 'aging-in-place' as an effective strategy of successful aging is well served by a growing array of technological innovations.

Selecting appropriate technologies of any kind involves important decisions regarding cost, usability, dependability, and consequences of product failure, safety, and adaptability to changing user needs. The common failure of technologies to produce improvements in the lives of elders is of great concern to gerontechnologists. In fact, numerous examples from distant and recent past show less than optimal attention to seniors' needs, wants, and capacities. In a 2000 Congressional Briefing on technology and aging sponsored by the American Psychological Society, Wendy Rogers reported that users of a commonly owned blood sugar testing kit made clinically significant errors more than 60% of the time.

At the microlevel, Rogers and associates (Czaja, Charness, Fisk, Mayhorn, and others) from the multicampus CREATE Centers (Center for Research and Education on Aging and Technology Enhancement) have conducted careful task analyses of many household technologies used by older adults and repeatedly found that failure of proper use results from either poor design, poor instructions, or a combination of both. Research at CREATE, Gerontech-The Israeli Center for Assistive Technology and Aging, SENTHA at the Technical University of Berlin, Age Place at MIT, and others, provides examples of best-practice for sustaining and accelerating groundbreaking applied research in technology and aging.

At the macrolevel, Lesnoff-Caravaglia and others have considered moral and ethical issues involved in the overuse of technology that may have negative consequences for individuals, societies, and planet Earth. Questions arise such as:

- How can we make the appropriate choice to forgo implantation of a cardiac pacemaker in an 85 years old and avoid the decade-long 'living nightmare' described in a recent *New York Times Magazine* article?
- When is the sacrifice of privacy worth the benefits of having one's house wired for remote behavioral monitoring systems? How can we insure that use of such technology does

not limit social contacts with family caregivers and providers?

- How is our overdependence on technology making it more difficult to adjust emotionally to 'normal' aging and to understand and accept the immutable fact of limited mortality?

The Time for Gerontechnology Has Arrived

The concept of gerontechnology has been discussed for about 30 years. Twenty-five years ago, the US GAO's now defunct Office of Technology Assessment published *Technology and Aging in America*, which delimited the issues quite effectively. In the ensuing quarter century, there has been slow but measurable progress. So, why now, is there a dramatic acceleration of interest and innovation in technology and aging? Why are products reaching the market as researchers, practitioners, designers, and marketers display previously unseen purposefulness in linking human aging to technological innovation? The most obvious answer is market forces related to the aging of the baby-boomers in first world countries. Seventy million strong in the United States alone, they have commanded our attention throughout their lives. Several other factors contribute to this reality:

- Research on aging has matured from early descriptive studies that were oversimplistic and pessimistic to prescriptive interventions and translational studies.
- The 'successful aging' paradigm has shifted attention from a focus on age-deficits to one of empowerment, enrichment, activity, and life satisfaction. Applied research has indicated that many capacities are amenable to intervention aimed at restoring function or slowing decline. Translational research has brought findings from lab to home and communities and provided new tools and applications for safety, well-being, and life satisfaction. Translational research has been stimulated by the US National Institute on Aging (NIA) through funding of 13 Edward R. Roybal Centers for Translational Research in the Behavioral and Social Sciences of Aging.
- The 'perfect storm' of population aging coupled with declining availability of caregivers has created a sense of urgency with respect to long-term care.
- Aging and technological advance are no longer viewed as independent, unrelated, or incompatible. There is a new optimism, previously unseen, that technology can be useful for a broad variety of older adults.
- Efforts to close the 'digital divide' such as AARP's 'Older, Wiser, Wired,' 'SeniorNet' and others have brought older adults into the twenty-first century and they now use the internet at rates comparable to other age groups.
- A belief in the power of interdisciplinary approaches has gained favor in academe, making gerontology and gerontechnology more valued and productive. Improved collaboration has emerged among basic researchers, product development, and marketing enterprises.
- University gerontechnology courses are becoming more common; recently Lorenzen-Huber and associates at Indiana University reported on an innovative course bringing

together faculty and students from multiple disciplines in a course entitled Health, Technology and Aging, which combined entrepreneurship, gerontechnology, and informatics. At CalState-Fullerton Echo Chang teaches a new interdisciplinary course to promote design and use of assistive technology by elders.

- Entrepreneurs, venture capitalists, and large corporations are joining the endeavor. While this began in the late 1990s, the 'com bust' of 1999 had slowed the progress. For example, in August 2010, GE Healthcare and Intel Corp. announced a joint venture to combine, enhance, and market their respective home health and independent living applications (Intel Health Guide, Intel Reader, and GE's QuietCare[®] products).

The Technology and Aging Imperative

Technology has been widely touted as a quick fix for the anticipated escalating costs associated with aging boomers. Effectively and efficiently deployed technologies may cut cost and reduce the burden of care. Recent examples of this enthusiasm include the December 2005 US White House Conference on Aging and the Obama Administration's support for enhanced use of electronic medical records. Similar efforts are underway in Europe, Asia, Australia, and elsewhere to optimize the use of information and assistive technologies to provide care for older adults. Indeed, technology is the centerpiece of many 'key systems change' initiatives for 'aging in place' currently promoted by the US Administration on Aging. Recently, the US Department of Health and Human Services funded the National Opinion Research Center at the University of Chicago, and the American Association of Homes and Services for the Aging (specifically its Center for Aging Services Technology (CAST) and Institute for the Future of Aging Services) to encourage technology development and adaptation.

Theoretical Contexts for Technology and Aging

The current proliferation of new technologies for older adults partly results from careful study in the lab and user-centered design. Unfortunately, this is not always true. Appropriate theoretical underpinnings can insure that gerontechnological innovations are more positive than negative, more useful than harmful. These theories provide a conceptual framework and significant heuristic value to guide careful research and perhaps encourage additional innovative uses of technologies for and by older adults.

All of the following are relevant and useful, some will be briefly describe here:

- Sociology's Modernization and Aging Theory (Cowgill & Holmes)
- Psychology's Field Theory (Lewin), and its extension to aging in Lawton and Nahimow's Ecological or Press-Competence Theory
- The Information Processing Paradigm's contributions to the understanding of sensory, perceptual, and cognitive processing

- Positive Psychology (Seligman, Csikszentmihalyi, and others) and Mindfulness & Conscious Aging (Ram Dass)
- Successful Aging (Rowe & Kahn, and others)

Modernization and Aging: Is Technology Good or Bad for Older Adults?

Modernization and aging theory, developed by Cowgill and Holmes in 1972, proposed that technological innovation during the industrial age caused older adults in western nations to experience dramatic losses in social status and income. Presumed mechanisms included increased competition for scarce jobs coupled with excess profits leading to mandatory retirement and social security, and consequential reduced income and marginalized status. Moreover, limited opportunities for retraining/retooling coupled with rapid technological innovations left mature adults with obsolete skills and an inability to compete in a changing work environment. Thus, the theory proposed that complex interactive mechanisms operating on major social institutions stripped elders of status and control, left them behind in deteriorating neighborhoods, with less material resources, obsolete skills and knowledge, and the anomie of a forced retirement from a meaningful job and into an undefined role of 'retired.'

Here we must ask, 'Why would we expect anything different now?' The answer is probably rooted in the acceptance of the 'successful aging' paradigm and concerns over the perils of population aging brought on by the aging baby-boom. Technological development during the industrial age was not intended to do harm to older adults. Today, they are increasingly intended to provide assistance and improve quality of life. A purposefulness to use technologies to improve the lives of elders is gaining momentum, and is readily apparent in research labs, Wall Street, and Madison Avenue. By understanding the harmful mechanisms during the industrial age, we can perhaps avoid such mistakes now and in the future.

Heidrun Mollenkopf of the German Centre for Research on Aging at the University of Heidelberg has been a leading scholar in this area. Doug McConatha's 'Theory of E-quality,' which systematically discusses the Internet's modern variants of the industrial age's institutions, shows how technologies can be used to assist the aged and transform the same institutions which previously had harmed elders. For example, accessible distributed education delivered via the internet is helping to make our educational system less child/youth-centered and to encourage lifelong learning.

Successful Aging Theories

Neither the psychological sciences, gerontology nor the other scholarly disciplines were unaffected by the pessimistic view of aging exacerbated by industrialization. Research as recently as the 1980s focused primarily on cataloguing age-related decline. Thankfully, and with important ramifications for gerontechnology, these disciplines have recently developed a more balanced view, and shifted focus to promoting healthy, successful aging.

Now a growing body of research and theory on aging from multiple perspectives (biological, psychological, and social) provides a more balanced view of aging. For example, research

in geropsychology discusses hold versus no-hold capacities in cognitive functioning (see below). Sociological theory is more optimistic (e.g., activity and reinvestment theories have replaced disengagement), and recent biological research on exercise, nutrition, and telomeres, for example, holds promise for slowing or reversing the aging process and compressing morbidity.

Successful aging is defined differently across the disciplines. Rowe and Kahn emphasized health, strength, and vitality. Successful aging depends on a wide variety of biopsychosocial processes, capacities, and opportunities. Rowe has noted that optimism is perhaps the most important variable. Fisher and Specht note the importance of social interactions and maintaining a sense of purpose, autonomy, and well-being. Paul and Margret Baltes described the need for selection, optimization, and compensation (SOC) as individuals adjust to aging and disease. Their notions are the foundation for Wong's approach (2000), which involves balanced adjustment to the natural decline of aging. SOC provides a very useful roadmap for applying technology to aging.

Field Theory and Ecological Theory

In the 1930s, Lewin proposed that understanding behavior means we must consider the characteristics of the person and their environment; behavior results from the interaction of the two ($B = f(P, E)$). In the 1950s, Reigel and others noted how complex, interdependent, and dialectic are the influences on human behavior and the formula was expanded to ($B = f(P, E, P \times E)$). This expanded model has significant heuristic value for gerontechnology. For example, technology can be added to the model as an intervening variable, viewed as part of the environment, or used to predict technology's impact.

Lawton and Nahimow's Ecological Theory of Aging extends field theory to gerontology and fills in several important details. By considering basic human *Competence* along a continuum, intersecting with basic environmental demands (known as *Press*) also on a continuum, the model helps to predict the outcomes of $P \times E$ transactions. Working on the microlevel, it brings us closer to understanding the core of gerontechnology: How can/should we design and provide technologies to enhance the lives of older adults?

Undesirable outcomes (*negative affect and maladaptive behavior*) occur whenever competence and press are significantly mismatched, when either greatly exceeds the other. Positive and desirable outcomes are obtained when press and competence are equivalent. Specifically, *maximum comfort* is likely when competence is marginally greater than environmental press; *maximum performance potential* is achieved when Press is marginally above Competence. Setting demands slightly above an individual's capabilities often yields improved competence or performance.

This Ecological Model did not explicitly consider the role of technology in aging; nevertheless, it has numerous implications. New or adapted technologies can stimulate and enrich older adults' lives and encourage them to stay active and involved. Innovations can also compensate for various age or illness-related incapacities. With declines, demands from the environment must be reduced to avoid precipitating negative affect or maladaptive behavior. However, we should also not

use technologies excessively and reduce stress too much, or negative outcomes such as laziness and 'excess disabilities' beyond that caused by aging or illness may result. In sum, the model encourages careful addition of AT-EI (assistive technology and environmental interventions) to seniors' lives to optimize the likelihood of positive outcomes.

Adding secular change to the ecological model

Fozard adds an important technology-related dimension to Lawton's model by discussing secular change, noting that cohorts experience technology somewhat differently, based primarily upon their age when each technology was introduced. Cohort rather than age may be a better predictor of affinity toward and comfort with specific technologies. Consequently, technology innovators must consider alterations to appropriate design, based upon the aging of successive cohorts.

The Human Information Processing Model and a Brief Review of Age-Related Changes

The Information Processing Model of cognitive processing developed during the 1960s through the 1980s led to significantly improved understanding of how humans acquire, interpret, and respond to environmental stimuli. Using this model, researchers conducted systematic task analysis of the sequential processes of sensation, perception, and cognition, and related areas of attention and depth of processing. Coupling parallel work in human factors engineering and ergonomics better allows innovators to match a variety of new technologies to the needs of elders. Knowledge of which human capacities decline, which hold up, and which are amenable to restoration or rehabilitation, helps gerontechnologists to assist with the selection, optimization, and compensation that Paul and Margaret Baltes proposed.

Age changes in information processing are predictable and often unavoidable. While there are some improvements (i.e., semantic memory), most changes involve eventual decline. Depending on the specific process and deficit, technological and/or environmental intervention can help slow, reverse, mitigate, or compensate. Some more common or problematic changes in sensory, perceptual, and cognitive function and their implication for the design of various technologies are briefly outlined below.

Sensation and Perception

Vision

Several changes in visual sensation and perception occur with normal aging (e.g., presbyopia & reduced UFOV (useful field of view)) and/or various age-related disease processes (e.g., cataracts, macular degeneration, diabetic retinopathy, and glaucoma). For example:

- *UFOV declines:* There are age-related decrements in information processing speed and efficiency. While normal peripheral vision spans up to 180° for simple stimulus detection, the ability to discriminate accurately among stimuli occurs in a much narrower field, referred to as the UFOV. UFOV decreases dramatically with age and this is exacerbated by situations requiring speeded performance

and divided attention. Age-related reductions in UFOV are believed to be responsible for a significant percentage of at-fault accidents involving older drivers. Recent evidence indicates that that UFOV may be restored and widened through training. Collision avoidance features and other technologies in new automobiles can also reduce accidents by compensating for age-related decrements.

- *Yellowing and hardening of crystalline lens:* Yellowing makes color discrimination less accurate particularly for short wavelength colors (e.g., violet, blue, and green). Hardening leaves the lens progressively less able to accommodate or change shape so to focus in a continuous range from proximal to distal objects (a condition called presbyopia). Web sites, computer programs, signage, and other visual displays should avoid requiring discrimination among these colors, provide high contrast between figure and ground, and allow user adjustment of fonts and text sizes. Careful prescribing of eyeglasses, contact lenses, or lens implants (in the case of cataract surgery) should consider the interaction of age, lens, distance to and resolution of computer, PDA, or in-vehicle informatics displays.
- *Susceptibility to glare and visual blur increase with age:* These changes have several implications for design of visual displays, signage, etc. Displays with dark background and light text are sometimes preferable.
- *Light and dark adaptation take significantly longer, are less complete with age:* The same scene appears darker to an older person compared to someone younger. Brighter ambient lighting, passage markings, and task lighting in homes, theatres, and restaurants should be provided. Screens on electronic devices such as cell phones that are carried into environments with dynamic changing ambient lighting should automatically adjust screen brightness to compensate for such changes but also allow user adjustments.

Leading advocates for the application of the above knowledge to technologies and environments for the aged include Steun and others at Lighthouse International, research sponsored by the SPRY Foundation, and conducted by Ball, Kline, Scheiber, Scialfa, Rebok, and others.

Computer hardware (screen size, resolution, brightness, contrast) and software allow users to tailor the screen display to their specific needs and preferences. Successive generations of MS Windows, MS Office, and other products, as well as the programs of several other vendors, have provided accessibility features and improved user options. MS Windows, for example, provides a variety of accessibility options and setup wizards for modifying screen characteristics, and input device function (keyboard, mouse, etc.), to meet individual needs. MS Office products include a lengthy tutorial on accessibility features.

Unfortunately, work in this area is incomplete and users sometimes encounter unanticipated barriers when various programs and program settings are incompatible. Legislation in the United States and elsewhere, such as the Twenty-first Century Communications and Video Accessibility Act of 2010 (S. 3304) passed by the US Senate on 5 August 2010 is being used to set appropriate standards for telecommunications and computer devices and signals/web sites to allow easier access to individuals with sensory/perceptual disabilities.

Changes in audition

Changes in auditory function can profoundly affect older adults' interaction with their environments and technological devices. Presbycusis, age-related diminished ability to discriminate among high-frequency sounds (e.g., consonants in the spoken language), is the most common age-related hearing loss, and it makes it difficult for seniors to comprehend speech, particularly when low sound intensities are coupled with noisy environments. Technologies that utilize auditory signals, or that transmit spoken information must be cognizant of this fact and be designed accordingly.

The signal quality provided by cell phones – dependent on transmitted signal quality, bandwidth, speaker, and microphone design – is often problematic for older users, particularly in noisy environments. Additionally, many cell phones are not compatible with hearing aids. The US Federal Communication Commission mandated that at least one-half of each manufacturer's digital wireless phones be hearing aid compatible (HAC) by February 2008.

Changes in other senses

Age-related changes in gustatory, olfactory, somesthetic (comprised of sensitivity to touch, pressure, cold, heat, and pain), vestibular, and kinesthetic senses have all been noted in the literature. As with vision and audition, 'normal' change can be accelerated by, or secondary to, various disease processes. In fact, health status and other variables often exert a greater impact than age alone. Some issues related to technology and environmental designs include:

- Weakened musculature and compromised vestibular and kinesthetic sensitivity (often coupled with the visual system problems noted above) dramatically increases the likelihood of falls among the very old and/or disabled. Issues with balance, posture, and gait are also involved. Successful environmental design helps to compensate – for example by providing adequate lighting, minimizing stairs, uneven surfaces, or deep pile/padded carpets, and providing handrails and clear visual cues for grade changes and edges. Various technologies have been utilized recently in the assessment and prevention of falls. PERS (personal emergency response systems) such as Lifeline Systems®, have been developed over the last 20 years to call for assistance when falls occur.
- Age-related decrements in sensitivity to heat and cold make the aged more susceptible to hypothermia and hyperthermia (heat stroke). Implications for design are clear with respect to appropriate signaling and thermostatic control devices.

Cognition

Cognition includes processes such as learning, memory, intelligence, attention, creativity, and wisdom. (These topics are covered in detail in several other articles in this Encyclopedia.) Age-related cognitive decline is not universal; for example, while crystallized intelligence is maintained into old age (absent disease processes), fluid abilities show general declines. Longitudinal research demonstrates that age-related declines occur later and are less severe than had been found in cross-sectional studies; many skills hold up quite well in the absence of chronic illness. Significant inter- and intra-individual

differences mean that the design of environments and technological interventions aimed at improving status or function of elders should accommodate variability and change.

Mayhorn and colleagues provide an excellent review of cognitive functions with implications for technological innovations (in Burdick and Kwon, 2004). They note that the promise of innovative technology will be unmet unless designers and manufacturers apply user-centered approaches, focusing on needs, capabilities, and limitations of the potential older users. Some important findings and issues include:

- Working memory and some spatial abilities decline with age and are exacerbated as task complexity increases and divided attention is required. For example, long or complex telephone menu systems put older adults at a disadvantage. Declines in spatial abilities including the ability to mentally manipulate objects may reduce older adults' ability to efficiently navigate complex web sites or utilize informatics and GPS displays in automobiles.
- The long-term memory storage of factual information and vocabulary (semantic memory), storage of familiar images (iconic memory), and storage of well-rehearsed procedural memory are maintained in healthy elders. Mayhorn and others note that gerontechnologies should capitalize on these common strengths.
- Other cognitive processes either hold or decline with advanced age, depending on specific task demands. Remembering to do something at a specific time tends to decline, but remembering specific events does not. Performance of time-based tasks can be improved by connecting to an event (or environmental cue).

Gerontechnology: Survey of Active Domains

This section provides diverse examples of currently active domains where technology and aging intersect with increasingly positive outcomes for older adults, their families, providers, and society. The section is organized using a helpful taxonomy developed by van Bronswijk, Bouma, and Fozard in 2002. They note that technologies have five general domains of influence: (1) health & self-esteem, (2) housing & daily living, (3) mobility & transport, (4) communication & governance, and (5) work & leisure. Further, they suggest the following types of impact: (a) prevention or delay of decline, (b) compensation for age-related loss of function, (c) care support and organization, and (d) enhancement and satisfaction with respect to quality of life. These impacts are indicated in parentheses after examples.

1. Health and Self-Esteem

- Improving Quality of Health Care Delivery
 - Health Information Technology (HIT), Telemedicine, Telehomecare, and Telecaregiving are all rather new terms, demonstrating how technology is transforming medical care away from hospitals and into communities. Because older adults have more chronic conditions, their management in home settings with the help of technology is a promising and flourishing new paradigm.
 - Telemedicine practice is expanding rapidly, allowing providers to monitor patients in their homes on a

wide variety of parameters, including body temperature, heart rate and blood pressure, blood oxygen levels, etc. PDAs, Smart-Phones, and other handheld devices are being repurposed as medication reminders and health/wellness coaches.

- Intel Health Guide is a touch-screen home monitoring device that links patients to caregivers. Patients regularly measure such vital signs as blood pressure, pulse, and weight, and respond to questions specific to their condition. Videoconferencing allows clinicians to further assess patients for signs and symptoms of illness.
- Recently, an informatics for consumer health (ICH) online portal and companion LinkedIn Group was developed by the US National Cancer Institute in a combined effort of seven federal agency partners (AHRQ, CDC, NIST, NLM, NSF, ONC, & NCI) to foster collaborations in behavioral research leading to evidence-based products that support increased health behavior among consumers.
- Well-Informed Consumers
 - *Health information* is increasingly available on the internet, helping older adults and caregivers (formal and informal) to become informed consumers, to communicate with providers, and to practice wellness and health promotion activities. The SPRY (Setting Priorities for Retirement Years) Foundation has sponsored research, conferences, and training on improving web design. They also promote health literacy projects so that consumers can assess the quality of online information. MedlinePlus, an online resource from the US National Institutes of Health provides information targeted at both professionals and the lay public on several health topics and conditions. Older adults are frequent users of this resource. Another US government web site, NIHSeniorHealth.gov is designed specifically for older adults. (Prevention or delay of decline; compensation for age-related loss of function, care support & organization, and enhancement/satisfaction & quality of life.)
 - Several other government web sites have become the gold standard for accessibility, comprehensiveness, and usefulness, with information for older adults and their caregivers. Examples include the US Administration on Aging's Eldercare Locator, First Gov for Seniors, information promoting healthy lifestyles, etc. (Prevention or delay of decline; Compensation, Care support & organization, and Enhancement/satisfaction & quality of life.)
- Encouraging Healthy Lifestyles
 - Cognitive abilities are exercised, stimulated, and perhaps improved by technology-driven enriched environments. In Japan, elders purchased over 3 million Nintendo Brain Training for Adults® games in its first year of sales. In the United States, the Practical Memory Institute's Memory Works® is designed to have a similar impact. Posit Science has created brain-training software resulting from translational research conducted at the leading research centers on neurosciences on aging. Recently McLaughlin and Allaire at

North Carolina State University and others received \$1.2 million from the US National Science Foundation to study whether playing video games may slow age-related cognitive decline. The Robert Wood Johnson Foundation in 2010 also pledged \$8.5 million to study the impact of video games on driving skills, Alzheimer's, and other age-related issues. Definitive evidence-based practice in these interventions is emerging, but additional research is needed. (Prevention, delay, or restoration; enhancement/satisfaction & quality of life.)

- Nintendo's Wii Sport has become a surprise hit with older adults in the United States and elsewhere. Several long-term care facilities and municipal senior centers have purchased Wii, including all of the Erikson Retirement Communities. The National Senior League organizes national Wii Golf and Wii Bowling Tournaments, recently featured on various media outlets. While not providing the same benefits as actually bowling and golfing, they promote social engagement, stretching, and hand-eye coordination. Scientific studies on effectiveness are preliminary; a recent study published in the *British Journal of Medicine* indicates that participation reduces subsyndromal depression.
 - *Enhancing self-esteem and promoting social engagement.* Examples above provide older adults with opportunities for greater self-esteem, self-efficacy, and choice in how and where they receive care. Technology also can enhance self-esteem in a variety of other ways. For example:
 - The Elder Wisdom Circle involves older volunteers from around the United States, including some nursing home residents, providing internet-based advice, often to younger people.
 - Older adults in Pittsburgh suburbs have assisted inner-city children with writing and math via computer networking applications.
 - Older adults are catching up with the young in the use of social networking sites such as the Facebook. Technologies such as Skype help them stay in touch with children and grandchildren when visits are not possible in-person. (Enhancement/satisfaction & quality of life.)
2. Housing and Daily Living
- Aging in Place is a growing paradigm, which coupled with new approaches to community/home-based health care is transforming house, home, and health care. Related concepts include Universal Design, Senior Friendly Design, and Smart House. Centers leading this work include the Center for Universal Design at North Carolina State University, SENTHA at the Technical University of Berlin, the CREATE Centers, SmartHome at Indiana University, Technology Centre at British Columbia Institute of Technology among others. The MetLife Mature Market Institute recently published an excellent report on aging in place. (Compensation, care support, & organization; enhancement/satisfaction & quality of life.)
 - Technologies designed to help individuals age in place include Personal Emergency Response Systems (such as Lifeline®), and automated behavioral monitoring

(ABM) systems such as GE's Quiet Care[®]. Quiet Care[®] utilizes infrared and mechanical motion sensors placed throughout an older adult's residence. (These are also known as lifestyle monitoring or remote personal monitoring systems.) By tracking behaviors, sending data to a base station, and analyzing activities and trends, the system alerts caregivers to potential problems. For example, deviation of normal meal preparation or sleep patterns may alert caregivers to check in and take appropriate action. (Compensation, care support, & organization; enhancement/satisfaction & quality of life.)

- Anti-wandering devices help keep dementia patients safe without restraining them or locking down an entire facility. GPS positioning devices can help locate others should they wander or get lost. (Compensation for age-related loss of function, care support and organization, and enhancement/satisfaction & quality of life.)
 - Assistive technology and environmental interventions (AT-EI) include a range of products, services, devices, home modifications, and so on, which for many years have been a mainstay of the fields of rehabilitation and occupational therapy. As these fields turn greater attention to the needs of frail older adults, there are additional positive outcomes. (Compensation, care support & organization, and enhancement/satisfaction & quality of life.)
3. Mobility and Transport
- At the University of South Dakota, Schieber and associates have noted that older drivers need significantly more time to reestablish situational awareness of road conditions after distractions by even short text messages provided by their vehicle. 'Texting' with hand-held devices is perhaps more perilous, yet according to recent reports, 80% of adults are 'texted' while driving. Cars of the future will need to better adapt to changing capacities of older drivers; in particular by drawing and focusing attention to (rather than away) from key road situations and conditions.
 - At the University of Calgary, Scialfa and associates are working on understanding the characteristics of on-board informatics systems (to assist with way finding, etc.) which are safest and most useful for older drivers (Compensation).
 - General Motors is developing an 'Augmented Reality Windshield,' the next generation of heads-up displays currently appearing in high-end automobiles. The expected availability date is around 2018 and the display will help to outline the road, alert drivers to objects in the road, and otherwise draw attention to important features of the road environment (MIT Technology Review, March 17, 2010) (Compensation.)
 - At Johns Hopkins University, Rebok and associates are combining simulator technology adapted from NASA and pilot training with neuroimaging technology (fMRIs) in order to develop a better understanding of age-related driver behavior. This work may result in effective means of deciding which older persons should cease driving and to train effective driver skills (Prevention, Compensation).
 - MIT's Age Lab, in collaboration with UMass-Boston, and the University of New England's Transportation Center are investigating claims by a wide variety of new 'Brain Fitness' software programs to reduce accident risk by older drivers; for example, through improved functional field of view. To date, most lab-based indications of success have not been replicated in real-world settings.
 - PositScience has made several evidence-based cognitive training products available, including one on improving driving skills (Compensation).
 - The US Department of Transportation has funded diverse research designed to adapt transportation to the needs of a maturing society, including how to make mass transit more user friendly. At the University of Akron, Ronnie and Harvey Sterns have studied ways to improve usability for bus and train timetables. (Compensation, enhancement/satisfaction, & quality of life.)
4. Communication and Governance
- Research leading to senior-friendly cell phones and other communication devices is being conducted in partnership with industry by Bill Mann and colleagues at the University of Florida Rehabilitation Engineering Research Center on technology for successful aging. New easier to use cell-phones that are also hearing aid compatible are available (e.g., Jitterbug[®] and others). (Compensation, enhancement/satisfaction, & quality of life.)
 - Modern hearing aids are significantly better than those of the previous generations. Instructions and training help users to adjust and reduces rejection rate. (Compensation, enhancement/satisfaction, & quality of life.)
 - Social networking sites such as Caregivers on Call and caregiver stress provide specific avenues of communication to support caregivers of the frail elderly, who are often spouses, offspring, or siblings. (Care support and organization.)
 - Connected Living[®], launched in 2009 provides easy interfaces and training to help connect older adults with each other and with their families. (Care support and organization.)
5. Work and Leisure
- Workplace accommodations and telecommuting: Progressive employers that recognize the value of older workers develop employment practices, retraining opportunities, and flexible benefits packages that meet the needs of this population. The Institute for Community Involvement at the National Center on Workforce and Disability at UMass-Boston has studied specific needs of older workers.
 - At the University of Miami CREATE center, Sara Czaja and associates are conducting comprehensive studies on telework and telecommuting. Utilizing the knowledge base regarding information processing, perceptions, and attitudes toward telecommuting, etc., the research is identifying barriers and producing training programs for telecommuting. (Enhancement/satisfaction & quality of life, prevention, or delay of decline; compensation.)
 - There is a wide and growing variety of local and national Online Learning Communities for older adults throughout the world (e.g., SeniorNet). (Enhancement/satisfaction & quality of life.)

- The AARP produces a monthly e-mailed Computers and Technology Newsletter. AARP also has an online web site for seniors on Social-Media. (Enhancement/satisfaction & quality of life.)
- Older adults seeking online intellectual stimulation can connect to Technology, Education, Design (TED) and listen to hundreds of lectures and performances on TedTalks.

Age related disabilities often reduce older adults' ability to participate actively in the labor force and in the myriad of leisure activities available in their earlier years. Technologies help older adults to stay engaged in a variety of ways.

Organizational Catalysts for Gerontechnology

Previous sections have demonstrated that gerontechnology research, design, and implementation are occurring at an accelerating pace and growing number of venues. This section briefly lists national and international professional organizations that have stimulated development in this field.

The Human Factors and Ergonomics Society has been a key player in the early development of gerontechnology. After initial emphasis on military applications, HFES gradually developed various technical interest groups (TIGs) in the 1970s and 1980s. The interest group on aging is currently quite active.

The Gerontological Society of America's Formal Interest Group on Technology and Aging was founded by Gari Lesnoff-Caravaglia in 1987. Today the group has over 100 active members, sponsors a listserv and several sessions at GSA's annual scientific meetings. GSA's Formal Interest Group on Physical Environments and Aging (PEA) and on assisted living often discuss technological issues.

The International Society for Gerontechnology, founded in 1997, publishes the scholarly journal *Gerontechnology* and has held several international conferences on gerontechnology.

The American Society on Aging's Network on Environments, Services, and Technology publishes a quarterly newsletter and has a growing presence in the field. Aging Today, the monthly newsletter of ASA regularly has gerontechnology articles. ASA's scholarly journal *Generations* has focused on gerontechnology several times in the last decade.

Division 20 (Adult Development and Aging) of the American Psychological Association has demonstrated significant interest in technology issues. (Three prominent gerontechnologists – Neil Charness, Jim Fozard, & Harvey Stearns have all served as presidents of the division.)

The Association for Gerontology in Higher Education (AGHE) has in recent years published a Brief Bibliography on Technology and Aging, a cover story in the AGHExchange on the importance of teaching gerontechnology in diverse courses on aging, and the results of a survey of gerontological educators on their coverage of gerontechnology issues across the curriculum.

The Center for Aging Services Technology (CAST), founded in 2003, has become a leading player in the effort to develop and deploy innovative technologies for older adults, particularly in long-term care. It now has over 400 members representing technology companies, government, universities, and service organizations.

Finally, large corporations such as 3-Com, Cisco Systems, Compaq, Honeywell, Intel, Microsoft, and Sony have become involved. Microsoft's Aging and Accessible Technology web site provides an excellent summary of the many ways that computers, assistive devices, and environmental modifications are improving the lives of older adults, enhancing the provision of services and health care, and reducing costs associated with population aging.

Summary

After years of preparation, speculation, theory building and basic research, gerontechnology has rapidly moved into a translational research and application phase, as university-based interdisciplinary research labs, large corporations and small start-up companies have developed and marketed technologies designed to enrich the lives of older adults. These efforts have been promoted through the efforts of a variety of professional organizations and societies. Gerontechnology is improving health and self-esteem, housing and daily living, mobility and transport, communication and governance, and work and leisure opportunities for older adults. Much research is still needed to test the effectiveness of various innovations and to develop a clear indication of the best evidence-based practices. Many developments are still needed to optimize gerontechnology's potential benefits.

For example, the promise of Health Information Technology will only be realized with an enormous expenditure of funds, adaptation of standardized systems, and training of primary care physicians and their staffs, and when questions of confidentiality of patient records are adequately addressed. Second, the wide and growing array of assistive technology and environmental interventions can be overwhelming and expensive to consumers. Efforts to integrate stand-alone AT-EI systems, robotics, telemedicine, and telehomecare are needed to simplify the systems and enhance their usability. Franchimon & Brink, and others have suggested the combination of these systems as add-on modules controlled by a single ICT (Information and Computer Technology) smart-network. Developments such as this and others will dramatically transform gerontechnology over the next half-century.

See also: Aging and Cognition; Aging and the Brain; Alzheimer's Disease; Environmental Psychology; Grandparenthood; Human Factors/Ergonomics; Memory; Neuroimaging of Dementia; Positive Psychology; Retirement; Visual Perception.

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- <http://www.jointnet.org.il/gerontech/> – GeronTech: The Israeli Center for Assistive Technology and Aging.
- <http://healthit.hhs.gov/portal/server.pt> – Health Information Technology for the Future of Health and Care. US Department of Health and Human Services.
- <http://www.gerontechnology.info/> – International Society for Gerontechnology. Also maintains 'Gerontechnology: ISG' at www.linkedin.com.
- <http://www.nlm.nih.gov/medlineplus/> – Medline Plus. National Institutes of Health, National Institute on Aging.
- www.microsoft.com/enable/ – Microsoft Accessibility. Microsoft Corporation.
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- www.positscience.com/ – Posit Science.
- www.resna.org/ – Rehabilitation Engineering and Assistive Technology Society of North America.

Gestalt Psychology and the Development of Perceptual Organization

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Glossary

Common region principle Elements are grouped if they are located in the same enclosed region.

Connectedness principle Elements are grouped if they are physically connected.

Gestalt principles of perceptual organization Principles by which small elements come to be grouped into larger perceptual units or wholes.

Good continuation principle Aligned elements are grouped to form perceptual units.

Novelty preference Established preference that infants display for novel over familiar stimulation, with some exceptions (e.g., preference for mother over stranger in the social domain).

Proximity principle Elements that are close together in physical space are grouped to form perceptual units.

Similarity principle Elements that are similar in one or more physical characteristics (e.g., lightness, color, form, size) are grouped to form perceptual units.

Grouping is considered to be a fundamental perceptual ability because it helps to establish coherence in complex visual scenes. It plays a critical role in generating the representations that form the basic processing units in the visual cognition system of adults. It also serves a cognitive simplification function in terms of reducing the number of things that need one's attention. For those wishing to understand the ontogenesis of this ability, the major issue is how during development human observers come to know which elements of a visual scene should be grouped together to form which objects.

Traditional Views on the Development of Perceptual Organization

As described by Donald Hebb in 1949, the perception of a whole object is founded in the perception of the individual features of the object and their integration. In other words, reality is constructed in the same way that homebuilders erect houses, piece by piece. Eye movements are used to generate an internal representation of a visual pattern. By the Hebb view, the emergence of perceptual organization takes considerable developmental time and is dependent on the progression of eye movements that yield more holistic perceptions as visual scanning becomes more systematic with experience. In contrast to Hebb, the original Gestaltists of the 1920s, such as Wolfgang Kohler, Kurt Koffka, and Max Wertheimer, adopted a nativist stance, contending that perceptual organization is automatic and present even in an initial encounter with a visual pattern. This is so because nervous systems are constrained to follow certain grouping principles that lead to the perception of one organization over other organizations that are equally physically possible.

Initial Empirical Efforts and Their Theoretical Implications

Eye Movement Recording

At the time that the Gestaltists were theorizing about the development of perceptual organization, empirical methodologies

were not yet available to investigate the perceptual abilities of infants. However, such methods did become available in the 1960s and 1970s, and one technique in particular provided some initial data on the debate that had been struck between Hebb and the Gestaltists. Specifically, Philip Salapatek devised photographic records of infant eye movements while infants were engaged in visual scanning of simple outline figures. Salapatek reported that there was a developmental trend that took place over the first months of life in which scanning was initially limited to single features and gradually expanded to include a set of features and eventually the whole pattern. These eye movement data, considered by themselves, are consistent with a Hebbian account of the development of perceptual organization, although one can question how direct a relation there is between fixation and the window of attention that surrounds the fixation point. That is, if attention is distributed broadly about the fixation point, then it is possible that an infant that fixates the lower right corner of an outline of a triangle form is actually processing information across the entire portion of the visual field that encompasses the whole pattern.

Looking Time Studies

Early behavioral investigations of the development of perceptual organization were able to capitalize on the finding that infants prefer to look at novel stimuli. This preference enabled researchers to develop a procedure whereby infants are familiarized with one stimulus and then presented with the familiar stimulus paired with a novel stimulus. A preference for the novel stimulus (that is not attributable to an a priori preference for that stimulus) implies both memory for the familiar stimulus and the ability to discriminate between it and the novel stimulus. In a classic study that followed this general procedure, one that can be viewed as ushering in the period of modern behavioral work on the development of perceptual organization in infants, Philip Kellman and Elizabeth Spelke in 1983 presented 4-month-old infants with a display consisting of a rod partly occluded by a block.

The question was whether infants represented the continuity of the rod behind the block based on the gestalt properties of the visible portions of the rod, including their good continuation and similarity of shape and color. To ask this question, after familiarization with the rod–box display, infants were presented with a complete rod and a broken rod. The rationale is that if infants represented the continuity of the rod (i.e., if they had grouped the bottom and top portions of the rod based on their gestalt qualities), then they would respond to the complete rod as familiar and the broken rod as novel. However, if the rod fragments were not grouped together, then the broken rod should be perceived as familiar and the complete rod as novel. The finding was that the infants looked equally to the complete and broken rod displays, a null result that was difficult to interpret. A follow-up experiment was conducted that was a replication of the initial experiment, except that the cue of common motion was added to the visible portions of the rod. In this instance, the infants preferred the broken rod test display, a result indicating that the complete rod had been perceived as familiar, implying that the infants had grouped together the bottom and top portions of the rod. Further research by Kellman and Spelke confirmed that it was common motion information alone rather than the combination of common motion, good continuation, and similarity that enabled infants to group the rod.

A similar methodology was used to determine that same-aged infants perceived the continuity of two adjacent objects as long as the object surfaces were contiguous and even when the surfaces were dissimilar in size, shape, and textural markings. The results of these studies led Spelke to propose an account of the development of object perception that was, in some sense, a hybrid model incorporating Gestalt notions of innate organizing principles as well as a role for Hebbian learning based on experience with a structured environment. Specifically, Spelke argued that infants at birth are constrained by two *core* organizational principles: common movement and connected surface. Adherence to these principles would essentially parse from a visual scene those surfaces that move together and maintain their coherence as they move and grant them the status of objects. The object ‘blobs’ that are the output resulting from observance in accord with the core principles can then be tracked over real time. This type of experience, according to Spelke, allows infants to discover that objects also exhibit other properties, including proximity of parts, similarity of surface, and good continuation of contour. In this way, what the Gestaltists had taken to be innate organizing principles are, by the Spelke account, learned through their natural correlation with the common motion and connected surface core principles.

A different take on the looking time findings, one that emphasizes biological determinants of development, was advanced by Kellman. This account includes two processes, including a ‘primitive’ edge insensitive process that is presumed to be operational from birth and that utilizes common motion information, and a maturationally determined ‘rich’ edge sensitive process that becomes available later beginning at around 7 months of age and that responds to good continuation information. Thus, according to Kellman, 4-month-olds failed to utilize continuity to organize the static rod–box display,

because infants that age lack the edge-sensitive organizing mechanism that is necessary to utilize continuity.

Progress on the Classic Grouping Principles

While the Kellman and Spelke rod-polygon studies revealed that common motion was a more potent determinant of grouping in infancy relative to similarity and good continuation in a perceptual display in which the different sources of information were pitted against one another, one can ask whether similarity and good continuation might be functional when not in competition with another principle. Moreover, although the principles of similarity and good continuation were not sufficiently strong to provide a basis for grouping when they were the sole sources for organization in the case of partial occlusion with the rod and box display, it is conceivable that the principles could be functional for displays in which all of the elements are completely visible. In addition, the study of infants responding to the rod–box display investigated only one type of similarity (form), thus leaving unresolved the issue of whether infants might be able to utilize other forms of similarity (e.g., lightness, color, size). Furthermore, one other of the classic Gestalt principles, proximity, was not investigated in the rod–box studies, thereby keeping open the question of its functionality.

To understand how young infants utilize classic Gestalt grouping principles for displays consisting of completely visible elements, investigations have been undertaken to examine how infants respond to arrays of elements that could be organized by one or another principle. An advantage to this approach is that a number of studies assessing use of grouping principles by adults have used such displays, thereby allowing for some level of informed comparison between the two age groups.

Lightness Similarity

An initial study investigated whether 3-month-olds utilize lightness similarity to organize visual pattern information. The familiarization stimuli were columns or rows of squares or diamonds that could be organized only on the basis of the lightness versus darkness of the elements, and the test stimuli were vertical versus horizontal bars (Figure 1). The rationale is that if the organization in the column and row arrays is

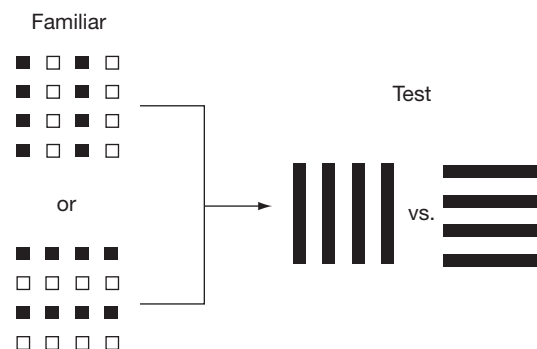


Figure 1 Familiarization and test stimuli used to investigate whether infants can organize visual pattern information in accord with luminance similarity.

apprehended, then infants familiarized with columns should prefer the novel horizontal bars during the test and infants familiarized with rows should prefer the novel vertical bars. The findings provided positive evidence for the use of lightness similarity: infants preferred the orientation of bars that was oppositely organized relative to the array of elements presented during familiarization, and a control group of infants presented with just the test stimuli and not the familiarization stimuli did not show a differential preference between the two orientations. An additional control experiment showed that infants could discriminate between arrays differing in the shape of the filled or unfilled elements (square vs. diamond). This latter finding mitigates explanations of the preference for the novel organization based on immature resolution acuity and indicates that the infants were able to perceive the individual elements of the displays and organize them into larger perceptual units (i.e., columns vs. rows) based on lightness similarity.

Good Continuation

A second classic principle investigated in the same line of studies was that of good continuation. Adapting a methodology that had been used to investigate good continuation grouping by adults, infants as young as 3 months of age were administered the experimental procedure depicted in Figure 2. The displays consisted of a line of distractor circular elements and a target element that was either a square or diamond. Infants were familiarized to one pattern and then tested for discrimination between that pattern and a novel one. In the top panel (a), the target element appeared in line (and thus in good continuation) with the distractor elements, whereas in the bottom panel (b), the target element was off line with the distractor elements. The expectation is that if infants perceive the patterns in accord with good continuation, then the change in the target element should be more difficult to detect when the target element is in a good continuation relation with the distractor elements. In other words, if good continuation is

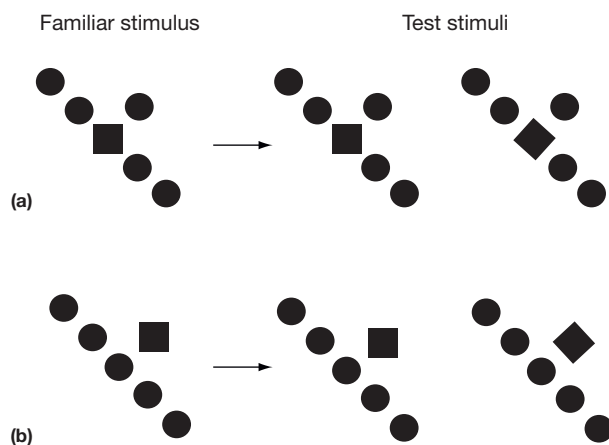


Figure 2 Examples of the familiarization and test stimuli used to investigate whether infants can organize visual pattern information in accord with good continuation. The in-line condition is depicted in panel (a); the off-line condition is shown in panel (b). Experimental design was fully counterbalanced so that for half of the infants in each condition, the target element in the familiar stimulus was a square; for the other half, it was a diamond.

functional, then the target element would be grouped with the distractors, thus making it less likely that a change in its form would be registered. By contrast, in the off-line condition, the target element would not group with the distractors and would retain its status as an independently processed unit of information, thereby increasing the likelihood that a change in its form would be detected. The findings were that infants preferred the novel test stimulus in the off-line condition, but not in the in-line condition. This evidence suggests good continuation as a second organizational principle that is available to young infants for the grouping of visual elements.

Proximity

A third classic grouping principle investigated was that of proximity. Using the same column versus row methodology employed to investigate infant sensitivity to lightness similarity, 3- to 4-month-old infants were presented with arrays of elements that could be organized into columns or rows of elements on the basis of proximity and then tested with horizontal versus vertical bars (Figure 3). Infants preferred the test stimuli with the novel organization, and subsequent control experiments indicated that these preferences could not be attributed to an a priori preference between the test stimuli or to an inability to resolve the elements within the columns and rows. The findings indicate that proximity joins lightness similarity and good continuation as a grouping principle that can be used to organize visual pattern information by young infants.

One may ask at this point in the presentation whether the results of the studies investigating use of lightness similarity, good continuation, and proximity by infants are inconsistent with the findings from the earlier rod-box investigation. The answer is not necessarily, inasmuch as proximity was not studied in the earlier investigation and lightness similarity was the principle at issue in the column-row study, whereas form similarity was the principle examined with the rod-box display. In addition, in the lightness similarity, good continuation, and proximity studies, all of the elements were completely visible, whereas in the rod-box investigation, one object was partly occluded by the other. This last point of comparison is consistent with the possibility that principles such as similarity and good continuation are functional in young infants for displays of completely visible elements, but perhaps not yet operational in cases of partial occlusion. The latter cases are arguably more complex because they not only require infants to connect the

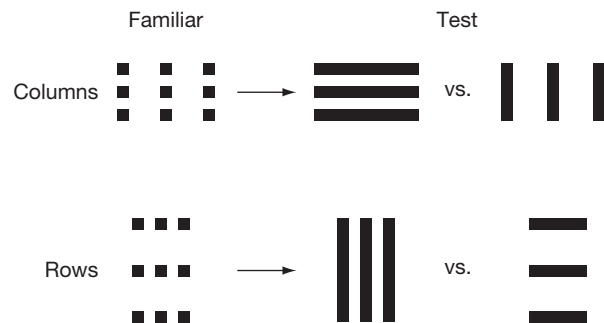


Figure 3 Familiarization and test stimuli used to determine whether infants adhere to proximity when organizing visual patterns.

visible parts of a partially occluded object, but also call upon infants to extract the depth placement of the occluder and the occluding surface. These observations are in turn suggestive of an ontogenetic trajectory in which infants initially deploy organizational principles in simple perceptual contexts and then with development come to utilize them more powerfully and flexibly so that they can be applied to increasingly more intricate perceptual displays of visual pattern information. A similar claim has been made about the ontogenesis of perceptual classification skills, namely, that with development, infants become more skilled at using inherent categorization abilities to represent less well-structured classes of information. A related conclusion has also been reached about how infants develop physical reasoning skills that are initially applied simply and narrowly, but become more sophisticated and more broadly utilized with development.

Progress on New Grouping Principles

While the classic grouping principles have been known to psychologists since the 1920s, the grouping principles that will be examined in this section, uniform connectedness and common region, were introduced by Stephen Palmer and Irvin Rock in the 1990s. Although there have been a number of investigations aimed at understanding how adults use the newer principles to group stimuli, to our knowledge, the studies to be reviewed in this section are the only ones to directly examine whether infants group visual elements in accord with these principles.

Uniform Connectedness

The principle of uniform connectedness (UC) refers to the visual system's tendency to group together elements that are connected and has been suggested to be the most fundamental principle of perceptual grouping. It has been argued that UC is needed to even determine that each local element in a configuration is itself a local entity. By this view, UC defines the 'entry level' units that are then grouped according to various organizing principles, such as proximity and similarity. To examine whether sensitivity to UC is functional in early infancy, as shown in Figure 4, infants as young as 3 months of age were habituated to the uniformly connected patterns shown in Panels A or B, and then administered a preference test pairing connected elements with disconnected elements. The rationale is that if the infants organized the habituation patterns on the basis of UC, then they should respond to the connected-element test stimulus as familiar and display a novelty preference for the disconnected-element test stimulus. This is the result that was observed, and a control condition showed that there was no a priori preference between the test stimuli. These findings indicate that infants by 3 months of age are sensitive to UC as an organizing principle. Notably, if the operation of UC allows for the delineation of entry-level units that can then be organized into holistic percepts according to other classic grouping principles such as proximity and similarity, then the infant results imply that 3-month-olds are able to use UC to identify the entry-level units that are then subject to further perceptual organization.

Habituation

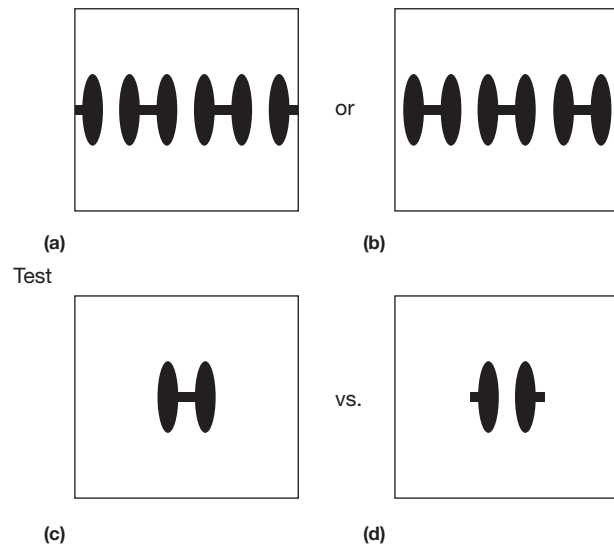


Figure 4 Stimuli used to test whether infants adhere to uniform connectedness when organizing visual patterns. Infants in the habituation conditions were habituated to the uniformly connected patterns in panel (a) or (b) and tested with the patterns in panels (c) and (d). Infants in the no-habituation condition were tested with the patterns in panels (c) and (d) without prior exposure to the patterns in panels (a) and (b).

Common Region

The second newer grouping principle investigated is that of common region. This principle proposes that elements within a region are grouped together and are separated from those in other regions. Grouping on the basis of common region is believed to help organize texture elements within a contour as going with each other and as belonging to the surface or object that is bounded by the contour. It has also been suggested that common region might be a different kind of organizational cue than classic Gestalt cues, because here the organization is driven by a characteristic that is external to the elements themselves. That is, the 'common region' quality that engenders grouping of the elements is not inherent in the elements. In contrast, other grouping principles such as similarity are based on the intrinsic characteristics of the to-be-grouped elements. One can thus differentiate between 'extrinsic' versus 'intrinsic' organizational cues, with common region conceptualized as an extrinsic cue. This distinction raises the possibility that common region could be a different kind of organizational cue than others, thereby adding to the importance of understanding its emergence in young infants to see if it is somehow unique.

To investigate whether young infants could use common region to organize visual pattern information, 3- to 4-month-olds were familiarized to images with two pairs of shapes, with one pair (say A and B) always located together in one region and the other pair (say C and D) located together in another region (see Figure 5). The actual location of the individual shapes changed from one trial to the next, but the shapes A and B always shared one region, while the shapes C and D shared another region. Infants were then tested for their preference between a *within-region* grouping (e.g., AB) versus a *between-region* grouping

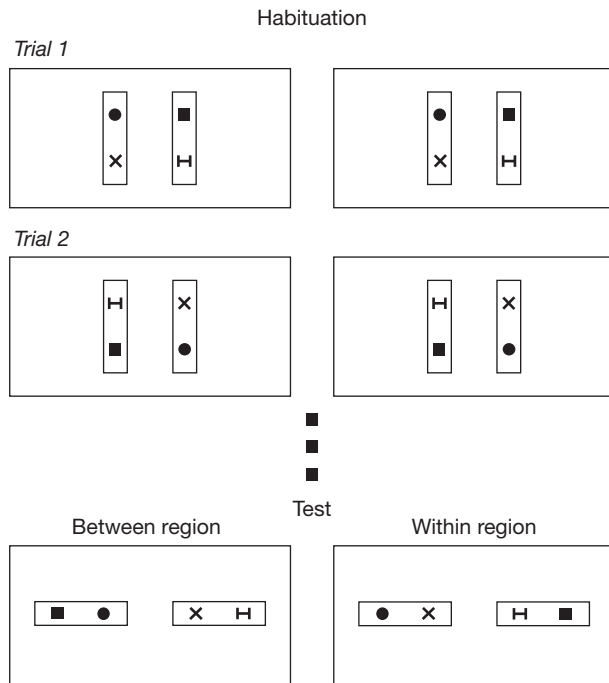


Figure 5 Illustrations of the stimuli used to examine organization based on common region.

(e.g., BC; [Figure 5](#)). The stimulus patterns presented to the infants were such that the physical distance between A and B and between B and C was always the same. In other words, the only difference in the relationships between A and B versus B and C was that the former pair always shared the same region while the latter pair contained shapes from different regions. If the principle of common region is operational in infancy, then the infants should find the *within-region* grouping to be familiar and the *between-region* grouping to be novel, and discriminate between these patterns during the test.

It should be noted that the common region task is a demanding one in that it asks if grouping will carry over to novel regions, given that infants were habituated to vertical regions during habituation and tested with novel horizontal regions. That is, this experiment gets at the following question: When elements that were previously grouped based on a set of regions are subsequently encountered in novel regional configurations, does the visual system expect this grouping to be intact? If grouping and perceptual organization are to be functionally advantageous, they need to allow the world to be organized into meaningful entities that transcend particular situations. For instance, if a perceiver were to be exposed to two standing humans and associated the individual faces to the individual bodies, then, for this organization to be functional, the perceiver should expect the same grouping to prevail if the humans were now lying down.

The major result from the common region study was that the infants discriminated between the grouping of elements from different regions from the grouping of elements that had shared a common region during habituation. This result indicates that the infants organized information based on common region. The finding that infants are sensitive to

common region suggests that the extrinsic nature of this cue did not preclude its role as an organizing factor in infancy. In other words, infants, like adults, are not solely dependent upon the intrinsic nature of elements to organize them; they are able to use extrinsic factors such as common region to organize.

Progress on the Special Case of Form Similarity

Although the proposals of Spelke and Kellman suggested that important cues for grouping and perceptual unit formation were not available to young infants, the results reviewed have provided evidence that infants as young as 3 months of age can use a variety of static grouping principles, both classic and modern ones, to organize visual pattern information. In particular, the findings indicate that the principles of lightness similarity, proximity, good continuation, uniform connectedness, and common region are functional in at least some perceptual contexts. These data suggest that some level of revision is in order with regard to thinking about the sources of information available to younger infants for perceptual grouping. However, form information and its relative lack of availability as an organizing cue to younger infants were central to the proposals of Spelke and Kellman. It therefore becomes important to ask whether form similarity can serve as a perceptual grouping principle for young infants.

Development of Form Similarity: An Age Difference in Performance

The functionality of form similarity in young infants was examined in a study in which 3- to 4-month-olds were familiarized with columns or rows of Xs versus Os, and then tested with vertical versus horizontal bars ([Figure 6](#)). Infants failed to display a preference. A control experiment showed that infants were capable of discriminating between the familiar arrays shown in [Figure 6](#) and arrays that consisted entirely of Xs or Os. This latter result indicates that the failure of the infants to use form similarity was not due to an inability to discriminate between the constituent X and O shapes. The outcomes suggest that young infants failed to group on the basis of form similarity. The same failure to group was observed even when Hs versus Is and squares versus diamonds were used in the place of Xs versus Os.

With the data thus far described failing to turn up support for young infants' use of form similarity, an older age group of infants, 6–7-month-olds, were tested on the same X-O elements → bars task ([Figure 6](#)). This older age group responded by preferring the novel stimulus organization. The combined findings from the two age groups indicate that 6–7-month-olds, but not 3–4-month-olds, can organize visual patterns in accord with form similarity. Given that younger infants are sensitive to a number of other organizational cues, the failure to organize based on form similarity suggests that different Gestalt principles may become functional over different time courses of development. The outcomes are consistent, in particular, with the hypothesized age of onset for Kellman's edge-sensitive process, and also with Spelke's proposal that some Gestalt principles may be learned in a constructivist framework, rather than automatically deployed as conceived by the original Gestaltists. The data are additionally consistent

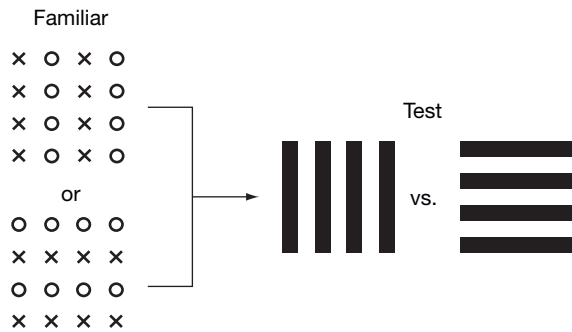


Figure 6 Familiarization and test stimuli that examined whether infants can organize visual pattern information in accord with shape similarity.

with evidence indicating that adults have independent luminance- and edge-based grouping mechanisms. They are further in accord with the finding that some visual agnostics (i.e., individuals with impaired ability to recognize objects usually associated with brain injury or neurological illness) show intact lightness similarity grouping, but impaired shape configuring ability, and the result that individuals with Williams Syndrome show superior lightness similarity grouping abilities relative to those for form similarity. However, as the next section reveals, young infants' inability to use form information to organize visual images is not absolute.

Development of Form Similarity: Maturation or Experience?

Given the results showing a later development of form similarity, the next question to ask was whether this development was driven by maturation or learning. To address this question, one may reason that if form similarity is under experiential control, then it might be possible to provide younger infants with experience that will allow them to organize visual pattern information in accord with form similarity. Alternatively, if infants' use of form similarity is maturationally determined, then experience would not be expected to bring about form similarity functionality. To this end, one can examine whether variation in the patterns used to depict rows or columns during familiarization enhances infants' performance in the form similarity task. With this manipulation, it is possible that the pattern variation will facilitate performance because the invariant organization of the stimuli will be more easily detected against a changing background. In other words, variation may provide infants with the opportunity to form concepts of 'rows' or 'columns.' To investigate this possibility, the elements → bars generalization version of the form similarity organization task that had previously produced null results (when each of the three different form contrasts was presented individually) was administered, but in this instance, with each of the three form contrasts presented during a single familiarization session (Figure 7). The younger infants now preferred the novel organization of bars. This striking result suggests that 3–4-month-olds are capable of using form similarity to organize elements if they are provided with varied examples with which to abstract the invariant arrangement of the pattern.

Further evidence of the role of learning in infants' use of form similarity was obtained in a study which examined whether an already functional luminance cue system can be

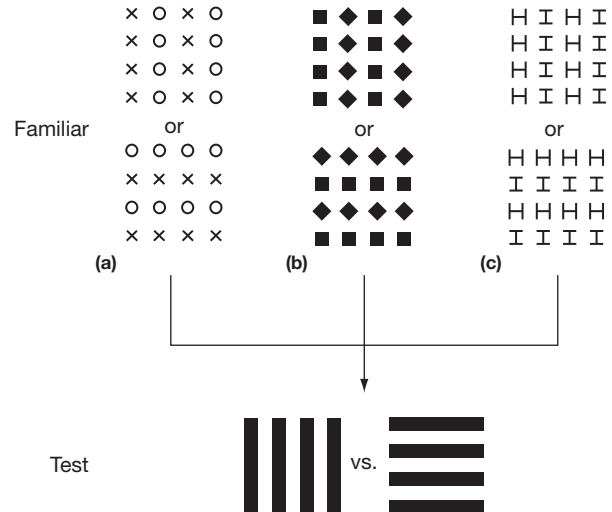


Figure 7 Familiarization and test stimuli used to investigate whether infants can use shape similarity to organize visual patterns if exposed to variable shapes during familiarization. Infants in the single pair condition were familiarized to one of the pairs shown in panels (a)–(c), that is, X-O, square-diamond, or H-I, whereas those in the variable condition were familiarized to all three pairs.

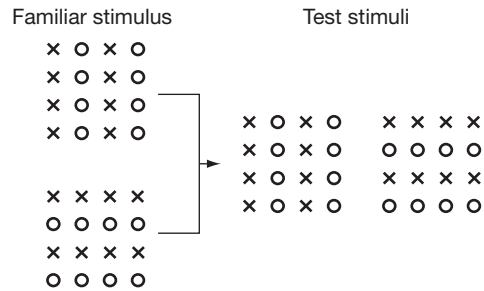
used to scaffold infants' use of form similarity cues. One group of infants was tested on a form-form task in which they were familiarized to columns/rows of Xs and Os and then tested with rows/columns of X and O shapes. Another group, the luminance-form group, was familiarized to columns/rows of dark and light squares and then tested with X and O shapes organized as columns/rows (Figure 8). As expected, the form-form group failed to exhibit evidence of organization, indicating again that 3–4-month-olds ordinarily do not organize using form similarity. However, the luminance-form group did exhibit systematic novelty preference during the test. These results indicate that infants were able to organize using form similarity during the test, provided they were initially able to generate the global gestalts during familiarization using a more readily available system, namely, the luminance similarity system. This work demonstrates that new organizational principles can be learned via bootstrapping onto already functioning organizational principles.

These results are theoretically significant because they demonstrate that the ability to use the form similarity principle does not have to wait until 6–7 months: even younger infants organize using this cue if exposed to variable stimuli or if an already functional organizing principle can scaffold their performance. The evidence is more consistent with the view that learning plays a role in acquiring some aspects of perceptual organization.

Progress on Understanding the Deployment of Lightness and Form Similarity: Automatic Versus Constructivist Grouping

The article has thus far documented a developmental difference in the use of lightness and form similarity and has also raised the possibility that grouping by form similarity may

Shape → Shape



Luminance → Shape

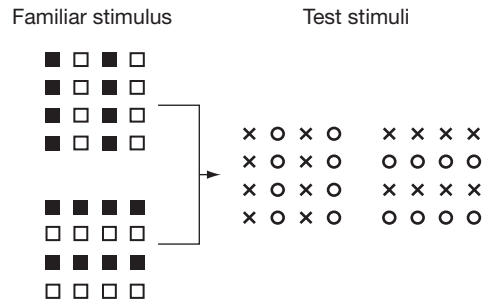


Figure 8 Illustrations of the shape → shape and luminance → shape tasks presented to infants to examine whether infants will learn to use shape cues to organize if presented in the context of organization based on luminance cues.

occur because of learning taking place via the perceptual experience that accrues during the time course of familiarization. These observations motivated an inquiry into the question of how readily the principles of lightness and form similarity may be deployed. The column versus row methodology was used once more, except that in this instance, a condition requiring infants to generalize from elements to bars was compared with a condition requiring infants to generalize from bars to elements. That is, one group of infants was familiarized with columns or rows of elements and preference tested with vertical versus horizontal bars (see Figures 1 and 6), whereas the comparison group tested on the same grouping principle was familiarized with vertical or horizontal bars and preference tested with columns or rows of elements (Figures 9 and 10). It is important to mention that in both the lightness and form similarity studies, the familiar stimulus was presented for six 15-s familiarization trials, whereas the test stimuli were presented for two 10-s test trials. The test trials were deliberately kept to few in number and to a short duration to capture a burst of differential responsiveness toward the novel versus familiar stimulus. If there were more test trials or they were made longer in duration, any initial advantage in responsiveness to the novel stimulus could conceivably begin to subside because that stimulus is now becoming familiar. The rationale behind comparing performance in the elements → bars versus bars → elements versions of the perceptual organization task is that if the Gestalt process that infants use to group by similarity is deployed readily, with the consequence that organization is rapidly apprehended, then one would not expect the nature of the switch from familiarization to test stimuli to affect

Familiar stimulus

Test stimuli

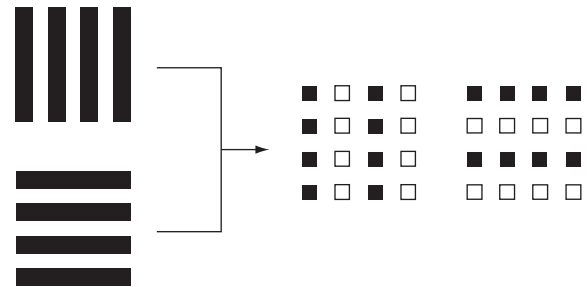


Figure 9 Illustration of the bars → elements version of the lightness similarity perceptual organization task.

Familiar stimulus

Test stimuli

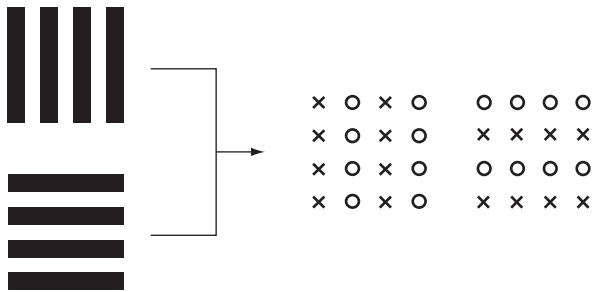


Figure 10 Illustration of the bars → elements version of the shape similarity perceptual organization task.

performance. If, however, Gestalt grouping by similarity occurs less readily, because of learning taking place during the time course of familiarization, then one might expect infants in the bars → elements condition to outperform infants in the bars → bars condition because of the reduced study time available to process the column versus row stimuli in the bars → elements condition.

The results for lightness similarity were that the novel organization was preferred, irrespective of whether infants were familiarized with elements and tested with bars or familiarized with bars and tested with elements. These findings suggest that perceptual organization that occurs via grouping by lightness similarity is readily apprehended. In contrast, in the case of form similarity, the novel organization was preferred only in the elements → bars version of the task. Infants in the bars → elements version of the task did not exhibit a preference between the test stimuli. The results indicate that grouping by form similarity was adversely affected by the switch in familiarization and test stimuli, which in turn implies that grouping via form similarity occurs less readily than grouping by lightness similarity.

The difference in performance on the elements → bars and bars → elements tasks imply that lightness and form similarity grouping processes differ qualitatively. That is, lightness similarity grouping processes may be deployed rapidly because they are hardwired, a suggestion that receives support from a report that even newborns may be capable of organizing visual patterns via lightness similarity. In this view, perceptual organization would be perceived immediately upon presentation

with a column or row pattern of light versus dark elements. By contrast, form similarity grouping processes may be learned from perceptual experience. In this account, perceptual organization would be constructed during the course of the familiarization trials. To these observations, one can add the finding that young infants perform successfully in bars → elements and elements → bars versions of the proximity organization task. These latter findings suggest that perceptual organization that occurs via grouping by proximity is also readily apprehended. Grouping by proximity thus appears to be more similar to grouping by lightness similarity than grouping by form similarity.

Theoretical Progress

The developmental research highlighted in this article reflects an effort to investigate the origins and development of perceptual unit formation during infancy. The data suggest that different organizational principles may become functional over different time courses of development, may be governed by different developmental determinants, that is, maturation versus experience, and that not all principles are readily deployed in the manner originally proposed by Gestalt theorists.

An Orthogenic Perspective

The findings reviewed are consistent with investigations of perceptual grouping in adults that have adopted a microgenetic approach and examined the time course of development of a particular percept. The outcomes of the adult investigations suggest that different grouping principles are differentially powerful or operational at different times in the overall course of processing. In particular, some forms of perceptual organization occur early in the time course of processing and do not require attention, whereas other forms of perceptual organization occur later in the time course of processing and require attention. This work has led to a newly emerging view that perceptual organization is not a monolithic phenomenon, but rather represents a confluence of multiple processes. The findings that lightness similarity and proximity emerge more readily than form similarity during early development (i.e., in younger infants with just a single example pattern and limited presentation time) suggest a correspondence between what is observed ontogenetically in infants and microgenetically in adults. This correspondence is more generally supportive of an orthogenic approach to understanding perceptual organization, one which emphasizes that mechanisms underlying performance become most transparent as they are revealed in the processes of change at different time scales.

Abstract Units

Two of the findings described so far are also noteworthy because they hint that perceptual organizing processes can produce units of processing that have an abstract nature. In the demonstration that proximity is readily apprehended, which was documented by successful performance in the bars → elements version of the proximity grouping task, the generalization from the bars to the familiar organization of elements was

accomplished even though the physical dimensions of the bar stimuli were different from those of the element stimuli. These results suggest that the units that arise as a consequence of grouping have an abstract quality in terms of their transfer. The findings on the flexible nature of proximity grouping are consistent with those reported for grouping by common region by infants where it was shown that elements that grouped in one region were also expected to appear together in a differently shaped region. Both sets of outcomes are further consistent with the finding that infants generalize from elements to bars on the basis of form similarity, but only when provided with multiple form contrasts depicting a column- or row-like organization. All three studies suggest that the emergent features formed from deployment of perceptual organizational principles are conceptual-like in terms of their generalizability.

A Top-Down Contribution

The studies reviewed in the article are consistent with the idea that there may be a multiplicity of cues available for perceptual unit formation by infants. Some of these cues, like those emphasized in this article (e.g., lightness similarity, good continuation, proximity), may be characterized as bottom-up. Other cues, such as knowledge of particular objects and object kinds, reflect experiential information, and may be thought of as top-down.

What are the relative contributions of bottom-up perceptual process and top-down knowledge access in perceptual organization? One current model posits that humans possess a flexible system of perceptual unit formation, one in which the features that come to define objects are extracted during the task of concept learning. The idea is that an individual's history of concept formation (i.e., the concepts possessed by an individual at a specific point in time) will affect his or her subsequent perceptual organization processes.

Investigations have been undertaken to determine whether the proposed interplay between adherence to Gestalt organizational principles and flexible feature creation would be manifested in young infants. The specific question asked was whether features that are specified as coherent by Gestalt principles are 'overlooked' by young infants if alternative means of perceptual organization are 'suggested' by presenting the infants with a category of objects in which the features uniting the objects are 'nonnatural' in the Gestalt sense. In the first experiment, 3- and 4-month-olds were familiarized with a number of complex figures, examples of which are shown in the top portion of [Figure 11](#). Subsequently, during a novelty preference test, the infants were presented with the pacman shape paired with the circle shown in the bottom portion of [Figure 11](#). The infants were found to recognize the circle as familiar as evidenced by their novelty preference for the pacman shape. This finding suggests that the infants had parsed the circle from the complex figures in accord with good continuation.

Follow-up experiments investigated whether an invariant part abstracted during category learning would interfere with perceptual organization achieved by adherence to good continuation. The experiments consisted of two parts. In Part 1, the infants were familiarized with multiple exemplars, each marked by an invariant pacman shape, and were subsequently administered a novelty preference test that paired the pacman

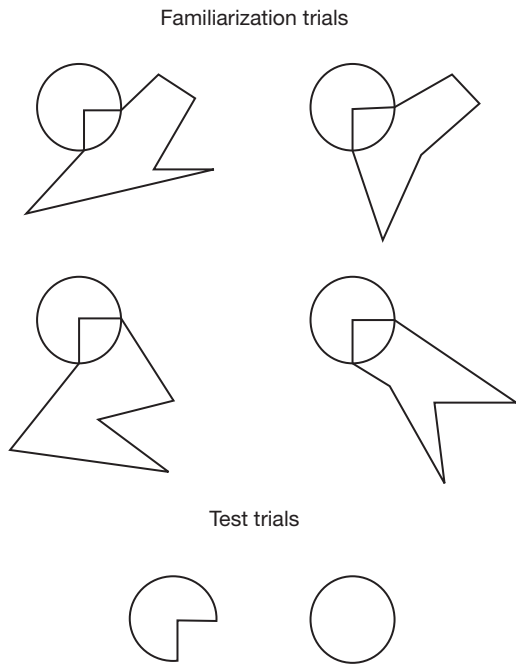


Figure 11 Illustration of the stimuli used to examine whether infants parse the circle shape in accord with the principle of good continuation.

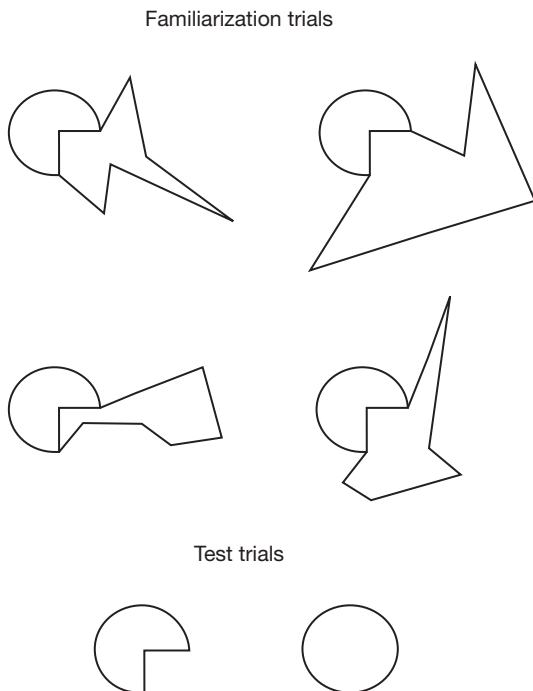


Figure 12 Illustration of the stimuli used to investigate whether exposing infants to novel features (Pac-man shape) causes them to parse images (shown in Figure 11) in novel ways.

shape with the circle shape (Figure 12). The pacman shape was recognized as familiar, as evidenced by a preference for the circle shape. Part 2 of the procedure was then administered and it simply followed the design of Experiment 1 (Figure 11).

The expectation is that if the category learning from Part 1 of the procedure, in particular, the representation of the invariant pacman shape, can interfere with the Gestalt-based perceptual organization that was observed in Experiment 1, then the preference for the pacman shape that was observed in Experiment 1 should no longer be observed. In fact, if the representation of the pacman shape carries over from Part 1 to Part 2 of the procedure, one would expect the opposite result, that is, the infants should continue to prefer the circle. The latter result is what was observed and it suggests that perceptual units formed during category learning can be (1) entered into a perceptual system's working 'featural' vocabulary and (2) available to subsequent object recognition processes. The bias set by the Gestalt principle of good continuation might thus be thought of as soft-wired in the sense that it is subject to interference. More generally, an individual's history of categorization will affect his or her subsequent object parsing.

Future Studies

The research described in this article indicates that the infant's perceptual world is systematically organized based on both general Gestalt rules and on specific personal experiences. However, much remains unknown about how perceptual organization develops. The complexity of the real world implies that Gestalt cues and experiences sometimes work in concert and other times in opposition; how infants at different ages deal with the organizational challenges under such diverse conditions needs to be understood. A comprehensive account of the development of perceptual organization thus has to include the relations between bottom-up rule-based organization and top-down experience-based organization. This will require a systematic analysis of the roles of different kinds of experience on perceptual organization in infancy and an understanding of how these experiences interact with bottom-up processes at different ages. More generally, the separate and interactive roles of experience and maturation have to be studied further in order to understand how the infant perceptual system develops into the adult system.

See also: Agnosia (including Prosopagnosia and Anosognosia); Autism and Pervasive Developmental Disorders; Depth Perception; Eye Movements; Perceptual Development; Spatial Perception; Visual Motion Perception; Visual Perception.

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Gestures

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Glossary

Aphasia Any disorder of speech resulting from brain damage.

Appeasement gestures Behavioral displays (e.g., making yourself smaller) that typically inhibit aggression from others.

Emblems Nonverbal acts which have a direct verbal translation such as nodding the head when meaning 'yes' or shaking the head when meaning 'no'.

Illustrators Movements directly tied to speech, which amplify and elaborate the verbal content of the message.

Manual gesture Communication through the hands and arms.

Microanalysis Study of interpersonal communication through the detailed analysis of video or audio recordings.

Phonemic clause A group of words, averaging five in length, in which there is only one primary (or tonic) stress indicated by changes in pitch, rhythm or loudness. It is terminated by a juncture, where these changes in pitch, rhythm and loudness level off before the beginning of the next phonemic clause.

Regulators Movements that guide and control the flow of conversation, influencing both: who is to speak and how much is said.

Syntax Study of the rules whereby words or other elements of sentence structure are combined to form grammatical sentences

Introduction

The study of gesture can be traced back to classical antiquity. In ancient Rome, both Cicero and Quintilian wrote treatises on rhetoric, which included a number of observations on the use of the hands in oratory. For Quintilian, the term 'gestus' referred not only to actions of the hands and arms, but also to movements of the rest of the body. This use of the term carries through to the modern day: gesture may refer not only to movements of the hands and arms (manual gesture), but also to communication through other parts of the body (the head, trunk, legs and feet). However, the section in which Quintilian deals with manual gesture is by far the lengthiest, and this is also true of contemporary research. It should be noted that gesture as a form of movement is conventionally distinguished from posture, which refers to static positions.

In the seventeenth century, the study of gesture acquired the status of a subject in its own right. Of particular importance were Giovanni Bonifacio's *L'Arte dei Cenni* (published in Vicenza Italy in 1616) and John Bulwer's two volumes: *Chirologia: or the Naturell Language of the Hand*, and *Chironomia: or the Art of Manual Rhetoricke*. Bulwer's two volumes were published in England in 1644. They were the first works written in English to be exclusively concerned with gesture, with what Bulwer called "the naturell language of the Hand, as it had the happiness to escape the curse at the Confusion of Babel." *Chirologia* comprised a descriptive glossary of 64 gestures of the hand and 25 gestures of the fingers. *Chironomia* was a prescriptive guide to the proper usage of an additional 81 gestures during well-delivered discourse, as well as cautions against the improper use of 'manual rhetoricke.'

In the modern era, the scientific study of gesture has only become possible with the development of sophisticated recording apparatus; most contemporary studies of gesture

have used either film or videotape as the main technique of observation. Such recordings allow the researcher the opportunity for repeated viewing, which is of course not possible with 'live' observation. Repeated viewing can be particularly important with complex sequences of movement; these can be replayed time and again, if necessary, in slow motion. In this context, the role of the video recorder has been likened to that of the microscope in the biological sciences. Through the detailed 'micro' analysis of video recordings, behavior can be repeatedly examined and dissected in the finest detail, such that interpersonal communication has become an object of study in its own right.

However, microanalysis did not develop simply as a consequence of innovations in technology. The extensive use of film and video technology in the study of social interaction has only really developed in the past few decades. Its predominance reflects not only a distinctive methodological approach, but also a fundamental change in the way in which we think about interpersonal communication. In particular, it reflects a belief in the value of studying the fine details of social interaction, and a belief in their social significance.

Recent microanalytic studies of gesture have been focussed primarily on its relationship to speech. This contrasts strikingly with the notion of nonverbal communication as 'body language,' regarded by its adherents as a more trustworthy alternative to speech. One particular danger of the body language approach is its neglect of the close interrelatedness between speech and nonverbal behavior. Indeed, it may well be the case that conflicts between nonverbal behavior and speech are the exception rather than the rule. On the other hand, an exclusive focus on the relationship between gesture and speech runs the risk of neglecting the role of gesture in communicating emotions and interpersonal attitudes. For example, in one recent major book on gesture, no attention is paid whatsoever to the

topic of emotion. As far as this book is concerned, the topic does not exist, the word 'emotion' does not even appear in the index.

In this article, both topics are discussed. The first section is focussed on gesture and speech, the second on emotions and interpersonal attitudes; in the final section, the role of gesture in interpersonal communication is discussed.

Gesture and Speech

The Synchronization of Body Movement

Frame-by-frame analysis of film has shown how the body of the speaker moves closely in time with his speech, a phenomenon which is referred to as self synchrony. These observations have not been confined simply to hand gestures; it is movements of all parts of the body that are believed to be closely synchronized with speech.

It has also been claimed that body movements are closely synchronized between conversationalists, sometimes termed interactional synchrony. Not only has it been said that "the body of the speaker dances in time with his speech," but also that "the body of the listener dances in rhythm with that of the speaker." Indeed, it has been claimed that interactional synchrony is a fundamental, universal characteristic of human communication, providing constant feedback from the listener to the speaker concerning the listener's level of attention and interest. These claims were based on detailed frame-by-frame analysis of filmed conversations. They were subsequently criticized by other researchers, who found that body movement coordination between the participants in a group conversation did not significantly exceed that which might have been expected by chance alone. Thus, the concept of interactional synchrony is very much open to dispute.

There is much more evidence for self synchrony, although it is not the case that every bodily movement is related to discourse. In a study of psychotherapy sessions, it was only non-contact hand movements (these do not involve touching the body) which were judged as related to speech; contact hand movements were considered for the most part to be unrelated to speech. In a study of political speeches, a close relationship was also found only between noncontact hand movements and vocal stress. Thus, for the most part, it seems that contact movements serve different functions from noncontact gestures. This view is further supported by a study which found that non-signaling movements (e.g., stroking oneself) were used significantly more by high anxious patients, while low anxious patients made significantly greater use of signaling movements (e.g., pointing). Self-touching movements are often used not for communication but for grooming, so that under conditions of high anxiety they may be used as a means of self-reassurance.

There are two principal ways in which gestures are related to speech: in terms of their temporal coordination, and also in terms of meaning. In terms of temporal coordination, gestures have been shown to be related to both syntax and vocal stress.

Syntax

The relationship between syntax and body movement was studied by analyzing the speech of a patient in a psychotherapy session. Observations were made of the number of postural

shifts, leg movements, and foot movements and it was noted whether they coincided with syntactic boundaries. A movement was scored as coinciding with syntax if it took place within but not across the duration of a clause. It was found that most of the observed body movements fell within syntactic boundaries, and hence it was concluded that body movement is closely related to syntax.

Vocal stress

Discourse has a discernible structure based on strings of words which seem to be spoken as a unit, known as the phonemic clause or tone group. A phonemic clause consists of a group of words, averaging five in length, in which there is only one primary (or tonic) stress indicated by changes in pitch, rhythm or loudness, and which is terminated by a juncture, where these changes in pitch, rhythm and loudness level off before the beginning of the next phonemic clause. It has been observed that most speakers of American English accompany their primary stresses with slight jerks of the head or hand, while junctures are accompanied by a movement of the head, eyes or hands. In a study of British informal conversations, it was found that over 90% of tonic stresses were accompanied by body movements, not only of the head or hands, but also of the trunk and legs/feet. In a study of political speeches, it was found that repeated movements (where, e.g., the speaker extends and flexes his forearm continuously for two or more occasions) always occurred within the duration of a tone group and never violated tone group boundaries. These movements seem to serve a dual function: they both pick out stressed words and demarcate the extent of the tone group. Such gestures are sometimes referred to as 'beats,' movements which may look as if they are beating out musical time, and pick out important words and phrases.

Meaning

Gesture and speech convey meaning in radically different ways. Speech relies on a lexicon, whereby words may have particular meanings, which may be combined into full sentences through the rules of syntax. In contrast, gestures convey meaning through their visual appearance. Some gestures, referred to as 'iconic,' seek to resemble the object or event they depict. Others, referred to as 'metaphoric,' seek to depict an abstract idea rather than a concrete object or event. In addition, gestures can represent multidimensional aspects of meaning. For example, a gesture may convey the appearance of an object as well as its size. It may also convey information about movement, for example, speed and trajectory, all at the same time. In spoken language, this information would have to be conveyed sequentially, but in gesture this information can be conveyed simultaneously, through one single powerful iconic image.

Gestures may also contribute to meaning by showing how an utterance is to be interpreted. Speech in itself can be understood as a form of social action. Through different kinds of speech acts, speakers may threaten, plead, apologize, joke, refuse, disagree, evaluate, or do many other things. Notably, the nature of that speech act may be indicated through associated gestures. For example, pointing is commonly understood as being performed with one finger, but it may also be accomplished with the thumb, the head, or with certain movements of the eyes. Furthermore, different forms of pointing

may have different meanings. An index finger point may be used to threaten or accuse. A wagging finger may be used to reprimand or scold. A thumb may be used to disparage whatever is being pointed out. Slight movements of the head or eyes in pointing may be used to keep the act of pointing inconspicuous, thereby indicating the need for discretion. Obviously, pointing is integral to the comprehension of an utterance, which necessitates knowing the direction of the point. But pointing can do much more than this, the type of the point can indicate how an utterance is to be taken.

The Functions of Gesture in Conversation

It has been argued that gestures serve a variety of functions in relation to speech, which can be divided into emblems, illustrators and regulators. The term 'emblem' refers to those nonverbal acts which have a direct verbal translation, such as nodding the head when meaning 'yes,' or shaking the head when meaning 'no'; their function is communicative and explicitly recognized as such. Illustrators are movements directly tied to speech, which amplify and elaborate the verbal content of the message. Regulators are movements which guide and control the flow of conversation, influencing both who is to speak and how much is said.

Emblems

Emblems are generally assumed to be specific to particular cultures or occupations, but there do appear to be pan-cultural emblems such as the 'eyebrow flash,' where a person raises his eyebrows for about a sixth of a second as a greeting; this has been observed in a wide number of differing cultures. In one study, the geographical distribution of 20 emblems was mapped across western and southern Europe and the Mediterranean. The findings showed that whereas some emblems were specific to one particular culture, others were much more widespread. In Italy, for example, pressing and rotating a straightened forefinger against the cheek (sometimes referred to as the cheek-screw) is a gesture of praise; it is, however, little known elsewhere in Europe. Another gesture referred to as the nose thumb, in which the thumb touches the tip of the nose with the fingers pointing upwards spread out in a fan, is widely known throughout Europe as a form of mockery. The meanings of other emblems vary between cultures. For example, a gesture sometimes called the ring, where the thumb and forefinger touch to form a circle, means in Britain something is good, in parts of France something is worthless, while in Sardinia it is an obscene sexual insult!

Some emblems have a long history. The Roman author Quintilian, writing in first century AD, describes a hand gesture which is formed by the first finger touching the middle of the right-hand edge of the thumb nail; this graceful gesture he says was well suited to express approval. It seems to correspond almost exactly to the ring emblem described above, since Quintilian's precise description of the relationship between the thumb and the first finger almost necessitates the adoption of a circular ring-like position. Again, the emblem known as the nose thumb is referred to as early as 1532 in the writings of the celebrated French author, Francois Rabelais, who devotes a whole chapter to a duel of gestures between

two of his characters. The nose thumb is also depicted in a 1560 print entitled 'La Fete des fous' by Pieter Brueghel. Bulwer in his *Chirologia ... Chironomia* (1644) gave a detailed description of a whole number of emblems.

Clearly the function of emblems is communicative, and they constitute a form of nonverbal communication of which people have explicit awareness. The question arises, however, why emblems should have emerged as an alternative form of communication to speech. It has been argued that they are often used when speech is difficult or impossible, and hence function as an alternative system to speech. For example, the policeman directing traffic on points duty, or the deaf-and-dumb person using sign language can both be said to be using emblems in situations where speech is not possible. Emblems are also useful for communication at a distance; many familiar signing systems are used in a variety of sports by officials communicating at a distance with other officials, players and spectators.

Some of the most notorious emblems are, of course, insults; it may be advisable to use emblematic insults at a distance, since it makes it more difficult for the insulted person to retaliate!

Regulators

Regulators are movements which are assumed to guide and control the flow of conversation, for example, in the way in which people exchange speaking turns. In an intensive set of studies of turn-taking it was found that attempts by the listener to take over the turn could be essentially eliminated by the speaker continuing to gesture; this was called the attempt-suppressing signal. Observations also showed that ceasing to gesture was one of five turn-yielding cues, signals that offer a speaking turn to the other person. It was proposed that the effect of these five cues is additive: a linear relationship was found between the number of turn-yielding cues displayed and a smooth switch between speakers. The other cues were the completion of a grammatical clause, a rise or fall in pitch at the end of a clause, a drawl on the final syllable and stereotyped expressions such as 'but er' and 'you know.'

Illustrators

Illustrators are movements directly tied to speech, and it is maintained that they facilitate communication by amplifying and elaborating the verbal content of the message. Whether illustrators do in fact facilitate communication was tested in a series of experiments that were conducted based on video recordings of participants narrating cartoon stories. These descriptions were then replayed either with speech or with speech and gestures to another set of participants who were subsequently asked a series of detailed questions about the stories. For example, in one experiment, observers were asked questions about the actions and objects described in the cartoons. These questions covered such things as the identity of people or objects reported, as well as their size, their shape and their relative position, also the nature of any actions described and the speed of such actions. Results consistently showed that participants who saw the gestures got significantly more information about the original story than those who heard only the speech.

Emotions and Interpersonal Attitudes

Cultural Universals in the Facial Expression of Emotion

Particular importance is commonly ascribed to nonverbal cues in the communication of emotion. In this respect, however, gesture appears to play an essentially subordinate role to the face. Charles Darwin proposed that if emotions are expressed in the same way in different cultures, then these expressions are probably inherited, whereas if they differ between cultures, then they are probably learned. Modern research has shown that facial expressions associated with seven emotions (anger, fear, happiness, sadness, surprise, disgust, and contempt) are decoded in the same way by members of both literate and preliterate cultures. However, even if one accepts the existence of universals in decoding, it is only necessary to hypothesize that whatever is responsible for common facial expressions is constant for all mankind: inheritance is one such factor, but learning experiences common to all mankind could equally well be another. Nevertheless, children born both deaf and blind show the basic repertoire of facial expressions of emotion, and all but one of the discrete facial muscle actions visible in adults can be identified in neonates born without such handicaps. We can also learn to control our facial expressions according to what are called display rules – norms governing the expression of emotion in different contexts. These rules may take the form of attenuation, amplification, substitution or concealment of particular expressions. It is now generally accepted that there are at least seven fundamental emotions with innate facial expressions, but that these can also be modified through the display rules described above.

Gesture and Facial Expression

There is no such evidence for cultural universals in gestural expression. However, a number of studies have been carried out in which people were asked to make judgements of emotion from the face alone, the body alone and from the whole person. If body movement is important in the judgement of emotion, then the accuracy of judgements from the whole person should be superior to that from the face alone. But in practice this seems not to be the case. Decoders appear to base their judgements on the face more than on the body; they found it easier to agree on the face, and their judgements from the face were more accurate.

Nevertheless, one potential problem with these studies is that the facial expressions and body movements may have differed in their degree of informativeness; the decoders may simply have paid more attention to whichever feature was carrying the most information. Moreover, there seems to be no reason in principle why gesture should not convey information about particular emotions, since we speak of people jumping for joy, or clenching their fists in anger, or cowering in fear. It is possible these gestures only occur under conditions of intense emotion, and were not reflected in the studies described above.

In fact, in certain situations, gestures do convey significant information about emotions and interpersonal attitudes. One such situation is deceptive communication. Because the face is so visible and has the capacity to send many different sorts of messages quickly, it is important to control facial expression

when engaged in deception. In one study, students of nursing were asked to watch two films, one intended to be pleasant, the other intended to be stressful (showing amputations and the treatment of severe burns). The nurses were interviewed after seeing the films and asked to describe their reactions to the pleasant film honestly, but to conceal any negative reaction they might have had to the stressful film. Videotapes of the interviews were shown to observers, who were asked to guess which film the nurses had just seen; they were significantly more accurate when making these judgments from the body than from the face. When the nurses were asked what expressions they should control or what they should do in order to avoid detection, significantly more of them mentioned the face than the body.

Embarrassment is another emotion which people often try to conceal. One ingenious experimenter contrived to study embarrassment in the laboratory by arranging a structured interview: the participant was asked to select from a collection of pictures the one which he/she most disliked and was then asked a series of 15 questions concerning the reasons for that choice. In the eighth question, the interviewer revealed that he himself had painted the picture (he had in fact painted all the pictures in the original collection). After the interview was over, each subject was shown a videotape of the interview and asked to rate their response to the 8th question on a list of 19 emotion categories which included embarrassment, to check that the experimental manipulation had been successful. Subsequently, the videotapes were shown to another group of observers, who were asked to identify embarrassment or amusement from either the face, the body, or the face and the body together. Accurate recognition of embarrassment required both facial and body cues, while amusement required only facial cues; in fact, embarrassment was incorrectly identified as amusement by those observers who saw the face alone. The decoders who saw both the face and the body were also asked which cues they had used to identify embarrassment; those which were significantly associated with accurate recognition were the eyes, the hands, the mouth and the lower legs.

Gender Identification Signals

Gestures are important in conveying information about sexual attitudes, through what are sometimes called 'gender identification signals.' In one study, on the basis of a questionnaire intended to measure sex-role attitudes, three groups of men and women were selected: one with strongly masculine characteristics, another with strongly feminine characteristics and a third described as 'androgynous' (with characteristics of both sexes). Each subject was then asked to role play being a junior high school maths teacher, and each performance was video recorded. The videotapes were then shown to observers, who rated the encoders in terms of masculinity/femininity under five different conditions: from the vision alone (head and body), the head only, the body only, the voice and from a still photograph. The observers were able to accurately guess the sex-role attitudes of the encoders only in the vision alone and the body alone conditions. Physical appearance or clothing seemed to be unimportant, since the observers could not make accurate guesses when they saw just the still photographs. Thus, movements of the body seem to be important in conveying information about sex-role identification.

In fact, sex differences in the use of gesture seem to occur at an age as young as 4 or 5 years. This has been highlighted by studies of children with sexual identity problems, who appear to make exaggerated use of gestures which are associated with the opposite gender. In two studies of normal children, researchers found that girls did make significantly greater use of five of the 'effeminate' movements used by gender-disturbed boys. These were referred to as the limp wrist, flutters (rapidly moving the arms up and down), walking with a flexed elbow (where the angle between the upper arm and forearm is between 0 and 135°), the hand clasp (touching the hands together in front of the body) and palming (a grooming movement which involves touching the palm to the back, front or sides of the head above the level of the ears). Thus, it appears that there are significant differences between the sexes in the use of gesture, and furthermore, that gesture is of considerable importance in conveying information about sex-role attitudes and sex-role identification.

Dominance and Submission

Gesture conveys information about other interpersonal attitudes, such as dominance and submission. It was Charles Darwin who proposed that 'making oneself smaller' appeases and inhibits human aggression. This suggestion has been taken up by modern researchers studying how fights between boys are resolved. They found that just before the fighting stopped, the boy under attack would often reduce his body stature in some way, for example, by bowing his head, slumping his shoulders, lying motionless on the ground, kneeling, or through what was called 'waxy flexibility' (the child allows the aggressor to manipulate his body without offering muscular resistance). An interesting alternative which indirectly achieved the aim of reducing body stature was the use of shoe tying.

In another study, the researchers observed fights which were terminated by the intervention of a third person. In a significant number of cases, the third person intervened against an antagonist who continued to attack a child exhibiting some kind of appeasement display, which involved a diminution of body stature. Thus, both these studies suggest that making oneself smaller does function as an appeasement gesture in human conflicts, which is also likely to provoke intervention by other people if the signals are ignored by the aggressor. In fact, the way in which these boys inhibit aggression by making themselves smaller finds obvious parallels in formal status systems where an inferior greets a superior by bowing, kneeling or even by kowtowing, a custom in Imperial China whereby the inferior touched the ground with his forehead in absolute submission.

The Role of Gesture in Interpersonal Communication

Gesture clearly has a variety of functions in interpersonal communication, but the question naturally arises as to why it is used in addition to speech. The concepts of 'illustrators' and 'regulators' imply that gesture is essentially subordinate to speech, amplifying and elaborating the spoken word. However, gesture and speech have very different characteristics as media of communication. First, since gesture requires vision for its transmission whereas speech requires hearing, the conditions that are

suitable for the reception of the two do not necessarily coincide. Secondly, whereas with speech it is the sequential and syntactic structure which is important, this is not the case with gesture, although it can be used to directly represent action sequences. Despite these radical differences, however, it is important to note that these two modes of expression are employed together in a highly integrated fashion, participants often freely choosing between them to meet the requirements of the communication task at hand. The distinctive features of gesture are discussed below and their implications for interaction considered.

Gesture as a Visual Means of Communication

The most obvious feature of gesture is that it is a visual means of communication. It is often easier or quicker, for example, to point to an object, rather than to describe it verbally. Because gestures can provide spatial and orientational information that is not available in words, they may make a verbal account more specific and precise, or provide information that was not included in the verbal account.

Gesture as a Silent Means of Communication

Because gesture is visual, it is also of course a silent means of communication. Hence, for example, gesture is often employed when it is difficult or impossible to use speech because of distance or noise. The speech channel may be momentarily blocked by noise, but it may also be blocked because it is already occupied. In multiparty conversations, the use of gesture may occasionally be observed by people who are not participating in the conversation. In this context, gesture may be used to comment on an interaction, without interrupting the flow of speech. This may be done cooperatively or critically, so that the commentator does not have to take a speaking turn.

An additional feature of gesture is that for its use people do not seem to have to enter into the same kind of mutual obligation as they do in conversation. As a consequence, in certain circumstances gesture may be a quicker means of communication, because gestural exchanges do not require the ritual conduct associated with conversation. Gesture may also be used in situations where the speaker seeks to be less fully bound or committed to what he/she has to say. So gesture is sometimes adopted as a substitute for speech, where speech might be regarded as too explicit or indelicate.

Gesture as a Form of Bodily Action

Gesture by its very nature is a form of bodily action and this also gives it certain advantages in communication. The appearance of an action can never be as adequately described in words as it can be represented through gesture. So, for example, gesture may be of particular importance in mimicry or in demonstrating how particular skills should be performed. Gesture may provide visual animation, thereby enriching the quality of the verbal account. Again, because gestures can be reminiscent of physical actions, they may acquire additional forcefulness as a consequence: a clenched fist may convey anger more effectively than a torrent of words. This may give gesture especial importance in the communication of emotions and interpersonal attitudes.

Gesture as a Visible Means of Communication

Another important feature of gesture is that it is not only visual but a highly visible means of communication. So, for example, one study of a birthday party showed how people used gesture as an initial salutation to capture one another's attention before entering further into conversation. In a study of medical consultations, it was found that when the doctor's attention was focussed on his notes, patients would use more flamboyant gestures as a means of attracting his attention. In this context, gesture has the additional advantage of indirectness as well as visibility, since a direct request for attention from a higher status figure like a doctor might well prove unacceptable.

A situation characteristically associated with the flamboyant use of gesture is that of public speaking. In this context, gesture has distinct advantages over other forms of nonverbal communication such as facial expression or gaze which may be less discernible to a distant audience. This can be illustrated through the detailed analysis of a political speech delivered in the 1983 British General Election campaign by the leader of the National Union of Mineworkers, Arthur Scargill. Scargill made extensive use of a number of rhetorical devices which have been identified as being effective in evoking applause, in particular, contrasts (e.g., 'there is something criminally insane about a government which puts war before peace') and three-part lists (e.g., 'Soviet Marxism is ideologically, politically, and morally bankrupt'). The analysis showed how Scargill used gesture to illustrate both these devices. In the case of contrasts, he employed ambidextrous gesturing, switching from one hand to the other as he moved on to the second part of the contrast: through his gesture he was literally saying 'on the one hand' and 'on the other hand.' With regard to three-part lists, the three items in each list were invariably marked out by carefully synchronized gestures. Where the list comprised three words, each word was stressed vocally and accompanied with a single hand gesture: where the list includes a phrase or clause with more than one vocal stress, then a repeated movement was usually employed picking out two or more vocal stresses and terminating at the end of the list item, a new gesture starting on the next item.

Another common rhetorical device which Scargill used to evoke applause was what has been called the 'headline-punchline' device, in which the speaker states that he is going to make a declaration, pledge or announcement, and then proceeds to make it (e.g., 'I'll tell you the most important task [headline]: it's to say to the Lord Matthews, it's to say to the Lord Rothermeres, it's to say to the Rupert Murdochs that the first obligation of a new Labour government will be to take into common ownership the press' [punchline]). On three occasions, Scargill progresses from unilateral to bilateral gestures for the final part of the punchline. This seems to have the effect of bringing the rhetorical device to a climax, highlighting the fact that here was an appropriate point in the speech for the audience to applaud.

If Scargill's hand gestures were closely intertwined with rhetorical devices which have the effect of inviting applause, they also constituted a significant part of the way in which he attempted to control applause. On 12 occasions, he used gesture to control applause either by holding his hand or his index finger outstretched; on two-thirds of these occasions, he used such a gesture just before a point in the speech where

applause might have been considered appropriate, in that he was about to present a statement in one of the rhetorical devices discussed above. This is a noteworthy example of the use of gesture as a regulator, since the speech channel is, so to speak, 'jammed' by the applause; in effect, he cannot make himself heard, so he uses gesture instead as a means of controlling the applause. In fact, Scargill actually seemed to conduct his audience: his gestures not only accompanied rhetorical devices which evoked applause but also curtailed the applause once it has been aroused – even to the extent of indicating to the audience the points at which they should, or should not, applaud.

Differences in Visibility Between Different Gestures

Arthur Scargill's use of two-handed movements in relation to the climax of the headline-punchline device can be used to illustrate another of the distinctive properties of gesture. Not only is gesture a highly visible form of communication, there are also differences in visibility between different forms of gesture, so that more important aspects of speech can be indicated by larger movements and/or movements involving more than one part of the body. This can be further illustrated from studies of conversation, where it has been shown that making a point may be indicated by a movement of the head or eyes, whereas the more important semantic unit of changing the point of view that a person takes may be indicated by a much larger postural shift involving at least half the body.

Gesture as an Optional Means of Communication

A further feature of gesture is that it is to some extent optional. Whereas features like vocalization, speech rate and amplitude are intrinsic to speech, that is, it is impossible to converse without them, it is perfectly possible to converse without the use of gesture. Thus, the presence or absence of gesture may in itself be seen as a form of communication. Certainly, gestures related to speech are clearly intended to be communicative. For example, gesture is used more frequently face to face than when talking over an intercom. Gesture is also part of the turn-taking system in conversation; it may be used as an attempt-suppressing signal to prevent someone else taking a turn, while ceasing to gesture acts as a turn-yielding cue.

These findings can all be taken as supporting the view that gesture is intended to be communicative; but the use of gesture in conversational turn-taking also suggests a further proposition: that gesture may be taken as indicating a wish to communicate. This proposition has a number of intriguing implications. Gesture may be used when a person is interested in the topic he is talking about, or to accompany certain parts of speech which the person regards as more important. Gesture may also be used when a person is interested in communicating to another person or group of people: for example, it has been found that people attempting to be persuasive used significantly more gesture than when asked to present a message in a neutral fashion. Conversely, an absence of gesture may indicate a lack of desire to communicate; for example, people suffering from depression used significantly fewer illustrators on admission to hospital than on discharge.

Gesture as Part of a Multichannel System of Communication

Finally, it needs to be stressed that gesture forms part of a multichannel system of communication, operating principally not as an alternative to speech, but essentially in conjunction with it. This view is supported by recent cognitive research on gesture: it has been argued that gesture and speech are part of the same psychological structure and share a common computational stage. This is because not only do gestures occur primarily during speech, they are also synchronized with linguistic units; indeed, they have semantic and pragmatic functions that parallel those of speech. In addition, gesture develops simultaneously with speech in children, and dissolves together with speech in aphasia.

That gesture is part of a multichannel system has important implications for its role in communication. Four main functions of nonverbal signs in conversation have been distinguished: semantic, syntactic, pragmatic and dialogic. Thus, nonverbal signs may either affect the meaning of speech or signify meaning in themselves (semantic function); they may regulate the simultaneous and sequential occurrence and organization of verbal signs and other nonverbal signs (syntactic function); they may indicate characteristics of the message sender and receiver (pragmatic function); finally, they may indicate the nature of the relationship between the conversationalists (dialogic function). Gesture can convey any or all of these functions; hence, by using gesture in conjunction with speech it is possible to communicate simultaneously on a number of different levels.

Lack of Standardization

Gestures can also convey meaning in a different way from speech, because there are no standard forms with gesture. Standards of form are a defining feature of all spoken languages to which utterances must conform, otherwise they will be dismissed as not proper or grammatical. Gestures have no standards of form. Thus, different speakers may convey meaning in idiosyncratic but still recognizable ways.

Conclusions

Interest in gesture has a long history, but it is only in recent years that it has become the focus of systematic scientific

investigation. Research has shown that gesture is closely synchronized with speech in terms of syntax, meaning and vocal stress; it is also important in communicating emotions and interpersonal attitudes. Three main types of gesture have been identified, referred to as emblems, illustrators and regulators. The concepts of illustrators and regulators, however, seem to imply that gesture is essentially secondary to speech, amplifying and elaborating the spoken word. However, when considered as media of communication, gesture, and speech have very different properties. Through a consideration of its distinctive features, gesture can be shown to be not so much subordinate to speech, as different. The key elements are that gesture is visual, that it is silent, and that it constitutes a series of bodily actions. In addition, it is highly visible, and there are also differences in visibility between different types of gesture. Furthermore, it is to some extent optional; it constitutes part of a multichannel system of communication and unlike speech, it lack standard forms. As a consequence, gesture is particularly useful for communicating certain kinds of information and this has significant consequences for the way in which it is used in social interaction.

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Glial Cells

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Glossary

Astrocyte Astrocytes are glial cells found only in the central nervous system, where they exhibit a wide variety of cellular properties and shapes. These cells are involved in a broad range of functions in disease and normal brain function.

Microglia Microglia are the immune system cells of the brain, protecting the central nervous system from infection and disease.

Oligodendrocyte One of the four major types of glia cells, oligodendrocytes form myelin electrical insulation on axons in the central nervous system, but they are not present in the peripheral nervous system.

Schwann cell Schwann cells are the glia in nerves of the peripheral nervous system. These cells form electrical insulation (myelin) on nerve fibers and perform all the functions of the three types of glia recognized in the central nervous system.

White matter One of two types of brain tissue, white matter is the densely packed core of nerve fibers (axons) located beneath the gray matter in the cerebral cortex, connecting neurons in different regions into circuits. The white color is due to the electrical insulation on axons (myelin) that is formed by oligodendrocytes.

The Predominant Cells in the Brain are Glia

Brain tissue is comprised of two types of resident cells: neurons, which are electrically excitable, and glia, which are not. Although neurons comprise only 15% of cells in the brain, the other 85% has attracted much less interest, because glia were generally regarded as an interstitial constituent, with no role in information processing. This fundamental conceptual bias is preserved indelibly in the language. Rudolf Virchow (1821–1902), a pathologist with a special interest in connective tissue, coined the name ‘neuroglia’ in 1858, from the root meaning ‘glue.’ There is no single noun equivalent to ‘neuron’ to refer to an individual glial cell. As a consequence of viewing glia as ‘stuff’ between neurons, thinking about glia has been constrained for 100 years.

Glia are far from inert interstitial brain cells. All types of glia can respond to activity in neural circuits by sensing ions, neurotransmitters, or other adhesive or diffusible cell–cell signaling molecules. Some types of glia are involved in synaptic transmission, which implicates these glial cells in many aspects of information processing and in nervous system dysfunction, including both neurological and psychological disorders. Glia cannot generate action potentials, so they lack the cellular structures identified with neurons, including axons, dendrites, and synapses. However, glia communicate with each other and with neurons by using chemical signaling. Ions and other small molecules are spread from cell to cell through gap junction channels coupling the cell membranes of adjacent glial cells, but glia also communicate by releasing signaling molecules. This includes many of the same neurotransmitter neurons used for synaptic transmission, as well as growth factors, cytokines, and chemokines. These chemical messages are detected by membrane receptors on other glia and on neurons.

In broad outline, glia perform three general functions, and distinct types of glia are primarily associated with each of these activities. Astrocytes maintain homeostasis of neuronal function. Microglia fight infection and respond to injury.

Oligodendrocytes and Schwann cells form the electrical insulation on nerve fibers (axons), which is essential for transmitting electrical impulses (action potentials). It is likely, however, that within the broad categories of astrocytes, microglia, oligodendrocytes, and Schwann cells, there are many different subtypes of glia yet to be characterized. There may be as many different kinds of glial cells as there are different kinds of neurons. A possible fifth category of glia are those with the intriguing and incompletely understood stem-cell-like properties that enable them to differentiate into astrocytes, oligodendrocytes, or neurons under the right conditions. These cells are called NG2 glia, a reference to a glycoprotein expressed on the surface of these cells, but these cells are also referred to as OPCs (oligodendrocyte progenitor cells), and polydendrocytes.

Astrocytes

The renowned Spanish neuroanatomist, Santiago Ramon y Cajal (1852–1934) originally referred to cells that are now called astrocytes as ‘spider cells,’ because of the multiple cell processes radiating from a cell body like spider legs. This structure also resembles stars, which is the root for their modern name. These descriptions only pertain to cellular appearance after histological staining of the cytoskeleton (Figure 1). Modern techniques reveal an extremely complicated cellular morphology, with fine busy cell processes that associate intricately with neurons and synapses.

Astrocytes were believed to provide physical support and nutrition to neurons and to respond to neural injury. We now know that they participate with neurons in nearly every aspect of nervous system function. Providing nutritional support for neurons was deduced from the close association of some astrocytes with small blood vessels (Figure 2). Astrocytes near blood vessels extend processes called ‘end feet’ that surround blood vessels, and through which substances are transported between the bloodstream and neurons. The astrocytes near blood vessels help regulate local blood flow in response to neural

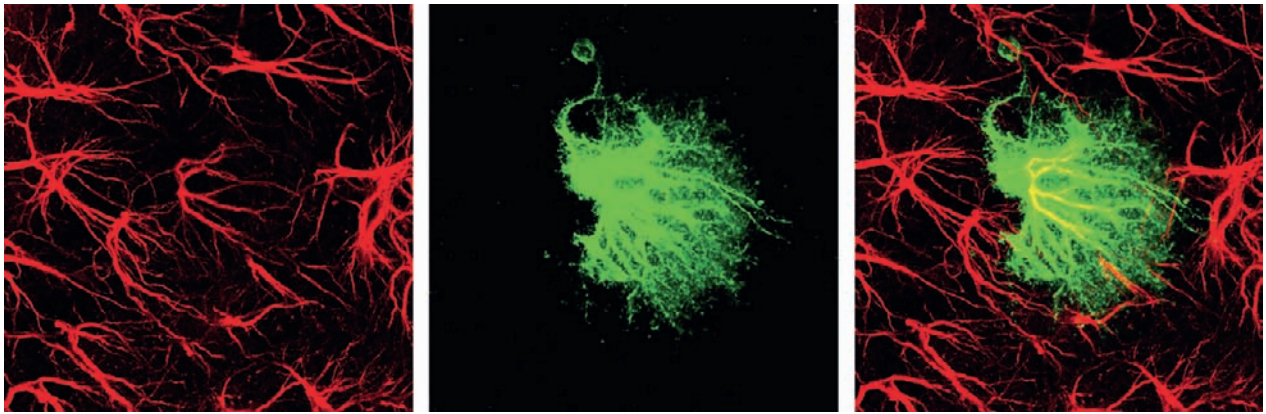


Figure 1 Astrocytes provide a supportive and homeostatic function in the brain, and they communicate with each other through chemical signaling. Astrocytes sense and control the transmission of information between neurons. The cytoskeleton of astrocytes is revealed by chemical stains and antibodies recognizing proteins in the cytoskeleton of astrocytes, such as GFAP, shown on the left. The true shape of the cells is revealed in the middle panel by filling an astrocyte with a green dye. The right panel superimposes the two images to show how much larger and more complicated the true structure of astrocytes is. This complex shape enables astrocytes to associate with hundreds of synapses and other structures. Courtesy of Ulrika Wilhelmsson, Eric Bushong, and Mark Ellisman, and reproduced with permission from Fields RD (2010) *The Other Brain*. New York: Simon and Schuster.

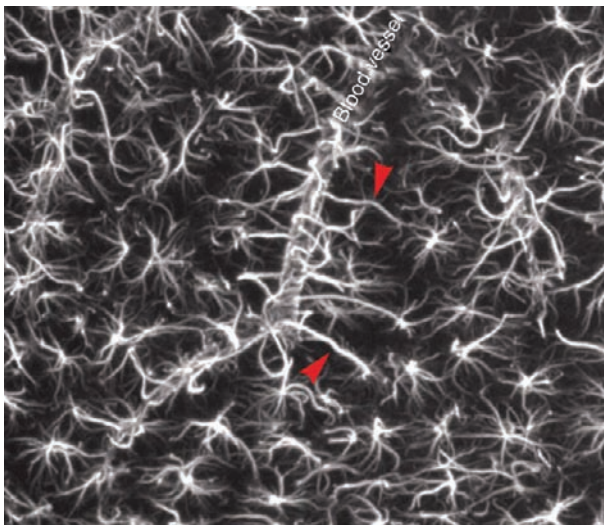


Figure 2 Astrocytes near blood vessels extend long processes (red arrows) to ensheath blood vessels in the brain. Specialized structures in astrocytes called ‘end feet’ allow them to transport ions, nutrients, and water between the bloodstream and brain tissue to maintain the optimal chemical environment for neurons. Astrocytes near blood vessels also release substances that constrict or dilate blood vessels to regulate the local delivery of blood to neurons according to neuronal activity. Reprinted with permission from Simard M, et al. (2003) Signaling at the gliovascular interface. *Journal of Neuroscience* 23: 1529–2401.

demand by sensing neuronal activity and releasing compounds that either dilate or constrict blood vessels in their vicinity. This local regulation of blood flow to supply active neurons is the basis for functional brain imaging using fMRI (functional magnetic resonance imaging). Astrocytes also regulate the exchange of ions and other materials and cells through the blood–brain barrier that separates brain tissue from the bloodstream.

Oligodendrocytes

Pio del Rio-Hortega (1882–1945), who studied with Ramon y Cajal, developed staining methods that revealed two additional types of glia. Oligodendrocytes, named for the numerous short cellular processes extending from the small cell body, were not easily identified by the unreliable stains of the time, making the existence of these glia controversial until 1924. Appropriate stains revealed that oligodendrocytes have long cellular extensions. Each cell process grips an individual segment of an axon and wraps layers of compacted cell membrane around it forming the electrical insulation called myelin (Figure 3). The myelin sheath on axons accelerates the speed of signal transmission by 10–100 times. Rather than propagating continuously down the axon, as in axons that lack myelin, the impulse (action potential) is generated at bare regions between adjacent segments of axons that are myelinated. These are the nodes of Ranvier, where sodium channels are highly concentrated, and where an action potential is generated upon depolarization to induce an impulse in sequential nodes, much like repeater stations in a communication system. Only vertebrates have myelin.

Microglia

Pio del Rio-Hortega first identified microglia (Figure 4) and correctly distinguished these cells as a different type of glia involved with nervous system pathology and inflammation. Microglia defend against infection and help repair damaged brain tissue. His observations clearly identified two major states of microglial cells: the ameboid form that migrates through tissue, and the ramified state, in which the cells have many actively extending and retracting cellular processes. Alois Alzheimer (1864–1915) described microglia surrounding the senile plaques in the brains of patients suffering from dementia from the disease that now bears his name.

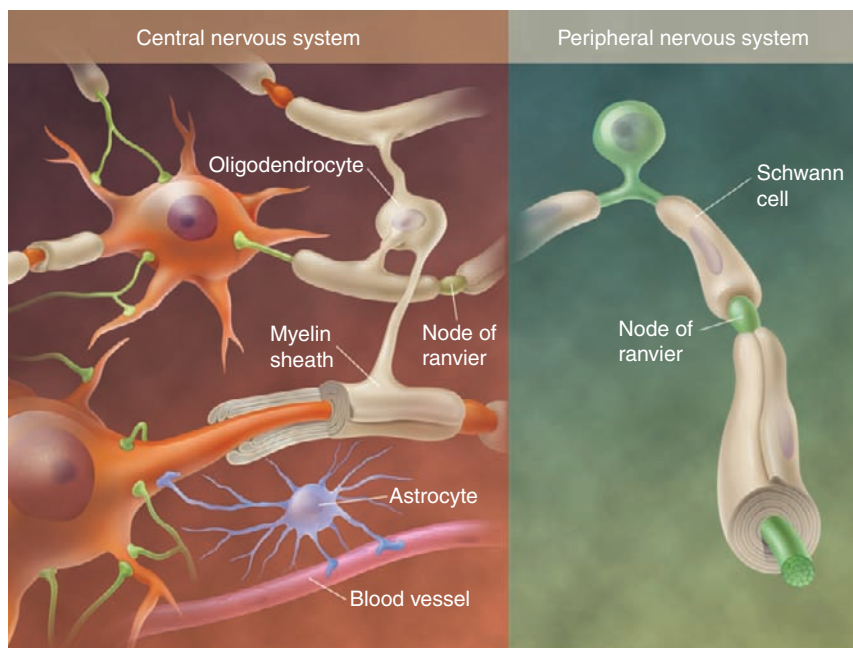


Figure 3 Myelinating glia form the electrical insulation on axons that is essential for high-speed transmission of impulses through nerve fibers (axons). Different types of glia form myelin in the CNS and PNS (oligodendrocytes and Schwann cells, respectively). Oligodendrocytes have multiple cellular extensions that can wrap myelin insulation around up to 50 axons, whereas Schwann cells ensheath axons individually. The gaps between the myelin insulation are the nodes of Ranvier where the electrical impulse is generated and propagated rapidly from node-to-node. Reprinted with permission from Fields RD (2006) Nerve impulses regulate myelination through purinergic signalling. *Novartis Foundation Symposium* 276: 148–158.

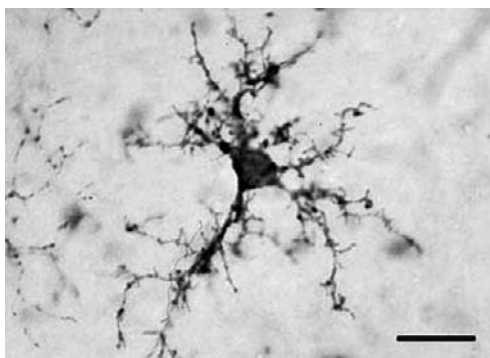


Figure 4 Microglia are the immune cells of the brain. Microglia fight infection and respond to injury to protect and repair the central nervous system. Reprinted with permission from Miller KR and Streit WJ (2007) The effects of aging, injury and disease on microglial function: A case for cellular senescence. *Neuron Glia Biology* 3: 245–253.

Schwann Cells

Schwann cells are the glial cells that form the myelin sheath on axons outside the brain. Unlike oligodendrocytes, Schwann cells do not have multiple cellular extensions, but instead each cell engulfs a segment of axon and forms a multilayered myelin sheath around it (Figure 3). Small diameter axons, which conduct impulses slowly, do not have a myelin sheath, yet they are not bare. Other Schwann cells, which do not form myelin, engulf multiple small diameter axons into bundles. Another type of specialized nonmyelin forming Schwann cell

encases the synaptic endings on muscles, much like astrocytes surrounding synapses in the brain. Schwann cells perform most of the functions of astrocytes, oligodendrocytes, and microglia in the brain, as none of these glia exists outside the CNS. Schwann cells are not found in the CNS, so they will not be discussed in the context of this article, which is concerned with glia in human behavior. These cells are named after Theodore Schwann (1810–1882), who also expounded the theory that all organisms are composed of cells.

Functions of Glia

Glia perform a broad range of functions (Table 1). In addition to the functions already mentioned, glia in the fetal brain guide the development and migration of neurons to reach their proper locations. Some glia have multipotent stem-cell-like properties. Astrocytes transport ions and neurotransmitters from the extracellular space into the cell to maintain the proper levels of ions and neurotransmitter in the extracellular space surrounding neurons. These functions are essential for maintaining the membrane potential of neurons necessary to fire electrical impulses and communicate by synaptic transmission. Cellular coupling among populations of astrocytes via gap junction channels siphons away potassium ions released by electrically active axons and disperses them through an astrocytic network for disposal in the bloodstream. Astrocytes provide physical support as well as metabolic support to neurons by delivering lactate and glucose. Microglia are the resident immune cells in the brain, which together with astrocytes,

Table 1 Functions of glia in the central nervous system

<i>Function</i>	<i>Type of glial cell</i>
1. Nervous system development	
Guide development and migration of neurons	Astrocytes
Multipotent stem cell properties	Astrocytes, NG2 glia
Axon pathfinding	Astrocytes
Inhibit axon sprouting	Oligodendrocytes
Help close the critical period	Oligodendrocytes
2. Homeostasis	
Regulation of ion concentration brain in tissue	Astrocytes
Provide physical support for neurons	Astrocytes
Provide physical support for axons	Oligodendrocytes
Provide glucose and lactate to neurons	Astrocytes
Regulate water and pH balance in brain tissue	Astrocytes
Control volume of extracellular space	Astrocytes
Contribute to extracellular matrix	Astrocytes
Detect foreign antigens	Microglia
Contribute to and regulate the blood–brain barrier	Astrocytes
Regulate local blood flow according to neural demand	Astrocytes
Provide antioxidants and reactive oxygen species	Astrocytes and Microglia
3. Synaptic function and information processing	
Remove neurotransmitters after release at synapses	Astrocytes
Release neurotransmitters	Astrocytes
Increase or decrease synaptic transmission strength	Astrocytes and microglia
Remove synapses	Microglia
Stimulate formation of new synapses	Astrocytes
Form electrical insulation (myelin) on axons	Oligodendrocytes
Control the release of hormones from neurons	Astrocytes
Sense and respond to neural impulse activity	Astrocytes, oligodendrocytes, microglia, NG2 glia
Release growth factors and cytokines	Astrocytes, oligodendrocytes, microglia
Have receptors for neurotransmitters	Astrocytes, oligodendrocytes, microglia, NG2 glia
Have receptors for hormones	Astrocytes, oligodendrocytes, microglia
Have ion channels	Astrocytes, oligodendrocytes, microglia, NG2 glia
Receive synaptic inputs	NG2 glia
4. Injury and disease	
Resident immune cells of the brain	Microglia
Multipotent stem cell properties	Astrocytes, NG2 glia

(Continued)

Table 1 (Continued)

<i>Function</i>	<i>Type of glial cell</i>
Respond to disease and injury	Astrocytes, microglia, oligodendrocytes
Targets of AIDS and other infectious diseases	Astrocytes and microglia, control neural excitability in chronic pain, epilepsy and other chronic states, astrocytes and microglia
Give rise to cancerous cells	Astrocytes, oligodendrocytes, NG2 glia
Inhibit axon sprouting	Oligodendrocytes
Participate in nerve regenerations	Astrocytes, oligodendrocytes, microglia, participate in Parkinson's disease, Alzheimer's disease, ALS, astrocytes, microglia, involved in multiple sclerosis, oligodendrocytes, microglia
Participate in other neurodegenerative disorders	Astrocytes, oligodendrocytes, microglia
Involved in chronic depression, schizophrenia	Astrocytes, microglia, oligodendrocytes, abnormalities seen in developmental disorders, such as autism, ADHD, oligodendrocytes
Receptors for opiates and cannabinoids	Microglia, astrocytes
Contribute to cognitive decline in aging	Oligodendrocytes, astrocytes, microglia

detect and respond to injury and infection. In addition to insulating axons, inhibitory proteins in myelin block axon sprouting and outgrowth, which helps close the critical period for learning and neuronal remodeling after injury. Many of these glial functions affect human behavior.

Glial Involvement in Mental Health and Behavior

Several cellular functions performed by glia involve them in many cognitive functions mediating normal and dysfunctional human behavior. Most pharmacological treatments for mental illness are based on regulating neurotransmission. SSRIs (selective serotonin reuptake inhibitors) used to treat depression, anxiety, and other psychiatric disorders, increase levels of the neurotransmitter serotonin in the synaptic cleft by inhibiting the reuptake of the neurotransmitter after it is released. Astrocytes at synapses, however, normally perform this function together with neurons (Figure 5). Many psychoactive drugs modulate neurotransmitter function. The psychotic behaviors of individuals under the influence of these compounds overlap with behaviors exhibited by people with mental illnesses such as schizophrenia. Similar cognitive effects may occur if astrocytes fail to properly regulate levels of neurotransmitters such as acetylcholine. Changes in astrocytes are seen in postmortem tissue of people with various mental illnesses. The decrease in the number of astrocytes in the cerebral cortex of people with chronic depression and schizophrenia, observed by Ladislav von Meduna in the 1930s, inspired electroconvulsive shock treatment, which remains the most effective treatment for medically refractory depression. In epilepsy, the number of astrocytes is increased and the astrocytes develop a more robust

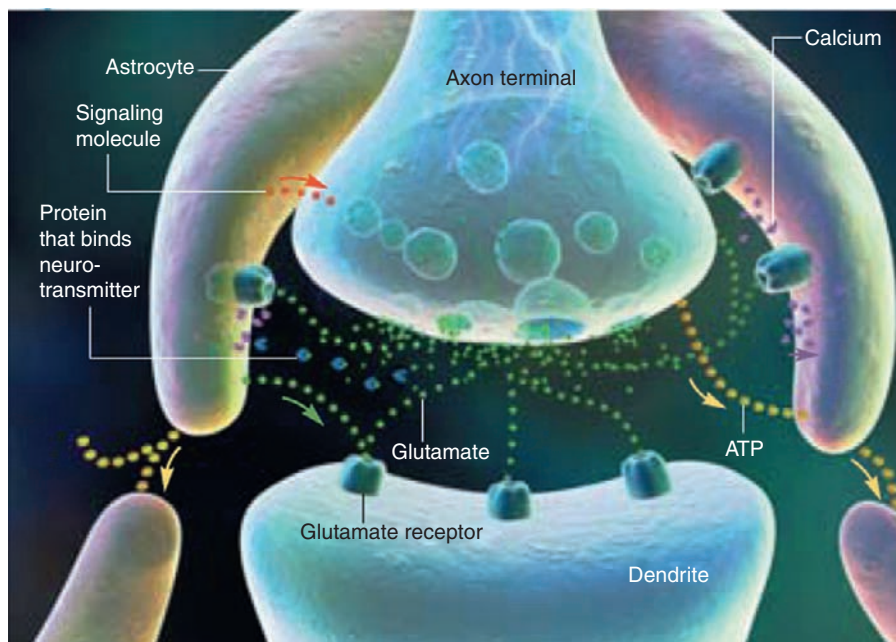


Figure 5 Astrocytes at synapses participate in synaptic transmission. Astrocytes at synapses have neurotransmitter receptors to detect the same chemical substances that allow neurons to communicate by synaptic transmission. Synaptic astrocytes also remove neurotransmitter from the synapse and release neurotransmitter and other neuroactive substances to increase or decrease the transmission of signals between neurons. Astrocytes can communicate with other astrocytes by chemical signaling to control the transmission of information at distant synapses. These functions of synaptic astrocytes involve them in many psychiatric illnesses, neurological disease, information processing, and the formation of memory. Reproduced with permission from Fields RD (2004) The other half of the brain. *Scientific American* 290: 54–61.

morphology, associated with biochemical changes affecting the cytoskeleton, membrane receptors, neurotransmitters, and other substances that astrocytes release. Increasing the number of astrocytes in the cerebral cortex of people suffering from chronic depression or schizophrenia by inducing seizure was proposed by Meduna in 1935 to correct the cellular imbalance. How electroconvulsive shock treatment works is still unclear, but the release of growth factors, neurotransmitters, and stimulation of neurogenesis may be involved. Glia participate in all these processes.

As glia and neurons share many of the same neurotransmitter receptors and ion channels, pharmacological treatments now in use likely act in part through effects on glia. In addition to having membrane receptors for most of the neurotransmitters used by neurons, glia have membrane receptors for many psychoactive compounds, including those in cannabis, heroin, and alcohol, as well as sex hormone receptors. The development of compounds targeted to glia should provide new drugs to treat mental and neurological illnesses.

Astrocytes at synapses also release neurotransmitters and other substances that affect synaptic transmission. Together with their role in taking up neurotransmitters, the release of neurotransmitters and other neuroactive substances allows astrocytes to regulate synaptic transmission to either facilitate or inhibit communication between neurons. This ability implicates astrocytes in epilepsy and many other neurological conditions where excitability is excessive or depressed. This is in keeping with the general homeostatic role of astrocytes in maintaining the environment for neurons and in moderating the general level of nervous activity. Behaviors such as sleep

and chronic pain are examples of astrocytes influencing neuronal excitability.

Oligodendrocytes are also implicated in mental illness by histological studies, analysis of gene expression, and brain imaging. Several genes are expressed at abnormally low levels in the brain tissue of people with schizophrenia and chronic depression, and a number of gene variants have been identified as risk factors for these mental illnesses. Many of these are genes expressed in oligodendrocytes or involved in controlling oligodendrocyte development. The number of oligodendrocytes is reduced in brain regions involved in higher cognitive functions. MRI brain imaging shows that the volume or structure of white matter tracts, which are brain regions where myelinated axons form major bundles connecting different regions of the cerebral cortex, is reduced in cortical regions known to be involved in schizophrenia and depression.

Glial Involvement in Neurological Illness

Astrocytes are involved in every aspect of nervous system injury and disease. Astrocytes and microglia are the 'first responders' to brain injury; they participate in scar formation, immune defense, and clearing and remodeling damaged tissue.

Glia are the major reason that damaged axons in the spinal cord and brain cannot regenerate. Damaged nerve fibers in the peripheral nervous system can regrow and establish proper connections to restore function because Schwann cells do not inhibit the outgrowth of damaged axons. Indeed, Schwann cells assist in the repair process by secreting growth factors and building extracellular matrix scaffolding to guide the

growth of regenerating axons to their proper targets. In contrast, proteins in the myelin sheath formed by oligodendrocytes, such as Nogo-A and others, strongly inhibit the growth and sprouting of damaged axons in the CNS (central nervous system). The normal role of this inhibitory protein may stabilize neural circuits in the brain after they have formed and been remodeled by functional activity that is driven by environmental experience and learning.

Mature neurons cannot divide. In contrast, many types of glia can divide and differentiate into oligodendrocytes, astrocytes, neurons, or other undifferentiated cells with the potential to generate various types of brain cells. This capability involves glia in responding to nervous system injury and disease, and in replacing brain cells lost with age by attrition. However, this 'stem-cell-like' property of glia also implicates them in brain cancer. Nearly all cancers originating in the brain are glial tumors.

Many infectious diseases attack glial cells and the loss of normal glial function results in neuronal degeneration or dysfunction. Dementia resulting from HIV is an example, as the virus does not infect neurons, but rather it infects microglia and astrocytes. Other neurological diseases result from direct effects on glia. Multiple sclerosis, which can impair sensory, motor, and cognitive function, is an autoimmune disorder that attacks oligodendrocytes forming the myelin insulation on nerve fibers, which is essential for normal impulse transmission. Axons that lose their myelin sheath can die, demonstrating the high degree of dependence of neurons on glial function.

Astrocytes release many types of growth factors and antioxidants that protect and stimulate the growth of neurons. Conversely, astrocytes under pathological conditions can release oxidizing compounds, neurotransmitters, inflammatory cytokines, and other toxic substances that damage or kill neurons. These actions involve astrocytes in neurological disorders such as ALS, Parkinson's disease, and Alzheimer's disease. The defensive actions of astrocytes and microglia also implicate them in cognitive decline in aging. Astrocytes can contribute to generating the toxic amyloid plaques that form in Alzheimer's disease, and microglia remove the toxic plaques. Both types of glial cells can be impaired in their normal functions when they become damaged due to Alzheimer's disease. A significant proportion of normal tissue loss in the aging brain results from the loss of white matter formed by oligodendrocytes. The regulation of blood flow by astrocytes implicates these cells in migraine and stroke.

Glia Participate in Information Processing and Memory

Glia are implicated in strengthening and weakening synaptic transmission in the hippocampus in conjunction with memory formation. Both strengthening and weakening of synapses (LTP and LTD; long-term potentiation and long-term depression) can be regulated by hippocampal astrocytes through the release of neurotransmitters, notably glutamate, ATP, and D-serine, but also by the delivery of glucose to neurons and the maintenance of normal concentrations of extracellular ions (notably potassium ions) and glutamate.

Glia communicate slowly compared to neurons. They communicate by broadcasting chemical signals rather than signaling serially as neurons do in communicating through chains of

synapses. A single astrocyte can cover large areas of the brain encompassing thousands of synapses. These features implicate glia in slowly changing nervous system processes having a more general influence on the brain. Examples include astrocyte regulation of hormone secretion regulating thirst, lactation, and maintaining the general levels of excitability in the brain.

Changes in white matter regions of the brain occur after learning complex skills, such as learning to read, play the piano, or juggle. White matter regions are comprised of axons coated with electrical insulation formed by oligodendrocytes. Situated beneath the grey matter cortex, white matter comprises half the volume of the human brain, which is a larger fraction than in any other animal. Changes in the number of myelinated axons or modifications of axons that are already myelinated could improve performance by optimizing the transmission of impulses between cortical regions mediating complex cognitive functions. The same effects on transmission speed and synchrony could involve white matter in cognitive dysfunctions, such as dyslexia, attention deficit hyperactivity disorder (ADHD), and psychiatric illnesses that are associated with disorganized or abnormal processing of cognitive function controlling thoughts, moods, and control of behavior. Electrical impulses in axons can be detected by oligodendrocytes and three cellular and molecular mechanisms for the activity-dependent communication between axons and oligodendrocytes have been identified thus far. These studies in cell culture have shown that action potentials can regulate glial cell proliferation and development, and stimulate myelination of unmyelinated axons.

Thus, the brain's glia and neurons work differently but in a close association that is essential for brain function. Glia perform far more functions in the brain than neurons. Neurons are highly specialized for rapid transmission and integration of information, but most of the brain's functions are carried out by cells that have been comparatively neglected by researchers until recently – glia.

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Grandparenthood

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Glossary

Co-parenting A caregiving arrangement in which grandparents and the adult child co-reside and often share responsibility for the care of the grandchild.

Countertransition A life event or role (e.g., becoming a grandparent) whose assumption depends upon the actions of others.

Custodial grandparents Grandparents who assume full-time responsibility for the raising of their grandchildren.

Skipped generation A caregiving arrangement in which the adult child is absent and the grandparents have sole caregiving responsibility for the grandchild.

Tenuous role A role (e.g., grandparenting) whose rights, responsibilities, and boundaries are ill-defined.

Verticalized families A multigenerational family in which the number of generations exceeds the number of persons within a given generation.

Introduction

Being a grandparent is generally viewed as a developmental task of middle or late adulthood; most persons are first-time grandparents in their late 40s. Indeed, grandparenting for some may help compensate for other losses they have experienced and give them a new purpose in life. If life expectancy is increased, the chances of becoming a grandparent are also increased. Seventy-five percent of those born in 2000 can expect to have at least one grandparent still living when they reach age 30. Nearly 60% of older adults have at least one grandchild, and 70% of older adults are grandparents. If we include persons who are in their 40s and 50s, the estimates of the number of grandparents would likely approach 80%.

There is great diversity among grandparents. The once-popular image of the grandparent as a kindly, elderly person in a rocking chair is no longer accurate. Grandparents are more likely to be men and women who are much younger, employed, and even have adult children still at home. This same individual may also be caring for a mother or a father who is quite old. Some people become grandparents in their 30s and 40s, while others do not become grandparents until their 60s or 70s. Because of this variability, it is not surprising to find that grandparenting is a *tenuous* role, having no clear criteria for what constitutes appropriate behavior. It is for this reason that grandparenting is largely an individual experience; while grandparenthood is imposed on persons, they nevertheless assign it meaning, and on that basis, adopt a particular style of grandparenting to reflect this meaning.

Despite the advantages to middle-aged and older persons whose identities centralize the role of grandparent and who see themselves as *self efficacious* grandparents (those who feel that they can exert a significant positive influence on the lives of their grandchildren), to the extent that people do not *choose* to be grandparents, the grandparent role has been termed a *countertransition*. That is, becoming a grandparent depends upon the actions of *others* (i.e., one's son or daughter), and thus, is not a role whose assumption individuals can control. Therefore, the meaning one assigns to being a grandparent and the particular style one assumes are *actively constructed* by each grandparent. In some cases, as grandparents know before they actually become

grandparents that they will be so, the process of actively constructing an assigned meaning and creating a satisfying style of grandparent may begin long before the birth of the grandchild.

While the grandparent–grandchild relationship may extend over 20 years, this is likely to be different when grandchildren are little and grandparents are in good health than when grandchildren are adolescents and grandparents are frail. Ultimately, if the grandparent's health deteriorates significantly, or that person suffers from dementia, the likelihood of that persons' eventual death becomes a loss with which both the adult child and the grandchild must cope. At the same time, for many older adults, becoming a grandparent can buffer fears about isolation, loneliness, feeling not valued, or dying.

Historically, we can expect future cohorts of grandparents to differ from their predecessors in several respects. Relative to previous cohorts of grandparents, today's grandparent is likely to live longer, be more educated, be in better health, have fewer grandchildren (decreasing competition between grandchildren for a grandparent's time), and more likely to be retired. For these reasons, grandparents are more likely to make meaningful investments of time, effort, and resources in their grandchildren's lives. On the other hand, children who are disadvantaged economically, who have single parents, whose grandparents are in poorer health or who have many grandchildren may not realize these advantages via a connection with a grandmother or grandfather. Yet, having a son or daughter who is a single parent can be seen as presenting many opportunities to be involved (again) in childcare and parenting (especially with a first-time mother who is caring for a handicapped/disabled or ill child) with the attendant possibility that the child and parent might disagree on issues regarding child-rearing, discipline, education, peer relationships, or whether the adult child should work or return to school. In this respect, grandparents and grandchildren are best thought of in dyadic terms; their influence on each other is dynamic and bidirectional, and often mediated by the nature of the grandparent's relationship to the grandchild's parent. Indeed, a family systems approach to understanding such relationships is not only beneficial but also indispensable. Thus, understanding grandparents at the level of their relationships with grandchildren as well as in the context of their relationships with

their adult children, spouses, age peers, and friends is key to an effective case conceptualization and clinical work with each member of the dyad.

A Life Course Perspective on Grandparents

The life course perspective is a dynamic approach to the study of change in families, to include the construction of social meaning surrounding life events and the social context in which transitions occur. The social context includes generational time, which refers to events or family transitions that alter interactions within families or change the ways that we view ourselves. Many of these transitions are predictable including adult children moving away from home and forming new partnerships and households. Divorces, births, deaths, and participation in work are other examples of normative life transitions experienced by families. In considering family time, these transitions may be characterized as normative, nonnormative, on-time, or off-time events. All transitions will influence the nature of the connections across the oldest (grandparent), middle (adult child), and youngest (grandchild) generations in a family, which is more likely to be *verticalized* (having more generations than there are persons within a given generation) now.

While the transition of parent to grandparent is normative and begins in middle age, grandparent–grandchild relationships are often mediated by the parent generation. Ties between grandchild and grandparent appear to be stronger when the ties between parent and grandparent are strong, and in some cases, relationships between older adults and their children-in-law are even more influential in determining quality grandparent–grandchild relationships. Often, the adult child's needs for instrumental and emotional support are central and it is these that activate the grandparent support system in times of family stress, where maternal grandmothers are the most involved in this respect. When all is well with their adult children, grandparents in the dominant culture typically adhere to a norm of noninterference, enjoying grandchildren, and engaging in family activities, but not playing an authoritative role with their grandchildren. They leave raising grandchildren and other family decision making to their adult children, and are likely to hold several other meaningful roles that may be more central to their lives and self-concepts than the role of grandparent. When things do not go right for their adult children, they (especially grandmothers) come to the rescue, making their parent and grandparent roles more central to their lives. They provide financial aid, housing, and emotional support to their single children, to children who divorce, and to their widowed children. The response of grandparents to a grandchild's disability or illness affects the ability of parents to adjust; when adult children are unable to take care of their own children, it is often grandmothers who step in and fulfill this role. In such cases, previously established relationships and the perception by family members that they were 'that kind of family,' one in which members helped one another in times of need, are key. Although intergenerational support from family members in times of crisis is common, it is clearly not a universal experience as it applies to remote or distant grandparents; such persons may not be helpful and indeed may cause additional stress to parents in times of need.

Grandparental Meaning

Key to understanding the meaning persons assign to grandparenting is the notion of the centrality of the role; while some middle-aged and older persons consider the role to define them, others consider it peripheral in their lives. Moreover, the grandparent role is not only *symbolic* (reflecting the meaning one assigns to it), but it also has *attitudinal* (beliefs about one's activities as a grandparent), *behavioral* (activities involved in one's interactions with grandchildren), and *emotional* (one's feelings about being a grandparent) dimensions that help define it.

While there is some evidence that more recent cohorts of grandparents construct a role that is either meaningful or not in *global* terms, that is, the role either is or is not, in varying degrees a meaningful one, historically, grandparental meaning has been viewed as multidimensional in nature, for example, being *central* in one's life, being the *valued elder* in the family, representing *immortality through clan* (living on through one's influence on a grandchild after one has died), allowing one to *reinvolvement oneself with one's personal past*, being able to be an *indulgent* (spoiling the grandchild) grandparent. As grandparenthood means different things to different people, how one perceives this role most likely influences one's style of grandparenting.

Meaning is also affected by the quality of one's relationship with the grandchildren. For example, White and minority young adult grandchildren believe their grandparents to be good role models and good sources of advice and support. Indeed, it is common to find that grandparents and grandchildren both give and receive tangible material and emotional support to one another. This type of mutually satisfying, reciprocal relationship strengthens one's convoy of support and enhances the positive meaning attributed to being a grandparent.

Styles of Grandparenting

There are many *styles* of grandparenting, and these are affected by a number of individual, environmental, and socioeconomic factors, especially the authority and control one exercises over the grandchildren. At one end of this continuum is the *surrogate-parent*, who will exercise authority and control over the grandchildren both in the presence and absence of the parent(s). For example, at the dinner table, if the grandchild engages in a behavior that is considered inappropriate, the grandparent will reprimand the grandchild. At the other extreme is the *fun-seeker* grandparent, who does not exercise any authority and control over the grandchildren. In the middle of the continuum are the *Formal*, *Reservoir of family wisdom*, and *Distant figure* styles, who will exercise authority and control over the grandchildren only in the absence of the parent, or on the authority of the parent.

The *Distant-figure* style is very common due to family mobility. It is important to note that although these types of grandparents may be distant in terms of physical proximity to the grandchildren, they may report being close emotionally. Further, when visiting with grandchildren, the distant-figure grandparent may take on characteristics of the other types of grandparenting styles, that is, fun-seeker or surrogate parent. While styles of grandparenting likely vary over time and with one's life situation, there is virtually no longitudinal work to empirically support this assertion. It is safe to say, however, that given the idiosyncratic nature of the meaning assigned to the role, there would be vast individual differences and

diversity regarding grandparenting styles, and that grandparental styles would likely change over time.

Given the above, it is not surprising to find that the role of grandfather is viewed as less salient than that of grandmother, and because of this, there is comparatively little research regarding the significance and function of grandfathers. However, grandfathers make unique contributions to the family network such as being reservoirs of wisdom and role models for those not regularly exposed to male family members.

Race/ethnicity affects grandparenting styles, where grandparents may serve the roles of the family historian or living ancestor, who teaches the grandchildren ethnic traditions, experience, culture, and history. For example, there are differences in grandparenting styles between African Americans and Whites, wherein African American grandparents have almost twice the degree of involvement with their grandchildren as Whites. Compared to Whites, African American grandmothers' parenting involvement is substantial, especially in the areas of control, support, and punishment. Indeed, Mexican Americans belong to larger, more multigenerational families; report higher satisfactions relating to their grandchildren; and have a greater degree of intergenerational contact. In this light, it would not be surprising to observe that cultural and subcultural variations may impact on the functions that accompany the grandparent role. This can include viewing grandparents as mentors for younger parents, as transmitters of cultural values and heritage, as persons who are agents of socialization for and influence over their grandchildren, or as persons who can simply enjoy their grandchildren but not be responsible for their raising. Grandparenthood can therefore be understood in terms of its primacy as a kinship relationship; that is, one becomes a grandparent through the birth of one's grandchildren. Whether one's cultural or ethnic background uniquely defines one's role as a grandparent depends upon whether this role is a valued one. Thus, studying the cultural context in which grandparenting occurs can enhance our understanding of what is likely a normative life transition for most middle-aged and older adults.

Influences on grandparents' contact with their grandchildren

Information on grandparent–grandchildren contact is important, since much contact with, and attitudes toward, older adults is partially influenced by interactions with grandparents. Moreover, contact with grandchildren is a dimension of grandparental style and is therefore influenced by the meaning one assigns to being a grandparent. If one's perceptions of a grandparent are positive, indicating affection and respect for grandparents, it likely enhances contact with that grandparent. Likewise, grandparents who centralize the role are likely to have more and/or desire more contact with their grandchildren. Thus, it is likely that grandchild contact influences and is influenced by the meaning and the style associated with grandparenting.

Race and ethnicity are powerful influences on how the grandparent is viewed by one's grandchildren, influencing contact with them. For example, African Americans see the grandparent role as a more active one in the family than do Whites, reflecting racial and cultural differences in perceptions of the extended family network. Viewed from the perspective of the grandparent, among African American and White grandfathers, it seems to be that (1) the grandfather role is more affectionate than functional among both older African

American and White men; (2) there is a higher centrality of the grandfather role among older African American than older White men (indicating that African Americans tend to be more involved in the lives of their grandchildren than Whites); (3) social and dependency factors, other than proximity, are of little relative importance in the grandfather–grandchild relationship; (4) as a group, African American men show greater variation in both the structural (number of grandchildren) and functional dimensions (association and helping) of the role. This variability appears to be related to (1) the African American family's flexibility in expanding and contracting sources to meet the specialized needs of various extended family members and (2) the flexibility of African American male family roles.

Kinship position is also a salient determinant of grandparents' contact with their grandchildren. Generally, maternal grandmothers and paternal grandfathers tend to display closeness and warmth toward their grandchildren, via the greater likelihood of contact between adult children (especially if they are female) and their mothers. In contrast, and only in a comparative sense, maternal grandfathers and paternal grandmothers manifest more negative attitudes toward their grandchildren, most likely borne of less direct contact with their son's children. As evidence suggests, grandmothers are more satisfied with their role than grandfathers; this may be due to their relative familiarity with intimate family relationships, having been principally responsible for raising their own children. Men who express satisfaction tend to be older, have had active relationships with their young grandchildren, and to have been happy with their involvement in the tasks of child rearing.

Gender also affects contact with grandchildren. Research indicates that grandmothers anticipate the role earlier than grandfathers and get involved sooner. Further, children tend to favor grandmothers over grandfathers, though they nevertheless report that their grandparents are influential in teaching and modeling moral values that are sexual, religious, or political in nature. Also, grandmothers are more likely to have frequent contact with their grandchildren. Grandchildren are therefore more likely to have more contact with maternal grandparents, and such contact with the maternal grandmother generally receives the most favorable evaluations. Not surprisingly, having meaningful frequent contact with a grandparent can buffer the effect of a parent's divorce, mental illness, or death. The age of a grandchild is a significant factor in the activities and roles played by its grandparents; grandparents play specific and different roles at different times in their grandchildren's lives. Specifically, when the grandchildren are young, grandparent roles focus primarily on direct care and involvement, such as play and child care. During the adolescence of grandchildren, grandparent roles revolve around listening, supporting, and serving as the family historian. As grandchildren get older and become more independent, their contact with grandparents likely lessens, though this lessened contact may not necessarily translate into less meaningful contact or perceive less influence of the grandparent on the grandchild.

As mentioned earlier, the number of grandchildren, in addition to age, also plays a significant role in the amount of contact with grandparents. As would be expected, as the number of grandchildren increases, the frequency of contact with each grandchild decreases, due to the fact that one's time and resources are limited.

Geographic distance is the strongest predictor of whether grandparents will have frequent or infrequent contact with grandchildren. The shorter the geographic distance, the more opportunity for interaction, though e-mail and texting may ultimately mitigate the effects of living far from one's grandparent. While geographic distance significantly influences the opportunity for contact between grandparents and grandchildren, most grandparents would like to maintain contact with their grandchildren. Physical proximity facilitates this interaction and distance decreases it.

The age of the grandparent also plays a significant role in contact with grandchildren and the types of activities grandparents engage in with their grandchildren; the age when one becomes a grandparent can greatly influence satisfaction with the role. As the age of the grandparents increase, the less able they are to get involved with active, physical interactions with the grandchildren, that is, active playing, sports, etc. Instead, with increasing age, grandparents provide more emotional support or offer advice to the grandchildren. The health of the grandparent (which may covary with grandparent age) is an obvious factor in determining the contact and types of interactions with grandchildren. It can affect one's vitality, types of activities engaged in, and emotional readiness to be a grandparent.

The quality of the relationship between the grandparent and his/her adult child has a key influence on the grandparent role; also, research consistently demonstrates that the quality of the relationship between a grandparent and his/her child affects the quantity of contact between the grandparent and that set of grandchildren. That is, the adult child serves as a *gatekeeper* for the grandparent–grandchild relationship. Furthermore, the quantity of contact depends on whether grandparents are linked to a set of grandchildren through a daughter or through a son, as maternal grandparents are more likely than paternal grandparents to have frequent contact with grandchildren (see above).

The grandparent's marital status also has an important effect on the frequency of contact with grandchildren, especially in the case of grandfathers. For example, divorced older men have far less contact with their adult children and grandchildren than married ones. Further, widowed grandfathers may have less contact with their grandchildren than married ones because they lack a wife to facilitate the maintenance of family ties. Marital status of grandmothers may also be significant because a lack of a spouse may weaken ties with children and grandchildren, or reduce the resources needed for traveling to visit the grandchildren. Overall, for both grandmothers and grandfathers, the ordering from most to least likely to have frequent contact with grandchildren is married, widowed, remarried, and divorced.

Overall, grandparenthood can indeed be satisfying to those who assign a positive meaning to the role, whose style creates the opportunity to interact with grandchildren, and whose relationships with the adult child are positive. The real value of grandparenthood for many middle-aged and elderly adults is that it can reinforce the sense of family; such persons have been referred to as *significant grandparents*. Such grandparents derive a great deal of satisfaction in knowing that the 'family theme' is being carried on by their grandchildren, even if contact with their adult children and their children's children are minimal.

Grandparents and Grief

Many middle-aged and older persons grieve over the losses that they have experienced in the context of their roles as grandparents. While grandparenting has become a common experience for most younger and older adults in our society, it is important to point out that grandparents, who may be as young as the late 30s, but are more likely to be in their mid-to-late 50s or older, may also be coping with other losses that overlap with the acquisition and maintenance of the grandparent role, which may interact with the death of a grandchild or the loss of contact with a grandchild via the divorce of an adult son or daughter, or affect the adjustment to the raising of one's grandchild via the death or divorce of an adult child. For example, grandparents, as persons who are aging, may be experiencing the loss of their own physical vitality, the loss of a salient work role via retirement or job loss, the loss of a vital relationship with a spouse who has become mentally or physically incapacitated, or the loss of a relationship with the youngest child via that child's departure from home. Such life changes may overlap, leading to what has been termed *bereavement overload*, affecting the nature and frequency of interactions with friends and other grandchildren, and undermining adaptive responses to any single loss. Such losses are not independent of one another. For example, changes in one's physical vitality may influence the nature of the relationship with a younger grandchild, that is, one may grieve over the loss of the ability to play with a school age grandson. Complementarily, grandparents who are ill, physically impaired, retired, or widowed themselves may be viewed differently by grandchildren who associate a relationship with a grandparent with physical activity, having the resources to travel, or with simply having both grandparents available. Thus, changes in the perception of the grandchild–grandparent relationship by both older and younger persons may be a source of grief to both.

We know virtually nothing about the normative dimensions of grief as they relate to grandparenting. Yet they are likely to affect a grandparent's particular response to other more primary losses through death or divorce. In the context of bereavement overload, the death of an adult child or grandchild may therefore symbolize the latest in a series of losses to which the grandparent has yet to adjust, complicating the grandparent's ability to function on an everyday basis, and negatively impacting on their mental and physical health. The death of a grandchild or the divorce of an adult child may coincide with the death of an older parent for some grandparents. While such topics have not been the subject of empirical research, they are not so obvious, but real, losses with which some grandparents may cope. While they may be secondary in nature, they are often co-experienced in concert with the death or divorce of one's adult child or grandchild.

More obviously, some grandparents may grieve the death of a grandchild, the death of an adult child, or the loss of contact with their grandchildren via disruptions in relationships with an adult son or daughter via the latter's divorce or separation. As the adult child helps mediate the degree of contact between grandparents and grandchildren, disagreements between adult children and their parents about child-rearing issues can undermine opportunities for and the quality of relationships with grandchildren. In this respect, 'token' grandparents report

feeling emotionally isolated from their grandchildren. Likewise, relationships with surviving grandchildren, or with an adult child (in the event of a divorce or death of a grandchild), may deteriorate.

Underscoring the salience of such losses in the lives of grandparents is the fact that grandparents play an important role in a grandchild's emotional, cognitive, and social development. Emotionally, grandchildren who benefit from a positive relationship with a grandparent will be better equipped to handle psychosocial conflicts throughout their lives. In addition, through the provision of unconditional love, grandparents aid in their grandchildren's developing self-esteem. Through the transmission of values and in serving as a support system in times of crisis, grandparents can play a significant role in the life of their grandchildren. In this context, it is important to point out that the importance of grandparents does not necessarily diminish as grandchildren reach adulthood, as adult grandchildren list knowing their grandparents and feeling close to them as important qualities in their relationship with a grandparent. Adult grandchildren also expect grandparents to be a buffer between their parents, in addition to being a role model and financial advisor. Thus, it is not surprising that grief is a shared emotional response to the divorce or death of an adult child on the part of the grandparent and grandchild.

As is grandparenthood itself, becoming a grandparent caring for a grandchild, adjusting to the death or incapacitation of a grandchild, or to the death, divorce, or separation of an adult child are all events that also are *countertransitions*. Thus, in terms of understanding grandparents' responses to such losses, it is helpful to see them as analogous to the experience of acute grief, that is, the reaction to sudden death, commonly believed to be more problematic than grief that is anticipatory in nature.

In contrast to the central role that grandparents can play in the lives of their grandchildren, the grief that they experience can best be understood in the context of what is termed *disenfranchised grief*. Such grief is deemed unimportant by others, and thus, survivors are 'not accorded a right to grieve.' This leads to a lack of support from family, friends, or coworkers, and therefore leads to diminished opportunities to reach out emotionally to others who, ironically, often not only do not (and sometimes, cannot) offer sympathy, physical, and instrumental support, but also cannot understand or empathize with what the grandparent may be going through emotionally.

Five characteristics define disenfranchised grief, each of which is relevant to grandparents: (1) *the relationship is not recognized*, wherein among grandparents who may not be seen as central to the family system, feelings and needs may be put on hold or ignored all together at the expense of those of the adult child/parent; (2) *the loss itself is not acknowledged*, as when a grandchild dies shortly after birth, or when the adult child has experienced an abortion or miscarriage; (3) *the griever is excluded*, as when a grandparent who is cognitively impaired via stroke or Alzheimer's disease is denied information about the death of a grandchild, is not permitted to ask questions or attend the funeral, on the assumption that they can no longer comprehend the nature of death; (4) *the circumstances of the death*, as when an adult child or a grandchild dies of AIDS or via suicide, or when grandparents assume caregiving responsibilities under stigmatizing social circumstances, such as in the

case of the incarceration of an adult child, unemployment, divorce, parental drug use, or sexual abuse of the grandchild (see below); and (5) *the ways individuals grieve*, referring to whether displays of emotion are appropriate versus grief that is expressed physically, cognitively, or instrumentally (e.g., involving oneself at work), where the former are encouraged shortly after a death, and the latter are not. In contrast, crying months or years after a death might be considered to be inappropriate as might going back to work too soon after a death. Grandfathers, for example, may be especially handicapped in this respect, in that they are more likely to express their grief instrumentally.

In the event of a grandchild's death, grandparents are often seen as 'forgotten grievers' to the extent that attention is focused upon the impact of the child's death on the parents. It is often presumed that because they have had more experience with death, grandparents will need less support and education in their adjustment to their grandchild's death. While the scientific literature is just emerging as it relates to grandparents' emotional needs when a grandchild dies, it has been observed that although their grief is likely to be twofold: they grieve for their adult child as well as for themselves. Family customs and rituals may not meet a grandparent's needs, and grandparents are put in a delicate position of attempting to support their adult child as well as meet their own needs for support from others. In many respects then, such grandparents' grief is indeed disenfranchised.

While published *empirical* research specific to grandparent bereavement following the death of a child is rare, we know from the writings of bereaved grandparents and those who provide support that grandparents are deeply affected by their loss, provide extensive support to their adult children, and may receive little attention or support from others. Compared to bereaved parents, grandparents are often focused on meeting the needs of their adult children, presumably to the exclusion of their own needs of support and understanding.

Published literature also suggests that although parents and grandparents have had different role relationships with the child who has died, grandparents tend to have shared many of the same responses as the parents to the death of the child. Yet parents express these feelings more often than grandparents and parents exhibit greater distress than grandparents. In some cases, grandparents report that they had not formed attachments to deceased grandchildren, usually those who were stillborn or died very early in infancy. Based on what we know at present, it is clear that grandparents experience much trauma in witnessing the pain and sorrow of their adult children and their own sense of helplessness in alleviating that pain, regardless of their level of closeness to the adult child. This appears to compound their own grief at the loss of their grandchild. Support offered by grandparents is at the cost of putting aside their own grief to attend to the needs of their children and their surviving grandchildren. On the other hand, grandparents identify being included by their adult children and being able to express their own feelings and emotions with their adult children as important sources of personal support they received from their bereaved children. In some cases, offering such support may bring them closer to their children. In other cases, a history of no relationship or a strained relationship with the child would explain a lack of support. Grandmothers are more likely than grandfathers to express a desire to

talk about the child who has died, and are more likely to turn to daughters than to sons for support. Grandfathers, more than grandmothers, offer instrumental support to their children through performing tasks and offering financial assistance, and engaging in work as a means to help with their recovery is more common among grandfathers than grandmothers.

While we know very little about the coping skills used by grandparents following their grandchild's death, they may use such coping skills as reminiscing, spiritual reappraisal, focusing on others, work activities, and moving on with previously made plans. For grandparents, *meaning making*, influenced by factors associated with the death, time since death, gender, generation, and lineage can be understood in terms of *making sense* and *finding benefit*, where the former refers to talking about their efforts to understand why these babies died, drawing on both rational (i.e., medical, physiological) and spiritual or philosophical reasons, and the latter refers to seeing greater closeness in family relationships, changed perspectives or worldviews, and personal growth. Important for grandparents are continuing bonds with the infant who has died, that is, funerals or memorial services, sharing memories of the child; rituals associated with holidays, birth, and death dates; spiritual connections; and symbolic representations (photographs and objects representing the child).

Grandparents and Divorce

Grandparents also grieve when they lose contact with their grandchildren because of the divorce of their adult child. Contact with grandchildren can diminish after divorce, but this depends on the physical proximity to the grandchild, the grandchild's age, and the gender and lineage of the grandparent. Importantly, divorce, separation, or remarriage for granddaughters can be seen as *opportunities* to reconnect with a grandmother.

The grandparent role has been described as a *double bind*, where grandparents must be ready to assume child care duties when asked by a son or daughter, and they cannot express their disagreement over the adult child's parenting practices lest they be prevented from interacting with their grandchildren. If there have been previous disagreements with the mother about child-rearing, when the mother has custody and moves away, both maternal grandmothers' and paternal grandparents' access to their grandchild may be limited. Indeed, the impact of the loss of contact with the grandchild depends upon whether the grandparent is viewed as an *agent* in the lives of a grandchild (by providing support and serving as a role model), or whether the grandparent is viewed as a *victim* (grandparenting is viewed as a compensation for the lack of other sources of life satisfaction). Relationships with grandchildren are most satisfying when visits with both a daughter and a grandchild are maintained.

Grandparents grieve over the failure of a child's marriage, worry about a grandchild's safety and well-being, fear never having contact with the grandchild ever again, and report intense feelings of depression, sadness, feeling useless and unfulfilled. Not surprisingly, in the event of divorce, less physical and emotional contact with grandchildren is associated with poorer physical health and emotional well-being. In most cases, it has become necessary for states to enact laws to

guarantee grandparents' visitation rights in the event of divorce, wherein some grandparents are able to successfully acquire court-ordered visitation if it is perceived to be in the best interests of the child and does not intrude on the rights of the newly adoptive parent. Complimentarily, when grandparents divorce, they report feeling less close to their grandchildren, less likely to play a friend role, and more conflicts with grandchildren, though such effects are moderated by the quality of the relationship with the adult child.

Step Grandparenting and Great Grandparenting

There is a limited literature on step grandparenting and great grandparenting. With regard to becoming a step grandparent, what exists suggests this to be a particularly ambiguous role, wherein positive relationships with step grandchildren are facilitated by (step) parental support, and often have much to do with the age of the step grandchild when the remarriage occurred and the quality of that child's relationship with the step parent. Regarding great grandparents, who are becoming more numerous as persons live well into their 80s, the little we know suggests that this role can have positive consequences in terms of contributing to one's self-esteem if the great grandparent role in the extended family is well defined and internalized as important by the great grandparent. Being a great grandparent may also help one cope with widowhood, and there are incidences of great grandparents raising their great grandchildren.

Custodial Grandparenting

It has been observed that custodial grandparents, adults who are caring for their grandchildren on a full-time basis, are becoming more prevalent. In 2000, 5.7 million grandparents lived with their grand children, and ~2.4 million of such persons were raising their grandchildren. Since 1990, there has been a 30% increase in the number of children (half of whom are under the age of 6) living in households maintained by grandparents. While the absolute incidence of grandparent caregiving is greater for Whites, the odds of becoming so are greater for Hispanics and African Americans.

That grandparent caregivers are both ethnically and culturally diverse is perhaps what is most notable about them. In this respect, the most recent (2000) Census data found that the incidence of grandparents living with their grandchildren varies greatly by race/ethnicity, with Whites considerably less likely to do so (2%) than Asians (6%), American Indians and Alaska Natives (8%), African Americans (8%), Hispanics (8%), and Pacific Islanders (10%). Of such persons, Asians (20%) were least likely to be solely responsible for their grandchildren, relative to Whites (41%), Hispanics (35%), African Americans (52%), American Indians and Alaska Natives (56%), and Pacific Islanders (39%).

Custodial grandparents tend to be younger, more likely to be the mother's parents, have poorer health and fewer social and economic resources, are less highly educated, and are more likely to be raising boys, all relative to traditional, noncaregiving grandparents. The common difficulties reported by custodial grandparents are less satisfaction with grandparenting, less meaningful grandparenting, impaired or strained relationships with their grandchildren, isolation from other

grandchildren and friends because of their parental responsibilities, feeling overloaded and confused about their roles as parents and grandparents, and caring for children (often boys, whose behavioral/emotional problems are more likely to be externalizing) who have behavioral or school difficulties, for which these grandparents are less likely to seek help.

Some grandparent caregivers, whose cultural traditions help define the caregiving experience by virtue of their exposure to insensitive or unskilled service providers, or as influenced by their negative feelings about seeking help from 'outsiders,' may be less likely to ask for assistance for themselves or their grandchildren. Thus, service providers who are sensitive to cultural traditions may be not only more effective in facilitating such grandparent caregivers' access to services, but also more sensitive in dealing with grandparent caregivers. Such interactions can go a long way toward helping grandparent caregivers feel that they are not alone in facing the challenges of raising a grandchild.

Many children being raised by their grandparents live in poverty, the percentage of grandparent caregivers living below the poverty line (19%) being greater versus other types of families with children (14%). Many such children have difficulty registering for school and while 20% of children in homes headed by their parents have no health insurance, 33% of children in grandparent-headed homes lack such insurance. Such difficulties are greatest for grandparents who are caring for their grandchildren 'informally,' lacking a formal legal basis (e.g., adoption, legal custody, guardianship) for doing so. In some cases, they care for grandchildren in a 'skipped generation' household, where the adult parent is absent, and in other cases, they have a 'co-parenting' household, wherein the grandparent and the adult child co-reside, even though the grandparent may have assumed primary responsibility for caring for the grandchild. These family constellations vary with ethnicity, that is, co-parenting is more common among Hispanics and African Americans, and skipped generation households grandparents tend to fare worse physically and emotionally. Unfortunately, grandparent caregiving usually comes about for reasons linked to the divorce, drug use, incarceration, job loss, or death of the adult child, as well as when the parents abandon or abuse their child. These circumstances are stigmatizing and isolate grandparents from needed sources of social and emotional support as well as make it difficult to be treated equitably by social service providers.

Most custodial grandparents, who are in their mid-to-late 50s, would likely endorse the notion that raising a grandchild is the most important task before them. Relative to parents who are raising their children, however, custodial grandparents often have little time to prepare for this tremendous responsibility, assume it under socially stigmatizing and oftentimes negative family circumstances, and frequently have had little direct and/or ongoing responsibility for raising a child for many years.

Underscoring the emotional and physical toll that caregiving takes, the incidence of such illnesses as depression, diabetes, hypertension, and insomnia is greater among grandparent caregivers, who often report more difficulty than their age peers in performing activities of daily living, and over time are more likely to experience poorer physical and mental health than noncaregivers. Such illnesses may cause custodial grandparents to fear for their grandchildren's well being in the event of their

own disability or death. Indeed, 'high levels' of caring for grandchildren (i.e., 9 h per week) increases women's risk of coronary heart disease over time. Taking on the parenting role can also strain grandparents' marriages and disrupt their life plans. Many custodial grandparents come to resent their children for creating the situation leading to the care of the grandchild, and yet, they may feel guilty over having failed as parents in raising such a child. To the extent to which the relationship with the adult child is ambivalent or the relationship between the grandparent and grandchild/adult child is poorly defined, the demands on the grandparent caregiver are more debilitating. Despite these demands, many grandparents put their own needs behind those of their grandchild, and feel a strong sense of love and commitment to their grandchildren to ensure that their lives turn out for the best.

See also: Parenting; Peer Relationships and Influence in Childhood; Personality Development and Aging; Personality Development; Retirement; Socioemotional Development.

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Relevant Websites

- www.aarp.org/families/grandparents/gic – American Association of Retired Persons Grandparent Information Center.
- www.generationsunited.org – Generations United.
- www.grandparents.com – *Grandparents.com* offers online resources for grandparents with their grandchildren.

Grief and Bereavement

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Glossary

Bereavement The situation of having recently lost a significant person through death. Bereavement is the cause of both grief and mourning.

Grief The primarily emotional reaction to bereavement, incorporating diverse psychological (cognitive, social/behavioral) and physical (physiological/somatic) reactions. Grief is a normal reaction to loss, not an illness or psychiatric disorder, although it is associated with higher risk of these disorders.

Grief counseling The helping of people through counseling to facilitate uncomplicated, or normal, grief to alleviate suffering and to reach healthy completion within a reasonable time frame.

Grief therapy Specialized techniques of intervention for bereaved individuals with an abnormal or

prolonged grief reaction to guide them toward a normal coping process.

Grief work The cognitive process of confronting the reality of a loss through death by going over the events surrounding the death, and of focusing on memories and working toward a detachment from the deceased.

Mourning Refers to the acts expressive of grief. These acts are shaped by the mourning practices of a given society or cultural group, which serve as guidelines for how bereaved persons are expected to behave.

Prolonged or complicated grief A deviation from the normal (in cultural and societal terms) grief experience in either time course or intensity of specific or general symptoms of grief.

Introduction

Bereavement is defined as the situation of having recently lost a significant person through death. Although comparatively rare in childhood, bereavement is a stressful life event that, sooner or later, becomes part of nearly everyone's experience. According to some estimates, of children younger than 18 years, 3.4% have experienced the death of a parent, whereas in elderly populations, spousal bereavement is most frequent, with ~45% of women and 15% of men older than 65 years becoming widowed. Thus, bereavement can be viewed as a normal, natural human experience. Even though suffering can be acute and the loss experience extremely painful, most people manage to come to terms with their bereavement – without the need for professional help – over the course of time. Nevertheless, it is associated with an increase in mental and physical health problems, and for some, these difficulties are extreme and persistent. Adjustment can also take months or even years, and there is substantial variation between individuals and across cultures. As such, bereavement is a concern not only for preventive care, but also for clinical practice.

Grief is understood to be a mainly emotional reaction to bereavement, incorporating diverse psychological and physical reactions, while a related term, mourning, denotes the social expressions or acts expressive of grief, which are shaped by the practices of a given society or cultural group. A minority of bereaved persons suffer from complications in the grieving process itself. Complicated grief has been defined as a deviation from the normal (in cultural and societal terms) grief experience in either time course or intensity, or both, entailing a chronic and more intense emotional experience, or an absent or inhibited response, which either lacks the usual symptoms or in which there is a delay in the onset of symptoms. Complicated

grief has not yet been classified as a category of mental disorder in the Diagnostic and Statistical Manual of Mental Disorders, although efforts are being made to have it included as a separate category in forthcoming editions (see section 'Forms of Intervention: Counseling and Therapy').

Over the past few decades, scientific study of phenomena relating to bereavement, grief, and mourning has expanded rapidly: reactions and symptoms, mental and physical health outcomes, risk factors, and efficacy of intervention have all been documented in increasingly sophisticated research investigations. Alongside such developments, theoretical models have been suggested to increase understanding of the manifestations relating to bereavement, grief, and mourning. Taken together, such research seeks to develop ways to identify and provide preventive care for individuals at risk for bereavement-related health problems.

The purpose of this article is to provide an overview of the current state of knowledge with respect to grief and bereavement. Several basic issues are addressed. First, the range of reactions and symptoms that constitute the syndrome of grief are described and changes in grief and grieving over the duration of bereavement are considered. Then the psychological and physical effects of the loss of a loved person on survivors are reviewed: Is the risk of succumbing to health disorders – even to mortality – greater in bereaved than nonbereaved counterparts, and what is the prevalence of health outcomes? Identification of especially vulnerable subgroups and risk factors are the focus of the following section. This leads to an overview of psychological intervention programs and evaluation of their effectiveness in reducing the risk of negative health consequences in bereaved individuals: Can counselors and therapists help to reduce the health problems of bereaved people? Finally, major psychological theories that have

contributed to understanding the health consequences of bereavement and how people go about coming to terms with their loss are outlined.

Symptoms and Course of Grief

In 1944, Lindemann published a systematic analysis of the range of symptoms associated with bereavement. Current understanding still owes much to this early formulation. Patterns of normal grief responses typically cover the following dimensions: affective manifestations include depression, despair and dejection, anxiety, guilt, anger and hostility, anhedonia, yearning, longing and pining, and loneliness; behavioral manifestations include agitation, fatigue, crying, and social withdrawal; cognitive manifestations include preoccupation with thoughts of the deceased, lowered self-esteem, self-reproach, helplessness and hopelessness, suicidal ideation, a sense of unreality, and problems with memory and concentration; physiological and somatic manifestations include loss of appetite (or appetite gain), sleep disturbances, energy loss and exhaustion, somatic complaints, physical complaints similar to those that the deceased had endured, changes in drug intake, immunologic and endocrine changes, and susceptibility to illness and disease. There is lack of evidence specifically on cross-cultural differences in these dimensions. However, studies from related areas, such as depression research, and clinical experience lead one to expect cultural differences in the relative frequency of symptoms across these different dimensions. It is also important to note that, while it has become familiar to talk about the 'symptoms' or 'symptomatology' of grief and grieving following early writers in the field, the above reactions are normal to bereavement and not necessarily a sign of physical illness or psychiatric disorder, even though bereavement is associated with a higher risk of these disorders.

The symptoms outlined above are more or less frequently found across different durations of bereavement. A milestone in the development of understanding the nature of grief and grieving over time was provided by John Bowlby in his three-volume monograph, *Attachment and Loss*. Bowlby documented his own observations with respect to the close relationship between manifestations of grief and time since death, which led him to suggest 'phases' or 'stages' of grief, linking many of the symptoms to different durations of bereavement. Bowlby postulated a succession of phases from an initial stage of shock, with associated symptoms of numbness and denial, through yearning and protest, as realization of the loss develops, to despair, accompanied by somatic and emotional upset and social withdrawal, until gradual recovery occurs, which is marked by increasing well-being and acceptance of the loss. Durations vary, but generally the first two phases are suggested to last up to a number of weeks, and the third, intense grieving phase may last several months or even years. There is considerable cross-cultural variation in the duration of the phases across time (or even with respect to their presence at all), which has to do with mourning customs and cultural norms.

There has been wide acceptance in the scientific as well as in applied fields of such phasal descriptions. However, it cannot

be assumed that a bereaved person will go through these phases in a set order, or even that they are necessarily conducive to good adjustment. Almost without exception, and certainly in the case of Bowlby's original formulation, the phases were introduced as descriptive guidelines, to aid understanding of loss and separation phenomena. They should not be regarded as set rules or 'prescriptions' regarding where the bereaved person ought to be in the 'normal' grieving process. Care must also be observed in speaking of 'resolution' or 'completion' of grief. Most bereaved people would confirm that one does not 'get over it and back to normal life' but rather, that one adapts and adjusts in the course of time to the changed situation and generally that one succeeds in reaching a new equilibrium.

A second influential scientific contribution to understanding the course of grief and the difficulties that are entailed at different periods has been William Worden's so-called task model, described in his monograph *Grief Counselling and Grief Therapy*, much used in counseling and therapy. This approach takes more account of the richness of idiosyncratic manifestations of grief than do phase models. Here, the grief process is taken to encompass four tasks, namely, acceptance of the reality of the loss; processing the pain of grief; adjusting to a world without the deceased; and finding an enduring connection with the deceased in the midst of embarking on a new life. Again, it needs to be emphasized that not all grieving individuals undertake these tasks and that they will be dependent on cultural factors (e.g., in societies where reverence of ancestors is customary, 'an enduring connection' takes place in a very different way: the deceased is, in a sense, still present). Further discussion of these duration-related models will be included in section 'Forms of Intervention: Counseling and Therapy' on theoretical approaches to grief and grieving.

Health Consequences

The majority of bereaved individuals undergo tolerable levels of the above symptoms, and research has shown that over the long term, most bereaved people are resilient, recovering with time from their loss, both emotionally and physically. However, the bereaved are indeed at greater risk than the nonbereaved of suffering from a variety of mental and physical ailments and disorders. These include depression, anxiety disorders, somatic complaints, and infections. In cases where the loss of life has been massive, or the nature of death horrific, bereaved persons are at risk of developing posttraumatic stress disorder. A minority are also vulnerable to complications in the grieving process itself, and sometimes this is related to other preexisting mental-health difficulties. While some of these ailments are most closely associated with recent bereavement, others extend over a longer time span. In line with these patterns, bereaved persons also have higher rates of disability, medication use, and hospitalization than nonbereaved counterparts. The former also consult with doctors more frequently than the latter, although there is also evidence that many of those with intense grief might fail to consult with doctors when they need to.

How prevalent are health problems following bereavement? Estimates vary considerably, depending not only on

the type of debility (and its precise measurement) but also across cultures and according to sample characteristics (e.g., the type of loss: whether death was of a spouse, child, or more distant relative; the nature of loss: whether it occurred in a timely or traumatic manner). Nevertheless, a few general patterns are evident. Most importantly, in general one can conclude that, across a range of debilities such as physical health difficulties, psychiatric disorders (such as posttraumatic stress disorder and clinical depression) and complicated grief, reasonably substantial minorities of bereaved individuals do suffer from severe and lasting consequences following the loss of a loved one, with a rough estimate of around 20–30% prevalence emerging from the different health vulnerability areas. For example, in one study of young widowed compared with matched married persons, 20% of the widowed compared with 3% of the married suffered from severe physical symptoms at 4–6 months post-loss. After 2 years, the rate among the widowed declined to 12%. Given the large number of people who are bereaved at any one point in time, this entails large numbers of persons at risk.

Not only are there a variety of ailments and disorders, but in extreme cases, there is also a higher risk of mortality following bereavement. An increasing body of scientific evidence testifies to the fact that bereaved persons can die of a 'broken heart,' either in the narrow medical sense, in which death occurs (excessively, compared with nonbereaved counterparts) as a result of heart disease, or in a broader metaphorical sense, when death occurs from a variety of causes such as suicide and alcohol-related causes, lung cancer, accidents and violent deaths, causes which are thought to bring about death indirectly, as a result of extreme suffering and pain following the death of a loved one. Most research indicates an early excess risk of mortality for bereaved persons, although excesses have been shown to persist for longer than 6 months after bereavement. It is noteworthy that sex difference patterns vary across types of loss. Whereas partner loss appears to affect men relatively more than it does women, the death of a child seems to have an even greater excessive mortality risk for mothers than for fathers, with relatively more bereaved mothers dying compared to nonbereaved counterparts than was the case for fathers. A study in Denmark showed that excess risk of dying for bereaved mothers extended at least across the first 18 years (the period of the study), whereas for fathers, greater risk was found early on in bereavement, particularly from unnatural causes such as suicide. Nevertheless, it is important to remember that the risk of mortality only affects a very small proportion of bereaved people. For example, in one sample of middle- to old-aged widowers, a mortality rate of 4.8% was observed, as compared with 3.2% for a comparable sample of married men.

Risk Factors

Given the physical and mental-health complications described above, as well as additional difficulties that bereaved persons experience in their ongoing lives (e.g., problems with continuing to work during their bereavement; difficulties in relationships with other persons; memory and concentration problems), research has been directed toward identifying risk

factors, that is, the situational, intrapersonal, and interpersonal characteristics associated with increased vulnerability to the range of debilitating bereavement outcomes. Some researchers have also examined protective factors that appear to promote resilience and to lower risk of adverse health outcomes. Research has also incorporated analyses of the coping process, which can impede or facilitate adjustment, looking at whether there are healthy and unhealthy ways of going about grieving.

The situation and circumstances of death contribute to adjustment, in complex ways. It is important to take the broader circumstances of death, including such factors as cause of death and caregiver strain, into account and to realize that a combination of situational factors (combined with other types, e.g., personal factors) can jointly account for the impact on adjustment. It has frequently been concluded that sudden unexpected death leads to worse bereavement outcome. However, caring for a very sick, terminally ill spouse over a long period has also been found to increase the likelihood of health difficulties subsequent to death.

Characteristics intrinsic to the bereaved individual and/or of the relationship to the deceased also play a part. Research on attachment strongly suggests that the quality and nature of the lost relationship has much impact on outcome. Robust individuals also adjust better to bereavement than people who are fragile. These patterns are probably related to attributional and emotional regulation processes; current research is beginning to look further into such underlying cognitive processes (see below). Childhood loss of a parent is one of the better-researched areas, indicating various long-term effects. Importantly, evidence suggests that the adequacy of remaining parental care (e.g., warmth combined with discipline) after the death of one parent, and personal characteristics of the child (i.e., factors contributing to resilience) are more powerful predictors of later adjustment than the loss of the parent *per se*.

Turning to interpersonal factors, inadequate social support (i.e., informal help provided by family, friends, and neighborhood networks) has generally been regarded as a major variable, protecting individuals from the negative health consequences of bereavement. However, research has shown social support to be a general risk factor, one that affects the health and well-being of nonbereaved as much as bereaved persons. It seems that others cannot easily take the place of the deceased individual or make up for the loneliness experienced on the loved one's death. Use of professional support can also be regarded as an interpersonal resource factor, one that for some, but by no means all bereaved people, can help adjustment to bereavement. We consider this factor in the next section on intervention for the bereaved.

The way that individuals go about dealing with the loss of a loved one, their coping with loss, is important because, unlike many other risk factor variables, it can be changed. For example, it may be amenable to brief interventions. Following older theorizing in the bereavement area, it was generally accepted that bereaved persons had to do their 'grief work' in order to overcome the loss of a loved one. Grief work was understood to entail confronting the reality of the loss and relinquishing the bond to the deceased person. More recently, doubts have been expressed about the adequacy of this postulated form of healthy coping. Empirical research has shown that people who do not work through grief frequently recover as well as, if not

better than, those who do so. Findings on emotional disclosure or social sharing, or on negative effects of avoidance or repression, also provided little support for the grief work notion.

Finer-grained examinations of maladaptive processes are beginning to provide useful leads. They suggest the importance of positive as well as negative cognitions and the regulation of emotion in the grieving process, both of which have been integrated into the dual process model (DPM) (see also section 'Forms of Intervention: Counseling and Therapy'). This model addresses shortcomings of the grief work model and posits an oscillation process, whereby the bereaved individual both confronts and avoids different stressors associated with bereavement. Adaptive grieving thus entails processes of both confrontation and avoidance.

As mentioned earlier, the situational, intrapersonal, interpersonal, and coping risk factors illustrated above affect the bereavement outcome in complex ways. We have noted the likelihood of interactions between factors such as personality and circumstances of death. Many potential risk factors have been under-researched, which makes it difficult for scientists to develop valid screening instruments for use by practitioners. Furthermore, the ways that risk factors relate precisely to the different health outcomes also remain to be seen, such as, for example, why one person may succumb to mental-health disorders while another might die prematurely after bereavement.

Measurement: Normal and Complicated Grief

A number of self-report questionnaires have been developed for the measurement of reactions to bereavement. Most of these inventories have been developed to enable categorization of the range of symptoms of grief in adults, to enable estimates of the intensity of grief and its various components. Frequently used batteries currently include Prigerson and colleagues' Inventory of Complicated Grief-Revised; Hogan, Greenfield, and Schmidt's Hogan Grief Reaction Checklist; and Faschingbauer, Zisook, and De Vul's (Revised) Inventory of Grief. Over the years, more specific measures have also been developed, including Toedter, Lasker, and Alhadeff's Perinatal Grief Scale; the Hogan Sibling Inventory of Bereavement; and Barrett and Scott's Grief Experience Inventory, which focuses on reactions characteristic of suicide bereavement, including feelings of disgrace or guilt.

It is important to realize that there are limitations with respect to applying such instruments for the assessment of grief reactions, and that they are generally more appropriate for research purposes than for clinical use. Individual assessment needs to take account of variables beyond those evaluated through psychometric instruments that are based on self-reports. Such inventories are also unlikely to be comprehensive. Furthermore, difficulties may have to do with just one or a few aspects of the total response (such as disgrace or guilt – but may be not loneliness, depression, or any other symptoms listed – following suicide bereavement). In such cases, calculating a score for the total symptom intensity would clearly not give an accurate picture of the difficulties associated with the loss. Psychometric properties and establishment of norms still need further investigation in the case of many of the developed questionnaires. It must also be remembered that grief itself is a

complex process; it cannot be assessed according to normality versus deviation without taking the length of time since bereavement into account.

Over the past decade, increasing effort has been made, most notably by Holly Prigerson and her colleagues, to develop criteria for the diagnosis of *complicated* or – as currently labeled by Prigerson – *prolonged grief*, for potential inclusion as a diagnostic category in the forthcoming edition of the *Diagnostic and Statistical Manual of Mental Disorders*, which is published by the American Psychiatric Association (bereavement is currently only considered among the V-Codes). These criteria are still being subjected to empirical testing and need to be applied and validated among wider subgroups of bereaved persons.

Given the arguments illustrated above regarding the limitations of self-report measurement and the complexity of the grief experience, there are good reasons to argue that both researchers and professionals in clinical practice must include diagnostic interviews in assessing the (maladaptive) course that grieving takes. A further possibility, sometimes followed by researchers and practitioners, is to use general diagnostic instruments such as the Symptoms Check List (SCL-90), the General Health Questionnaire (GHQ-28), and/or depression lists such as the Beck Depression Inventory or the Zung. In the context of traumatic bereavement, Horowitz, Wilner, and Alvarez's Impact of Event Scale (note its revised form by Weiss & Marmar) is frequently used for the assessment of posttraumatic stress symptomatology.

Forms of Intervention: Counseling and Therapy

A useful distinction between grief counseling and grief therapy was made by William Worden. This distinction helps clarify the range of support programs that are available to bereaved persons, although in practice, the division between the two types of intervention may be hard to judge. *Grief counseling* was defined by Worden as 'helping people facilitate uncomplicated, or normal, grief to a healthy completion of the tasks of grieving within a reasonable time frame.' Emphasis is thus on general support, the offering of comfort and care, helping with secondary stresses that occur as a result of the loss, and encouragement of appropriate grief and mourning. The informal support network is increasingly supplemented in contemporary (western) society by voluntary bereavement organizations such as the Widow-to-Widow program or Cruse (with those who have themselves suffered a loss being involved in the counseling of more recently bereaved persons). Other sources include pastoral care workers and doctors, and health care professionals such as social workers and psychologists. Within the last decade too, an increasing number of possibilities for the type of support that would fall into this category have emerged on the Internet, with many websites providing links to specific sources of bereavement support, including access to internet forums, e-mail groups, chat rooms, and online memorial websites. In both face-to-face and Internet support, it is important to have trained volunteers and the availability of advice and guidance of a skilled and experienced professional to back up voluntary aid. These days, such assistance is typically planned and organized within voluntary programs.

A major question concerns the helpfulness of such sources of support. Most participants report beneficial effects, but this does not mean that such programs would benefit all bereaved persons (those who found no use for them would probably drop out and be lost to impact assessment figures). Nor does satisfaction alone mean that the program actually succeeded in reducing negative health consequences or promoting adjustment. To assess the latter, carefully controlled trials including nonintervention bereaved persons for comparison are necessary. We return to the evaluation of the efficacy of intervention later.

Grief therapy, also defined by Worden, refers to “those specialized techniques . . . which are used to help people with abnormal or complicated grief reactions.” Most experts see grief therapy as appropriate when the grief process has become ‘derailed’ or gone wrong in some way. Ramsay described it as occurring when “the ‘normal’ reactions of shock, despair, and recovery are . . . distorted, exaggerated, prolonged, inhibited, or delayed.” Thus, put simply (and at the risk of oversimplification), while grief counseling would be appropriate for normal grief, grief therapy would be indicated for more pathological variants, which we call complicated grief. It is important to note that expert knowledge is necessary to evaluate whether the special techniques of therapy are needed in any particular case. Nevertheless, a number of indicators can be identified. These include an inability to face up to or process the reality of the death. Avoidance of some aspect of the loss itself or of one’s emotional reaction to it lies at the heart of problematic adjustment. For example, some bereaved persons continue to cling to and talk about the deceased person in order to remain closely bonded to him or her (again, the duration of bereavement needs to be taken into account: such reactions would be typical for most bereaved people early after loss). This too can be interpreted as avoidance: over time, the continued presence of such preoccupation serves the purpose that one does not have to face the reality of the loss. Systematic dealing with avoidance reactions is a common feature in psychotherapy programs for complicated grief.

What types of therapy are available to the bereaved who are suffering complications in their grieving process? In line with the above indicators, a variety of different programs has been developed, all of which, in one way or another, basically stimulate confrontation with the painful associations to do with grief. These differ with respect to the directiveness with which confrontation is forced. For example, within behavior therapy, techniques of systematic desensitization or ‘flooding’ have been used to break down defense mechanisms and release intense emotional reactions. Currently, (probably more) popular cognitive behavior therapy and rational emotive therapy techniques are directed toward certain ideas or assumptions that the bereaved have, for example, that one had not done enough during the terminal phase of the loved one’s life. Part of therapy might then be aimed at disputing the impossible demands that the person had placed on himself or herself during that period. When a client accepts such a reinterpretation, it should be possible to move on in the grieving process. Psychodynamic therapy focuses on conflicts within the grieving individual; for example, concentration might be on working through conflicts in the previous relationship, including both positive and negative aspects. It can also focus on

strengthening aspects having to do with the ego, by facilitating emotions such as anger or guilt.

Within the past couple of decades, grief therapy techniques have expanded to include creative therapy (in combination with other types of therapy), such as drawing, painting, or working with clay, and using music and photos. This technique is particularly useful when the bereaved person is unable to express his or her grief well in words. A different type of technique, hypnotherapy, has most frequently been used in cases of traumatic loss, oriented toward treating posttraumatic stress disorder, and focusing on the dissociation between the traumatic experience from normal consciousness, which has been assumed to inhibit normal grieving. A somewhat similar technique, known as guided imagery, involves reliving, revising, and revisiting the loss experience, with the aim to break down barriers to confronting the reality of the loss. Finally, given the recent popularity of mindfulness training in psychotherapy in general, it seems likely that grief therapy programs will increasingly incorporate mindfulness techniques into their intervention programs in the future, whereby there is mindful awareness of and attention to sensations, thoughts, or feelings associated with grief, and where these are experienced for what they are.

Certain therapeutic procedures are common to different therapeutic interventions. For example, leave-taking or ‘saying goodbye’ ceremonies are frequently used in directive types of therapy. Another is bibliotherapy, in which the bereaved person reads selected publications such as (auto)biographies, which help to make clear that certain grief reactions are common to bereavement. All forms of therapy assume that the bereaved person will ultimately come to the realization, both cognitively and emotionally, that the deceased person has gone, never to return, that leave must be taken from him or her, and finally, that he or she needs to be displaced and a new place found for him or her in the bereaved person’s ongoing life.

Like grief counseling, grief therapy programs are also becoming available on the Internet. For example, Alfred Lange and his colleagues have produced an Internet technique they call *Interapy*, an online standardized treatment for post-traumatic stress and complicated grief that includes a number of elements including psychoeducation and protocol-driven treatment (incorporating exposure to bereavement cues, cognitive reappraisal, and integration and restoration). The effectiveness of such programs specifically for bereaved persons and over long-term bereavement need further evaluation.

The Efficacy of Intervention

Since bereavement is associated with mental and physical health problems, it needs to be established whether intervention is to be recommended, and whether it is actually effective. In considering these matters, review is restricted to psychological, and not medical or pharmacological intervention; that is, it is limited to discussion of effectiveness studies of psychosocial counseling and therapy programs. To our knowledge, very little research exists on the effectiveness of pharmacological and medical interventions for bereaved people. The quality of research into the efficacy of bereavement intervention varies considerably across investigations. Only those studies that

conform to high standards, observing strict methodological criteria (presence of control groups, nonsystematic assignment to the experimental and control condition, an appropriate design with valid and reliable assessment instruments, correct statistical analyses, etc.), have been used to form the basis of conclusions.

Too few studies are available to permit comparison of the relative efficacy of the different types of counseling and therapy or their specific therapeutic techniques described above. However, it is possible to compare efficacy of bereavement intervention programs in terms of the *target group* of bereaved persons for the intervention. Grief interventions can be divided into primary, secondary, and tertiary preventive interventions. Primary preventive interventions are those in which professional help is available to all bereaved individuals irrespective of whether intervention is indicated. Secondary preventive interventions are designed for bereaved individuals who, through screening or assessment, can be regarded as more vulnerable to the risks of bereavement (e.g., high levels of distress, traumatic circumstances of loss, etc.). Tertiary preventive interventions denote those providing therapy for complicated grief, grief-related depression, or posttraumatic stress disorders, usually evident longer after bereavement (since pathological processes usually take time to develop). The efficacy of each of these three types is considered next.

Most primary intervention studies have failed to find positive effects, although more positive results have been reported in more recent studies. There are suggestions that better results occur among females (adults and young girls) than in young males. Within these studies too, better results have been found for people with mental-health problems at baseline, for both adults and children. One likely reason for the lack of effects is that nearly all the studies used outreaching recruitment procedures, in which help was offered rather than asked for. Where positive results were found, the design of the intervention was more often based on inreaching, whereby bereaved persons requested help.

Secondary interventions have generally, though not unequivocally, proven to be more effective than primary interventions, although effects were typically modest and improvements temporary. Recently, for example, improvements have been found among children bereaved by suicide in group intervention (compared to community care). Families at high risk have been found to have slightly more improvement after family-focused grief therapy in terms of general distress (but not with respect to family functioning). Emotion-focused interventions have been found to be most effective for distressed widowers, while problem-focused interventions were most effective for distressed widows. With respect to parents, fathers, in general, and mothers with low baseline values of grief and distress did not benefit from group intervention focused on problems and emotions; highly distressed mothers improved most through intervention. Taken together, the patterns for secondary intervention indicate that effectiveness is associated with strict use of risk criteria and that tailoring intervention toward high-risk subgroups is called for.

Tertiary intervention programs – including both individual and group programs, and across the range from analytically oriented dynamic psychotherapy to cognitive and behavioral therapy – have evidenced lasting positive effects on symptoms

of pathology and grief. For example, strong effects on levels of symptoms of intrusion and avoidance, grief, depression, and anxiety have been reported. A combination of medication (nortriptyline) and psychotherapy gave the best results in a study of elderly bereaved persons. In general, therapy for complicated grief or bereavement-related depression and stress disorders has led to quite substantial and lasting results.

In conclusion, as Colin Murray Parkes noted in 1998, there is “no evidence that all bereaved people will benefit from counseling and research has shown no benefits to arise from the routine referral to counseling for no other reason than that they have suffered a bereavement.” Primary intervention may indeed be helpful when the initiative is left to the bereaved individual. Secondary interventions for high-risk group are an important provision, but, as noted earlier, improvements in assessment of empirically based risk factors are essential to achieve better results. Finally, with respect to tertiary interventions, a reasonably wide variety of treatments for complicated grief is available, and these are generally quite effective.

Theoretical Approaches

Theoretical approaches to bereavement provide explanations for the phenomena and manifestations of grief and grieving. They provide insights into (mal)adaptive coping, that can potentially be used for the planning of empirical research to validate the theoretical principles, and, ultimately, for applied use in helping the bereaved. A wide variety of theories have been proposed and different principles of adjustment have been derived, at different levels of analysis (e.g., individual vs. interpersonal) and with differing degrees of specificity (e.g., from grief work to identification of specific coping mechanisms). Theories range from general psychological theories, such as psychoanalytic and attachment theories, to theories of loss, trauma, and bereavement, such as stress theory, to the bereavement-specific DPM of coping with bereavement. These different types of theories are briefly outlined next, to illustrate the nature of theorizing in the bereavement area.

Theoretical explanations of the psychological reactions and ways of coping with grief have been greatly influenced by Freud's 1917 paper ‘Mourning and Melancholia,’ its impact being evident in the later work of major figures in the bereavement field, including Bowlby, Parkes, Raphael, and Jacobs. According to psychoanalytic theory, when a loved one dies, the bereaved person is faced with the struggle to sever the ties and detach the energy invested in the deceased person. The psychological function of grief is to free the individual from his or her ties to the deceased, achieving the gradual detachment by means of the process of grief work. As noted in section ‘Risk Factors,’ this implies a cognitive process of confronting the reality of loss, of going over events that occurred before and at the time of death, and focusing on memories and working toward a detachment from the deceased. Since Freud, the notion that one has to work through one's grief was for a long time central in the major theoretical formulations on grief and in principles of counseling and therapy. The major cause of pathological grief, according to Freud, was the existence of ambivalence in the relationship with the deceased preventing the normal transference of libido

from that person to a new object. In section 'Risk Factors,' we noted lack of empirical confirmation for the grief work notion.

A second general theory, namely, attachment theory, grew from the psychoanalytic tradition but provided a new and different perspective on the nature of grief. Bowlby's attachment theory emphasized the biological rather than the psychological function of grieving. The biological function of grief is to regain proximity to the attachment figure, separation from which has caused anxiety. In the case of permanent loss, this is not possible, and such a response is dysfunctional, in the sense that reunion cannot be achieved. However, Bowlby, like Freud, also argued for an active working through of the loss. Like Freud, Bowlby sees the proximal cause of pathological grief in the relationship with the lost person. However, the distal cause is childhood experiences with attachment figures, leading the individual toward either a secure or an insecure style of attachment or bonding with the caregiver. These experiences are assumed to have a lasting influence on later relationships. For example, frequent separation from attachment figures in childhood can lead to anxious attachment in later relationships, which results in chronic grief, a complicated reaction consisting of an indefinite prolongation of grief over the death of a loved one. Attachment theory is still enormously influential in the bereavement field, with leading investigators such as Mikulincer and Shaver conducting sophisticated empirical research, which has confirmed the importance of attachment styles in the prediction of adjustment to bereavement.

Stress theory, like attachment theory, has had and still has an enormous impact on bereavement research. One line within this approach is represented by the influential work of Horowitz and his colleagues, whose interest and analysis spans not only bereavement but also traumatic life events in general (see, e.g., his classic 1986 volume *Stress Response Syndromes*). The basic assumption of stress theory is that stressful life events play an important role in the etiology of various somatic and psychiatric disorders. This approach has also received much impetus through the work of Lazarus and Folkman, whose volume *Stress, Appraisal, and Coping* appeared in 1984. According to this theoretical perspective, a stressful life event may precipitate the onset of a physical or mental disorder, particularly if a predisposition to that disorder already exists. The intensity of stress created by a life event depends on the extent to which the perceived demands of the situation tax or exceed an individual's coping resources, given that failure to cope leads to important negative outcomes. Coping may either be directed at managing and altering the problem that is causing the distress (problem-focused coping) or it may be directed at managing the emotional response in order to reduce emotional distress and to help maintain one's emotional equilibrium (emotion-focused coping). Stress theory provides the theoretical underpinning for the so-called 'buffering model,' which suggests that high levels of social support (a coping resource) protect the individual from the deleterious impact of stress on health (see also section 'Risk Factors'). Research has identified neurophysiological mechanisms linking stress with various detrimental consequences to the immune, gastrointestinal, and cardiovascular systems.

The DPM of coping with bereavement was developed by Stroebe and Schut in 1999, to overcome shortcomings of earlier models in describing adaptive coping with

bereavement, in particular, the grief work notion. The DPM grew from cognitive stress theory. It postulates two types of stressors, namely, those relating to the deceased person himself or herself (known as loss-oriented coping, e.g., ruminating about the death), and those having to do with secondary stressors that come about indirectly but as a result of the loss (known as restoration-oriented coping, e.g., actively dealing with a new financial burden). The pattern changes over time, with more loss orientation early in bereavement, and more restoration-orientation as time goes on. Rather than assuming phases or tasks, the DPM includes an emotion regulation process, labeled oscillation. Adaptive coping entails oscillation between both the loss- and restoration-oriented domains, and 'time out,' giving a necessary respite from the arduous process of dealing with these different types of stressors. As such, the DPM is compatible with, but extends beyond, earlier coping models.

Conclusions

Loss of a loved person causes deep suffering and brings with it the risk of mental and physical health consequences. It is not surprising, then, that bereavement and grief have become the subject of considerable scientific investigation. At the same time, it is important to remember that grief is a normal, natural process after bereavement. Most reactions are not complicated, and for most bereaved persons, family and friends, religious and community groups, and various societal resources will provide the necessary support. Professional psychological intervention is generally neither justified nor effective for uncomplicated forms of grief.

Much is now known about the health consequences, risk factors, and forms of complications following loss. Intervention programming has made major advances. Although improvements in research across all the above areas are evident in recent years, methodological shortcomings are still present in some investigations. Furthermore, even though statements about general occurrences and manifestations associated with bereavement could be made, considerable gaps in knowledge still remain. For example, we need to learn more about mortality patterns following different types of loss, or about co-determinants of the poorer outcomes of bereavement. Finally, there is scope for improvement in the design of intervention studies and for strict assessment of their effectiveness following evidence-based criteria.

See also: [Cognitive Behavior Therapy; Posttraumatic Stress Disorder.](#)

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Group Dynamics

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Glossary

Additive task A group task in which the contributions of individual members are added together to form a group product.

Compensatory task A group task in which the contributions of individuals are averaged to form a group product.

Conjunctive task A group task in which all of the group members must complete a specific action before it is finished. The worst performing group member determines group performance.

Deindividuation A state of decreased self-awareness and a lowering of self-control that can occur when individuals are actively, and typically anonymously, involved in groups or crowds.

Disjunctive task A group task in which there is one correct solution. As soon as it is discovered by one member and accepted by the group, the task is solved. The best performing group member determines group performance.

Group Two or more individuals having some common bond, goal, or task, and exerting influence on one another.

Group brainstorming Generating as many ideas in groups as possible without concern for quality or evaluation.

Group norms Consensual expectations for what is correct or appropriate group behavior.

Group polarization The tendency of group members to become more extreme in their attitudes or opinions after

discussions with individuals who have similar attitudes or opinions.

Group socialization The process by which individuals become full-fledged members of groups.

Groupthink Defective decision-making in groups that results from in-group pressure to reach consensus.

In-group identification The degree to which group members self-identify with and place subjective value on membership social group or category.

Intellective task Verbal or mathematical tasks for which there is a demonstrably correct solution.

Judgmental task Tasks for which demonstrably correct answers do not exist.

Media richness The extent to which the means of communication involves multiple channels such as video and audio.

Mixed motive Situations in which group members are confronted with the choice of whether to cooperate or compete with other group members or other groups.

Social comparison The tendency to compare our opinions and abilities with those of others when we are uncertain about them.

Social facilitation A term describing the tendency for easy or dominant tasks to be enhanced in the presence of others.

Social loafing Reduction in effort by individuals in groups when their individual performances are not easily identified or evaluated.

Group dynamics is the study of the forces or processes that are responsible for various group phenomena (e.g., the formation, development, interaction processes, social influence, and performance of groups). Groups influence individual behavior in many ways, but individuals can also have an impact on groups. Groups appear to satisfy many needs, but they often lead to performance or decision-making that is less than optimal. Several processes that underlie group behavior and ways of improving group functioning are discussed.

Major Characteristics of Groups

Groups come in many forms and have many different reasons for existing. Some groups are merely short-term aggregations of people with no strong interrelationship, such as groups at spectator events, at bus stations, and in elevators. Other groups such as clubs, churches, peers, friends, and families have strong bonds and maintain long-term relationships. Some groups develop simply to have a good time, while others are concerned with accomplishing specific tasks. Other groups are based on large-scale identities, such as gender, ethnicity, or

nationality. It is difficult to use a single description for all types of groups, but most would agree that groups consist of two or more individuals who have some similarity, common bond, goal, or task and who exert influence on one another.

Reasons for Joining Groups

There are many different reasons (i.e., instrumental, personal-emotional, identity, group's resources, and knowledge-related reasons) why people join groups. Instrumental reasons refer to choosing a group because one shares with other members a desire to reach a certain goal (e.g., a political party), to perform a particular task (e.g., play basketball), or to have social connections. The decision to join a particular group may also be motivated by a variety of personal or emotional needs, such as needs for belonging, self-esteem, attention, affection, approval, support, and the reduction of uncertainty about the social world. Individuals who are motivated by such needs are likely to seek groups that consist of individuals who have similar values and beliefs. By involvement in groups, individuals can also establish an identity as in the case of joining a fraternity, sorority, or a political activist group. Individuals may join

groups for other needs such as achievement and influence, to make money, to obtain information, or to learn a skill. They may also join groups for resources such as power, status, and personal recognition. Finally, they may join groups because they want to learn new ideas or perspectives that they cannot obtain by themselves alone.

Group Socialization

Groups differ greatly in the process by which individuals join and become full-fledged members of the group. Some groups have stringent entrance requirements while others have few if any (e.g., political parties). Most individuals who join groups appear to go through some sort of socialization process. At first, the prospective member and the group will investigate each other to determine whether group membership should be considered. Once someone joins a group, groups typically have various procedures and programs to help the newcomer learn group norms and fill social roles. Once this socialization process is complete, full acceptance as a member of the group occurs. At this point, the new member typically feels a strong commitment to and identification with the group. This commitment may wane over time because of conflicts, boredom, or competing interests. The group may attempt to resocialize the individual, but if these efforts are not successful, the individual may exit the group.

Group Development

Groups go through various stages during their existence. In the forming or inclusion stage, individuals get to know each other and the various group rules. At this stage, behavioral patterns in groups lead to the formation of expectations about task, group rules, and interaction processes. Expectation states theory suggests that interactions in groups may follow expectations group members have about other group members on the basis of their personal characteristics, such as gender or age, and relevant skills or experiences. As a result of such expectations, this stage is often followed by a storming or control stage in which members compete for positions, roles, and leadership. Some members tend to take on mostly task related roles whereas others may focus more on socioemotional issues. If the conflicts associated with this stage are resolved effectively, the group enters the norming or affection stage in which there is the development of a deeper emotional bond and common perspective about how the group should function. At this point, the group can focus on the achievement of its goals and tasks in the performing stage. As long as groups function satisfactorily in pursuit of various goals or tasks, they should be able to maintain their existence rather easily. However, if the major goals for tasks are achieved or if the group is having difficulties in achieving its goals, the group may adjourn or disband.

Influence Processes in Groups

Arousal

Although groups differ along many dimensions, there are certain forces that play an important role in most groups. One of

the most basic impacts is that of degree of arousal. When others are observing us or working with us and we do know how they will react to us, we may experience a state of heightened arousal or motivation. This may be in part because of a concern with how others might react to or judge our behavior. This enhanced arousal may increase our ability to do simple tasks or behaviors but it may hinder the performance of more difficult tasks or behaviors. When the presence of audiences or coworkers enhances performance, it is termed social facilitation. By contrast, when the presence of others hinders performance, it is called social inhibition. However, when group members face some external stress, the presence of group members can have a calming effect.

Diffusion of Responsibility

When one becomes immersed in group activities in which one's individual actions or unique contributions are difficult to separate from those of the other group members, group members may experience a diffusion of responsibility. That is individuals may not feel personally accountable for their actions. In extreme cases, this may take the form of deindividuation in which the person loses a sense of self-awareness or experiences a lowering of self-control. In this state, the individual may be very susceptible to the influence of others in the group. Therefore, if others are exhibiting antisocial behaviors or behave ambiguously in a helping situation, the individual may be prone to act in similar ways. However, prosocial norms in groups can increase individual prosocial behavior as well. Diffusion of responsibility can also take its toll on group task performance. When individuals work on a task as a group, especially if the task is an additive or compensatory one (see section 'Working in Groups'), they may not feel individually accountable for their performance. The larger the group, the less is the accountability and it is more likely that individuals will demonstrate social loafing or reduced efforts. By contrast, group members tend to increase their collective effort when they feel accountable or responsible to the overall group product and value the group task. Diffusion of responsibility in groups is not inevitable. It is most likely to occur when it is difficult to identify individual group members, there is no individual or external evaluation of performance, the task being performed is easy or boring, and members of the group are all doing the same task. Alternatively, it can be reduced or eliminated by increasing individual evaluation or identifiability, by using tasks that are difficult or interesting, and by having individuals in the group doing different tasks.

Social Comparison

Comparison of opinions

Groups perform a variety of activities. They make decisions, solve problems, perform tasks, set goals, make plans, or engage in social activities. Each of these activities provides opportunities for individuals in groups to compare themselves with others. This tendency or drive toward social comparison is seen as one of the basic social influence processes in group situations. It is motivated by one's uncertainty about the accuracy of one's beliefs or opinions and a desire to evaluate one's adequacy or ability along a variety of dimensions. Individuals can

use this social comparison process to evaluate their opinions, attitudes, personal characteristics, and abilities. For opinions and attitudes, the tendency is to compare oneself with individuals who are generally similar to oneself in a variety of characteristics that are salient to the group members such as age, gender, religion, values, and other opinions or attitudes. This implies that individuals will seek out groups consisting of individuals who already appear to be similar to them on a number of dimensions. As a result, many groups form on the basis of similarity of interests, attitudes, and characteristics. Such formation or homogeneity, then, creates a pressure for an individual or newcomer to conform to the majority of group or group norm. Moreover, interaction among such group members should increase the extent to which the members receive support for their existing opinions or ideas. Thus, groups should increase the confidence of individual group members in their collectively shared ideas, opinions, and values.

Comparison of abilities

Comparison of abilities among group members involves a slightly different type of process. Comparing one's ability or characteristics with those of others has potential implications for one's self-esteem. If one compares favorably, one's self-esteem is likely to be enhanced. If one compares unfavorably, one's self-esteem may be reduced. One way to increase the probability of a favorable outcome is to use someone who is slightly superior to oneself as a basis of comparison. If as a result of this upward comparison process (e.g., a game of tennis, a sales contest) this other person is indeed superior to oneself, the negative impact on one's self-esteem should be minimal. That outcome should have been expected. Yet if one actually performs in a way superior to that of the comparison person, one's self-esteem should receive a strong boost. Group members can engage in upward comparison processes if there is a strong tendency for competition among group members and incentives to show a high performance.

Sometimes, individuals engage in downward comparison. This involves comparing with someone of less ability, or lower status, or who is less fortunate than oneself. This is most likely among people of low self-esteem or people who have low expectations or self-confidence. Because these people do not expect to compare favorably with others of superior ability or status, this can be seen as a way in which they can ensure maintenance of their self-esteem or positive perceptions of their performance or situation. In group situations, group members tend to display downward comparison even in performance if contribution to the overall group product is costly, motivation of group members is low, and proportion of least productive individuals in groups is high.

Comparison processes often occur between groups as well as within them. Intergroup comparisons can produce higher in-group identification among group members, and consequently greater cooperation and group performance, in an effort to compare favorably to another group.

Conformity and Independence

Individuals in groups have a variety of social needs. Most have a need to be accepted by others and to be seen in a favorable light. People also have a strong desire to have certainty about

different aspects of their social world. Although certain physical features of our world are subject to little disagreement (e.g., color, shape, and size of objects), there is potential for significant disagreement about issues for which there are no objective or commonly accepted answers (e.g., religion, values, and politics).

Our social needs are often met in groups. Other group members can provide acceptance and approval or help increase one's certainty about subjective issues. This fact is the basis for power of group members over the behavior of other members. This power may be exerted to make group members adhere to social norms of the group. Norms are strong expectations for behavior that develop and exist in groups. Groups may expect certain types of dress, manners, and beliefs. Individuals who do not adhere to the group norms may face disapproval or possible rejection. To the extent that individuals are concerned with maintaining positive acceptance by other group members, the group has normative influence over the individual. The degree to which the individual depends on the group as a basis for deciding subjective or social issues (e.g., how to vote) is the extent to which the group has informational influence. As a result of the social and informational influence processes, group members often adhere closely to arbitrary social norms and share a high degree of similarity in opinions and attitudes. When individuals deviate from the group norms, other group members may exert pressure to have the individuals change their behavior or opinions to match those of the group more closely. The degree to which individuals match the standards of the group as a result of such pressure is known as conformity. If they do not change their behavior, they may be rejected or ignored by the group. Ostracism or exclusion from groups may have serious detrimental individual consequences, such as low self-esteem, embarrassment, sadness, anxiety, and helplessness.

Communication in Groups

Communication involves the exchange of information in groups. Most groups or organizations have both formal and informal means of communication. Formal communication networks can vary in degree of centralization. In centralized networks, information from all group members goes through one individual. This is an effective structure when transmission of information is the primary group task. These networks are associated with less satisfaction for peripheral members but may be very efficient for relatively simple tasks. In decentralized networks group members freely communicate with one another. Decentralized networks are best when the group is confronted with complex problems that require full exchange of information. Downward communication in an organization or group goes from the top to the bottom of the organizational hierarchy and typically involves directives and information related to performance of tasks. Upward communication goes from the lower levels of the hierarchy to higher ones and often is used to provide feedback about performance and effectiveness of procedures or policies. Lateral communication is the exchange of information among members or subgroups at a similar level of the hierarchy. Effective functioning of groups requires accurate and efficient communication throughout the organization using all available channels.

Groups also have various informal means of communication. For example, grapevines are informal communication networks based on interpersonal relationships. They are often involved in the transmission of rumors. Informal communication can take various forms such as verbal, nonverbal, written, or electronic. Communication appears to be most effective if multiple channels are employed. Verbal messages followed up by written ones may optimize both impact and clarity. When messages are delivered in person, the receivers have access to nonverbal cues such as facial expressions, eye contact, and bodily movements. These may allow individuals to look for hidden meanings in the verbal message. For example, bodily cues may be helpful in assessing whether someone's verbal message reflects this person's true feelings. Electronic communication is becoming increasingly important in many organizations. It can be very efficient and may facilitate high levels of communication across different levels of the group hierarchy. Such communication can vary in media richness, which is the extent to which it involves multiple channels (e.g., audio only vs. audio and visual). As tasks become more complex or subject to differing interpretations, richer media may be required.

Working in Groups

Types of Group Tasks

Many of our daily tasks are done in group situations. We may prepare meals at home with family members, fix a car with a friend, play basketball with our neighbors, and work in an office with our coworkers. While some tasks can be done only with groups, in other cases individuals can do them in isolation. One interest has been to determine to what extent groups are a help or hindrance to the solution of problems or performance of various tasks. This, of course, depends on the type of task or activity. Much research has investigated tasks that simply involve the addition of individual products such as counting money or generating ideas. These are additive tasks. Although groups obviously will produce more than any single individual, they may not out-produce a similar number of individuals performing alone. On the other hand, if the group members are in competition with one another or there is evaluation of individual performance, individuals in groups may outperform solitary individuals. These patterns of results hold only for relatively simple tasks in which motivation is closely related to performance level. On relatively complex, learning, or conjunctive tasks, the individuals in groups may perform more poorly than solitary individuals because of increased anxiety associated with accountability or evaluation in groups.

Some tasks involve averaging the contributions of group members, such as estimating the number of beans in a jar. These are called compensatory tasks because the biases in judgment of a specific member can compensate for the biases of the other members. Disjunctive tasks require members of a group to discover a correct solution to a problem. As soon as one member comes up with a correct solution that is accepted by the group, the task is complete. However, unless the solution is fairly obvious, groups may sometimes not accept correct solutions and therefore function more poorly than comparable groups of individuals working alone. On a conjunctive task, all

of the members must complete a certain action before that task is completed. This is exemplified by a mountain-climbing team. Here, the performance of the group is determined by its least able member.

Group tasks can also vary in the extent to which it is possible to demonstrate that there is a correct answer. There are no demonstrably correct answers for judgmental tasks that involve evaluations such as the attractiveness of art or the appropriateness of social positions. Intellective tasks involve verbal or mathematical problems for which demonstrably correct solutions do exist. On judgmental tasks, group consensus is the main determinant of the group judgment. For intellective tasks, the correct answer will be chosen if it is recognized by one or more of the group members. In fact, groups appear to be quite good at detecting errors or wrong solutions in the process of determining the correct answers on such problems.

Group Brainstorming

Perception of group performance

Although groups may excel in some situations, they often perform below expectations. Individuals seem to believe that groups will be quite productive, as in the case of group brainstorming. This involves the generation of ideas in groups under a set of rules designed to encourage free exchange of novel ideas. Group members are encouraged to generate as many ideas as possible and instructed not to criticize or evaluate the ideas of others in the group. While most individuals expect this to be an effective procedure, brainstorming groups actually generate fewer ideas than do a comparable group of solitary individuals (nominal groups).

Processes in group brainstorming

The relatively poor performance of brainstorming groups is caused in part by the blocking or interfering effects of the activity of other group members that occurs when one is trying to generate ideas in a group. In addition, group members may be concerned about others' reactions and inhibit the number of ideas they contribute. Because the task is additive, group members may also reduce their efforts or loaf in the group because they typically are not held accountable for individual ideas. All of these factors tend to inhibit performance of individuals in groups. Furthermore, group members may be inclined to match their level of performance to that of the less productive members.

Procedures for effective brainstorming

Various techniques may help counteract and overcome some of the problems of brainstorming groups. Group brainstorming should be used only with individuals who are comfortable working in groups. The group should be given a challenging goal and held accountable for it. Moreover, some procedural techniques can greatly facilitate performance. When groups exchange ideas on pieces of paper without talking (brainwriting) or by means of computers, the performance of groups can exceed the performance of nominal groups. It is also useful to have an incubation session immediately after group brainstorming in which participants can reflect on the shared ideas and build on those ideas.

Group Decision-Making

The Nature of the Process

Much decision-making occurs in groups. Committees, task forces, legislatures, and social organizations are just a few examples of groups that often have to make group decisions. The advantage of group decisions is the opportunity for input from a wide variety of members. This also helps distribute responsibility for the decision among the group members. Unless formal procedures are in place, groups often do not effectively organize their decision-making process. For example, groups tend to go along with the first plausible idea. Also, when the majority of the group has accepted a particular idea or solution, the group consensus rarely changes. The direction of the group decision in juries and other similar groups can be predicted quite well from a knowledge of the prior support for a position among group members. The direction of influence typically goes in the direction of the largest faction. So, if a plurality of a group initially favors a particular position, the final group decision is likely to be consistent with that position. This strength-in-numbers effect may reflect both normative and informational influence processes. Of course, this effect is most likely to occur on judgmental tasks where there is no objective right or wrong decision.

Group Polarization

Groups often come together to discuss issues or opinions. Although there is typically a wide range of opinions among individuals, sometimes group members have similar attitudes or opinions about a topic. This is particularly true in the case of groups that form on the basis of that agreement (special interest groups, political groups). When groups of individuals who are biased to a particular side of an issue discuss the issue, they tend to move their opinions further in the already-favored direction after the group discussion. This shift toward more extreme opinions in groups is termed group polarization. It appears to be caused by three different processes – social comparison, information exchange, and intergroup social categorization.

Individuals in a group who perceive themselves as favoring a particular side of an issue may discover during the group discussion that others more strongly endorse that position than they do. As a result, they may feel some pressure to change their opinions to more strongly reflect the valued direction. In addition, most of the ideas exchanged in such a group would tend to support the favored direction, especially in the absence of input from outsiders. Moreover, polarization can be due to group members' conforming to in-group norms in contrast to out-group norms. When an out-group or intergroup relationship is made salient, in-group members are likely to take more extreme positions as to be more clearly differentiated from out-group norms, which provides additional support for the individual taking a more extreme position.

The group polarization phenomenon applies to groups that have a fair degree of homogeneity of opinions, attitudes, or values. Because people tend to select groups on the basis of similarity of interests and beliefs, many groups are fairly homogeneous. The social comparison, information exchange, and categorization processes in such a group tend to move the

group's attitudes in more extreme directions. It is therefore not surprising that there is so much conflict between groups that are divided along political, religious, and ethnic lines or any other dimension that is related to strong differences in values (e.g., management vs. labor, environmentalist vs. developer). To minimize such polarization tendencies, it may be useful to increase interaction in cooperative activities among members of the different groups.

Groupthink

The nature of groupthink

Even if members in a group have a broad range of opinions, it does not guarantee that these will be carefully examined in a group discussion. Sometimes decision-making groups have strong pressures to come to agreement. This pressure may come from competitors, from crises that demand quick solutions, or from arbitrary deadlines. Groups that are under such pressures may come to decisions without carefully evaluating alternative courses of actions. The processes related to such defective decision-making are known as groupthink.

Characteristics of groupthink

There are a number of features that appear to facilitate the occurrence of groupthink. Consistent with the polarization effect, groupthink is most likely to occur if the group is fairly homogeneous in member characteristics and is insulated from other groups. In addition, a directive leader who champions a particular point of view and exerts pressures for consensus is likely to lead to groupthink.

Moreover, groupthink is most likely to occur in groups where conformity to group norms are desired or expected. In groups that are prone to groupthink there is pressure toward uniformity of opinion, with direct pressure being applied on dissenters. Group members may also rationalize away information inconsistent with their decision. In such groups, members are unlikely to make well-informed decisions and to carefully examine a broad range of alternatives or information. They will tend to overlook the risks of the favored alternative or fail to develop contingency plans. Information in support of the impending decision will be given more weight than information inconsistent with it. Decisions approached in this fashion may be disastrous for businesses and governments. The Bay of Pigs invasion under the direction of president Kennedy, the decision to escalate the war in Vietnam, and the Challenger disaster are among some of the highly publicized instances of groupthink. Detailed analyses of the decision-making involved in these events have revealed much evidence for symptoms of groupthink and the related defective decision-making process. Both experimental and field studies have demonstrated that leadership style is one of the strongest predictors of groupthink.

Preventing groupthink

A number of procedures may minimize or eliminate the occurrence of groupthink. The group should set a goal of making the best possible decision rather than simply developing consensus quickly with a minimum of conflict. Group leaders can play an important role by promoting this goal and not pressuring the group in a particular direction or plan early in

discussion. They may make their groups and their members more openly accountable or responsible for their role (e.g., devil's advocate) in the decision. Procedures should be developed to assure a wide-ranging and full discussion of the alternatives. Breaking the group into small subgroups at various points in the decision-making process may increase the chances of diverse perspectives being carefully considered. If these groups come to similar decisions, confidence in the correctness of the decision is increased. Groups should have 'second chance' meetings in order to reconsider the wisdom of the initial decision. Input from knowledgeable outsiders or experts who are not subject to the pressures of the groups may also be helpful in providing some assessment of the reasonableness of the decision.

Influence of Individuals on Groups

Minority Influence

There are many forces within the group that constrain or limit the behavior of its members. Groups generally do not respond favorably to those who disagree with the majority consensus or position. This fact often inhibits individuals from expressing deviant opinions. When individuals have the courage to deviate, other group members typically attempt to persuade them that they are wrong and to move them in the direction of the majority. If these attempts are unsuccessful, opinion deviants are often rejected or ignored. While opinion deviants are not liked, they do have some potential positive impact on groups. Because of their distinctive position, they gain the attention of group members and may stimulate them to rethink the issue, if not publicly. The fact that someone is willing to dissent may give them some additional credibility and influence because of their low perceived self-interest in the issue. This is particularly true if this person persists forcefully and consistently in the face of attempts by the majority faction to produce compliance with their position. As a result, majority members may actually change their opinion on the main issue or related ones in the direction of the minority position. This change tends to be genuine, in the sense that it is an actual change in their personal opinions that may not be expressed during group interaction but is evident in anonymous measures of beliefs taken after exposure to minority influence. In contrast, individuals who change their position in response to majority influence typically are only complying publicly with the group norm. Assessments of private beliefs often indicate little personal change. The ability of minority factions to stimulate cognitive reevaluation on the part of members of the majority may be one reason that exposure to minority positions in groups can produce subsequent increased creativity in individual problem solving. Exposure to minority perspectives can also increase the subsequent generation of novel ideas or divergent thinking in groups, especially if group members are able to fully participate in the group interaction process.

Leadership in Groups

Characteristics of leaders

Most groups have leaders. As discussed earlier, these are individuals who have the capability or responsibility of directing

the group's activities. They may be informal or temporary leaders who derive their status from actively contributing to the welfare of the group. Those who dominate the discussion in a group are often seen as leaders. Leaders may also attain more formal positions of leadership by means of election or appointment.

The types of skills, traits, and interpersonal styles required of leaders will depend greatly on the type of group. Certainly, military units and research teams require different types of leaders. However, there are some characteristics that appear to be generally important for successful leadership. Leaders must desire to have influence over others, need to be motivated to achieve goals, and should have the determination to persist in this process. Successful leaders tend to be self-confident, honest, and flexible. Intelligence, creativity, and relevant knowledge are also important. Although it makes a great deal of sense that leaders should be motivated and capable, these characteristics do not ensure attainment of positions of leadership or leadership effectiveness. The behavioral style of leaders and situational factors often appear to be more influential than personal characteristics.

Behavioral style

Analyses of leadership behavior have revealed the existence of two distinct styles. Some leaders are consideration- or person-oriented. They are concerned primarily with maintaining good relationships among group members. Their approach to group members is one of interpersonal warmth and trust and involves open communication between leader and followers. A second type of leader is known as production or structure oriented. Their main concern is structuring the situation so that the task is done well and efficiently. This involves developing ways for the group members to function more effectively without concern for developing positive interpersonal relationships. It is possible for leaders to exhibit a wide variety of combinations of degree of concern for people and concern for productivity. A hybrid leader or team manager who is able to exhibit both a concern for people and who has the ability to structure the work environment for productivity may be ideal.

Situational factors

The effectiveness of a particular style of leadership appears to depend on characteristics of the situation such as follower support of the leader, degree of task structure or clarity, and leader power over followers. These features influence the degree of control the leader has over the situation. With low degrees of situational control, production-oriented leadership may be required for effective group performance. Under these conditions, group members need direction and structure, and attempts at improving interpersonal relations may have little impact. With moderate degrees of situational control, a person-oriented style may yield more positive group relations and motivation to perform. A task-oriented leader may alienate group members by using a directive or autocratic approach and as a result further weaken the situational control. With high degrees of interpersonal control, a person-oriented style is not necessary and the group may respond positively to the task- or production-oriented behaviors of the leader. Group member satisfaction and performance tend to be highest in groups with the appropriate match of situation with leadership style.

Transformational leaders

Sometimes, leaders excite the imaginations of their followers and are able to motivate them to perform at high levels or make extreme sacrifices. Franklin Roosevelt, Winston Churchill, and Martin Luther King, Jr. are examples of leaders who fall into this category. These types of leaders have a vision, act in a confident manner, and are good communicators who have a dynamic personal style. They are also skilled in judging others and manipulating their own attractiveness and appeal to their followers. Transformational leaders tend to emerge when groups face crisis situations and need both a strong and visionary leadership and an emotional commitment to a cause by the followers. These types of leaders are not necessary and probably not useful when groups are focused primarily on routine activities.

Summary

We have learned much about group dynamics. Groups are subject to a wide range of processes as they go about their various tasks. Our present state of knowledge can aid us in getting the most out of these groups. However, there is still much to learn and there are many interesting new issues on the horizon. Electronic technology allows for new ways of organizing group interaction and structuring group tasks. These interactions and tasks will be mostly cognitive or informational in nature. New developments in cognitive psychology may allow for the development of more sophisticated understanding of such cognitive interactions among group members. However, it seems likely that many of the principles of group dynamics discovered with face to face interacting groups will be applicable to understanding the interactions of electronic groups.

See also: Conformity and Obedience; Creativity; Decision Making (Individuals); Interpersonal Perception and Communication; Leadership; Social Comparison; Social Values (Influence on Behavior).

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Hallucinations

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Glossary

Association cortex Areas of the cerebral cortex that are responsible for sensory processing, so that primary sensory input. For example, when a person looks at another person, the light reflected from that person travels to the eye, and information is then sent back to the primary visual cortex, which then sends signals to the association cortex where it is interpreted and understood to be the image of a person.

Charles Bonnet syndrome A syndrome in which visual hallucinations occur after loss of normal visual function.

Lewy body disease A form of dementia that affects both the cerebral cortex and subcortical nuclei.

Phantom limb syndrome A syndrome in which an individual feels abnormal sensations or pain in a limb (arm or leg) that has been amputated.

Subcortical nuclei Collections of gray matter containing neurons deep in the brain, above the brainstem and below the superficial gray matter, that play a role in transmitting, receiving, and integrating information from other parts of the nervous system.

The psychological history of man does not offer a more curious question than that of hallucinations. To see what no eye perceives, to hear what no ear hears, to be convinced of the reality of sensations to which all are incredulous – does not this present matter for research full of interest?

Brierre de Boismont

The word *hallucination* has its roots in the Latin *hallucinari* or *allucinari*, which means ‘to wander in mind.’ A contemporary definition of hallucinations was suggested by David in 2004:

A sensory experience which occurs in the absence of corresponding external stimulation of the relevant sensory organ, has sufficient sense of reality as to resemble a veridical perception, over which the subject does not feel direct and voluntary control, and which occurs in the awake state.

Introduction

We become aware of the outside world through our senses. As information enters and moves through the various centers of the brain, it is parceled, filtered, and analyzed by an orderly sequence of events, which culminates in conscious awareness. The processing starts in the peripheral sensory organs, moves through the thalamic nuclei, and ends in the primary sensory regions of the cerebral cortex. Lastly, the information moves downstream to a variety of unimodal and multimodal sensory association areas. Dysfunction of this orderly sensory system caused by any one of the many neurological or psychiatric insults may clinically manifest as hallucinations.

The full spectrum of hallucinations is beyond adequate description in a book chapter or even an entire volume devoted to the subject. Hallucinations may occur in both pathological and nonpathological contexts. Normal people without neurologic disease who experience sensory deprivation, starvation, or extreme pain may experience vivid hallucinations. In contrast, hallucinations may occur in people crippled by a severe neurologic illness such as viral encephalitis, stroke, epilepsy, or dementia. Hallucinations may occur as undesirable symptoms of many disease states such as schizophrenia and become the focus of treatment. Hallucinatory states may also be induced by ingesting naturally occurring or artificially created substances. Hallucinations may arise in any sensory modality. They may occur in the visual modality and appear in the form of ballerinas dancing next to a person’s bed. They may occur in the somatosensory modality and manifest as the feeling of a persistent limb following amputation of the extremity. Some may hear people speaking when alone, while others perceive smells.

David makes several important points in his definition. First, hallucinations are fundamentally a *subjective* sensory experience and thus are somewhat resistant to objective analysis using the scientific method. Second, the degree of insight that the person experiencing the hallucination has into the reality of the experience is variable. For instance, patients with schizophrenia may be convinced that the voices that they hear are arising from a tape recorder playing in the room though the device, if present, is inactivated. In contrast, a patient with Charles Bonnet syndrome (CBS) often realizes that the visual hallucinations are artificial. Third, although people with hallucinations may, to some degree, influence the context of the hallucination, they generally do not have any control over them. Lastly, dreams are not true hallucinations as they do not occur in the wakeful state.

In antiquity, a strikingly modern categorization of hallucinations existed. The Hippocratic School considered the experience of visions and voices to be associated with *paranoia* which was differentiated from *epilepsy*, *mania*, and *melancholia*. The experience of visions and voices was therefore classified as a medical entity. Hippocrates believed that the source of hallucinations was a special ability to experience phenomena which were not apparent to normal individuals. This type of ‘gain of function’ explanation for hallucinations has a common theme in antiquity. For instance, the oracle and high priestess Pythia in eighth century BC experienced hallucinations which were interpreted as prophecies (see [Figure 1](#)). The mathematician Pythagoras was thought to be guided by voices. Even Socrates marveled at a perceived voice which he believed to be exterior to his own mind, which has been referred to as the Demon of Socrates.



Figure 1 Priestess of Delphi by John Collier, 1891. The oracle was inspired by vapors rising from a crack in the rock below.

In medieval Europe, visions and voices were categorized instead as possessions by external forces, such as the devil or an angel. The person who experienced hallucinations might be thought to have absence of all rational thought, might be deemed insane, and was referred to religious courts for trial and punishment. For instance, in fifteenth century France, Joan of Arc proclaimed that she had visions from God that told her to fight to recover her homeland from English domination (see [Figure 2](#)). She was eventually captured by the English and burned at the stake at the age of 19.

The mid-nineteenth century European scientists brought fundamental changes to the understanding of hallucinations. In 1845, a French physician from the Pitié-Salpêtrière in Paris, named Jean-Étienne Esquirol, published a work titled *Mental Maladies: A Treatise on Insanity*. In this treatise, Esquirol first used the word *hallucination* to refer to visual or auditory experiences which were considered real by the person experiencing them but not real to observers. Esquirol unified hallucinatory experiences occurring in various sensory modalities as fundamentally similar. He postulated that all hallucinations are autonomous activations of memory traces which have an influence on primary sensory systems. Eight years later in 1853, another French physician named Brierre de Boismont championed the position that hallucinations are not necessarily an accompaniment of insanity, and posited that they may occur as purely isolated phenomena. In the 1890s, Augusto Tamburini, an Italian neuroscientist, first proposed that hallucinatory experiences arise due to ‘irritative activation of regions of the brain which are active in processing of information in the modality of the hallucination’ ([Ireland, 1893](#)).



Figure 2 Jeanne d'Arc, by Eugene Thirion, 1876. Joan of Arc receives divine inspiration from visions.

Classification of Hallucinations by Proposed Mechanism

Contemporary understanding of the neurophysiology of hallucinations comes from several lines of both clinical and experimental evidence. The largest contribution comes from clinical descriptions of patients with hallucinations due to either destructive or activating lesions of the nervous system. From clinical accounts, it has become clear that vivid hallucinatory experiences can arise in patients without comorbid cognitive or psychiatric disease. Clinical accounts of vivid hallucinations in patients with isolated dysfunction of peripheral sensory organs have demonstrated that without access to the outside world, the primary sensory networks can function in an autonomous manner, producing vivid hallucinations. Clinical accounts of hallucinations in patients with lesions of the subcortical structures have demonstrated that the sensory systems are modulated by neural structures in the brain stem and the thalamus. Reports of hallucinatory experiences by patients undergoing cortical electroencephalographic (EEG) recording during evaluation for epilepsy surgery have provided evidence for hallucination arising either as a consequence of seizures or electrical brain stimulation; these reports demonstrate specific anatomic-clinical correlations depending upon the location of the involved cortex ([Table 1](#)).

In addition to clinical accounts, current understanding of hallucinations has been enriched by structured experiments using functional brain imaging. This line of evidence has strengthened correlation between hallucinatory modality and the regions of the brain involved. Functional experiments using PET and functional MRI in patients actively hallucinating have outlined primary and participating regions in the generation of the hallucination.

In the following sections, the most frequent causes of hallucinatory experiences are described and defined on the basis of the proposed mechanism or underlying pathological

Table 1 Classification of hallucinations by proposed mechanism

Hallucinations arising from direct cortical activation or inhibition
1. Epilepsy
2. Migraine
Hallucinations consequent to peripheral sensory organ dysfunction
1. Charles Bonnet syndrome
2. Musical hallucinosis
3. Phantom limb syndrome
Hallucinations arising from dysfunctional subcortical processing
1. Peduncular hallucinosis
2. Hypnagogic and hypnopompic hallucinations of narcolepsy
3. Lewy body disease
4. LSD intoxication
Hallucination due to impaired reality monitoring
1. Schizophrenia and other psychiatric diseases

Proposed mechanisms for hallucinations may be well characterized or may only be theoretical. The mechanism in each case may be mixed and the hallucination is classified by the most likely mechanism to be contributing to the hallucinations.

condition. However, the mechanism of production of hallucinations is often not definitively established.

Hallucinations Due to Pathological Cortical Activation or Inhibition

Tamburini postulated that hallucinations may arise from direct activation of the cortex which was involved in processing this modality. Current evidence suggests that both pathological cortical activation and pathological cortical inhibition may generate hallucinatory experiences. The strongest evidence for this comes from intracranial EEG. In addition, functional imaging experiments in patients experiencing migraine attacks have provided evidence that cortical inhibition may generate hallucinatory experiences.

Hallucinations associated with epilepsy

Seizures may arise from any region of the cerebral cortex with some predilection for the limbic system. The modality and complexity of the hallucination which is experienced by the patient is determined by the type and amount of cortex that undergoes regional activation or regional inhibition during the course of a seizure. Elementary sensory phenomena such as hearing an auditory tone, seeing phosphenes, or feeling unilateral somatosensory paresthesias occur if a seizure arises from the primary sensory cortex. For instance, a patient may hear buzzing when seizures arise close to Heschl's gyrus of the temporal lobe and are a strong localizing feature. In addition, elementary positive visual phenomena such as simply shaped flashes and negative phenomena such as scotomas strongly localize to the occipital cortex.

Seizures arising from sensory association areas of the occipital, temporal, parietal, or frontal lobes may produce more complex hallucinatory phenomena. Seizures arising near the temporal-occipital junction may produce complex, formed visual illusions such as animals, people, and flowers as in pallinopsia; images may appear in duplicate, have altered size with macropsia and micropsia (similar to Alice in Wonderland syndrome of migraine), or autoscopia where the patient may see himself as though outside his body. Seizures arising from association areas of the temporal lobes may produce

vivid auditory hallucinations of voices, singing, or music. Complex auditory hallucinations in epilepsy tend to be stereotyped. For instance, a patient with temporal lobe epilepsy reported that she heard the song *Smoke Gets in Your Eyes* at the beginning of every seizure. This is contrary to musical hallucinosis resulting from progressive hearing loss where a large repertoire of childhood or popular songs may be heard. Vivid multimodal hallucinatory experiences resembling actual memories may be seen in patients with seizures arising from the hippocampus or other limbic areas. For instance, patients may feel that at seizure onset, they are reliving an experience from early on in life, including seeing, feeling, and hearing the events of the experience. This type of multimodal complexity is generally not seen in seizures arising from isolated association regions of the cortex and suggests that involvement of the limbic structures is likely.

Hallucinations and migraine

The hallucinations of migraine auras encompass a wide spectrum of phenomena, from simple elementary visual disturbances in the migraine scotomas to complex visual illusions. The most common elementary visual hallucination of migraine is the scintillating scotoma. Patients report bright, jagged, shimmering, and moving zigzags which start at the visual fixation point and move outward toward the periphery of one side of vision. The scotoma frequently takes the shape of a horseshoe and moves through the visual field over a period of 20 min (see [Figure 3](#)). In addition to the typical aura, a large variety of hallucinations have been reported to occur prior to a migraine headache. For instance, some patients report the feeling of a presence next to themselves, hallucinations of physical duality, or simple auditory hallucinations such as static or beeping. Rare reports of multimodal hallucinations in the visual and auditory modalities also exist. For instance, one patient reports seeing a pulsating colored ball which would ring with each movement.

A small subgroup of patients who experience the typical aura of migraine will experience more complex visual disturbances which typically start following the initial scintillating scotoma. Patients may describe complex disturbances of body perception referred to as Alice in Wonderland syndrome. In this syndrome, patients describe the sensation of their body getting larger until it fills up the entire room or their head growing to twice its size. In addition, hallucinations of little people or animals performing complex acts have been well described as an aura migraine and have been termed Lilliputian vision.

Hallucinations Secondary to Dysfunctional Subcortical Processing

Multiple lines of both clinical and experimental evidence suggest that vivid hallucinations can be generated by isolated dysfunction of specific neuronal systems located in the upper brain stem and in the thalamus. The implicated nuclei include the serotonergic nuclei of the dorsal raphe, the aminergic nucleus coeruleus, the GABAergic nuclei of substantia nigra pars reticulata, and several nuclei of the thalamus. In general, these nuclear groups project a variety of cortical and subcortical targets and have wide-ranging effects in control of state functions ([Mesulam, 2000](#)).

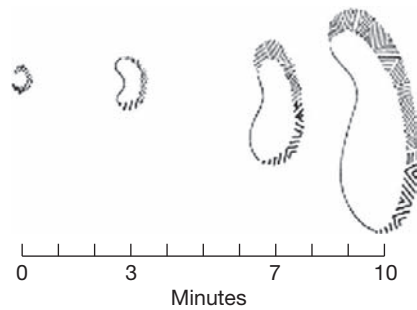


Figure 3 Evolution of the scintillating scotoma over time. Reproduced from Lashley KS (1941) Patterns of cerebral integration indicated by scotoma of migraine. *Archives of Neurology and Psychiatry* 46: 333. Copyright 1941.

Multiple clinically distinct yet neurophysiologically similar hallucinatory syndromes arise from postulated dysfunction of the nuclear groups in the upper brainstem. These include peduncular hallucinosis, hallucinations of narcolepsy, hallucinations of Lewy body disease (LBD), and intoxications with certain hallucinogenic substances. Why hallucination may occur with dysfunction of these nuclear groups is not clear. However, it is likely that normal thalamic function is modulated by regulatory activity of these brainstem nuclei. Altered synaptic input to the thalamus might then be postulated to cause disturbed processing of sensory information in the thalamus, leading to hallucinations. A fascinating potential explanation for well-formed hallucinations proposes that these arise from abnormal entry of the patient into a state similar to dreaming. In fact, hallucinations of peduncular hallucinosis (see below for further detail) have significant dream-like qualities, that is, they involve the entire visual field and frequently have a story associated with them.

Further experimental support for the idea that hallucinations in these disorders result from inappropriate entrance into the dream states comes from the discovery of the ponto-geniculate-occipital (PGO) waves. PGO waves are bursts of synchronous neuronal activity which start in the pons, propagate to the lateral geniculate nucleus, and then reach the striate cortex of the occipital lobe. A lesion affecting the dorsal nuclei of the raphe causes transient increase in the PGO spikes, recorded on EEG during the paradoxical sleep, and evokes potential dreams, namely, hallucinosis. These hallucinatory syndromes may occur when inhibitory control of the PGO system is suspended.

Peduncular hallucinosis

The syndrome of peduncular hallucinosis refers to the occurrence of vivid visual hallucinations in the context of an acute lesion in the midbrain or other subcortical region. It was first described by Jacques Jean Lhermitte in 1922 and was later refined by Van Bogaert in 1927. The term 'peduncular' was not intended as a reference solely to the cerebral peduncles but to the whole midbrain and its surrounds. De Morsier extended the syndrome to include thalamic lesions. The syndrome has been reported with a variety of lesions in the upper brain stem and pulvinar nucleus of the thalamus, isolated lesions of the substantia nigra pars reticulata, right paramedian

thalamic infarction, following infarction of left cerebral peduncle, and mass lesions in the posterior fossa and pineal region. In addition, a similar syndrome with lesions of the cerebellum has been reported.

Descriptions of the hallucinations experienced by patients with peduncular hallucinosis are largely limited to case reports and small case series. Benke et al. provided detailed descriptions of hallucinations in five patients diagnosed with peduncular hallucinosis. All patients had acute brainstem lesions such as stroke or hemorrhage. The hallucinations were highly complex with scenes of familiar places and people performing stereotyped behavior and encompassed the whole visual field. The hallucinations appeared realistic, with few fantastic qualities to them. Frequently, the same hallucination lasting several minutes occurred over a period of weeks. The hallucinations might become more vivid with eye closure. This is opposite to CBS in which hallucinations disappear after eye closure.

Patients with peduncular hallucinosis may have a variety of associated signs and symptoms. Neurological examination frequently reveals the presence of upper brain stem dysfunction, such as vertical eye movement abnormalities, hemiparesis, dysarthria, or ataxia. In addition, patients have frequently been reported to have difficulties with arousal and suffer significant hypersomnolence. Neuropsychological evaluation of patients with peduncular hallucinosis has revealed significant cognitive disturbances, including deficits of memory and frontal network function. It is not clear if cognitive dysfunction is necessary for the development of this syndrome or is merely an associated factor.

Hypnopompic and hypnagogic hallucinations of narcolepsy

Jean-Baptiste-Édouard Gélinau first coined the term 'narcolepsy' from Greek to mean 'seized by somnolence.' He described patients with excessive daytime sleepiness, sleep attacks, and episodes of muscle weakness triggered by emotions. Later, Gélinau added that patients with narcolepsy may report hallucinatory experiences wither while falling asleep or while waking up from sleep. Patients with narcolepsy report vivid visual, auditory, or tactile hallucinations, which occur shortly after the person feels the characteristic urge to go to sleep or when waking up. As the hallucinations start, the patient is generally aware of his surroundings and is awake. Patients report seeing vivid images or complex scenes, hearing voices, feeling a presence, or feeling someone brushing against them. EEG studies of hypnopompic hallucinations have shown that they may occur as the patient inappropriately enters rapid eye movement (REM) sleep from wakefulness or stage I sleep. The hallucinations typically occur in the first REM cycle and are characteristically absent during subsequent REM cycles later in the night. The specificity of hypnagogic and hypnopompic hallucinations for diagnosis of narcolepsy has come under scrutiny. Ohayon et al. determined that both types of hallucinations frequently occur in normal healthy adults, though hallucinations upon waking from sleep may be more specific for narcolepsy.

Hallucinations of LBD

LBD was first described by Woodard in 1962 with additional features and improved diagnostic criteria provided by McKeith

in 1992. Patients present with a history of chronic, progressive cognitive decline and have prominent deficits of working memory and visuospatial function. They then soon develop an extrapyramidal syndrome which is somewhat different from Parkinson's disease. Hallucinations are a common early feature of LBD and occur in ~80% of patients over the course of illness. Patients frequently describe vivid, nonthreatening, hallucinations, primarily visual, consisting of seeing people and animals which are usually superimposed onto a normal background of the environment. For instance, a patient may report seeing a group of children playing on the floor in his bedroom. Insight into the artificial nature of the hallucinations is frequently fully preserved.

Research into the mechanism of hallucinations in LBD generally refutes the claim that they must arise from widespread cortical atrophy or focal atrophy of the occipital regions. As summarized by Nestor, there are several lines of evidence which suggest that a cholinergic deficit is responsible for hallucinatory experiences in LBD. This is supported by the observation that visual hallucinations generally improve with cholinergic augmentation in LBD. In addition, the hypometabolism seen on PET in patients with LBD is reversed by cholinergic augmentation. This is further supported by studies of neurohistochemical markers of muscarinic receptors in patients diagnosed with LBD.

Lysergic acid diethylamide, mescaline, and psilocybin intoxication

Lysergic acid diethylamide (LSD) was first synthesized in 1938 by Albert Hofmann as a derivative from the rye fungus *Claviceps purpurea*. Its psychoactive properties were discovered in 1943 by accidental ingestion of the drug by Dr. Hoffman. LSD causes euphoria, a perceived enhanced capacity for introspection, vivid visual hallucinations, synesthesias, and alterations of thinking and time experience. The hallucinogenic action of LSD is likely secondary to specific effects of the drug on serotonergic receptors of the raphe nuclei of the midbrain and the locus coeruleus. In fact, the affinity for serotonergic receptors is a common property of other hallucinogenic substances, including mescaline and psilocybin. Mescaline occurs naturally in the peyote cactus *Lophophora williamsii*. The hallucinations experienced during the intoxication are similar to LSD. Psilocybin is produced by many species of fungi and has hallucinogenic properties similar to LSD and mescaline.

Hallucinations due to Cortical Deafferentiation

Abundant clinical evidence suggests that patients who lose the function of peripheral sensory systems, such as vision or hearing, can experience vivid hallucinations in the same modality as the sensory loss. Reports of such hallucinations date back to the 1700s with descriptions of CBS. CBS is the prototypical cortical deafferentiation syndrome which occurs in situations when afferent input of the primary visual cortex is lost, often from eye disease. Musical hallucinosis and phantom limb syndrome may have similar causes. The hallucinations experienced by patients with these symptoms suggest that if central sensory systems are deprived of adequate peripheral input, they may start to function in a semiautonomous manner.

Charles Bonnet syndrome

CBS is defined to be vivid visual hallucinations which occur in the setting of worsening vision (Fernandez et al., 1997). The Swiss naturalist Charles Bonnet first described such hallucinations in his grandfather. The visual hallucinations may not occur as part of another entity, such as LBD, although this approach has been questioned. Hallucinations have most frequently been described in the presence of macular degeneration, cytomegalovirus (CMV) retinitis, or other causes of acute and chronically progressive blindness. The hallucinations have most frequently been described in adults, but it is likely that the full syndrome can occur at any age, including childhood. Patients report vivid and well-formed images of people which occur in the setting of poor lighting. The hallucinations are nonthreatening, are exclusively in the visual modality, and they characteristically disappear upon eye closure.

Functional imaging studies done on patients with CBS demonstrate that during the course of the hallucination, the primary visual cortex is in fact not active. During the hallucination, visual association areas which lie downstream from the primary visual cortex demonstrate BOLD signal activation on functional MRI. Areas include the lateral temporal cortex, striatum, and thalamus. Further functional MRI experiments in patients with CBS found activation in areas corresponding to the content of the hallucination. Patients who hallucinated in color activated the V4 color area of the cortex, and patients who hallucinated in black and white did not.

Treatment of CBS focuses on improvement of lighting in the residence of the person. A variety of antiepileptic and antipsychotic medications have been tried with variable efficacy (usually lacking effect) in CBS.

Musical hallucinosis

Exclusively auditory musical hallucinations in the absence of psychiatric disease have been described since the 1950s (Ross, 1978). Patients typically report hearing loud and well-formed instrumental music with or without singing. The music is typically something they know well from childhood. Berrios found that ~70% of cases of musical hallucinosis are associated with hearing loss and typically occur in the presence of otosclerosis. The syndrome has also been reported following traumatic brain injury, brain stem strokes, and epilepsy. The neural mechanism of musical hallucinosis, at least in cases of peripheral hearing loss, may be similar to the visual hallucinosis of CBS and includes autologous activation of downstream association areas. The syndrome occurs with static lesions of the temporal lobes and may also occur in the course of temporal lobe epilepsy, which in the authors' experience at times produces tunes that cannot be readily identified by the patient. Treatment usually is aimed at removal of the underlying cause. Use of hearing aids and cochlear implants has been associated with decrease of musical hallucinosis when peripheral hearing loss underlies the condition, and neuroleptics usually fail in this circumstance. Attempts at treatment using an antiepileptic typically fail if the auditory hallucinations are not produced by seizures.

Phantom limb syndrome

In 1872, Weir Mitchell reported that a patient may continue to feel the presence of the limb after it has been amputated. Amputation of other body parts, such as the nose or genitals, may also

produce similar sensations. Following an amputation, the patient reports a conscious presence of the limb, which he may be able to move at will. Often, the limb is stuck in an awkward position or is dramatically misshapen, being the wrong length or thickness. The phantom limb may be painful with burning, aching, prickling, or crushing sensations.

A variety of peripheral and central neural mechanisms have been proposed to explain the appearance of phantom limbs. Initially, the syndrome was thought to arise peripherally from enlargements of nerve stubs which grew at the site of the amputation. However, removal of these seldom produced significant relief from phantom limb pain and did not affect perception of the limb. Other largely unsuccessful methods for eliminating the pain of phantom limbs included injection of procaine into stump, dorsal rhizotomy, and spinal anesthesia.

More recently, central causes of phantom limb syndrome have been proposed, based on clinical observations of patients following limb amputations. Ramachandran et al. recognized that full somatotopic representations of the amputated extremity may exist on the face ipsilateral to the amputation. Stimulation of the face produced modality-specific sensations on the phantom limb of the patient. Subsequent studies of patients with upper extremity amputation using MEG functional mapping showed that sensory stimulation of the face produced activation in the primary sensory cortex of the hand. From the aforementioned experiments, it seems that phantom limbs may be generated by activation of peripheral somatosensory endings of the face which activate regions of the primary sensory cortex, which previously was attributed to the hand. He further demonstrated that use of a mirror box, which provides the patient with the perception of the missing limb, can alleviate phantom limb pain, further supporting the concept that a disturbance of central mechanisms of perception generates the symptoms. The phantom limb syndrome therefore shares fundamentally similar features with CBS. How the mechanism of reorganization occurs, and the extent to which the thalamus and cortex interact, is not known, though clinical features suggest the importance of the cortex in these syndromes.

Hallucinations Due to Deficits Top-Down Processing in the Idiopathic Psychiatric Disorders

Clinical phenomenology of hallucinations in idiopathic psychiatric disorders has been well studied. Hallucinations characteristically occur in schizophrenia, but are also common in major depression, bipolar disorder, and schizoaffective disorder. Auditory hallucinations occur in 60% of patients with schizophrenia; visual, olfactory, and somatosensory hallucinations likewise occur but are far less prominent. Patients with schizophrenia may describe hearing a clear voice like a tape playing in their head. Frequently, these take the form of conversations between people. The voices may issue commands, compliments, or insults addressed to the person. Schizophrenics often lack control over the voices and feel powerless to stop them. Sometimes, they may exert full control over the voices and can summon or quiet them at will.

Hallucinations experienced in psychiatric disorders may have several characteristics that distinguish them from hallucinations that appear in neurologic disease. Strong emotional reactions to hallucinations are common when they occur in

neurologic diseases. For instance, patients with peduncular hallucinosis often fear the hallucinatory experience but rarely report strong emotional content in the hallucination itself. Conversely, strong emotional content is frequent in hallucinations caused by psychiatric disorders. For instance, voices that criticize and threaten are common in schizophrenia (see Table 2). In addition, the content of hallucinations in psychiatric disease may be influenced by the personal ideas, preferences, or previous experiences of the patient. For instance, hallucinations associated with posttraumatic stress disorder may include the vivid experience of reliving the trauma. In contrast, hallucinations in neurological disease are generally not influenced by past experience, personality characteristics, or expectations of the patient.

Although hallucinations in psychiatric disease have been well characterized, the neural mechanisms underlying their formation remain poorly understood. Among the more influential cognitive models is the concept that psychiatric disease alters a patient's ability to distinguish between internally and externally generated events; it creates deficits in reality monitoring. Internally generated events include imagination and reasoning, whereas externally generated events are limited to the perceptual process. The model therefore suggests that patients with schizophrenia have hallucinations because they incorrectly perceive internally generated ideas as externally occurring perceptions. Neuroimaging studies provide some support for this model. For instance, hallucinations in schizophrenia are associated with inappropriate activation of the anterior cingulate region of the frontal lobe; this area is important for distinguishing between internally generated thoughts and externally generated percepts. Other imaging studies in patients with schizophrenia show a decrease in the size of the superior temporal gyrus, cerebellum, insula, temporal pole, and the thalamus, though how these might influence propensity for hallucinations is unclear. Functional imaging studies find superior temporal gyrus activation during the presence of auditory hallucination. Successful treatment with antipsychotic agents that block dopamine receptors in basal ganglia provides another anatomic locus that plays a role in generating

Table 2 Hallucinations and clinical disorders: dominating modality, emotional content of hallucinations, and emotional reaction

<i>Disorder</i>	<i>Dominant modality</i>	<i>Emotional content</i>	<i>Emotional reaction</i>
Schizophrenia	Auditory, visual	Yes	Yes
Affective disorders	Auditory, visual	Yes	Yes
Posttraumatic stress disorder	Auditory, visual	Yes	Yes
Postpartum psychosis	Auditory	Yes	Yes
Borderline personality disorder	Auditory	Yes	Yes
Lewy body disease	Visual	No	Possible
Parkinson disease	Visual	No	No
Alzheimer's disease	Visual	No	No
Charles Bonnet syndrome	Visual	No	Possible

Source: Aleman A and Larøi F (2008) *Hallucinations: The Science of Idiosyncratic Perception*. Washington, DC: American Psychological Association.

hallucinations. A clear cognitive model of hallucinations in psychiatric disease still needs to be elucidated.

Conclusion

Hallucinatory experiences have been woven into the fabric of history and have provided the impetus for brain research. Present understanding of the mechanisms comes from several sources: clinical description with neuroanatomical correlations from MRI, clinical descriptions correlated with EEG, functional imaging during the experience of hallucinations, and assessment of functional consequences of therapy. These have provided at least four distinct mechanisms of generation of hallucinations: cortical deafferentiation, direct cortical stimulation or inhibition, subcortical release, and top-down dysfunction. Despite these observations, no single neuroanatomical model likely explains the whole spectrum of hallucinatory experiences. The approach to a patient who is experiencing hallucinations should include detailed history of time of onset, spectrum, modality type, and inciting phenomena. Examination of a patient should focus on cognitive testing, examination of peripheral sensory organs such as eye and ear, and a history of psychiatric disease. The patient should get structural imaging such as an MRI, and an EEG if seizures are suspected. Treatment depends on the syndrome in which the hallucinations appear and ranges from dopamine antagonism,

cholinergic augmentation, antiepileptic medication, or modulation of the function of preserved sensory organs.

See also: Brain and Behavior Relationships; Confabulation and Reality Filtering; Schizophrenia.

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Handedness

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Glossary

Ambidexterity The ability to use both hands equally well; can take two forms: doing 50% of things with the left hand and 50% with the right, or doing all things equally well with either hand.

Aphasia Disordered processing of grammatical and/or semantic aspect of speech and language after left hemisphere damage.

Carotid artery (left and right) Large blood vessels that form the brain's principal blood supply.

Corpus callosum A brain structure consisting of hundreds of millions of nerve fibers (axons) that serves as

the primary connection between the left and right cerebral hemispheres.

Episodic memory Our memory for specific episodes from our lives, as opposed to semantic memory (our general world knowledge).

Median The middle value in a series of data points; the value for which 50% of the data points are larger and 50% are smaller.

Testosterone A hormone responsible for the development of masculine traits, in contrast to estrogen, a feminizing hormone.

Historical and Sociological Overview

The term 'handedness' in psychology refers to the related facts that (a) humans generally display a preference for the use of one hand over the other when performing tasks that require agility and fine motor control and (b) the majority of humans specifically display a right-hand preference. This right-handed predominance has been part of our species' nature for a long time, as evidence from ancient tools and drawings suggests that the majority of humans have been right-handed for at least the past 100 000 years.

Although the left and right hands of humans are anatomically equivalent, human societies have long noted (and puzzled over) the fact that roughly 90% of all humans exhibit a preference, particularly when writing, for the right hand, with only about 10% preferring the use of the left hand. The exact proportion of left-handedness remains a matter of dispute, with estimates based on North American and European samples ranging from 8% to 15%, with males being slightly more likely to be left-handed. In contrast, many non-Western cultures appear to have lower rates of left-handedness ranging from 2% to 8%. However, this applies only to left-handedness for the socially relevant activities of writing and eating. Evidence suggests that when less socially relevant activities, such as throwing a ball or combing hair, are examined, the rates of left-handedness in non-Western societies approach those found in the West.

The right-handed majorities' reaction to the left-handed minority has ranged from the negative to the positive. Aristotle thought that left-handedness and ambidexterity posed a serious problem for the prevailing view of his time on the inherent superiority of the right side of the body. In contrast, the Bible speaks approvingly of the 700 left-handed sling shooters from the tribe of Benjamin, who were renowned for their accuracy; on the other hand, the Bible also states that sinners on the Day of Judgment will sit at the Lord's left hand before being cast into everlasting fire (while the righteous await at the Lord's right hand). In total, negative associations of left-handedness outweigh positive ones.

This prejudice against the left hand (and left-handers) extends beyond the Judeo-Christian tradition. In Buddhism, the path to Nirvana forks, with the left-hand path representing the wrong way of life. In Hinduism, the right hand is used for many civil and reverent activities, including eating, giving, receiving, and worshipful offering. In Islam, ritual washing of the hands involves pleas that, on the Day of Judgment, the book of one's actions in life be placed on the right hand, representing salvation, not the left hand, which represents damnation. Among Gypsies, it is believed that if your right palm itches, you will receive money, while if your left palm itches, you will lose money. In many African cultures, twitching of the right eye signifies that something pleasant is about to happen, while left eye twitching may foretell a death in the family. In Morocco and among Eskimos, left-handers are viewed as potential sorcerers or cursed persons. The list is virtually endless.

This bias against the left hand is amply reflected in human languages. The English word *left* derives from the Anglo-Saxon term *lyft*, meaning 'weak' or 'broken.' The French word for left, *gauche*, means 'awkward' or 'tactless' in English. The German word for left is *linkisch*, which also means 'clumsy.' The Spanish word for left, *zurdo*, is used in phrases like *no ser zurdo*, meaning 'to be very clever' but is literally translated as 'not to be left-handed.' The Italian word for left, *mancino*, also means 'dishonest.' Finally, the English word *sinister* comes directly from the Latin term for 'left,' *sinister*, while the English word *dexterity* derives from the Latin term for 'right,' *dexter*.

The late nineteenth century saw the rise of an ambidexterity movement that encouraged people to become proficient with both hands, yet standard educational practices in the early and mid-twentieth century advised teachers to strongly discourage left-hand use among schoolchildren. Not surprisingly, the actual nature of human handedness is more complicated and nuanced than any simple view that 'left-handedness is good' or 'left-handedness is bad.'

Given the anatomical similarity between the left and right hands, the human tendency toward right-handedness does not

reside in or arise from the hands themselves. For millennia, human societies viewed right-handedness as essentially a moral choice: since most people are right-handed (e.g., because of what sacred traditions prescribe), everybody should choose to be right-handed.

It is worth noting that this bias against the left may have more to do with the left hand of right-handers than it did with left-handers themselves. As is discussed below, research into manual skill and dexterity shows that the left and right hands of left-handers perform at comparable levels as the right hand of right-handers: it is the right-handers' left hands that turn out to be weaker and slower and are the 'odd hand out.' Presumably, right-handers assumed that everybody had weaker left hands, leading them to wonder why anybody would choose to use their left hands.

Not surprisingly, the right-handed predominance in human hand use has led to systematic biases favoring the right hand in our environment and tools: most buttons and controls are on the right side of objects, virtually all scissors and can openers are designed for right-hand use, and so on. This is not necessarily that big a problem, however, because, as just mentioned, left-handers are generally better at using their right hands than right-handers are at using their left (right-handers would likely have problems, however, if confronted with a world full of left-handed tools).

Interestingly, there is one common tool that has been specifically designed to favor the left hand over the right hand: the typing keyboard. In the early days of mechanical typewriters, typing at too fast a rate would cause the typewriter to jam up and stop working. As a result, the layout of the keyboard (the so-called QWERTY keyboard, named after the initial set of letters on the top row) was set up so that the most common letters (e.g., 'E,' 'R,' 'S') were put on the left side of the keyboard in an intentional effort to slow down the typing of the right-handed majority. A more efficient keyboard layout (at least for right-handers), the DVORAK layout, has been shown to significantly increase typing speeds for right-handers, but has been unable to overcome the preexisting dominance and popularity of the QWERTY layout.

Another common object that, while originally designed to favor the right hand, has ended up possibly favoring the left hand is the guitar. When the guitar was first developed, guitars were tuned to an open chord, meaning that the left hand's role consisted primarily of fretting one string at a time to create the melody. The more demanding job of finger picking was given to the right hand. As the guitar evolved, however, the left-hand role became more challenging (e.g., fingering chords that required three or four strings to be fretted) while the right hand's role typically switched to strumming, a task requiring less dexterity than finger picking. It has thus been suggested that what is currently called a 'right-handed' guitar may be better characterized as a left-handed guitar, and vice versa. This line of reasoning has been applied to the guitar-playing talent of Jimi Hendrix, a right-hander who plays a left-handed guitar.

Early Research on Handedness

The modern era of handedness research can be dated back to the French physician Paul Broca's landmark 1865 paper on the

localization of language in the brain, showing a link between damage to the left hemisphere and aphasia. Although Broca originally set out to simply demonstrate that language functions were localized to the frontal lobes of the brain, he and his contemporaries were surprised to learn that language was lateralized to the *left* frontal lobe in particular. This finding that the brain was not characterized by the same bilateral symmetry found in other paired organs of the body (e.g., lungs, kidneys, eyes, etc.) helped shed light on the nature of handedness: since the left hemisphere of the brain (a) is in charge of language and (b) controls the *right* side of the body, then it made sense that humans would be right-hand dominant for writing. It was thus reasoned that left-handedness was associated with right hemisphere dominance for language. Broca's findings presented one of the first hints that handedness may not be a simple personal choice, but instead may be grounded in human physiology.

The prevailing assumption at the time was that left-handers were mirror images of right-handers, such that left-handedness was presumed to be associated with *right* hemisphere localization of language. In turn, this led to a widespread view of left-handedness being somehow pathological and/or inferior, since left-handers had language in the 'wrong' side of the brain. Much of the research on handedness during the first half of the twentieth century tested claims that left-handedness was associated with various negative conditions, such as low IQ, neurosis, speech defects, psychopathology, bed wetting, and poor muscular coordination. As a result, it was common educational practice to force left-handers to learn to use their right hand for writing, in the belief that this would benefit their educational development. As it turned out, evidence began emerging showing that forcing schoolchildren to switch from left-handed to right-handed writing led to an *increased* risk for developing various learning disabilities. As a result, the practice of forced switching of writing hand has gradually disappeared.

Another important focus of research on handedness during the first half of the twentieth century was the measurement and classification of handedness. One of the most important insights to emerge was that the hand preferences of left-handers differed markedly from those of right-handers. For example, while most right-handers prefer their right hand for most everyday activities, left-handers display a much more variable pattern of hand preference, being more likely than right-handers to use their nondominant hand for various activities. More generally, strong and consistent hand preferences are more likely to be found for skilled activities (e.g., writing, eating) than unskilled activities (e.g., grip strength, picking up objects).

Of particular importance were studies of language lateralization in left- versus right-handers. The development of a new technique, the Wada Test, provided conclusive determination of which side of the brain contained language areas by allowing researchers to put one or the other side of the brain to sleep (via injection of an anesthetic into the left or right carotid artery) and then testing the language capacity of the remaining hemisphere. This research confirmed what had been assumed about right-handers: 96% had language solely in the left hemisphere (the remaining 4% had right hemisphere language). The picture for left-handers was somewhat surprising, as the majority of left-handers (70%) also had language solely in the

left hemisphere. However, left-handers were more likely than right-handers to have right hemisphere language (15%) or language in both sides of the brain (15%). This confirmed the growing realization that left-handers were not simply mirror images of right-handers. Instead, a new view began emerging: brain asymmetry was roughly similar in left- and right-handers, but was more variable in left-handers.

An interesting foreshadowing of a new approach to handedness that is described at the end of this article can be found in related research which argues that the relation between left-handedness and language lateralization was qualified by variations in the strength of left-handers: pure left-handers were thought to be more likely to have right hemisphere language, while language in both hemispheres was thought to be associated with left-handers whose overall hand preference was mixed (e.g., they used their nondominant hand for at least a few activities). At the very least, it had become clear that the relationship between hand dominance and language lateralization was not a straightforward one.

Modern Research on Handedness

Behavioral and Physiological Research

Interest in handedness saw a marked increase in the 1960s as a result of Roger Sperry's groundbreaking (and Nobel Prize winning) work on the so-called 'split-brain' patients, who had their corpus callosum surgically severed to control the spread of epileptic seizures. While Sperry's own research primarily focused on differences between the left and right hemispheres, it sparked renewed interest in the differences between left- and right-handers.

As mentioned above, early research assumed that left-versus right-handers were right- versus left-hemisphere dominant, respectively. Accordingly, right-handers were thought to be better at left-hemisphere functions such as language and logical thinking, while left-handers were thought to excel at right-hemisphere functions such as spatial processing and intuition. This notion is reflected in the bumper sticker slogan: "If the left brain controls the right side of the body and the right brain controls the left side of the body, then only left-handers are in their right mind." In hindsight, this research was flawed because of incorrect understandings of both the relationship of handedness with cerebral dominance and the precise nature of what mental functions the left versus right hemispheres are specialized for.

By the 1980s, a more nuanced view of handedness began emerging, featuring three new developments. First and foremost, it started becoming clear that the vast majority of humans, left- and right-handed, have left-hemisphere dominance for speech and language functions. Although the majority of left-handers do have left-hemisphere dominance for language, a sizable minority of left-, but not right-, handers have either right hemisphere language or have language functions represented in *both* sides of the brain. It is worth noting that left-handedness is associated with a slightly increased risk of stuttering, which in turn is thought to be associated with having speech ability in both sides of the brain: we have a single mouth, so when both sides of the brain are trying to talk at the same time, there can be interference if the two sides of the brain are not working together.

Second, the notion that left-handers are 'right-brained' was replaced by the idea that the majority of all humans, regardless of handedness, have the same functions lateralized to the left and right hemispheres, but the brains of right-handers are more strongly lateralized. That is, the division of labor between the two sides of the brain in right-handers is relatively 'all-or-none,' while in left-handers it is 'most-or-some.' For example, a common method to determine which side of the brain handles which types of tasks is to present information to a single side of the brain. This can be accomplished by presenting that information to the left versus right visual fields or the left versus right ears, which project to the right versus left hemispheres, respectively. Such studies show, for example, that while just about everyone shows right visual field advantages and right ear advantages for linguistic materials, the size of these advantages is significantly larger in right-handers. In other words, the brains of right-handers are more lateralized than those of left-handers.

A nice example of this principle can be found in studies of fine motor control. In general, the left hemisphere is better at fine motor control than the right. Thus, right-handers are much better at tasks requiring fine motor control (such as speeded finger tapping or placing small pegs into small holes) when using their right hand than when using their left hand. Left-handers, in contrast, show much smaller differences between left- and right-hand performance, as fine motor control is more evenly distributed across both hemispheres. Thus, as mentioned earlier, it is the left hands of right-handers, not left-handers themselves, that are relatively weak and clumsy.

The third new development involved a rethinking of exactly how the two sides of the brain differed in their functions. Through the 1970s, the prevailing view was that most types of tasks and stimuli were always handled by one hemisphere; for example, all verbal tasks were presumed to be processed exclusively by the left hemisphere and all visuospatial tasks exclusively by the right hemisphere. This has been replaced by a componential approach, emphasizing that both sides of the brain work together in dealing with most tasks and stimuli, dividing up the labor so that one hemisphere handles some components of the task and the other hemisphere handles the remaining components. To illustrate, in the verbal domain, when we are listening to another person talk, the left hemisphere processes the phonology (i.e., specific speech sounds), while the right hemisphere processes the prosody (i.e., the varying intonation of speech that carries emotional information). Similarly, in the visuospatial domain, the left hemisphere processes the 'trees' (i.e., local details) and the right hemisphere processes the 'forest' (i.e., the global configuration).

These developments led to a switch from the prior emphasis on 'cerebral dominance' (e.g., each side of the brain being dominant for different tasks) to a new emphasis on inter-hemispheric interaction (e.g., how the two sides of the brain divide up the labor of ongoing tasks). There was also emerging evidence that the corpus callosum, the bundle of nerve fibers that constitutes the primary connection between the left and right cerebral hemispheres, is larger in non-right-handers. Taken together, this suggested that left-handers may exhibit greater amounts of interhemispheric interaction than right-handers, a theme that is revisited in the final section of this article.

In conclusion, brain asymmetry in left-handers is more variable in both magnitude and direction than in right-handers. Interestingly, this increased variability in left-handers is mirrored in other domains. For example, while there are no overall differences in intelligence with respect to handedness, left-handedness is associated with increased variability in intelligence: left-handedness is overrepresented among both mentally impaired and mentally gifted populations.

Development and Genetics of Handedness

The exact origins of right- versus left-handedness, both in terms of the evolution of our species and the development of the individual, remain somewhat mysterious. From an evolutionary standpoint, many conjectures have been offered. From a male-based perspective, it has been argued that our species became right-handed because of the practice of carrying shields in the left hand (to protect our left-sided hearts), thus freeing the right hand to become specialized in the fine motor control required by weapon use. From a female-based perspective, it has been argued that we became right-handed because of the practice of mothers carrying their babies in their left hand (to keep the baby close to the comforting sound of the mother's left-sided heart), thus freeing the right hand to become specialized in the fine motor control required by foraging for food. Others have argued that the fact of right-handedness was arbitrary; what was important was that, for the purposes of efficiency when working together in groups, we all used the same hand (think of a left-handed violinist in the string section of an orchestra) and it just happened to end up being the right hand.

While the precise evolutionary history of handedness remains unknown, perhaps the most plausible account is based on the notion that our earliest ancestors may initially have been right hemisphere (and left hand) dominant for basic communication and postural control functions. As our ancestors started developing linguistic and tool-making ability, the previously underused left hemisphere was 'available' and hence language and fine motor control functions ended up being lateralized to the left side of our brains.

A little more is known about the development of handedness within an individual. First and foremost, it is clear that handedness has a hereditary basis, as it does tend to run in families. That said, handedness does not appear to have the simple genetic basis that traits such as hair and eye color have. For example, 20–25% of identical twins are discordant for handedness (i.e., one is left-handed and the other is right-handed). Intriguingly, modern genetic models of handedness get around this puzzle by arguing that there is no gene for left-handedness *per se*.

Rather, such models argue for a genetic spectrum ranging from strong right-handedness to random or mixed-handedness. It is assumed that there is a gene that predisposes us to be right-handed (the so-called 'right shift' gene). If we get two copies of that gene, we will be strongly right-handed. If we get only one copy, we will be weakly to moderately right-handed. And if we get no copies of that gene, our handedness will be the random outcome of chance environmental factors, with about half of people with no copies of that gene ending up right-handed and the other half ending up left-handed.

Specifically, this model suggests that about 25% of the human population lacks both copies of the right shift gene; hence, roughly 12.5% of these individuals will end up being right-handed and about 12.5% being left-handed, very close to the actual population percentages. This model suggests that the optimal pattern involves inheriting a single copy of the right shift gene. People with both copies may end up being so left hemisphere and right-hand dominant that they experience difficulties with right hemisphere nonverbal functions and left-hand use, while people with zero copies may end up with insufficient left hemisphere-based verbal abilities.

Other nongenetic bases for handedness have also been proposed. First, there appears to be an association between left-handedness and birth trauma and stress. The idea is that birth complications, such as hypoxia (reduced oxygen to the brain), can lead to left hemisphere damage and hence non-right-handedness. Moreover, this model suggests that a predisposition to birth complications may be genetic, thus accounting for the heritability of left-handedness. While birth stress may indeed be a factor in left-handedness, it cannot be the whole story, as many left-handers have no history whatsoever of birth trauma or stress.

Another potential, nongenetic cause of left-handedness involves the effects of testosterone on fetal development. A curious association between left-handedness, autoimmune disorders (e.g., allergies, eczema, asthma, Crohn's Disease) and pigmentation anomalies (e.g., albinism, premature graying, blond hair) has been explained by the effects of testosterone on the fetal development of the neural crest, an embryological feature that eventually matures into the central nervous system, the pigmented cells of the body, and important components of the immune system. It has been proposed that increased exposure to (and/or increased sensitivity to) testosterone slows the development of the left hemisphere, allowing the right hemisphere to become more dominant and thereby increasing the likelihood of left-handedness.

These three accounts (genetic, birth stress, testosterone) are not necessarily mutually exclusive. For example, perhaps what runs in families is not a handedness gene, but a genetic predisposition to increased exposure to testosterone, which then leads to left-handedness. Similarly, increased fetal exposure to testosterone in females can result in masculine characteristics such as slimmer hips, which in turn could be a factor in producing birth stress. It is quite possible that all three accounts have merit, and human handedness is the result of a complex interaction between genetic, environmental, and hormonal factors.

Measurement of Handedness

A few words are in order concerning the measurement and classification of handedness. Because humans vary in both direction (left vs. right) and degree (strong vs. mixed) of handedness, defining handedness solely in terms of 'the writing hand' is insufficient. A better inventory of hand use and preference is required. The most commonly used measure of handedness in contemporary research is the Edinburgh Handedness Inventory. It asks about hand use for ten common activities: writing, drawing, throwing, using a spoon, using a knife without a fork, using scissors, opening a jar, brushing teeth, upper hand on a

broom, and lighting a match. For each activity, there are five possible responses: always left, usually left, no preference, usually right, and always right (worth -10 , -5 , 0 , $+5$, and $+10$ points, respectively). Total scores range from -100 (indicating pure left-handedness) to $+100$ (pure right-handedness).

This measure allows one to classify handedness in terms of both direction and degree. In terms of direction, positive versus negative scores reflect left- versus right-handedness, respectively. In terms of degree of handedness, the picture is a bit more complicated, as there is no obvious criterion for distinguishing between strong- and mixed-handedness. However, current convention uses a median split: at the population level, about half of all humans score above 80 (indicating a right-hand preference for all ten activities, leading to classification as strong-handed) and the other half score 80 or below (indicating that they use their nondominant hand for at least one activity, leading to classification as mixed-handers). This distinction between strong- versus mixed-handedness, instead of the usual right- versus left-handedness, is discussed further below. The frequency distribution of handedness scores for a large sample is shown in Figure 1.

Another way to measure handedness involves the use of performance-based tasks, instead of simple self-report. Tasks requiring fine motor control (such as the pegboard task described earlier) are typically used. Although performance-based measures yield the same overall picture (e.g., most humans are better with their right hand), performance and self-report measure do not always agree entirely with one another. The reasons for this discrepancy remains unclear, although it does suggest that hand preference reflects a complex interaction between innate, physiological hand differences and various social, personal, and environmental factors.

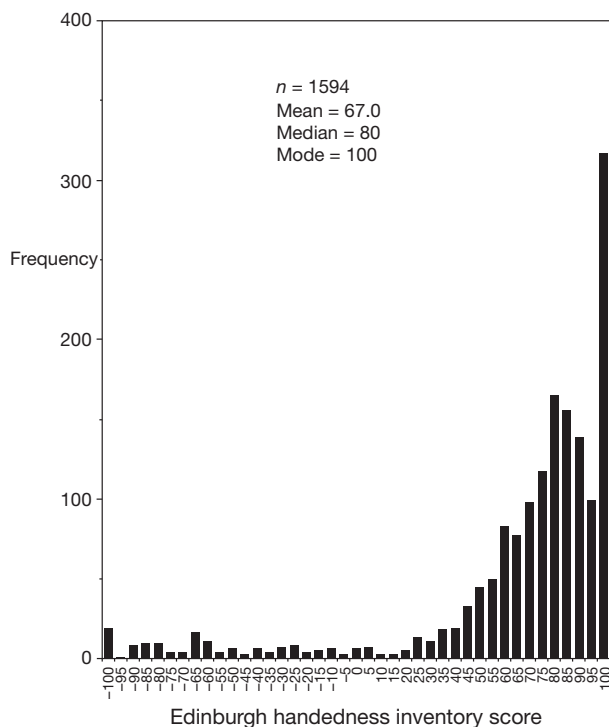


Figure 1 Frequency distribution of handedness scores for a large sample.

Handedness and Other Lateral Preferences

In addition to showing systematic hand preferences, humans are also characterized by related preferences for foot, eye, and ear use. Foot preference refers to the foot used for tasks such as kicking a ball or trying to pick up a small object with the toes. Eye preference refers to the eye used for things like sighting down a telescope. Ear preference refers to the ear used for listening to a phone or pressing an ear against a watch to hear its ticking. Research indicates that all four preferences (hand, foot, eye, and ear) are positively correlated: right-handers are more likely to be right-footed, right-eyed, and right-eared. The strongest relation is between handedness and footedness. However, none of these correlations are very strong, as it is quite common to find instances of crossed dominance (e.g., being right-handed but left-eyed). There is a suggestion in the research literature that crossed dominance for hand and eye may be associated with various psychological disorders and cognitive impairments; however, the evidence for this association remains weak at best.

Handedness in Nonhumans

No overview of handedness would be complete without at least a brief consideration of handedness and lateral preferences in nonhuman species. While individual animals often display strong and consistent preferences for use of one side of the body over the other, it is rare to find population-level asymmetries comparable to human's overall right-hand preference. When such population-level asymmetries are observed, they can involve either left- or right-sided preferences: for instance, parrots are left-footed for manipulating objects, some species of bears are left-pawed for killing prey, and blue gourami fish are left-finned for initiating social contacts, while rats are right-pawed for food reaching, the common European toad is right-footed for various manual activities, and many birds are right-eyed for looking for food and use their right foot to initiate ground scratching while looking for food. Interestingly, pawedness in dogs and cats is dependent on sex: male dogs and cats tend to be left-pawed, while females tend to be right-pawed, suggestively echoing the increased left-hand preference among human males.

Handedness in nonhuman primates is most likely to be directly related to human handedness. Studies of chimpanzees indicate that they possess a similar pattern of hand preferences to humans, using their left hands for reaching and catching and their right hands for tasks requiring finer motor control such as throwing and gesturing. However, these preferences are not as strong at the population level as those in humans, as the ratio of right- to left-handedness in chimpanzees is about 2:1 or 3:1, compared to the 8:1 or 9:1 ratio found in humans.

Animal research allows the running of genetic breeding studies that would be unethical in humans. A landmark study involved an attempt to breed for a right-pawed strain of mice. Although individual mice typically display strong paw preferences, there is no population-level paw preference (half prefer the left paw and half the right). Hypothesizing that perhaps mice had never encountered an evolutionary pressure favoring right-pawedness, researchers set about trying to breed for a

right-pawed strain of mice. For multiple generations, the most strongly right-pawed mice were bred together, the most strongly left-pawed mice were bred together, and the mice without clear paw preferences were bred together. In the end, this attempt was a failure: even when breeding two strongly right-pawed mice, whose parents, grandparents, great grandparents, etc. had all been strongly right-pawed, their litter of baby mice were equally divided between being left- and right-pawed. Unexpectedly, however, all the baby mice were strongly pawed (left or right). The researchers had inadvertently discovered that while direction (left vs. right) of paw preference was not heritable, degree (strong vs. mixed) of preference was heritable. By the end of the experiment, they had established two distinct genetic strains of mice: one was very strongly pawed (half left and half right), while the other strain consisted of mice with weaker and more balanced paw preferences.

A New Approach to Handedness: Degree, Not Direction

Findings such as those from the breeding study just discussed have prompted a new approach to the classification of handedness. In contrast to the traditional approach of comparing left- versus right-handers, a growing body of evidence suggests that degree of handedness (e.g., having a *strong* preference for use of a single hand vs. having a *mixed* pattern of hand preferences) may be a more powerful and appropriate way of approaching the nature of handedness.

Rather than the usual classification of ~90% right-handed and ~10% left-handed, this approach argues that ~50% of humans display a strong and consistent preference for the same hand across most activities, while the other 50% display a mixed-hand preference. As mentioned above, the median score on the Edinburgh Handedness Inventory is 80: scores above 80 indicate that a person uses the dominant hand for all ten activities listed on the inventory, while scores below 80 indicate use of the nondominant hand for at least one activity. In other words, 'mixed-handedness' does not refer to ambidexterity, but simply to the use of the nondominant hand for at least one or two things.

This new way of classifying handedness helps address a number of lingering puzzles about handedness. First, it explains an evolutionary mystery: given that left-handedness does not appear to be either beneficial or deleterious relative to right-handedness, the proportion of left- and right-handers should gradually drift toward a 50–50 equilibrium, instead of remaining at the stable 90–10 ratio. The strong versus mixed approach is more consistent with a stable and balanced equilibrium. Second, it maps more directly onto the existing genetic models which postulate a continuum between random (mixed) handedness versus strong right-handedness, not left- versus right-handedness. Third, it maps more directly onto studies in both humans and non-humans showing that *degree* of laterality, but not *direction* of laterality, is heritable.

From a theoretical perspective, this new approach to handedness focuses on interhemispheric interaction and, specifically, functional access to right hemisphere processing: given the evidence described above that stronger degrees of

handedness are associated with a smaller corpus callosum size, it is assumed that strong right-handers have decreased access to right hemisphere processes. For example, the right hemisphere is responsible for the retrieval of episodic memories, and strong right-handers perform more poorly than mixed-handers when remembering both real-world and lab-based memories. Strong right-handers are also more prone to false memories. Similarly, the right hemisphere is responsible for accurate representations of our body image, and strong right-handers are more prone to significant distortions of their body image. Also, the right hemisphere is responsible for the updating of currently held beliefs in response to new information, and strong right-handers are less open to persuasion. Finally, the right hemisphere is involved in divergent thinking, an important component of creativity, and mixed-handers are better at divergent thinking.

Importantly, in the majority of these studies, strongly left-handed people tend to be more similar to strongly right-handed people than either are to mixed-handers. Accordingly, these studies routinely fail to find differences between left- and right-handers; the handedness differences are confined to mixed–strong comparisons. That said, the totality of the evidence currently indicates the existence of three distinct handedness groups: strong left, mixed, and strong right.

Summary

Along with sex and age, handedness constitutes one of the primary biological dimensions of human individual differences. And just as most human societies display various prejudices and biases concerning sex and age, handedness, and specifically the left hand and left-handers, has also been the subject of many biased beliefs.

Research into the traditional classification of left- versus right-handedness has shown that left-handers are not the mirror image of right-handers; rather, all humans possess the same basic pattern of brain asymmetry, but that asymmetry is more variable in left-handers. Although handedness clearly has a hereditary basis, there is no evidence for a 'left-handed' gene per se; rather, genes appear to simply code for strength of right-handedness. Birth stress and hormonal factors have also been implicated in the development of left-handedness.

Lateral preferences for use of one side of the body over the other have been found in many nonhuman species. However, the strengths of such preferences at the population level are rarely as strong as those seen in humans. Hand preferences in Great Apes appear to be closely analogous to those found in humans.

Recently, there has been a growing shift from thinking about handedness in terms of direction (left vs. right) to thinking in terms of degree (mixed vs. strong). About half of all humans have strong handedness, using the same hand for virtually all skilled activities, while the other half uses their nondominant hand for at least one or two activities. Mixed-handedness is associated with increased access to right hemisphere processing, and has been shown to be associated with, among other things, superior memory, more accurate body image, and increased tendency to update beliefs.

See also: [The Brain](#); [Comparative Primate Psychology](#); [Motor Control](#).

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Hippocampal Formation

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Glossary

Action potential A nerve impulse, comprising a brief rising and falling of a cell's membrane potential.

Episodic memory Memory for events and episodes that were personally experienced.

Local field potential Local voltage changes in a brain region due to the combined electrical effects of a synchronously active population of neurons.

Medial Toward the midline of the brain.

Neurogenesis The birth of new neurons.

Pyramidal cell The main excitatory cell type in the neocortex and hippocampal formation, the cell bodies of which appear pyramidal in shape.

Introduction

The undulating, twisted, interlocking brain structure called the hippocampal formation has fascinated anatomists from the dawn of dissection in ancient Egypt. Over the centuries, its physical appearance has been likened to seahorses, silkworms, and the horns of a ram. The seahorse stuck, and we know it today from the Latin for seahorse: hippocampus. The hippocampal formation is composed of the hippocampus, subicular complex, and entorhinal cortex. It is unparalleled in terms of its unique circuitry and physiology. Housed within it are some of the most morphologically spectacular cells in the brain. Decoding their activity patterns has opened a window into some of the brain's fundamental operating characteristics and uncovered the existence of a map and compass within the brain. Unlike most of the brain, new neurons are born within it during adulthood, which must strive to integrate themselves into an intricate network of existing cells. With the discovery of dense amnesia following the surgical removal of the hippocampal formation in the famous patient HM, this brain region has been firmly wedded to memory. But just what 'type' of memory it supports and how it functions remains contentious. This article aims to distil the key concepts surrounding the hippocampal formation into a digestible form and provide a brief overview of its anatomy, physiology, pathology, and theorized functions.

A Seahorse in the Brain: Anatomy

Like many of the world's international borders, the borders of the hippocampal formation are disputed. One view, adopted in this article, is that the hippocampal formation is composed of six regions. These are the hippocampus proper, dentate gyrus, subiculum, presubiculum, parasubiculum, and entorhinal cortex. In other nomenclatures the entorhinal cortex, presubiculum, and parasubiculum are separated from the hippocampal formation and are gathered under the term 'parahippocampal region.' When the term 'hippocampus' is used it often refers to the hippocampus proper and the dentate gyrus collectively.

A cross-sectional cut through the hippocampal formation reveals a snugly curled up snaking shape in which the dentate

gyrus appears to be 'biting' the hippocampus proper (see [Figure 1](#)). The hippocampus proper is divided into three main subdivisions: CA1, CA2, and CA3. CA stands for 'Cornu Ammonis,' which refers to Amun's horns, named after the ancient Egyptian god of the hidden world whose symbol was ram's horn. The pyramidal cells in the Cornu Ammonis occupy a single packed layer, quite unlike the neocortex where pyramidal cells are spread over several layers. By contrast the dentate gyrus contains no pyramidal cells, but is densely packed with smaller granule cells, ~18 million in the human brain. In addition to these cells, a variety of interneurons are found in the different structures of the hippocampal formation.

From mouse to man the hippocampus is highly homologous across all mammals. In primates, the hippocampal formation is curled inside the medial temporal lobe ([Figure 1\(a\)](#)), alongside the amygdala, perirhinal cortex, and parahippocampal cortex. The entorhinal cortex has been viewed as the neocortical gate-keeper, sending projections into the structure, receiving its output and communicating with other neocortical structures. The other major source of communication with the rest of the brain is the fornix, the white matter pathway connecting the hippocampal formation to various subcortical structures and providing some output to prefrontal cortex. Via this pathway and other routes the hippocampal formation receives modulatory input from dopamine, norepinephrine (adrenaline), serotonin, and acetylcholine systems.

Theories of hippocampal function were influenced by several features of its connectivity. Four important ones are: (1) information arriving at the hippocampal formation has been highly processed through various unimodal and multimodal neocortical pathways, (2) there are largely unidirectional connections between its regions, (3) there are dense projections from the dentate to CA3, and (4) there are highly self-connected network pyramidal cells in CA3. Unidirectional connectivity is unusual in the cortex, where pyramidal cells are usually characterized by dense reciprocal connections to other cells. A full characterization of connections is beyond the scope of this article (see [Further Reading](#)).

The main flow of information follows four fiber pathways (see [Figure 1\(b\)](#)). Two arise from the entorhinal cortex. The first is the perforant path, bringing input from its layer II to the dentate and CA2/CA3, the second (less dense) is the

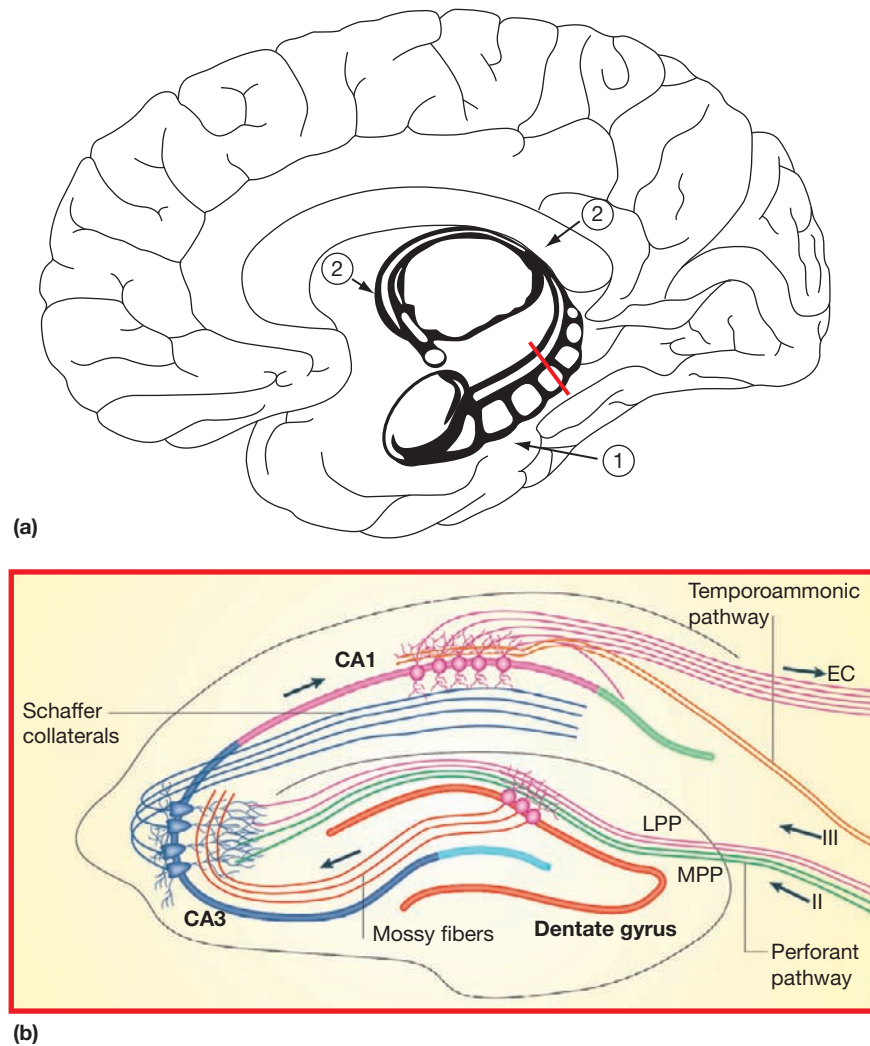


Figure 1 Anatomy of the hippocampal formation. (a) An illustration of the medial surface of the human brain. The front of the brain is to the left. The position of the hippocampal formation in the medial temporal lobe is highlighted by darker lines, (1) hippocampal formation and (2) fornix. Reprinted from Amaral DG (1994) Hippocampal formation. In: Ramachandran V (ed.) *Encyclopedia of Human Behavior*, 1st edn., pp 509–515. Academic Press, with permission from Elsevier. (b) A diagram of the circuitry in the hippocampal formation. Solid arrows depict the main ‘trisynaptic’ excitatory pathway. MPP, medial perforant path; LPP, lateral perforant path. II, III refer to layers II and III of the entorhinal cortex (EC). The fornix output pathway (not shown) arises from the CA1 collaterals and subiculum. Adapted from Figure 1 in Deng W, Amoni JB, and Gage FH (2010) New neurons and new memories: How does adult hippocampal neurogenesis affect learning and memory? *Nature Reviews Neuroscience* 11: 339–350, with permission from Macmillan Publishers Ltd.

temporoammonic pathway from layer III to CA1. From the dentate arises the dense ‘mossy fiber pathway’ which projects exclusively to CA3. The synapses from this pathway are referred to as ‘detonator synapses,’ because of their strength in driving CA3 cell activity. The CA3 cells project to CA1 via Schaffer collaterals, and to many other CA3 cells via recurrent collaterals. CA1 cells project to the subiculum and the deep layer neurons of the entorhinal cortex and via the fornix to other structures. The subiculum, presubiculum, and parasubiculum have interconnections with the entorhinal cortex and with various other structures.

Spikes and Waves: Physiology

The physiology of the hippocampal formation has played an important role in providing evidence for its function. A central

idea in neuroscience is that memories are stored in the brain by the strengthening or weakening of synaptic efficacy between cells in regions responsible for memory storage. Evidence for this was first provided by Bliss and Lømo in 1973 with their discovery of long-term potentiation (LTP) in the hippocampus. LTP refers to a persistent enhancement in signal transmission between two neurons resulting from synchronous activity of the neurons. It has been traditionally studied either ‘in vitro’ (literally: ‘in glass’) by cutting a living slice from the hippocampus, stimulating fiber pathways within it and recording cells, or ‘in vivo’ by stimulating and recording in awake, behaving animals using chronic indwelling electrodes. Since its discovery, it has been studied extensively and observed in many brain structures. Mounting evidence indicates that memory storage requires LTP. Research focused on its induction, maintenance, and expression and a wealth of knowledge has been gained about the molecular cascades underlying it.

Our understanding of hippocampal physiology has been advanced considerably by the use of extracellular microelectrodes to record the local field potential (LFP) and individual cell activity in awake, active, and sleeping animals, typically rats or mice. The LFP is generated by local voltage changes in the brain region due to the combined electrical effects of a synchronously active population of neurons. Two predominant LFP states have been observed during awake behavior: theta state and large irregular activity. When a rat is either alert or moving, a prominent regular 4–12 Hz ‘theta rhythm,’ oscillation is observed throughout the hippocampal formation; when resting or eating the LFP is instead dominated by large irregular activity. Several interesting aspects of theta are worth considering. Theta is modulated by the speed of running and influences the temporal pattern of pyramidal cell activity in hippocampus proper. The ability to induce LTP varies with the theta cycle, which has led to the suggestion that encoding and retrieval may be separated temporally by theta cycles. The theta oscillations are thought to reflect the combination of subthreshold membrane potentials and spiking activity, and appear to synchronize across the hippocampus to create a traveling wave across its axis. Large irregular activity has also been associated with synchronization in the bursting activity of the cells, particularly with the occurrence of sharp wave-ripples of 150–200 Hz. Evidence indicates that the ripples are generated by CA3, and during these events, brief near synchronous activity of many hippocampal neurons occurs. This reactivation of recently active cells may be important for the strengthening of connections between cells and for transfer of information to other regions. Sharp wave-ripple events are common in sleep and their disruption impedes spatial learning.

In addition to studying the LFP, remarkable insights into the function of the hippocampal formation have been found

by decoding the activity of individual neurons during awake behavior. This is discussed in greater detail below.

Maps and Compasses: Neural Coding

Each of us carries in our head an internal map of our world and a compass to orient within it. These appear to be located within or near the hippocampal formation. This was discovered by implanting microwires into the hippocampal formation of rodents and recording the extracellular activity while the animal explores an environment. By continually recording the animal’s position together with the neuronal activity it is possible to map the activity of cells to the surface of the environment and to the momentary orientation of the animal within it. This approach revealed an elegant system dedicated to spatial mapping and orientation.

Because of their distinctive properties, cells in different regions of the hippocampal formation have been labeled with names such as ‘place cells,’ ‘head-direction cells,’ ‘grid cells,’ and ‘border cells.’ The first to be discovered were place cells by O’Keefe and Dostrovsky in 1971. These exist in the hippocampus proper and fire action potentials (a rapid depolarization in the membrane potential) when an animal is in a particular location in the environment, but are typically silent otherwise (see [Figure 2\(b\)](#)). The location in an environment where a cell fires is called its place field. In a given environment, only a subset of place cells will be active, with each cell’s place field occupying a slightly different location, such that their collective, overlapping place fields carpet the whole environment. Place cells express different activity patterns in different environments, a phenomenon known as remapping. By recording a large ensemble of cells it has been possible to decode a rat’s

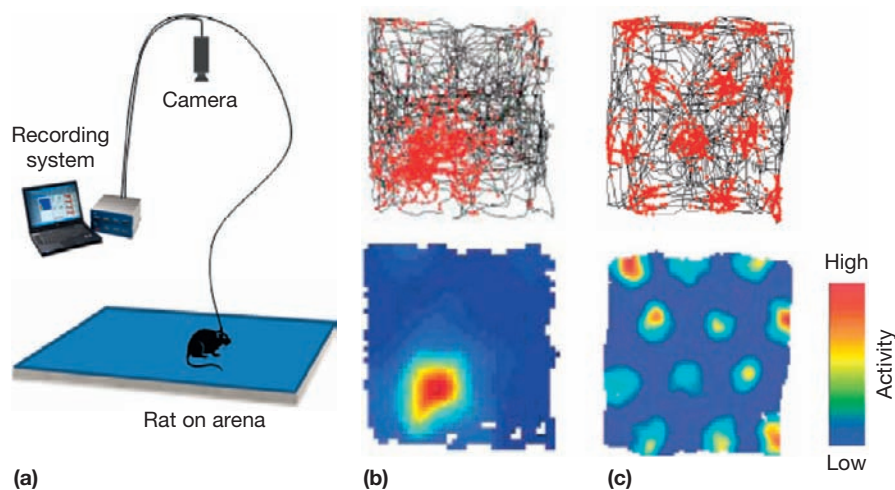


Figure 2 Single-unit recording in the hippocampal formation. (a) A diagram of a set up used for in vivo single unit electrophysiology, courtesy of Kathryn J. Jeffery. A rat is shown in a rectangular flat arena. A cable connects the implanted microwires in the rat’s hippocampal formation to a recording system. The recording system also receives information about the location of the rat via a camera. (b, c) Top, plots of a rat’s trajectory in the arena (black lines). Overlaid red dots are the locations at which action potentials were fired by a single place cell in CA3 (b), and a single grid cell in the dorsomedial entorhinal cortex (c). Below each is shown a false color plot of the spatially smoothed firing rate of each cell, showing the Gaussian peaked fields of activity. Note that, in this example, the place cell field is large than the grid cell field, but field size can vary substantially along the dorso–ventral axis. Adapted from Figure 1 in Fyhn M, Hafting T, Treves A, Moser MB, and Moser EI (2007) Hippocampal remapping and grid realignment in entorhinal cortex. *Nature* 446(7132): 190–194, with permission from Macmillan Publishers Ltd; Figure 2 in Hafting T, Fyhn M, Molden S, Moser MB, Moser EI (2005) Microstructure of a spatial map in the entorhinal cortex. *Nature* 436(7052): 801–806, with permission from Macmillan Publishers Ltd.

location in an environment to within 1 cm. Unlike the topographic maps in the visual, somatosensory, and motor cortices, the place cell map is not topographically organized within the hippocampus. Cells with place fields next to each other in an environment are not located next to each other in the hippocampus. However, the size of the place field varies from small in the dorsal hippocampus to large in the ventral hippocampus. Place cells have several interesting properties. Their response appears to be a high-level, multimodal conjunction of inputs that includes information about self-motion. They respond by remapping predominantly to changes in the boundaries, distant landmarks, and large-scale sensory aspects of the environment, such as the floor and wall colors. They can learn incidentally (without reward) over several trials to discriminate very similar environments.

The cells in a number of peri-hippocampal areas such as the mammillary bodies, anterior thalamus, dorsal presubiculum, and retrosplenial cortex also produce a spatially tuned response, but it is not place related. Instead, these cells offer something akin to an internal compass by expressing activity tuned to certain head-directions in the current environment. Thus, one cell might fire maximally when an animal's head is facing Northeast, another when facing Southeast, another Northwest, etc. Collectively the population covers all possible heading orientations. These cells are referred to as 'head-direction cells.' The cells can be modulated both by self-motion information (such as vestibular or motor signals) and visual information. When prominent landmarks in an environment are rotated between visits to an environment, these cells will tend to follow the rotation, with all cells rotating by the same amount.

'Grid cells' and 'Border cells' have both been discovered in the medial entorhinal cortex and more recently in other regions of the subicular complex. They are similar to place cells in that they show spatially localized patterns of activity in an environment, but they each differ from place cells in intriguing ways. Grid cells generate multiple place fields arranged in a tessellating grid-like pattern across the environment (see [Figure 2\(c\)](#)). If lines are drawn between all fields, their pattern appears somewhat like a sheet of graph paper imposed on the environment, but rather than graph lines being at 90° right angles forming squares, the grid lines are at 60° to each other forming triangles. Simultaneously recorded grid cells show the same orientation of their grid pattern within an environment, but may show different spacing between fields. Mirroring the dorsal ventral scaling of place field size, cells in the dorsal region have a small spacing between fields, whereas those in the ventral region have large spacing between fields. It is thought that grid cells provide inputs to place cells about the distance traveled in the environment.

Border cells, referred to as boundary vector cells, likely provide inputs about the environment, and as their name suggests, they signal the location of borders in a given environment. Border cells will typically fire along, or just slightly offset to, a border placed in an orientation matching its preferred orientation, for example, Northwest. An important facet of the system is that in addition to the cells described, conjunctive cells which combine grid or place properties with head-direction tuning, exist. These cells will only fire in a given place or set of places and only when an animal is facing a particular direction. These have been found in the medial entorhinal cortex and

presubiculum, but not the hippocampus proper. Cells in dentate gyrus can express spatially localized patterns of activity, but in any given environment very few cells are active.

It seems humans too have place cells and grid cells. Evidence for place cells has come from recordings made from electrodes implanted in patients with drug-resistant epilepsy while they navigated a virtual reality (VR) environment. Indirect evidence for grid cells has been provided by using functional magnetic imaging (fMRI) to examine brain activity patterns during VR navigation. Because a proportion of conjunctive head-direction modulated grid cells align to the 60° triangular grid orientations it was predicted that the activity of such cells might produce a sixfold symmetry of activity patterns. This proved to be true for activity in the right entorhinal cortex, indicating that this region in humans may contain grid cells.

Combining human neuroimaging and VR has provided a number of other insights into the response dynamics of the hippocampal formation. For example, people who are better navigators produce more activity in their hippocampus; activity in the right entorhinal cortex increases with the Euclidean distance to a goal, and hippocampal activity is maximal during the initial learning of a network of streets. In summary, while analyses of neural activity have taught us much about the information processed in the hippocampus, combining such work with other approaches can help uncover the functions of the hippocampal formation.

Mapping, Declaring, Relating, Binding, Constructing: Theories of Function

What is the function of the hippocampal formation? Does it serve a unique function or multiple functions and does it operate as part of a wider system? Undoubtedly, it does not work alone and its contributions to cognition are likely varied. A full characterization of its function will arguably require understanding the computational contributions of each subregion in its structure and their interrelations. This is a significant challenge far beyond current knowledge. However, some constraints on what it may, or may not, be involved in have been gleaned over the years, but not without considerable debate and disagreement.

Historically, the hippocampal formation was linked to olfaction through a supposed strong relationship to the olfactory bulb and later tied to emotion because of its connections to other brain regions. These views are generally no longer held. However, there is evidence that the hippocampal formation forms part of a circuit involved in anxiety and this idea was developed into a theory by Gray. There is expanding interest in the role the hippocampus plays in stress disorders and depression (see section '[Dying Cells: Pathology](#)'). However, it was the discovery of dense amnesia following the surgical bilateral removal of the hippocampal formation in patient HM in 1953 that firmly cemented its role in memory processing. Patient HM, now known as Henry Molaison, was reported (along with several other cases) in a seminal paper by Scoville and Milner in 1957. He underwent the surgery for the treatment of drug-resistant epilepsy (see section '[Dying Cells: Pathology](#)'). The surgery removed the hippocampal formation,

parahippocampal gyrus and amygdala. From the time he awoke from the surgery until the time of his death in 2008 he was unable to remember any new events he experienced – a severe anterograde amnesia. He also suffered a temporally graded retrograde amnesia, such that he could not remember events or information from a period just before the surgery, but the further back in time he was probed, the better he was able to recall memories. This gradient of retrograde amnesia has been observed across a large number of amnesic cases.

Despite HM's dense amnesia he (and other similar patients) showed a remarkable capacity for short-term memory, procedural memory and priming (the speeded response to a repeated stimulus). This led to the argument that the hippocampus is necessary for a 'special type' of memory. While numerous theories have been proposed over the past 60 years, this article will highlight six current and influential theories. The focus of many of these theories has been on the role played by the hippocampus, as opposed to the hippocampal formation more broadly. These theories are:

1. *Cognitive map*: Hippocampus stores a map of the environment supporting flexible navigation and spatial memory retrieval, and in humans, remembering events.
2. *Declarative memory*: Hippocampal formation is part of a medial temporal lobe system which supports memory for facts and events for a limited time period.
3. *Relational memory*: The hippocampus is necessary for storing and representing flexible relationships between stimuli disjointed over space and/or time.
4. *Multiple trace*: The hippocampus is permanently needed to support rich detailed episodic memory, but not semantic memory.
5. *Episodic memory* (binding – what/where/when): The hippocampal formation is necessary to bind together information about what happened, where and when, and later retrieving this memory for such episodes. It plays a time-limited role in representing these memories.
6. *Construction*: The hippocampal formation is part of a system supporting the reconstruction of the past or construction of possible future events.

Cognitive map theory was developed by O'Keefe and Nadel. It argues that the hippocampus forms a flexible cognitive map of the environment to support the recall of what is located or happened in different places and navigation to unseen goals. This theory evolved primarily from the idea of a cognitive map put forward by Tolman in the 1940s, together with an analysis of the effect of lesions to the hippocampus and the discovery of place cells. An important aspect of the cognitive map is that information is learnt rapidly and incidentally, that is, without explicit reward. A criticism leveled at the theory is that in humans the hippocampus appears to be in need of remembering nonspatial information, and that spatial information is just one type of information stored by the hippocampus. However, it was proposed that the map may store information about what objects are located in different places and that for humans the map may have evolved with the addition of linguistic and temporal inputs to support an episodic memory system. One aspect of cognitive map theory that is disputed is that it puts no time limit on the involvement of the hippocampus. Thus, once a map of an environment is

formed in the hippocampus, the brain is dependent on the hippocampus indefinitely for the retrieval of the information in the map or the episodic memory.

Declarative theory, proposed by Cohen and Squire, and developed by Squire thereafter, contrasts with cognitive map theory by arguing that: (1) the hippocampus has a time-limited role in memory retrieval and (2) the hippocampal formation is part of a unitary medial temporal lobe memory system (which includes the perirhinal and parahippocampal cortices) for the conscious encoding and memory for facts and events. The term 'declarative' is used because both memory for facts (semantic memory) and events (episodic memory) can be declared as either true or false, for example, 'Socrates was a man,' 'I ate eggs for breakfast today.' A central idea in the theory is that the declarative memory system is distinct from several nondeclarative memory systems, which are responsible for procedural memory, priming, conditioning, and stimulus adaption. Information in these systems is not veridical. For example, knowing how to move your body to ride a bicycle (a form of procedural memory) cannot be said to be true or false. Unlike other theories, declarative theory makes no specific claims about the contribution of different medial temporal lobe regions to memory function. Based on the temporal gradient of amnesia, declarative theory argues for a time-limited role in long-term memory. Building on a model by Marr, initially declarative memories are stored in the connections within medial temporal lobe and between it and the neocortex. Gradually, over time a 'systems-level consolidation' occurs such that connections form and strengthen between neocortical regions and eventually the neocortex rather than the hippocampus is needed to recall the memories. This view has also been referred to as the standard model of memory consolidation.

Multiple trace theory (MTT), proposed by Moscovitch and Nadel disputes the idea that the medial temporal lobe is a unitary long-term memory system in which all information is consolidated in the neocortex. MTT agrees with the standard view with regard to semantic information, but argues that the rich, vivid reexperiencing of events or episodes always relies on the hippocampal region. This is based predominately on the observation that amnesic patients with medial temporal lobe damage typically report few episodic memories from any time point before their lesion and those they do are rarely vivid and detailed. This view is disputed by declarative memory proponents who argue amnesics can recall detailed episodic memories from time points in their remote past.

Relational theory, proposed by Cohen and Eichenbaum, builds on the idea of a declarative memory system and a time-limited role in memory. It argues that the specific role of the hippocampus is in processing the relationships between stimuli disjointed in space or time and that other regions of the medial temporal lobe are involved in processing information about items or contexts. In this view, the hippocampal formation can be used to compare and contrast information held in the system to extract relationships and apply this information flexibly to new situations. The focus on processing relationships and flexibility is somewhat similar to the concept of a cognitive map, since a map is a very good example of this. However, the key difference is that in relational theory space is viewed as only one of the many types of relationship that can be coded by the hippocampal formation.

The episodic memory theory has multiple proponents and has evolved from a range of findings. According to this view, the main purpose of the hippocampal formation is to encode and store episodic (or episodic-like) memories for weeks, months, or possibly years. Episodic-like is used to refer to the fact that while animals can show something like episodic memory, it may be qualitatively different from the sense of mental time travel that accompanies episodic retrieval in humans. This view is similar to the MTT view, with the exception that episodic memories are consolidated in the neocortex. Evidence that hippocampal formation might be especially crucial for episodic, but not semantic memory came from the study by Vargha-Khadem and colleagues in 1997 of several patients with amnesia due to bilateral hippocampal damage that occurred in childhood. They all had profound episodic memory problems. Despite this they had all gained a remarkable amount of semantic knowledge. This was surprising because amnesics with damage in adulthood do not show such levels of semantic learning. This led to the view that the neocortex may be able to slowly incrementally learn about information, and that the hippocampus normally facilitates this process by providing information stored in episodic memory. Like many other cases of amnesia due to relatively selective damage within the hippocampal formation, children were unable to recall past events, but were unimpaired in their capacity to recognize previously seen stimuli on some recognition tests. This and results from lesion studies in primates and rats led to the view, proposed by Aggleton and Brown, that the hippocampus supports the episodic or episodic-like abilities, and that the perirhinal cortex imbues the brain with the capacity to determine whether a stimulus is familiar or not. Evidence for the latter comes from lesions and single unit recording of perirhinal neurons which signal whether a stimulus has been encountered before or not. In addition, some models argue that the parahippocampal cortex is important for representing context. These 'binding into context' models argue that the role of the hippocampus is to bind together perirhinal object representations with parahippocampal background context representation, allowing a rich reexperiencing of the whole event when information is later recalled. The idea of vivid recollection of the past emphasized by MTT, has led several researchers recently to argue that the hippocampal formation does more than store and retrieve memories; it reconstructs the past and even constructs possible future events.

The 'construction' theory is relatively new and based predominantly on neuroimaging and neuropsychological observations. It argues that the hippocampal formation is part of a 'core network' required to support episodic memory and navigation, and also imagination. Increased activity in the hippocampus has been observed during periods when subjects were thinking about the future and amnesic patients with hippocampal damage has been found to struggle to describe new, imagined situations. Such patients appear to be able to imagine individual objects and colors, suggesting that their problem lies in creating a rich and coherent mental construction of a scene. This view also accords with other evidence indicating that the hippocampus is needed to solve odd-one-out or working memory tasks, which involve holding a mental representation of a room or scene in working memory. Thus, it has been

argued that a function of the hippocampal formation is to construct rapid online mental representations of scenes and places. This view offers an alternative explanation for why the hippocampus may be critical for remembering rich, vivid events from all time periods of one's life in that they need to be reconstructed. It would seem hard to imagine that constructing future scenarios is a function of the rodent or other nonhuman animal hippocampi. However, recent evidence suggests that hippocampal place cells can show activity that might be akin to 'simulating possible future paths.' During some sharp-wave-ripples (see section '[Spikes and Waves: Physiology](#)'), a set of cells can briefly fire action potentials in the order that they would be activated if an animal ran along a path in the environment. While this 'sequence replay and preplay' might be related to future thinking, an alternative possibility is that during evolution humans adapted a spatial memory system to support not only the reconstruction of episodic memories, but also the construction of fictitious events and places.

Undoubtedly, pinning the theory on the tail and body of the hippocampal formation will continue for decades to come. The study of hippocampal formation has, and will continue to be, influenced by research conducted with patients who have suffered some form of pathological damage to the hippocampus. Such pathological states are considered in the next section.

Dying Cells: Pathology

The hippocampal formation appears to be particularly prone to disruption from a variety of causes. In this section, the effects of dementia, stress, epilepsy, and schizophrenia are considered. Before we consider these various aberrant states, it is worth considering the healthy aging. Analysis of the human brain has revealed mixed results as to whether cell loss occurs substantially in the hippocampus. In rats, healthy aging is not associated with significant cell loss, but rather with disrupted synaptic plasticity, such that LTP is short lasting. Place cells (see section '[Maps and Compasses: Neural Coding](#)') in aged rats show reduced remapping responses to changes in the environment, suggesting that these cells are less capable of detecting environment novelty. The place cells can also fail to reestablish old patterns of activity in familiar environments, suggesting that they are not capable of detecting a previously visited place with the same accuracy.

Common causes of substantial cell damage in the hippocampal formation include Alzheimer's dementia, ischemia/hypoxia (loss of oxygen supplied by the blood), trauma, hypoglycemia (low blood glucose), and epilepsy. Hippocampal damage is also associated with rare conditions such as herpes encephalitis, where an acute infection from the herpes simplex virus spreads through the hippocampus, amygdala, and associated structures. Due to the relative sparing of other brain structures that can occur in this disease and in cases of hypoxia, patients with these pathologies have proved highly important for the study of hippocampal amnesia.

Epilepsy and Alzheimer's disease are among the most common of neurological diseases and are both strongly associated with the dysfunction of the hippocampal formation.

Alzheimer's disease is a hugely debilitating disease that typically manifests as an inability to acquire new memories and disorientation. It has been associated with cell loss, originating in the entorhinal cortex and spreading to the rest of the hippocampal formation and beyond as the disease progresses. Epilepsy is commonly linked to hippocampal pathology, in the form of hippocampal sclerosis. It is unknown whether the seizures arising in epilepsy are the result of hippocampal damage or whether they are the cause of the damage. In cases of hippocampal sclerosis, evidence indicates that the seizures originate from the hippocampus. Links have been made between its unique anatomy and the origin of the seizures. Increased connectivity, neurogenesis, loss of inhibitory inputs and increased excitatory drive, among other factors, have all been suggested to contribute to the development of epilepsy.

Stress can also have a damaging affect on the hippocampal formation. Stress produces glucocorticoids which then bind to the dense glucocorticoid receptors inside the hippocampal formation. They have been found to inhibit neurogenesis (see section '[New Birth: Adult Neurogenesis and Morphological Change](#)'), alter gene expression and reduce the excitability of some classes of cell, and prune the dendrites of CA3 pyramidal cells. Patients suffering posttraumatic stress disorder and who have experienced extreme stress over long time periods can show hippocampal atrophy.

Schizophrenia is another disease associated with hippocampal damage in the form of reductions of its volume. It has been argued this may be the cause of the long-term memory problems many patients show with the disease. Because of the lack of cell damage markers at autopsy and the presence of abnormal cytoarchitecture, established prenatally, it has been suggested that the changes are likely the result of altered developmental processes rather than due to damage. Also, altered dopamine levels, central to the syndrome, may be partly caused by the reduction of hippocampal formation input.

New Birth: Adult Neurogenesis and Morphological Change

While the hippocampal formation seems particularly fragile, prone to decay and disease, it is also one of the few brain regions where the birth of new neurons (neurogenesis) occurs in adulthood occurs. From the time of the renowned neuro-anatomist Ramon y Cajal, a central tenet in the brain was that no new neurons grow in adulthood. It took many decades before this view was overturned and the growth of new neurons was identified in two brain areas, the olfactory bulb and part of the hippocampal formation: the dentate gyrus. This neurogenesis may help support new learning and memory, possibly by reducing interference, increased capacity, and tagging memories with temporal information. Despite initial mixed results, this research is continuing to weigh in favor of neurogenesis being important for memory.

Does size matter? It would appear to for the hippocampal formation. In several nonhuman species, its size varies depending on the demands placed on spatial memory. Furthermore, in some species the volume may change as a function of

the seasonal demands. In humans, some jobs place greater demands on spatial memory than others. An extreme case of this is the licensed London taxi driver, who must learn the labyrinth of London's (UK) ~25 000 streets in order to obtain a license, and navigate to hundreds of destinations on a daily basis. By examining magnetic resonance imaging scans of London taxi driver brains, Maguire and colleagues found greater gray matter volume in the posterior hippocampi and reduced gray matter volume in their anterior hippocampi compared with an age-matched control group. In addition, the longer taxi drivers had navigated in London the greater the posterior gray matter volume and the more reduced the anterior gray matter. Thus, suggesting that healthy adult humans have the capacity to change the structure of their hippocampus when accruing knowledge of complex environments. The same changes do not appear to occur in London bus drivers who were matched for driving experience, indicating that this change is unlikely to be driven by stress, driving experience, or daily self-motion. Whether the change in structure is related to neurogenesis, changes in cell morphology, or other factors remains to be explored in future research.

Summary

From the ancient Egyptian era to present day, people have written about the hippocampal formation and pondered over its anatomy and function. In the last 40 years, our knowledge has leapt forward. Crucial discoveries have been made in understanding its unique circuitry, physiology, neural code, and functional properties. This has been made possible by the development of a wide range of technical innovations and a creative approach to experimentation. There is a general consensus that the hippocampal formation is crucial for episodic memory, but how best to characterize its involvement in this and other functions remains an issue to be resolved.

See also: [Amnesia and the Brain](#); [Episodic Memory](#); [Memory, Neural Substrates](#); [Memory](#); [Our Cognitive Map](#); [Spatial Orientation](#).

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Relevant Websites

- <http://www.cognitivemap.net> – The Hippocampus as a Cognitive Map.
- <http://www.ucl.ac.uk/spierslab> – Webpage for Dr Hugo Spiers.

History of Film and Music

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Glossary

EEG (electroencephalogram) Electrodes attached to the scalp to record the electrical activity in the brain.

fMRI (functional magnetic resonance imaging) An imaging technology used to examine changes in the brain, including blood flow.

Hippocampus A structure in the brain involved in the processing of memories.

Lateral prefrontal region A region located in the frontal lobes of the brain; it has been implicated that this region is related to personality, and cognitive and social behavior.

Skin conductance (measure) A measure of change in the electrical conductivity of the skin that occurs through the activity of the sweat glands, causing an increase in level of perspiration.

Somatic (measure) A measure of body movement through the skeletal muscles.

Introduction

Empirical research on the psychology of film music examines how people respond to film and music on a number of different psychological levels using a variety of methodological approaches. Experimental investigators have conducted these studies in order to demonstrate how people perceive both auditory and visual elements. Many of the early experiments used simplistic examples. The experiments are categorized into the following sections: visual information; auditory versus visual information; music, film, and association; music, film, and structure; music, film, and emotion; music, film, and memory; music, film, and closure; music, film, and plot continuation; music, film, and sound quality; physiological affect; music, film, and affect; and music, film, and meaning.

Research on the psychology of film music began in the 1950s with the work of Tannenbaum. Osgood, Suci, and Tannenbaum and Gerrero were among the first to use the semantic differential method. Freeman and Neidt conducted a film music and education experiment to examine the effect of familiar and unfamiliar film music on the perception of visual elements. In the 1970s much of this research employed simple audio and visual clips. For example, Massaro and Warner conducted an experiment to study the relationship between audio and visual elements using simple tones and letters, and Berg and Infante examined the impact of musical modes on visuals. Marshall and Cohen examined the relationship between music and visual elements using animation. Some experiments focused strictly on the visual elements, while others examined audiences' physiological responses to disturbing stimuli accompanied by different types of audio material.

There were few studies on the perception and cognition of film music in the fields of both musicology and psychology prior to the 1990s. Cohen suggested that the cognitive framework for exploring film music should focus on meaning, structure, memory, awareness, and experimental aesthetics. A special volume of the journal *Psychomusicology*, on the psychology of film music, presented a range of empirical studies that examined the relationship between music soundtracks and different types of images, film, and television. Following these groundbreaking studies, scholars have conducted a

variety of experiments on film music, broadening our understanding of how audiences respond to both music and film using different techniques, methods, models, and theories.

Semantic Differential

Osgood, Suci, and Tannenbaum used the semantic differential method to examine the effects of music on three different interpretations of a film. This technique was used in several of the following studies, measuring participants' reactions using bipolar scales with contrasting adjectives at each end. These adjectives are organized through 'evaluation,' 'potency,' and 'activity' (EPA). For example, evaluation may include the adjectives, 'good-bad'; potency, 'strong-weak'; and activity, 'active-passive.' The bipolar scales used in EPA studies are usually numbered 3-2-1-0-1-2-3, where 0 is labeled 'neutral,' 1 'slightly,' 2 'quite,' and 3 'extremely.' In studies that involve the semantic differential, researchers may assess subjects' confidence in particular choices by means of a 5-point scale, from 1 (I have no idea) to 5 (I am sure that it is). Some scholars ask subjects to rate music on scales that have extreme values of 'low-high liking,' 'very strong disagreement-agreement,' 'highly displeasing-pleasing,' and 'not familiar at all-extremely familiar.' Others require subjects to rank emotions according to certain adjectives from 1 (not at all) to 5 (very much).

Visual Information

Film music cognition experiments are often conducted with examples featuring the film alone to determine how viewers perceive visual material. An early experiment conducted by Zadny and Gerard focused on audiences' interpretations of visual elements. This study focused strictly on the visual images to find if viewers presented with certain scenarios, would remember objects onscreen connected to the scenarios. In this experiment, the participants were divided into three groups and then presented with a video clip of a man and woman looking around an apartment and picking up certain objects. Each group was presented with a different scenario:

the man and woman were searching for drugs; they were burglars searching for valuables; or they were waiting for their friend. The participants in the 'burglar' condition remembered the objects (credit cards and diamond ring) related to this scenario. These items were more easily remembered than other items, such as the drug paraphernalia. Zadny and Gerard found that viewers remembered objects connected to specific story lines, suggesting that film genres and scenarios define how audiences perceive film.

Auditory Versus Visual Information

Perceptual psychologists focus on auditory and visual sensory modalities (sensations originating from the sensory systems). Experiments by Massaro and Warner on auditory versus visual perception created a foundation for later empirical research. These types of studies were valuable in determining how sound and image interacted before scholars later examined motion pictures and film scores. They provided a basic understanding of how listeners perceive audiovisual material through a simple task of pairing tones with letters. The experimenters required participants to identify tones of higher or lower pitch while their attention was focused on a letter. These experiments were designed to test the degree to which selective attention can affect auditory or visual perception. Massaro and Warner found that tone recognition decreased when a participant's attention was divided between tones and letters.

In a more recent study, Repp and Penel conducted an experiment using tones, letters, and shapes to find out how listeners perceive audio and visual information. Their goal was to determine whether auditory information dominates visual information in perception and in a coordinated action (finger tapping). The audio material consisted of identical high-pitched piano tones. They were presented with two visual sequences, including a black 'X' and two squares, and a circular green flashing light. The audio and visual examples were shown separately and together. Participants were asked to view the images on a computer monitor, and were required to tap their finger with the sequence of events. The results demonstrated that in the audio alone and visual alone conditions, there was greater variability of taps in the results for the visuals. Their overall finding was that audio material provides more temporal information (where people were able to stay in synchrony with a sequence) than visual material.

Koelsch et al. wanted to determine if music activates certain neural (brain) mechanisms related to the processing of semantic meaning using EEG, a method of recording the electrical activity of the brain. Participants were presented with target words on a screen after listening to either a spoken sentence or a musical clip. The results suggested that both music and language can prime or set up the meaning of a word. They maintained that it is possible for music to activate neural mechanisms related to the processing of affective meaning.

Music, Film, and Association

In the 1970s and 1980s, a number of scholars began to examine the interaction between music and moving images. The early work of Berg and Infante focused on the impact of

the major and minor modes of music on the perception of film. Participants were required to view examples that showed a man with either a happy, neutral, or sad facial expression followed with clips that relayed a 'favorable' or 'unfavorable' situation. The music accompanying each clip consisted of a major or minor melody. They suggested that the modes affected participants' responses where the major mode elicited favorable responses and the minor mode elicited unfavorable responses.

Marshall and Cohen hypothesized that music and visuals that match in meaning, direct a viewer's attention to certain visual features in film. In their initial experiment, participants were assigned to one of five conditions, including 'adagio-film,' 'allegro-film,' 'film only,' 'adagio only,' and 'allegro only.' They were asked to describe what had occurred in the film and provide adjectives to describe the visual elements, which included large and small triangles, a circle, and music. They were then required to assess each figure on a bipolar scale. One of their findings suggested that music influences the meaning of film characters.

Sirius and Clarke wanted to determine how individuals would respond to music and moving images that were precisely composed for one another. They used a series of examples, utilizing computer-generated geometric shapes without sound, specifically composed music sequences without animation, and animation with music. They stated that these examples were more characteristic of film music (less abstract) than those used in Marshall and Cohen's study. Participants were required to view film alone and film with soundtrack examples and rate them on bipolar scales. They found that the soundtrack increased the rated 'pleasingness' (music was rated high on the evaluative dimension) of the film images, and lowered the activity ratings. The results of the aforementioned studies suggest that music impacts the audience's perception of film, creating an association between the two elements.

Cohen conducted an experiment to follow up on the results of her earlier work. She suggested that the audience's perception of film and music can be described through the concept of 'associationism.' This occurs when the meaning of the music is then transferred to the film. Cohen further elaborated on the Congruence-Association Model (CAM) to demonstrate the functions of film music. Structural congruence allows the audience to focus on specific details of the visuals. This framework suggests that when viewing a film, the audience member becomes engaged in creating a working narrative (i.e., the viewer's interpretation of the story), and the film music helps to create greater awareness and attention to the story.

Music, Film, and Structure

Cohen later conducted an analytical study revealing that there were similarities in mental processes employed by film and music for different types of structure (e.g., rhythm and direction). Scholars in film music cognition have wondered whether audiences feel the music and film is congruent. In the 1990s, empirical studies on film music cognition began to address this question. Lipscomb and Kendall examined audiences' perception of commercial film music, and hypothesized that the majority of participants would choose the

composer's intended score as best fit or most suitable for a particular film. They wanted to determine how Hollywood film composers and audiences understand films in relation to the soundtrack. Participants were required to view five scenes from Hollywood films combined with five different soundtracks, and were asked to select the version that was most suitable. The majority chose the composer's original version as best fit for the film.

Lipscomb proceeded with this research for his dissertation and then a study. He maintained that current empirical studies investigated 'association' and film music. However, Lipscomb and Kendall found that there was another judgment made while viewing a film with music-accent structures, meaning the points at which important events in the film score are aligned with important events in the images. He utilized music combined with different types of visual material to determine whether individuals can detect the matching of music and visuals. In the first experiment, he employed sound files and computer animations with three degrees of alignment, including 'consonant' (i.e., perfect synchronization), 'out-of-phase' (i.e., share a common temporal interval, but perceived as out of synchronization), and 'dissonant' (i.e., out of synchronization). In the second, he used clips that consisted of abstract geometric shapes with the same degrees of audiovisual alignment as the first experiment. In the third experiment, three short clips were selected from a motion picture accompanied by the soundtrack. The overall finding was that participants were able to distinguish between the different levels of synchronization more easily in a simple film (e.g., music with geometric shapes) than in a major motion picture.

Bolivar, Cohen, and Fentress designed an experiment to show how soundtracks and temporal relationships influence the meaning of film. The participants viewed a series of audiovisual clips and were required to rate them for 'friendliness' or 'aggressiveness.' The visual examples were taken from a series that examined the social interactions between pairs of wolves, and the soundtracks consisted of instrumental passages that were extracted from commercial recordings. The examples included 'friendly audio with friendly video,' 'friendly audio with aggressive video,' 'aggressive audio with friendly video,' and 'aggressive audio with aggressive video.' Participants were required to view the clips and then rate them for matching, including 'do not match,' 'cannot tell,' and 'they match.' When the mood of the soundtrack matched with the visual action, the majority of participants stated that the meaning was congruent or matched. In addition, participants were able to determine whether an example temporally matched.

The next experiment focused on a different type of audiovisual relationship. Krumhansl and Schenck examined the structural properties between music and dance using Balanchine's choreography for Mozart's *Divertimento No. 15*. Participants were assigned to one of three conditions, including 'music only,' 'dance only,' and 'music and dance.' They were required to view the music and dance examples, indicating where new ideas in the music and dance began in addition to the ends of sections. During this test, they were asked to judge the amount of tension and emotion, and found that the new ideas corresponded with low levels. These ratings increased before the ends of sections, suggesting that there is temporal organization between music and dance.

In a recent study, Tan et al. set out to determine if music needs to be presented concurrently with visual images in order to influence viewers' interpretation of film. Participants were required to view film clips focusing on a single character. The music was presented before or after each clip. The characters displayed emotionally neutral facial expressions, and the music conveyed happiness, sadness, fear, or anger. Tan et al. demonstrated that music does not need to be presented in relation to the film in order to influence audiences' interpretation of the content.

Music, Film, and Emotion

Cohen stated that music is one of the strongest sources of emotion in film. However, it is difficult to determine how audiences respond to stimuli on an emotional level. The scholars in the following study measured participants' neural (brain) activity to understand what occurs in the brain when listening to and viewing film. Elder et al. conducted a study to find out whether film music would increase activity in certain brain regions. Participants were required to view short film and music examples. The music examples were rich in emotion and poor in concrete content (i.e., information about the concrete world). The film examples were poor in emotion but rich in concrete content. The music examples were negative, positive, or neutral in emotional character, and the film clips were all emotionally neutral. They used functional magnetic resonance imaging (fMRI) to measure participants' neural activity. The results demonstrated that combining the music and film examples caused an increase in activity in the amygdala; these are groups of nuclei located in the medial temporal lobes of the brain that perform primary roles in the storage of memories associated with emotion. This combination also caused an increase in the hippocampus and lateral prefrontal regions of the brain. The emotional music on its own did not increase participants' neural activity. Edler et al. suggested that the amygdala responds to an emotional stimulus when associated with visual images that are rich in concrete content.

Music, Film, and Memory

Empirical studies on film music cognition began to examine whether music would aid in the memory of film. Boltz, Schulkind, and Kantra conducted an experiment to determine if music matched to the subject matter of a film, helped the listener in the memory of the visual action. The participants viewed a series of visual examples taken from network television. The music consisted of a number of unaccompanied instrumental melodies that either matched or did not match with the film. Watching the examples participants were required to estimate the time between the beginning and end of each example, and indicate whether they had viewed the episode before. They were then required to provide unexpected memory responses. The results demonstrated that the visual examples were more easily remembered when cued by the music.

Boltz is known for her film music cognition experiments incorporating the schema theory. This theory of knowledge organization suggests that individuals hold a web of mental

structures related to certain words or concepts. For example, individuals may associate 'feathers,' 'wings,' and 'beak' with the word 'bird.' She suggested that schemas are often incorporated into film, and may be activated when listening to the soundtrack and viewing the film. Boltz conducted a study to determine whether music can contribute to the understanding of a story. Participants were required to view film clips accompanied by positive (major, tonality, and regular rhythm), negative (minor, atonality, and irregular rhythm), and no music. After viewing the clips, they were required to determine the ending of the film, and the motivations and personalities of the main characters. They were also asked to rate the film's actions on bipolar scales. Some of the participants returned a week later, and were asked to remember certain objects from each film. Her main finding was that positive and negative music influenced the participants' interpretation and memory of the film in relation to its mood.

Boltz then designed another experiment to determine whether music that matches the subject matter of a film aids in its memory. In the first experiment, participants were asked to view a series of music and film clips that matched or did not match in emotional content, and were asked to remember the music and film. When the mood of the music matched the mood of the film, the music and film were more easily remembered. When the music and film did not match, participants remembered only one of the elements. In the second experiment, the matched examples were remembered when cued by the original scenes. The examples that did not match were more easily remembered when there was no information about the scene. Her results suggested that music paired with film examples of a similar mood were recognized more often than those from pairs that were not matched. Recently, Boltz et al. continued these types of experiments and found that the affect (positive and negative) and format (e.g., video, montage) of the visual material was also influential in how participants perceived the music.

Music, Film, and Closure

Film composers usually compose closed music in order to create a sense of closure for the audience. In music, a sense of closure is created when music comes to a final point, and in film, closure is created when the events taking place in the story line are resolved. Thompson, Russo, and Sinclair examined closure in film with three experiments featuring closed music, open and closed music, and closed music with visuals. They wanted to find out whether musical closure influences closure in film. The first experiment was designed to determine whether musical closure in underscoring or background music would affect the participants' sense of closure in a short animated film. In the first condition, participants were presented with examples of strongly closed underscoring, and in the second condition a different group of participants was presented with music that did not convey a sense of closure. The results indicated that individuals were more likely to relate their experience to visual cues than audio, since only five subjects mentioned the music. Thompson et al. found that listeners felt musical underscoring alone created a sense of closure, but when combined with images, the visual elements were more effective in its portrayal.

Music, Film, and Plot Continuation

Scholars have conducted studies to determine how music affects audiences' perception of the story line or plot of a film. The following studies employ different techniques in order to determine the influence of the music. Bullerjahn and G ldenring conducted an experiment to demonstrate how the soundtrack influences the interpretation of film. The participants viewed a film produced by drama professors and students, and were presented with five contrasting soundtracks. Three professional film composers wrote different film scores, including two crime versions, a thriller, a melodrama, and an 'indefinite' version. The music differed in style, orchestration, use of motifs, and place and length of music. Participants were required to provide information about the film through rating scales and open-ended questions about the relationships between the characters, the history, and the film events. The overall results suggested that the soundtrack plays a role in determining the mood of a film, the film genre, and how the film progresses. They maintained that each soundtrack created its own type of film and plot.

In the next study, Magliano et al. examined a number of elements that make up film productions. They wanted to determine whether certain film elements would enable participants to predict future events in the story line. In the first experiment, participants were instructed to write predictions while watching the film, and in the second, they were asked to provide think-aloud statements at different points in the film. Magliano et al. determined that music was one of the factors influencing participants' predictions of the visuals. Film composers call the prediction of the visuals, 'telegraphing.' The music can telegraph before certain events occur, thereby affecting audience expectations.

Vitouch conducted a study to determine if film music influences the reality of film. The participants were required to view two identical film clips accompanied by the original score and a 'fake' score. They were then asked to write a continuation of the plot, and these were analyzed with a focus on emotional content. Vitouch found that differing scores influenced how participants interpreted the plot.

Music, Film, and Sound Quality

The results of the experiments outlined so far have demonstrated that music is extremely important in how audiences perceive film. However, the visual elements play a very important role as well. To explore this interaction, Iwamiya examined the relationship between audio and visual elements with two different experiments in order to examine the quality of film and music, and if film compensates for degraded music (poor sound quality). Participants were presented with examples where the audio and visual materials matched or did not match. In the first experiment, participants were required to rate the audio and visual meaning, and degree of matching. He found that auditory meaning influenced the visual meaning for certain congruent examples. In the second experiment, the music was presented with and without visuals, and with degraded sound as well as the original fidelity. Iwamiya maintained that the visuals compensated for the effects of the audio degradation, suggesting that there are varying levels of auditory-visual interaction.

Physiological Affect

Empirical studies on physiological responses to film music span from the early 1970s to the late 2000s. These studies use a variety of methods to demonstrate how the human body responds to film and music while viewing accident scenes. Koriat et al. conducted one of the first studies in this area to measure the self-control of emotional reactions to a stressful film using dialog instead of music. The participants were asked to view an industrial safety film, showing accident scenes with a dialog soundtrack. Before viewing the film, they were required to listen to sets of instructions, including 'neutral,' 'increased involvement,' and 'increased detachment.' They found the participants' heart rates and skin conductance levels increased while viewing the film in the increased involvement condition, and the arousal levels of participants in the increased detachment condition were lowered.

Thayer and Levenson then conducted an experiment to measure participants' psychophysiological responses. The participants were presented with a film on industrial safety using two different musical conditions while their physiological responses, including cardiovascular, skin conductance, and somatic were monitored. The 'horror music' condition employed music that increased the stressfulness of the film and the 'documentary music' condition used music that decreased the stressfulness. They were then required to report on their perceived level of anxiety. Thayer and Levenson's results showed that when participants viewed the accident scenes with the horror music soundtrack, their level of anxiety and perspiration increased, demonstrating that film scores affect the body through skin conductance levels. More recently, Khalfa et al. conducted an experiment to demonstrate that skin conductance levels are affected when listening to emotional music. The emotions of fear, happiness, sadness, and peacefulness were tested. Similar to the results of the previous studies, they found that skin conductance levels increased with examples that induced fear. They also found that the levels increased for music that created happiness.

Heuer and Reisberg used disturbing and neutral pictures in their study, but instead of music, the images were presented in combination with spoken dialog. This experiment was designed to show the effect of arousal on an individual's memory. They hypothesized that participants would better remember the information if the subject matter caused physiological arousal. The participants were divided into four groups, including 'arousal,' 'neutral,' 'memorizing,' and 'problem-solving' (participants in this group were told that the experiment was about the relationship between physiological responses and problem solving). They attended one session and were instructed to return 2 weeks later. The arousal group watched a story with 12 slides accompanied by a simple taped sentence. The slides were shown for 6 s, relaying the story of a surgeon father operating on an accident victim. The neutral, memorizing, and problem solving groups watched 12 slides that relayed the story of an auto mechanic father fixing a car. The participants witnessed accident scenes on slides while their heart rate and arousal levels were monitored. Following the slide presentations, they were required to rate the emotion of the story. They were also given a questionnaire to fill out at home, and in the second session, they were asked to write as much as they could about the presentation. One of their main

findings was that the participants in the arousal group recalled more from the story than the other groups.

In a more recent study, Sokhadze examined the effects of music on recovery after viewing stressful stimuli. Participants' physiological responses were monitored while viewing film clips that displayed elements of disgust followed with pleasant and sad music, and white noise. Sokhadze stated that the stimuli caused participants' heart rates to decelerate in addition to increased heart period variability, increased skin conductance levels and response frequency, decreased facial blood flow and velocity, and variations in brain wave patterns. He found that the pleasant and sad music restored the physiological measures to their normal baseline levels.

Music, Film, and Affect

Scholars have focused on the relationship between audio and visual elements in empirical studies by presenting participants with music and soundtrack clips, and then the music alone. Participants are then required to respond to the clips through a variety of written responses, including cognitive tests, scale ratings, and open-ended questions as well as writing down whatever comes to mind when listening to the music. Gerringer, Cassidy, and Byo used some of these methods, and conducted an experiment on the effects of film music and video on nonmusic majors. Participants were divided into groups and presented with abstract and programmatic musical examples. Half of the participants viewed film and music examples and the other half listened to music alone examples. One of their main findings was that participants in the music alone group were more analytical in their responses for both musical examples.

Many of the empirical film music studies focus on music in general, but not on the music of specific film composers. Recently, Force conducted eight different experiments for her dissertation to determine how audiences affectively respond to music of the film composer, Philip Glass. He composes film scores that are minimalist or repetitive in nature. This study examined a variety of different methods inspired by many of the previously mentioned experimental investigations. The film and soundtrack examples were selected from a wide range of films from 1982 to 2004. The experiments tested whether audiences liked Glass's music, and if it matched the films, in addition to the mood that it created, the themes that it portrayed, the perceptions of the characters, and the emotion and anxiety created. Participants were required to respond to the examples through a number of forced-choice responses (scale ratings and descriptive words) as well as open-ended written responses. Similar to Gerringer et al.'s results, one major finding was that when participants were given the opportunity to freely write about the music, they provided very detailed and descriptive responses.

Music, Film, and Meaning

Experimental investigations have explored how audiences perceive the meaning of film music, and recently, cross examined music within scientific, cross-cultural, and evolutionary

perspectives. He focused on the meaning of music and how listeners engage with it. In this more theoretical study, he maintained that the meaning of music is often shared, and can be used to relay visual information.

In the following two studies, investigators have developed new types of methodology to examine meaning in film music. Tagg and Clarida explored the response to music accompanying the credits for ten television series to determine the relationship between music as structure and as meaning, identifiable and repeatable by members of a community. In this highly descriptive book, they hypothesized that it is possible to establish links between the two, and their goal was to determine what constitutes a musical structure. Tagg presented the examples to students at the beginning of a lecture with instructions varying in each session. He introduced the lecture topic and stated that they would be examining the audience's experience of music. He then asked the students to participate in a short experiment. The participants were required to listen to the clips and then instructed to write down anything that could be happening on an imaginary film or television screen. They analyzed the listeners' written responses by means of a visual-verbal taxonomy where words were extracted from full sentences provided by the participants. The response sheets were collected and filed according to a number for each respondent, and the results for each tune were displayed in numerous tables. After analyzing the responses using the taxonomy, they found that certain visual examples had a large number of visual-verbal associations related to certain themes, for example 'love' or 'kindness.' Tagg and Clarida revealed that audiences respond to film based on attitudes formed by their social and cultural environments.

Kendall conducted a study on the perception of musical meaning in music and film after creating a one-dimensional 'continuum of referentiality' model to measure musical meanings that range from pure sound events that are considered 'areferential' to iconic associations, and then to arbitrary associations, considered 'referential.' His goal was to determine if participants would use the entire continuum in response to film with soundtrack examples. Participants were presented with six short film clips in random order that were hypothesized to span the full length of the continuum. He found that participants were able to use the entire scale when judging the audiovisual clips. Kendall's finding suggested that the continuum would be an effective method to use in future film music studies.

Summary

The experiments outlined in this entry examined how music and visual elements interact to create a film-watching experience for audiences. The studies focused on the role of the visual elements, the audio elements, and a combination of the two. The early studies explored the perception of audio and visual elements, and used simplistic examples for testing. For example, Massaro and Warner's research demonstrated that audiences are able to perceive music and film at the same time. Many of the experiments over the years focused on how music influences the perception of visual elements. This research began with Marshall and Cohen's groundbreaking experiment

that demonstrated that the meaning of background music has a direct effect on the meaning of film. In addition, Boltz, Schulkind, and Kantra's research indicated that music aids a listener in remembering visual elements. Some studies examined the role of music separate from the visuals. For example, Bullerjahn and G ldenring's results indicated that soundtracks conjure up certain types of film and plot for listeners. The majority of the studies in recent years have focused on the congruency between music and visuals. In Boltz's study, she found that when the mood of the music matched the visuals, the majority of participants felt that the meaning matched as well. In addition, Lipscomb and Kendall found that participants chose the composer's original score as most suited to the film. Scholars have shown that the audio and visual elements can work together to create the film experience. Thompson, Russo, and Sinclair's study found that certain music created a sense of closure for audiences, but it was further strengthened with the visuals. A few experiments showed how the visual elements effect the perception of the music. For example, Iwamiya demonstrated that the visuals compensated for degradation in the audio material. Other scholars examined physiological responses to audio and visual elements. Thayer and Levenson's study demonstrated that when disturbing scenes were presented with disturbing music, the human body responded to this through an increase in anxiety and perspiration. Scholars have also approached this research from a more theoretical level, and have examined how shared meanings and associations of film and music help to relay certain ideas in the film. For example, Cross's research showed that if the meaning of the music is shared, it can be used to relay certain ideas about the visuals. In addition, Tagg and Clarida's research demonstrated that audiences respond to film based on attitudes formed by their environment.

Experiments on the psychology of film music began as early as the 1950s, but most of the research did not begin until the late 1980s and early 1990s. Since then, a very small group of scholars have conducted research in this field. Over the years, film music experiments have evolved from the utilization of simple tones and visuals to complex studies involving whole sections of film and certain genres of music. There are still many unanswered questions about how humans respond psychologically and physiologically to both film and music, but with the increasing number of scholars emerging in this field many of these issues will continue to be explored.

See also: [Visual Motion Perception](#); [Visual Perception](#).

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- www.lipscomb.umn.edu – Dr. Scott D. Lipscomb.
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- www.tagg.org – Philip Tagg.

Histrionic Personality Disorder

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Glossary

Axis II disorder One of the five axes of the multiaxial system of the Diagnostic and Statistical Manual. Axis II contains information about personality disorders and mental retardation.

Borderline personality disorder Personality disorder that overlaps substantially with histrionic personality disorder; it is characterized by marked instability in mood, interpersonal relationships, impulse control, and identity.

Histrionic From the Latin word *histrionicus*, meaning of or pertaining to actors, acting, or theater.

Hysteria A historically common medical diagnosis in women, marked by excessive emotionality and unexplained physical symptoms. HPD traces its roots to this condition.

Hysterical personality disorder A precursor to histrionic personality disorder described briefly in the DSM-II in 1968. This diagnosis emphasized seductiveness, impressionistic speech, dramatic and emotional displays, and clinging and demanding relationships.

Impressionistic speech Also known as hyperbolic speech. A term used to describe speech lacking in detail and emphasizing emotion.

Description

Histrionic personality disorder (HPD) manifests itself by early adulthood. Like other personality disorders, HPD is associated with enduring abnormalities in emotion, cognition, and interpersonal behavior. According to the most recent version of the American Psychiatric Association's Diagnostic and Statistical Manual (DSM), the DSM-IV-Text Revision (DSM-IV-TR), published in 2000, individuals with HPD are characterized by excessive displays of emotionality and need for attention. They are often flamboyant and dramatic, frequently earning the reputation of the 'life of the party.' Indeed, this theatrical behavior inspired the name 'histrionic,' after the Latin 'histrionicus,' meaning pertaining to an actor.

Not surprisingly, people with HPD often experience discomfort when not the focus of interest. Their attention-seeking behavior, which often expresses itself as enthusiasm and flirtatiousness, may initially charm a new friend or love interest. Nevertheless, this behavior quickly becomes frustrating once it becomes evident that these dramatic behaviors serve largely as attention-grabbing gestures. Individuals with HPD may also attempt to attract others through inappropriately seductive and sexual behavior. Because they tend to use their physical appearance to draw attention to themselves, they often expend an inordinate amount of resources on fashion and grooming. In addition, they may 'fish' for compliments and become distraught by an unflattering photograph or trivial criticism of their physical appearance.

Individuals with HPD are characterized by exaggerated expressions of emotion that typically strike others as overblown or insincere. Their language often seems vague and generalized (sometimes termed as 'hyperbolic speech'), and is marked by black-and-white opinions lacking in detail or supporting evidence (e.g., "That movie was just wonderful," "He was a horrible, terrible boyfriend"). Individuals with HPD are easily influenced by people and fleeting trends, and may be overly trusting of others. Additionally, people with HPD tend to believe their interpersonal relationships to be more intimate

than they actually are, and may refer to a casual acquaintance as a cherished friend.

Some of the associated features of the disorder, which are not listed as formal diagnostic criteria in the DSM-IV-TR, include persistent difficulties with romantic and sexual relationships. The relationships and friendships of individuals with HPD often lack genuine emotional intimacy, and their sexual seductiveness may coexist with a tendency to find sexual relationships consistently unsatisfying. People with HPD may be manipulative, a tendency that often coexists with pronounced dependency on their romantic partners. Their friendships are often unsuccessful, largely because friends are often alienated by their incessant demands for attention and sexually provocative behavior. Individuals with HPD usually expect immediate satisfaction and may become excessively frustrated when forced to wait for desired rewards, such as a return call from a friend. They frequently seek excitement and novelty, although their interest in new things wanes quickly. Finally, individuals with HPD may make manipulative suicidal gestures and threats to gain attention, although they rarely commit suicide.

History

HPD traces its roots to the broad and poorly delineated condition once known as 'hysteria,' a state of excessive emotionality traditionally linked to females. The origins of hysteria extend at least as far back as 1900 BC to the writings of ancient Egypt and Greece. At that time, hysteria was said to be brought on by a misplaced uterus or 'wandering womb'; indeed, the prefix 'hyster' means 'womb' in Latin. In Hellenic Greece, people often thought of the uterus as akin to a wild animal, free to roam around a woman's body. This wandering occurred when the womb remained barren for an extended period of time. Thus, women with unsatisfactory sex lives, such as virgins and widows, were especially considered prone to hysterical outbursts. In fact, in ancient Greece, sexual behavior was often prescribed as a remedy for hysteria.

By the Middle Ages, theories regarding the causes of hysteria had shifted considerably. Hysteria was then viewed as the result of wanton sexuality, which supposedly predisposed women to the disorder. Hysteria also became increasingly associated with witchcraft and demonic possession. As early as the seventeenth century, doctors began to see what they called 'disorders' in the personality traits of patients with hysteria. These traits included mental dullness, lethargy, egocentricity, and unexplained physical ailments, most of which are not considered relevant when diagnosing HPD today. Other features, such as suggestibility and outbursts of emotion, evolved from the idea of theatricality, and are commonly associated with HPD today.

Following the Middle Ages, hysteria was increasingly recognized as a natural and physical disorder. Eventually, the idea of hysteria as a disease of the brain and mind emerged. Viennese neurologist Sigmund Freud, whose work with hysterical patients in the late nineteenth and early twentieth centuries laid the groundwork for later theories concerning the unconscious, believed that women possessed innate characteristics, most importantly the absence of the penis, which predisposed them to hysteria.

Following World War II, the American Psychiatric Association developed the DSM to standardize the vast array of diagnostic systems used to diagnose mental disorders. Neither HPD nor hysterical personality was listed in the first edition, DSM-I, which was published in 1952. Nevertheless, both conditions resemble the DSM-I entry for 'emotionally unstable personality.' In 1968, 'hysterical personality' was described briefly in DSM-II, with an emphasis on seductiveness, impressionistic speech, histrionic and emotional displays, and clinging and demanding relationships. Finally, HPD, now referred to by the somewhat less pejorative term histrionic personality disorder, appeared in full-fledged form in DSM-III in 1980, with a substantial focus on dramatic and attention-seeking behavior that persists in today's diagnostic descriptions.

Prevalence and Demographics

Studies using standardized interviews suggest that the prevalence of HPD is about 2–3% of the general population. Much higher rates of HPD occur in clinical settings, with rates typically ranging between 10 and 15%. The differences in prevalence across studies are probably due in part to differences in the measures used to diagnose HPD.

DSM-IV warns readers that cultural factors may influence the manifestation of HPD. However, the manual does not delineate these factors or their specific effects on the manifestation of the disorder. In fact, scant research has examined cultural differences in the prevalence or expression of HPD. Some researchers suspect that differing cultural norms affect the rate of HPD across various populations. For example, HPD may be diagnosed less frequently in Asian cultures than North American cultures due to the discouragement of overt sexuality in the former cultures. In contrast, in Hispanic cultures, where overt displays of sexuality are less stigmatized, HPD may be more prevalent. Nevertheless, there is little systematic research on these conjectures.

Historically, HPD has been viewed as a predominantly female disorder, and DSM-IV notes that HPD may occur

more often in females than in males. Psychologist Paula Kaplan has speculated that HPD is a collection of exaggerated behaviors traditionally perceived as feminine. Some authors, like George Washington University psychiatrist Paul Chodoff, have even argued that merely behaving in a highly traditional 'feminine' manner may lead to a diagnosis of HPD, although research evidence for this claim is wanting. Notably, in non-clinical samples, HPD is equally prevalent in males and females. This finding suggests that the apparent sex difference in HPD may be due to a selection bias. Specifically, women with HPD may be more likely than men with HPD to seek treatment, perhaps because they are more likely to suffer from co-occurring conditions, including depression.

Several researchers have examined the potential for sex-bias in the diagnosis of HPD. In 1989, University of Kentucky psychologists Maureen Ford and Thomas Widiger examined psychologists' ratings of a case vignette describing an individual with either HPD, antisocial personality disorder (APD) – a condition marked by manipulateness, dishonesty, and irresponsible behaviors – or an equal number of features of both disorders. The sex of the individual was listed as male, female, or unspecified. For the APD vignette, clinicians diagnosed the disorder more frequently in men than in women, or in those of an unspecified gender. Clinicians tended to diagnose females who exhibited APD features with HPD. When the vignette described an individual with HPD, clinicians diagnosed it at high rates in women and low rates in men. In contrast, when clinicians rated individual diagnostic criteria in the DSM, sex differences disappeared, suggesting that sex bias for HPD exists at the level of the overall diagnosis, but not at the level of individual diagnostic criteria.

Although HPD may be associated with traditional manifestations of femininity, David Klonsky, then at the University of Virginia, and his colleagues also found associations between the disorder and masculinity in a 2002 study. Specifically, people who behaved in a traditional fashion consistent with their biological sex, such as a stereotypically 'masculine' male or a stereotypically 'feminine' female, displayed more histrionic features. Some authors have conjectured that traditionally 'masculine' manifestations of HPD, such as the 'macho' male, may exist, but due to biased diagnostic criteria these people may be overlooked or underdiagnosed.

Co-occurrence and Comorbidity

HPD frequently co-occurs with other personality disorders, which are listed in Axis II of the DSM. This co-occurrence is especially marked for Cluster B ('dramatic, emotional') personality disorders, which in addition to HPD are borderline personality disorder (BPD), APD, and narcissistic personality disorder (NPD). This overlap of HPD with BPD, which is especially pronounced, may be due in part to similarity in the diagnostic criteria of these conditions, including attention seeking and manipulateness. Nevertheless, individuals with BPD tend to be more marked by self-destructiveness, feelings of emptiness, and anger-filled relationships than individuals with HPD. DSM-IV attempted to reduce the overlap between these two conditions by removing the criteria of angry outbursts and manipulative suicidal gestures from the diagnosis of

HPD. Some researchers, such as Emory University psychologists Drew Westen and Christine Heim, have even proposed the existence of a subtype of BPD with prominent histrionic features.

Both HPD and APD are characterized by manipulative behaviors, impulsiveness, and recklessness. However, HPD lacks the pervasive involvement with antisocial and criminal behavior associated with APD. Individuals with HPD or NPD are both known to crave attention; however, those with NPD are more likely to use this attention for validation rather than satisfaction of sexual or interpersonal needs.

HPD also overlaps highly with dependent personality disorder (DPD). Individuals with DPD and HPD are similar in their reliance on others for approval and guidance; however, individuals with DPD typically lack the theatrical quality of those with HPD.

Finally, HPD exhibits moderate to high rates of co-occurrence with Axis I conditions (major mental disorders), such as somatization disorder, dissociative disorders (e.g., dissociative identity disorder, known formerly as 'multiple personality disorder'), major depression, and dysthymic disorder, a form of chronic and low-level depression. Still other Axis I conditions can be confused with HPD. In particular, bipolar disorder, formerly known as 'manic depression,' may superficially resemble HPD because of its high levels of impulsivity, self-centeredness, and extraversion, especially during manic and hypomanic (mild manic) states.

Assessment

There are no published diagnostic instruments for the assessment of HPD per se. As a consequence, clinicians typically use 'omnibus' or broadband measures of personality disorders to diagnose HPD. These measures include the Structured Interview for DSM-IV Axis II (SCID-II) and the Personality Diagnostic Questionnaire, DSM-IV version (PDQ-4), both of which contain subscales for HPD. In the SCID-II, a clinician rates one item per HPD diagnostic criterion on a scale of one to three. A rating of one indicates the criterion is absent, whereas three indicates the criterion reaches threshold or is true. In contrast, the PDQ-4 is a True or False self-report questionnaire. Other broadband measures such as the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) and Million Clinical Inventory, 3rd edition (MCMI-III), may be helpful in detecting HPD. For example, on the MMPI-2, individuals with HPD will often display a Hysteria-Psychopathic deviate profile or a Psychopathic Deviate-Hypomania profile. Elevations on the Hysteria scale of the MMPI-2 reflect a Pollyannaish view of the world, along with a propensity toward physical complaints; elevations on the Psychopathic deviate scale reflect a propensity toward antisocial behavior, including dishonesty, manipulateness, and elevations on the Hypomania scale, reflecting a propensity toward high levels of energy, poor impulse control, and grandiosity. Individuals with HPD sometimes also exhibit high scores on the MMPI-2 Psychasthenia scale, reflecting self-doubt and worry.

Most diagnostic measures for HPD rely largely or entirely on self-report. Nevertheless, some authors have questioned the utility of self-report in the assessment of HPD given that people with this condition tend to lack insight into the nature and

extent of their symptoms. As a consequence, the use of informants, such as coworkers or friends, may offer fresh opportunities for the assessment of HPD and related personality disorders. In a pioneering study of the effects of maladaptive personality traits on military discharge, University of Virginia psychologist Thomas Oltmanns found that peer nominations of HPD were substantially superior to self-reports of HPD in predicting early separation from active duty. This study suggests that informant reports can not only provide meaningful information about the maladaptive traits associated with HPD, but also help to circumvent some of the limitations of self-reports in detecting this condition.

Another potentially fruitful avenue for the assessment of HPD stems from rapid perceptions of small pieces of interpersonal behavior, sometimes termed 'thin slicing.' In another study by Oltmanns' team, participants viewed the initial 30 s of a videotaped interview of individuals diagnosed with personality disorders, including HPD. Even from this brief clip of behavior, observers blind to participants' diagnoses judged people with HPD as more extraverted and likeable than other people. These findings suggest that relatively little interpersonal information may be required to detect at least some of the hallmark interpersonal features of HPD.

Etiology

The etiology (causation) of HPD remains poorly understood. Comparisons of monozygotic (identical) and dizygotic (fraternal) twins suggest that HPD is moderately heritable, but as yet unknown environmental factors also play a role in its development. Some authors have argued that early parenting factors play a role in HPD; for example, some have contended that HPD stems from an anxious attachment style. Nevertheless, it is not clear whether the deficits in interpersonal attachment observed in individuals with HPD are causes of the disorder, or merely manifestations of it.

From a personality trait perspective, individuals with HPD differ from other individuals on the dimensions of the five-factor model of personality. In particular, studies show that HPD is associated with elevated scores on some facets of extraversion, such as gregariousness and excitement-seeking; neuroticism, such as impulsivity; openness to experience; and fantasy, and decreased scores on some facets of conscientiousness, such as self-discipline and deliberation. Nevertheless, the extent to which these trait differences shed light on the causes of HPD, as opposed to merely describing its personality features, is unclear.

Treatment

Psychologists and psychiatrists have implemented a variety of interventions with HPD, none of which has been systematically investigated in controlled studies. No studies have examined the potential utility of medications with HPD patients, so most of the attention has been focused on psychotherapies.

Cognitive and cognitive-behavioral treatments are designed largely to alter the underlying assumptions of HPD patients. University of Pennsylvania psychiatrist Aaron Beck and other cognitive therapists have argued that HPD is associated with a

set of core and often unspoken beliefs, such as “I need others to admire me to be happy” or “Unless I am consistently entertaining, people close to me will abandon me.” Their treatment for HPD is centered on challenging this and other core beliefs using cognitive restructuring and behavioral experiments (‘homework’) intended to disprove these beliefs. For example, a cognitive therapist might set up a behavioral experiment in which an HPD person remains quiet at several parties and determines whether her friends actually abandon her.

Other commonly used therapies for HPD include (a) behavioral therapy, which attempts to extinguish maladaptive behaviors, such as manipulateness or excessive seductiveness, and to reinforce adaptive behaviors, such as efforts to achieve attention in socially healthy ways (e.g., appropriate assertiveness); (b) interpersonal therapy, which attempts to improve the social skills of individuals with HPD; and (c) psychodynamic therapies, which attempt to use the therapeutic relationship to resolve childhood conflicts and parenting deficiencies (e.g., insufficient attention from one’s mother, father, or both) that ostensibly contribute to HPD. Without controlled scientific data, however, it is difficult to recommend any of these psychotherapies with confidence. Research is needed to compare the efficacy of competing therapeutic approaches for HPD, and to ascertain whether attempting to alter HPD individuals’ deep-seated personality traits is more fruitful than accepting these traits and attempting to alter their problematic behavioral manifestations.

See also: Antisocial and Narcissistic Personality Disorder; Borderline Personality Disorder; Personality Disorders; Psychopathology: Diagnosis, Assessment, and Classification.

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HIV/AIDS: The Role of Behavior and the Social Environment in a Global Pandemic

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Glossary

Antiretroviral treatment (ART) Treatment of retroviruses with genome in the form of RNA rather than DNA; mostly used to refer to the treatment of HIV with a combination of drugs. Also known as Highly Active Antiretroviral Treatment (HAART), which refers to increased efficacy compared to early treatments.

Empowerment Strengthening individuals and communities by building confidence, capacity, and resources.

HIV surveillance The regular and comprehensive monitoring of the spread of HIV in a population. Second-generation surveillance also includes the monitoring of risk behaviors to signal and explain changes in infection rates.

Magic bullet A perfect drug to cure disease or, more generally, a simple solution for a complex problem.

Opportunistic infections Infections that are mostly present when someone has a compromised immune system, for example, because of HIV.

Pandemic An epidemic that has spread across a large region, such as a continent.

Risk compensation Adjustment in behavior in response to perceived changes in risk; individuals may behave less cautiously when risk, for example, for HIV infection is perceived as lower.

Social cognition The study of how people make sense of their social world and process social information, including its encoding, storage, and retrieval in memory.

Social drivers Social, political, and economic factors that may contribute to ill health and impaired well-being in a population; mostly used to explain health inequities between population groups. Social factors also shape the behaviors of individuals and communities and their access to health services.

Social stigma Social disapproval of individuals and communities because of specific characteristics, beliefs, or practices; often rooted in stereotypes and prejudice; contributes to ostracism and discrimination.

Viral load Amount of virus in a person's body fluid, such as blood; measure of the severity of a viral infection.

Introduction

Since AIDS was first noted in the early 1980s, the epidemic of HIV, the virus that causes it, has become one of the major health crises humanity has ever seen. Today's pandemic affects millions of people across the globe. As an unprecedented public health crisis, the HIV epidemic also undermines the social fabric and the economic development of entire communities and nations. Ensuring appropriate, adequate, and continued engagement of individuals, communities, leaders, and funders in the HIV response continues to be a major challenge, often augmented by the stigmatized nature of the practices involved in HIV transmission and the marginalized position of many of the affected communities. An important lesson learned over the past decades is that there is no easy and simple prevention 'magic bullet,' nor is there one for treatment. However, a significant body of research in the behavioral and social sciences has revealed some of the factors that shape sexual and drug use behaviors.

As the remainder of this article will discuss in more detail, the multiple behavioral practices that are implicated in effective HIV prevention, diagnosis, and treatment are not only shaped by individuals' awareness, preferences, and skills but also by the barriers and opportunities in their wider social environment. The next sections focus on the primary prevention of HIV, and, in particular, highlight the role of sexual practices and sexual health promotion. Following a brief

outline of the history, evolution, and status of the global HIV epidemic, social cognition approaches to understanding and changing sexual risk-taking will be discussed. This is followed by a consideration of the limitations of conceptual frameworks that focus on individuals' decision-making, and an exploration of the ways in which social processes shape sexual practices and vulnerability to HIV. Against this background, the subsequent section addresses the evolution of prevention models that have emerged. Continuing innovations in medical research promise a new approach to HIV prevention, and these biomedical HIV prevention approaches are also discussed.

History and Epidemiology of HIV

An excellent, detailed overview of the history of the HIV epidemic has been collated by Avert, an international HIV and AIDS charity (see websites listed below). This reminds us that awareness of AIDS began in the United States in mid 1981, when a number of reports in medical journals documented the occurrence of unusual numbers of a rare form of aggressive cancer and a rare lung disease in young gay men in New York City and California. Experts at the US Centers for Disease Control and Prevention quickly suspected that this outbreak of co-occurring life threatening opportunistic infections possibly signaled a new disease caused by an infectious agent that

might be sexually transmissible. It was however unclear what the cause was, how many people were affected or at risk and what might be done. Following the alarming first reports, public health concerns rapidly increased as AIDS was also diagnosed in other communities in the United States, in particular people who inject drugs, people with hemophilia and Haitian migrants; very soon AIDS had also been reported in many other countries and in every continent. In these times of fear of an unknown, lethal disease that could possibly affect entire populations, the discovery, in 1983, of HIV, the virus that causes AIDS, was of critical importance. Once the etiological agent was known, diagnostic tests could be developed and epidemiological studies could be conducted to assess prevalence, incidence and risk factors.

Today, we know that there are three main ways in which HIV is transmitted: contact with blood, mother-to-child transmission, and sexual intercourse. Sexual transmission is by far the most important route for the spread of HIV globally. Sexual risk of HIV mainly results from vaginal–penile and anal–penile intercourse, and can be prevented by the consistent use of male or female condoms. Antiretroviral drugs provided to HIV-positive pregnant women can substantially reduce the likelihood of their children being infected. In many parts of the world, infection through blood and blood products is now effectively prevented. The main risk related to contact with blood involves the sharing of needles, syringes, and other equipment for injecting drug use. Transmission via this route is preventable through the use of sterile equipment; disinfecting equipment reduces the likelihood of transmission but does not eliminate it. Programs that provide sterile needles and syringes are effective harm reduction measures to prevent the spread of HIV and other infectious agents, notably the hepatitis C virus, among people who inject drugs.

In its 2010 report on the global epidemic, the Joint United Nations Program on AIDS (UNAIDS) estimated that by the end of 2009 a total of 33.3 million people were living with HIV worldwide, of whom 2.5 million were children younger than 15 years. Since 2001, the estimated number of people living with HIV (PLHIV) has increased by 16%, which is in part explained by the successful expansion of access to antiretroviral treatment (ART) that is saving lives. Worldwide, 5.2 million people received ART in 2009, a 30% increase compared to only 12 months earlier. As a result of increasing numbers of people receiving treatment, AIDS-related deaths declined from a peak of 2.1 million in 2004 to an estimated 1.8 million in 2009. Also, while HIV infections still occur at high rates, with an estimated 2.6 million new infections diagnosed in 2009, this number is down by 21% compared to 1997, when the annual number of new infections is thought to have peaked. Substantial prevention success has in particular been achieved in Sub-Saharan Africa. Although it is difficult to establish the factors that underlie this prevention success at the global level, it is thought to at least in part reflect the effectiveness of ART, particularly for the prevention of mother-to-child-transmission (PMTCT). It is also clear that other prevention programs have been strengthened, including the availability of free, anonymous, and voluntary counseling and testing for HIV (VCT), as well as the promotion and distribution of condoms. Despite some prevention success and the rapid increase in

access to ART in developing countries, numbers of people newly infected remain high. Stemming the HIV epidemic upstream, by strengthening prevention of new infections, continues to be critical.

Understanding the Role of Behavior

Mapping Risk Behaviors

The recognition that HIV is in particular transmitted via sexual and drug use practices has sparked an unprecedented amount of research into these behaviors. This research addresses three major, interrelated, questions: what is the association between behavior and HIV infection, how do risk behaviors differ between individuals and communities and how do they evolve over time, and which factors can explain risk behaviors and offer points of entry for prevention through behavior change. Behavioral risk factors for HIV infection have mainly been addressed through case-control studies that compare individuals with and without HIV, and through cohort studies that follow individuals over time and assess the potential risk factors of individuals who become newly infected during the course of the study. This type of behavioral epidemiology has provided a strong evidence-base that unprotected vaginal and anal intercourse and the sharing of needles and syringes are the main behavioral risk factors for the transmission of HIV. It has also established that the consistent, correct use of condoms and lubricants effectively prevents transmission, as does the use of sterile injecting equipment. An important focus of behavioral epidemiology is to more precisely establish the likelihood of transmission of HIV under different conditions. This work has shown that in heterosexual intercourse, HIV is more easily transmitted from an infected man to a woman than vice versa, and is more easily transmitted through anal than vaginal intercourse. In homosexual anal intercourse, the risk of HIV transmission is higher for the receptive than the insertive partner. The risk of HIV infection also increases with the number of sexual partners that individuals have, in particular when these partnerships are concurrent.

Knowledge of behavioral risk factors has contributed to understanding that specific communities are more vulnerable to HIV infection, and has enabled behavioral surveillance to track changes over time in most-at-risk-populations. Worldwide, behavioral risk for HIV is particularly high among gay and other men who have sex with men, including transgender men, and this increased risk extends to the female partners of bisexually active men. Sex workers and their clients are also at behavioral risk for HIV, in particular in developing countries where sex workers are less empowered, and condom use is less established and less normative than in many parts of the developed world. The risk for HIV in people who inject drugs is reduced in countries that have put in place effective harm reduction approaches, but in many countries coverage of such services remains absent or limited. Moreover, sexual partners of drug users are at risk of HIV infection, and there frequently is overlap between communities of people who inject drugs, sex workers, and men who have sex with men. In most societies, young people are considered vulnerable to HIV because of their developing

sexual relationships, and their higher number of sexual partners compared to many adults. In countries where the HIV epidemic has generalized, and is mostly transmitted through heterosexual contact, all sexually active individuals are considered at risk.

Social Cognition Theories

Second-generation surveillance of HIV that not only gathers information regarding the occurrence of infections but also monitors risk behaviors, has become an important tool to guide the allocation of resources for prevention, and to track its impact over time. However, this behavioral monitoring in itself is insufficient to guide the development of approaches that effectively promote preventive behaviors, notably the use of condoms. Theory-based research into the factors that shape behaviors is critical for the development of effective prevention programs. Much of this research is informed by theories derived from a social cognition perspective of social behavior. Broadly, this perspective acknowledges that individuals' behaviors are shaped by a wide range of factors extrinsic and intrinsic to the individual. Individuals' cognitions, or thoughts, about their behavior are seen as important proximal factors, which mediate the effects of other factors. Cognitions are also assumed to be more open to change than other factors (e.g., a person's social environment), which makes them attractive targets for behavior change programs. Over time, a range of social cognition theories of behavior have been developed, some of which have been specifically designed to explain health behaviors more generally or HIV-related behaviors in particular. These theories have in common a concern about how individuals make sense of social situations, and are based on the assumption that the way in which people perceive reality offers a more important explanation of their behavior than an objective description of the environment in which they live and act. In a social cognition perspective of behavior, beliefs are more important than factual knowledge, although beliefs at least in part reflect knowledge and can be changed through direct experience, modeling, or the provision of information.

The social cognition approach to health behavior encompasses a range of well-known and frequently used theories, such as the Health Belief Model, Protection Motivation Theory, the Theory of Reasoned Action, the Theory of Planned Behavior, and Social Cognitive Theory. These theories differ substantially in the precise variables they propose as explanations of behavior and the relationship between these variables, but, across theories, several key concepts can nevertheless be identified that are thought to influence people's behaviors. These include a notion of perceived threat that is thought to motivate individuals to change their behavior. Perceived outcomes of the behavior and perceived social norms are thought to further guide behavioral decision-making. The likelihood that people enact their behavior of choice is thought to be also influenced by their perception of self-efficacy, that is, their sense of ability to enact the behavior. The relationship between these variables and behavior is often assumed to be mediated by people's intentions, a reasoned plan that captures individuals' motivation and reflects their salient beliefs about the behavior. Based on the recognition of overlap between theories, several integrated

models have been proposed to explain HIV-related behaviors. These include the Information–Motivation–Behavioral skills model that sees HIV preventive behavior as a reflection of individuals being well informed, motivated to act, and having the skills and confidence to take action. This model also delineates implications for HIV prevention, which should focus on providing effective, relevant, and targeted health information; increasing personal motivation (e.g., by influencing perceived threat and the consequences or outcomes of behavioral alternatives) and social support; and skills training to strengthen self-efficacy.

Enacting Motivation

For a long time, the extensively researched social cognition models have been considered to offer a good explanation of health behavior. However, more recently, they have come under substantial scrutiny and it is acknowledged that, while they may explain more variance in behavior than alternative approaches, they usually only explain one-quarter to one-third of the variance in behavior. Social cognition models have also been criticized on several conceptual grounds. One longstanding criticism notes that individual theories are incomplete and focus only on some factors while ignoring others, as illustrated by the diversity of factors that different theories highlight and the many studies that have proposed additional factors. An influential version of this criticism underscores that social cognition models highlight factors that contribute to individuals' motivation, but fail to explain how motivation is translated into action. In part, this is addressed by the important role of the self-efficacy concept in many theories. Furthermore, the reasoned approach to behavior, which encompasses the Theories of Reasoned Action and Planned Behavior, acknowledges the importance of environmental constraints and individuals' skills and abilities in acting on behavioral intentions. In addition, stage theories in the social cognition tradition, in particular the Transtheoretical Model (also known as the Stages of Change Model), underscore that behavioral change is a process that involves a progression from being essentially unengaged to successfully maintaining change. Stage theories differ in the number of phases they distinguish. The AIDS Risk Reduction Model, for instance, distinguishes three stages, whereas the Transtheoretical Model proposes five stages. Nevertheless, two broad stages are commonly proposed: a motivational stage and a behavioral enactment stage. The motivational stage involves deliberating alternatives and setting a goal, while the behavioral enactment stage involves planning and acting to achieve the set goal. Stage models hypothesize that different types of cognitions are influential at different stages of the change process, and that progression through stages of change is supported by a range of evolving, experiential and behavioral, self-regulation processes.

A body of theory and research, which also draws on traditions in clinical psychology, underscores the importance of self-regulation skills and strategies in translating intentions into behavior, such as the setting of goals, cognitive and behavioral preparations, and the ongoing monitoring and evaluation of goal-directed activities. This research has in particular demonstrated the role of preparatory behaviors, such as buying, carrying, and talking about condoms, and highlights the importance of planning when and how to act on one's good

intentions (action plans) and how to deal with potentially difficult situations and setbacks (coping plans). One specific form of planning, the formation of implementation intentions that specify more precisely when, where, and how to perform a specific behavior, has been found especially effective in strengthening the link between intentions and behavior in many health behavior domains. Despite substantial promise for HIV prevention, the application of planning strategies to condom use remains limited, perhaps because of the complexity of the multiple (preparatory) behaviors, and the need for their repeated enactment to achieve the goal of consistent condom use.

Behavior in Context

A second criticism leveled at social cognition models holds that these models overemphasize the role and importance of individuals' decisions. It is argued that many behaviors occur in complex and evolving social interactions, and social cognition models are seen as failing to take into account the influence of the situation, context, and social environment on behavioral practices. At least in part, this criticism may, however, reflect theoretical misunderstandings. Social cognition models, in particular the reasoned action approach, underscore that individuals' behaviors reflect beliefs that are salient in a specific situation and time. Nevertheless, alternative theoretical approaches have also emerged that more generally question the role of decision-making in social behavior. These approaches build on theory and research in experimental social psychology, which has shown that individuals' goals can be activated automatically by cues in the environment, and guide behavior without much deliberate thought. Furthermore, these automatically activated goals often provide alternative courses of actions, such as habits, that pose barriers to acting on 'good intentions.'

Recently, so-called dual systems theories have been proposed, such as the Reflective-Impulsive Model, which see behavior as resulting jointly from two action systems: one reflective or reasoned, and one impulsive or reactive. According to these models, whichever action system is most influential in guiding behavior depends on a range of factors, such as the motivation and ability to devote thought to deciding on a course of action, and the strength of action tendencies in the impulsive system. Impulsive action tendencies tend to be stronger when they reflect habits, social concerns, and personal needs, especially when these have been deprived. This type of theory can well explain why individuals are more likely to engage in sexual risk-taking when they are sexually aroused or in love, as these affective states result in behavioral responses that originate in the impulsive system. Furthermore, the influence of the use of alcohol and drugs on sexual risk-taking can be explained by a reduction of behavioral guidance provided by the reflective system.

The concern that social cognition models overemphasize individual decision-making and largely ignore the importance of social interactions and the influence of the situation, context, and social environment is also acknowledged and addressed in these theories themselves. Importantly, building on the Major Theorists' Model of Behavior that integrates concepts from prominent social cognition models, the reasoned action approach now identifies environmental constraints and

individuals' skills and abilities as factors that affect the translation of intentions into behavior. However, although social cognition models increasingly address the role of the environment in which individuals enact their intentions in more explicit ways, and specify mechanisms through which the environment affects behaviors, we note that their primary focus remains on the proximal factors that affect individuals' behavioral decisions.

Environmental Constraints

It is increasingly recognized that individuals' health and behaviors are shaped by factors in their environment. The main conceptual tenet of a resulting social-ecological approach is that health behaviors are functions of the reciprocal relationships between an individual and the environment. In this perspective, the environment controls and sets limits on behavior, which implies that changing aspects of the environment will result in the modification of behavior. At the same time, individuals' behaviors shape their environment, and changes that promote health can be achieved through empowering individuals and communities. The environment in which individuals live is multilayered and multidimensional, and a distinction is often made between the physical, the sociocultural, and the socioeconomic environment, at the macro-, meso-, and microlevel. Commonly distinguished environmental influences encompass regulations, policies, services, and practices that are located in the broader society, more delineated communities, specific organizations, and close social relationships, such as peers and families.

Empirical support for a social-ecological approach to health comes from epidemiological studies that document social inequalities in health and from social science research to understand these social drivers. Social drivers refer to the social processes and arrangements that operate around an individual and that reflect prevailing norms, values, networks, structures, and institutions. Research into the social drivers of the HIV epidemic reflects the recognition that the developing world is much more strongly affected than the developed world. Moreover, in developing and developed countries alike, the more socially vulnerable or marginalized, notably women, young people, men who have sex with men, and people who inject drugs, are more likely to become affected, as are ethnic/racial minorities, in particular African-Americans in the United States. Research into the way these social factors affect the HIV epidemic is still limited and fraught with difficult challenges. Importantly, social drivers are complex, interactive phenomena that need to be understood within a specific context. This requires sophisticated methods and conceptual frameworks. Nevertheless, evidence is accumulating that illustrates that preventive practices can be undermined by cultural myths and misconceptions regarding the transmission and prevention of HIV. Also, religious teachings, such as those that prohibit sex outside of marriage and ban the use of condoms in most if not all instances of sexual intercourse, may increase the vulnerability of individuals and communities. Gender inequality and traditional masculine values disempower women to insist on sexual faithfulness or condom use, in particular when their opportunities for economic independence are limited. Armed conflict, political instability, displacement, and economic hardship may promote sex work, and, to the extent that this source of revenue

is critical for survival, sex workers' ability to insist on condom use is compromised. Furthermore, social stigma and taboo underlie the denial of the existence of specific communities, such as men who have sex with men, and result in a lack of services or make services difficult to access because of real or expected discrimination. The increasing recognition of the importance of these and other social factors in the health and behavior of individuals and communities supports a focus on creating an enabling environment as an indispensable health promotion strategy for the prevention of HIV infection.

Evolving Prevention Responses

Behavior Change Approach to Promote Condom Use

HIV prevention encompasses a range of strategies that broadly comprise behavioral change programs and the provision of health services. The promotion of behavior change, in particular condom use and HIV testing, is the earliest response to prevent HIV. Importantly, behavior change was initiated by affected communities, in particular gay men, before being promoted by governmental and nongovernmental agencies. There is now a large body of evidence that has been synthesized in numerous reviews and meta-analyses of original studies that show that significant effects of behavioral prevention of sexual risk can be found in a range of population groups, including adolescents, heterosexual adults, gay and other men who have sex with men, people who use drugs, PLHIV, ethnic minority groups, sexually transmitted infections (STI) clinic patients, and people with mental illness. Significant effects of behavioral prevention have been obtained using a range of outcome measures, in particular increased condom use, reducing unprotected sex, and reducing numbers of partners. Effects on the acquisition of HIV and STI infections have been assessed less often than effects on behaviors. Evidence is now also growing that a range of behavioral prevention strategies can be effective in promoting risk reduction behaviors, including mass media campaigns, computer-delivered interventions, individual counseling, small-group programs, peer education, and community social influence and empowerment approaches. Curriculum-based sex and HIV education has also been found to improve sexual behaviors. Importantly, while it is sometimes thought that frank, comprehensive sex education may hasten sexual initiation or increase sexual behavior in young people, there is strong evidence that it may in fact delay sexual initiation and reduce sexual behavior. Abstinence-only education for young people, in contrast, is generally not effective and has been criticized for misrepresenting information and withholding life-saving options.

HIV behavioral prevention programs are highly diverse, and not only target a range of communities in different countries, but typically also encompass multiple components, use a range of delivery strategies, and differ in intensity and composition of the target audience. Consequently, much remains to be learned regarding the features that are most likely to contribute to program efficacy, but it is clear that well-targeted and well-designed behavioral prevention programs can be cost-effective. What has been learned is that, irrespective of target audience and delivery strategy, programs that are most effective are informed by behavioral theory, based on appropriate formative

behavioral research, and address the real needs of the individuals and communities they target. These needs may well change as the HIV epidemic evolves, as may preferred (electronic) delivery channels. What is required is a continuing adaptation of HIV prevention that reflects these and other changes, as well as evolving behavioral theory.

VCT and Other Health Services

The availability and accessibility of health services also is a cornerstone of HIV prevention. HIV prevention health services that have proven to be effective include VCT, the prophylactic use of ART to prevent HIV infection from mother-to-child, and, depending on laws and policy acceptance, harm reduction measures for people who inject drugs. Evidence is also available now from studies in high prevalence countries in sub-Saharan Africa, which suggests that male circumcision reduces the likelihood of men becoming infected with HIV through heterosexual intercourse. Over time, male circumcision may also benefit women, as it reduces the likelihood that their male partner is HIV positive. VCT in many ways is seen as a key element of HIV prevention, and is therefore also often offered outside of the health care system (e.g., in community venues), anonymously, and free of charge. Testing for HIV has important advantages for individuals' health and well-being, as well as for public health. It can give concerned individuals who test HIV negative peace of mind and link people who test HIV positive to treatment and support services. Early detection of HIV infection enables the timely initiation of ART, with substantial benefits for individuals' health. Furthermore, there is a considerable body of evidence that shows that people who test positive for HIV change their sexual behavior in ways that reduce the likelihood of infecting their partners.

The health and prevention benefits of HIV testing are well recognized, and a range of health agencies, including the US Centers for Disease Control and Prevention and the World Health Organization, have provided recommendations and guidelines to scale-up provider-initiated testing in a wider range of health care settings. To be optimally effective, this routine offering of HIV testing needs to be accompanied by adequate referral and access to prevention, treatment, care, and support services. As HIV infection remains a serious condition that in many contexts is highly stigmatized, it is argued that obtaining informed consent for provider-initiated HIV testing remains important, even though this may pose a burden on the health care system and reduce uptake. Testing HIV-negative typically has no effect on individuals' behaviors, and behavioral counseling is often not appreciated by people who test HIV negative. In our view, these are, however, insufficient reasons to abandon counseling for individuals who test HIV negative. Rather, this suggests that more acceptable and effective counseling models need to be developed. There is some research that shows that enhanced or more tailored counseling can be acceptable and have beneficial effects on sexual risk-taking of individuals who test negative. Furthermore, while the uptake of HIV testing can be increased when this is more frequently and routinely initiated by providers, it remains important to also promote client-initiated testing through communication approaches. This requires understanding and addressing barriers to and facilitators of client-initiated HIV

testing. In addition to easy access to services and timely provision of test results, these include an awareness of personal risk, and, perhaps most importantly, perceived stigma of HIV and fears of social rejection by partners, family, and the wider community.

Biomedical Prevention: Promises and Challenges

VCT, PMTCT, and male circumcision make explicit use of medical technologies for the prevention of HIV, and as such are part of what has become known as biomedical HIV prevention. This also includes the diagnosis and treatment of STIs that increase the likelihood of HIV infection, in particular those that can cause genital ulcers, such as syphilis and genital herpes. Evidence of the efficacy of community interventions to treat STIs on HIV infection rates is, however, mixed, at best. Ideally, biomedical prevention also includes vaccination, but it is unlikely that an effective and safe vaccine against HIV will become available in the near future, due to the complexities of the virus. A biomedical HIV prevention approach that is seen as particularly promising is ‘treatment for prevention,’ which refers to the use of ART to reduce the likelihood of HIV transmission. PMTCT is a currently used form of treatment for prevention, with a robust evidence-base to support its efficacy. Other forms of treatment for prevention, for which there is some evidence, include the initiation of ART for the prevention of HIV infection shortly after accidental exposure to HIV, known as postexposure prophylaxis. Preexposure prophylaxis is a novel use of ART for prevention that is being investigated for efficacy. Preexposure prophylaxis involves providing people who are not infected with HIV with antiretroviral drugs to reduce the likelihood that they become infected upon possible exposure to the virus. These drugs can be provided orally or in the form of topical microbicides. The treatment-for-prevention approach rests on the notion that the likelihood of HIV transmission is associated with the viral load of an infected person, and should hence be reduced when this viral load is reduced, as a result of effective treatment. The available evidence has led the Swiss Federal AIDS Commission to take the position, known as the ‘Swiss statement,’ that an HIV-infected individual, who has no other STIs and successfully adheres to ART that has reduced the presence of HIV in the persons’ blood below detection thresholds, is not infectious during heterosexual intercourse. Advocates argue that a way to address the global HIV epidemic would be to regularly test everyone at risk for HIV, and immediately start treating all infected individuals, regardless of the status of their immune system as is currently the case. This would result in a reduction in HIV viral load at the population level and reduce the likelihood of HIV transmission in most-affected communities.

Biomedical prevention offers a range of benefits, but also holds major challenges. In particular, while PMTCT is widely supported, other forms of treatment for prevention have proven to be particularly controversial, as has male circumcision. A major benefit of biomedical prevention is that it (potentially) increases the range of options to reduce the sexual transmission of HIV. This is particularly important when condom use remains inconsistent because of limited availability or acceptability. Alternative options that can (also) be

controlled by women and girls are particularly important in social and cultural contexts in which their ability to negotiate condom use is restricted, because of sociocultural, socioeconomic, and gender inequity. Furthermore, many men and women prefer not to use condoms, and numerous studies show that some gay men in particular have developed a range of noncondom risk reduction strategies, on the basis of shared understandings of the mechanisms of HIV transmission and prevention. These community understandings have produced two broad risk reduction strategies based in particular on HIV testing practices, such that some gay men, in some relationship contexts and under some conditions, are willing to engage in unprotected anal sex with a partner who has a similar (i.e., concordant) HIV status (a strategy known as serosorting), or adjust their sexual role to minimize the risk of transmission when engaging in anal sex with a partner who has a different (i.e., discordant) HIV status (a strategy known as strategic or seropositioning; HIV-positive partner takes receptive role, HIV-negative partner takes insertive role).

It is thought that gay men who engage in noncondom risk reduction strategies are aware that these reduce but not eliminate the risk of HIV transmission, and accept this risk to balance protection with pleasure and intimacy. This balance may have substantially shifted for many (gay men), as a result of effective ART that changed HIV infection from a once lethal to a now chronic, challenging condition that has much less impact on people’s health, well-being, and life-expectancy. Incorporating regular viral load testing and knowledge and communication of results may contribute to further reducing the risk of HIV transmission, in particular when viral load is undetectable. However, substantial resources are required for a roll-out of biomedical prevention, which may detract from less costly alternatives. Concerns have also been raised regarding the use of treatment for prevention in countries where availability and accessibility of treatment remains limited. Additionally, biomedical prevention is generally less protective than condom use, and it is possible that a reduced risk of transmission resulting from biomedical prevention can be offset by increased risk behavior. Some evidence of such risk compensation is found among gay men, with increasing trends in unprotected sex and HIV diagnoses observed after the introduction of antiretroviral therapy, which have been linked to optimistic perceptions of treatment efficacy. Furthermore, biomedical prevention may well increase the range of options under the control of women, girls, and others in vulnerable positions, but it leaves unaddressed the social, cultural, and economic factors that shape and perpetuate the structural inequities between individuals, communities, and nations.

HIV Prevention Through Structural Change

Structural approaches constitute the third cornerstone of HIV prevention, which have gained substantial traction, in particular in response to the HIV epidemic in developing countries. Structural approaches aim to address the social drivers of the HIV epidemic that shape the vulnerability of individuals and communities to HIV. This structural approach to HIV prevention is an integral component of health promotion and the new public health approach. Health promotion and new public health approaches go beyond biomedical disease

eradication aims and health education to change behavior, by recognizing the wider social influences on health, and emphasizing the experience of positive health and well-being, rather than the mere absence of illness and disability. Health promotion is a comprehensive approach that, in addition to the development of personal skills and a reorientation of health services, highlights the importance of the development of healthy public policies, the creation of supportive environments, and the strengthening of community action. The community is seen as central to health promotion and should be supported, enabled, and empowered to advocate, inform, and lead holistic programs of action in specific settings, such as neighborhoods, workplaces, schools, and cities. Some communities are organized around shared interest rather than geography, and the prevention of HIV among gay men is a prime example of community-led health promotion.

Renowned examples of a structural approach to HIV prevention include needle and syringe programs. Since the first programs were implemented in the early 1980s, a large body of evidence has accumulated that strongly supports the efficacy of this approach, and shows that, conversely, they do not promote (injecting) drug use. An example of structural prevention for the general population is the national response of Uganda, where the government provided the supportive environment and leadership for a multitude of activities. Other structural approaches to HIV prevention are also supported by evidence, such as the 100% condom use programs in brothels in Thailand, in which managers and police played a key role, or the fostering of empowerment and capacity-building of sex workers and their organizations. Beneficial effects have also been found for structural approaches to mitigate the vulnerability of women and girls, through programs that aim to transform masculine norms or reduce gender-based violence by providing women with microcredits to attain economic independence. A more structural approach focusing on life skills has also been adopted for HIV prevention in young people. Life-skills education addresses a number of topics, such as human rights, citizenship, and social issues, rather than narrowly focusing on health-related skills. Human rights, in particular sexual and reproductive health rights, inform a range of activities of family planning organizations, including sexuality education, service provision, and advocacy for policy and legal reform. Although life-skills and life-skills education are fuzzy concepts, there is evidence to suggest this approach has positive effects on young people's knowledge, attitudes, intentions, skills, and abilities. Effects on sexual behavior and infection rates are less often found.

Structural approaches are promising because of the substantial contribution they can make to the HIV response. To date, however, the implementation and evidence-base for structural interventions remain limited. Structural factors operate in context-specific ways, and the implementation of structural approaches therefore requires a clear conceptual analysis and understanding of this context, and programs may not be directly transferrable to other contexts. Also, multiple structural factors operate in a specific context and can be addressed in various ways, requiring sophisticated analysis and prioritizing. Furthermore, health promotion agencies and practitioners may consider structural interventions beyond their expertise and remit. To date, the number of structural interventions that

have been rigorously evaluated remains limited. Building the evidence-base for structural approaches has proven challenging because of their focus on distal factors that are indirectly related to health behaviors and outcomes, the multiple and dynamic activities that make up structural interventions, and their context specificity.

Conclusion

The HIV pandemic is intricately linked to human behavior, in particular sexual practices, which account for the vast majority of infections globally. Since the early days of the epidemic, a range of effective behavior change approaches have been developed, but there is agreement that these alone are insufficient to curb the epidemic, as is treatment of HIV infection. An important lesson learned is that health behaviors are not only shaped by individual factors but are also patterned by social, economic, and political factors that play-out in structural inequities at the level of relationships, organizations, communities, and nations. A structural approach to HIV prevention is nascent, and much remains to be done to advance conceptual understanding, develop practical guidance, and build the evidence-base. Furthermore, structural approaches target distal factors, and mostly work toward longer term goals. There is no prevention 'magic bullet,' and it is increasingly recognized that the global HIV epidemic can only be effectively addressed by a combination of responses. This combination prevention includes treatment, biomedical prevention and behavior change programs, as well as structural approaches. However logical this may seem, the challenge is to find the right programmatic 'mix' that adequately reflects the epidemic in a country or region, and appropriately addresses the needs of most-affected individuals and communities. Thus far, unfortunately, history has illustrated that much remains to be done to develop, adapt, implement, and bring to scale prevention programs that are known to be effective.

See also: Alcohol; Psychosocial Effects; Attitude Change; Behavioral Medicine; Decision Making (Individuals); Evidence-Based Practice; Motivation; Perceived Control; Persuasion; Planning; Prejudice, Discrimination, and Stereotypes (Racial Bias); Risk-Compensating Behavior; Self-Efficacy; Sexual Behavior; Social Cognition; Social Support; Social Values (Influence on Behavior).

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Relevant Websites

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- <http://www.aids2031.org> – Consortium looking at lessons learned and the future AIDS response.
- <http://www.worldaidscampaign.org/> – Global coalition of civil society advocating governments to honour their AIDS commitments.
- <http://www.ippf.org> – Global service provider and leading advocate of sexual and reproductive health and rights.
- <http://www.thebody.com/> – HIV/AIDS resource for treatment and prevention.
- <http://www.unaids.org/> – Website of the Joint United Nations Programme on HIV/AIDS on the global HIV epidemic.
- <http://www.theglobalfund.org> – Website of the major multilateral funding agency of the global AIDS response.
- <http://www.cdc.gov/> – Website of the US Centres for Disease Control and Prevention with extensive resources.
- http://www.who.int/social_determinants – Website of the WHO social determinants of health programme.

Homeostasis

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Glossary

Allostatic load The progressive pathological state that occurs when regulation is constantly challenged in a way that chronically activates the autonomic nervous system, neuroendocrine stress axis, or immune system.

Control In the context of physiological regulation, variables that are altered so as to maintain the constancy of another (regulated) variable are controlled variables.

Control system A physical or biological system that is affected by its own behavior.

Homeostasis The state of relative constancy of numerous bodily variables that is achieved by active physiological processes.

Milieu intérieur The internal environment of the body, including the blood, extracellular fluid, various tissues, etc.; the French term is used in homage to the great physiologist Claude Bernard, who began the science of homeostasis.

Negative feedback A signal based on the output of a system that leads to a reduction in that output; negative-feedback control is the basis of many homeostatic regulations.

Osmolality The concentration of a solute in bodily fluids, that is, the total amount of solute in moles per kg water; for bodily fluids, usually given as mOsm kg⁻¹ water.

Regulation In the context of physiology, the maintenance of some variable in a homeostatic state, that is, in a state of relative constancy.

Rheostasis The regulation of a changing state rather than a constant state, for example, the regulation of body temperature during sleep or fever.

Setpoint A reference value to which feedbacks can be compared in order to generate compensatory control signals.

Settling point In a system that is regulated in the absence of a setpoint, the level that the regulated variable reaches when feedback and other influences reach equilibrium.

Introduction

Homeostasis denotes the maintenance, or regulation, of a number of internal bodily variables in a state of relative constancy. Homeostasis is a characteristic of all organisms that have internal environments, from the cytoplasm of individual cells (which for unicellular organisms is all there is) to the multiple 'systemic' internal environments of mammals. Homeostasis is a fundamental organizing principle of physiology, similar in importance to the principle of adaptation in evolutionary biology or the principle of gene regulation in cell biology. In their classic *Textbook of Medical Physiology*, Guyton and Hall write that "essentially all organs and tissues of the body perform functions that help maintain ... constant conditions" and therefore, a large part of physiology is concerned "with the manner in which each organ or tissue contributes to homeostasis" (p. 4). In general, the number of variables regulated, the precision with which they are regulated, and the complexity of the systems regulating them increase with increasing complexity of the organism. Nevertheless, although the number of regulated variables is quite large in more advanced organisms, it is still only a fraction of the total number possible.

Key to the definition of homeostasis is that homeostatic variables are maintained in a state of *relative* constancy. That is, they are maintained within a certain range, or envelope, not at an exact value. The ranges vary considerably. In each case, however, the variable is held within a range that is small in comparison to the range that would occur in the absence of regulation.

Cellular Homeostasis

At the cellular level, crucial regulated variables include the membrane potential, the concentrations of several ions, pH, and volume. The membrane potential, usually between -30 and -70 mV in mammalian cells, is a characteristic of all cells and is regulated mainly by the arrangement of ion-specific membrane channels and transport mechanisms, especially the 'sodium-potassium pump' (Na^+/K^+ ATPase, one of the major energy users of the body). Most cells maintain a cytoplasmic pH of 7.0–7.3, corresponding to an H^+ concentration of 50–100 nmol. This is the optimal range for many enzymatically controlled metabolic processes, gene expression, etc. Intracellular pH is regulated both by ion-transport mechanisms and the buffering action of various molecules, especially proteins that vary the amount of bound H. Cellular volume is regulated under powerful regulatory influences. Mild cell shrinkage itself is not harmful to cellular function, but the increase in intracellular osmolality that it reflects is very harmful. As explained below, thirst is the most powerful defense against cell shrinkage. This is a good example of how cellular homeostasis can be directly related to the highest levels of bodily function.

Systemic Homeostasis

The internal or systemic environment consists of a number of separate organs and fluid compartments, such as blood, extracellular fluid, cerebral-spinal fluid, etc. The concentrations of many molecules are separately regulated in different

compartments. Glucose, a crucial source of metabolic energy, is a good example. In the plasma (i.e., the noncellular fraction of the blood), glucose concentration is regulated between 4–8 mmol l⁻¹ (as described in detail below), whereas glucose concentration in the extracellular fluid of the brain is regulated at much lower values, ~0.1–2.5 mmol l⁻¹. The reduction in concentration is due to specialized tight junctions and astrocytic foot processes found in the cerebral microvessels (i.e., the blood–brain barrier). Given that the brain is normally wholly dependent on glucose as an energy source and utilizes about one-fourth of the body's glucose supply, it may seem paradoxical that such a barrier impedes passage of glucose from the blood into the extracellular fluid and subsequently into the neurons. The explanation is that neuronal glucose supply is in the end determined by the influx of glucose into the neuron and that molecular concentrations do not reflect molecular fluxes, or rates of movement. Glucose influx into the neurons is controlled differently than glucose influx into most tissues, and proceeds at levels more than sufficient to supply the neurons with energy until extracellular glucose concentration reaches levels well below 1 mmol l⁻¹. In contrast, as described below, glucose influx into muscle, adipose tissue, and most other peripheral tissues is reduced to almost nothing when plasma glucose falls toward 4 mmol l⁻¹.

History of Homeostasis

Homeostasis has a long history. Present concepts represent the crystallization of the thinking of a long line of people of great genius, beginning well before the advent of an empirical science of physiology. In his history of physiological regulation, Adolf describes Hippocrates, who lived about 2500 years ago, as teaching that the healthy body is characterized by equilibria among 'constituent qualities,' that disease disrupts this balance, that the body attempts to heal itself by reinstating it, and that the goal of medicine is to aid this process. Galen, about 1800 years ago, speculated about the contributions of specific bodily mechanisms to these processes and was even able to demonstrate some examples, such as the control of breathing by the central nervous system, which he showed in animal vivisection experiments. Many similar examples of the contributions of physiological controls of vital functions slowly accrued over the centuries. The next conceptual advances, however, were quantum leaps. These are associated with four great scientists, Bernard, Cannon, Richter, and Wiener.

Claude Bernard (1813–1878)

Bernard, a professor at the Collège de France in Paris, made many groundbreaking discoveries in physiology. Some of these are (1) that pancreatic secretions are required for fat digestion, (2) that the liver produces glucose, (3) that the liver and other tissues store glucose in the form of glycogen, (4) that the brain contributes to the control of hepatic glucose metabolism, (5) that the nervous system controls peripheral vasodilation and vasoconstriction, (6) that changes in blood flow to various tissues contribute to maintenance of proper body temperature, and (7) that water intake and loss are equated so as to maintain blood volume, one of the first demonstrations of a

physiological balance. Equally important, however, were two of Bernard's theoretical legacies. The first of these (1865) was his codification of the scientific method as it applies to physiology and medicine. The second was arguing the central physiological importance of homeostasis, which he described in other words, for advanced life forms. In his final work, published just after his death in 1878, he wrote the famous sentence: "The constancy of the internal environment is the condition for a free and independent life." In homage to the importance of this idea to physiology, the key phrase, 'la fixité du milieu intérieur,' is still often given in the original French. The external environment changes dramatically, but the internal environment is maintained constant.

Walter B. Cannon (1871–1936)

Cannon, a professor at Harvard Medical School, Boston, MA, USA, also pursued a wide range of physiological investigations. These included, in addition to vegetative functions, the physiological bases of emotions, such as fear and rage, and of motivational states, including hunger and thirst. Cannon coined the term homeostasis in publications in 1926 and 1929. He recognized that Bernard's work was his starting point, but extended it in important ways. First, he emphasized that the body is not able to maintain the internal environment perfectly constant, but maintains it in a more or less narrow range. This is evident in his choosing to combine the prefix *homeo*, or similar, rather than *homo*, or same, with *stasis*, or standing still. Second, Cannon emphasized the coordinated and dynamic operation of homeostatic mechanisms. Central to his view was the existence of mutually antagonistic control mechanisms, so the regulated variable could be simultaneously pushed and pulled into place. In addition, he emphasized how individual controls could be either stimulated or inhibited, depending on the environmental challenges at hand. Finally, Cannon brought homeostasis into the public eye with his 1932 classic, *The Wisdom of the Body*.

Curt Richter (1894–1988)

Richter was a professor at the Johns Hopkins University School of Medicine, Baltimore, MD, USA. His special contribution was the documentation of numerous examples of how motivated behavior contributed to homeostasis. Sodium appetite was an early example. He discovered that removal of the adrenal glands, which causes uncontrolled excretion of sodium in the urine, elicits a dramatic appetite for sodium. The rats maintained themselves in good health by ingesting large amounts of sodium chloride solutions, even if the solutions were so concentrated that they were shunned almost entirely by intact rats. Furthermore, the appetite was highly selective – ingestion of magnesium chloride, for example, was not increased. Richter subsequently demonstrated the existence of a large number of appetites for nutrients that are elicited during deficiency states. In most cases, however, the animal did not appear to innately recognize the taste of the depleted nutrient, but had to learn which foods contained it. Nonnutritive homeostatic regulations, for example thermoregulation, were also shown to include behavioral components, such as nest building.

Homeostasis was, in Richter's words, the product of 'total self-regulatory functions' of the body.

Norbert Wiener (1894–1964)

Wiener, a professor at the Massachusetts Institute of Technology, Cambridge, MA, USA, made fundamental contributions to mathematical information theory, especially as applied to the use of feedback to govern dynamic systems. Wiener called this cybernetics; control theory is the more current term. The most general definition of a cybernetic system is a system that affects its own behavior. Two types of classical closed-loop negative-feedback control systems are diagrammed in **Figure 1**. Note the terminology: the variable that is held constant is said to be *regulated*, and the various effectors or response variables that are varied in order to achieve such regulation are said to be *controlled*. A powerful tool developed during this early period was mathematical analyses of the dynamics of positive- and negative-feedback control systems; particularly useful are the 'control transfer functions,' which allow calculation of the time courses and final levels of the controlled and regulated variables if the system characteristics are known. On a very different level, Wiener and others recognized at the outset that cybernetic principles have implications spanning mathematics, engineering, biology, computer science, and even philosophy. For example, they provide potential explanations for apparently purposeful,

goal-directed behavior without resort to volition, intention, or teleology. Wiener's connection to homeostasis was direct: one of Cannon's last students, Arturo Rosenblueth (1900–1970), also worked with Wiener and in 1943 published with Wiener a seminal paper that included a description of the application of control theory to homeostasis.

Current Concepts in Homeostasis

A number of new perspectives about homeostatic regulation have developed in recent decades. This section outlines some of these.

Settling Points

The mathematics of control theory indicates that dynamic control systems can achieve impressive stability even in the absence of a reference value or set point. The regulation of blood glucose, described below, is an example. Essentially, if compensatory feedback mechanisms are activated when the regulated variable reaches a certain threshold, then the system will achieve constancy. The lower schematic shown in **Figure 1** diagrams this. In such a system, negative-feedback control will return the regulated variable to the original level following a temporary challenge, so that the system is indistinguishable

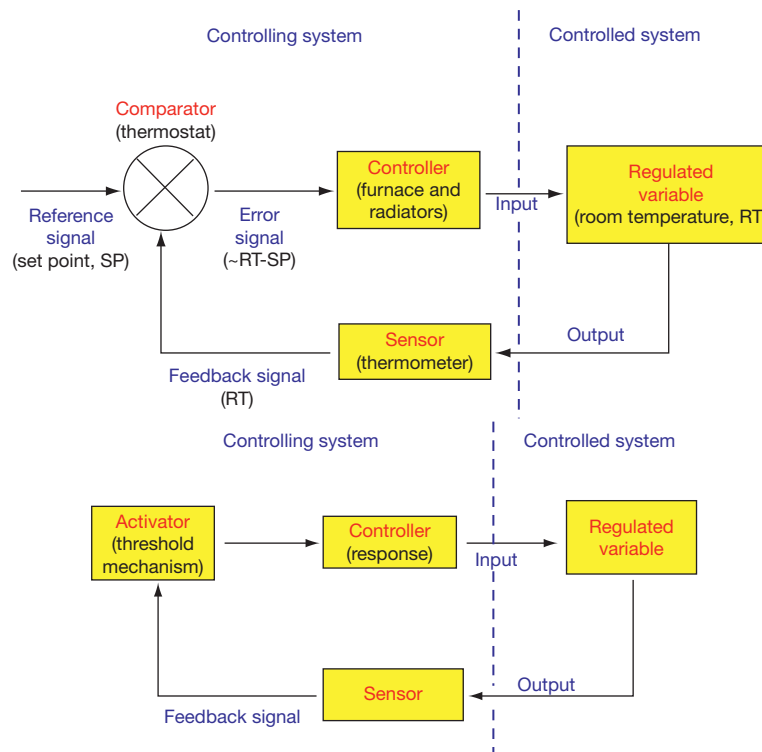


Figure 1 Upper panel: the organization of a negative-feedback regulatory system with a setpoint. The regulated variable, or some surrogate of it, is sensed (negative feedback) and compared to a reference signal (setpoint), and discrepancies (error signals) activate a controller mechanism that changes the regulated variable in a way that reduces the feedback. The system components of a thermostatically controlled central-heating system are labeled in black. Lower panel: the organization of a negative-feedback regulatory system without a setpoint. Instead of a comparator mechanism, the feedback signal elicits a response in the controller mechanism when a certain threshold is reached. Most neural and endocrine regulations are organized in this way. The two systems produce equivalent regulation under many circumstances, but the latter is more susceptible to partial failures when chronically challenged; that is, the regulated variable is held at a different level than that originally held. See text for details.

from a setpoint system. During a chronic challenge, however, the constant level might be altered, so that regulation occurs as if the setpoint were increased. The new level is called a settling point. The difference between the original level and the new one is determined by the magnitude of the challenge in relation to the number, strength, and dynamics of the various feedback mechanisms involved. The majority of physiological regulations appear to operate in this way.

Rheostasis

Many regulated variables change in the absence of changes in the challenges they experience. Body temperature, for example, changes regularly through the course of the day, changes for long periods in animals that undergo seasonal periods of dormancy or hibernation, and changes as a result of activation of the immune system during many illnesses (i.e., fever). All of these alterations display the characteristics of active regulation. Thus, as the organism enters such situations, regulation does not promote constancy, but change. This is called rheostasis or variable-state regulation.

Allostasis and Allostatic Load

The simplest regulatory situation involves temporary responses to occasional, transient challenges. Sometimes, however, homeostatic challenges are frequent, long-lasting, or even permanent. In these cases, regulation requires frequent or long-maintained responses. Allostasis, meaning constancy of change, refers to the idea that regulatory control systems are often not at a state of rest, but are operating frequently or for long periods. Central heating exemplifies this – in cold climates furnaces run all winter to maintain room temperature. Unlike furnaces, however, physiological systems often appear to be adapted to operate for only relatively brief periods (i.e., phasically). Furthermore, if they are required to operate for long periods (i.e., tonically), there are often deleterious side effects. The neuroendocrinologist Bruce McEwen coined the term ‘allostatic load’ to describe the progressive increase in risk of such pathophysiological consequences when homeostasis is continually challenged. The immune system and the stress axis (described below) are both powerful homeostatic effectors, but both produce deleterious side effects if forced to operate tonically. For example, arousal caused by physical or psychological stress includes elevations in blood pressure and cortisol secretion (described below). Both of these prepare the body for impending action. However, if such events occur frequently or if recovery is slow, as is the case in some individuals, pathologies can develop. For example, blood pressure surges accelerate atherosclerosis and increase the risk of cardiovascular disease, and chronic, mild increases in blood cortisol concentrations inhibit bone formation. Other examples of allostatic load are the disruptions of rheostatic regulations of sleep and metabolism suffered by people who work during the night.

Anticipatory Controllers

Negative-feedback control requires that a perturbation occurs in order for the system to react. This introduces a time lag into the system, which can reduce the efficiency of regulation or,

depending on the dynamics of the relevant effectors, lead the system into unstable oscillations. The simplest way to avoid these problems is for the system to detect changes that typically occur before the regulated variable changes appreciably. For example, the heating systems of some houses are connected to outdoor thermometers; when the temperature falls outdoors, the furnace starts to heat the house so that an increase in heat delivery averts cooling in the interior. In higher organisms, anticipatory controllers help maintain many regulated variables in narrower envelopes than would otherwise be possible. The mechanisms generally depend on nervous or endocrine reflexes, as described below for the regulations of body temperature and blood glucose.

Homeostatic Control Systems

Endocrine Mechanisms

Hormones, defined as chemical messengers that are secreted into the bloodstream by glands, carried in the circulation to target tissues, and elicit biological responses by acting on specialized receptors in the target cells, play numerous vital roles in homeostasis. Several such endocrine mechanisms are described in the following sections. The secretion of many hormones is controlled by the action of circulating factors, often including other hormones, on the gland cells. Most are also controlled by neural inputs. The secretion of the pancreatic hormone insulin, which, as described below, is crucial for blood-glucose regulation, exemplifies these types of controls: blood glucose, other hormones, and neural inputs all affect insulin secretion.

A number of hormones that are important for homeostasis are part of the *neuroendocrine system*, which links the hypothalamus, the pituitary gland at the base of the brain, and the peripheral glands. This system is outlined in the section on the hypothalamus below. The *immune system* is another homeostatic system that depends on chemical messengers, although these are not classically described as hormones. The immune system also affects the brain, and many immune responses, such as fever, are generated by the brain.

Neural Mechanisms

There is no single set of brain structures devoted to homeostatic regulation. Rather, as is also the case for other brain functions, the neural controls of homeostatic functions depend on neural networks that are defined functionally more than anatomically, that are spread diffusely through large portions of the brain, and that overlap with other functional neural networks. Furthermore, these networks are both redundantly and hierarchically organized. That is, the neural control systems include several semiautonomous subnetworks (or representations), typically in increasingly more rostral brain areas, with each representation (or partial representation) contributing increasingly sophisticated aspects of homeostatic control. This leads to increasingly flexible responses in more complex organisms, arming them with a variety of different homeostatic responses which can be adapted to fit very different situations, thereby enabling them to pursue the ‘free and independent’ life described by Bernard.

Autonomic Nervous System

Direct neural control of internal homeostatic functions is mediated mainly by the autonomic nervous system, which innervates most glands and smooth muscle, that is, vascular and gastrointestinal muscle. The autonomic nervous system consists of two sub-systems, which generally have opposite effects on the tissues that they innervate. (1) The 'sympathetic' system consists of (a) 'preganglionic' neurons with cell bodies in the intermediolateral column of the thoracic and lumbar spinal cord, which project to (b) 'postganglionic' neurons in the sympathetic chain ganglia just outside the thoracic and lumbar vertebral column; the postganglionic axons project to the target tissues. The primary neurotransmitter of the sympathetic nervous system is norepinephrine. (2) The 'parasympathetic' nervous system consists of (a) 'preganglionic' neurons with cell bodies in the dorsal vagal complex of the caudal brainstem (the sources of motor neurons of the tenth cranial nerve, the vagus) or in the sacral spinal cord, which project to (b) 'postganglionic' neurons located in various peripheral ganglia; again, the postganglionic axons project to the target tissues. The primary neurotransmitter of parasympathetic postganglionic neurons is acetylcholine. Strong sympathetic activation, as occurs in anger or fear, leads to physiological arousal – increased vigilance, heart rate, and blood flow to the skeletal muscles, and decreased blood flow to the gastrointestinal system and skin (which is why arousal leads to cold hands and feet). In contrast, when the parasympathetic nervous system is more active, one relaxes, the heart rate slows, and more blood is directed into the digestive organs.

Caudal Brainstem

A number of small regions in the caudal brainstem are involved in the motor control of many homeostatic functions. Blessing refers to these areas as 'groups' of neurons rather than 'centers' in order to emphasize, first, that they are important points in widely distributed neural networks, not the areas in which function is 'localized,' and, second, that their properties remain incompletely understood. The medullary respiratory groups are good examples. Lesion, stimulation, and recording studies indicate that a 'dorsal respiratory group' of neurons in and adjacent to the nucleus tractus solitarius as well as a more ventrally located 'rostral ventrolateral respiratory group' project to and usually control the activity of lower motor neurons in the brainstem and spinal cord that mediate inspiration. More caudal to the latter is the 'caudal ventrolateral respiratory group,' which projects to and controls lower motor neurons that mediate expiration. These groups also connect with each other and with further medullary groups, including groups that appear to generate the rhythms of respiration as well as a different network of neural groups that participate in the control of vasodilation and vasoconstriction, thus coordinating oxygenation of the blood via respiration and delivery of oxygenated blood to the tissues. All these groups of neurons are on the output side of the neural control of respiration. They receive afferent information from a variety of sources, including, for example, chemoreceptors sensitive to the concentrations of O_2 , CO_2 , and H^+ in the blood and mechanoreceptors in the upper and lower respiratory tract and in the lungs.

Hypothalamus

The hypothalamus is a second brain area intimately involved with homeostasis. There are three types of contributions. (1) *Neuroendocrine controls*: 'Magnocellular' neurons in the supraoptic (SON) and paraventricular (PVN) nuclei of the hypothalamus project to the posterior lobe of the pituitary gland, and 'parvocellular' neurons in the PVN project to the median eminence, where they secrete 'releasing hormones' into the portal capillaries that carry them to the anterior lobe of the pituitary gland. The pituitary responds by releasing hormones that either have direct regulatory functions (e.g., growth hormone) or regulate the activity of peripheral glands involved in homeostasis (e.g., adrenocorticotrophic hormone, or ACTH, which causes the adrenal cortex to release cortisol and other glucocorticoid hormones). Typically, both pituitary and peripherally released hormones also act as negative feedbacks in the hypothalamus. **Figure 2** summarizes the organization of hypothalamic – anterior pituitary – endocrine controls. (2) *Autonomic controls*: Neural projections from various hypothalamic areas to autonomic cell groups in the medulla (e.g., the dorsal motor nucleus of the vagus nerve, a principal parasympathetic nerve) and the spinal cord (e.g., the intermediolateral column of the thoracic and lumbar spinal cord, the source of sympathetic preganglionic neurons). (3) *Behavioral controls*: The hypothalamus contributes to the generation of motivational states leading to behaviors that contribute to homeostasis, such as thermoregulatory behavior, drinking, and eating.

Cerebrum

Brainstem and hypothalamic homeostatic mechanisms are linked to the highest levels of neuronal control, the neural networks in the cerebral hemispheres. This is also the least well understood level of control. One example is illuminating. In all mammals, a cerebral brain area known as the amygdala receives quite direct inputs from several sensory systems and appears to integrate them to produce a signal essentially representing how good or how aversive something feels, whether it be the temperature of water on the skin or a taste in the mouth. In primates, a particular area of the cerebral cortex that does not exist in lower mammals, the orbitofrontal cortex (OFC), has similar connectivity and functions in concert with the amygdala. Presumably, the OFC representation of hedonics allows more sophisticated, plastic, and useful judgments than achieved by the amygdala alone. An apparent function of the OFC is probably familiar: during hypothermia, for example after cold exposure, a shower that normally is felt to be aversively hot is felt to be pleasant. Pleasure and aversion, therefore, can serve homeostasis in an adaptable way. At the same time, it is also clear that modern life presents many circumstances in which the influence of pleasure can overwhelm other homeostatic control mechanisms.

Examples of Homeostasis

Regulation of Cell Volume

Cell membranes are highly permeable to water, but impermeable to most solutes, so that these are trapped inside or outside the cell. Thus, loss of water in the systemic compartments

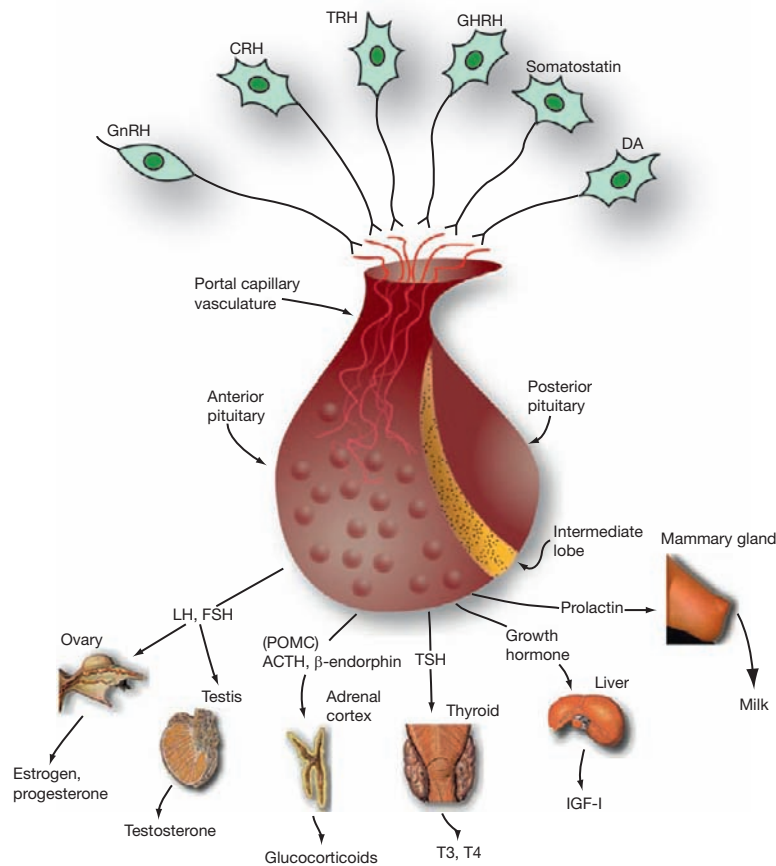


Figure 2 The neuroendocrine system of the anterior pituitary. A variety of hypothalamic neuroendocrine cells (top) project to the median eminence and secrete releasing hormones into the local portal circulation, which delivers them to the secretory cells of the anterior pituitary (middle); these cells then secrete hormones that either control the activity of peripheral glands or act directly on target tissue (bottom). See text for details. Abbreviations: adrenocorticotropic hormone (ACTH); corticotropin-releasing hormone (CRH); dopamine (DA); follicle-stimulating hormone (FSH); growth hormone-releasing hormone (GHRH); gonadotropin-releasing hormone (GnRH); insulin-like growth factor-1 (IGF-1); luteinizing hormone (LH); pro-opiomelanocortin (POMC); thyrotropin-stimulating hormone (TSH); T3, T4, thyroid hormone 3 and 4; thyroid-stimulating hormone (TSH). Reprinted with permission from Gore AG and Roberts JL (2003) Neuroendocrine systems. In: Squire LR, Bloom FE, McConnell SK, Roberts JL, Spitzer NC, Zigmond MJ (eds) *Fundamental Neuroscience*, 2nd edn., pp 1031–1065. San Diego, CA: Elsevier.

(blood and extracellular fluid) increases systemic osmolality, creating an osmotic force that causes water to leave the cells until an equilibrium is reached. Thus, the cell shrinks and intracellular osmolality increases in proportion to the amount of water lost. The first line of defense against cell shrinkage is secretion of the hormone arginine vasopressin (AVP, formerly called antidiuretic hormone) from the posterior pituitary. AVP causes the kidney to excrete higher osmolality urine, thus effectively decreasing systemic osmolality, allowing water to move back into the cells, and restoring cell volume. AVP secretion and the kidney response are proportional to the amount by which plasma osmolality increases over the normal value of 280 mOsm kg^{-1} water. The second, and more powerful, line of defense against cell shrinkage is thirst. Increases of only a few percent osmolality elicit a strong desire to drink water, which causes people and animals to interrupt other activities and seek water. Both responses to cellular dehydration originate from neurons in the anterior hypothalamus and an adjacent area

(the vascular organ of the lamina terminalis), which increase activity upon shrinkage. Some of these neurons project to the magnocellular neurons of the SON and PVN, whose axons project to the posterior pituitary and release AVP. The neural circuitry for thirst is less well understood. The increase in renal sodium excretion and inhibition of ingestion of sodium and other solutes also contribute to cell-volume homeostasis. Finally, note that both the hormonal and the behavioral controls of cell volume appear to correspond to the type of negative-feedback control system depicted in the lower panel of [Figure 1](#), in which regulation is achieved by a variety of threshold mechanisms without a setpoint.

Regulation of Body Temperature

Humans live, work, and play in ambient temperatures that range from below freezing (0°C) to over 40°C , yet maintain deep or core body temperature with a few tenths of a degree.

This regulation is asymmetric: we defend against hyperthermia more vigorously than against hypothermia. This is probably because the regulated temperature, although near optimal for many enzymatic metabolic reactions, is only a few degrees from the upper limit of survival.

The regulation of body temperature is achieved by a neural mechanism that appears to closely match the classical negative-feedback control system that includes a setpoint, as described in the upper panel of [Figure 1](#). The most important temperature-sensitive neurons are in the preoptic and anterior hypothalamic areas (POA/AH). About 20% of the neurons in these areas are intrinsically warm-sensitive: they increase the rate of activity upon local warming. A small percentage of POA/AH neurons are cold-sensitive, but in this case it appears that the sensitivity is indirect; that is, these neurons receive synaptic inputs from distantly located cold-sensitive neurons in the skin or in spinal cord (POA/AH warm-sensitive neurons also receive inputs from extra-hypothalamic temperature-sensitive neurons). The skin receptors, of course, exemplify the anticipatory homeostatic mechanisms discussed above. Finally, the POA/AH also includes neurons with constant spontaneous rates, which are thought to provide the setpoint signal. The comparator is a neural computation based on antagonistic synaptic connections between the temperature-sensitive and setpoint neurons and the effector neurons that initiate thermoregulatory responses. Thus, when the temperature-sensitive neurons and the setpoint neurons are equally active, their postsynaptic effects cancel out and the system is quiescent. Finally, the setpoint is variable: factors such as immune system activation and state of arousal change the setpoint to produce fever and the changes in core body temperature during sleep, hibernation, etc.

Behavioral thermoregulatory responses are organized by neural networks in the forebrain. Little is known about them. The most important vegetative cooling mechanism is vasodilation in the skin, which can increase heat transfer out of the body several fold. Vasodilation is controlled by inhibitory neural projections from the POA/AH to cell groups in the posterior hypothalamus that control sympathetic projections to the peripheral vasculature. Sweating, which increases evaporative heat loss, is controlled by different POA/AH outputs to various cell groups in the caudal brainstem that control parasympathetic projections to the sweat glands. When the body is too cold, the opposite responses occur. In addition, a projection from the POA/AH to the 'cell group for shivering' in the posterior hypothalamus is stimulated, leading via several synapses to the skeletal muscles. The resultant shivering can increase bodily heat production several fold. The various thermoregulatory controllers appear to be driven by separate assemblies of temperature-sensitive and setpoint neurons in the POA/AH.

Regulation of Blood Glucose Concentration

Glucose is the major energy-yielding molecule in nonruminant mammals and normally is the only metabolic fuel used by the brain and kidney. The supply of glucose is assured by regulation of blood glucose levels. As shown in the upper panel of [Figure 3](#), glucose enters the blood from exogenous (i.e., intestinal absorption) and endogenous (i.e., metabolic production) sources and normally leaves the blood only via uptake into

the cells (during pathological hyperglycemia some glucose is also excreted via the kidneys). The rates of both influx of glucose into the blood and efflux from the blood vary considerably according to the cell type and physiological state. Net blood glucose flux is held in balance, so that plasma glucose is maintained between ~ 4 and 8 mmol l^{-1} (plasma is the noncellular component of blood, normally about 45% of blood volume; plasma glucose is often expressed as mg dl^{-1} ; $0.0555 \text{ mg dl}^{-1} = 1 \text{ mmol l}^{-1}$).

Plasma glucose is usually highest soon after a carbohydrate-rich meal and lowest in the morning, that is, during the 'post-absorptive state,' when no glucose is being absorbed. The upper panel of [Figure 4](#) shows typical fluctuations in blood glucose across the day. At first glance, these fluctuations may seem large. In fact, however, they are small in comparison to what would occur without regulation. This can be appreciated by consideration of glucose flux in the postabsorptive state. In this state, endogenous glucose production and utilization are each $\sim 2.2 \text{ mg kg}^{-1} \text{ min}^{-1}$, which in a 70-kg person represents $\sim 150 \text{ mg min}^{-1}$. The amount of glucose in the plasma at any moment in the same person is $\sim 2 \text{ g}$. Thus, if utilization were not actively balanced by production, the entire amount of glucose in the plasma would be used up in $< 15 \text{ min}$! The postabsorptive state is the simplest steady-state situation, when glucose utilization is minimal and the physiological systems affecting blood glucose are not changing. After carbohydrate-containing meals, influx is greater than efflux. If glucose were not cleared from the plasma efficiently in this situation, plasma glucose levels would rise to $> 30 \text{ mmol l}^{-1}$. This occurs in uncontrolled type 1 diabetes mellitus, a disease in which the pancreas makes no insulin.

Three levels of control contribute to blood glucose regulation. The first, known as autoregulatory mechanisms, consists of fixed metabolic arrangement that facilitates regulation. The second set of mechanisms consists of neural and endocrine responses that are elicited by increases or decreases of blood glucose beyond fixed thresholds. Finally, a behavioral mechanism – hunger – is an emergency response elicited by very low levels of blood glucose. The latter two mechanisms proceed via negative feedback, but with threshold-activated responses rather than a setpoint and comparator.

The most important metabolic mechanisms occur in the liver. Ingested carbohydrates are absorbed into the hepatic portal vein and pass through the liver before reaching the systemic circulation. Glucose enters the hepatocytes by facilitated diffusion and is transformed into glucose-6-phosphate (glucose-6-P) by a class of enzymes known as hexokinases. Hexokinases exist in most cells, and the resulting glucose-6-P enters a variety of metabolic pathways. In the liver, most of it is transformed into glycogen; in most other cell types, it is oxidized. When glucose levels are low, glycogen is converted back to glucose. In addition, the liver is the main site of gluconeogenesis, that is, the production of glucose from lactate, amino acids, and fatty acids. Although the muscles also contain glycogen and the kidney is also capable of gluconeogenesis, there is little glucose efflux from these tissues into the blood. That is because the muscles (and most other tissues) do not express glucose-6-phosphatase, so cannot convert glucose-6-P back to glucose, and because the kidney oxidizes glucose for energy, whereas the liver oxidizes mainly fat. In addition, the particular

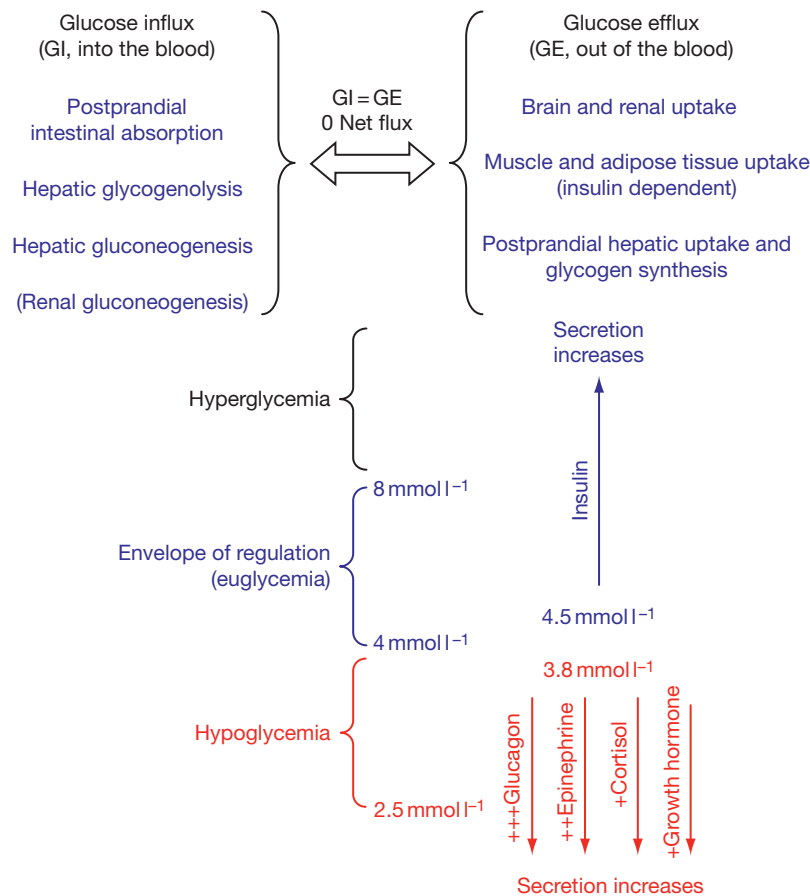


Figure 3 Upper panel: how glucose enters (influx) and leaves (efflux) the bloodstream, emphasizing the normal zero net flux in the postabsorptive state, as described in the text. Lower panel: the normal regulatory envelope of blood glucose (euglycemia) together with the endocrine responses to increases or decreases in blood glucose. The number of plus signs (+) indicates the relative regulatory potency of the hormone; only insulin is indispensable.

hexokinase expressed in the liver, glucokinase, or type IV hexokinase, contributes to maintenance of blood glucose in two other ways. First, whereas the rate of production of glucose-6-P is maximal at quite low glucose concentrations for other hexokinases, glucokinase enables high rates of glucose-6-P synthesis only when intracellular concentrations are relatively high. As a result, when blood glucose concentrations are low, the enzyme is inactive, free glucose levels in the hepatocyte remain relatively high and little glucose diffuses in. In contrast, when glucose levels increase toward hyperglycemia, glucokinase is more active, leading to rapid formation of glucose-6-P and helping the liver to clear glucose from the blood. Second, whereas the buildup of glucose-6-P inhibits other hexokinases, it does not inhibit glucokinase. This further facilitates hepatic glucose uptake when glucose levels are high.

Endocrine mechanisms make crucial contributions to the regulation of blood glucose (Figure 3, lower panel). The contribution of insulin is indispensable. Indeed, because of its unique role, insulin is known as the glucose-regulatory hormone, and the hormones discussed below that have opposite effects to that of insulin are known as 'counter-regulatory' hormones. Insulin is secreted by the pancreatic beta cells in proportion to blood glucose levels, as shown in Figure 3.

Insulin facilitates the uptake of glucose by muscle, adipose tissue, and other tissues, thus preventing hyperglycemia during periods of high influx of glucose from the intestines. Insulin also inhibits hepatic glucose production. Chronic hyperglycemia is toxic; thus, the absence of insulin, that is, type 1 diabetes mellitus, is a deadly disease. Insulin secretion drops to basal levels during the postabsorptive state, thus reducing glucose uptake into the muscle and adipose tissue toward zero. These tissues switch to fat and protein as energy sources. This spares glucose for brain and kidney, which utilize glucose preferentially and in which glucose uptake is not insulin-dependent.

Decreases of blood glucose toward the normal lower limit of regulation elicit secretion of several other hormones. Glucagon is the most important under normal conditions. Glucagon stimulates hepatic glycogenolysis and gluconeogenesis, both of which occur at high rates in the postabsorptive state. As glycogen is depleted, after about 8 h of fasting, gluconeogenesis predominates. During longer fasts, the brain begins to utilize fat, in the form of ketone bodies, so that the rate of gluconeogenesis can decrease and body protein is not consumed more rapidly than necessary. Epinephrine, secreted from the adrenal medulla, also stimulates hepatic glucose production. Unlike glucagon, however, epinephrine also acts in

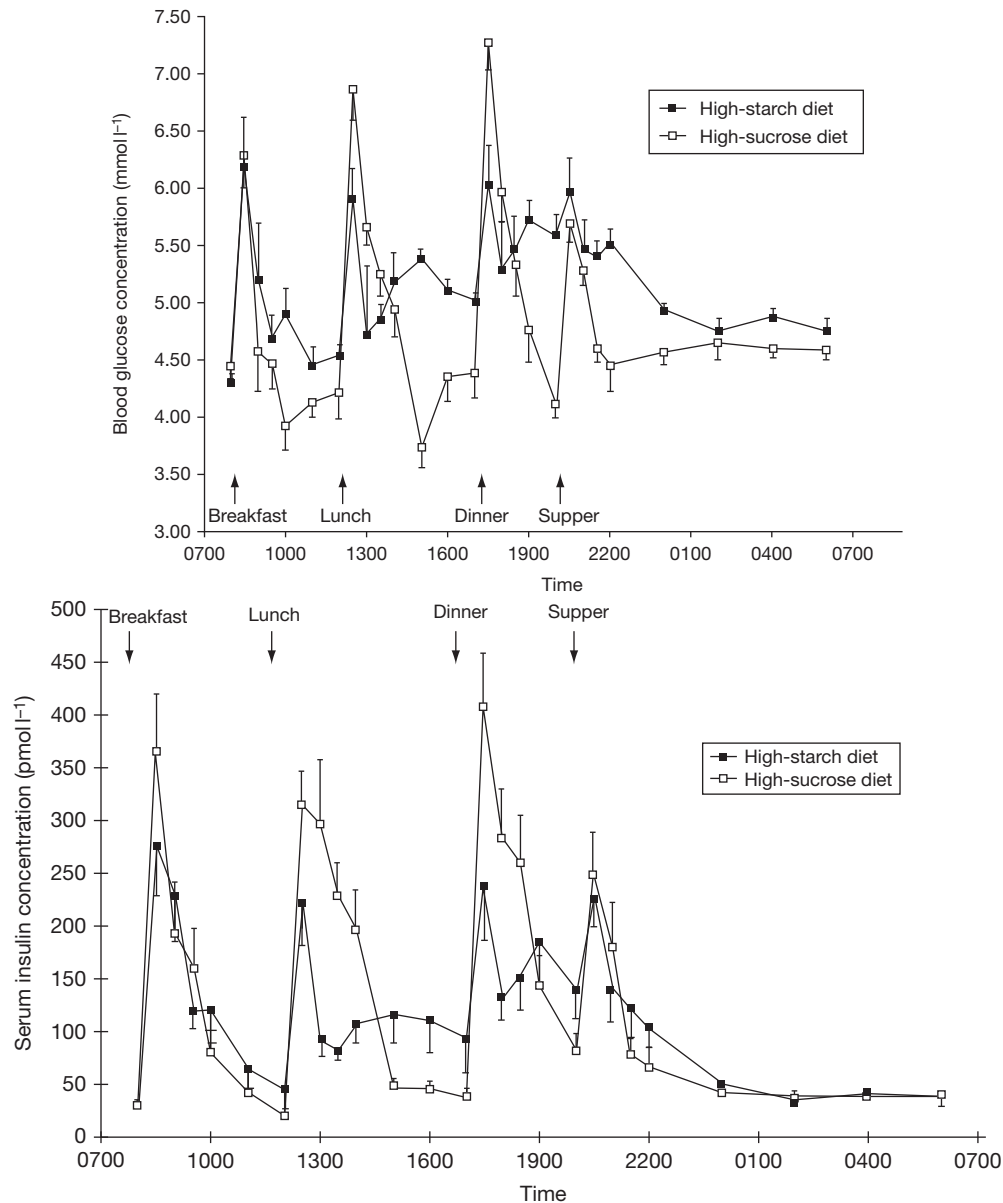


Figure 4 Normal patterns of blood glucose (upper panel) and insulin (lower panel) in healthy normal-weight individuals (four men, four women) who ate four daily meals. Each meal consisted of a variety of normal foods that were matched in protein, fat, and energy contents and contained 50% of energy as either sucrose or starch; dietary fiber was also higher in the starchy foods (14 vs. 6 g day⁻¹). Note how insulin levels closely track glucose levels and how rapidly blood glucose is brought back to near the basal level after meals. Reprinted with permission from Daly ME, Vale C, Walker M, Littlefield A, Alberti KGMM, Mathers JC (1998) Acute effects on insulin sensitivity and diurnal metabolic profiles of a high-sucrose compared with a high-starch diet. *American Journal of Clinical Nutrition* 67: 1186–1196.

insulin-sensitive tissues to decrease glucose utilization and to increase the production of gluconeogenic substrates, which are transported to the liver via the blood. When glucose levels are low for still longer periods, growth hormone and cortisol contribute to the inhibition of glucose utilization and stimulation of glucose production. Cortisol also appears to increase the actions of glucagon and epinephrine.

The behavioral regulation of blood glucose is a last defense against lethal degrees of hypoglycemia. Hunger is elicited when plasma glucose falls to $\sim 3 \text{ mmol l}^{-1}$. Prompt carbohydrate ingestion can act within minutes to increase plasma glucose.

Unfortunately, if plasma glucose falls just a little more, to $\sim 2.8 \text{ mmol l}^{-1}$, neural function is compromised, and people may no longer have sufficient cognitive function and motor coordination to eat. To make matters worse, with repeated episodes of hypoglycemia, the system eliciting hunger becomes less sensitive.

Eating is linked to glucose regulation in another unfortunate way. The abundance of highly palatable, energy-dense foods in affluent societies has led to chronic overeating and an obesity epidemic. Chronic overeating and obesity lead to chronic increases in insulin secretion, which has the

unfortunate consequence of reducing the sensitivity of most tissues to insulin. Thus, more and more insulin must be secreted to control blood glucose. In time, the control is faulty, leading to elevations in both blood glucose and insulin, or type 2 diabetes mellitus. Other pathogenic consequences also occur, for example, a chronic state of systemic inflammation; this is a type of allostatic load. Finally, the pancreatic beta cells become exhausted and die, leading to type 1 diabetes mellitus.

Anticipatory controls are also important in the normal regulation of blood glucose. Sweet taste and, after experience with food, just the smell, sight, or thought of food elicit secretion of insulin via neural reflexes. This is known as the cephalic phase of insulin secretion because the receptors are cephalad, that is, in the head. In addition, the entry of food into the intestines elicits secretion of the gut hormones GLP-1 (glucagon-like peptide-1) and GIP (gastric-inhibitory polypeptide or glucose-dependent insulinotropic polypeptide), which act in the pancreas to stimulate insulin secretion. This is known as the incretin effect or the intestinal phase of insulin secretion. Under normal conditions, this anticipatory mechanism accounts for ~40% of meal-stimulated insulin secretion.

See also: [Adrenal Glands](#); [Appetite](#); [Catecholamines and Behavior](#); [Central Nervous System](#); [Hormones and Behavior](#).

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Homicide

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Glossary

Adaptation An evolved trait in all or most individuals in a population that functions to solve an adaptive problem.

Adaptationist Explaining the evolution of traits in terms of their adaptive function.

Adaptive problem A problem hindering survival and reproduction that was recurrently faced during the evolutionary history of a species.

Ancestral benefits Benefits to the survival and reproduction of the ancestors of a species.

Coevolution When two (or more) species or sets of strategies in the same species reciprocally affect each other's evolution.

Coevolutionary arms race The back-and-forth evolution of defense and offense between opposing evolutionary

strategies (e.g., strategies of predators and prey; strategies of exploiters and victims).

Conspecific Another individual of the same species.

Intrasexual rival A member of the same sex with whom an individual is in conflict over some limited resource(s).

Lethal raids Short duration, often surprise attacks made by a small group of warriors against another group to obtain resources or exact revenge.

Metatheory A set of principles that both describes and prescribes what is acceptable and unacceptable as the means of conceptual exploration of the foundations, structure, properties, methods, or results of some theory in a scientific discipline.

Homicide may be defined as the killing of one human being by another. There are different legal categories of homicide that vary from one jurisdiction to another. In general, legal systems view some homicides to be justifiable or excusable, while others are not. Justifiable homicide is limited to the killing of a felon by a law enforcement officer in the line of duty or the killing of a felon by a private citizen during the commission of a felony. First-degree murder, in contrast, is unlawful killing that is willful, deliberate, and premeditated. The term homicide typically is used by government agencies to explain causes of mortality, while murder and manslaughter are used by criminal justice agencies.

The Epidemiology of Homicide

A total of 13 636 people were victims of homicide in the United States in 2009. This converts to a homicide rate of 4.5 out of 100 000 people for that year. With an average life span of 78 years in the United States in 2009, the lifetime risk of being a homicide victim is 1 in 287. According to homicide data from the Federal Bureau of Investigation, at least 78.5% of homicide victims in 2009 were male. Forty-nine percent were African American. Homicide rates were highest in the South and lowest in the Northeast region of the United States. These homicide statistics do not include members of the US military who were killed in warfare.

Historically, the homicide rate in the United States remained quite steady during the 1980s, decreased markedly in the 1990s, and has remained steady through the early 2000s. Researchers in the United States have argued that faster ambulances and better emergency room care, much of which was developed during the first Gulf War between the United States and Iraq from 1990 to 1991, are partly responsible for the decrease in homicide rates during the 1990s in the

United States. They have estimated that there would be 30 000–50 000 additional killings in the United States every year—at least tripling or quadrupling the current homicide rate—without the advances in emergency care technology that have occurred during the last 30 years.

In 2007, homicide ranked fifteenth among the leading causes of death for men and women of all ages. Women and men, however, did not have the same likelihood of being killed by someone else. For men, homicide was the thirteenth leading cause of death. For women, homicide did not crack the top twenty. The likelihood of being killed also differed as a function of age and ethnicity. For all men between the ages of 15 and 24 years, homicide was the second leading cause of death, but for black men in the same age group, it was the number one cause of death.

It is more likely that a killer will be someone the victim knows than someone the victim does not know. However, Dr. Martin Daly and Dr. Margo Wilson from McMaster University have noted that the killing of genetic relatives is significantly less common than the killing of unrelated individuals, suggesting that proximity alone is not a satisfactory explanation for why people kill. Across cultures, 65% of homicides involve males killing other males, 22% involve males killing females, 10% involve females killing males, and only 3% involve females killing other females.

The most common method for homicide in the United States in 2009 was firearms (67.1%), followed by knives or cutting instruments (13.4%), unknown or other dangerous weapons (13.7%), and hands, fists, feet, etc. (5.9%). Homicide rates do not vary significantly with the season or lunar cycle. Less than a third of those who commit homicide are intoxicated when they kill.

Regional differences in homicide rates have been well documented. In the United States, the rates of killing are much higher than in many industrialized nations, exceeding those

in the United Kingdom and Japan by a factor of ten; exceeding those in France, Austria, Sweden, and Germany by a factor of nine; and exceeding the rates in Canada, Italy, Portugal, Korea, and Belgium by a factor of five. But, the homicide rates in many other countries are equivalent to or exceed those in the United States. The lifetime probability of being a homicide victim in Venezuela and Moldova is 1 in 90, twice that of the United States. In Estonia and Puerto Rico, the likelihood is 1 in 60, three times that of the United States. And in Colombia and South Africa, the likelihood is greater than 1 in 20 that a person will die at the hands of a killer, more than ten times the lifetime homicide risk in the United States. Even among those nations that currently exhibit low homicide rates, much higher frequencies of conspecific killing were a consistent part of their histories. Historical evidence suggests that the relatively low homicide rates in many modern societies are a recent phenomenon. It should also be noted that the rates of homicide recorded by nations typically do not include casualties of warfare or genocide.

The homicide rates in industrialized nations pale in comparison to the risk of being killed by a competitor in many preindustrial cultures. Including deaths resulting from lethal raids and tribal warfare, homicides account for roughly one in ten deaths of adult men among the Huli, one in four deaths among the Mae Enga, and one in three deaths among the Dugum Dani and Yanomamo. Even among the so-called gentle people or peaceful Kung San of Botswana, there were 22 homicides over a 25-year period in a population of 1500, more than four times the rate of killing in a typical year in the United States.

Theories of Homicide

Despite the fact that tens of thousands of homicides are committed worldwide every year, lethal violence is not well understood. For our understanding of homicide to be complete, we must explain, for example: (1) why men are vastly overrepresented among killers (87%); (2) why men are also overrepresented among murder victims (75%); (3) why women commit some kinds of homicide more than men (e.g., infanticide of own children); (4) why people kill in qualitatively distinct conditions, leading to predictable motives for killing; and (5) why people experience homicidal fantasies in circumstances that correspond closely to the contexts in which people actually kill.

The majority of theories that have been used to explain homicide were not designed specifically for that purpose. They are general theories of behavior, all crimes, or all violent crimes. Different theories of homicide need not be competing. They often address different levels of explanation and are often complementary, capable of contributing unique insights into the explanation of why people kill.

Homicide Adaptation Theory

Dr. David Buss from the University of Texas and Dr. Joshua Duntley from Richard Stockton College have proposed a theory that humans possess adaptations designed for killing conspecifics. Psychological adaptations for homicide are

argued to be the outcome of the process of natural selection. Over human evolutionary history, they were favored by selection when they contributed better solutions to adaptive problems, on average, than competing designs. Information processing adaptations evolved to scrutinize and sometimes produce homicidal behavior in adaptive problem contexts similar to those recurrently solvable by homicide in the ancestral past. Although some have suggested the possibility of adaptations for homicide and others have argued that humans may have an instinct to kill, few other theorists have gone into depth in exploring the evolved design of adaptations for homicide.

Dr. David Buss and Dr. Joshua Duntley hypothesize that homicide was functional in solving a wide variety of adaptive problems. Specifically, the killing of a conspecific could have contributed to: (a) preventing the exploitation, injury, rape, or killing of self, kin, mates, and coalitional allies by conspecifics in the present and future; (b) reputation management against being perceived as easily exploited, injured, raped, or killed by conspecifics; (c) protecting resources, territory, shelter, and food from competitors; (d) eliminating resource-absorbing or costly individuals who are not genetically related (e.g., stepchildren); and (e) eliminating genetic relatives who interfere with investment in other vehicles better able to translate the investment into genetic fitness (e.g., deformed infants, the chronically ill, or infirm).

Homicide is such a unique and potentially powerful strategy with dramatic fitness consequences for both the perpetrator and the victim that it is reasonable to hypothesize that it has been subjected to evolution by natural and sexual selection. Homicide is different from other strategies for inflicting costs because it leads to the absolute end of direct competition between two individuals. The person who is killed can no longer compete with his killer. A dead competitor can no longer directly influence the environment or social context that he shared with his killer. The distinct outcomes of homicide would have created equally unique selection pressures to shape human psychology specifically for contexts of homicide.

Adaptations for homicide would be more likely to evolve when they reliably contributed to the solution of an adaptive problem with a high impact on individual fitness, such as preventing a rival from killing one's child. Adaptations for homicide also would be more likely to evolve when a large number of different adaptive problems could be solved, or at least partially solved, by adopting a homicidal strategy. Consider, for example, the intrasexual rival of a man who was preventing his ascension in a status hierarchy, attempting to poach away the man's mate, monopolizing a scarce and valuable shelter as winter approaches, and who took every opportunity to publicly humiliate the man's brother. Killing the rival has the potential to contribute to the solution of each of these adaptive problems.

Different ancestral problems required different specific solutions. Homicide adaptation theory proposes that there are multiple, different psychological adaptations for homicide, each of which is devoted to the solution of different kinds of adaptive problems. It follows that the psychological design that produces infanticide is distinct from the psychological design for warfare and the psychological design that produces mate homicide in men is distinct from the psychological design for mate killing in women. Some information

processing mechanisms are undoubtedly shared between the different adaptations for homicide and with adaptations for the solution of other adaptive problems. Selection would favor the sharing of subroutines performing the same function over reinventing them anew for each psychological adaptation. However, any given adaptation for homicide has at least one design feature that is distinct from other adaptations. Homicide adaptation theory, in short, proposes that selection has fashioned a number of specialized psychological adaptations that produce conspecific killing in order to solve distinct and historically recurrent adaptive problems.

Homicide adaptation theory is a coevolutionary theory. Just as killers obtained large ancestral benefits from the use of homicide in some contexts, victims and their genetic kin suffered extraordinary costs. The costs of being killed by a conspecific are hypothesized to have created selection pressure for the evolution of defenses against homicide and to adaptations in victims' genetic kin to prevent relatives' untimely deaths or otherwise minimize their costs. The evolution of defenses against lethal aggression would have created new selection pressure on adaptations for homicide, shaping new design features capable of bypassing victims' defenses. This coevolutionary arms race between homicide adaptations and victim defenses is hypothesized to have contributed to rapid evolutionary change and elaborate design in both.

Homicide adaptation theory proposes that there were specific combinations of adaptive problems individuals recurrently faced in the evolutionary past that would have been best solved by killing. Selection would have favored individuals who possessed the psychological adaptations that reliably led to the production of homicidal behavior when they faced such contexts. The best solution to most adaptive problem contexts faced by our ancestors did not involve homicide. However, the potential fitness gains accomplished by the use of killing to solve a small, specific set of adaptive problems would have selected for psychological adaptations that produce conspecific killing.

Homicide adaptation theory argues that the psychological mechanisms that produce homicide steer an individual in the direction of adaptive behaviors that reliably result in the death of another individual. This is accomplished through a variety of affective, motivational, and computational systems that narrow in on homicide as the solution to adaptive problems. The adaptive problems to which we are referring are fluid, changing as they unfold over time. As other individuals pursue their own goals, the nature of adaptive problems changes and the solution to one set of adaptive problems may reliably create others. Rather than evolving in response to a single, static set of circumstances, homicide adaptations were shaped by the ancestrally reliable unfolding of adaptive problems.

Homicide adaptation theory does *not* imply that homicide will be the *preferred* strategy for each or any adaptive problem in all situations. In most circumstances, the high costs of committing homicide would have outweighed its benefits. Instead, the theory proposes that homicidal behavior was the best solution for rare combinations of adaptive problems and circumstances. It is not possible to point to just one feature of a context that will activate a psychology of homicide in every instance, in every person. There are always other, mitigating environmental factors, heritable personality features,

hormonal influences, and the developmental and experiential calibration of psychological mechanisms that influence behavior. Many or all of these features were part of the selection pressures that shaped homicide adaptations. Thus, a combination of external cues to the presence of an adaptive problem ancestrally solvable by conspecific killing and internal psychological states that make lethal violence an adaptive option activate homicide adaptations. The presence of these cues and psychological states, as well as their magnitude, can help us to predict when conspecific killing will be more or less likely to occur. Without complete knowledge of how human psychology produces homicidal behavior, however, it is not possible to make perfect predictions about whether homicide will occur in an individual case. The same is true of making predictions about any behavior.

In sum, homicide adaptation theory proposes a new explanation of homicide: Over the long expanse of human history, there were recurrent sources of conflict between individuals, such as conflict over reputation and social status, conflict over resources, and conflict over romantic partners. Killing is hypothesized to be one among an arsenal of context-contingent strategies shaped by natural selection to win conflicts with others. Homicide differs qualitatively from nonlethal solutions to conflict. Once dead, a person can no longer damage the killer's reputation, steal his resources, prevent the killer from attracting a romantic partner, hurt the killer's genetic relatives, or have sex with the killer's spouse. According to homicide adaptation theory, our evolutionary heritage has endowed all of us with a psychology to kill others. These psychological processes lead us to entertain fantasies of killing and, in rare instances, act on them when we encounter sources of conflict that were successfully won by homicide in the evolutionary past.

Cultural and Social Theories

Cultural and social explanations of homicide rely on the fundamental principles of learning theory. These explanations propose that learning from the social environment is responsible for differences in homicide rates between groups, including differences in men's and women's propensities to kill. The specific environmental source identified as the causal force behind lethal aggression differs from one explanation to another. For example, some theorists suggest disorganized communities lead to crime, others argue that crime is learned through differential association with deviant peers, while others argue that the gap between desires for a better lifestyle and lack of legitimate means to fulfill them creates strain that fuels crime. Each of these theories argues that homicide is the product of learning by normal people.

A core assumption of social theories that lead them to predict men should be more likely to commit homicide than women is that observing violence in the world causes violent behavior. Because humans observe more instances of men perpetrating violent acts in life and in the media, the theories argue men are more likely than women to engage in similar behaviors. The causal arrow linking violence in the world to the violent behavior of individuals, however, need not run in this direction. For example, evidence shows that boys preferentially seek out violent toys and media images. When parents

encourage their boys to be tough and their girls to be gentle, they may be responding to existing predispositions in each sex. Popular media may target boys with more violent programming than girls to exploit desires each sex already has.

The imitation of violence in the media is also limited in its explanatory power as a causative influence of homicide because it cannot explain evidence of killing in the distant past. Evidence of lethal violence appears in the archaeological record as early as the Paleolithic, between 20,000 and 30,000 years ago. Researchers have found skeletal remains in Europe and Egypt that show projectile points embedded in bone and depressed fractures on skulls, indicating blunt force trauma. Most cranial fractures have been found on the left side of the skulls, suggesting they were made by a right-handed attacker in face-to-face combat.

In sum, cultural and social theories of homicide propose that the process of learning from the social environment is responsible for differences in homicide rates between cultures and differences in men's and women's propensity to kill. Cultures of honor valorize violence as a solution to interpersonal disputes, and violence is socially encouraged in male children but discouraged in female children. Learning is undoubtedly important for the adaptive calibration and activation of adaptations that produce lethal violence and the pursuit of homicidal strategies, accounting for some of the variance in why people kill. However, cultural and learning theories in their present form are too general to generate specific hypotheses about how experience affects psychological processes involved in producing homicide differently from psychological processes involved in addressing other domains of human experience, such as mating relationships and food preferences. The addition of an evolutionary perspective to the study of how social and cultural processes affect individuals' psychology of homicide has great potential to suggest fruitful directions for future research and may help to account for many observed patterns of homicide (e.g., infanticide perpetrated primarily by young mothers). This would allow novel, specific predictions to be generated about trends in homicide that may be the function of different social environments and help to explain why people sometimes commit homicide instead of doing something else.

Pathology Theories

Pathology theories of homicide propose that people kill when their thinking is abnormal. The causes of cognitive malfunctions vary, as do the forms of abnormal cognition they produce.

A prospective study of major mental disorders and criminality conducted using a birth cohort in Northern Finland found that violent offenses were most prevalent among males with alcohol-induced psychoses or schizophrenic alcohol users. Those suffering from depression were least likely to kill. Research conducted in Australia found a similar trend in the disorders that are most common among killers, which also include bipolar disorder, psychopathy, dissociative identity disorder, and unipolar mania. In both studies, people with mental illness were found to be more likely than people not suffering from a disorder to kill members of their families. Proximity theory, which argues that people are most likely to

kill those with whom they interact the most, has long been dismissed as an explanation for homicide, but may be somewhat compatible with the trends in homicide apparent among the mentally ill.

Suboptimal arousal theory is based on the observation that some people have a preference for intense environmental stimulation. Those who feel most starved for arousal are presumed to be more likely to engage in highly arousing thrill-seeking and risk-taking activities. Criminal behaviors, including homicide, may be committed more often by those who are suboptimally aroused.

Seizuring theories of crime are based on research into the causes of epilepsy. Not all seizures lead to convulsions. If subconvulsive seizures are located in the limbic system, they may have significant effects on emotions, sometimes resulting in criminal behavior.

Other pathology explanations have argued that failure of the frontal lobes to function properly may disinhibit violent behavior. Frontal lobe damage is associated with increased impulsivity and lack of planning ability that may contribute to some homicides.

Another pathology theory is rooted in the observation that one male out of every 700–1000 is born with an extra Y-chromosome, and one male out of every 500 is born with an extra X-chromosome. Both genetic abnormalities result in males who score lower on standard intelligence tests and show an increased likelihood of criminal behavior, including lethal aggression. However, these genetic abnormalities are likely to explain only a tiny fraction of the homicides committed, since males with an extra chromosome only constitute 1–2% of the total prison population.

The percentage of all homicides that can be attributed to psychopathology in a particular region appears to be linked to the homicide rate. Where homicide is rare, a higher proportion of killings are committed by people suffering from disorders such as schizophrenia. Where homicide is more frequent, a smaller percentage of killers are identified as suffering from major psychopathology. For example, studies of the perpetrators of homicide in Britain found that 39% of killers suffered from a mental disorder. In Sweden, 53% of killers were found to be mentally ill, as were 35% of Canadian killers. Britain, Sweden, and Canada have some of the lowest homicide rates in the world. In contrast, only 19% of killers in New York City, 4.4% of killers in Detroit, and 4.4% of homicidal offenders in Australia were found to suffer from mental illness.

In sum, there is evidence that psychopathology is a contributing factor in some (albeit a minority of) homicides and that these killers are more likely to manifest symptoms of mental disease, such as targeting genetic relatives. This does not mean, however, that psychopathology is the sole cause of such homicides. Psychopathology and probably most individual differences do not add additional information-processing capabilities to human psychological adaptations. Sources of individual differences more likely distort cognitive adaptations, perhaps occasionally affecting the likelihood that a person will kill. An individual with schizophrenia who has delusions that his mother is an extraterrestrial who has plans to eliminate all of humanity, for example, is clearly delusional. Despite errors beliefs and interpreting input from the environment, the activation of psychological mechanisms to produce

homicide may be appropriate and adaptive if indeed his mother were an extraterrestrial. It is difficult to kill someone. The production of a sequence of behaviors capable of successfully ending another person's life requires a large number of calculations that cognitive system errors, by themselves, would be incapable of producing. One reasonable hypothesis is that psychopathology leads to the inappropriate activation of psychological mechanisms capable of producing successful homicidal behavior. A challenge for future research is the identification of how, specifically, different forms of psychopathology influence and activate the psychological processes that produce homicide.

Individual Differences Theories

Individual differences in personality may also lead to the differential activation of cognitive mechanisms that produce homicide in other ways. Personality leads people to experience the same environments differently, seek out different environments, and be excluded from a certain subset of social environments. People with personalities that lead them to occupy environments characterized by high levels of interpersonal conflict may be more likely to encounter contexts that predictably lead to lethal aggression. For example, people who score high on measures of antisocial personality, low in conscientiousness, high in neuroticism, and low in intelligence are more likely to engage in criminal activities, including homicide.

Another group of explanations for killing propose that individual differences may make homicide more adaptive for some people in terms of evolutionary fitness. Cheater theory argues that two, alternative reproductive strategies have evolved in human males. One type of male (Dads) is law-abiding and loyal to women. Male cheaters (Cads), on the other hand, are argued to adopt strategies of criminality, including homicide in order to obtain resources and short-term mates.

Dr. David Rowe's alternative adaptation theory points out that criminals typically devote more effort to mating than they do to parenting. Rowe argues that criminality is a strategy that can only thrive when there are others to exploit. As the number of criminals in a population increases, the effectiveness of criminal strategies like homicide will decrease.

Conditional adaptation theory (CAT) attempts to integrate adaptive individual difference theories and learning theories. It proposes that everyone has the same genetic potential to exhibit criminal behavior at birth. Early life experiences cause individuals' potentials to change. Children who witness poor, unstable relationships between their genetic parents and live in relatively resource-scarce environments are argued to be more likely to adopt short-term, opportunistic mating strategies as adults and riskier strategies for obtaining resources, including theft, violence, and lethal aggression.

Individual difference factors may interact with evolved psychological mechanisms for homicide to produce a decreased threshold for conspecific killing by leading to the inappropriate activation of adaptations for homicide. The mistaken activation of adaptations that lead to lethal aggression may have several sources, including (a) the presence of evolutionarily novel stimuli in modern environments that 'trick' homicide adaptations into recognizing a problem as potentially solvable by killing when it is not; (b) errors in the mechanisms that

weigh the costs and benefits of homicide, leading to the underestimation of costs, the overestimation of benefits, or both; and (c) a failure of some mechanisms that are necessary for the normal functioning of homicide adaptations to activate, leading to incomplete processing and the erroneous motivation of homicidal behaviors. In each of these cases, the majority of evolved mechanisms for homicide continue to function as they were designed. Thus, despite systematic errors at certain levels of cognitive processing, a complete explanation of killing others that is partially the result of inappropriate activation of homicide mechanisms must include an analysis of the evolved mechanisms involved. While the preceding individual difference theories suggest that lethal aggression may have been adaptive for some individuals in the ancestral past, other explanations propose that homicide was never adaptive.

The By-product Hypothesis

Over the past few decades, several evolutionary scientists have offered explanations for homicide. Almost without exception, however, the evolutionary hypotheses posit killing as unnatural and not part of our evolved psychology. The ethologist Eibl-Eibesfeldt, for example, proposed that killing (e.g., in war) is a culturally imposed behavior that overrides an innate human inhibition to kill. Killing, according to this view, is a cultural aberration and in no way part of human evolved psychology. This explanation leads to no detailed predictions about the various forms of homicide or about the contexts in which they occur.

The most comprehensive evolutionary explanation specifically advanced to account for patterns of homicide to date was proposed by Daly and Wilson, who have made pioneering contributions to our understanding of homicide and the contexts in which it occurs. They advance two distinct arguments about homicide. In the first argument, Daly and Wilson are agnostic about whether there are adaptations designed to produce homicide, "...our evolutionary psychological approach in no way depends upon homicide per se being 'an adaptation.' It may or may not be the case that actual killing was a regular component of the selective events that shaped human passions".

Daly & Wilson also advance the view that humans do not have an evolved psychology of homicide. Rather, they propose that homicides can be viewed as "dysfunctionally extreme byproducts," "epiphenomena", or "overreactive mistakes" of evolved mechanisms designed for their non-lethal outcomes. According to this argument, "It is quite possible that actually killing one's antagonist is more often than not an overreactive mistake—an act with negative consequences both for the killer's net hedonic utility and for the actual expected fitness of which that utility is an evolved token." These arguments illustrate that Daly and Wilson explicitly are not proposing that humans have evolved distinct adaptations for homicide, although they do not rule out the possibility completely.

Although Daly, Wilson, and colleagues do not propose that humans have evolved psychological mechanisms specialized for killing, they do emphasize the importance and priority of an evolutionary psychological explanatory account: "...what is needed is a Darwinian psychology that uses evolutionary ideas as a metatheory for the postulation of cognitive/emotional/motivational mechanisms and strategies." Daly and Wilson

must be correct that at least some homicides are byproducts of the operation of evolved mechanisms designed for non-lethal outcomes, such as coercion and control. Homicide Adaptation Theory, in contrast, would argue that these represent a minority of killings. David Buss, Joshua Duntley, and other Homicide Adaptation Theorists argue that most killings are better explained as the designed products of adaptations selected specifically for their lethal outcomes.

In sum, nonadaptationist explanations of homicide may be able to predict some variance in who is likely to become a criminal and to identify some broad features of contexts that may trigger criminal behavior. When considered individually, they all share similar weaknesses, which include (a) a failure to provide a comprehensive explanation of the patterns of homicide; (b) not making predictions about when homicide, instead of some other criminal behavior, is likely to occur; (c) not offering explanations for a large number of the observed patterns of homicide; (d) not specifying whether homicide is a kind of criminal behavior that could have ever been adaptive during our evolutionary history; (e) failure to provide an explanation for why people who are not pursuing a general strategy of criminality would ever commit homicide; (f) an inability to explain why the majority of normal people report experiencing homicidal fantasies; and (g) failure to explain the patterns of people's homicidal fantasies.

Detering Homicide

The two major debates in the problem of deterring lethal aggression today concern the effectiveness of capital punishment and gun control.

The Role of the Death Penalty

Research on the effectiveness of the death penalty at the societal level has been conducted by economists who have applied sophisticated statistical techniques to the problem, both over time (from year to year) and across regions (from state to state). However, the results of the research are conflicting and any conclusion by a reviewer of the research may be colored by the reviewer's own opinion. A cautious conclusion must be that the deterrent effect has not yet been proved.

An alternative methodology has been to explore the number of homicides committed in the days following an execution. A meta-analysis of numerous studies has supported the deterrent effect of executions on subsequent homicide rates. However, the researchers who conducted the meta-analysis cautioned that the effect depended on the type of study carried out and the effects of publicity.

Other researchers conducted a study of the deterrent effect of the death penalty in Texas, where the death penalty is used frequently enough to generate stable estimates of whether homicide rates respond to executions. They found small, short-term reductions in homicides in the first and fourth months following executions, amounting to 2.5 fewer killings. However, the researchers argued that the executions may have functioned merely to displace homicides from one month to another, which reduces the lives saved to 0.5 in the year after an execution.

The Role of Guns

Advocates of gun control often argue that limiting people's access to firearms would prevent violent crime and, in particular, homicide. Testing this assumption in the United States is problematic because gun control is quite weak by the standards of other nations where guns are rarely owned by private citizens. Tests of the effectiveness of the introduction of gun control laws have been conducted in other countries. For example, Australia introduced strict gun laws in 1997 in response to a mass shooting in Port Arthur, Tasmania in 1996, where 35 people were killed. Some researchers have concluded that the law has led to a decrease in homicide rates, while others using the same data have argued that the law did not have any significant effects on reducing firearm homicide. More research is needed on this important topic.

See also: Aggression; Evolutionary Psychology; Mate Selection; Violence.

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Hope and Optimism

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Glossary

Hope A positive feeling and motivational state, which arises from the beliefs that one has the agency (i.e., energy) and pathways (i.e., behavioral means) required to attain one's goals.

Optimism The extent to which individuals expect desired outcomes to happen in the future, and expect undesired outcomes not to happen.

Hope and optimism are hallmarks of psychological health. Both terms have been used in common language for centuries to describe people who hold positive expectations about the future. Modern research shows that such people, in contrast with those who hold negative expectations, engage in a variety of coordinated, adaptive responses to the challenges and opportunities they encounter in life. The study of hope and optimism also reveals key themes in the development of psychology over the past 30 years, including our grasp of (a) the centrality of *goal-strivings* to human behavior, (b) how people's understanding of the *causal structure* of life events is related to their subsequent emotions and motivation, and (c) factors contributing to the *positive* range of human experience, including physical and psychological health beyond the absence of illness.

In this article, our principal aim is to review the definitions, leading standardized measures, and adaptive consequences of hope and optimism. Following these topics, we review ongoing research into the possible risks of hope and optimism, including the misperception of personal risks and failure to disengage from unattainable goals. We conclude with some general observations about the realistic or unrealistic nature and value of positive future expectations. As a caveat, we note that our review is couched in a modern and Western perspective on hope and optimism. In our estimation, the available literature on hope and optimism offers few definite statements about historical or cross-cultural variability in these concepts, but cross-cultural research in this general area of psychology (i.e., including related topics, such as attributions, perceived control, and mindfulness) holds some implications that may be fruitful to pursue with respect to hope and optimism. In particular, it appears likely that people in different cultures and historical eras have used substantially different cognitive mechanisms or strategies in order to attain and maintain positive future expectations. Once attained, however, the adaptive consequences of these expectations may be a universal feature. These consequences, with respect to striving and well-being, have been confirmed in research spanning different cultures and even different species.

Definitions

Hope and optimism both involve positive expectations about the future, but only optimism is defined strictly in these terms.

Optimism is the extent to which individuals expect desired outcomes to happen in the future, and expect undesired outcomes not to happen. As individuals drop in their expectation of desired outcomes and gain in their expectation of undesired ones, they move from the positive pole, optimism, to the negative pole, pessimism. Optimism has most often been conceived as a character trait or strength, which people possess in varying degrees. As such, it is a relatively enduring and beneficial aspect of how individuals approach a wide range of situations. The term 'optimistic' has also been used to describe specific perceptions (e.g., of low risk) or self-evaluations (e.g., of high ability) that are overly positive or inflated in comparison with objective standards. Although such perceptions may be unrealistic, they can soothe people's worries and doubts in a difficult situation, and encourage continued striving toward goals.

Like optimism, hope is a positive feeling and motivational state, but one that intrinsically involves beliefs about the self and one's own actions as they relate to the attainment of desired outcomes. These beliefs, as articulated in Snyder's influential theory of hope, include a successful sense of *agency*, which refers to the energy required to attain goals, and *pathways*, which refers to the means of attaining goals. Hope is also typically regarded as a stable individual difference. People with high hope, as opposed to those with low hope, more often think about different routes to their goals, more fully specify these alternate routes, and more frequently tell themselves that they can and will accomplish their goals.

As with other personality traits, hope and optimism emerge from a combination of genetic and environmental influences, as well as cultural and historical ones, operating over the lifespan. Indeed, each of the broad dimensions of temperament that can be observed in infancy or childhood, and that have a probable biological basis, may set the stage for hope and optimism in adulthood. A child's temperament describes the way he or she notices and reacts to changes in his or her external environment or internal state. The broad dimensions of such reactions include negative affectivity (i.e., fear, anger, sadness, ease of being soothed from distress), effortful control (i.e., planning, capacity to focus or shift attention), and extraversion or surgency (i.e., activity level, excitement, lack of inhibition, affiliation). A child who exhibits a high capacity for effortful control may have an easier time than one with lower capacity in forming the experiential basis for beliefs about high agency and pathways, which are essential to hope. A child who exhibits high negative affectivity may have correspondingly

more frequent experiences of events not working out to his or her liking, and by generalizing these experiences may tend toward pessimism.

An interesting case of temperamental bias is related to extraversion/surgency, or the way infants react to unfamiliar stimuli with either an inhibited or an uninhibited behavioral profile. Infants with the inhibited profile show distress in response to unfamiliar people, places, objects, sensations, or events, whereas infants with the uninhibited profile show a relatively bold or spontaneous approach to the same sort of experiences. Research by Kagan and colleagues has shown the preservation of these inhibited or uninhibited reactions to unfamiliarity from as early as 16 weeks after a normal term birth to the age of 17 years. Although there may be no simple mapping between these infant temperaments and adult traits of hope and optimism, people's reactions to unfamiliarity throughout their childhood and youth will still shape their adult personality development in terms of how they view the future or the unknown. Whereas some hopeful or optimistic adults will have had a high tolerance for unfamiliarity and uncertainty throughout their lives, others will have arrived at being hopeful or optimistic by nurturing self-views or world-views that reduce their fear of the unknown.

Leading Standardized Measures

Research on hope and optimism has benefited from the development of self-report measures that corresponded closely with the theoretical elaboration of each concept. We review three of the leading measures here: that is, the Life Orientation Test (LOT), the Attributional Style Questionnaire (ASQ), and trait and state versions of the Hope Scale.

Dispositional Optimism and the Life Orientation Test

Scheier and Carver developed the LOT to measure dispositional optimism, a concept that figured prominently in their overarching theory of self-control. The theory assumed that most if not all of people's actions are goal-directed, and that people's emotional balance had much to do with the success or failure of their goal pursuits. The role of dispositional optimism could be seen in the self-control theory's formulation of goal strength as the product of two factors: the degree to which an outcome was expected, and the degree to which it was valued or desired. A logical implication was that people with generally higher expectations – that is, optimists – would have generally stronger goals, leading in turn to greater persistence, faster progress, more positive affect, and less negative affect.

In line with this major implication of their theory, Scheier and Carver coined the term *dispositional optimism* and developed the LOT so as to capture individual differences in positive expectations that were tied, not to a specific pursuit, but to the occurrence of good outcomes in general. The LOT, in its revised form, consists of ten self-statements with which respondents can agree or disagree, to varying degrees, using a 0–4 numerical rating scale. Eight of the statements refer to the likelihood of good or bad outcomes and thus contribute directly or inversely to the total score: for example, 'In uncertain times, I usually

expect the best,' or 'If something can go wrong for me, it will.' The remaining two statements are fillers that reduce the salience to respondents of the concept being measured.

This method of scaling lends itself to psychometric testing. Such testing typically examines the agreement or internal consistency of responding across items, temporal stability of the rank-ordering and separation of individuals' total scores, and correlation of these scores with relevant outcomes and other optimism measures. In a noteworthy example, Scheier and colleagues showed that scores on the LOT predicted depression, even in partial correlation analyses that controlled for individual differences in neuroticism, trait anxiety, self-mastery, and self-esteem. This finding suggests that optimism has unique features that are related to psychological adaptation, beyond those that may be shared with these other characteristics, and also that scores on the LOT indeed reflect these unique features of optimism.

Learned Optimism and the Attributional Style Questionnaire

Another approach to the definition and measurement of optimism grew out of research on explanatory style and the learned helplessness model of depression. An individual's explanatory style refers to the way in which he or she usually engages in explaining life events, by attributing them to an underlying cause. Weiner first introduced the idea that these attributions can be arrayed on several dimensions. The first dimension is *internality*: internal causes originate from within oneself or are subject to personal control, whereas external causes originate with other people or circumstances. The second dimension is *stability*: stable causes are durable and unlikely to change, whereas unstable causes are temporary and likely to change. The third dimension is *globality*: global causes influence all or a wide range of personal endeavors, whereas specific causes influence an isolated or narrow range.

Informed by this dimensional analysis, Abramson, Seligman, and Teasdale realized the potency of certain attributions to account for learned helplessness – a phenomenon previously observed in learning experiments, which seemed to provide a model for depression. Learned helplessness is a motivational deficit that occurs as a result of exposure to painful or noxious stimuli that are also inescapable. The deficit becomes apparent at a later time, when escape is possible, but it goes undetected because the individual ceases to try. What Abramson and colleagues realized was the parallel implication of attributing a negative life event to an underlying cause that was internal (i.e., 'it's my fault this happened'), stable (i.e., 'it's something about me that will never change'), and global (i.e., 'it's going to affect everything I try to do'). In the wake of this type of attribution, it is understandable that one might lose motivation. The flipside of this argument, however, is that making an external, unstable, and specific attribution for the same event would tend to curtail or counteract the motivational loss. Seligman coined the term *learned optimism* to describe this route out of depression, whereby setbacks became the occasions for learning that better outcomes lay ahead.

Research on explanatory style produced a self-report measure, the ASQ, which quantifies individuals' proneness to learned helplessness on one hand, or optimism on the other. The ASQ presents respondents with 12 hypothetical events,

such as searching unsuccessfully for a job, or being treated lovingly by a spouse or a significant other. The 12 events are balanced in referring to good or bad outcomes, in either the achievement or affiliation domains. For each event, respondents write down one major cause. They then rate the cause on each of the three attributional dimensions, using 1–7 numerical rating scales. These ratings are summed across good or bad events, such that higher ratings in the direction of greater internality, stability, or globality contribute directly to the total score. In support of the reliability and validity of these scores, Peterson and colleagues demonstrated the internal consistency and temporal stability of dimensional ratings for good and bad events, and discussed additional evidence that ASQ scores predicted respondents' attributions for specific events at a later time, as well as depressive symptoms.

Hope and the Hope Scale

According to Snyder's theory, hope is a two-dimensional concept, which manifests itself in a person's beliefs about successful agency and pathways to attain goals. The Hope Scale reflects this theoretical structure, being composed of four items on successful agency, four items on successful pathways, and four filler items. The agency items refer to goal pursuit in the past, present, and future: for example, 'I've been pretty successful in life,' 'I energetically pursue my goals,' and 'My past experiences have prepared me well for my future.' The pathways items refer to overcoming obstacles to goal pursuit: for example, 'I can think of many ways to get out of a jam,' or 'I can think of many ways to get the things in life that are most important to me.' Each item is answered using a 1–4 rating scale from 'Definitely False' to 'Definitely True.' Snyder and colleagues introduced the Hope Scale with substantial psychometric evidence from diverse samples consisting of college students and patients in a state mental hospital. This evidence consistently supported a two-factor structure and convergent validity with respect to optimism, desire for control, self-esteem, hopelessness as a symptom of depression, and other clinical symptoms.

The Hope Scale, as described above, is a *trait* measure. However, soon after, Snyder and colleagues introduced a 6-item *State* Hope Scale. The state scale was intended to capture the additional variability in hope, around an individual's dispositional set-point, which he or she might experience in connection with current goals and problems. The State Hope Scale consists of three items on successful agency and three on successful pathways, which were formed by modifying the contents of the dispositional scale to refer to the present moment. Thus, the original item, 'I energetically pursue my goals,' was changed to, 'At the present time, I am energetically pursuing my goals.' Snyder and colleagues showed that scores on the State Hope Scale were positively correlated with those on the trait Hope Scale, and with other state measures of mood and self-esteem. In an experimental test, participants completed the State Hope Scale both before and after they had engaged in a relaxation and guided visualization exercise. As part of this exercise, participants were randomly assigned to recall vividly a time when they either succeeded or failed to reach an important goal. Both agency and pathways subscores of the State Hope Scale changed significantly, such that

participants who visualized a past success gained hope, whereas those who visualized a past failure lost hope for their current goals.

Adaptive Consequences

A vast literature now attests to the adaptive consequences of hope and optimism. Indeed, despite carefully reasoned arguments and substantial research effort, it has been hard to find contexts in which these traits do not have adaptive effects. In reviewing this literature, it is useful to note that just two broad categories of adaptive outcomes follow directly from the theory of hope and optimism as positive motivational states. These categories are (a) effort and persistence at goal-directed tasks, and (b) positive and negative feelings that arise from ongoing goal pursuits. Other broad categories, which have emerged as extensions of research on the initial two, include (c) the use of adaptive coping strategies, and (d) positive physical and psychological health outcomes related to the length and quality of people's lives. We review these categories, in turn, in this section. In each case, although we may rely on research illustrations that are specific to hope or optimism, the adaptive consequences are applicable to both concepts.

Effort and Persistence

The willingness to keep trying in the face of problems or setbacks is a defining quality of both hope and optimism. Accordingly, numerous studies of hope and optimism have shown this behavioral outcome, covering a wide range of goal domains and settings. In the case of optimism, we review some relevant examples in the sections on health and risk perception below.

In the case of hope, Snyder and colleagues provided a clear experimental demonstration when they asked college students (all of whom had previously completed the trait Hope Scale) to imagine themselves in an introductory college course, in a field that might eventually be their major, having set the goal of receiving at least a B grade in the course. In one condition, participants imagined only this much, whereas in the other condition they further imagined receiving a poor grade on the first exam. After thus imagining either no feedback or negative feedback, all participants answered questions about the effort they would exert to reach their goal of a B grade. They also listed specific strategies they would use, rating each strategy as to the likelihood that they would use it and the certainty that it would work. Among participants with low pretest scores on the Hope Scale, both indicators of effort and persistence were significantly lower in the negative-grade feedback than in the no-feedback condition. However, among participants with high pretest scores on the trait Hope Scale, there were no significant differences on either indicator of effort and persistence between the two feedback conditions. Thus, these hopeful participants were apparently unfazed by the imagined setback of a negative grade.

Extending this research from a hypothetical scenario to real life, Snyder and colleagues conducted a related study of achievement in an actual college course. Students' performance (final course grade) was used as an indicator of their effort

and persistence after the first exam. Hope scores at the start of the term reliably predicted final course grades, even after statistically controlling for students' grades on the first exam. Thus, the positive effect of hope on final course grades occurred, regardless of the initial feedback, the ability level of the students, and the many other factors that might lead some students to do well and others poorly on a given test. As the results of the earlier study would also imply, it appeared that students with higher hope consistently tried harder than their counterparts with lower hope, and thus attained a better average performance in the remainder of the course.

Positive and Negative Feelings

When people expect positive outcomes, they are apt to feel relatively good about their current situation, even if it is a challenging one. To begin with, negative feelings will be lower: that is, the challenging aspects of a situation will be less frustrating, distressing, and depressing to individuals who expect things to work out alright in the end, as compared with those who hold negative expectations. Furthermore, positive feelings will be higher: that is, by maintaining effort and persistence, hopeful and optimistic individuals will increase their chances of ultimately reaching their goals and will have the positive feelings such as happiness, interest, and enthusiasm that come with each step of progress along the way.

In line with these predictions, numerous studies have linked optimism to the absence of distress and depression in samples facing a variety of stressors: for example, students entering university, caregivers to people with a major illness or disability, terror/trauma survivors, new parents, couples facing infertility, surgical patients, patients with progressive diseases such as cancer or AIDS, or older adults experiencing falls. Hope has also been linked to psychological adjustment in challenging settings or circumstances of academics, physical health, sport, interpersonal relationships, and psychotherapy, among others. Indeed, in one study, trait hope scores were related to the positive and negative feelings participants had about their goals of the next 6 months, when these feelings were summed across the goals that participants had generated for four broad life domains: work and school, primary family life, intimate relationships, and personal changes or development.

Coping with Problems

To say that people who are hopeful and optimistic tend to redouble their efforts and maintain a favorable affective balance when confronted with stressors further suggests that these individuals have effective ways of coping with problems. One aim of Scheier and colleagues' work on the LOT was to clarify the relationship between dispositional optimism and specific coping strategies. Thus, in addition to optimism and depression, this research involving large samples of university undergraduates as respondents concurrently assessed on coping strategies of planning, suppression of competing activities, seeking of social support, positive reinterpretation, using humor, turning to religion, acceptance, denial, venting emotions, behavioral and mental disengagement, and use of drugs or alcohol, among others. Dispositional optimism correlated significantly with the self-reported frequency of use of

all of the strategies that were measured in this research. The direction of these correlations suggested both greater use of effective strategies such as planning or positive reinterpretation, and lesser use of questionable strategies such as denial or drug/alcohol use, by individuals higher as opposed to lower in dispositional optimism.

As the length and variety of the foregoing list implies, coping is complex. People engage in many different behaviors for the purpose of coping with problems, and many typologies and theories have been advanced to explain the coping process. However, two broad dimensions of coping that are commonly agreed upon are (a) whether coping behaviors or strategies are oriented toward solving problems versus soothing distressed emotions, and (b) whether they are oriented toward approaching problems versus escaping from or avoiding them.

Solberg Nes and Segerstrom performed a meta-analytic review of 50 studies on optimism and coping, in which the strategies were cross-classified according to both of these dimensions. A key finding from the meta-analysis was that optimism related positively to both problem- and emotion-focused coping strategies that had an approach orientation, and negatively to both problem- and emotion-focused strategies that had an avoidance orientation. This finding is important, not only because it revises previous thinking about the relationship of optimism to each dimension of coping on its own, but also because it suggests that dispositional optimists are prepared to cope head-on with either a controllable stressor that can be reduced directly by taking action, or an uncontrollable stressor that requires acceptance and accommodation. Approach-oriented coping by dispositional optimists thus appears to be quite flexible and resourceful, according to the demands of the stressor or situation, rather than locked into a certain repertoire that may be better suited to some stressors than to others.

Physical and Psychological Well-Being

If we can add effective coping with problems to a list of adaptive consequences that already includes goal-directed effort and attainment, and more positive and fewer negative emotions, we might next begin to wonder about the accumulation of these benefits of hope and optimism over time. Several lines of research now suggest that hope and optimism have effects on physical as well as psychological health, through which they can extend and improve the quality of people's lives.

Physical well-being

In one of the earliest examples, Peterson and colleagues coded the prevailing explanatory style that was expressed by 99 men in an open-ended questionnaire they completed in 1946 about difficult wartime experiences. These men were all Harvard University graduates, carefully selected for the study on criteria of sound physical and psychological health, who were approximately at the age of 25 when they completed the questionnaire. The coding of a pessimistic explanatory style, in terms of the use of internal, stable, and global attributions for bad events, followed the same underlying logic as the ASQ measure we described earlier. Summary ratings of physical health were derived from records of the men's physical exams, which were performed by their physicians every 5 years.

Pessimistic explanatory style at age 25 predicted ill health (including mortality), beginning at age 45 and continuing to the last available record at age 60. The ill effects of pessimism thus spanned over 30 years of these men's lives and occurred despite this study's careful control of their prior health conditions, both in the initial sample selection and afterwards in the intervening physical exams.

Scheier and colleagues examined the effect of dispositional optimism on recovery from coronary artery bypass surgery in 51 men who were assessed the day before their surgery, approximately 1 week afterward, and again 6 months afterward. Recovery after 1 week was assessed using patient and physician ratings and physical markers, which included the length of time before first sitting upright in bed, walking around the room, and walking unassisted for 10 min or more. Recovery after 6 months was assessed in terms of whether the patient had resumed normal activities and the number of domains in which this was so (e.g., working, exercising, having sex, socializing, and doing hobbies). Detailed medical information on each patient was used to evaluate the effects of dispositional optimism on recovery at each time. Independent of medical factors such as the patient's standing on multiple risk factors for coronary disease, severity of existing disease, and extensiveness of surgery that was performed in each individual case, more optimistic patients showed a faster and fuller recovery than their pessimistic counterparts by walking sooner in the first week after surgery, and by resuming more of their normal activities, faster, in the first 6 months after surgery.

Bailis, Chipperfield, and Perry assessed optimistic self-perceptions of physical health and activity level in a sample of 322 older adults, who were mostly women between the ages of 74–86. Optimism in this study was expressed in terms of the difference between where the respondents thought they stood in comparison with the norm for their age, and their normalized scores on comparable objective measures of preinterview hospitalizations, chronic health, and functional ability. Of the various ways to measure optimism that we have reviewed thus far, overestimation of one's health and activity level relative to the age-appropriate norm might seem the least likely to convey an adaptive benefit. Yet in the sample overall, and especially among the subset with low perceptions of control over their health, more optimistic self-evaluations were related to significantly lower odds of being hospitalized in two postinterview years. Moreover, these optimistic self-evaluations had survival implications over the next 2–6 postinterview years. An individual with relatively optimistic self-evaluations (+1 standard deviation above the sample average) had a probability of death that was lower by half from that of an otherwise similar individual with relatively pessimistic self-evaluations (–1 standard deviation below the sample average).

Psychological well-being

Being seriously ill or hospitalized takes a toll on psychological well-being, and it is striking from the standpoint of both physical and psychological health that hope and optimism can allay these negative conditions. Even among people who have these negative conditions, however, hope and optimism lead to differential outcomes in terms of quality of life. For instance, in Scheier and colleagues' study of coronary bypass patients, dispositional optimism was a significant positive

predictor of quality of life judgments taken 6 months postoperatively. This prospective relationship held even after statistically controlling for the extent of the patients' illness, surgery, and risk factors for future coronary health problems. Furthermore, this relationship was due, in part, to the influence of dispositional optimism on coping strategies that were observed in the first postoperative week, such as seeking information about the recovery process and not dwelling on negative emotional aspects of the experience. In this example, the cumulative effect of many small acts of coping is particularly salient.

Recently, however, research on hope, optimism, and well-being has taken another turn by considering hope and optimism, not as incremental predictors, but rather intrinsic properties of psychological well-being. For example, Chipperfield, Perry, and Weiner examined well-being among 353 community-dwelling older adults by asking them to report how often, during the past 2 days, they had experienced a series of discrete positive and negative emotions. One of the main findings of this study, in contrast with the anecdotal view of later life, was of the broadly positive nature of older adults' daily emotional experience. Thus, positive emotions such as happiness, hope, gratitude, and pride occurred much more frequently in this sample than negative emotions such as frustration, sadness, boredom, regret, guilt, shame, or fear. Over 85% of respondents reported at least one instance of feeling hope, in particular, which was also significantly correlated with perceived social support. The emotional side of hope has perhaps been overshadowed by the emphasis on cognitions in previous research and theorizing on hope and optimism. However, as Chipperfield and colleagues point out, there is new reason to be interested in hope as a feeling state, with increasing knowledge of the health-related psychological functions of positive and negative emotions.

Together with positive and negative emotions, another key aspect of psychological well-being is the sense that one is prospering or flourishing in life. In order to develop a brief measure of flourishing, Diener and colleagues reviewed the various philosophical and research traditions that have examined psychological well-being from the perspective of basic human needs, social capital, psychological resources, or existential purpose and meaning. From this enormity, the authors extracted just eight statements to represent flourishing. We find it instructive to note that three of them are devoted to hope and optimism: 'I am engaged and interested in my daily activities,' 'I am competent and capable in the activities that are important to me,' and 'I am optimistic about my future.' Here, again, hope and optimism appear as direct indicators of flourishing, a major component of psychological well-being.

Possible Risks

Modern research on the traits of hope and optimism has been energized as much by questioning their potential downside as by advancing their claim of adaptive effects. To the extent that hope and optimism stand for rigidly positive thinking, individuals who strongly express these traits should be relatively vulnerable to misperceiving personal risks. Such individuals also should find it especially difficult to disengage from goals that cannot be attained. To foreshadow our main conclusion,

it is probably the case that hope and optimism stand for positive thinking that is flexible rather than rigid, and therefore more beneficial than costly, even in situations that are marked by high risks or near-impossible goals. However, research into these kinds of situations is ongoing, and this part of the story of hope and optimism is continuing to unfold.

Misperception of Personal Risks

Virtually all models of judgment and decision-making incorporate perceived risk as a variable that influences motivation and action. Such theorizing has been particularly common in the study of health behaviors, where, for example, an individual's motivation to obtain a preventive medical exam for cancer is thought to depend, in part, on the likelihood that he or she perceives of developing the disease. If highly hopeful or optimistic individuals perceive automatically that developing cancer is unlikely to happen to them, they should be correspondingly disinclined to obtain the preventive exam – and therefore vulnerable to missing the benefits of early detection. The danger is most acute to those hopeful or optimistic individuals who may also have a variety of objective risk factors for the disease, in the form of their other health behaviors, age, dwelling, occupation, family history, and so on.

Aspinwall and Brunhart asked the question whether optimism functions like denial in the situation of being confronted with personal health risk information. Participants in their research were vitamin users or tanners who had completed relevant health behavior and optimism measures some months earlier, and were then given the opportunity in experimental sessions to read about the health risks and benefits of vitamin use and ultraviolet exposure. By further measuring the amount of time participants spent reading each type of information, and their recall of it 1 week later, the investigators could determine whether more optimistic participants tended to ignore information about the risks associated with the particular behaviors in which they themselves engaged, as the denial metaphor would suggest. To the contrary, however, both dispositional and health-related optimistic beliefs were associated with greater attention to and recall of personally relevant risk information in this study. This pattern, which is really the mirror image of denial, coincides with the studies reviewed earlier that showed more approach-oriented coping by more optimistic individuals.

As noted above, however, the prediction of danger or negative outcomes relies, not just on the extent of an individual's optimism, but also the extent to which it is unrealistic in comparison with his or her profile of objective risks for those outcomes. Dillard, Midboe, and Klein assessed unrealistic optimism in a large-scale, longitudinal study of alcohol consumption by college students. The classification of unrealistic optimists in this study followed from a comparison of their scores on two standardized measures: one on alcohol-related risk perceptions and the other on alcohol consumption. The students' dispositional optimism was also assessed. Although dispositional optimism did not predict any negative outcomes in this study, unrealistic optimism predicted a greater number of alcohol-related negative events that were reported in four follow-up interviews over the next 18 months. Among others, these negative events included having a hangover, forgetting

places and events, getting behind in schoolwork, engaging in regretted behaviors, damaging property, getting into trouble with security or police, having arguments, getting injured, and requiring medical treatment. Thus, it appears that optimistic risk perception has a downside, when it is both unrealistic and applied to the regulation of risk behaviors. It also appears that dispositional optimism is not fundamentally unrealistic.

Failure to Disengage from Unattainable Goals

Everyone eventually confronts the fact that some personal goals cannot be attained. The reasons for goal-unattainability are manifold, from aging and developmental changes, to social and cultural constraints, negative life events, or even conflict with other goals for the limited time, attention, energy, and material resources that people have available to devote to all of their pursuits. Wrosch and colleagues have proposed and provided evidence for a model of adaptive regulation of unattainable goals. According to the model, thriving or subjective well-being is accomplished by first disengaging from the unattainable and then reengaging in alternate attainable goals.

From the evidence we reviewed previously, it stands to reason that highly hopeful and optimistic individuals should have extra difficulty with the first step of this process, disengagement. Therefore, in comparison with less hopeful or optimistic individuals, they may be less likely to thrive when confronting unattainable goals. To date, however, the evidence for this prediction has been mixed. Aspinwall and Richter gave participants a set of unsolvable anagrams, ostensibly as a measure of verbal intelligence, under conditions in which they either could or could not move on to another set of solvable anagrams. All participants who had no alternative worked on the unsolvable anagrams until they reached the time limit of 20 min. Among participants who had an alternative, however, those higher in dispositional optimism were significantly faster to move on to the next task, and they showed greater persistence and performance on some variants of that task. These results directly counter the prediction that optimism equals blind persistence. They suggest, instead, that optimism predisposes adaptive regulation of unattainable goals, with respect to both the disengagement and reengagement steps in the model by Wrosch and colleagues.

Although it is indisputable that the participants in the foregoing study had a confrontation with goal-unattainability, the confrontation was also brief. Segerstrom has proposed that less adaptive functioning might result from dispositional optimism if or when people are confronted with goal-unattainability on an ongoing basis. One of her studies followed students through the notoriously difficult and competitive first year of law school, comparing those who relocated with those who did not relocate in order to attend. Between these two groups of students, she reasoned that those who remained in their usual social context would encounter more complex or difficult problems in balancing their academic and social goals. The outcome of major interest to Segerstrom's research was a test of the students' immune response (i.e., skin redness or swelling), following injection of a preparation of mumps virus. Suppression of the immune response is potentially mediated by stress-related affect and motivational states, and it presents another pathway by which optimism

could be linked to physical health outcomes. Among students who relocated to attend law school, those higher in dispositional optimism showed a correspondingly stronger immune response, across five relevant testing points throughout the first year. However, among students who did not relocate, and thus found themselves in a more complex and difficult goal-conflict situation, those higher in dispositional optimism showed a weaker immune response. Thus, in these conditions, in which students' current goals were mutually unattainable for an extended period due to time constraints, optimistic students apparently had a harder time managing the conflict and were more predisposed than pessimistic students to physical illness.

Conclusions

In this article, we reviewed the definitions, leading standardized measures, adaptive outcomes, and possible risks of hope and optimism. We conclude with two main points that can be drawn from this review. The first such point is that *small differences in thinking can make a large difference in adaptive outcomes*. Especially when we consider the roots of hope and optimism in the accessible products of cognitive processes – including attribution, social comparison, and recall of previous instances of successful agency and pathways – the difference between hopeful or optimistic individuals and their counterparts seems almost arbitrary. For everyone who tries to evaluate the likelihood and desirability of future events, there is always a multitude of relevant causes, comparison standards, and memories that he or she could bring to bear. Although hope and optimism are frequently conceived as traits, and they are empirically as stable and influential as any aspect of personality, both come down to a matter of emphasis on certain causes, comparison standards, or memories that keep the future looking bright. Set beside the variety and fullness of adaptive outcomes that are related to hope and optimism, this matter of emphasis seems slight.

We have not included the topic of cognitive-behavioral interventions in our review. It is sufficient to say that interventions such as attributional retraining have been effective in shifting individuals' emphasis in the direction of greater hope or optimism. However, the larger point to emerge from consideration of the roots of hope and optimism, and effects of interventions, is that people do not ordinarily have much insight into their own mental processes of evaluating the future. Each person thus arrives at the same perceptions repeatedly, without necessarily realizing the extent of mental processing that has taken place, or the potential to either fine-tune or compensate for individually specific aspects of this processing. Such self-insight could help all of us to make better plans.

The second general point is that *people who feel invested in the future take better care of themselves in the present*. Whether through adaptive goal regulation, risk regulation, emotional management, or coping with problems, as reviewed here, hopeful and optimistic people make the most of their opportunities in life, and the least of their difficulties. Even the apparent exceptions we considered, such as unrealistic optimism or goal conflict, seem only to prove the rule: that is, people who express little concern with the risky behaviors in which they routinely engage, or who find themselves chronically unsure of which

goal to pursue, seem not to be invested in the future so much as in the present moment.

We acknowledge that hopeful and optimistic perceptions can be overly positive, and that hopeful and optimistic people are not always aware of when or how they sustain their positive beliefs. Even so, we wish to end on the note that better self-care in the present is an entirely rational response to the condition of being invested in the future, whether the basis of such investment is objectively wise or foolish. Thus, in our view, the branding of hope and optimism as 'cockeyed' in the vernacular, or 'illusory' and 'irrational' among social scientists, misses the overarching point. That is, hope and optimism are self-fulfilling beliefs about the future. By encouraging better self-care today, they pave the way for better physical and psychological well-being tomorrow – the better, in turn, for people to enjoy the results of their current goal pursuits and to form the goals that they will be pursuing next.

See also: Stress and Illness; Attribution; Coping; Motivation; Perceived Control; Positive Psychology; Self-Efficacy; Social Comparison.

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Hormones and Behavior

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Glossary

Alloparental behavior The exhibition of parental behavior toward another individual's offspring.

Androgens Hormones (testosterone and dihydrotestosterone) and related compounds (e.g., anabolic steroids) with a chemical structure that will act at the androgen receptor.

Estrogens Hormones (estradiol, estriol, estrone) and related compounds with a chemical structure that will act at the estrogen receptors.

Estrous cycle The ovarian cycle of nonprimate species.

Hormone A substance that is produced in a gland that is carried through the blood stream to produce an effect on a target organ.

Neurohormones Hormones produced in the brain and released into the blood stream as well as directly within the brain. Oxytocin and vasopressin are examples of

neurohormones. Importantly, the peripheral and central release of neurohormones can occur synchronously or independently.

Oocyte The primordial egg, immature ovum, or egg cell that is produced in the female ovary during early stages of development.

Progestins Hormones (progesterone) and related compounds with a chemical structure that will act at the progesterone receptors.

Sexual differentiation The process through which males and females develop from a bipotential individual to individuals with a masculine or feminine phenotype throughout the body.

Stress response The coordinated response of the autonomic nervous system and neuroendocrine systems (primarily the hypothalamic, pituitary, adrenal axis) to a perceived stressor.

Introduction

In the majority of mammalian species, life proceeds in a rather predictable direction. An individual is born, matures, and finally attains sexual maturity. All throughout these processes, hormones have played a role in the behaviors in which an individual engages. When the body lacks the necessary materials for growth and maintenance, the appropriate hormonal signals are sent out that promote ingestive behaviors. When an individual encounters a life-threatening situation, once again hormone signals are issued that mobilize energy resources and allow the individual to mount an appropriate response. Finally, when an individual is fertile and conditions are good for reproduction, hormones shift the individual's behavior into finding and securing a mate. For most male mammals, behavior does not change as a consequence of mating. In females, when mating results in fertilization of eggs, hormones coordinate changes in her physiology and behavior that support pregnancy maintenance, fetal development, and preparation for motherhood. With parturition, the ensuing birth starts the entire cycle again for a brand new individual.

Of course, this is a gross oversimplification of life, intended to highlight how hormones function to coordinate physiology and behavior with the environment. We tend to think about hormones and behavior as unitary concept, but not all hormones act in the same way, nor do all hormones act the same in males and females. The simplest and most direct way hormones act is to have a rapid and direct action on behavior. The increase in heart rate and blood flow that we experience when we slam on the brakes to avoid hitting the car in front of us is an example of the adrenal medulla stress hormones having such an effect. Other hormones can take longer to produce an effect or just set the stage so that if a particular event

happens the appropriate behavior will be triggered. The hormones that the female rat's ovaries release to prepare her to be sexually receptive around the time of ovulation are an example of this type of hormone action. The hormones set the stage or prime the animal to be able to engage in the behavior, but if the male does not mount the receptive female, she does not engage in sexual behavior.

During development one of the things that hormones influence is how the brain develops, resulting in sex differences in brain and behavior of adult animals. The sex differences may be seen independent of hormonal activation, or hormones may be required to see that brains of males and females are different. Hormones secreted during the perinatal period of brain development and again at puberty induce sexual differentiation of the brain that determines whether animals will exhibit masculine or feminine sexual behavior as an adult. These behaviors still require the appropriate male and female hormones to activate the behavior during adulthood, and then the presence of a conspecific of the other sex is needed to actually engage in the behavior.

Finally, it is important to remember that the relations among hormones, behavior, and the environment are not linear and unidirectional, but rather involve complex reciprocal relations. Thus, while it is apparent that physiological or social state can drive changes in hormones that promote certain behaviors, the reverse is also true. Changes in the social or physical environment can induce hormone changes that subsequently modify physiology and behavior. Therefore, when considering a species in which a certain behavior appears to have been liberated from hormones, it is probably more accurate to consider the behavior to have been liberated from a specific physiological state, with either a new set of hormones contributing to the regulation of the behavior, or even more

likely, those original hormones and/or their downstream signaling pathways having become coupled to other environmental stimuli or internal signals. This consideration is especially important in species, such as humans, where behavior has been heavily shaped by learning and cultural influences and therefore oftentimes appears to be beyond hormonal regulation. Books have been written on the topic of hormones and behavior. This overview is not meant to be comprehensive, but rather present a brief picture of how hormones and behavior are related in humans and other species.

Sexual Behavior

Sex is a risky endeavor for both males and females due to the possibility of physical injury, either from the act itself or from intraspecific competition for mates, and the transmission of pathogens that can affect survival and future reproductive potential. Like many dangerous ventures it also has its rewards, it is the ultimate reward in this case, propagation of one's genes into future generations. 'Nothing ventured, nothing gained' is only a profitable strategy when one is sure that there is actually something to be gained. Thus, selection has favored a tight coupling of fertility with the motivation to seek out mates and engage in copulation in both males and females. Therefore, when considering hormonal regulation of sexual behavior, it is essential to consider both the appetitive (or motivational) components, as well as the consummatory phase, which comprises the performance of the sexual act from beginning to end. This distinction is especially critical when examining sexual dysfunctions, as in many instances motivation and ability can become uncoupled.

Male Sexual Behavior

Males and females differ in reproductive strategies that are believed to have evolved from the amount of resources invested in the offspring. Female mammals, birds, and other vertebrates are limited in the number of offspring they can produce, because they put considerable energy into the nurturing and caring for the young. Consequently, females have evolved to be 'choosy' when it comes to selecting a mate. Males, on the other hand, have evolved strategies to attract and mate with as many females as possible in order to pass along the greatest number of their genes to future generations. As such, males have evolved a number of techniques to compete for mates – to gain access to the best territories, or for the best partners. Oftentimes, these techniques will put the males themselves at risk for injury or even death, indicating that the motivation to engage in sexual activity must be sufficiently high to drive the animal to seek out and mate with a partner. Gonadal hormones drive many of these behaviors and exhibitions.

Male sexual behavior can be broadly classified into two distinct phases: the appetitive phase (or motivation to engage in sex) and the consummatory phase (the ability to engage in sexual activity). Hormones affect both phases of sexual behavior, although to differing extents in different species. In order for sexual activity to be fully functional, both components

must be fully functional. Androgens produced by the testes are involved in masculine sexual behavior by affecting the reception, perception, and processing of stimuli associated with the female (making a mating episode more likely to occur), and by facilitating the mechanics of the sexual interaction. Androgens may have their effects directly, by increasing motivation to engage in sexual activity, or indirectly, by enhancing the effects of requisite neural systems. In both cases, androgens are permissive in that a threshold amount of testosterone is usually necessary for a male to engage in sex, but more testosterone does not further increase male sexual ability or motivation.

Sexual experience can modulate sexual behavior in males, as experienced male rats exhibit increased resistance to impairment by stress or castration (removal of the source of the hormones), show greater changes in the brain during sex, and will ejaculate after fewer intromissions with a female compared to sexually naïve animals. The neurotransmitter dopamine plays a large role in aiding male sexual behavior by facilitating genital reflexes and copulation. In fact, female-stimulated dopamine release, which is dependent upon testosterone, is necessary for efficient mating behavior. On the other hand, the neurotransmitter serotonin is inhibitory with respect to sexual behavior – it is released upon ejaculation and is responsible for the refractory period that occurs after ejaculation (this also helps to explain why some patients, both men and women, taking selective serotonin reuptake inhibitors for depression often experience decreased libido and sexual performance).

Peptide hormones also play a role in male sexual behavior. Elevated prolactin levels interfere with male sexual behavior, and may be due in part to its role in bonding and parental care (see section 'Parental Behavior'). Opioids have been shown to inhibit male sexual behavior in humans and nonhuman primates, and may be due to their suppression of testosterone.

Female Sexual Behavior

As mentioned above, males and females differ in their potential rates of reproduction. The female gamete required for reproduction is large and expensive in terms of the resources the body requires to produce mature follicles, and caring for offspring is energy consuming and dangerous. A female is also born with a finite number of primordial eggs (i.e., oocytes) available, so the supply is limited. This, however, is not thought to be a limiting factor for reproduction in most species. In humans, and in some other species where life expectancy exceeds the supply of eggs, menopause is thought to result at least in part due to the loss of available oocytes. Thus, when considering that the ultimate reason for engaging in sexual intercourse is to pass along one's genes to subsequent generations, it is of great benefit to females of most species to increase the chances that her eggs are fertilized when mature. While women have evolved to free themselves from these tight regulations that link receptivity to ovulation, females of many other species are often limited in their ability to engage in sexual activity by hormones. The hormones estradiol and progesterone coordinate both ovulation and sexual receptivity, ensuring that females are receptive to a male's advances at a time when the sexual interaction would have the greatest

chances of yielding a successful pregnancy. At the same time, engaging in sexual activity is risky for females for a number of reasons including: increased vulnerability to predators, exposure to infection or disease, and risk of injury or even death as males are frequently larger than females and can engage in violent behaviors before and during sexual intercourse. It is therefore the greatest benefit to the female to expose herself to these risks only when doing so will have the greatest chances of yielding a successful mating episode and result in pregnancy.

An excellent example of the coupling of ovulation and receptivity can be seen when examining sexual behavior in the rodent. A female rat will not allow a male to mount her for sexual intercourse unless she has been appropriately primed with the steroid hormones estradiol and progesterone. These hormones act on the brain and, in conjunction with hormones that are produced in the brain and pituitary (such as oxytocin, luteinizing hormone, and follicle stimulating hormone), act throughout the body to result in a cascade of events ending in ovulation at a time when the female is behaviorally receptive to a male's advances, or in estrous.

While hormones do not restrict women in terms of ability to engage in sexual activity throughout the menstrual cycle, hormones do affect other aspects of sexual behavior such as interest in and motivation to engage in sexual activity. For example, women's preferences for masculine traits such as facial characteristics, height, and expression of dominant behaviors changes across the menstrual cycle, with the greatest preference for masculinity around the time of ovulation when estradiol is elevated. An increased degree of masculinity is thought to indicate a higher 'quality' of mate with improved genetic fitness – a characteristic that is sought after when the likelihood of conception is high. Sexual motivation also changes across the cycle; women report increased sexual fantasies and self-stimulation, more interest in sex, and a higher number of sexual episodes during their fertile period. These increases in sexual interest can be visually noted as well, as women have been shown to dress more provocatively during their fertile phase compared to other phases of their menstrual cycle.

Sexual Dysfunction

Sexual dysfunction with men is most often the loss of ability to engage in sexual activity due to diabetes, aging, or other illness such as hypertension. For women sexual dysfunction is most frequently due to hypoactive sexual desire disorder (HSDD), or a loss of the desire to engage in sex.

In women the loss of desire does not appear to be mediated only by hormones, as young women with normal levels of hormones can experience decreased sexual desire. The ability to engage in sexual activity is not compromised in women reporting reduced motivation, as genital blood flow is not decreased in the aroused state. Thus, the decrease in sexual motivation is not linked to reduced ability. There do appear to be some differences in brain areas and neurotransmitter systems activated in association with sexual motivation and arousal in women experiencing HSDD compared with women who do not have the disorder, which may interact with hormone levels. HSDD is believed to be a disorder of the brain's reward circuitry, with two general possibilities: women

experiencing HSDD may have overactive (or hyperfunctional) inhibition of sexual reward circuitries, or underactive (or hypo-functional) sexual arousal circuits. Recent neuroimaging studies have pointed to the former as the leading possibility, indicating that hyperfunctional serotonergic systems can inhibit the dopaminergic sexual arousal system, resulting in reduced sexual motivation.

Currently, there are no successful pharmacologic therapies for women experiencing HSDD. Testosterone has been linked to increased sexual motivation and increased self-reported incidents of sexually satisfying experiences in women, but there are a number of unwanted side effects of taking testosterone to increase desire, such as growth of facial hair and increased risk for breast cancer with prolonged use. More research is needed in order to identify exactly how and where the disorder manifests itself in women experiencing HSDD, and to develop and test potential therapeutics to treat the disorder.

For men, sexual dysfunction is most commonly related to performance, or ability, and not to motivation. One of the causes of erectile dysfunction in men who don't have diabetes or other disease is a reduced level of dihydrotestosterone (DHT), an androgenic product that results from breakdown of testosterone in the testes, which interacts with nitric oxide (NO) to achieve and maintain an erection. The production of NO is dependent upon DHT, levels of which decrease in men over the age of 40. NO stimulates cGMP by activating guanylate cyclase, resulting in smooth muscle relaxation and blood inflow to the penis. Treatments that have been effective in many men with erectile dysfunction act by potentiating the action of NO by inhibiting PDE5, the enzyme that breaks down cGMP.

Insulin resistance is present in many patients with endocrine-metabolic disorders like type 2 diabetes and obesity, and produces attenuated synthesis and release of NO and higher NO consumption in tissues. The reduced NO impairs vasodilation in patients, often resulting in erectile dysfunction. Patients with erectile dysfunction have a higher body mass index and obesity prevalence compared to men with normal erectile function. In fact, many patients learn of their endocrine-metabolic disorder or cardiovascular disease upon presentation to the doctor with erectile dysfunction. Insulin resistance has also been associated with reduced testosterone levels, which may indirectly affect ability to engage in sexual activity by reducing the available amount of DHT.

Testosterone and Aggression

In male animals, testosterone levels have been related to aggressive behaviors. This is seen most clearly in territorial animals that breed seasonally, such as the red deer or big horn sheep. In these animals, the onset of the breeding season is associated with testicular growth and the production of testosterone, which induces the growth of secondary sex characteristics in the red deer, such as antlers, and also induces these males to establish individual territories and become aggressive toward other males. In many of these species, the social rank of the male is correlated with testosterone and age, and aggressiveness is correlated with testosterone levels.

So while testosterone is only permissive for masculine sexual behavior, it is positively correlated with the level of aggression in many species, including humans. Testosterone has also been correlated with risky behavior in men, but not women, although low testosterone may result in risk aversion in women.

Parental Behavior

Parental care involves a trade-off in which the increased survival of existing offspring is weighed against various costs of parenting. In mammals, parental care is almost the exclusive domain of the female due to the obligations of gestation and lactation. Some species of rodents, canines, and primates, including humans, however, are biparental with males contributing substantial amounts of paternal care. Whatever the species, the expression of parental care is ultimately determined by the interplay of genes, experience, and the environment, and hormones represent one of the primary mechanisms mediating communication among these factors.

In all mammalian species, the changing levels of estradiol and progesterone that occur during gestation are necessary for maintaining pregnancy, mammary gland development, and lactation. Additionally, these ovarian steroids appear to be critical for the subsequent expression of nurturing maternal behaviors, in large part due to the sensitization of the brain to oxytocin and prolactin, two neuropeptides that are essential for parturition and lactation and directly promote the expression of maternal behavior in rodents, sheep, and primates.

In addition to gonadal steroid hormones, corticosterone, or cortisol (CORT; exact hormone varies across species) is secreted from the adrenal glands and elevated during mid- to late gestation to contribute to mobilizing energy reserves, fetal lung maturation and labor induction. First-time mothers with higher CORT levels are also more attracted to and better able to recognize their own infant's body odor. Similar to estradiol and progesterone, CORT also sensitizes oxytocin signaling in the brain, which may underlie the correlation between CORT levels and maternal responsiveness to infant cues.

Even though fathers don't go through the same physiological changes during gestation as their pregnant mates, they do show dramatic changes in hormone levels. In most mammals, fatherhood is generally associated with reduced testosterone levels and elevations in estradiol, CORT, prolactin, and oxytocin. Many of these hormonal changes, such as increased prolactin and CORT levels, are initiated during gestation and may serve to prepare the expectant father for the energetic costs associated with paternal care. These changes may result from programmed neuroendocrine responses following mating or represent direct modulation by cues from the pregnant female.

The reduction in fathers' testosterone levels may be secondary to the rise in prolactin, as hyperprolactinemia results in hypogonadism in males; however, it may also serve an adaptive function by reducing the chances that the male will abandon his offspring in order to seek out additional mating opportunities. In nonhuman primates, infant odors rapidly decrease testosterone secretion and a similar phenomenon may occur in human fathers, as cross-cultural studies reliably demonstrate that married men with young children have lower

testosterone levels than married men without children and single men. Interestingly, mothers of young children also have reduced testosterone levels compared to nonmothers. Conversely, a transient increase in testosterone following infant distress vocalizations occurs in both men and women and may represent an adaptive response to increase protection and attendance to the infant. Thus, one model is that low levels of androgens support soothing and nurturing parental activities in both sexes, whereas acute increases in androgens may promote vigilance, increased attendance to offspring and their defense.

While changes in gonadal and adrenal steroids coordinate reproductive physiology and parental behavior, oxytocin and prolactin mediate the expression of parental responses. In most species, this induction of oxytocin and prolactin signaling is mediated by the changes in estradiol and progesterone that occur during gestation; however, it is also possible to induce oxytocin and prolactin secretion and thereby induce maternal behavior in individuals who haven't been primed with these ovarian hormones. In rodents, the process of pup sensitization induces parental responses in ovariectomized females and in males simply via repeated daily exposure to pups. Since rodents and primates both show increased oxytocin and prolactin secretion following exposure to infants, it appears that these systems can also be activated independent of gonadal steroids. This route of activation may be especially important in primates, including humans, as well as other species that engage in alloparental behavior, in which individuals other than the biological parents contribute parental care.

More research is required to clarify the role played by specific hormones in the regulation of parental behavior, especially in humans. Nevertheless, a common endocrine profile appears to support parental responses in most species. In some species, parental responses are entirely dependent upon the priming of gonadal steroid hormones; in others, infant cues themselves may be sufficient to induce parental responses by directly tapping into the oxytocin and prolactin systems. It has been said that, "There are but two lasting bequests we can give our children. One is roots, the other, wings." In light of emerging research in humans, it is possible that oxytocin provides the roots (i.e., the nurturing dyadic relationship), whereas prolactin provides the wings by encouraging exploratory play and extra-dyadic activities.

Sex Differences in Energy Homeostasis

Males and females differ in the regulation of energy balance and body weight, and at least part of these differences is due to differences in the gonadal hormones secreted – estradiol in women and testosterone in men. Maintaining a positive energy balance requires communication between the adipose tissue and the brain. Insulin from the pancreas, leptin from fat, estradiol from the ovary, and testosterone from the testes are important hormones that allow the brain to keep track of the amount and location of adipose tissue and adjust food intake and metabolism appropriately.

Leptin acts in several brain regions, including the hypothalamus, to regulate metabolic activity. Increased leptin levels are associated with reduced food intake and increased energy

usage. Interestingly, estradiol directs fat to be deposited subcutaneously (i.e., under the skin) rather than viscally (i.e., in the abdominal cavity around the organs), and subcutaneous adipose tissue secretes leptin at a higher rate than does visceral fat. Therefore, the brain may receive more reliable information about subcutaneous fat stores, which could lead to excessive (i.e., 'under-reported') fat accumulation in visceral stores. Leptin synthesis is regulated by sex hormones, with testosterone being negatively correlated with leptin levels, whereas estradiol results in increased leptin levels.

Leptin levels are relatively stable in contrast to insulin levels, which fluctuate rapidly in response to circulating glucose. Because visceral adipose tissue is relatively insensitive to insulin, obese men are at greater risk for metabolic disorders than women. This sex difference disappears if obese women accumulate visceral fat and thus become more insensitive to insulin. In addition to sex differences in insulin sensitivity from differences in fat distribution in the body, there are also indications for differences in central effects of insulin. Intranasal application of insulin, which increases insulin levels in the cerebrospinal fluid, results in a reduction of body fat in men but not women. This indicates a clear sex difference in the central effects of insulin.

Feeding Regulation by Estradiol

Ovarian hormones also regulate food intake. For example, during the proestrous phase of the rat's estrous cycle (following the rise in estradiol) food intake is reduced. Primates, including humans, show a similar pattern, with a reduction in food intake around ovulation. Estradiol is the ovarian hormone responsible for this effect, as shown by studies using estradiol replacement in ovariectomized female rats. This regulatory effect of estradiol appears to take place in the brain and not in the periphery. One possible mechanism by which estradiol can influence food intake is by affecting the satiety signals by interacting with cholecystokinin (CCK). Additionally, estradiol appears to attenuate orexigenic signals in the brain, possibly by affecting neuropeptide Y (NPY) and ghrelin signaling. Estradiol also affects peripheral leptin and insulin signaling, which impact metabolism and food intake as described above. Estradiol and leptin receptors are present in the same brain nuclei, especially in the hypothalamus, allowing for a direct communication between estradiol and leptin levels. Even though leptin levels do not fluctuate over the rat estrous cycle, leptin receptors in the brain are inversely correlated with estradiol levels. This provides a way for estradiol and leptin to communicate about the adipose tissue distribution to the brain and sex-specifically regulate energy homeostasis.

While the effect of estradiol on food intake is mediated in the brain, gonadal hormones also affect peripheral adipose tissue distribution. Subcutaneous fat has higher levels of estradiol and progesterone receptors, whereas visceral adipose tissue has more androgen receptors. The amount of visceral fat is inversely correlated with estradiol levels, hence after menopause in humans or ovariectomy in rats, when estradiol levels drop, the amount of visceral fat is increased.

As estradiol has positive effects in women, the same is true for testosterone in men. Hypogonadism in men is

accompanied by a loss of muscle and an increase in subcutaneous fat, which can be reversed by injections with testosterone. Also in elderly men, who show reduced levels of testosterone, there are indications that supplementing testosterone has positive effects on maintaining lean body mass.

Sex Differences in Eating Disorders

The DSM-IV defines three broad categories of eating disorders: anorexia nervosa, bulimia nervosa, and eating disorder not otherwise specified. Anorexia nervosa is recognized by extremely low body weight and a fear of increase in weight. Bulimia nervosa is characterized by repeated binge eating and measures to counteract the effects of the binge. Variants of these disorders with sub-threshold symptoms are gathered in eating disorder not otherwise specified.

Anorexia nervosa and bulimia nervosa both have a higher prevalence (about 3 times) in women, whereas sub-threshold binge eating is more common in men. Anorexia nervosa mainly occurs in young women around puberty, suggesting a role for estradiol. Bulimia nervosa usually emerges somewhat later. In contrast to the traditional view that anorexia nervosa and bulimia nervosa are caused by psychosocial factors, twin studies have shown that there is a 50–80% genetic component. Hypersensitivity could play a role in the development of anorexia nervosa, although clinical data about manipulation of estradiol levels are infrequent and inconclusive. Some polymorphisms have been found in the estradiol receptor gene in anorexia nervosa and bulimia nervosa patients. Estradiol affects expression of many other genes, so it could easily indirectly affect feeding behavior.

Hormones and Cognition

In humans there are activational influences of hormones on cognitive function and circumstantial evidence for effects of hormones during sexual differentiation of the brain. In general, there are sex differences in spatial abilities (three-dimensional manipulation of objects in space or mental rotation tasks), perceptual speed and accuracy, and verbal fluency, with males having an advantage on tests of spatial abilities and females an advantage on tests of perceptual speed and accuracy as well as verbal fluency. While performance on these tests can be enhanced with learning, evidence from imaging studies using fMRI suggests that males and females use different parts of the brain to do tests that require 3D manipulation through space. It is thought that the female advantage in language comes at least in part from greater bilateral representation of language in women than in men due to sexual differentiation of the brain.

Evidence that hormones can influence these sex differences during development come from women exposed in utero to androgens due to congenital adrenal hyperplasia. These women tend to have better spatial abilities than their unaffected sisters, but perform slower on tests of perceptual speed and accuracy. Evidence from analysis of the amniotic fluid during gestation for testosterone concentrations has also led to evidence that suggests a correlation between the

concentration of testosterone and the degree of language lateralization. Girls and boys with lower testosterone in utero had more bilateral language representation than those with higher testosterone prenatally. As more studies use this approach to assess the relations between prenatal hormones in humans and subsequent behaviors, it may be possible to determine if there are causal effects of this hormone exposure in utero, and even where in the brain the hormones are acting during development.

There are also effects of hormones on these sexually dimorphic cognitive tasks in adults. In women, performance on a mental rotation tasks when the ovarian hormone estradiol is low and verbal abilities are enhanced when estradiol is high. This effect of estradiol on verbal ability can also be seen in postmenopausal women when their performance is assessed when on estradiol treatment compared with periods of hormone withdrawal. In men, spatial ability is correlated with testosterone, but the relationship is not linear. It seems that there is an optimal amount of testosterone and too much or too little testosterone is correlated with reduced spatial ability on mental rotation tasks.

The Stress Hormones and the Stress Response

Exposure to stimuli that threaten homeostasis (i.e., stressors) activates autonomic, behavioral, and neuroendocrine systems that permit the organism to respond to the threat. The hypothalamic–pituitary–adrenal (HPA) axis is exquisitely responsive to stress exposure and its activation is critical for the response to the current threat. The first phase of the stress response is due to the rapid activation of the sympathetic nervous system and release of hormones, like epinephrine (adrenaline) from the adrenal medulla. These hormones result in the ‘flight or fight’ response. Stressors induce a secondary response as well, referred to as the general adaptation syndrome: the activation of neural systems result in release of corticotropin releasing hormone (CRH) from the brain and adrenocorticotrophic hormone (ACTH) from the pituitary to induce the release of CORT as well as other hormones from the adrenal cortex. Together the two phases of the stress response allow an animal to mount both a rapid and a sustained response to a stressor. In the brain, CORT and CRH influence anxiety-related behaviors, memory and other cognitive functions, as well as the effect of drugs of abuse on subsequent drug-taking behavior. In general, the magnitude of the stress response is proportional to the magnitude of the stressor, and an individual’s energy needs are met by the metabolic effect of the stress response which mobilizes glucose to be used for energy while curtailing processes that utilize or store glucose. The HPA axis activity is regulated by a negative feedback mechanism at the level of the anterior pituitary and the paraventricular nucleus of the hypothalamus, thus preventing excessive levels of CORT. Dysregulation of this feedback mechanism has been found in addiction and stress-related disorders, like major depression and anxiety disorders.

Sex Differences in the Stress Response

In rodents and humans, there are sex differences in activation of the HPA axis that can play a role in behavior and physiology.

For example, in female rats, both basal and stress-induced CORT secretion are more pronounced than in males. Furthermore, HPA secretions vary across the estrous cycle in the rat. Females in proestrous or estrous show elevated basal and stress-induced CORT concentrations relative to diestrous animals. Similarly, women show greater ACTH and cortisol responses in the luteal phase (when estradiol and progesterone are elevated) compared to the follicular phase (when estradiol is slowly rising). Females are also less sensitive to suppression of the HPA axis by the synthetic glucocorticoid, dexamethasone, than are males.

Sex differences and ovarian hormones also affect the central neural circuits regulating neuroendocrine and behavioral stress responses. Proestrous and estrous females show attenuated cortical and hippocampal induction of c-fos relative to males or diestrous females, while during the luteal phase women demonstrate impaired glucocorticoid feedback relative to the follicular phase. In males, testosterone attenuates stress-induced CORT and ACTH secretion, and inhibits CRH gene expression in PVN neurons controlling the HPA axis response.

Stress and Drug Abuse

In humans and nonhumans it is widely accepted that the rewarding aspects of drugs of abuse are due to the ability of these drugs to activate the neural system known as the ‘reward’ system. The ascending dopamine system and its targets are part of a motivational system that regulates responses to natural reinforcers (e.g., food, drink, sex) and drugs of abuse. Importantly, activity in the ascending dopamine system is also modulated by the neural responses to stressors, and the effect of drugs of abuse and the neural stress response interact in a way that can influence drug-taking behavior.

First, drugs of abuse induce the activation of the HPA axis to induce an increase in CORT release. CORT in turn acts to enhance drug-taking behavior. With repeated exposure to the drug, there are long-term changes in both the neural system mediating the reinforcing effects of the drug and in the stress system. One way that drugs of abuse become addictive, in susceptible individuals, is by inducing activation of the stress axis. Drug-taking behavior also results in long-term changes in the stress response, which can induce increased drug-taking. In other words, exposure to drugs of abuse enhances the HPA response to stressful stimuli, and prior stress enhances drug-taking behavior.

Currently, adult men are 2–3 times more likely than women to have a drug abuse/dependence disorder, but this current gender difference is thought to reflect differences in opportunity during vulnerable periods, rather than sex differences in vulnerability to drug abuse. Historically, there have been periods of time when women outnumbered men in their use of drugs. During the ‘Gin Craze’ in England in the 1700s, for example, approximately 75% of users were thought to be women. Again in the 1800s, in the United States, 70–80% of the opiate addicts were women, addicted to laudanum and patent medicines that were sold legally. The perception of many was that this opium addiction among women was an upper-class affliction, but in fact when doctors were surveyed in a more systematic manner, there was no distinction by class, occupation, or regional location; all women were at risk.

The current male predominance in drug use may be waning, as data collected in the past 5 years in the United States indicate that among high school age males and females, there is no longer a sex difference in drug-taking behavior. Among individuals who use drugs, more females are using cocaine and other psychomotor stimulants than males. There are also sex differences in the rate of escalation of drug use, with women tending to increase their rate of consumption of alcohol, marijuana, opioids, and cocaine more rapidly than do men. The sex differences in the psychomotor stimulants are the best studied, and women begin using cocaine or amphetamine earlier in life and enter treatment at earlier ages than men. They also have more severe cocaine use and intake than men and more severe dependence upon cocaine. Furthermore, once addicted to a drug, women can find it more difficult to quit than men do. So, in the clinical populations patterns of drug use differ between men and women.

In animal models of drug use, sex differences have been reported during all phases of the addiction process: acquisition, escalation, maintenance, and relapse/reinstatement. Additionally, in females the ovarian hormone estradiol enhances acquisition of drug-taking, the motivation to take drugs, and relapse/reinstatement of drug-taking after abstinence. In animals that are reliably taking cocaine, for example, if female rats are given a choice between two doses of cocaine, females in estrous, following an elevation of estradiol in blood, prefer higher doses of cocaine compared with females in other phases of the estrous cycle or male rats. Furthermore, estradiol treatment increases the initial binge length and total amount of cocaine self-administered. These results show that estradiol enhances drug-taking as well as the motivation to take cocaine. Since the HPA axis is enhancing the response to drugs of abuse, establishment of drug-taking behavior, and subsequent neural changes resulting in addiction, sex differences in the HPA axis may play a role in the enhanced susceptibility of females for drug abuse.

Environmental Factors Influencing Hormones and Behavior

Humans, in general, are social creatures, and the presence of a social network has a positive influence on mental and physical health. More specifically, social support is known to attenuate the CORT response and the increased heart rate in response to stressors in both men and women, although women appear to be the more effective support providers. Social support also has beneficial effects on the outcome of stress-related disorders like major depression and can prevent relapse, possibly by reducing the impact of stressors. Interestingly, the amount of social support is associated with a reduced risk for a depressive episode in women but not men.

The neuropeptides oxytocin and vasopressin are two of the likely mediators of the positive effect of social support/contact. Although most data come from studies with rodents, human data have become available recently. Using nasal spray to deliver oxytocin or vasopressin to the brain, CORT responses to a psychological stress test were lowest in subjects given both social support and oxytocin, and highest in subjects without support who received a placebo. Trusting other people is an

important requirement for affiliative behavior, and intranasal oxytocin has been shown to increase trust in other people using a trust game. In addition, oxytocin nasal spray increases accuracy in recognizing the emotion of facial expression. Less is known about vasopressin and human social behavior. Interestingly, a sex-specific effect has been found for vasopressin, with men rating facial expressions as more unfriendly after intranasal vasopressin, whereas in women it had prosocial effects.

As is seen with the stress response, the way hormones and behavior interact is not a one-way street. Experience through all sensory modalities can influence hormone secretion, which can then impact behavior. For example, visual input regulates the release of melatonin from the pineal gland to control circadian rhythms and circannual rhythms in all species. Fear-inducing visual, auditory, and/or olfactory stimuli can induce the HPA stress response. Olfactory stimuli and chemical stimuli that activate the vomeronasal organ can induce a number of neuroendocrine responses including synchronization of woman's menstrual cycles. Tactile stimuli can induce oxytocin release that can influence subjective feelings in humans. A hormone that is quite sensitive to events and actions in humans is testosterone. In both men and women, winning a competition like playing tennis or soccer results in increased testosterone, and losing results in a decrease in testosterone. Successfully completing a mentally challenging test can also result in a boost in testosterone.

Summary

This brief overview of some of the ways that hormones and behavior interact is meant to give examples of the principles involved in these relations. The effects of hormones are wide reaching and powerful. From their influence during development to their effects on behavior of adults, hormones help an individual interact with the environment.

See also: Addictions and Adolescence; Adrenal Glands; Aggression; Appetite; Brain and Behavior Relationships; Drugs, the Brain, and Behavior; Motivation; Parenting; Semantic Memory; Sense of Smell; Sense of Taste (Effect on Behavior); Sexual Behavior; Spatial Orientation; Spatial Perception; Stress and Blood Pressure Dysregulation; The Sense of Touch; Touch.

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Introduction

The convergent scientific disciplines of human factors and ergonomics (HF/E) are primarily concerned with how human beings interact with technological systems in all their various forms. HF/E has focused particularly on ways of improving the quality and safety of human work. Contemporary HF/E encompasses the imagination, design, fabrication, operation, maintenance, and decommissioning of all technical systems. To accomplish these goals, HF/E draws heavily on the theoretical and empirical bases of experimental psychology and, more recently, the neurosciences. It combines these theoretical perspectives on human behavior with the practical tenets and principles of engineering. The aim of this fusion is to optimize the conjoint abilities of humans and technological systems. HF/E is also involved with the creative processes of design as well as the affective nature of user experience. In seeking to accomplish such aims, HF/E professionals draw information from a wide variety of allied areas, ranging from ethnology and sociology through engineering, modeling and simulation, to anatomy and physiology. While HF/E has been, since its inception, a pursuit directed to the practical improvement of human life, it is important that its future should be much more central in articulating and achieving the more fundamental purposes of humankind. This article begins with a brief perusal of the history of HF/E: for, to see clearly into the future, we have to look well into the past.

A Brief History of HF/E

One can argue that, in their essence, HF/E have been around since the very inception of human tool use. When humans first shaped tools, concern about finding ways to work more efficiently was born. However, the modern scientific foundations of these areas of study began much later. 'Ergonomics' was a term first coined by the Polish scientist Jastrebowski in his treatise of 1857 entitled *"An Outline of Ergonomics or the Science of Work Based Upon the Truths Drawn from the Science of Nature."* Later, the term ergonomics would be reinvented by the English scientist Murrell, as part of the gestation of the Ergonomics Society of Great Britain, one of the oldest such scientific societies in the world. Traditionally, ergonomics as a science and practice has been associated predominantly with human interaction with physical work. Growing out of the social concerns for industrial worker safety and productivity around the turn of the twentieth century, studies in time-and-motion research and in industrial fatigue represent the earliest expressions of ergonomic concern. Today, ergonomic practitioners collaborate directly with professionals in systems safety, industrial engineering, industrial hygiene, and occupational medicine to prevent damage and injury on the job. They mutually collaborate to eliminate or reduce the adverse effects of hazardous

occupational environments and poor physical work designs. Physical ergonomists work on issues such as manual handling of materials, slips and falls, and repetitive strain trauma which are the concern of agencies such as the National Institute for Occupational Safety and Health (NIOSH) in the United States, the Health and Safety Executive (HSE) in Britain, and the International Labour Organization (ILO) which is based in Switzerland. The historical antecedents of ergonomics lie largely within the countries that have emphasized the importance of safe working conditions. It is therefore no surprise that ergonomics has traditionally been considered to be of European origin. One of the classic texts *'Fitting the Task to the Man,'* for example, was produced by the Swiss scientist Etienne Grandjean. The name 'ergonomics' is retained in the title of many major scientific and professional organizations of Europe. Indeed, the name ergonomics is incorporated in many research societies worldwide, including the overall global organization, the International Ergonomics Association (IEA).

In contrast to ergonomics, the science of human factors can be considered the North American face of the same fundamental enterprise. Largely emanating from the technical difficulties that challenged the US military in the Second World War, especially the US Army Air Corps, human factors was motivated by a search for efficient and error-free operations. With its origins stemming from concerns about piloting aircraft, human factors was originally much more focused on elements of cognition than its European counterpart. Thus, a classic 1947 paper by Fitts and Jones on the origin, etiology and prevention of pilot error is emblematic of the earlier human factors' type studies in the United States. It should, however, be noted that the war had exerted the same pressures in England, and the 'Cambridge Cockpit' represents an expression of comparable concerns about cognitive performance in similarly complex military environments. This example illustrates how various aspects of the two disciplines have been inextricably interwoven over the years. A number of events and trends that followed the cessation of the hostilities of World War II conspired to initiate the emergence of human factors science. In particular, the promulgation and wide dissemination of Shannon's *'information theory'* provided a common language through which the more experimentally oriented behavioral psychologists could now interact with the more mathematically oriented engineering community. It was the presence of this *lingua franca*, as well as the tenets of emerging 'control theory,' that permitted some of the first fruitful forms of interaction at the base of human factors. Founded subsequently on the basis of advances in information theory and servomechanism theory, Norbert Wiener's invention of 'cybernetics' served to provide further valuable conceptual and quantitative basis for the generation of models of early human-machine interaction. However, the most important development along the path of convergence of HF/E was, arguably, the rise of the 'computer.' When the computational medium became the

setting of activity in most modern workplaces, it represented the collapse of the most important barrier between the cognitive and the physical nature of work that had previously separated HF/E. As the byte rather than the erg became the currency of work in most 'postindustrial' circumstances, many HF/E pursuits coalesced. However, there remain many circumstances in which physical labor is still very much the dominant element of human work. In such circumstances, traditional ergonomic concerns about manual handling of materials, repetitive strain trauma, and physical workplace injuries still predominate. This is especially true in parts of Europe and indeed a number of regions across the globe, including the emerging powers of China, India, and Brazil. Overall, the increasing unity of HF/E in the developed world is now reflected in the names of the respective scientific societies, which most often use both terms in their title. Nevertheless, even in the purportedly 'developed' nations, there remain segments of the economy, both in the manufacturing and service industries, in which the physical demands of work still predominate.

The Rise of Computer Influence in HF/E

In this article, it is not possible to deal with all of the various facets of HF/E, such as workplace safety and physical ergonomics. Such issues are fully explored in several of the handbooks cited for further reading. Here, I have chosen to emphasize one major facet of HF/E evolution that deals with human interaction with automated and semiautomated systems. Indeed, the central theme that has dominated computer-mediated work in recent decades has been the removal of the human operator from the inner loop of control. Perhaps the best example of this has occurred in aviation, which was perhaps the first setting for human factors research. Aircraft control of the early years, including the World War II era, featured hands-on piloting. Indeed, the competence of an individual pilot was judged by his or her so-called 'stick and rudder' skills. Even into the era of the Apollo space flights, most advanced systems still relied upon the manual flying skills of pilots as a critical backup capacity, as the first ever moon-landing so clearly illustrated.

In HF/E, this phase of development was reflected by a strong emphasis on the motor control aspects of system operators' responses. The landmark work of Kenneth Craik, who, sadly, died in a road traffic accident, very much reflected the notion of human-in-the-loop actions. A major series of conferences that focused on these issues was even nicknamed 'Annual Manual.' It featured energetic discussions of various engineering models of operator movement responses, typified by the 'transfer function model' and the 'optimal control model.' Such research led to helpful insights, which were incorporated into the later models of operator response capacity. These are still being used by various agencies and military organizations. Despite the progress made in understanding such manual response capacities, it was not too long before the advent of computer-mediated control enabled the human operator to reduce the need for hands-on response. In commercial aviation, this development took the form of the 'automatic pilot.' Similar forms of automation were developed for many other dynamic control situations, including, for

example, industrial process control. This evolution saw the human operator transition from an active, momentary controller of the system to a relatively passive supervisor, his or her requirement to interfere with the on-going processes becoming increasingly sporadic. Researchers such as Sheridan, Moray, and their colleagues revealed a hidden, but growing, problem in semiautomated control systems. That is, when systems rarely require people to respond, people will rarely respond when required. People are not good at passively monitoring systems that fail rarely. This shortcoming is reflected in the inherent problem of human vigilance or sustained attention.

Since the pioneering work of the English scientist Norman Mackworth in the late 1940s and early 1950s, we have known that human beings, in general, are rather poor at vigilance tasks. Asking individuals to monitor the repetitive actions of the more reliable automated systems is not an advisable strategy. Humans quickly get tired, bored, and fatigued in such circumstances. They end up failing to respond. This has been referred to as being 'awake at the switch,' but might be more realistically thought of as being 'asleep at the switch.' Despite this understanding, many systems are designed to take as much advantage of automation as possible. However, because all functions cannot always be automated, we see the human being employed as 'the subsystem of last resort.' Thus, vigilance tasks persist in many occupations and we see them everywhere, modern airport screening being a good example. Vigilance decrements are also very evident in the spectacular failures of many large scale semiautomated systems.

Sadly, it is a true observation that nothing has served to provide an impetus for the HF/E profession as much as the spectacular failures of large scale technical systems. Disasters that are commonly recalled today, such as the '*Chernobyl disaster*' and 'the *Bhopal gas tragedy*,' present evidence of HF/E related failures, and calls for improved HF/E applications quickly followed their occurrence. Perhaps the most famous of such events in the U.S. was the '*Three Mile Island*' accident. In March 1979, events at a nuclear power station in the Susquehanna River near Harrisburg, Pennsylvania, threatened to lead to the nightmare scenario of a nuclear explosion adjacent to a large urban area. Because of safety concerns associated with this incident, construction of nuclear power plants essentially ceased in the United States. However, with the current energy policies now favoring a return of investment in nuclear power generation, and the circulating fear of three decades ago now dissipated, HF/E has again emerged as a critical issue in the prospective safety of any new nuclear facilities. After the threat of immediate disaster had been averted at Three Mile Island, it became very clear that the critical situation had been created by a number of HF/E related failures. These included the poor design of the control room that prevented a clear representation of the state of the plant to the operators who were in charge of the plant and its complex control loops. In its essence, this was a human-machine interface problem made worse by the poorly designed rules of the operation. The impact of Three Mile Island on HF/E was crucial not only in terms of interest and the promotion of science, but also in terms of the many insightful conceptual advances that were made. One of the most profound of these was that of Perrow, whose text '*Normal Accidents*,' became an HF/E classic. The questions for HF/E were many: How should displays be created

to best represent system status to the operators? How should displays be grouped so that the closely related functions appear in appropriate proximity? How do we combat the vigilance decrement? How much cognitive load should each operator be asked to sustain and for how long? What balance is needed between hard rules and spontaneity in operating procedures? These questions provided a major impetus to areas of research such as sustained attention and mental workload evaluation. Also, it created fields of study, such as ecological interface design, that form the centers of discussion in the discipline even today, as do also studies of the social dynamics of teams and the design of operating procedures.

We are still developing our understanding of human interaction with increasingly automated technology. The selfsame questions of vigilance and interface design are still being asked in more modern contexts, such as the control of multiple unmanned aerial vehicles (UAVs). Here, we see the next stage of removal from the direct control loop. The nominal 'pilot' is now not even inside the vehicle itself. In the military context, remote piloting means that the 'operator,' 'controller,' 'supervisor,' and 'pilot' (the roles begin to blur with this progressive remoteness of control) can be, and is indeed on occasion, half a world away. As some UAVs are also armed now, this individual can potentially rain down death and destruction via remote control virtually anywhere on the planet. More than HF/E design questions, this 'remoteness' from the site of action raises moral questions about the technology that we are creating and the way in which it is being used. HF/E cannot divorce itself from such ethical issues.

The most recent trends in HF/E have seen expansions and elaborations into areas of interest beyond the central core discipline. Perhaps the first of such expansions of note concerns the area of sociotechnical systems or 'macroergonomics,' as it has sometimes been called. Traditional HF/E was mainly concerned with one operator acting in conjunction with one single system, just like a single person sitting at a Personal Computer (PC). This limited identification presents useful boundary conditions for scientific study. For example, one can focus on individual cognition, one single interface (i.e., keyboard, mouse, and screen) and one overall response loop. These immediate constraints mean that the problem is bounded and, therefore, somewhat amenable to immediate problem resolution. Unfortunately, people rarely work in isolation. PCs themselves are embedded in both a physical and social context. All too often, supposed 'solutions' that can be derived in the experimental laboratory prove to be unreliable, and even irrelevant, when used in the 'real' world. The importance of the operational context was emphasized in classic works such as Ed Hutchins's *Cognition in the Wild* and a series of HF/E related conferences on Organizational Design and Management (ODAM). It has become clear in the decades of the eighties and nineties that the context of work (e.g., its social and environmental setting), is at least as, if not more, important as the design of interfaces or the memory capacities of a particular operational system. It may well be that this emphasis was derived from earlier European concerns for the overall work environment. In Europe, the standards bodies have had particular influence on such working conditions since the earliest days of the Industrial Fatigue Board that operated in Britain in the early years of the twentieth century. In many

countries, legislation compels the use of ergonomic principles in workplace design.

In addition to the environmental context of work, there has been an increasing emphasis on the social conditions of work settings. Often, people work in teams, and the productivity of a team is contingent upon more than simply the action of each of its individual members. These emergent social properties add another layer of complexity to an already difficult study. Now it was insufficient to simply specify how, for example, the vigilance decrement might influence an operator. It became imperative to specify whether that individual was working alone or in a team setting, such as military special forces or typical industrial operators, where a team-mate might make up for any lapse. Examples such as these have led us to realize the importance of the much more complex evaluation of sociotechnical systems.

One approach to these increasing complexities was to build overall system models. Early models of this type focused on the performance of a single operator. They were often created as an assembly of modules related to the psychological dimensions of response capacity, for example, memory. The development of these models (e.g., SAINT, IMPRINT) were often funded by the military, which needs to predict the performance of servicemen and women. Such selection tools go all the way back to the very earliest efforts at intelligence testing. Other agencies such as NASA pursued their own version of these modeling efforts (e.g., MIDAS) because their particular context of performance had to be modeled in its own special detail. Although large scale sociotechnical models often have certain basic assumptions in common, in detail they tend to vary according to the particular needs of those who had the resources and the capacity to support their creation. Some HF/E modeling efforts have also derived impetus from painful system failures. Today, there are a number of such models, which are integrated with more 'micro' level models of cognition and they are used for the design, selection, and training of large numbers of individuals and systems. They continue to be refined as the empirical basis of understanding itself evolves. The degree to which they accurately portray reality continues to be strongly debated, and their application in real-world situations remains somewhat limited. However, their very formalization gives a solid basis to such disputes, a basis that is sometimes missing in other dimensions of HF/E.

In addition to reaching out to the social sciences, such as organizational design, ethnology, and sociology, one recent effort in HF/E has tried to combine the significant advances in the neurosciences with the control of technology. In HF/E, this effort has been termed neuroergonomics, which is a name first proposed by Parasuraman, a leading researcher in both realms. He defined neuroergonomics as "*the study of brain and behaviour at work.*" Largely as a result of the tremendous innovations in noninvasive brain imaging techniques, we are now able to get a much more detailed and dynamic representation of the brain in action. This view provides diagnostic information that can be used as control inputs for technical systems. Perhaps the most obvious example of this type of brain-machine interface derives from the clinical efforts to provide opportunities for the handicapped, especially those who suffer from what is termed as 'locked-in' syndrome. Such individuals may have unimpaired cognitive capacities but are unable to

express such acts of cognition through their own muscular system. Through the use of technologies such as EEG and imaging approaches, the electrical activity of the brain can be collected, analyzed, subjected to a degree of interpretation and then used as technology control inputs. These enable the individuals with very little or even no voluntary muscle control capacity to activate and operate mostly computer-mediated systems. It is true that at present these systems are often slow and unwieldy. However, these are communication bandwidth and interface issues. Such barriers to efficient interaction should be diminished in the near future. Similar augmented feedback designs can work equally well for unimpaired individuals. This promises an exciting avenue through which to conceive developing HF/E applications.

In these conceptions of mind-machine interfaces, the human operator is the source of intention and generates the command for action. This is then communicated to the computer, which acts as the intermediary and carries out the intended human desire by communicating that command to some other remote entity. However, this feedback loop can be run in a somewhat different fashion. If instead of a simple sequence of momentary events, that is, command, communication, interpretation, and response, we consider this channel as a more general flow of behavior and the operator as commanding the computer, those selfsame neurophysiologic signals can be used by the computer to monitor the state of the operators themselves. Let us hark back to an earlier concern about vigilance failures for an example of how this could work. Suppose that some of the brain signals being monitored by the computer could diagnose an incipient vigilance failure? The computer could then warn the individual of the failing state. Indeed, in extreme emergencies, the computer could take over the function of the operator to ensure that the overall system performed safely. It is this conception that lies at the heart of a program supported by the Defense Advanced Research Project Agency (DARPA) named AUGCOG (for Augmented Cognition). AUGCOG, a very successful program, was initially based on the principle of adaptive systems. To speculate on the future of such adaptive systems, we must delve briefly into their antecedents as human-machine symbiosis is one of the identified directions for future HF/E efforts.

The notion of mutual adaptation between human and machine runs as a general theme through the whole history of HF/E. In the earliest days, of course, the adaptation was slow and episodic. A craftsman may have made a tool to fit his own hand, but it may have been very poorly adapted to any other individual who tried to use it. In the age of mass production, standard sized tools were produced to try to accommodate as much of the population as possible. With later developments, greater ranges of users were catered to, which included the progressive inclusion of women as they entered the workforce and became an increasingly important segment of consumers. Thus, tools in general were fabricated to fit a sufficient number of individuals but for the most part, during the last century and a half, it was the human that did the adapting. This continued into modern times when early PCs were relatively slow, and both hardware and software difficult to use. The idea of static adaptation came with the notion of individualized design, and we can see bespoke products as early indicators of this form of customization. However, computational systems are much

more agile and dynamic in their capacities, and so, moment to moment task adaptation was proposed by Rouse. The extension of this idea by using dynamic physiological indicators, such as heart rate and EEG to perform adaptive, on-line changes in task demand and task structure was introduced by Hancock and Chignell in the early 1980s; from these origins, the notion of dynamic, adaptive systems has developed. It was in these notions and earlier observations of augmentation in the robotic realm of the early 1960s that the idea of going beyond adaptation to human augmentation was also born. Today's opportunities found in web-based applications and hand-held portable technologies, which can access such sources of augmented support, are examples leading toward an eventual state of human-machine symbiosis. However, before I turn to a brief examination of possible future trends for HF/E, I wish to look briefly at some current issues and also at what qualifications it takes to become an HF/E professional.

Contemporary Issues in HF/E

Given that HF/E professionals are looking to improving all forms of interaction with technical systems, it is unsurprising that they are often involved with the most pressing issues of the day. One of the more recent of such concerns has centered around the problems of medical error. Unlike errors in commercial sectors such as aviation, medical error has remained largely hidden. Traditionally, the medical profession has not been associated with extensive public scrutiny of medical failures. Such failures often resulted in the injury or death of only a single individual and as road safety professionals are very aware, such events are not as newsworthy as large scale failures, such as the crash of a commercial aircraft. This relative insulation has also served to inhibit the identification of systemic failures. Each particular incident tended to be seen as the failure of an individual and not the failure of some other element, such as inadequate equipment design or procedural shortcomings. Fortunately, the recent social emphasis on understanding medical error has begun to expose these various forms of failure and now the medical profession has begun to embrace disciplines, such as HF/E, that have now served to significantly improve the record of safety. This is a solid success story, not simply for HF/E, but for the medical profession in general. Although there remains much to be accomplished, the groundswell of effort has set medicine firmly on the track of systematic improvement here.

Another issue that has experienced strong and persistent social interest is sustainability. Care for the environment, in terms of pollution reduction and recycling have begun to have impact. Whether this expression of collective social conscience can be effective within the limited time available, is an inevitable source of concern. However, here the HF/E professional can make a profound contribution. Many incidents of major pollution, for example, *Exxon Valdez*, derive from operator (human) errors expressed in error-intolerant systems. HF/E contributions to improve system safety and reliability can help address these man-made ecologic disasters. As one HF/E luminary, Nickerson, has pointed out, there are in fact very few major social issues where HF/E cannot make a significant impact. From the simple improvements of design for filtering

potable water to the most complex industrial and manufacturing systems, HF/E can contribute not only to improved safety but also to enhanced productivity. One epithet used by many HF/E professionals is that "*good ergonomics is good economics*." Whether good economics is itself good, is a larger ethical issue that HF/E professionals have now begun to wrestle with. From the way in which we elect our representatives to the way we conduct war or provide aid and relief to those in need, HF/E can have a pivotal role in improving the quality of all aspects of life. It is an important and burgeoning profession.

On Being an HF/E Professional

One question that might then come to mind is where those in HF/E come from and how one might join such a profession. The answer to this question is that HF/E professionals come from a wide variety of backgrounds. This fact is evident as one looks through the membership roles of many of the professional societies. The majority of professionals in HF/E possess a background in either experimental/applied psychology or in industrial engineering. Formal programs of study are usually found in such departments in the major universities that teach HF/E in the United States. In Europe, Australia, and Japan also, this is often the case, but around the world, the parent Departments in which HF/E can be found tend to be more diverse. Although any professional can graduate in HF/E or some formally related discipline, there are always a significant proportion of people in HF/E, who have followed programs of study beyond these traditional core disciplines. For example, many from the medical sciences are involved, especially in ergonomics. The formal study of kinesiology also frequently provides a strong base from which to begin a professional career in HF/E. Thus, students of biomechanics can easily apply their knowledge and skills in the field of occupational ergonomics, and graduates in motor control have much of the foundational knowledge of skill development and operator performance assessment. More recently, those studying computer science with a particular focus on interface design and development have entered the field, through concern for usability and specific interest in related fields, such as serious games design. Also, many modeling and simulation graduates specialize in aspects of applied HF/E. Consequently, although there are a number of accepted paths, many diverse avenues of interest can eventually lead to a career in HF/E. Finally, HF/E has a strong and persisting link with Industrial Design. The diversity in the backgrounds of HF/E professionals has led to many debates about the core competencies and professional accreditation of those in HF/E. Indeed, there are a number of such accrediting bodies in existence. However, contentions over the inclusion of diversity while retaining the basic professional standards are issues that have still to be fully resolved in HF/E.

Future Concerns of HF/E

Kenneth Oakley's wonderful text of the mid-twentieth century '*Man the Tool-Maker*' emphasized the crucial relationship between early humans and their tools. Today, we might extend

this vision to suggest that, perhaps, it was not humans who created tools, but rather the tools themselves that served as one of the crucial factors that helped differentiate the human species from all others. However, the idea of tools cannot be confined to their physical representation alone. Indeed, non-physical tools such as language and mathematics have been just as influential in human progress, if not more so. Alongside the progressive evolution of all forms of tools, there has been a comparable evolution in interfaces. Interfaces provide the link between human and tool. Interfaces have also evolved across the ages. Interface evolution represents the growth in the level of intimacy between humans and technology.

For many millennia, we have lived in an active and progressively more symbiotic relationship with our tools. Now, in our own times, the tools are starting to invade our physical being. As we go about our daily activities, we carry many of our essential technologies in our pockets. One can scare people by threatening to take their 'Blackberry' from them. (For those who are reading this in the future, a Blackberry was a form of portable wireless device, which no doubt will soon seem dated, but descriptions of it, will be able to be accessed by existing computer database search engines.) Our current support tools are portable because of the development of microelectronics and the now almost ubiquitous wireless access across the globe. Much of the present size of portable technologies is actually dictated by the need for an interface to have a visible and usable screen, as well as an input device such as a mouse or a keyboard. These interface elements are still at the 'slow and clunky' stage compared to the actual information processing capacities of the devices themselves. But we are starting to do more than simply transport our technologies in our pockets. For example, with devices such as cochlear implants and heart pacemakers, technology is slowly becoming indwelling, within the body itself.

Internal devices, such as pacemakers, act as medical support technologies to help those suffering from disease and injury, or to compensate for inherent problems. Recently, there has been a significant increase in the number of implanted devices for damage mitigation and the amelioration of disease effects. While these are used as forms of function restoration, there is no barrier to their being employed as forms of functional enhancement. My automobile contains a device to provide an automated alarm, if there is an attempt to steal it. My dog has an implanted device to identify his owner, in case he is lost. It will not be long before we have technologies introduced into normal human beings to provide similar capacity enhancement. Devices will literally become a part of us. The future promises a much more radical increase in this form of physical and indeed cognitive intimacy. As the symbiosis between humans and tools is perfected, therefore, interfaces will become not merely transparent but, eventually, like the smile of the Cheshire Cat, they will disappear altogether. We shall have reached true symbiosis when our interfaces with our technology have become completely invisible. These are the optimistic upsides of technological innovation. However, there is a potential downside. For example, greater technological sophistication can mean greater vulnerability. Thus, if we lose the capability to manufacture such devices or the ability to produce energy dense power supplies, either through large scale natural disasters or even man-made global disasters,

our highly interdependent technical world could collapse easily, so much so that we would then envy even the ancient artisan and his 'primitive' survival capacities.

Such developments concerning our ineradicable intimacy with technology will be the subject of much social discussion about issues of privacy, personhood, etc. However, the current state of technology certainly permits such innovation, and there are very few examples of situations in which a technology once invented is intentionally not implemented somewhere in the world. These types of development will begin to force us to ask questions about what it is to be human. For example, where does an individual end? For instance, in education, we test individuals on their memory of learned material, but when memory can be extended by many orders of magnitude by access to distal storage facilities, why are we testing the individual's unaided capacities? Presently, we do not let students use web-access laptops into standardized test examinations. However, will we be able to prevent such access when the individual has an indwelling chip? Indeed, would we want to? This is just one simple example of the possibility of physical extensions of individual human capacities with the bodily insertion of technological support. But the next stage of evolution promises to go well beyond this.

As the physical and cognitive barriers between humans and technologies begin to crumble, we begin to reach what Kurzweil has called the 'singularity' or in De Chardin's prior conceptualization – the 'omega point.' Here, the very nature of consciousness promises to evolve to a following stage of development. When and how those barriers are overcome will have a direct effect upon the nature of this emergent consciousness, and so a direct influence on who and what human beings will turn into. Thus, the purpose of the process will dictate the process of the purpose. The science at the heart of that transition is HF/E.

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Human Intelligence

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Glossary

Culture The set of attitudes, values, beliefs, and behaviors shared by a group of people, which are communicated from one generation to the next, via language and various other means of communication.

General ability An ability that applies across a very wide range of kinds of cognitive tasks, and, arguably, all cognitive tasks.

Heritability The proportion of phenotypic variation in a trait that is due to genetic influences.

Human intelligence A mental quality that consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to manipulate one's environment.

Modifiability The malleability of a trait – its susceptibility to change either in an upward or in a downward direction.

Human intelligence is a mental quality that consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to manipulate one's environment.

Several investigators have emphasized diverse aspects of intelligence in their definitions. For example, in a 1921 symposium, American psychologists Lewis M. Terman and Edward L. Thorndike differed over the definition of intelligence, Terman stressing the ability to think abstractly and Thorndike emphasizing learning and the ability to give good responses to questions. More recently, however, psychologists have generally agreed that adaptation to the environment is the key to understanding both what intelligence is and what it does. Such adaptation may occur in a variety of settings: a student in school learns the material he needs to know in order to do well in a course; a physician treating a patient with unfamiliar symptoms learns about the underlying disease; or an artist reworks a painting to convey a more coherent impression. For the most part, adaptation involves making a change in oneself in order to cope more effectively with the environment, but it can also mean changing the environment or finding an entirely new one.

Theories of Intelligence

Four of the most influential paradigms have been psychological measurement, also known as psychometrics; cognitive psychology, which concerns itself with the processes by which the mind functions; cognitivism and contextualism, a combined approach that studies the interaction between the environment and mental processes; and biological science, which considers the neural bases of intelligence. What follows is a discussion of developments within these four areas.

Psychometric Theories

Psychometric theories have generally sought to understand the structure of intelligence: What form does it take, and what are its parts, if any? Such theories have generally been based on and established by data obtained from tests of mental abilities, including analogies (e.g., *lawyer* is to *client* as *doctor* is to ___), classifications (e.g., Which word does not belong with the

others? *robin*, *sparrow*, *chicken*, *blue jay*), and series completions (e.g., What number comes next in the following series? 3, 6, 10, 15, 21, ___).

Psychometric theories are based on a model that portrays intelligence as a composite of abilities measured by mental tests. One of the earliest of the psychometric theories came from British psychologist Charles E. Spearman (1863–1945), who published his first major article on intelligence in 1904. Spearman concluded that just two kinds of factors underlie all individual differences in test scores. The first and more important factor, which he labeled the 'general factor,' or *g*, pervades performance on all tasks requiring intelligence. In other words, regardless of the task, if it requires intelligence, it requires *g*. The second factor is specifically related to each particular test. For example, if you give someone a test of arithmetical reasoning, performance on it would require a general factor that is common to all tests (*g*), and a specific factor of whatever mental operations are required only for mathematical reasoning as distinct from other mental tests. Thus, these specific (*s*) factors are not of great interest to theories of intelligence because they do not generalize. Spearman did not know exactly what the general factor was, but he proposed in 1927 that it might be something like 'mental energy.' He left the exact nature of mental energy largely undefined.

American psychologist L.L. Thurstone disagreed with Spearman's theory, arguing instead that there were seven factors, which he identified as the 'primary mental abilities.' These seven abilities, according to Thurstone, were verbal comprehension (e.g., knowledge of vocabulary and in reading), verbal fluency (e.g., writing and otherwise producing words), number (e.g., solving fairly simple numerical computation and arithmetical reasoning problems), spatial visualization (e.g., visualizing and manipulating objects, such as fitting a set of suitcases into an automobile trunk), inductive reasoning (e.g., completing a number series or in predicting the future on the basis of past experience), memory (e.g., recalling people's names or faces), and perceptual speed (e.g., proofreading to discover typographical errors in a text).

Although the debate between Spearman and Thurstone has remained unresolved, other psychologists – such as Canadian Philip E. Vernon and American Raymond B. Cattell – have suggested that both were right in some respects. Vernon and

Cattell viewed intellectual abilities as hierarchical, *g*, or general ability, being located at the top of the hierarchy. But below *g* are levels of gradually narrowing abilities, ending with the specific abilities identified by Spearman. Cattell, for example, suggested in 1971 in *Abilities: Their Structure, Growth, and Action* that general ability can be subdivided into two further kinds, 'fluid' and 'crystallized.' Fluid abilities are the reasoning and problem-solving abilities measured by tests such as analogies, classifications, and series completions. Crystallized abilities, which are thought to derive from fluid abilities, include vocabulary, general information, and knowledge about specific fields. American psychologist John L. Horn suggested that crystallized abilities more or less increase over a person's life span, whereas fluid abilities increase in earlier years and decrease in later ones.

American psychologist John B. Carroll, in *Human Cognitive Abilities* (1993), proposed a 'three-stratum' psychometric model of intelligence that expanded upon existing theories of intelligence. Many psychologists regard Carroll's model as definitive, because it is based on reanalyses of hundreds of datasets. In the first stratum, Carroll identified narrow abilities (roughly 50 in number) that included the seven primary abilities identified by Thurstone. According to Carroll, the middle stratum encompassed broad abilities (~10) such as learning, retrieval ability, speediness, visual perception, fluid intelligence, and the production of ideas. The third stratum consisted solely of the general factor, *g*, as identified by Spearman.

It might seem self-evident that the factor at the top would be the general factor, but it is not, in the sense that there is no guarantee that there is any general factor at all. Carroll, as well as many other psychometric theorists, posited that there is such a general factor.

Cognitive Theories

During the era dominated by psychometric theories, the study of intelligence was influenced mostly by those investigating individual differences in people's test scores. In an address to the American Psychological Association in 1957, American researcher Lee Cronbach, a leader in the testing field, decried the lack of common ground between psychologists who studied individual differences and those who studied commonalities in human behavior. Cronbach's plea to unite the 'two disciplines of scientific psychology' led, in part, to the development of cognitive theories of intelligence and of the underlying processes posited by these theories.

Underlying most cognitive approaches to understanding intelligence is the assumption that intelligence comprises mental representations (such as propositions or images) of information and processes that can operate on such representations. A more-intelligent person is assumed to represent information more clearly and to operate faster on these representations. Researchers have sought to measure the speed of various types of thinking. Through mathematical modeling, they divide the overall time required to perform a task into the constituent times needed to execute each mental process. Usually, they assume that these processes are executed serially (one after another) and, hence, that the processing times are additive. But some investigators assume parallel processing, in which more than one process is executed at the same time. Regardless of the type of model used, the fundamental unit of

analysis is the same – that of a mental process acting upon a mental representation. There is fairly good evidence at this point that speed in thinking is one of the sources of individual differences in intelligence. However, this finding needs to be viewed in the context of task needs. In some tasks, it is more intelligent to process information more slowly and more deeply, as when one studies for a test that will measure one's depth of knowledge.

A number of cognitive theories of intelligence have been developed. Among them is that of American psychologists Earl B. Hunt, Nancy Frost, and Clifford E. Lunneborg, who in 1973 showed one way in which psychometrics and cognitive modeling could be combined. Instead of starting with conventional psychometric tests, they began with tasks that experimental psychologists were using in their laboratories to study the basic phenomena of cognition, such as perception, learning, and memory. They showed that individual differences in these tasks, which had never been taken seriously before, were in fact related (although rather weakly) to patterns of individual differences in psychometric intelligence test scores. Their results suggested that the basic cognitive processes are the building blocks of intelligence.

The psychologists hypothesized that a critical ability underlying intelligence is the rapid retrieval of lexical information, such as letter names (e.g., the name of the written letter 'h') from memory. Hence, they were interested in the time needed to react to the question about letter names. By subtracting the reaction time to the question about physical match from the reaction time to the question about name match, they were able to isolate and set aside the time required for sheer speed of reading letters and pushing buttons on a computer. They found that the score differences seemed to predict psychometric test scores, especially those on tests of verbal ability such as reading comprehension. Hunt, Frost, and Lunneborg concluded that verbally facile people are those who are able to absorb and then retrieve from memory large amounts of verbal information in short amounts of time. The time factor was the significant development in this research.

A few years later, Sternberg suggested an alternative approach that could resolve the weak relation between cognitive tasks and psychometric test scores. He argued that Hunt and his colleagues had tested for tasks that were limited to low-level cognitive processes. Although such processes may be involved in intelligence, Sternberg claimed that they were peripheral rather than central. He recommended that psychologists study the tasks found on intelligence tests and then identify the mental processes and strategies people use to perform those tasks.

A different approach was taken in the work of British psychologist Ian Deary, following up on the work of Ted Nettlebeck among others. He argued that inspection time is a particularly useful means of measuring intelligence. It is thought that individual differences in intelligence may derive in part from differences in the rate of intake and processing of simple stimulus information. In the inspection-time task, a person looks at two vertical lines of unequal length and is asked to identify which of the two is longer. Inspection time is the length of time of stimulus presentation each individual needs in order to discriminate which of the two lines is the longest. Some research suggests that more-intelligent individuals

are able to discriminate the lengths of the lines in shorter inspection times.

Other cognitive psychologists have studied human intelligence by constructing computer models of human cognition. Two leaders in this field were American computer scientists Allen Newell and Herbert A. Simon. In the late 1950s and early 1960s, they worked with computer expert Clifford Shaw to construct a computer model of human problem solving. Called the General Problem Solver, it could find solutions to a wide range of fairly structured problems, such as logical proofs and mathematical word problems. This research, based on a heuristic procedure called 'means-ends analysis,' led Newell and Simon to propose a general theory of problem solving in 1972. More recently, Marcel Just, Patricia Carpenter, and others have devised computer-simulation models of problem solving of the kinds required for complex problem solving.

All of the cognitive theories described so far rely on what psychologists call the 'serial processing of information,' meaning that in these examples, cognitive processes are executed in series, one after another. Yet the assumption that people process chunks of information at a time may be incorrect. Many psychologists have suggested instead that cognitive processing is primarily parallel. It has proved difficult, however, to distinguish between serial and parallel models of information processing. Advanced techniques of mathematical and computer modeling were later applied to this problem. Possible solutions have included 'parallel distributed processing' models of the mind, as proposed by the psychologists David E. Rumelhart and Jay L. McClelland. These models postulated that many types of information processing occur within the brain at once, rather than just one at a time.

Recent cognitive work on intelligence has emphasized the importance of working memory, usually viewed as that portion of long-term memory that is activated at a given moment in time. Working-memory tasks usually involve some element of active information processing. For example, one test of working memory is to recall a string of digits in backward order – that is, the order opposite to that in which the digits were presented. Research by Alan Baddeley, Patrick Kyllonen, Meredyth Daneman, Randall Engle, and others has suggested that working-memory ability is highly correlated with and may be a precursor to the 'general ability' described in the section on psychometric models.

Cognitive–Contextual Theories

Cognitive–contextual theories deal with the way in which cognitive processes operate in various settings. For example, being smart in a hunting–gathering society might involve somewhat different skills from those involved in being smart in an industrialized society. There might be some, but not complete, overlap. Two of the major cognitive–contextual theories are that of American psychologists Howard Gardner and Robert Sternberg.

In 1983 and then at various times into the 2000s, Gardner first challenged the assumption of a single intelligence by proposing a theory of 'multiple intelligences.' Earlier, theorists had gone so far as to contend that intelligence comprises multiple abilities. But Gardner went one step further, arguing that intelligences are multiple and include, at a minimum, linguistic, logical-mathematical, spatial, musical, bodily kinesthetic, naturalist, interpersonal, and intrapersonal intelligence.

Some of the intelligences proposed by Gardner resembled the abilities proposed by psychometric theorists, but others did not. For example, the idea of a musical intelligence was relatively new, as was the idea of a bodily kinesthetic intelligence, which encompassed the particular abilities of athletes and dancers. Gardner derived his set of intelligences chiefly from studies of cognitive processing, brain damage, exceptional individuals, and cognition across cultures. He has also speculated on the possibility of an existential intelligence (a concern with 'ultimate' issues, such as the meaning of life), although he was unable to isolate an area of the brain that was dedicated to the consideration of such questions. Gardner's research on multiple intelligences led him to claim that most concepts of intelligence had been ethnocentric and culturally biased but that his was universal, because it was based on biological and cross-cultural data as well as upon data derived from the cognitive performance of a wide array of people.

An alternative approach that took similar account of cognition and cultural context was Sternberg's 'triarchic' theory, which he proposed in *Beyond IQ: A Triarchic Theory of Human Intelligence* (1985). Both Gardner and Sternberg believed that conventional notions of intelligence were too narrow; Sternberg, however, questioned how far psychologists should go beyond traditional concepts, suggesting that musical and bodily kinesthetic abilities are talents rather than intelligences because they are fairly specific and are not prerequisites for adaptation in most cultures.

Sternberg posited three ('triarchic') integrated and interdependent aspects of intelligence, which are concerned, respectively, with a person's internal world, the external world, and experience. The first aspect comprises the cognitive processes and representations that form the core of all thought. The second aspect consists of the application of these processes and representations to the external world. The triarchic theory holds that more-intelligent persons are not just those who can execute many cognitive processes quickly or well; rather, their greater intelligence is reflected in knowing their strengths and weaknesses and capitalizing upon their strengths while compensating for their weaknesses. More-intelligent persons, then, find a niche in which they can operate most efficiently. The third aspect of intelligence consists of the integration of the internal and external worlds through experience. This includes the ability to apply previously learned information to new or wholly unrelated situations.

Sternberg and his colleagues have found that this broader model of intelligence can be used as a basis for both instruction and assessment. They found that students instructed in ways that emphasize creative and practical information processing as well as memory and analytical processing show improved performance in school. Tests based on the theory can improve prediction of performance in the first year of university and can also reduce ethnic-group differences relative to more conventional psychometric tests.

Other intelligences were proposed in the late twentieth century. In 1990, psychologists John Mayer and Peter Salovey defined the term *emotional intelligence* as the ability to perceive emotions, to access and generate emotions so as to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions so as to promote emotional and intellectual growth.

The four aspects identified by Mayer and Salovey involve (1) recognizing one's own emotions as well as the emotions

of others, (2) applying emotion appropriately to facilitate reasoning, (3) understanding complex emotions and their influence on succeeding emotional states, and (4) having the ability to manage one's emotions as well as those of others. The concept of emotional intelligence was popularized by psychologist and journalist Daniel Goleman in books published from the 1990s through the first decade of the 2000s. Several tests developed to measure emotional intelligence have shown modest correlations between emotional intelligence and conventional intelligence.

Another kind of intelligence first proposed by Edward Thorndike early in the twentieth century, and then studied later by John Kihlstrom and Nancy Cantor and popularized by Daniel Goleman, is social intelligence, or one's ability to interact effectively with others. The basic notion underlying this work is that, without the ability to get along with others, people high in cognitive intelligence may find that they cannot adapt effectively to the social demands of everyday life.

Biological Theories

These theories seek to understand intelligence in terms of hypothetical mental constructs, whether they are factors, cognitive processes, or cognitive processes in interaction with context. Biological theories represent a radically different approach that dispenses with mental constructs altogether. Advocates of such theories, usually called reductionists, believe that a true understanding of intelligence is possible only by identifying its biological basis. Some would argue that there is no alternative to reductionism if, in fact, the goal is to explain rather than merely to describe behavior. Although relatively little is known about the biological bases of intelligence, progress has been made on three different fronts, all involving studies of brain operation.

Hemispheric studies

One biological approach has centered upon types of intellectual performance as they relate to the regions of the brain from which they originate. In her research on the functions of the brain's two hemispheres, psychologist Jerre Levy and others found that the left hemisphere is superior in analytical tasks, such as are involved in the use of language, while the right hemisphere is superior in many forms of visual and spatial tasks. Overall, the right hemisphere tends to be more synthetic and holistic in its functioning than the left. Nevertheless, patterns of hemispheric specialization are complex and cannot easily be generalized.

The specialization of the two hemispheres of the brain is exemplified in an early study by Levy and American neurobiologist Roger W. Sperry, who worked with split-brain patients – that is, individuals whose corpus callosum had been severed. Sperry, a Nobel-Prize winner, was a pioneer in this field. Because the corpus callosum links the two hemispheres in a normal brain, in these patients, the hemispheres function independently of each other. Michael Gazzaniga has also been active in this field and has suggested that, to some extent, the left hemisphere of the brain serves a monitoring function, including monitoring the activities of the right hemisphere.

More recently, lesion studies have suggested areas of the brain particularly associated with intelligence. They include

but are not limited to the superior colliculus, posterior cingulate, dorsal hippocampus, posterolateral hypothalamus, parietal cortex, and occipitotemporal cortex. Further studies have implicated the ventrolateral thalamus, pontine reticular formation, dorsal caudatoputamen, globus pallidus, substantia nigra, ventral tegmental areas, and median raphe as well.

Brain-wave studies

A second front of biological research has involved the use of brain-wave recordings. German-born British psychologist Hans Eysenck, for example, studied brain patterns and speed of response in people taking intelligence tests. Earlier, brain-wave research had studied the relation between these waves and performance on ability tests or in various cognitive tasks. Researchers in some of these studies found a relationship between certain aspects of electroencephalogram (EEG) waves, event-related-potential (ERP) waves, and scores on a standard psychometric test of intelligence. The results of this approach have been inconsistent and not always promising. However, use of averaged evoked potentials by Aljoscha Neubauer and his colleagues have suggested that speed of processing is associated with individual differences in intelligence.

Blood-flow studies

A third and more recent front of research involves the measurement of blood flow in the brain, which is a fairly direct indicator of functional activity in brain tissue. In such studies, the amount and location of blood flow in the brain is monitored while subjects perform cognitive tasks. Psychologist John Horn, a prominent researcher in this area, found that older adults show decreased blood flow to the brain; that such decreases are greater in some areas of the brain than in others; and that the decreases are particularly notable in those areas responsible for close concentration, spontaneous alertness, and the encoding of new information. Using positron emission tomography (PET), the psychologist Richard Haier found that people who perform better on conventional intelligence tests often show less activation in relevant portions of the brain than do those who perform less well. In addition, neurologists Antonio Damasio and Hannah Damasio and their colleagues used PET scans and magnetic resonance imaging (MRI) to study brain function in subjects performing problem-solving tasks. These findings affirmed the importance of understanding intelligence as a faculty that develops over time.

Development of Intelligence

There have been a number of approaches to the study of the development of intelligence. Psychometric theorists, for instance, have sought to understand how intelligence develops in terms of changes in intelligence factors and in various abilities in childhood. For example, the concept of mental age was popular during the first half of the twentieth century. A given mental age was held to represent an average child's level of mental functioning for a given chronological age. Thus, an average 12-year-old would have a mental age of 12, but an above-average 10-year-old or a below-average 14-year-old might also have a mental age of 12 years. The concept of mental age fell into disfavor, however, for two apparent reasons. First, the concept does not seem to work after about the age of 16. The mental

test performance of, say, a 25-year-old is generally no better than that of a 24- or 23-year-old, and in later adulthood some test scores seem to start declining. Second, many psychologists believe that intellectual development does not exhibit the kind of smooth continuity that the concept of mental age appears to imply. Rather, development seems to come in intermittent bursts, whose timing can differ from one child to another. Third, it assumes that all abilities mature at roughly the same times and at the same rates.

The Work of Jean Piaget

The landmark work in intellectual development in the twentieth century derived not from psychometrics but from the tradition established by Swiss psychologist Jean Piaget. His theory was concerned with the mechanisms by which intellectual development takes place and periods through which children develop. Piaget believed that children explore the world and observe regularities and make generalizations – much as a scientist does. Intellectual development, he argued, derives from two cognitive processes that work in somewhat reciprocal fashion. The first, which he called assimilation, incorporates new information into an already existing cognitive structure. The second, which he called accommodation, forms a new cognitive structure into which new information can be incorporated. Cognitive development, according to Piaget, represents a dynamic equilibrium between the two processes of assimilation and accommodation.

As a second part of his theory, Piaget postulated four major periods in individual intellectual development. The first, the sensorimotor period, extends from birth through roughly age 2. During this period, a child learns how to modify reflexes to make them more adaptive, to coordinate actions, to retrieve hidden objects, and, eventually, to begin representing information mentally. The second period, known as preoperational, runs approximately from age 2 to age 7. In this period, a child develops language and mental imagery and learns to focus on single perceptual dimensions, such as color and size. The third, the concrete-operational period, ranges from about age 7 to 12. During this time, a child develops so-called conservation skills. Conservation skills enable a person to recognize that things that may appear to be different are actually the same, that is, that their fundamental properties are ‘conserved.’ For example, suppose that water is poured from a wide short beaker into a tall narrow one. A preoperational child, when asked which beaker has more water, will say that the second beaker does (the tall thin one); a concrete-operational child, however, will recognize that the amount of water in the beakers must be the same. Finally, children emerge into the fourth, formal-operational period, which begins at about age 12 and continues throughout life. The formal-operational child develops thinking skills in all logical combinations and learns to think with abstract concepts. For example, a child in the concrete-operational period will have great difficulty determining all the possible orderings of four digits, such as 3-7-5-8. The child who has reached the formal-operational stage, however, will adopt a strategy of systematically varying alternations of digits, starting perhaps with the last digit and working toward the first. This systematic way of thinking is not normally possible for those in the concrete-operational period.

The Environmental Viewpoint

The views of intellectual development described earlier all emphasize the importance of the individual in intellectual development. But an alternative viewpoint emphasizes the importance of the individual’s environment, particularly his social environment. This view is related to the cognitive-contextual theories discussed earlier. Championed originally by Russian psychologist L.S. Vygotsky, this viewpoint suggests that intellectual development may be largely influenced by a child’s interactions with others: a child sees others thinking and acting in certain ways and then internalizes and models what is seen. An elaboration of this view is the suggestion by Israeli psychologist Reuven Feuerstein that the key to intellectual development is what he called ‘mediated learning experience.’ The parent mediates, or interprets, the environment for the child, and it is largely through this mediation that the child learns to understand and interpret the world.

The role of environment is particularly evident in studies across cultures. In her research on the cultural contexts of intelligence, Greenfield, studying indigenous Mayan people, found that the Mayan conception of intelligence is much more collective – group oriented – than the conception of intelligence in European or North American cultures. To the Maya, much of being intelligent involves being able to work effectively with others. In addition, psychologist Elena Grigorenko and her colleagues, in *The Organization of Luo Conceptions of Intelligence: A Study of Implicit Theories in a Kenyan Village* (2001), reported that rural Kenyans have a broad conception of intelligence that emphasizes moral behavior, particularly duty to others.

Children who grow up in environments that do not stress Western principles of education may not be able to demonstrate their abilities on conventional Western intelligence tests. Sternberg and others have found that rural Tanzanian children performed much better on skills tests when they were given extended instruction beyond the normal test instructions. Without this additional instruction, however, the children did not always understand what they were supposed to do, and, because of this, they underperformed on the tests. Similarly, a study in Kenya measured children’s knowledge of natural remedies used to combat parasites and other common illnesses. Tests for this type of knowledge were combined with conventional Western tests of intelligence and academic achievement. Results showed a negative correlation between practical intelligence (knowledge of medical remedies) and academic achievement. These findings suggested that in some cultures, academic skills may not be particularly valued; as a result, the brighter children invest more effort in acquiring practical skills.

Research also suggests that people around the world have somewhat different conceptions of just what it means to be intelligent. For example, North American and Northern European notions of intelligence have emphasized cognitive skills, whereas African notions have more emphasized social ones. Asian views have often deemphasized the importance of intelligence as an individual-differences variable and instead have focused upon the importance of group products and of effort. According to Richard Nisbett in *The Geography of Thought* (2004), Asians often perceive things quite differently. For example, in a picture of fish swimming against a background context, Americans more notice the fish and Asians more notice what to the Americans is the background context.

Measuring Intelligence

Almost all of these theories employ complex tasks for gauging intelligence in both children and adults. Over time, theorists chose particular tasks for analyzing human intelligence, some of which have been explicitly discussed here – for example, recognition of analogies, classification of similar terms, extrapolation of number series, and performance of transitive inferences. Although the kinds of complex tasks discussed so far belong to a single tradition for the measurement of intelligence, the field actually has two major traditions. The tradition that has been discussed most prominently and has been most influential is that of French psychologist Alfred Binet (1857–1911).

An earlier tradition, and one that still shows some influence upon the field, is that of English scientist Sir Francis Galton. Building on ideas put forth by his uncle Charles Darwin in *On the Origin of Species* (1859), Galton believed that human capabilities could be understood through scientific investigation. From 1884 to 1890 Galton maintained a laboratory in London where visitors could have themselves measured on a variety of psychophysical tasks, such as weight discrimination and sensitivity to musical pitch. Galton believed that psychophysical abilities were the basis of intelligence and, hence, that these tests were measures of intelligence. The earliest formal intelligence tests, therefore, required a person to perform such simple tasks as deciding which of two weights was heavier or showing how forcefully one could squeeze one's hand.

The Galtonian tradition was taken to the United States by American psychologist James McKeen Cattell. Later, one of Cattell's students, American anthropologist Clark Wissler, collected data showing that scores on Galtonian types of tasks were not good predictors of grades in college or even of scores on other tasks. Cattell nonetheless continued to develop his Galtonian approach in psychometric research and, with Edward Thorndike, helped to establish a center for mental testing and measurement.

The IQ Test

The more influential tradition of mental testing was developed by Binet and his collaborator, Theodore Simon, in France. In 1904, the minister of public instruction in Paris named a commission to study or create tests that would ensure that mentally retarded children received an adequate education. The minister was also concerned that children of normal intelligence were being placed in classes for mentally retarded children because of behavior problems. Even before Wissler's research, Binet, who was charged with developing the new test, had flatly rejected the Galtonian tradition, believing that Galton's tests measured trivial abilities. He proposed instead that tests of intelligence should measure skills such as judgment, comprehension, and reasoning – the same kinds of skills measured by most intelligence tests today. Binet's early test was taken to Stanford University by Lewis Terman, whose version came to be called the Stanford-Binet test. This test has been revised frequently and continues to be used in countries all over the world. The Stanford-Binet V (fifth edition) test, and others like it, has yielded at the very least an overall score referred to as an intelligence quotient (IQ). The fifth edition, published in 2009, also yields scores for fluid reasoning, knowledge, quantitative reasoning, abstract/visual

reasoning, visual-spatial processing, and working memory. Each is assessed in verbal and nonverbal domains. Some tests, such as the Wechsler Adult Intelligence Scale IV (fourth edition, published in 2008) and the Wechsler Intelligence Scale for Children IV (fourth edition, published in 2004), have verbal and performance tests. The scales yield an overall IQ as well as scores for verbal comprehension, perceptual reasoning, working memory, and processing speed. An example of a verbal subtest would be vocabulary, whereas an example of a performance subtest would be picture arrangement, the latter requiring an examinee to arrange a set of pictures into a sequence so that they tell a coherent story.

Later developments in intelligence testing expanded the range of abilities tested. For example, in 1997 and in 2004, psychologists J. P. Das and Jack A. Naglieri published the *Cognitive Assessment System*, a test based on a theory of intelligence first proposed by Russian psychologist Alexander Luria. The test measured planning abilities, attentional abilities, and simultaneous and successive processing abilities. Simultaneous processing abilities are used to solve tasks such as figural matrix problems, in which the test taker must fill in a matrix with a missing geometric form. Successive processing abilities are used in tests such as digit span, in which one must repeat back a string of memorized digits.

IQ on these and other tests was originally computed as the ratio of mental age to chronological (physical) age, multiplied by 100. Thus, if a child of age 10 had a mental age of 12 (i.e., performed on the test at the level of an average 12-year old), the child was assigned an IQ of $12/10 \times 100$, or 120. If the 10-year-old had a mental age of 8, the child's IQ would be $8/10 \times 100$, or 80. A score of 100, where the mental age equals the chronological age, is average.

The concept of mental age has fallen into disrepute. Many tests still yield an IQ, but they are most often computed on the basis of statistical distributions. The scores are assigned on the basis of what percentage of people of a given group would be expected to have a certain IQ.

The Distribution of IQ Scores

Intelligence test scores follow an approximately normal distribution, meaning that most people score near the middle of the distribution of scores and that scores drop off fairly rapidly in frequency as one moves in either direction from the center. For example, on the IQ scale, about 2 out of 3 scores fall between 85 and 115, and about 19 out of 20 scores fall between 70 and 130. Put another way, only 1 out of 20 scores differs from the average IQ (100) by more than 30 points.

The significance of a given test score can be different for different people. A certain IQ score may indicate a higher level of intelligence for a person who grew up in poverty and attended an inadequate school than it would for a person who grew up in an upper-middle-class environment and was schooled in a productive learning environment. An IQ score on a test given in English may also indicate a higher level of intelligence for a person whose first language is not English than it would for a native English speaker. Another factor that affects the significance of test scores is that some people are 'test-anxious' and may do poorly on almost any standardized test. Because of these and similar drawbacks, it has come to be

believed that scores should be interpreted carefully, on an individual basis.

Heritability and Malleability of Intelligence

Intelligence has historically been conceptualized as a more or less fixed trait. A minority of investigators believe either that it is highly heritable or that it is minimally heritable, while most take an intermediate position.

Among the most fruitful methods that have been used to assess the heritability of intelligence is the study of identical twins who were separated at an early age and reared apart. If the twins were raised in separate environments, and if it is assumed that when twins are separated they are randomly distributed across environments (often a dubious assumption), then the twins would have in common all of their genes but none of their environment, except for chance environmental overlap. As a result, the correlation between their performance on intelligence tests could identify any possible link between test scores and heredity. Another method compares the relationship between intelligence-test scores of identical twins and those of fraternal twins. Because these results are computed on the basis of intelligence-test scores, however, they represent only those aspects of intelligence that are measured by the tests.

Studies of twins do in fact provide strong evidence for the heritability of intelligence; the scores of identical twins reared apart are highly correlated. In addition, adopted children's scores are highly correlated with their birth parents and not with their adoptive parents. Also significant are findings that heritability can differ between ethnic and racial groups as well as across time within a single group. That is, the extent to which genes versus environment matter in IQs depends on many factors including socioeconomic class. In general, the heritability of intelligence is estimated to average around 0.50, meaning that 50% of phenotypic (observable) variation in IQ is a result of genetic causes. However, work by Eric Turkheimer and colleagues suggests that heritability is lower in people of lower social classes than in people of higher social classes, presumably because environment has more of an effect on the former than on the latter. Moreover, psychologist Robert Plomin and others have found that evidence of the heritability of intelligence increases with age; this suggests that, as a person grows older, genetic factors become a more important determinant of intelligence, while environmental factors become less important.

Whatever the heritability of IQ may be, it is a separate issue from whether intelligence can be increased. Evidence that it can was provided by American-born New Zealand political scientist James Flynn, who showed that intelligence test scores around the world rose steadily in the late twentieth century. The reasons for the increase are not fully understood, however, and the phenomenon thus requires careful further

investigation. Among many possible causes of the increase, for example, are environmental changes such as the addition of vitamin C to prenatal and postnatal diet and, more generally, the improved nutrition of mothers and infants compared with earlier in the century. The so-called 'Flynn effect' appears to have tapered off in the twenty-first century.

In their controversial book, *The Bell Curve* (1994), Richard Herrnstein and Charles Murray argued that IQ is important for success in life, and that differences between ethnic and other groups in life success can be attributed in part to differences in IQ. They speculated that these differences might be genetic. As mentioned earlier, at this time, this statement remains speculative.

Recent research, reviewed by Samuel Mandelman and Elena Grigorenko in 2009, attempts to identify the genetic loci of individual differences in intelligence. Research in this area has been challenging, as some of it has utilized small numbers of cases, or only extreme cases. Some possible loci of intelligence have been identified, but replications are needed. Moreover, intelligence almost certainly appears to be diffusely represented across genes rather than localized in any small number of genes.

Richard Nisbett in 2009 reviewed the literature on the malleability of intelligence and concluded that, although it is not possible to transform people with intellectual disabilities into geniuses, there is good evidence that intelligence can be improved through good schooling and through various kinds of mental exercises. Thus, there is reason to believe that, for those who wish to improve their intelligence, at least small gains are well within the realm of plausibility.

See also: Academic Achievement; The Behavior-Genetics of Intelligence; Creativity.

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Human Mating

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Glossary

Allomothering An arrangement between a collective of females to cooperate in rearing their offspring.

Estradiol A hormone that co-occurs with ovulation.

Fecundity cues These are cues that signal an individual is likely to bear numerous offspring.

Heuristic A decision shortcut that is best described as a 'rule of thumb.'

Life history theory A mid-level evolutionary theory accounting for species-level and individual-level tradeoffs

between the allocation of bioenergetic resources to survival and mating.

Proximity Located near one another.

Serotonin A neurotransmitter associated with feelings of bonding, empathy, and happiness.

Sex ratio More specifically, the operational sex ratio refers to the ratio of sexually reproducing members of each sex.

Socioecology A composite of biological, environmental, and social factors that compose the environment.

Introduction

What do women want? What do men want? Why do people cheat? Why does sexual harassment and rape occur? Modern answers to these questions come from two paradigms. The sociocultural paradigm argues that because of differing access to economic resources either today or over generations, men and women have different mating psychologies. Specifically, because women have historically had limited access to economic resources, it makes sense for them to acquire such resources through their mates. The other approach is based on evolutionary theory, and posits that men and women differ with respect to unique, recurrent adaptive challenges they faced over evolutionary time. Whereas the sociocultural paradigm tends to be based on cultural norms and proximate factors, an evolutionary approach emphasizes on more ultimate causations, drawing upon theories and findings from biology, anthropology, and ethology. Specifically, humans may have evolved certain psychologies in mating and other domains that enable them to reproduce more successfully. In this article, we focus on the evolutionary perspective, as much of the theoretical developments and empirical findings in human mating have emerged from this perspective in recent years.

Parental Investment Theory

Parental investment theory enables evolutionary psychologists to formulate hypotheses and make predictions regarding sex differences in mating strategy. According to this theory, the sex that is physiologically required to invest more in offspring evolves to be more choosy regarding mates, because a mating error (mating with a low-quality or noninvesting partner) is more costly to that sex. In other words, it is in the reproductive interest of the higher-investing sex (actually, their genes) to avoid mating with low-quality mates. In contrast, it is in the reproductive interest of the non- or lesser-investing sex to be intrasexually competitive in order to gain access to members of the more valuable sex. In the vast majority of mammals,

females are physiologically required to invest more heavily on their offspring; thus, they have evolved to be the choosier sex.

For humans, sexual activity can lead a woman to incur several months of pregnancy and (in ancestral times, when mating psychologies evolved) years of nursing. Although human males often invest in their children, a copulation is the extent of their physiological obligation to parenting. Thus, relative to one another, women, who have to invest much more, have evolved to prefer long-term, committed relationships with high quality and resourceful partners, whereas men have evolved to prefer short-term, casual sexual relationships with numerous fertile partners (those who, upon having sex, are likely to become pregnant).

Consistent with this theory, research has shown that women, more than men, try to slow the speed at which relationships escalate to sex, have a lessened willingness to engage in casual sex, and engage in short-term mating as a way to better access long-term relationships. In contrast, men, who have low costs associated with casual sexual encounters, tend to desire easy and quick access to willing partners, be patrons of adult entertainment (i.e., strippers, prostitutes, and pornography), fall in love quickly (in order to convince partners of their commitment and thus, to induce sexual activity), be aroused by fecundity cues, and be more willing to engage in casual sex.

Mating Systems

Because human offspring require several years of nurturance and benefit greatly from biparental care, human mating systems tend to be centered around long-term relationships and marriage. The exact form that such relationships take depends on both biological and socioecological constraints that occur both intersexually and intrasexually.

Marriage and Long-Term Relationships

The sex ratio for each marriage can involve one man and one woman (monogamy), one man and many women (polygyny),

or two or more men with one woman (polyandry). Which form predominates depends on the access that men have to resources. Polyandry tends to occur where resources are difficult to acquire. For instance, in mountain farming communities, resources are scarce – they are extracted from the earth in a labor-intensive manner whereby the collective effort of multiple males are necessary to produce enough resources to sustain a single family. In other words, on their own, men in these communities cannot individually afford a wife and family, so they team up. However, they team up not randomly, but with brothers, who are genetically related. These ecological constraints instigate a situation that, on average, is beneficial to the female, but less than ideal for the individual males.

In contrast, polygyny tends to occur where there is large variance in the amount of resources that men have. Whereas many men are very poor with little or no resources, some are able to accumulate and defend an immense amount. If famines occur, men with plentiful resources would still be able to feed their families, whereas poor men may have no means of keeping their families alive. In such circumstances, wealthy men are able to attract and secure many wives. Indeed, various kings and emperors have each had hundreds of wives and evidence suggests that polygyny has been pervasive throughout human history. In today's societies, mating arrangements seem to follow a form of mild polygamy. That is, most people mate with more than one person throughout their lifetime, but do not commit to more than one person at the same time for a life-long partnership.

Long-term relationships encompass not only marriages but also (at least in modern societies) monogamous dating relationships. In long-term mating contexts, both sexes would be investing heavily in a single partner and any subsequent offspring. As such, it makes sense that each sex would have high standards in mate quality and value traits that denote good long-term potential. Indeed, social and evolutionary psychologists have found that this is the case: for committed, long-term relationship partners, both sexes are very selective. Both large-scale international studies and smaller-scale studies have shown that men and women both want long-term mates who are kind, have a sense of humor, and are intelligent. However, in line with sex differences in what constitutes reproductive value, men value physical attractiveness and youth (because women who are young and physically attractive are likely to be fertile and have many fertile years remaining) in their long-term mates more whereas women place higher value on a potential partner's social status and resources (and thus, ability to invest in potential offspring).

Short-Term Relationships

Although most people in most societies get married, not all human mating relationships are for the long term. Some individuals mate by engaging in casual sex. Short term, casual sexual relationships have recently been investigated by various researchers. Typically, researchers have focused on the one-night stand. In such relationships, individuals meet and go relatively quickly from zero-acquaintance to the act of sex and then back to zero-acquaintance. There is little promise of future relationship potential. Although relatively rare in actual occurrence, the one-night stand is theoretically

important because, when compared to the committed, long-term relationship, it illustrates key sex differences.

Although men are by no means exclusively interested in this type of relationship, they are much more willing to engage in such behavior than women are. In a noted study that has been replicated numerous times, confederates asked strangers in a campus mall one of three questions: Will you go on a date with me? Will you go back to my apartment with me? Will you go to bed with me? Although half of women and half of men said yes to a date, very few women agreed to going back to a stranger's apartment and not a single woman agreed to the overtly sexual invitation. In contrast, men's likelihood of agreeing increased as the prospect of sexual activity increased (about 75% of men said yes to sex; many of the other 25% apologized or attempted to reschedule).

Women do engage in casual sex behavior, albeit more sparingly and perhaps more strategically. Although women reproductively benefit the most from having a long-term partner who is both genetically fit and who invests plentiful resources, such men tend to be in short supply and to not be monogamous. Thus, women may enact a mixed mating strategy: securing the investment of one man as a long-term partner, but obtaining higher quality genes from another (more physically attractive) man, via sexual affairs. Indeed, an extensive line of research on women's menstrual cycles has found that when they are ovulating (and thus, most likely to conceive), women are most likely to engage in extrapair sex and their psychology seems to be aligned toward attracting extrapair partners. Women who are ovulating tend to be more scantily dressed, more likely to go out without their long-term mate, likely to have more sexual fantasies – but about men other than their primary partner, and may even release a pheromone that increases sexual arousal in men. Moreover, when women are ovulating, their male partners tend to guard them more (e.g., keeping tabs on their whereabouts). Around ovulation, women have a pronounced preference for men with masculine and symmetrical features, who presumably are more genetically fit.

In addition to those playing a mixed mating strategy, women may seek sexual encounters when they are single. Such women tend to be those who have more testosterone and score high on measures of sociosexuality (i.e., willing to have sex without signs of love and commitment), but may also be attempting to secure a long-term relationship partner by casting a wider (sexual) net or to extract immediate resources from a man who lavishly spends money.

Hybrid Relationships

Whereas long-term, committed relationships (e.g., marriage) and short-term, casual sexual relationships (e.g., one-night stands) represent opposite types of relationships, there are various relationships that are somewhere in between, with elements of each. Such relationships include the booty-call, friends-with-benefits, and swingers. The former two are situations in which individuals with some level of acquaintance engage in sex, but are not committed to each other. Between one-third and one-half of college students report engaging in these types of mateships.

Such relationships can potentially be viewed as market-driven compromises between men's and women's ideal

relationship types. That is, men would prefer to have casual sex with whomever they want, but women are unlikely to provide this. In contrast, women tend to want commitment, but men are not always offering that. Hybrid relationships tend to provide women with access to mates they would be unable to attain as monogamous, fully committed partners. For men, these couplings may provide sexual access for a relatively low level of investment. Thus, in the process of implicit negotiations taking place between individuals in the mating market, each sex gives some ground in order to facilitate a mateship that takes the form of a hybrid relationship.

Another form of compromise between the sexes might be consensual nonmonogamy (CNM). Between 25% and 75% of Americans have reported engaging in extramarital sex, but it is unknown how much of this is cheating and how much is actually consensual. CNM consists of three main types of relationships: swinging, polyamory, and open relationships. Swinging consists of couples who are involved in a serious, romantic relationship (usually marriage), but also engage in some degree of partner-swapping. Polyamory is based on the idea that one can be in love with, and committed to, multiple partners. Open relationships are quite variable and can consist of anything from casual to committed dating with more than one individual. All of these relationships typically involve explicit negotiation. First, both partners discuss whether or not they want to be nonmonogamous and what the terms of their relationship will be. Second, each sex may be motivated to pursue this relationship option to satisfy some of their needs that are not being met in their current relationship. For instance, CNM may provide increased sexual variety (more appealing to men) and the chance to obtain further intimacy (more appealing to women). Scientific understanding of such relationships is still, however, rather limited. Thus, future research is needed to more carefully explore the motives behind these relationships.

Homosexuality

A common criticism of evolutionary psychology is that it only explains heterosexual behavior. From noteworthy reports by Janus and Kinsey, we know that up to 10% of men and 5% of women report being homosexual; these rates have remained reasonably stable over the last 60 years. Furthermore, twin studies have indicated that homosexuality is up to 50% heritable. Superficially, being homosexual should decrease one's inclusive (reproductive) fitness because the person does not mate. Thus, it does not seem to make sense how homosexuality persists. Evolutionary psychologists suggest three adaptive mechanisms under which homosexuality can be maintained in a population. First, it is possible the relatively low rates of homosexuality in either sex are detecting random variation in sexuality – mutations occurring at constant rates over time. Second, homosexuals, although not reproducing themselves, might increase their fitness indirectly by helping their nieces and nephews; a prediction not well-supported, however. Third, it could be that homosexuality, especially in females, is a conditional mating strategy. Research on conditional mating strategies describes how individuals adjust their mating strategies as result of being unable to satisfy their fitness interests.

If there is limited access to quality men in a population a woman may benefit from allomothering. Sex, in this case, would confer upon two females the important function of bonding as it plays in Bonobos. There is evidence in sea-birds that two females will pair-up to rear an offspring together when there are limited males. In this case, male homosexuality could either be a by-product of the flexibility or erotic plasticity present in females, or have alternative nonreproductive functions (e.g., establishing dominance, releasing sexual aggression).

Whatever the mechanisms maintaining homosexuality in the population, sexual orientation may be separate from other elements of a person's psychology. For instance, even though many homosexual men have hundreds more sexual partners than typical heterosexual men do, this is not because of having a greater sex drive *per se*. Rather, homosexual men have similar preferences for casual sex with young and attractive mates; however, because they serve as each other's mates, they do not encounter the more selective constraints imposed by women. Relative to men, women have a higher need for emotional intimacy and lower needs for sexual variety, and these aspects tend to be characteristic of homosexual female couples. Implicitly, heterosexual couples must reach an agreement in order to have a relationship. Such negotiation may be less applicable or contentious among homosexual relationships wherein both sexes share preferences and psychological dispositions regarding sexual interactions.

Clash of the Sexes

Once individuals have implicitly negotiated their way into relationships, the sexes may also come into conflict once such relationships are under way. In this section, we review research on infidelity, how men and women conflict on inferring sexual intent, and aggression in relationship contexts (i.e., sexual harassment and rape). All three of these may be manifestations of a breakdown of the implicit negotiation between sexes.

Infidelity

Perhaps the most well-known manifestation of intersexual conflict is the case of infidelity. While marriage occurs in all known cultures, rates of extramarital affairs hover between 25% and 75% in reports by Hite and Kinsey. In cross-cultural research, it appears in as many as 160 cultures and is the primary reason for divorce. Why might people cheat? Popular media portrays cheating as the acting out of juvenile fantasies or the result of some psychological impairment such as low self-esteem or a dysfunctional parent-offspring relationship. Although these are possible explanations, there are also more systematic factors to consider.

Proximate factors abound mostly in personality traits. The most popular taxonomy of personality is the Big Five personality traits – extraversion, emotional stability, conscientiousness, and openness. The Big Five provide a cross-culturally replicated, methodologically robust, and highly predictive means of understanding individuals. Low agreeableness and conscientiousness have been implicated in infidelity in small and large-scale international studies. As would be expected,

individuals' sociosexuality – the degree to which individuals find casual sex acceptable and their casual sexual behaviors – is also associated with rates of infidelity.

Unfortunately, most of this work tends to be descriptive. Some new work that has a strong theoretical backing is based on a mid-level theory called Life History Theory. This theory suggests those who have antisocial personality traits like the Dark Triad – narcissism, psychopathy, and Machiavellianism – may enact an opportunistic life strategies. The Dark Triad appear to be associated with (1) a short-term mating disposition, (2) a rejection of long-term mating, (3) a high number of sex partners in one's lifetime, (4) increased rates of mate defection, and (5) generally, a *fast* life strategy. Effectively, these personality traits predispose individuals to have a 'take the money and run' life strategy and a 'hit and run' mating strategy. Although these traits are higher in men than in women because men suffer fewer costs by inhabiting a *fast* life strategy than women do, women who are high on these traits may also benefit from short-term matings enacted through infidelity.

Numerous reasons have been proposed for why people may engage in some form of short-term mating. All of them suggest a more strategic approach to short-term mating in women than in men. That is, men engage in short-term mating as a function of their generalized disposition toward low investment sex. Women, who may pay a higher penalty for infidelity, may engage in infidelity for more specific reasons. For example, a woman might be unfaithful (1) to test her value on the market, (2) to motivate her partner, (3) to get good genes from the partner with whom she cheats, (4) to access greater resources, (5) for more protection for her and her offspring, and perhaps more. Whatever the reason may be, personality traits may predispose individuals to pursue certain fitness-relevant goals on different time-scales.

However, the primary limitation of most work on infidelity we have discussed thus far is based on self-report data; the problems of which have been clear in psychology since at least 1978. Modern research has begun to integrate non-self-report measures in the form of physiological and hormonal assays; data that tends to pack more of a punch. This is because it is rather hard to argue that a biological/physiological factor could be the result of some social role or learned behavior. As far as we know, individuals have no control of or access to their hormones. Therefore, findings links between hormones and infidelity provides strong evidence consistent with an evolutionary approach. In men, greater levels of testosterone and lower level of serotonin are associated with greater numbers of sex partners and a greater likelihood of committing infidelity. In particular, men who have high testosterone and low levels of serotonin are selected by women as short-term partners and, therefore, are able to pursue their preferred mating strategy.

When women are ovulating they experience high levels of estradiol and they report a large series of attitudes and commit behaviors that facilitate committing infidelity. Ovulation is linked to (1) conception rates, (2) preferences for the odor of men who are high in testosterone, more masculine faces, more masculine bodies, lower voice pitch, and men who display social presence and direct intrasexual competitiveness, (3) more flamboyant dancing, (4) a tendency to wear more revealing clothing, (5) self-reports of increased willingness to flirt, kiss, date, have a one-stand, and a serious affair with

another man, and (6) tendency to go out with their friends instead of their partner. Estradiol also seems to make women more attractive in terms of a lower waist-to-hip ratio and lower levels of fluctuating asymmetry (the degree to which a person deviates from a bilaterally symmetrical appearance). Women have a generally slower mating disposition, but during ovulation women may benefit enough from short-term sexual interactions to risk infidelity.

Adaptive functions of infidelity and reactions to infidelity

From an evolutionary perspective, infidelity signals the diversion of important reproductive resources. For a woman, an unfaithful partner may be investing resources in another woman. This is a particular concern for women given the high degree of investment they are saddled with for their offspring. As we noted above, women are attuned to not only detect a man's willingness to commit but to also slow down his rate of access to sex until he shows clear signs of investment potential and commitment. Consistent with these inclinations, women tend to be more bothered by emotional infidelity than sexual infidelity.

In contrast, sexual infidelity poses a more serious reproductive problem for men than women. Sexual infidelity from a female partner greatly increases the level of paternity uncertainty. Because men cannot be certain that any children are theirs, they may have evolved to be attuned to cues of an unfaithful partner. Ancestral men who were indifferent to sexual infidelity risked investing in other men's children and tended not to leave descendants. Indeed, men are more bothered by sexual infidelity than emotional infidelity. Stronger female reactions to potential emotional infidelity and stronger male reactions to potential sexual infidelity are generally consistent across populations, techniques, and researchers.

However, it is noteworthy that there is at least some work suggesting that men and women should not differ in the degree to which these types of infidelity bother them because (1) both sexes feel that one type of infidelity will lead to the other type and (2) individuals in the Environment of Evolutionary Adaptedness (the time during human history when heritable psychologies, such as ones for jealousy, would have arisen) would not necessarily be aware of the direct connection between sexual relations with a particular man and the birth of a child given the 9 month gestational delay between sex and childbirth. Some cultures still believe in partible paternity – that is, the idea that more than one father can contribute biological materials to a child, and share in paternal responsibility. This idea of paternity might be beneficial to females, and could mean that human mating is more complex than previously assumed.

Moreover, there is a battery of behavioral albeit indirect evidence to show that men are especially attuned to sexual infidelity. For instance, step-children and children who do not resemble the male parent are at much greater risk of being neglected and abused. Children living with one genetic and one step-parent are 40 times more likely to be physically abused. Preschool aged stepchildren are 40–100 times more likely to be killed. Not only are men more likely to endanger the life of stepchildren and those who do not physically resemble them, they may commit partner-directed violence. Men who do not perceive physical resemblance to their children are more likely to severely beat their wives. Evidence also suggests that

when dating a particularly attractive woman, men may actually aggress toward the woman and the woman's extra-pair partner in response to infidelity. However, these problems do not just trigger one's response. Indeed, when a man is mated with a highly attractive, youthful, and potentially fertile mate he may be more willing to tolerate cuckoldry. Generally, men who tend to be of lower value on the mating market than their partners are more likely to engage in mate guarding and mate retention. As an enticement for their partners to stay in the relationship, these men may dole out gifts and affection to compensate for shortcomings, including low physical attractiveness. Whether it takes the form of mate retention, mate guarding, or aggression, males seem to have evolved mechanisms in response to the problems of female infidelity.

Although jealousy is the most well studied emotional response to ongoing or potential infidelity, depression, anger, and self-reproach are other large categories of emotional reactions to infidelity. These systems seem to be finely tuned to the nature of the infidelity. Individuals, upon learning of infidelity, attempt to gauge the nature of it by probing for more information in order to decide what to do about the apparent violation. Emotions give people heuristic-based information about how to proceed. In cases where individuals had an ongoing relationship with their infidelity partner, this is likely to cause more distress compared to a single episode. Indeed, women are more likely than men to forgive a single sexual transgression.

Sex Differences in Inferring Sexual Intent

How does one know if someone else wants to have sex? Do men and women have a predisposition to make judgments that may serve their fitness interests? In a word, yes. Studies by social and evolutionary psychologists indicate women underestimate the degree to which a man will commit to them and men overestimate the degree to which a female wants to have sex with them. Many decisions effectively pit a Type I error (i.e., falsely assuming a particular state exists) against a Type II error (i.e., falsely denying the existence of that state), whereby one error is costlier than the other. For situations of reproductive consequence that recurrently presented themselves in ancestral environments, humans should have evolved a systematic bias to make decisions that favor the less costly error. For males, a Type II error – inferring a lack of sexual interest when it is actually present – would be more costly because female sex partners are in short supply. For a woman, a Type II error, falsely interpreting that a man's commitment is insufficient, and thus requiring more evidence of commitment before engaging in sexual relations is not a costly error: it encourages displays of quality, greater investment, and more commitment from would-be partners.

Research demonstrates men are not simply projecting their own views onto their perceptions of sexual intent in opposite-sex others – a man's perceptions of women's sexual intent is not the same for a potential mate as it is for his sister. This suggests men are not simply ascribing greater sexual intent to all women; rather, only to those who constitute potential partners. Indeed, self-reports suggest women who are friendly have experienced men's tendency to think that those women are sexually interested. In short, this causes conflict between the sexes because of evolved cognitive biases in how they interpret the actions

of those with whom they could mate. These biases are the result of recurrent asymmetries in the costs associated with decisions in the mating contexts. Here we discuss a number of ways in which this misunderstanding manifests itself.

Sexual Harassment

In the modern workplace, men and women spend much time coming into contact with each other and getting acquainted. As a result of this propinquity, the workplace is an environment that may be especially conducive to the development of potential romantic relationships. However, this also means it is a setting in which conflicts in mating strategies may readily occur. Up to 90% of women report having been sexually harassed at work, with about 10 000 cases filed in the United States in the last 20 years costing \$48 million in victim-compensation. By today's standards, sexual harassment in the United States includes staring in a sexually suggestive manner; making offensive remarks about looks, clothing, or body parts; touching (e.g., patting, pinching, or intentional brushing against another's body); telling sexual jokes or displaying sexually suggestive posters; making sexual gestures; and sending, forwarding, or soliciting sexually suggestive letters, notes, emails, or images. Consistent with the divergence in reproductive strategies, the large majority of complainants are female, although the percentage of male complainants is slowly increasing.

From an evolutionary perspective, sexual harassment occurs when people in the workplace experience a conflict between the mating strategy they desire to utilize and what is allowed by other persons or contextual factors. Because men are (1) more eager to engage in sex with others and (2) likely to overestimate sexual interest in target females, they may pursue women who do not want them or in work contexts where it is deemed by societal standards to be inappropriate. Those who are sexually harassed most commonly are women who have the most reproductive value vis-à-vis being youthful and attractive. In addition, individuals perceive it is these women who pose the greatest threat for filing sexual harassment claims. Laws governing sexual harassment discourage and punish the perpetrator, typically men, from pursuing an eager sexual strategy and acting upon potential overperceptions of sexual interest.

Importantly, the definition of sexual harassment suggests sexual attention may not be considered harassment if it is welcome. In other words, if no strategic interference has taken place and both parties are explicitly or implicitly amenable to potential sexual relations, then no one will be motivated to seek legal redress, and they may not be awarded any compensation if they do. Such a distinction appears to be reflected in perceptions of sexual harassment. In short, the interpretation of sexual harassment is a function of the degree to which the target of the advance is attracted to the advancer. Advances from men who are viewed as having high value in the mating market vis-à-vis being successful and physically attractive are less likely to be seen as harassment.

Rape

Sexual harassment, although expensive and even psychologically troubling, is relatively benign compared to perhaps the

most drastic result of the failed negotiation of the sexes in mating: rape. A note of caution to the reader: evolutionary accounts of rape by no means justify the behavior. Explaining phenomena by no means excuses it. There are numerous reasons to be appalled by this behavior, but one must not allow moral judgments to interfere with one's ability to examine a phenomenon dispassionately as scientists strive to do. Nevertheless, because this is such a contentious topic we delineate the research about this topic in detail.

Rape in humans is a subject of intense study, with the number of studies on the topic steadily increasing since the 1960s and rates that are fairly consistent around the world. Between about 15% and 50% of females in countries like the United States and New Zealand report some experience with sexual coercion/rape. However, these events seem to most commonly be perpetrated by nonstrangers such as acquaintances, boyfriends, or husbands (80%) and much more rarely by strangers (20%). Thus, studies indicate the majority of sexual coercion occurs not between strangers, but between acquainted individuals who are within a mating context. Therefore, as with sexual harassment, the role of differing mating strategies should be viewed when considering and understanding rape. It is between those who know each other that negotiations can break down, and sexual conflict can occur.

Within an evolutionary psychological framework, some theorists have proposed that rape might be an adaptive, conditional mating strategy. As a result of being unable to get the mates one wants, some men may use rape as a last-ditch solution to solve the adaptive problem of mating. However, this is a rather risky solution given that women, her family, and her friends may have antirape adaptations (e.g., women may have male friends to act as body-guards) and any subsequent offspring may not have two parents or that child may be abused or neglected, thereby decreasing the chances that any resultant offspring will survive. Therefore, while rape might provide some reproductive benefits, the rapist must take into consideration the costs of pursuing this mating strategy. Nevertheless, there may actually be some psychological systems that have evolved to allow men to detect which potential victims would incur fewer of these costs. Some of these psychological adaptations include being able to assess the vulnerability of potential rape targets, a rape mindset that activates when sexual access to consenting partners is not attainable, preferences for young and fertile females, and sexual arousal in response to female resistance to men's sexual advances.

The most direct evidence of rape's potential reproductive benefits comes from pregnancy rates of rape victims. When researchers adjust for contraceptive use, rape-pregnancy rates are near 8%, significantly greater than consensual pregnancy rates of about 3%. The majority of rape pregnancies were also concentrated in the 15–24-year-olds; of the 26 rape pregnancies reported, 21 (81%) occurred in this age range. However, rapists' targeting of reproductively aged women may be a by-product of men's preferences for women within this age range – they are at peak fertility – or some unknown mechanisms to detect ovulation in men. It might be argued that this finding is a by-product of women in this age group being more likely to associate with young men, who are themselves the age group most likely to engage in criminal activities in general. However, when age distributions of rape and murder victims were compared,

murder victims tend to be older than rape victims, and are not concentrated among individuals in their 20s.

The mate deprivation hypothesis has not received much support with respect to its prediction that men who are unable to obtain mates because of low value in the market (e.g., socioeconomic status) are any more likely to commit rape. In fact, men who reported being physically and nonphysically sexually coercive also reported having higher mating success and more sexual experience. Such an account suggests that rape may not be an evolved, condition-dependent mating strategy, but instead, could be a by-product of men's increased sexual desire. However, this may be because men's rape adaptations may be more varied than previously thought. Recent work suggests as many as five domain-specific types of rapists that respond to certain contextual cues to motivate the act of rape: disadvantaged men, specialized rapists, opportunistic rapists, high-mating-effort men, and partner rapists. More research in this area is certainly needed to better understand this phenomenon.

Summary and Conclusions

Because of fundamental differences in minimum required parental investment, men and women have evolved to ideally prefer different types of relationships. On the one hand, women tend to prefer having long-term relationships with high quality men who commit and invest plentiful resources. On the other hand, men tend to favor having easy sexual access to many fertile women. Because human infants benefit greatly from a long period of biparental care, human mating tends to be centered around long-term, committed relationships. Indeed, some form of marriage, whether monogamy, polygyny, or polyandry – is found in most societies.

Nevertheless, noncommitted sexual relationships are also quite prevalent. For instance, individuals may seek sexual affair partners outside of an ongoing long-term relationship. In particular, around the time of ovulation, women are more open to having sexual affairs with physically attractive men, who may be more genetically fit than their current partner. In addition to mixed mating strategies that involve having long- and short-term relationships at the same time, individuals may engage in hybrid relationships (e.g., booty-calls, friends-with-benefits, and swinging), which tend to be largely sexual but contain at least a minimal level of investment or continuity. Such relationships may effectively represent compromises in the mating market between men's and women's ideally preferred relationships. Sometimes, however, the sexes' opposing interests result in conflict, wherein the pursuit of one's own mating strategies comes at the expense of one's partner's. Specifically, conflicts can take the form of sexual harassment, intimate partner violence, or rape.

In presenting this article on human mating, we have relied on an evolutionary approach to mating psychology. Although not the only perspective on mating, an evolutionary approach has fueled much of the interesting research that has emerged in recent years on mating. It is also the only perspective that is connected to theories of all living things, including biology, anthropology, and ethology. At all levels of human mating, evolutionary theory is informative about the pursuit of sex as well as the battle of the sexes.

See also: Evolutionary Psychology; Evolutionary Social Psychology; Mate Selection; Personal Relationships in Everyday Life; Sex Differences.

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Hypnosis

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Glossary

Hypnotherapy Addition of hypnotic procedures to accepted psychological or medical treatment.

Hypnotizability or hypnotic suggestibility Observed or reported responsivity to suggestions following a hypnotic induction, as indexed by behavioral and subjective measures.

Indirect suggestion Compared to traditional authoritative suggestions, they generally contain more subtle, indirect, or implicit cues, are more permissive, ambiguous, and less obviously related to the response sought by the hypnotist.

Induction Verbal or nonverbal communications or procedures intended to induce a 'hypnotic state' or increase subsequent responsivity to hypnotic suggestions.

Simulator Low suggestible subject instructed to fake the behavior and/or subjective reports of an excellent hypnotic subject. This is typically done in accordance with Orne's simulation paradigm in which the simulator is informed that the experiment will stop if the hypnotist sees through the deception.

Introduction

The term 'hypnosis' refers to a social influence situation in which a person designated as a hypnotist attempts to influence the experiences and behaviors of a subject or patient. The suggestions administered in the hypnotic situation typically call for changes in sensation, perception, affect, memory, cognition, and control over behavior or psychophysiological processes. It is useful to think of these suggestions as divided into two phases, induction and application, although in practice these may not be entirely distinct. Historically, a wide variety of induction procedures have been used. These include waving hands over patients and having them ingest substances. Many of these methods are rarely if ever used now. Procedures that are currently in vogue involve asking subjects to close their eyes and telling them to sleep, instructing them to relax, having them fix their gaze on an object or their attention on an idea, suggesting various images or automatic movements, telling them stories, and so on. Most inductions include suggestions for relaxation. However, inductions involving physical tension and alertness are as effective as relaxation inductions in enhancing suggestibility. The suggestions included in many hypnotizability scales typically involve motor behaviors (e.g., hand levitation), challenges to the subject (e.g., 'try to lift that heavy hand, just try'), and the so-called cognitive-perceptual suggestions that encompass positive and negative hallucinations, dreams within hypnosis, and posthypnotic amnesia.

People vary substantially with respect to their ability to experience hypnotic phenomena, and range on a continuum of hypnotizability, according to the number of suggestions they pass. For example, subjects who pass 3 or fewer suggestions on a 12-point standardized scale of suggestibility are, conventionally, regarded as low hypnotizable (about 15–20% of the population), subjects who pass 4–8 suggestions are regarded as medium hypnotizable (about 60–70% of the population), and subjects who pass 9–12 suggestions (about 15–20% of the population) are regarded as high hypnotizable. Many people are more responsive to suggestion after an

induction than they were before, but the average increase in suggestibility is on the order of 10–20%. Moreover, the nature of the induction appears to have little bearing on hypnotizability.

Hypnotic suggestibility is relatively stable, with test–retest reliability as high as 71 at 25-year follow-up. This stability has been variously described as a reflection of the trait-like aspects of hypnotizability versus a reflection of subjects' attitudes and beliefs about hypnosis, and interpretations of hypnotic suggestions that remain stable over time, unless subject to modification procedures described below.

A hypnotic induction is not, in itself, a treatment for psychological disorders. After the induction, a wide variety of applications have been used in hypnotherapy, which often involves a blending of ideas and techniques from different theoretical perspectives. The appropriate use of hypnosis is an adjunctive treatment, rather than a treatment in itself for any disorder. Hypnotherapy can be defined as the addition of hypnosis to accepted psychological or medical treatment. As such, it should only be practiced by professionals, who have the appropriate training and credentials to provide the treatment that is being augmented by hypnosis.

Often, perhaps in the majority of the cases in which hypnosis is used clinically, hypnotic procedures are framed in terms of self-hypnosis. Many clinicians inform clients that they are ultimately responsible for generating suggestion-relevant imagery, experiences, and behaviors. Self-hypnosis is most frequently taught by first introducing the client to traditionally administered hypnotic techniques and then encouraging the client to assume increasingly greater responsibility for devising suggestions appropriate to achieving treatment goals. In self-administering therapeutic suggestions, the client replaces the therapist as the active agent in the therapeutic proceedings. Therapists often make customized tapes for clients to listen to at home or at work. This is done in order to minimize dependency on the therapist, generalize treatment gains, and encourage mastery of self-suggestions that can be implemented, in the absence of the tape and the hypnotist, in a variety of situations.

History of Hypnosis

Since the beginning of recorded history, procedures that are today labeled 'suggestive' have been used to treat a wide range of physical disorders and psychological disturbances. For example, religious healing rituals such as 'dream healing' in Ancient Greece, and exorcism in Medieval Europe, attest to the importance of psychological factors in easing discomfort and, at times, producing beneficial physiological changes.

In the seventeenth and eighteenth centuries in Western Europe, religious explanations and treatments for physical and psychological disturbance practiced were gradually replaced by naturalistic explanations and treatments. Mesmer, a Viennese physician, developed one of the best-known naturalistic explanations in the eighteenth century. Mesmer believed that an invisible fluid that he labeled animal magnetism permeated the universe. Supposedly, sickness resulted from a disruption in the harmonious flow of this fluid through the body, and a healer (magnetizer) could produce a cure by passing his hands close to the patient's body and thereby transmit the magnetic fluid. During this process, patients frequently experienced a range of unusual sensations and behavioral changes that ended in convulsions and in a diminution of symptoms.

Mesmer moved his practice to Paris where he quickly became a sensation among the cultural elite and gained ardent supporters, as well as powerful enemies among the medical establishment. Eventually, two Royal commissions, with luminaries including Benjamin Franklin and Lavoisier, investigated Mesmer's claims. With a series of clever experiments, the commissioners demonstrated that the behavioral changes seen in magnetized patients did not result from the flow of an invisible fluid, but instead reflected the patients' expectations, beliefs, and imaginings. On the basis of the negative reports by the commissions, French physicians were banned from practicing magnetism. Despite the ban, magnetism flourished. It soon became associated with the occult as well as with healing and, in various forms, was transported to countries throughout Europe and also to America.

In England, as in France, magnetism underwent oscillating periods of acceptance and rejection by the medical establishment. In the middle of the nineteenth century, Braid, a Scottish physician, witnessed a stage demonstration in which a subject got magnetized by staring at a shiny object. Braid rejected the fluid theory of magnetism and hypothesized, instead, that the behaviors of magnetized subjects resulted from neural inhibition that flowed backwards from the eyes (strained by staring) to the brain and produced a condition akin to sleep. Braid labeled this phenomenon as neurohypnosis, and the shortened name, 'hypnosis,' gradually replaced the name magnetism.

As Braid gained more experience, he realized that the behavior of hypnotic subjects was greatly influenced by ideas and expectations transmitted to them by the hypnotist. He modified his earlier theory of neural inhibition and developed the theory of monoideism. Monoideism was based on ideomotor action in which vivid ideas or images that remain uncontradicted in the mind of a subject lead automatically to the corresponding action. Thus, if a person vividly imagines that his or her arm is light and rising in the air, and if this vivid imagining is not

contradicted by other thoughts, then the vivid imagery will lead the arm to rise automatically.

Braid's early ideas about neurohypnosis strongly influenced the famous French neurologist Charcot. Unfortunately, Charcot was not influenced by Braid's later notion of monoideism or by his emphasis on how the hypnotist's expectations influence the subject's responses. Charcot studied patients who were diagnosed as hysterics and came to believe that hypnosis, like hysteria, reflected a neurological weakness, and that only hysterics could be hypnotized. According to Charcot, there were three stages to hypnosis, and each stage was associated with invariable behavioral symptoms. Charcot's notion of an association between hypnosis and hysteria influenced his pupil Pierre Janet, who came to believe that both hysteria and hypnosis involved dissociations between sets or subsystems of ideas.

Braid's work also influenced Bernheim, a well-known French physician from Nancy. According to Bernheim, hypnotic behavior resulted from suggestion. People differed in terms of suggestibility, and suggestions produced their effects by leading subjects to develop corresponding ideas that led via ideomotor action to hypnotic behavior. Bernheim rejected Charcot's notions that hypnosis was related to hysteria and that degrees of hypnosis were associated with invariant behavioral symptoms. Instead, Bernheim argued that Charcot inadvertently suggested to his hysterical patients those very behaviors that he came to erroneously believe resulted automatically from hypnosis. Charcot's ideas nevertheless remain significant today in so far as they underline the fact that by understanding hypnosis and suggestibility, it may be possible to better understand a wide range of experiences associated with psychopathology and unusual experiences (e.g., functional disorders of psychogenic origin, phantom limb pain, psychotic hallucinations).

Freud studied briefly with both Charcot and Bernheim. Nevertheless, he rejected the therapeutic use of hypnotic procedures. Freud's psychoanalysis became highly influential in both Europe and America and his rejection of hypnosis served to relegate it to the fringes of medicine and psychology for much of the first half of the twentieth century, with notable exceptions including the work of Hull and Young, whose systematic experimental studies and the development of suggestibility scales constituted important contributions.

Toward the beginning of World War II, White reviewed the available data concerning hypnosis and concluded that, because of their overly mechanistic nature, neither the theory of dissociation nor the theory of ideomotor action could adequately explain hypnotic responding. White argued that hypnotic behavior was goal-directed social action and that hypnotic subjects responded in terms of their ideas about what the hypnotist wished them to do. At the same time, however, White continued to believe that hypnotic behavior occurred during an altered state of consciousness that was characterized by subtle cognitive changes.

White's ideas greatly influenced the subsequent generations of hypnosis researchers and theorists, who variously described hypnosis in terms of an altered state of consciousness versus the product of suggestion and social and cognitive variables. White particularly influenced M.T. Orne, who apart from emphasizing the role of social factors in hypnosis attempted

to delineate cognitive changes unique to hypnotic response. Orne devised a simulator control methodology that compared the performance of low suggestible individuals who role-played the behavior of an excellent hypnotic subject with highly suggestible individuals who genuinely tried to experience hypnotic suggestions. Orne believed that this paradigm would enable the separation of those subtle cognitive characteristics that constituted the 'essence' of hypnosis from what he considered to be behavioral artifacts produced in response to social demands. Research using Orne's simulation design was important in demonstrating that a wide range of hypnotic responding that had been assumed to reflect a hypnotic state could be explained more parsimoniously in terms of the expectations transmitted to subjects by the social demands of the experimental situation.

The development of well-constructed, reliable standardized hypnotizability scales has done much to advance the scientific study of hypnosis. Early scales developed in the 1930s were important precursors to the more psychometrically sophisticated tests devised by Hilgard and Weitzenhoffer, who created the widely used 'Stanford scales' of hypnotic susceptibility in the 1960s, and Orne and Shor who developed the Harvard Group Scale of Hypnotic Susceptibility.

Since these pioneering efforts, many hypnotizability scales have been developed for different purposes and populations. These include brief tests for hypnotizability and tests for assessing waking suggestibility, hypnotizability in a group context, and hypnotizability with child populations. Scales of hypnotic depth have also been developed along with well-validated scales that tap the subjective aspect of hypnotic responsiveness. In general, hypnotizability tests are highly and positively correlated with one another, although some scales are better able to capture the subjective aspects of hypnotic experiences than other scales.

Neurophysiological research is one of the most intriguing and active areas of hypnosis-related inquiry. Researchers have established that hypnotic suggestions can produce impressive changes in brain activation that correspond, more or less, to those produced by actual perceptual experiences. Neurophysiological studies of hypnosis have implicated the anterior cingulate area of the brain involved in some alterations of consciousness experienced during hypnosis. To some researchers, findings like these provide evidence that hypnosis is a discrete state of consciousness. However, critics of this position reply that that merely documenting the physiological changes is insufficient to demonstrate causality between the altered subjective experiences than other scales.

Since the 1950s, interest in clinical hypnosis has bloomed in tandem with advances in the scientific understanding of hypnosis. Erickson's writings and his creative use of permissive, nonauthoritative, and indirect hypnotic suggestions, including the use of metaphors and storytelling, sparked interest in a wide range of clinical applications of hypnosis.

Over the past 40 years or so, hypnosis has increasingly moved into the orbit of mainstream psychology. Today, hypnosis research is routinely incorporated into empirically supported psychotherapies; myths and misconceptions regarding hypnosis have been dispelled by careful research; and hypnosis studies are published in well-respected psychology journals and have informed cognitive science (and vice versa) in meaningful ways.

Misconceptions About Hypnosis

Public education about hypnosis is important in so far as misconceptions (e.g., the Svengali-like power of the hypnotist) persist in the general population, partly as a result of the media's sensationalized depiction of hypnosis. Indeed, since the nineteenth century, mesmerism and later hypnosis have been associated with the idea of unusual and even supernatural capabilities. For instance, some of the nineteenth-century investigators argued that magnetized (and later hypnotized) subjects could see without the use of their eyes, travel mentally to distant planets and report back accurately about the inhabitants, spot disease by seeing the internal organs through the skin of sick individuals, and communicate with the dead.

Although scientific investigators no longer take these outlandish ideas seriously, unusual claims for hypnosis continue to be made. For example, some investigators argue that the use of hypnotic procedures enables people to recall their earlier abduction by space aliens, and others argue that hypnotic regression to past lives supports the theory of reincarnation. There is no more scientific evidence to support notions like space alien abduction and reincarnated past lives than there is to support nineteenth-century notions of mental space travel or seeing without using the eyes by magnetized somnambulists.

Many misconceptions and stereotypes about hypnosis derive from what is popularly known as stage hypnosis. The outlandish actions of people in shows have nothing to do with a trance state. In stage shows, the hypnotist carefully selects potential performers by observing how they respond to waking suggestions. Moreover, volunteers often feel compelled to do bizarre things because they are under intense pressure to entertain the audience. Many stage hypnotists also use the stage whisper technique, in which they whisper instructions ("When I snap my fingers, bark like a dog") into the volunteer's ears.

The study of hypnosis has done a great deal to eradicate many misconceptions about hypnosis. These include the belief that hypnosis produces a sleep-like state; that hypnosis is a dangerous procedure that robs people of their willpower; that hypnosis involves a radically altered state of mind and that one cannot 'come out' of this state; that hypnotized people cannot remember what occurred during hypnosis; and that only weak-willed people can be hypnotized.

We now know that hypnosis (1) is not related to sleep; people are just as responsive to hypnotic suggestions administered while exercising on a stationary bicycle as they are following hypnotic suggestions for sleep and relaxation; (2) is something done by the subject rather than by the hypnotist; and (3) does not produce spontaneous amnesia for the events that transpire during hypnosis. Scientists have also established that subjects neither lose touch with their surroundings nor relinquish control of their behavior – in fact, they can resist and even oppose suggestions. Moreover, many people do not experience hypnosis as much different from waking consciousness and instead report that they experience hypnosis as a state of focused attention. Finally, contrary to popular belief, subjects can experience many hypnotic phenomena, such as hallucinations and pain insensitivity when they receive suggestions alone, even without hypnosis.

Contemporary Theories and Research

Virtually, all hypnosis theorists agree that most people who receive a hypnotic induction, and are motivated to think and imagine along with suggestions can experience a wide variety of alterations in consciousness. Indeed, Amir Raz and his colleagues demonstrated that some highly suggestible individuals can completely eliminate Stroop interference following a posthypnotic suggestion to see the words in a foreign language. There is also agreement that most individuals, who undergo hypnosis, do not merely fake their subjective experiences or comply to please the hypnotist. However, beyond these points of consensus, there are sharp differences among theorists in their explanations of hypnotic phenomena. Indeed, theorists have proposed different and often conflicting accounts about the feeling of involuntariness that often accompanies responses to hypnotic suggestions and individual differences in suggestibility.

Psychoanalytic Theory

Freud was so impressed by the apparent submissiveness of certain hypnotized subjects, that he likened hypnosis to being in love. There is no evidence to support the idea that hypnosis fosters an erotic or sexual 'transference' relationship between the therapist and patient. Contemporary psychoanalytic theorists, including Baker, Fromm, and Nash, have instead relied more on concepts allied to ego psychology (e.g., relaxation of the general reality orientation, regression in service of the ego) in which hypnosis increases subjects' primary process thinking (e.g., fantasy, imaginative activity) and their ability to temporarily relinquish critical judgment and deliberate control of behavior.

Based on a review of more than 100 studies, Nash concluded that hypnosis does not permit subjects to literally 'age regress' and reexperience the events of childhood or function in a truly childlike fashion. Rather, Nash maintains that hypnosis engenders a type of regression with specific properties that include an increase in the primary process material, more spontaneous and intense emotion, unusual body sensations, the experience of nonvolition, and the tendency to transfer or displace core attributes of important others onto the hypnotist.

Support for psychoanalytic concepts has come from a number of quarters. Several studies are consistent with the proposition that hypnosis increases primary process thinking. Nevertheless, it is unclear whether increased primary process during hypnosis is attributable to suggestions for eye closure, relaxation, and attention to imagery, rather than to unique characteristics of hypnosis.

Many subjects report unusual perceptual and bodily experiences during and after hypnosis. However, studies indicate that the reports of the experiences of hypnotized subjects are indistinguishable from that of nonhypnotized subjects in a variety of different test conditions such as (1) sitting still with eyes closed, (2) relaxing, (d) imagining suggested events, and (e) focusing on parts of the body that are parallel to the parts that are the targets of hypnotic suggestions. Thus, although altered experiences are readily produced by hypnotic suggestions, they are by no means unique or specific to hypnotic conditions.

Studies support the hypothesis that certain hypnotic subjects evidence an especially motivated involvement with the hypnotist or cognitive commitment to respond to hypnotic tasks. Indeed, researchers have shown that improving hypnotic rapport may increase the responsivity of low hypnotizable subjects, while degrading hypnotic rapport has no appreciable effect on the responding of high hypnotizable subjects, who seem to be prepared to respond to the hypnotist, regardless of the nature of the hypnotic relationship.

Evidence of shifts in affect is mixed. However, the finding that hypnosis is associated with brain activation linked with emotional regulation provides support for the role of affect in hypnosis. Although psychoanalytic constructs provide a plausible account for reports of suggestion-related involuntariness, a variety of other theories do so as well.

Neodissociation Theory

After a long hiatus of interest in dissociation, in 1977, E.R. Hilgard published an influential book that revitalized the concept. Hilgard proposed a neodissociation theory on the basis of a contemporary cognitive model of divisions of consciousness, in which multiple cognitive systems or cognitive structures in hierarchical arrangement exist under some measure of control by an 'executive ego.' The executive ego or 'central control' structure is responsible for planning and monitoring functions of the personality. The induction of hypnosis serves to temporarily dissociate relevant subsystems of control from conscious executive control. Under these circumstances, hypnotic suggestions can directly activate dissociated subsystems (e.g., sensory and motor activity in the arm and hand, visual perceptions). This lack of conscious controls largely depends on an amnesic barrier or process that walls off ideas, emotions, and fantasies from consciousness. This diminished executive control and failure to monitor the ongoing action is responsible for the subjective impression of nonvolition that typically accompanies hypnotic responses.

The empirical roots of neodissociation theory can be traced to Hilgard's introduction of the metaphor of the 'hidden observer' to describe the phenomenon by which a person registers and stores information in memory, without being aware that the information had been processed. Hilgard and his associates' initial research on the hidden observer phenomenon involved experimental studies of pain and hearing. In a typical pain study, high hypnotizable subjects were able to recover concealed experiences or memories of pain during hypnotic suggestions for analgesia, when they were informed that they possess a hidden part that can experience high levels of pain during analgesia, and that this part can be contacted by the hypnotist with a prearranged cue. Research in Hilgard's laboratory has demonstrated that hidden observer reports can penetrate hypnotic blindness, hypnotic deafness, and positive hallucinations.

Hidden observer studies and their interpretation have been controversial. For instance, Spanos and his associates have shown that hidden observer reports vary as a function of the nature and explicitness of the instructions that subjects receive about the nature of the hidden observer. According to this perspective, the hypnotist implicitly or explicitly suggests experiences that produce the 'hidden observer.' The hidden observer, therefore, can be thought of as no different from

any other suggested hypnotic phenomenon that is guided by the subjects' expectancies and situational demand characteristics. Whether the hidden observer reflects a true or preexisting division of consciousness that is directly accessed by hypnotic suggestions, or whether it is a product of suggestion, continues to stimulate research and theoretical controversy.

Bowers and Woody presented a modified version of Hilgard's neodissociation model of hypnosis called dissociative experience theory, which rejects amnesia as fundamental to dissociation. Instead, Bowers and Woody proposed that dissociation is largely a function of the direct and automatic activation of subsystems of control by the hypnotist's suggestions. Kihlstrom has also extended neodissociation theory in interesting directions that incorporate concepts of modern cognitive psychology, including memory models and the distinctions between procedural and declarative knowledge. Kihlstrom's theoretical work emphasizes changes in the executive monitoring of thought and action, more so than control, and he has argued that such alterations in monitoring can account for a wide variety of hypnotic phenomena, including posthypnotic suggestion, hypnotic blindness, and hypnotic analgesia.

The Sociocognitive Perspective

Another influential view of hypnosis – the sociocognitive perspective – rejects dissociation as an explanatory mechanism. The term 'sociocognitive' captures this perspective's dual emphasis on the social and cognitive dimensions of hypnosis. Sociocognitive hypnosis theorists contend that hypnotic behavior is fundamentally mundane, role- or expectancy-governed social behavior.

The sociocognitive perspective can be traced to attacks on the concept of hypnosis as an altered state of consciousness. In 1950, Sarbin challenged the traditional concept of hypnosis as a state (e.g., hypnotic trance, hypnotic state). Sarbin contended that hypnosis could be conceptualized as 'believed in imaginings' and developed a theory that relied heavily on the metaphor of role to capture parallels between the hypnotic interaction and a theatrical performance in which both the hypnotist and the subject enact reciprocal roles. Sarbin and Coe elaborated the theory and conducted research that highlighted the contribution of the following variables to subjects' hypnotic responsiveness: knowledge of what is required in the hypnotic situation, self- and role-related perceptions, expectations, imaginative skills, and situational demand characteristics.

T.X. Barber was influenced by Sarbin's theories and criticized the state concept because of its logical circularity (i.e., hypnotic responsiveness can both indicate the existence of a hypnotic state and be explained by it). In an extensive series of studies in the 1960s and early 1970s, Barber and his associates Spanos, Chaves, and Calverley demonstrated the important roles played by subjects' attitudes, expectations, and motivations in hypnotic responding.

Barber and his colleagues repeatedly demonstrated that nonhypnotized subjects showed increments in responsiveness to suggestions that were as large as the increments produced by hypnotic procedures. This research supported the idea that despite external appearances, hypnotic responses were not particularly unusual, and therefore did not require the positing of unusual states of consciousness.

Later in his career, Barber advanced the hypothesis that the great majority of people respond in keeping with 'sociocognitive variables' (e.g., expectancies, beliefs, attitudes), whereas much smaller numbers of participants respond because of an extensive history of fantasy involvements, and a still smaller number of participants experience profound dissociative reactions (e.g., spontaneous amnesia) following an induction. Barber's theory, while largely untested, represents a tentative integration of sociocognitive and dissociation accounts of hypnotic responding.

Spanos has conducted an extensive research program that has drawn particular attention to the importance of social psychological processes (e.g., subjects' attributions and interpretations of their own behaviors and hypnotic communications, response biases) and the importance of subjects' goal-directed activities and strategic responding (e.g., imagery, fantasy, allocation of attention) in the hypnotic context. This emphasis can also be seen in the writings of Wagstaff and Lynn and his colleagues, who view hypnotizable subjects as creative problem-solving agents, who seek to integrate information from an array of situation, personal, and interpersonal sources to respond to hypnotic suggestions.

Spanos and his associates have developed a social learning, cognitive skills-based hypnotizability modification program that provides low hypnotizable subjects with information designed to modify their attitudes about hypnosis, increase their involvement in imaginings, and interpret hypnotic communications in a manner consistent with passing hypnotic suggestions. This program has successfully modified the hypnotizability of about half of the low hypnotizable subjects tested, so that after training they tested as high hypnotizable subjects. This research has thus challenged the idea that hypnotic responsiveness is trait-like and cannot be substantially modified.

Sociocognitive theories have drawn critical fire from researchers who have questioned whether treatment gains that follow hypnotizability training represent genuine changes in hypnotic ability, or whether they can be accounted for in terms of compliance and conformity with demands for improved performance inherent in the training program. Spanos has addressed this critique by showing that treatment gains generalize to a variety of novel items and subjective measures; that trained subjects respond comparably to nontrained 'natural' high hypnotizable subjects; and that skill trained subjects continue to respond to hypnotic suggestions while they are surreptitiously observed, whereas untrained simulating subjects cease responding when they believe that they are not being observed. However, it is true that hypnotizability training is typically effective with no more than half of the participants, implying that variables other than those emphasized by sociocognitive theorists are associated with hypnotic suggestibility.

Irving Kirsch's response expectancy theory, which is an extension of Rotter's social learning theory, is based on the idea that expectancies can generate nonvolitional responses. Kirsch's research has shown that a wide variety of hypnotic responses (e.g., amnesia, experienced nonvolition, response to motoric suggestions) covary with people's beliefs and expectancies about their occurrence. According to Kirsch, expectancies, motivation, and responsiveness to waking imaginative suggestions can account for the lion's share of variance in

responding to hypnotic suggestions. In fact, Kirsch and Braffman have argued that hypnotic suggestibility should be measured as the increase in suggestibility produced by hypnotic induction, above and beyond responsivity to waking imaginative suggestions.

Kirsch and Lynn's response set theory proposes that all actions, mundane or novel, planned or unplanned, hypnotic or otherwise, are at the moment of activation initiated automatically, rather than by conscious intentions. Actions are prepared for automatic activation by response sets (i.e., intentions, expectations), and hypnotic suggestions can trigger response sets that influence thoughts, feelings, and actions. Similarly, Dienes and Perner's cold control theory of hypnosis argues that unconscious intentions influenced by beliefs and expectations can account for the feelings of involuntariness that often accompany hypnotic suggestions. These theories represent a bridge between sociocognitive and dissociation theories.

Bowers has been the most forceful critic of sociocognitive theory in marshaling evidence that: (1) compliance and social influence may account for the behavior of low hypnotizable subjects, but different (dissociative) mechanisms apply to high hypnotizable subjects; and (2) response to hypnotic analgesia suggestions can occur in the absence of goal-directed fantasies (e.g., suggestion-related fantasy activity, such as imagining that a hand and arm are made of rubber following an analgesia suggestion), indicating that such patterns of imaginative activity are more limited in their ability to account for the experience of nonvolition and response to suggestion than sociocognitive theorists acknowledge.

Phenomenological/Interactive Models

Theories that place particular emphasis on understanding the subjects' experience and the interaction of multiple variables during hypnosis have been termed 'phenomenological/interactive' theories. Sheehan's contextual model highlights the interactive reciprocal relations between an active organism and an active context, the 'fine-grained variation' in response to suggestion that exists among very hypnotizable subjects. Sheehan's research has also established the relevance of hypnotic rapport to a range of hypnotic phenomena (e.g., hypnotic dreams, hypnotically created memories). Sheehan contends that hypnosis can be distinguished from waking behavior by hypnotized subjects' 'motivated cognitive commitment' or problem-solving attempts to respond appropriately to suggestions.

According to McConkey, in order to understand the essential variability that characterizes subjects' hypnotic responses, it is necessary to examine the meaning that subjects place on the hypnotist's communications, the idiosyncratic ways in which they cognitively process suggestions, and intraindividual differences that can occur in responding across suggestions. McConkey's research, as well as studies by his former students Barnier and Bryant on posthypnotic suggestion, hypnotic blindness, and suggested sex change, have supported the hypothesis that high hypnotizability reflects the ability to process information that is both consistent and inconsistent with a suggested event in such a way that facilitates the belief in the reality of the event. Sheehan and McConkey's models are related to other interactional hypnosis models (e.g., Nadon,

Laurence, and Perry) in so far as they call attention to the need to examine multiple, potentially interactive determinants of hypnotic responding.

Clinical and Forensic Aspects of Hypnosis

The available clinical evidence indicates that hypnotic treatments are often effective in helping to treat a wide variety of clinical problems. Reviews and meta-analytic studies consistently document the effectiveness or promise of adding hypnosis in treating a wide variety of psychological and medical conditions including depression, anxiety, obesity, posttraumatic conditions, smoking cessation, irritable bowel syndrome, asthma, and conversion disorders. Hypnosis has applications in dentistry, interventional radiology, and pre- and postsurgical situations. Indeed, hypnosis may provide varying degrees of pain relief for as many as 75% of the population. Furthermore, meta-analyses have shown that hypnosis enhances the effectiveness of both psychodynamic and cognitive behavioral psychotherapies. However, it has not been conclusively demonstrated that hypnotic treatments are more effective than nonhypnotic treatments for a variety of problems.

Fortunately, for most therapeutic tasks involving hypnosis, high suggestibility is not a prerequisite. Although there is no universally close relation between hypnotic suggestibility and treatment gains, suggestibility is not completely irrelevant to outcome. In no study reported to date, is high hypnotic suggestibility associated with a negative treatment outcome. Moreover, in the following disorders or conditions, the findings regarding suggestibility and treatment outcome are at least somewhat promising: smoking cessation, obesity, warts, anxiety, somatization, conversion disorders, and asthma.

Hypnosis has received a great deal of attention in the forensic arena. One common misconception holds that hypnotic procedures can greatly enhance the ability of people to accurately recall forgotten events. On the basis of this misconception, police departments in a number of countries have often arranged to have eyewitness to crimes hypnotized in the hope that the recall of the witnesses would thereby be enhanced.

Most of the laboratory evidence available now indicates that the hypnotic procedures do not dramatically enhance accurate recall and do not enhance the accuracy with which witnesses identify perpetrators, whom they have observed commit mock crimes. Although sometimes subjects do recall new information following an hypnotic interview, they may also recall as much new information when motivated by nonhypnotic instructions. When hypnotic (and sometimes nonhypnotic) procedures are used to obtain new information from witnesses, the new information obtained often is inaccurate (i.e., a pseudomemory). Moreover, in most real-life situations, there is nothing that enables either the witnesses or the interviewer to discriminate between the accurate and inaccurate aspects of the recall.

Some investigators have argued that hypnotic subjects are likely to be influenced by leading questions such as, "What color was the suspect's mustache?" The proposition that misleading questions influence and degrade the accuracy of recall is not in dispute. This effect of leading questions has long been

known and has been elegantly demonstrated in the laboratory in a large number of studies conducted by Elizabeth Loftus as well as others. Indeed, several studies indicate that the effects of the leading questions can exceed that of hypnosis in producing false memories, although in one study, leading questions and hypnosis combined to enhance the likelihood of inaccurate recall.

A serious concern in forensic contexts is that hypnosis enhances witness confidence in inaccurate as well as accurate memories. In the majority of studies that examined witness confidence, witnesses who received hypnotic interviews were more confident about the inaccurate aspects of their recall or about their misidentifications than nonhypnotic witnesses. Questions surrounding the accuracy and unwarranted confidence of hypnotically elicited memories have led to courts in 27 states to ban the admission of testimony of people who have undergone hypnosis to augment recall. However, because several studies indicated that hypnotic testimony was no more resistant to cross-examination than nonhypnotic testimony, a ban on hypnotically assisted testimony remains subject to debate. Less controversial than the issue of admitting hypnotic testimony in the courtroom is the fact that extreme caution needs to be exercised in administering hypnotic procedures to victims and witnesses.

The field of hypnosis will advance apace with careful experimental and clinical research and by way of theoretical tensions and rapprochements between competing paradigms. In this process, the study of hypnosis will continue to enrich the broader field of psychology by contributing insights into the affective, cognitive, behavioral, and relational dimensions of human experience.

See also: Attention; Mental Imagery; Persuasion.

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Relevant Websites

- <http://www.asch.net> – American Society of Clinical Hypnosis.
- <http://www.ish-web.org> – International Society of Hypnosis.
- <http://www.sceh.us> – Society for Clinical and Experimental Hypnosis.

Hypochondriasis or Health Anxiety

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Glossary

DSM-IV-TR Diagnostic and Statistical Manual of Mental Disorders, the official diagnostic manual of the American Psychiatric Association.

ICD-10 International Classification of Diseases, the official diagnostic manual of World Health Organization.

Introduction

Hypochondriasis, or hypochondria, is often called excessive health anxiety. Some health anxiety is considered normal and is the reason why people seek medical attention when appropriate. Health anxiety can gradually increase, and in hypochondriasis it has exceeded the normal range and is now an energy-consuming and disabling problem for the patient. Hypochondriasis covers both disease conviction and fear of having or getting a serious disease. The term is one of the oldest medical terms and used to describe disorders believed to be situated in the hypochondrium, which is the area under the 'khondros,' the cartilage, ribs, especially stomach, spleen, and liver. In ancient times, it was synonymous with melancholia, which was believed to be caused by mela chloe = black bile. Gradually, the meaning of hypochondriasis changed and from the seventeenth century, it came to describe health anxiety, while melancholy described a depressive state. Excessive health anxiety is described by the famous French playwright and actor Jean-Baptiste Poquelin (1622–1673), best known as Molière, in his play 'La Malade imaginaire,' 'The Imaginary Invalid' from 1673. Molière suffered from tuberculosis, and ironically he died hours after collapsing on stage due to coughing and hemorrhaging while playing the part of the hypochondriac Argan.

Many people associate hypochondriasis with malingering, and should the doctor introduce the diagnosis, patients might feel offended or not taken seriously. For the doctor, it may seem easier to continue searching for a somatic or organic cause than to sit down with the patient and reflect upon what his attitudes to various symptoms, to life and death, uncertainty, and risk are. For many patients, the term health anxiety is more acceptable than hypochondriasis. Hypochondriasis leads to time-consuming worrying, reduced social and occupational functioning, and overutilization of health care services. The disability and impairment in role functioning is comparable to major depression, anxiety disorders, and many chronic medical diseases. Hypochondriacs are found to be high utilizers of primary and secondary medical care services. Untreated, the prognosis is dubious and 50–70% of patients do not recover. Psychiatric comorbidity does not seem to influence the course of hypochondriasis. How a possible genetic vulnerability factor might interact with environmental factors is still unclear and a subject of ongoing research. The environmental effect is evident in findings of transient increased health anxiety in medical students while entering the clinical years followed by a

significant decrease later on. In older medical textbooks, hypochondriasis was considered an untreatable disorder, resistant to psychological treatment. This has now changed dramatically with the advent of effective psychotherapeutic treatments, especially cognitive-behavioral therapy (CBT).

Diagnostics and Prevalence

There is a continuum between normal health anxiety and persistent, disabling health anxiety. Hypochondriasis has always been part of our diagnostic systems. In both ICD-10 Hypochondriacal disorder F45.2 and DSM-IV-TR, Hypochondriasis 300.7 is found under the heading Somatoform disorders. According to ICD-10, "The essential feature is a persistent preoccupation with the possibility of having one or more serious and progressive physical disorders. Patients manifest persistent somatic complaints or a persistent preoccupation with their physical appearance. Normal or commonplace sensations and appearances are often interpreted by patients as abnormal and distressing, and attention is usually focused upon only one or two organs or systems of the body." These criteria are under discussion. The additional requirement of 'persistent refusal to accept medical reassurance' often is a bottleneck in the diagnosis of hypochondriasis in primary care, as many patients transiently accept the doctor's reassurance. Fear of death has been found to be an integral part of hypochondriasis, but is not included in the diagnostic criteria. Body dysmorphic disorder (BDD) is included in the F45.2 Hypochondriasis in ICD-10, and is characterized by an extreme focus on an imagined or slight physical defect, often in the face but can be in any part of the body. Most patients with BDD consider themselves extremely ugly, and many seek plastic surgeons to correct the defect. BDD differs from 'regular' hypochondriasis in many aspects, and in DSM-IV-TR it has its own identity alongside, but separate from, hypochondriasis. In DSM-IV-TR, hypochondriasis is described as "preoccupation with a fear or belief of having a serious disease based on the individual interpretation of physical signs or sensations as evidence of physical illness. Appropriate physical evaluation does not support the diagnosis of any physical disorder that can account for the physical signs or sensations or the individual's unrealistic interpretation of them." It is stated in DSM-IV that the symptoms must persist for 6 months or more. Both ICD-10 and DSM-IV-TR agree that the main feature of hypochondriasis is the tendency to misinterpret bodily symptoms and sensations as signs of a serious physical illness.

The patients will also often have a tendency to misinterpret and catastrophize medical information, either given by the doctor, media, or the Internet. Most hypochondriacs seek reassurance and have frequent visits to doctors, ask friends and family what they think, check their body for signs of disease, and review medical literature or the Internet, but some avoid all factors that might provoke their anxiety (like watching TV, physically working out, etc.). If the patients' fear is focal and they avoid any situation that may lead to contracting an illness, the diagnosis Specific Phobia might be used. In contrast to a hypochondriac, the patient with Specific Phobia does not believe that he has the disease and he recognizes that the phobic fear is excessive and unreasonable. The fear in Specific Phobia can be cancer or heart disease, and also for example fear of vomiting. Delusional syndromes of somatic type, where the patient's thoughts are usually bizarre, are not included in hypochondriasis as defined by ICD-10 or DSM-IV-TR. If hypochondriasis is secondary to another psychiatric disorder, like major depression, schizophrenia, panic disorder (PD), generalized anxiety disorder (GAD), obsessive-compulsive disorder (OCD), etc., this disorder is the one diagnosed, and not hypochondriasis.

Excessive health anxiety can be triggered by life changes, for example, getting a baby, which makes it very unsuitable to die, by being close to a person dying from a serious and painful disease, focus by media on specific dangers, or even from something the patient learned from his parents. It has been documented that hypochondriasis is connected with reduced quality of life and represents a high cost to the medical society because of many unwarranted CT-scans, MR, doctor visits, etc. Untreated hypochondriasis has a tendency to persist.

Diagnostic Interviews and Questionnaires

The diagnosis of hypochondriasis is usually based on interview, where the patient's fear and tendency to catastrophize becomes evident, in combination with a normal physical checkup. A clinician-administered semistructured interview to assess hypochondriacal thoughts and behaviors, known as "The Hypochondriasis Yale-Brown Obsessive-Compulsive Scale" (H-YBOCS), was published in 2009. H-YBOCS is a modification of a commonly used interview in OCD. It covers 16 items, among which the three factors, hypochondriacal obsession, compulsion, and avoidance are identified. Interrater reliability is good, internal consistency satisfactory, and construct validity low. The low discriminant validity will have to be examined further, and could be due to comorbid anxiety or depression. H-YBOCS is promising but its contribution to the assessment of hypochondriasis is not yet established. So far, structured or semistructured interviews giving ICD-10 or DSM-IV-TR diagnoses are used in research.

Several self-administered questionnaires have been developed to evaluate and diagnose excessive health anxiety. The older ones include Whiteley Index (WI) developed by Pilowsky in 1967, Illness Behaviour Questionnaire (IBQ) developed by Pilowsky and Spencer in 1975, and The Illness Attitude Scale (IAS) published by Kellner in 1986. WI has traditionally been the most commonly used questionnaire. In the original version, it was dichotomous (true/false), but has later been used mostly in a Likert scale version. Factor analysis of

WI has identified three factors, 'bodily preoccupation,' 'disease phobia,' and 'conviction of the presence of disease with non-response to reassurance.' WI has adequate test-retest reliability, internal consistency, and convergent and concurrent validity. As a screening instrument, it is unspecific, and a person with a diagnosed serious disease will also have high scores on some of the questions, such as: 'Do you think there is something seriously wrong with your body?' WI is a good measure of health anxiety and the score is a good indicator of the effect of treatment. IBQ is not only a measure of hypochondriasis but has a wider approach as it focuses on inappropriate ways of responding to the state of one's health. IAS is a commonly used self-report measure and also has a wider focus than specific hypochondriasis. It has 29 items and nine subscales: 'worry about illness,' 'concerns about pain,' 'health habits,' 'hypochondriacal beliefs,' 'thanatophobia,' 'disease phobia,' 'bodily preoccupation,' 'treatment experiences,' and 'effects of symptoms.' It has been found to have good reliabilities and the subscale 'bodily preoccupation' (three questions) has been found to be a useful screening instrument for hypochondriasis. The Minnesota Multiphasic Personality Inventory (MMPI) has a hypochondriacal scale but is more a measure of somatization than hypochondriasis.

More recently developed questionnaires include Health Anxiety Questionnaire (HAQ) from 1996 and the Reassurance Questionnaire published in 2000. HAQ has 21 questions. This questionnaire also has good internal consistency. The scale has four factors: worry and health preoccupation, fear of illness and death, reassurance-seeking behavior, and the extent to which symptoms interfere with a person's life. The latest addition to the self-administered questionnaires is The Health Anxiety Inventory (HAI), in a short and long version. HAI is, like HAQ, based on the cognitive-behavioral theory of health anxiety and was published by Salkovskis in 2002. HAI has 64 questions, including additional questions about how much the person worries about specific conditions like heart attacks, strokes, cancer, multiple sclerosis, AIDS, or other and the following themes: own death, pain, death of a relative, death of a friend, being unable to look after yourself, and going mad. The last two forms to be filled in register avoidance of consulting the family doctor, talking about illness, watching TV programs about illness, etc. and finally how the person seeks reassurance. The initial study reported good internal consistency and test-retest reliability and the scale was sensitive to change in health anxiety due to treatment. The short form of 18 questions, which is easy to use in daily practice, was found to have comparable properties to the full length scale. Short form, SHAI, consists of two factors assessing their perceived likelihood of becoming seriously ill ('illness likelihood') and the perceived negative consequences of being seriously ill ('negative consequences'). However, the factor analysis, whether it is two or three factors, is still open for discussion. An advantage of HAI compared to WI is that patients with a serious disease do not tend to get a high score.

Is Hypochondriasis a Somatoform or Anxiety Disorder?

The main similarities between hypochondriasis and the other somatoform disorders are the presence of medically unexplained symptoms, a tendency to interpret physical complaints

and symptoms as signs of a physical disorder or disease, an urge for medical examinations in order to identify the cause, and a general preoccupation with health and illness. However, hypochondriacs are in many aspects different from other somatoform disorders. A patient with somatization disorder or persistent pain will usually readily accept treatments that can relieve their pain, be it painkillers or other interventions. They believe that their symptoms have an organic cause, but they usually accept that it is not dangerous, it will not kill them. A hypochondriac with headache, on the other hand, will not readily accept paracetamol or other analgesics to relieve the pain. He wants to get rid of the tumor, not the pain! In fact, many patients with hypochondriasis claim that if they could just know for sure that the pain is not caused by a serious disease, the symptom itself would not be the main problem. Another difference between hypochondriasis and other somatoform disorders is the lack of secondary gain. In somatization disorder or persistent pain, attention from significant others, economic compensation, or other benefits are common and will often complicate the therapeutic alliance in treatment. In hypochondriasis, the secondary gain is usually low. There is not much gain in being anxious, and an imagined cancer disease seldom evokes compassion and understanding from family or friends. Another difference between a person with somatization and a hypochondriac is what kind of physical causes they tend to come up with in search for an explanation to their problem or symptoms. Hypochondriacs usually stick to normal, mainstream diseases like cancer, coronary heart disease, tuberculosis, multiple sclerosis (MS), etc., while some patients with somatization syndrome tend to be open to more speculative explanations, which are hard to prove or discard completely, for example, be radiation, electricity, food intolerance, amalgam, postvaccination complications, etc.

There are many similarities between hypochondriasis and anxiety disorders, for example, the intolerance of uncertainty, which drives many patients to develop avoidance and safety behaviors. This is typical also in patients with hypochondriasis. Perhaps the best argument why hypochondriasis is best considered an anxiety disorder is the development of a cognitive-behavioral model of the disorder by Warwick and Salkovskis, which has led to effective treatment. According to this model of hypochondriasis, the basis is a tendency to misinterpret harmless bodily symptoms as threatening. This results in higher body vigilance, leading to higher awareness of normal physiological alterations and higher anxiety caused by catastrophic misinterpretations. Anxiety-symptoms due to autonomic activation like palpitations, chest pain, nausea, dizziness, etc. are in the patients' mind interpreted as a sure sign that there must be something seriously wrong with their body. This way, a vicious circle is established. This model was derived from observation of similarities between symptoms and symptom presentations in hypochondriasis and panic disorder (PD), generalized anxiety disorder (GAD), and obsessive-compulsive disorder (OCD). Patients with GAD worry about almost everything that can happen, including death and diseases. In some presentations of OCD, health concerns are evident, especially in fear of contamination. In some patients with a specific fear of already having or getting HIV/AIDS, the differential diagnosis between hypochondriasis and OCD can be difficult. One striking difference is that while the

hypochondriac makes little effort to resist his self-checking, self-examination, and reassurance-seeking, the obsessional often tries to hide his behavior from others. Both patients with PD and hypochondriasis are hypervigilant to bodily symptoms and readily misinterpret the common physiological reactions to elevated adrenalin levels as a sign of serious heart disease, stroke, going mad, or imminent death. The difference between a patient with PD and a hypochondriac is that the hypochondriac has this focus more or less all the time, while the panicking person only misinterprets symptoms during attacks. Under attack, patients with PD fear that they are dying, while a patient with hypochondriasis fears death all the time, and may worry just as much about progressive diseases like lung cancer as heart attack or stroke.

Prevalence

The prevalence of hypochondriasis in the general population is around 0.05–1.3% and in primary care settings between 3 and 9%. Hypochondriasis is most commonly found between the ages of 25 and 45 years and equally distributed between both sexes. The prevalence does not seem to vary remarkably from one culture to the other.

Treatment

Psychotherapy

The conceptual shift when hypochondriasis changed from being untreatable and chronic to a treatable disorder started when pilot studies in the 1980s indicated that CBT could be useful. This has later been confirmed in several studies, and reviews have concluded that psychotherapy reduces symptoms of hypochondriasis compared with waiting list, placebo, or treatment as usual. Few randomized controlled trials have compared different types of psychotherapy to each other, but overall CBT is the best-documented treatment available. CBT given individually or in groups has been compared with interpersonal therapy, psychoeducation, brief psychodynamic therapy, counseling, hypnotherapy, and relaxation training. The first controlled clinical study of CBT in hypochondriasis was published by Warwick et al. in 1996. Thirty-two patients were randomly assigned to waiting list or 16 sessions of CBT. At 3 months follow-up, the patients in active treatment were better than the waiting-list patients. In a later study published by Clark et al. in 1998, 48 patients were randomized to CBT or behavioral therapy focusing on stress management. At the 12 months follow-up, both treatment groups were better than the control group. Patients in CBT had lower health anxiety, but CBT as well as behavioral therapy were effective. This has later been confirmed on other randomized controlled studies, and in four of four trials involving 345 patients CBT has been found to be beneficial in terms of hypochondriacal cognitions and behaviors. The recovery rate is however still relatively low in most studies, ranging from 30% to 50%.

Increased health anxiety can be secondary or coinciding with somatic disease. For example, a patient with coronary heart disease can develop a heightened awareness of any sign of relapse or a new infarction and develop serious heart disease. CBT has been found to be beneficial even if the patient

has an underlying organic disease. Recently, a study was reported where greater improvement was seen in HIA in patients treated with brief (mean 4.3 sessions) CBT compared to the control group in a genitourinary medicine clinic. These patients had a score of HIA lower than what would be expected in patients with hypochondriasis. The patient number was low (23 allocated to CBT-group) and the selection of patients was not randomized, but this study suggests that CBT can be used in a wider medical setting and applied to patients with bothersome health anxiety, even though they might not fulfill the criteria for ICD-10 or DSM-IV-TR Hypochondriasis. Similar results have been published from pain clinics.

Lately, elements of mindfulness have been included in CBT of hypochondriasis. This approach not only takes into account the dysfunctional beliefs patients have about health and their tendency to misinterpret normal physiological complaints but also focuses on dysfunctional cognitive processing, for instance, attentional biases, and rumination. In a pilot study by Lovas and Barsky from 2010, ten patients with hypochondriasis received 8 weeks of mindfulness-based stress reduction (MBSR) and mindfulness-based cognitive therapy (MBCT) in groups. The participants were taught mindfulness meditation; they were provided with guided meditation CD and were asked to practice formal meditations for at least 30 min every day. The main outcome measure was WI. The results showed significant reductions in hypochondriacal health anxiety at post-treatment and 3 months follow-up. The patients also demonstrated improvement in somatic symptoms, a finding which is relatively rare in other studies. This pilot study has been supplemented by a randomized clinical trial including a mindfulness-based approach published by Sørensen et al. in 2011. In this study, CBT (a combination of individual CBT and mindfulness training in groups) was compared to short-term psychodynamic psychotherapy (STPP) and no intervention (waiting list). The treatment consisted of 16 sessions and lasted up to 6 months. The main outcome measures were Health Anxiety Inventory short version (SHAI) and Hamilton Anxiety Rating Scale for general anxiety. Twenty patients were allocated to CBT, 40 to waiting list, and 20 to the STPP group. The patients were followed up at 6 and 12 months after treatment. Patients in the CBT group did significantly better on all measures compared to the waiting-list control group and on HAI also compared to the STPP group. The STPP group did not differ from the waiting-list group on any primary or secondary outcome measure.

Studies of Long-Term Follow-Up After Psychotherapy Has So Far Not Been Published

Pharmacological Treatment

So far, relatively little research has been done on pharmacological treatment of hypochondriasis. Most studies have been open and uncontrolled, and due to similarities between hypochondriasis and OCD and other anxiety states, mainly serotonin reuptake inhibitors (SSRI) have been studied. In open studies, Fluvoxamine has been found to be beneficial, but a relatively high portion of the patients discontinued the treatment.

In a randomized controlled study by Greeven et al. published in 2007, both CBT and paroxetine, another SSRI, were

superior to placebo, but no statistical difference was found between the treatment groups. Responders were defined as at least one standard deviation below the mean pretest score on the WI. Percentages of responders were on the intent-to-treat and completer cohort 45% and 54% in the CBT-group, 30% and 38% in the paroxetine group, and 14% and 12% in the placebo group. The patients have later been followed up and 45% of the patients of the intent-to-treat sample of the CBT group and 30% of the paroxetine group were considered responders. No significant difference between CBT and paroxetine was found in the follow-up. However, significantly more patients in the paroxetine group (12 out of 22) received psychological or pharmacological treatment during the follow-up period compared with patients in the CBT group (7 out of 28). The relapse rate in both groups was small. Effect sizes for SSRI seem to be smaller than for CBT and dropout from treatment seems to be higher in pharmacological treatment than in psychotherapy. This is not surprising, considering the hypochondriac's hypervigilance to bodily symptoms and tendency to misinterpret bodily sensations.

Several treatment options are available, but most review articles agree that CBT is best documented and should be the treatment of choice. Psychotherapy is not always available and there is some scientific support that treatment with SSRI can be beneficial, but further studies are necessary.

The Cognitive-Behavioral Approach to Treatment

The treatment of hypochondriasis has changed after the introduction of a cognitive-behavioral model. At Haraldsplass Deaconal Hospital in Bergen, Norway, we have used this model since 1996 in an outpatient clinic specifically designed for patients with hypochondriasis. Around 100 patients are accepted every year and the number of sessions has gradually been reduced from initially 16 to presently around 5. The main aspects of the treatment will be outlined here. Usually, the diagnosis of hypochondriasis is established with a semi-structured interview and WI is filled in by the patient. This establishes a baseline from which change can be monitored. After a relatively short life history, focusing mainly on the important factors that might have established or triggered the health anxiety, the main themes in hypochondriasis are highlighted.

The point in CBT is to help the patient reflect upon his attitudes and behavior. With attitudes we mean basic assumptions, schemas, or worldview. There are many situations or problems in this world which are beyond our reach; we cannot do anything about them. But our attitudes and the way we evaluate a situation, a problem, or a symptom can always be changed.

Death

Since fear of death usually is an integral part of hypochondriasis, this is focused in the first session. We usually ask our patients if they are willing to be mortal. A typical answer is: 'In principle yes – but not now! It is too early.' In other words, they try to control death. The problem is that to control death, irrespective of how many good arguments you might have and

how important it is that you stay alive, is impossible. None of us know how or when we are going to die. It is normal to fear death, but it is questionable to try to control it. This can in some patients be the driving force behind their tendency to check the body and be hypervigilant to any physical complaint. If the patient tries to control death we ask him how he actually does it. A typical question could be: 'Do you choose a broad approach and try to control all causes of death, or do you specialize?' Most of our patients choose not to focus on all causes of death, but to specialize only on some. It can be causes of sudden death, like heart attacks, stroke, etc., or it can be more slowly developing causes like cancer, HIV, etc. If the patients are especially concerned about cancer, they try to detect the disease as soon as possible, at least before it spreads. This means that they cannot wait and see how a symptom or complaint evolves and often disappears, as it then might be too late! The problem with this approach is that most people, also completely healthy people, have a lot of subjective somatic complaints. Several studies have shown that normal people often have a transient headache. It is very seldom caused by a brain tumor. May be they have drunk too little, or may be too much. They might have had some distress leading to tension headache, or it might be migraine. Sometimes we just do not know why. It is also normal during a month to have some back pain, nausea, dizziness, etc. This is all part of life, and usually not deserving of attention. However, if you are not willing to be mortal now, you cannot admit yourself the luxury to wait and see. You must act now, which either means to check every day or seek the doctor immediately. It is common in CBT to give the patients homework assignments, and the first question we want them to reflect upon is this: 'Am I willing to be mortal?'

A theme that often comes up in therapy is the question of control. Most people want to be in control in their life. We usually tell our patients that it is perfectly normal and OK that they want to be in control in their life, but we suggest that they stick to factors that are controllable. Death is not one of them. To most normal people, death is very negative; it is an enemy, an unwanted guest. We do not suggest idealizing death or making the bitter pill sweeter than it is. The point is to accept that it is uncontrollable. The nice thing about being willing to be mortal is that we then can focus on living and spend our energy and time on that, instead of spending it on not dying.

Consequences of Disease

To some patients, fear of death is not the biggest problem, but they have the notion that they will not be able to cope with a specific disease or prolonged suffering and uncertainty. This is usually not a fact or something they have tested out, but a thought, something they believe. If it is a fact, they might have to focus on increasing their coping skills, but most people have not so far tried this theory in practice. Many people minimize their own coping capacity. In fact, most of us have no idea how we some day in the future will handle a nasty situation or cope when facing, for example, real cancer. To some people, the biggest challenge in life is not real problems but the imagined catastrophes. Some patients argue that if they are terribly scared just thinking about a problem, it must be

even worse if it actually manifested itself in reality. This is usually not the case. Most people handle imagined and real problems very differently. Imagined problems are hard to deal with, they are just thoughts, and they cannot be reached using normal coping skills. Real problems are different. They are limited by time and space, while imagined problems are only limited by the patient's phantasy. The question to reflect upon at home is: 'Are you really going to keep this negative view on your own coping abilities?' Patients who are trying to control death usually fear mostly life-threatening diseases like cancer, heart disease, stroke, etc., but those who distrust own coping abilities tend to focus on diseases like MS, amyotrophic lateral sclerosis (ALS), HIV/AIDS, etc.

Worrying

Since hypochondriasis in many aspects resembles anxiety disorders and the patients are very good at catastrophizing, it is important to reflect upon the question of worrying. How much worry are we going to have in our life, and what are we going to worry about? It is perfectly normal to spend some time worrying about real problems, diseases which are diagnosed, conflicts, bills, etc. That is why we have worry and anxiety, so that we can find good solutions. The question is how many of the things that might happen are we going to worry about. Patients with GAD have a wide approach when they worry and can worry about almost all that might happen. Patients with hypochondriasis have specialized on health issues, and worry about cancer, heart disease, ALS, etc. Usually, people have some kind of reasoning why they worry, but it has seldom been articulated and reflected upon. Some common arguments are: 'I want to be prepared for the worst!' 'If I don't worry, anything can happen!' 'If I am too happy and optimistic the chances that it might happen increase!' 'I am an unlucky person – it would be so typical that it happened to me!' etc.' Depending on what reason they come up with, we look into it and ask ourselves: 'Is this a good argument, something we would recommend to others?' The idea behind being prepared for the worst is that it will take some of the pain out of a bad diagnosis or accident. Is that true? Can we rehearse real catastrophes? If something bad actually happens to one of your children, and you have rehearsed this for many years, will you then say that it was a good thing that you were prepared, otherwise you would not have coped? The answer is no. Real challenges can be tough, and it does not help to rehearse. Another problem is that we can rehearse the wrong challenge. Actually, it is hard to find good reasons why we should worry today about things that might (or might not) happen tomorrow. If the patient believes that it is dangerous to be too happy, we ask them if they really believe that their emotional life really can influence what happens in this world. It is hard to explain the connection between their emotional status and the occurrence of real accidents, diseases, etc. Most people realize that this is magical thinking, and they then have a choice to keep or dismiss it.

If the patient decides to worry about only real problems and factors he can actually control, he has to figure out how this is done in real life. Some aspects of mindfulness can be very useful in applying this new attitude. Many patients complain that even though they have decided not to worry, they still get

their catastrophizing thoughts. They want to get rid of them completely; they distract themselves or try to suppress thoughts. This is impossible and unnecessary. Thoughts are just thoughts. It is important to differentiate between thoughts and facts. We cannot decide what kind of automatic thoughts we get, but we can choose how we react to them. In mindfulness, people are encouraged to accept their thoughts. Let them come, and go. Be passive, observant, and nonjudgmental. Just let thoughts come, they are just thoughts anyway. Do not give them power and energy by focusing on them and reacting strongly to them. When a worrier gets a catastrophizing thought, he tends to think: 'Oh, that was a terrible thought! Let me ruminate on it and follow it to the bitter end!' This kind of thinking is usually neither fun nor rewarding. It is like treating thoughts as if they were a thin, stray cat passing by. You feel compassion and give the cat some food, milk, and TLC. Eventually you say: 'You must not come back! You don't live here!' This is usually not very effective. A mindful approach is to accept the thoughts when they come. Do not judge it or involve yourself in it, just let it pass, like a cloud in the sky! Thoughts are just actions in my mind, not in reality. If the therapist is trained to do it, he can anchor the mindfulness training in breathing. The homework question after this reflection is: 'How many of the sorrows you cannot do anything about that might happen tomorrow are you going to worry about today?'

Symptom Interpretation

Hypochondriacs are preoccupied with their body and all kinds of complaints and symptoms. In psychotherapy, it is more important to focus on how symptoms are interpreted than the actual symptom itself. Many hypochondriacs view a bodily complaint as if it was a red light on the dashboard of a car. Only a stupid person would ignore that. However, this is not a good comparison. Bodily complaints are very common and usually not important. When you experience pain or subjective complaints, it is extremely important how you evaluate them. Our brain is very interested in our survival and well-being. If you tell it that there is something going on in a certain place in your body, keep an eye on it, it puts on the magnifier, scanner, and danger light and amplifies whatever it detects. If you on the other hand tell your brain that the danger is over, 'I have decided to believe that everything is OK, you can now focus on other tasks!', the brain will do so, and hence the symptom loses some of its power and strength.

Intolerance of Uncertainty

The question of risk and uncertainty nearly always comes up when dealing with a hypochondriac. If they fear heart disease, they have already been to GP and sometimes even cardiologist, who have assured them that there is nothing wrong with their heart, but they have chosen to doubt this. In our hypochondria-clinic, we seldom discuss with the patients whether they have a disease or not, but we encourage them to examine how they evaluate the thought that they might have, for example, a heart disease. A person cannot choose if he has a real heart disease or not, but he can choose whether he will believe that he has a heart disease or not. The question is if

he is willing to make this decision while still in doubt. If the patient insists that he must seek 100% assurance, there is not much the therapist can do. If, on the other hand, the patient accepts that he has to make his decision under some uncertainty, this will be his next homework assignment. Studies have found that to have an imagined heart disease can lead to a lower quality of life than a real one. People with real coronary heart disease often live good lives. If you ask them whether they work out, they will often say: 'Yes, I am in better shape than before my heart attack!' People with imagined heart disease, on the other hand, have not got any stents or medication and do not know what their heart can take. If you ask them if they work out, they usually answer no, they do not, it might kill them. It is an important choice whether you decide to trust your heart or distrust it, as it directly influences what you dare do or not do in your daily life.

When these basic attitudes are discussed and reflected upon and the patient hopefully has made new choices, these new attitudes can be applied in their lives. In CBT, it is not enough to change cognitions or attitudes; you must also behave as if you mean it. Otherwise, this is just theory, intellectual insight, but of no value in real life. There will come a time, sometimes surprisingly short but sometimes longer, when the patient must struggle with a new way of thinking and behaving. Avoidance must be challenged and safety behaviors be done away with (checking the body, frequent visits to the doctor, etc.). Many patients find it liberating to no longer bear the responsibility of staying alive, and they can now focus on living instead of on not dying.

Empathy is always important in therapy. The patient must be understood, and most people like it when the therapist briefly summarizes what he has heard and adds an emotional touch, like 'this must be scary! make you feel sad.' However, empathy has its limits, and there is also a time for confrontation. It can strengthen the therapeutic alliance if the therapist is frank, sincere, polite, honest, and direct in his communication. Questions like: 'Is what you are saying now really true, or is it an opinion?' 'Do you really mean this?' or 'Would you suggest that I adopt the same attitude as you now have displayed?' can help the patient to reflect upon his attitudes in life. Most patients haven't really thought through why they live like they do, and in particular they have not been aware that they have a choice of how to interpret and evaluate the different problems they face. When a person understands that he has spent a lot of time trying to control factors which are in principle uncontrollable, he might wonder if he is stupid, since he has not understood this before. The answer is no. The patient is not stupid, but scared of death. And that is a big difference.

Discussion

As it has been pointed out, health anxiety is a continuum with patients with ICD-10 or DSM-IV-TR hypochondriasis at the extreme end. Several studies have found that even slight increase in health anxiety has a strong negative effect on well-being. When Gureje et al. did their study of hypochondriasis in 15 different sites from a broad diversity of cultures and socioeconomic development, they found that when they

lowered the diagnostic threshold and introduced abridged hypochondriasis, many more people fulfilled the criteria. Interestingly, these new people now included in the category of hypochondriasis were no less disabled than the people who fulfilled the ICD-10 or DSM-IV-TR diagnostic criteria and they found that subjects with abridged hypochondriasis were significantly more psychologically impaired than non-hypochondriacal subjects. This is in accordance with findings from our own research group. In a study published by Mykletun et al. in 2009, we found that health anxiety was a strong predictor of disability pension award, exceeding the effect of general anxiety, and comparable to the effect of depression. The effect was not limited to high symptom level but followed a dose-response association. However, it was not recognized as medical diagnosis in any awards of disability pension in the study population. Our conclusion was that health anxiety is a strong, independent, and underrecognized risk factor for health disability pension award. Today, we have focused, time-limited, and effective therapy, and hence health anxiety deserves increased attention also in primary care settings.

Conclusion

Hypochondriasis seems to defend its position as a distinct mental disorder and deserves a place in our diagnostic manuals. Whether it is best conceptualized as a Somatoform or an Anxiety disorder remains to be decided, but with the development of a cognitive-behavioral model of the disorder, the similarity to the anxiety disorders has been emphasized. The addition of mindfulness techniques to CBT is promising, but more research on the possible added effect is needed. Health anxiety, also when it has not developed into full-blown hypochondriasis, has been found to be a strong, independent, and underrecognized risk factor for health disability pension award in a Western society.

See also: [Cognitive Behavior Therapy; Somatoform Disorders.](#)

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Id, Ego, and Superego

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Glossary

Eros One of the two classes of instincts that motivate behavior. It is described as 'life' instinct, the 'preserver of all things,' incorporating the elements of sexuality and self-preservation. This is in contrast to the opposing tendency to reduce life to an inanimate state, or the 'death instinct,' which is revealed by aggression and sadism.

Erotogenic zones The zones of the body (oral, anal, phallic) that are sequentially invested with sexualized energy (libido), and are hence the source of autoerotic pleasure. The sexual instinct is thus a composite instinct, only to become organized in the service of reproductive, genital sexuality upon maturity.

Libido The name reserved for the sexual instincts.

Oedipus complex The libidinal cathexis of phallic erotogenic zone leads to a desire for union and contact with the opposite-sex parent, and a concomitant desire to displace the same-sex rival parent. The competition for the opposite-sex parent engenders anxiety, insofar as the

retaliation of the rival is feared ('castration complex'). This is resolved by repressing incestuous desires, and identifying with the same-sex parent, which is the foundation of superego formation. Freud once suggested that the course of Oedipal development between boys and girls was exactly analogous, but later formulations postponed the resolution of the Oedipal conflict for girls until marriage and childbirth.

Pleasure principle The motivating principle of behavior is the pursuit of tension reduction, which is experienced as pleasure.

Primary process The workings of unconscious (id) processes. Instinctual energy is freely mobile, and capable of displacement and condensation. In contrast, secondary process, attributed to ego functioning, attempts to postpone, revise, or otherwise deflect instinctual motivations.

Transference In the therapeutic situation, the (unconscious) incorporation of the analyst in the internal conflicts of the patient.

Freud in Context

Psychoanalysis is one of those rare intellectual achievements that had the effect of radically transforming human self-understanding. Indeed, Freudian notions have so thoroughly permeated human culture that the jargon (if not the substance) of psychoanalysis is accessible to even the most untutored observers of human behavior, so much so that the poet W.H. Auden could write that for us, Freud is not so much a person but rather *a whole climate of opinion under whom we conduct our different lives*. By Freud's own estimation, psychoanalysis effectively completed the intellectual revolution begun by Copernicus, and advanced by Darwin, a revolution that undermined human conceit regarding its putatively special and privileged position in the cosmos and in nature. While Copernicus displaced mankind's planet from the center of the universe and Darwin showed that no comfort can be taken in the idea that mankind is nonetheless above the forces of nature, Freud completed the assault on human pretense by showing that even human reason is not what it has been supposed, that human psychology is, in fact, besieged and driven by irrational, unconscious motivations.

Freud's discovery of a hidden psychic reality that is beyond the pale of sensible consciousness was thought (by Freud) to be an application of the same Newtonian dualism that accepted the distinction between human sensory abilities (percepts) and a hidden physical reality that could only be apprehended by mathematics and the armamentarium of physical science. The Newtonian scheme was invoked by psychoanalysis to advance an understanding of psychic life, an application that hinges on the distinction between conscious and unconscious mental life.

Just as physics develops scientific techniques to apprehend a physical universe that is beyond human sensibility, so also psychoanalysis attempts to pierce hidden unconscious realities with its special clinical techniques. Psychoanalysis, then, according to Freud, is to be counted among the natural sciences; it is a specialized branch of medicine (with the caveat that medical training gives no necessary expertise in psychical affairs), with mental life being the object of inquiry.

Although psychoanalysis shocked conventional sensibilities, particularly with its claims regarding unconscious mental dynamics and infantile sexuality, it was grounded nonetheless in themes common to nineteenth century science. The Freudian theory of instincts seemed at home in a culture that was getting used to the ideas of Darwinian biology. Freud's use of spatial models to locate psychic structures was in keeping with the efforts in neurology to localize brain functions. And the mechanistic Freudian image of the psychological architecture as an apparatus for channeling instinctual drive energies was not out of step with the energy mechanics of nineteenth century physics. Yet, for all the trappings of scientific positivism that Freud wanted to claim for psychoanalysis, the Freudian project was met with considerable resistance, and the history of the psychoanalytic movement is a history of struggle for academic, clinical, and popular respectability, a respectability that is still not completely won.

Freud himself was at pains to recount this struggle in a number of histories, outlines, and encyclopedia articles. Although one aim was to popularize the new science of mental life, Freud was also keen to demarcate psychoanalysis from rival depth psychology (e.g., Jung, Adler) and to show that the controversial psychoanalytic claims were the result of careful

scientific investigation of the positivist, natural science kind. He would claim, for example, that the hypothetical entities and forces of psychoanalysis were not different in kind from the hypothetical entities and forces claimed in the ostensibly harder, more respectable sciences. It will be of interest for our purposes to recount the early development of psychoanalysis to set the proper context for considering Freud's account of the tripartite personality. The structural notions of id, ego, and superego were rather late theoretical developments that can be understood properly only in the context of prior theoretical revisions – revisions that Freud would claim were forced upon psychoanalysis by evidentiary warrant.

The Cornerstone of Psychoanalysis

Freud was initially drawn to the dynamics of depth psychology by the inability of the neurological community to come to grips with the problem of hysteria. Hysterics appeared to suffer a host of somatic and physical maladies (e.g., motor paralysis, glove anesthesia) that had no apparent neurological basis. One promising treatment was the use of hypnosis. Josef Breuer, a medical colleague of Freud, claimed to have relieved the hysterical symptoms of a female patient ('Anna O.') by such means. In *Studies on Hysteria* (1895), Breuer and Freud presented a series of case studies and theoretical articles on the etiology of hysteria and the role of hypnosis in treating it. The authors claimed that hysterical symptoms have a symbolic meaning of which the patient had no conscious knowledge. Symptoms are substitutes for mental acts that are diverted from taking their normal course because the affect associated with the mental processes becomes 'strangled' (as a result of trauma) and channeled into physical symptoms ('conversion'). That is, a strong affect is prevented from being consciously worked out in consciousness, and is diverted instead into 'the wrong path,' taking the form of somatic symptoms. Under hypnosis, this strangled affect can be set free or purged ('abreacted'), allowed normal discharge into consciousness, thereby leading to a removal of symptoms. This treatment was called *the cathartic method*. Moreover, patients under hypnosis tended to recall 'psychic traumas' from a remote past, extending to early childhood, so that Breuer and Freud could claim that hysterics 'suffer from reminiscences.' When these traumas are allowed expression in the hypnotic state, strangled affect is released and directed into normal consciousness.

One sees in these studies and in the papers that followed the preliminary delineation of some of the foundational notions of psychoanalysis. To observe that traumatic 'reminiscences' could be recalled only under hypnosis suggests that their conscious expression is met with certain resistance (defensive repression). These reminiscences, though resisted, continue to exert pathogenic effects (as symptoms), which are suggestive of unconscious mental processes.

Freud was soon to abandon the hypnotic technique for the good reason that not all of his patients were amenable to hypnotic induction. In addition, Freud observed that the amelioration of symptoms seemed to depend more on the nature of the patient-analyst relationship. If this relationship was disturbed, symptoms reappeared. This clinical insight was later reformatized as transference love. Transference describes

a phenomenon that emerges during the course of psychoanalytic treatment, whereby the patient comes to involve the analyst as a substitute for a past interpersonal relationship, a finding that some consider being one of Freud's great discoveries. The hypnotic technique was replaced by the method of free association, a method that requires the patient to read off the content of conscious experiences and memories without judgment or embarrassment.

Free association depends on the assumption of strict determinism, which holds that associated ideas and memories are not randomly yoked, but are instead determined by a dominant (and often pathogenically repressed) trend of thought, which is unconscious (but is causally active nonetheless). Given the assumption that symptoms have sense and meaning, and are substitutes for actions that are omitted or repressed, the task of the analyst was to interpret the free associations in a way that successfully deciphered their meaning, a meaning that was otherwise obscured by censorship. To distinguish this technique from the cathartic method, Freud called this treatment 'psychoanalysis.' Freud claimed that the transition from catharsis to psychoanalysis yielded two important novelties: the extension of psychoanalytic insights to phenomena associated with normality, and the discovery of the significance of infantile sexuality for understanding the etiology of neuroses.

In *The Interpretation of Dreams* (1900) and in *The Psychology of Everyday Life* (1901), Freud extended this notion of mental determinism to include not just the symbolic character of neurotic free associations, which of necessity require analytic interpretation, but also the various parapraxes of normal life ('Freudian slips,' accidental self-injury, and other putatively 'haphazard' acts) and dreams. These too are like neurotic symptoms in that they express a meaning that can be deciphered by analytic interpretation. The difference between normality and neurosis was not as great as had been supposed. Indeed, the interpretation of dreams was to provide important clues to the nature of the unconscious and the process of symptom formation.

Freud distinguished between the manifest and the latent content of dreams. The manifest content was simply the recollected dream, often bizarre and strange. The latent content is provided by analytic interpretation. Latent dream thoughts are distorted and condensed 'residues' of the previous day. They are arranged so as to allow pictorial representation and, through 'secondary revision,' are given a sense of coherence. The motivation for dream formation is a repressed unconscious wish that seeks satisfaction ('wish fulfillment') in the form of the latent material of the dream. Dreams represent, then, a disguised attempt at the fulfillment of an unconscious wish that was denied satisfaction. The attempt is disguised, that is, the manifest content is strange and bizarre, because of the efforts of a restrictive, disapproving agency in the mind (e.g., the ego). Dream censorship, according to Freud, points to the same mental process that kept the wish repressed during the day. So, on the one hand, there is an unfulfilled, repressed wish that is striving for expression. On the other, there is a disapproving, censoring ego that is striving to repress it. The result is a compromise formation that takes the form of dreams, in normality, and of symptoms, in the case of neurosis. Dream formation and symptom formation, then, are the expressions of identical mental dynamics. Both are compromise formations

that reflect the conflict between unconscious impulses (wishes) and the censoring ego.

The second novelty revealed by the psychoanalytic method was that the search for pathogenically significant traumatic experiences typically took one back to early childhood. And these experiences were invariably a reflection of a disturbance of infantile sexual life. This remains one of the most controversial aspects of Freud's theory. 'Infantile sexuality' refers to the sensations of pleasure that accompany holding, maternal caressing, and oral and anal satisfactions. Freud's use of the term 'sexuality' is thus much broader and more general than the common use of the term. Freud claimed that the development of human sexuality was diphasic. There is, first of all, an infantile period when the sexual instincts are sequentially invested in different zones of the body ('erotogenic zones'), and then a more adult period when the component sexual instincts (oral, anal, phallic) are organized in the service of genital, reproductive sexuality. Intervening between the infantile period and adult period is the latency period of childhood, when the sexual motivations are diverted to other purposes (e.g., skill building, school work).

The sexual instinct is thus an organization of component instincts that takes the adult form only at puberty, and it is decisive for understanding the etiology of neuroses. This is particularly true when libido becomes invested in the phallic region, which gives rise to the 'Oedipus complex' (ages 2–5). The Oedipus complex is foundational for the emergence of the superego and more will be discussed about it in the following pages. Suffice it to say here that this emotionally charged complex of family relationships is the source of the neuroses. As Freud noted, normal individuals survive and master their Oedipal feelings; neurotics continue to be mastered by them.

To this point, we have reviewed what Freud called the 'cornerstones' of psychoanalytic theory: the discovery of unconscious mental processes, the theory of repression and of transference, and the importance of infantile sexuality and the Oedipus complex for understanding neuroses. No one could be called a psychoanalyst unless one accepted these tenets. Yet, we are still far from articulating the structural features of the personality (id, ego, and, superego). This is best done by further recounting the evolution of his thinking on these important constructs.

Evolution of Theory and the Emergence of the Tripartite Personality

The division of mental life into conscious and unconscious suggests a topographical hypothesis, viz., that mental life can be demarcated into psychic portions or regions. Unconsciousness is at once a quality that can be attributed to a repressed idea or impulse and also a region or 'province' (the 'system *Ucs*') to where the idea is banished. Consciousness and its precursor ('preconsciousness') too were formulated as psychic provinces ('system *Cs*, *Pcs*'), and attributed to the workings of the ego. Psychic conflict, then, was a matter of unconscious ideas, emanating from the system *Ucs*, struggling against the repressive forces of the conscious ego. Furthermore, unconscious and conscious processes follow different laws. The *Ucs* consists of 'instinctual representatives' or impulses that seek

discharge. These impulses are illogical (not subject to contradiction) and timeless (not ordered temporally) and not oriented to reality. They are driven by the pleasure principle and are characterized by *primary process*. This means that the wishful, instinctual impulses are undirected and freely mobile, and therefore could be displaced or connected to various objects. This is in contrast to the *Cs* (*Pcs*), where secondary process is dominant. Secondary process is a later developmental achievement associated with ego. As a reality oriented process it revises, censors or binds the discharge of instinctual impulses.

Although Freud never abandoned the notion of primary and secondary process, he did come to revise the provisional *topographical model* of the psychic architecture as one involving 'systems' and also the *dynamic hypothesis* that the unconscious was in conflict with the conscious ego. These notions were revised in light of Freud's clinical observation that his patients were often unaware of the fact that they were employing certain resistances. If the ego is responsible for repression, it is also the seat of consciousness, then it is inexplicable how one could not be conscious of one's own resistances and one's own act of repression. Freud concluded that much of the ego, too, must be unconscious. In other words, the unconscious does not consist entirely of that which is repressed (although all that is repressed is unconscious), a fact that makes the division of the psychic architecture into systems *Ucs* and *Cs* (*Pcs*) less compelling.

The concept of ego was further clarified as a result of revisions to the instinct theory. Instincts arise from internal sources and exert a constant force or pressure demanding satisfaction. The relentless pressure of instinctual drive energies makes it possible for the nervous system to remain in an unstimulated condition ('principle of constancy'), and hence motivates psychic adaptations so as to effect the satisfaction of internal needs. The *pressure* of an instinct is a 'motor' factor, that is, a demand for psychic work. The *aim* of an instinct is gratification through tension reduction. The *object* of an instinct is anything through which satisfaction can be achieved. The *source* of an instinct is a somatic process experienced as a kind of 'hunger' or 'need.' Indeed, Freud often described instincts as the 'psychic representatives' of somatic processes.

In *The Three Essays on Sexuality* (1905), Freud identified sexual instincts as 'libido.' Libido is both a quantitative and qualitative variable – quantitative in the sense that it serves as a measure of the forces of sexual excitation, qualitative in the sense that it can be distinguished from other kinds of psychic energy. Psychoneurotic conflict could then be described as a clash between sexuality and the various functions of the ego (e.g., reality testing, resistance, and repression). However, in addition to libidinal (sexual) instincts, Freud later identified a second group of primal instincts, called *ego instincts*. Ego instincts subsumed the functions of self-preservation, repression, and all other impulses that could be distinguished from sexual (libidinal) instincts. By identifying a second group of primal instincts, Freud could now characterize psychoneurotic conflict as a clash between libidinal (sexual) and the self-preservative (ego) instincts.

Matters are further complicated, however, by the pivotal paper *On Narcissism* (1914). Here, Freud argues that the sexual instincts are attached originally to self-preservation, which is an ego instinct. The sexual instincts detach from

self-preservation only later, when libido seeks external objects (e.g., mother). Libido that cathects with external objects was called object libido. Yet, Freud observed that libidinal attachment toward objects (such as mother) could be derailed. Instead of seeking an external object, it was possible to libidinally cathect oneself. That is, rather than choosing one's mother as an object of love, one chooses oneself. Libido could be apportioned, then, depending on the kind of object choice one made. Libido apportioned to oneself was called 'narcissistic' (or ego) libido, to distinguish it from the libidinal cathexis of external objects (object libido). In Freud's view, the narcissistic libidinal cathexis of the ego is the original state of things, and therefore the initial phase of libidinal development was one of *primary narcissism*. It is from the stance of primary narcissism that one seeks out interpersonal relations.

By 1920, however, in *Beyond the Pleasure Principle*, Freud rejected the dualism between libidinal instincts and ego instincts. In his view, this distinction is no longer tenable because narcissistic self-preservative instincts were also libidinal. It would thus seem that all of instinctual mental life could be reduced to sexual instincts after all, a conclusion that would either justify Jung's monistic use of 'libido' as a term denoting a generalized psychic drive or vindicate those critics who accused Freud of pan-sexualism.

One solution to this theoretical problem was to group the libidinal instincts as *Eros*, or the life instincts, the 'preserver of all things,' and to contrapose to the life instincts (*Eros*), a contrary instinctual impulse that seeks to restore organic life to an inanimate state, which Freud called the *death instincts*. Freud was led to postulate the existence of death instincts by his observation that those who suffer from traumatic neuroses tend to repeat traumatic dreams. The dreams of war neurotics, for example, seemed contrary to the general case that dreams represent symbolic wish fulfillment. The compulsion to repeat traumatic experiences appeared, then, to operate 'beyond the pleasure principle,' and to point toward an instinctual tendency at odds with libidinal self-preservation.

The struggle between *Eros* and death instincts can be observed at every level of biology, in every particle of a substance, even in molecular organisms. *Eros* attempts to preserve life through combinations, and this is to neutralize the instinctual striving toward death. The two instincts can also fuse together which results, at the psychic level, in sexual sadism. Defusion can result in the discharge of death instincts toward objects, which then takes the form of aggression, destructiveness, or sadism. Masochistic tendencies result if the ego is the object of discharge. Indeed, if it is possible for erotic libido to cathect the ego and to result in a phase of primary narcissism, it must correspondingly be possible for the death instinct to cathect the ego and result in a phase of *primary masochism*, a possibility that Freud did not reject outright.

Freud's account of the two classes of instincts, *Eros* (sexuality and self-preservation) and death (aggression), allowed him to preserve a dualistic classification of the instincts. The question that now loomed is how these twin instincts interacted with topographical features of the mind, now that the notions of 'consciousness' and 'unconsciousness' no longer had any straightforward implications for a structural depiction of mental life. This issue would be taken up in Freud's seminal work, *The Ego and the Id* (1923). In this work, Freud amends the

structural theory to include three psychic provinces, id, ego, and superego. He also describes how instinctual drive energies can be economically transmuted among these structures, and how certain neurotic conditions can be explained as a result of this hydraulic model of the mind.

Id, Ego, and Superego

The mature structural theory largely replaces the ill-defined notions of unconsciousness and the system *Ucs* with the 'id.' The id becomes a psychical province that incorporates instinctual drive energies and everything else that is part of our phylogenetic inheritance. The id operates unconsciously, accords with primary process, and impels the organism to engage in need-satisfying, tension-reducing activities, which are experienced as 'pleasure.'

Within the id are undifferentiated elements that would later emerge as the 'ego.' Freud's conceptualization of the ego and its functions shows clear lines of theoretical development. In early formulations, it was identified with the system *Cs* (*Pcs*), and known largely in terms of its repressive and self-preservative functions and for its putative opposition to things unconscious. As noted above, a clear change is evident in the paper *On Narcissism*, where Freud argued not only that ego instincts were libidinal, but also that ego functions were largely unconscious. Two further developments are evident in this paper. First, the ego begins to be described not as an impersonal 'apparatus' whose function is to detension the biological strivings of the organism, or as a 'device' for mastering excitations, but rather as a personal self. A second development is Freud's tentative hypothesis that ego development entails the renunciation of narcissism in favor of the idealization or aggrandizement of cultural and ethical ideals, which is represented to the child by the influence of parents. This 'ego ideal' becomes a substitute for lost infantile narcissism, at which time the child has his or her own ideal. Freud goes on to suggest that perhaps a special psychical agency emerges to observe the ego and to measure it by its ideal. This self-observing agency, and the ego ideal, will later take the form of a third psychical province, the superego.

What is the nature, then, of ego and superego formation, as outlined in *The Ego and the Id*? At the outset, the psychic system is described as an undifferentiated id-ego matrix. Topographically, a portion of the id lies in proximity to the boundaries of preconsciousness and external perceptual systems (system *Pcpt*), which brings the influence of the external world upon it. The resulting modification results in the formation of the ego. Hence, the ego is that part of the id, which is modified as a result of the perceptual system and by its proximity and access to consciousness, although the ego itself, like the id, is unconscious.

The ego takes on a number of functions. It commands the voluntary movement. It has the task of self-preservation and must therefore master both internal (id) and external stimuli. The ego masters external stimuli by becoming 'aware,' by storing up memories, by avoidance through flight, and by active adaptation. Regarding internal drive stimuli, it attempts to control the demands of the instincts by judiciously deciding the mode of satisfaction, or if satisfaction is to be had at all.

Indeed, the ego attempts to harness instinctual libidinal drives, so that they submit to the reality principle. If the id is a cauldron of passions, the ego is the agent of reason, common-sense, and defense. Yet the ego is never sharply differentiated from the id. Freud argues that the 'lower portion' of the ego extends throughout the id, and it is by means of the id that repressed material communicates with (presses 'up' against the resistances of) the ego.

The nature of the function of the ego is further clarified, and complicated, by superego formation. One clue to understand superego formation was provided by Freud's analysis of melancholia. He suggested that when a personal (or 'object') relationship is 'lost,' the lost object can be regained nonetheless by 'identification,' that is, the lost object is 'set up again inside the ego.' When the sexual object is given up, the ego is altered, insofar as the abandoned libidinal object is now set up inside the ego. The ego incorporates the object within itself (as introjection), 'identifies' with it, and thereby builds up its structure or 'character.' In this way, an object cathexis is substituted by an introjection. Freud suggests that perhaps the id can give up its objects only by identifications of this sort and that the ego can consequently be considered a precipitate of abandoned object cathexes.

It was from this analysis of how the ego can be built up and altered by identification that Freud found the theoretical foundation of superego formation. He argued that the initial identifications in early childhood would be those that would have lasting and momentous significance in the sense that here would be found the origins of the 'ego ideal.' Moreover, the necessity for making these identifications would be found in the triangular character of the Oedipus complex.

For illustrative purposes, consider the simple Oedipal situation for boys. A boy develops a libidinal attachment to his mother while identifying himself with his father. Eventually, the erotic investment in the mother intensifies and the father then comes to be seen as an obstacle or as a jealous rival. The boy desires not only to possess his mother but also to displace his rival, who is now viewed with some ambivalence. Yet this engenders considerable anxiety insofar as the powerful rival is capable of significant retaliation through the threat of castration. Hence, the Oedipal situation is untenable for the boy given the surge of castration anxiety. The libidinal cathexis must be given up. Although many complications are possible, some with pathological consequences, the standard maneuver is for the boy to repress his Oedipal desires for his mother.

Yet the infantile ego is still too feeble to carry this out effectively. Since the expression of oedipal desires is met with an obstacle in the person of the boy's father, one way of repressing these desires suggests itself: to set-up the obstacle within himself by intensifying his identification with his father. In this way, the boy musters the wherewithal to carry out the required act of repression, insofar as this identification is a way of borrowing the strength of the powerful father. But, as we have seen, identification typically results in an alteration of the ego. Indeed, the identification with the father as a solution to Oedipus complex is so momentous that a new psychical agency emerges from within the ego, the superego, which will thereafter retain the character of the father. Furthermore, every act of identification results in a sublimation of libido. Libido is 'desexualized.' But this sublimation also

means that the aggressive (death) instincts are no longer bound to erotic libido – it is now 'defused,' set free, and no longer neutralized. Freud suggested that herein lies the source of the cruel harshness of the dictatorial injunctions ('Thou shalt') of the superego – it lies in the pool of aggressive energies set free by the act of identification and libidinal diffusion.

The superego is thus a precipitate of family life. It is an agency that seeks to enforce the striving for perfection, as it holds out to the ideal standards of ego and moralistic goals. As a consequence, the superego is the 'conscience' of the personality, and it can retaliate against the imperfections of the ego by inducing guilt. Insofar as the superego is derived from the id's first object cathexis (in the Oedipal situation), the superego remains close to the id 'and can act as its representative' (in contrast to the ego, which represents reality). And because the origin of conscience is tied to the Oedipus complex, which is unconscious, the corresponding sense of guilt, too, must be unconscious. Indeed, Freud asserts that the superego reaches down into the id, and is consequently 'farther from consciousness than the ego is.' This leads to an interesting paradox that was noted by Freud. Because one is unconscious of having irrational libidinal and aggressive desires, one is far more 'immoral' than one believes. But because the superego (and the guilt that it imposes as punishment) is also unconscious, one is also more moral than one knows.

Superego formation, and the ideals that it represents, allows one to master Oedipus complex. And because it emerged at a time when the ego was still vulnerable, it retains a dominant position with respect to the ego. Freud was keen to point out that the superego is that part of his theory that expresses the 'higher nature' of man. He argued that as children we knew the higher nature in the person of our parents, 'we admired and feared them; and later we took them into ourselves' as introjections. And if religion, morality, and sociality are held to be what is higher in mankind, these too find their psychological origin in the workings of the superego. The religious longing for a protective and nurturing God finds its origin in the fact that the superego is a precipitate of our infantile longing for father. Our religious humility in the face of a judgmental God is a projection of the self-criticism of an ego that has fallen short of the ideals held out by the superego. With development, the injunctions of the father (which are introjected as the superego) are supplemented by other moral authorities, which then fortify the workings of conscience and thereby intensifies the feelings of moral guilt. And social feelings of all kinds are rooted in the kind of object identification of which superego formation is the model.

In addition to representing that which is higher in human nature, the superego is also implicated in a variety of pathological conditions. It is implicated in a 'resistance to therapeutic recovery,' since the prolongation of neurotic suffering is a kind of punishment for failing to meet the exacting demands of the superego. Melancholia results when the superego appropriates the violence of aggressive instincts and directs them against the ego. Certain kinds of obsessional neuroses ('tormenting' the object, as opposed to the self), too, can be linked to the harsh reproaches of the superego.

It should be clear that the ego is besieged from two directions. It must cope with the libidinal and aggressive drives of the id, from 'below,' and also the harsh moralistic and

perfectionistic demands of the superego, from 'above.' The ego must further reconcile these contrary tendencies with the demands of external reality. 'Whenever possible,' Freud writes, "it [the ego] clothes the id's *Ucs.* commands with *Pcs.* rationalizations; it pretends that the id is showing obedience to the admonitions of reality, even when in fact it is remaining obstinate and unyielding; it disguises the id's conflicts with reality and, if possible, its conflicts with the superego, too." Freud also likened the ego to a man, who struggles to check the superior power of a horse, to a constitutional monarch, who is ultimately powerless to frustrate the will of parliament, and to a politician, who too often "yields to the temptation to become sycophantic, opportunist and lying." One has to take recourse to psychoanalysis when such a struggle batters the personality into neurosis.

Summary

One way to summarize Freud's account of the tripartite personality is to make explicit the meta-psychological assumptions that have until now remained only implicit. Freud's *topographical* perspective is that the critical determinants of human behavior are unconscious, emanating from a biological province which he calls the 'id.' The *dynamic* point of view is that these critical determinants are instinctual drives, of which two classes can be identified: Eros (sex, self-preservation) and the death instinct (aggression, sadism). The *economic* point of view is that the 'hydraulic' dispositions of these drive energies among the psychic regions is a regulator of behavior.

Selected Post-Freudian Developments

Although there are still many adherents to Freud's classical theory, a palpable development since Freud has been the proliferation of competing psychoanalytic theories, all of which claim some support or other from the many searching insight to be found in the vast Freudian corpus. The most important post-Freudian development is a collection of related theories that is referred to as the 'object relational' school. Although these theories can be clearly distinguished on both obvious and subtle theoretical points, it is fair to say that they share in common a distaste for Freud's emphasis on energy dynamics as the foundation of human personality and for his division of personality into tripartite, evolutionary layers. They deny, for example, that the human organism is at first asocial, convulsed by bestial instinctual passions, embedded in primary narcissism, and only later to become social and socialized. To picture a human being as one driven by libidinal and aggressive energies is to liken the human being to a 'centaur' – the mythological creature with a human head affixed to the body of a beast.

One objection to the 'Centaur model' is that it is yoked to an implausible notion of 'instincts.' Freud suggested that human motivation can be explained with reference to two instincts, sex and aggression. But sex is not an instinctual impulse that exerts constant pressure, but is rather like an 'appetite' that shows a measure of periodicity. Aggression is not even an appetite, but is rather a reaction of the ego to a threat to the personality. And both sex and aggression are aspects of personhood that are ineradicable from interpersonal relationships. Furthermore,

Freud's notion that human psychology is driven by the energies afforded by the struggle between life and death instincts has been dismissed by some critics as mere 'biological mysticism.'

A related criticism concerns Freud's account of the ego. In Freud's theory, the rational ego emerges from a portion of the irrational id, but only as an impersonal apparatus or device for channeling drive energies and for securing the detensioning of the organism. What Freud describes is a control system and not a personal self that is involved in motivated relationships from the very beginning. When Freud describes the tripartite personality as consisting of 'provinces' that are 'extended in space,' he is describing a material reality that is based on a biological model of localization, and not the psychodynamic reality that whole human selves are formed in meaningful relationships that begin at birth. Hence, object relations theory rejects the Centaur model, rejects the instinct theory, rejects primary narcissism (and masochism), and rejects the impersonal ego.

Yet the object relations approach is often thought of as a movement that develops Freud's own best object relational insights. The notion of transference, for example, and the Oedipus complex of family relations, and the account of the ego as an 'agency' (as opposed to a 'province') would be ready examples of object relational insights that counter Freud's own preoccupation with impersonal, biological energy mechanics. It is ironic that the Oedipal theory, which is generally considered to be that which is most unpalatable about Freud's theory, is actually the foundation of the keen object relational insight – that personality is grounded in the nexus of family relationships. Of all the psychic structures, the superego is the only one to emerge as a consequence of interpersonal relationships. It comes to represent the influence of family and societal institutions on the formation of personality. Transference enshrines the view that the history of our experience of interpersonal relationships provides us with a template by which we attempt to manage our current relationships. Hence, the object relations approach tends to focus on the agentic whole self (the 'person ego') whose personality develops within the dynamics of complicated, meaningful relationships – and the warrant for this conceptualization, too, is often to be found in Freud's own writings.

Freud's theory is rarely studied in modern psychology departments, other than for historical purposes, although it still has a certain appeal in theology, literature, and other interpretive, hermeneutic disciplines. Freud did not view psychoanalysis as a form of literature, but as a set of scientific propositions about personality development, psychopathology, and treatment. Yet, it is on this score that psychoanalysis is found wanting. If the propositions of psychoanalysis are treated as scientific claims, then their probative value should be attested by the canons of scientific scrutiny. But many Freudian claims are simply unfalsifiable, fantastic, or the product of flawed analysis and reasoning (Grunbaum, 1984, 1993).

We noted at the outset that psychoanalysis has revolutionized human self-understanding in this century. Yet, for all that, the theory is still very much a product of nineteenth century conceptions of science. While one has cause to question Freud's reliance on outdated biological and physical science metaphors, his mechanistic conception of energy dynamics and his preoccupation with brain physiology and with localization, what will survive are the psychodynamic features of his

theory and the clinical insights about human personality that have given everyone new vocabulary. Defense mechanisms, ego, insight therapy, unconscious processes, the symbolic nature of symptoms, dreams, parapraxes, and transference – these are notions that are not far from even lay discourse. Indeed, some core Freudian notions such as unconsciousness, and the localization of ‘psychic provinces’ in the brain, are being rehabilitated by recent developments in cognitive and social neuroscience. Contemporary attachment theory has strong object relational elements that bear resemblance to Freud’s theory.

Although it is not easy to divorce the clinical facts attributed to Freud from the theories developed to explain them, especially when the probative and epistemic status of the theory is at stake, it is fair to say that the contemporary study of psychopathology and personality, the conduct of clinical practice, and the way ordinary people confront themselves and others would be very different were it not for Freud’s monumental, pioneering work. When one adds to this the whole domain of ‘applied psychoanalysis’ – the extension of psychoanalytic insights for understanding the artistic process, group psychology, esthetics, religious experience, and other cultural products – then the truth of W.H. Auden’s elegy is apparent. Freud lurks wherever one considers the human condition: a ‘whole climate of opinion under whom we conduct our different lives.’

See also: Aggression; Hypnosis.

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Implicit Memory

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Glossary

Adaptation Phenomenon in which an exposure to a sensory input, such as seeing the color red, continues so long that the neural response decreases when the sensory input repeats a brief time later (usually immediately or within about 1 s). Many mechanisms have been proposed and vary with the particular circumstances of adaptation.

Amnesia Syndrome where memory is impaired selectively relative to other cognitive abilities, such as language, attention, and perception. For example, in medial temporal lobe amnesia, patients have problems encoding and consolidating explicit memory following the brain damage. Implicit memory is relatively spared in amnesia.

Conscious Experience of being aware of oneself and the environment. This encompasses any perceptions, thoughts, and feelings that one is aware of at the moment.

Dissociation In neuropsychology, this can be single or double or more. A single dissociation is demonstrated if patient(s) with a particular kind of brain dysfunction (e.g., in temporal cortex) are impaired on one task (e.g., an implicit memory test) but normal relative to a matched control group on another task (e.g., an explicit memory test). Better evidence comes from a double or higher dissociation. A double dissociation is demonstrated if the patient(s) with one kind of brain dysfunction (e.g., in temporal cortex) are impaired on task A (e.g., an implicit memory test) but not another task B (e.g., an explicit memory test), whereas other patient(s) with another kind of brain dysfunction (e.g., in frontal cortex) are impaired on task B but not task A, both relative to their matched healthy control groups.

Lesion In the brain, this refers to damage to neuronal cells due to a variety of causes, such as stroke, tumor, or gunshot wounds.

Mental simulation A pattern completion process that can occur when retrieving memory. This process re-enacts the modal processing that had occurred originally during learning. Mental simulation includes conscious mechanisms implicated in mental imagery but can also occur nonconsciously and automatically, as when reading a word for meaning. Mental simulation is thought to involve activity across chains of hierarchically-organized zones of convergence and divergence in association cortex. These zones have reciprocal connections with lower-level modal processing areas. Activating a zone triggers feedback input to

lower-level modal processing areas from which the memory was initially constructed. Consequently, seeing an object or reading its name re-enacts associated features (e.g. shape, color, motion, actions) that were stored during prior learning experiences, thereby constructing cognition.

Neocortex Newly evolved cerebral cortex of the central nervous system. It has six layers and four lobes (occipital, temporal, parietal, and frontal). Implicit memory is stored in the neocortex, particularly in areas beyond the primary sensorimotor areas.

Neuropsychology A clinical specialization or field of science focused on characterizing cognitive problems in patients with brain dysfunction.

Occipital cortex Located in the occipital lobe, this is the most posterior region of neocortex and is responsible for visual perception. It includes the primary visual area (V1) in striate cortex at the occipital pole and adjacent extrastriate (prestriate) visual cortex. This lobe is retinotopically organized such that adjacent neurons receive input from adjacent parts of the visual field (and corresponding retinal locations). Neurons adjacent but displaced laterally from each other across the cortex represent adjacent but likewise displaced visual field (and retinal) locations. Consequently, this cortex effectively represents an orderly image of light hitting the retina, though distorted to magnify central over peripheral retina. Extrastriate visual areas contribute to perceptual implicit memory.

Temporal lobe Neocortex located ventrally that includes association areas for visual processing, primary and association areas for auditory processing, and multimodal association areas. Lateral parts of the temporal lobe support advanced visual and auditory perceptual processing, perceptual and conceptual knowledge and implicit memory. By contrast, medial temporal cortex (parahippocampal region) is implicated in explicit memory.

Transcranial magnetic stimulation Noninvasive, reversible neuroscience technique that uses an electromagnetic coil to produce weak electrical activity in superficial regions of the cortex. This alters neural activity temporarily in these regions, typically disrupting processing so as to impair function. This enables the causal role of these regions in cognition to be inferred. Logic of using the technique is the same as neuropsychology. Dissociations are produced transiently in healthy participants.

Memory can influence behavior based on people's prior experience in the world, even without them being aware that this has happened. For example, people ride bicycles years after initially learning how, read a book faster and with greater comprehension the second time around, and make decisions about objects around them faster and more accurately as they

gain more experience with them. In such cases, memory can influence performance implicitly, without awareness. By contrast, people are consciously aware of explicit memory when they categorize objects or read words or when they recognize people, places, and objects as familiar or recollect details from prior experience with them.

Early History

The notion of memory without awareness has been traced to thinkers as early as Descartes. This philosopher referred essentially to fear conditioning in which frightening childhood experiences can have a lifelong influence, even though one cannot remember the origin of the fear-inducing event. Leibniz also referred to insensible or unconscious perceptions that influence behavior without conscious memory of the source of such influences. However, among early thinkers, Maine de Biran offered the most detailed and the deepest analysis of memory for unconscious habits and their influence on cognition and behavior. This philosopher has been credited with explaining that a habit can, with sufficient experience, eventually influence performance automatically and without being accompanied by awareness of using memory. He also distinguished between habits of motor actions and habits of emotional expression, and distinguished these two types of habits from conscious recollection (i.e., explicit memory). This essentially characterizes an initial version of the now predominant, multiple systems theory of memory that distinguishes between systems for implicit memory and explicit memory. Herbart further proposed that ideas can lie below a threshold for awareness but still influence conscious cognition. Around this time, many philosophers started to develop further ideas about unconscious processing. For example, Hering criticized the large body of earlier scholarship for focusing exclusively on explicit memory and introduced the idea of organic or unconscious memory. Also around this time, psychologists, biologists, and medical scientists further articulated ideas about organic (implicit) memory and how it relates, or does not, to explicit memory. For example, by the 1890s, Freud described how his hysterical amnesia patients could not recall the traumatic events leading to the hysteria but still revealed memory for those events in other indirect ways, and Freud is well known for emphasizing the importance and power of unconscious memory on behavior. Notably, Ebbinghaus conducted the first true experiments on memory, but he focused exclusively on explaining explicit memory. Nonetheless, his primary testing method assessed savings on relearning previously studied lists. To assess this savings on relearning did not require recollecting the preceding study episode or lists but rather just relearning the list now presented again better this time. This improved performance for repeated than newer information, regardless of conscious memory, fits the definition of an implicit memory phenomenon. Indeed, Ebbinghaus acknowledged that his method of measuring savings on relearning assessed unconscious memory, as has been confirmed empirically more recently. Finally, it is notable that McDougall was the first psychologist to use the terms implicit and explicit memory.

Indirect Memory Tests Reveal Implicit Memory

Implicit memory can be reactivated without a conscious strategy to retrieve memory or without intent to use memory. Moreover, a cardinal feature is that it can occur without conscious awareness that the memory has been reactivated. Consequently, changes in behavioral performance due to experience demonstrate implicit memory. Such tests of memory are

indirect. People are not instructed to use memory to do the task as they are on direct memory tests, such as categorization, recognition, or recall. Instead, on an indirect memory test, they just do the task. They perform differently depending upon their prior experience with elements of the task and do so without awareness of this, demonstrating implicit memory.

Indirect memory tests are the standard approach to assess implicit memory. On the other hand, direct tests are the standard approach to assess explicit memory. However, a thorny issue in memory research is that both direct and indirect memory tests can potentially reactivate both explicit memory with awareness and implicit memory without awareness to some extent. This remains a problem despite decades of research aimed at dissociating implicit and explicit memory. Nonetheless, several aspects of implicit memory have become clear.

Implicit Memory Supports Priming

To reveal implicit memory on an indirect test, by definition, people are not asked to report memory. A conscious report about memory cannot be used to measure implicit memory, at least not directly; note, implicit memory can occur during a direct test of conscious memory but special methods must be used to reveal it. Instead, using an indirect test, while people perform a task, a measure taken in response to an item that is old (i.e., repeated, studied) is compared to that to a new item (i.e., nonrepeated or nonstudied item). New items are basically the control condition for the experimental memory condition. Priming is the difference in behavioral performance between an old item relative to a new item (**Figure 1a**). For example, people press one of two keys to report whether an object is larger or smaller than a shoebox. Faster and/or more accurate key presses to old than new objects demonstrate priming. The priming difference is taken to reveal the magnitude of implicit memory.

Numerous studies have revealed some factors that consistently affect or do not affect priming. One factor is prior knowledge. Priming is greater for known or meaningful than unknown or meaningless items (e.g., real words *vs.* nonsense letter strings). Priming can be specific to the sensory modality, becoming smaller when the modality changes from study to test. Priming can be perceptually specific, becoming smaller when perceptual features of the stimulus change from study to test. While depth of processing (i.e., shallow perceptual *vs.* deep semantic) affects explicit memory (e.g., recognition), it has less or minimal effects on priming. Based on these findings, implicit memory thus varies with prior knowledge and is modality-specific, perceptually specific, and relatively insensitive to the depth of processing.

Varieties

Short- and Long-Term

Implicit memory can last briefly (short-term implicit memory) or indefinitely (long-term implicit memory). Priming effects have been shown to last to some degree for 48 weeks or more, especially with meaningful pictures. In general, priming reflects long-term implicit memory when it is shown to last

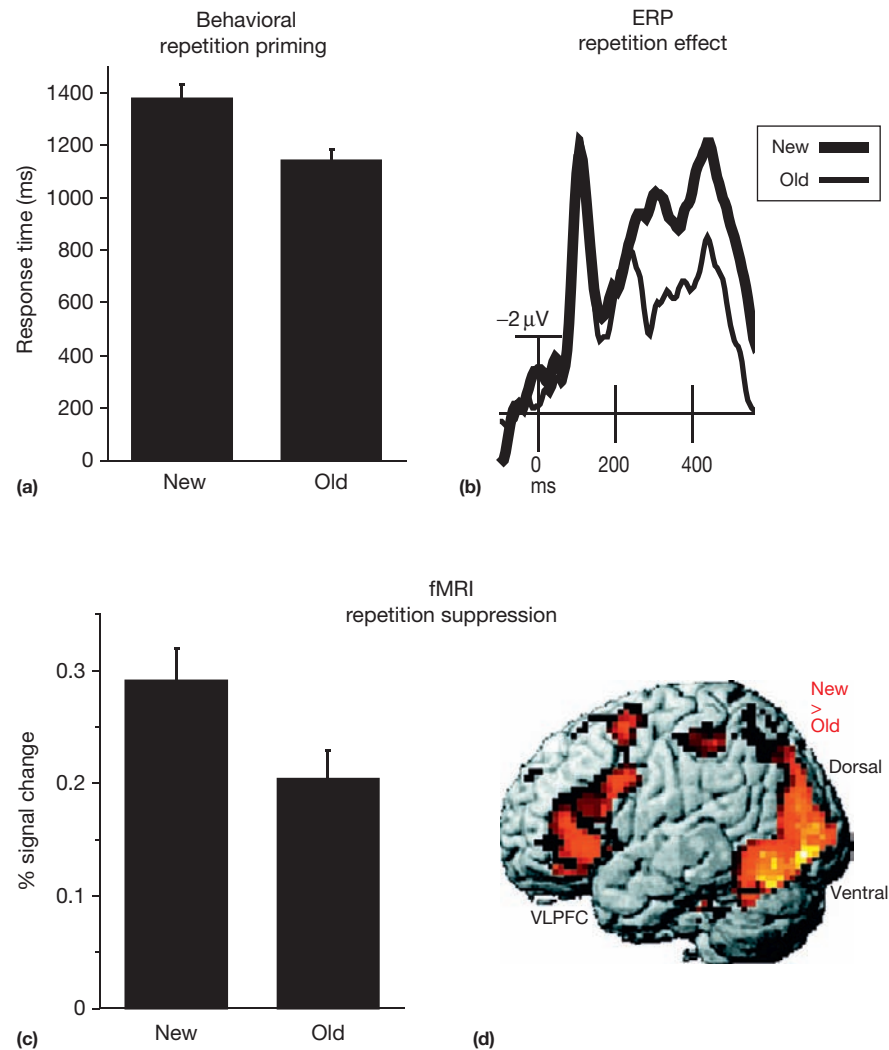


Figure 1 Behavioral and neural repetition effects related to implicit memory on an indirect test. Shown are results during visual categorization of a new object and an old object studied earlier in a separate learning session; note, data obtained by the author from a combined fMRI and ERP extension of Schendan and Kutas' (2003) experiment. (a) Response times (RTs) are faster for old relative to new items, demonstrating behavioral priming. (b) Event-related brain potentials (ERPs) show that long-term repetition effects are observed only after about 200 ms. Shown is the repetition effect on the N3 complex to objects at a right frontal scalp site referenced to the mean mastoids. The N3 is smaller (i.e., less negative) for old than new visual objects. (c) Relative to new items, repeated items show a reduced blood oxygenation level dependent (BOLD) response, known as repetition suppression. Percent signal change extracted from lateral occipital sulcus in a ventral object processing area (see brightest yellow region in (d)). (d) fMRI activation (new greater than old objects) is shown on an individual canonical brain (Montreal Neurological Institute). Neural repetition suppression related to implicit memory is found in ventrolateral prefrontal cortex (VLPFC) and ventral and dorsal visual object processing areas of association cortex.

for 2 min or more or 4–9 or more other items are shown between the first and second presentation of the repeated item. Short-term implicit memory includes cases of immediate repetition in which an item is repeated with no other items in between first and second presentations, and items repeat with a very brief time interval of usually <2 s and as little as no time between them. While long-term priming depends upon associative and long-term implicit memory processes, immediate repetition priming depends upon other memory mechanisms. Immediate repetition priming depends upon (1) working memory, (2) automatically sustained activation in knowledge networks, and/or, (3) for extremely brief presentations of items (e.g., <1 s) and extremely short delays (i.e., 200 ms or less), on

nonassociative habituation (including sensory adaptation). Most research on implicit memory has focused on long-term priming. Short-term varieties have been the focus of studies of working memory, perception, and semantic memory. Thus most of the rest of this review focuses on long-term priming.

Processing

Implicit memory varies not only in how long it lasts (i.e., short- or long-term) but they also vary in the processes that drive the effects. To appreciate the different varieties of implicit memory revealed by priming phenomena, a few words about the relation between processing and memory are needed.

Transfer appropriate processing and encoding-specificity theories of memory emphasize the relation between information processing at study and the processing during the memory test. For example, transfer appropriate processing theory says that memory depends upon the degree to which the processes recruited during the study (or learning) phase transfer appropriately to the memory test. Transfer will depend upon the degree to which the memory test recruits the same processes that take place during learning. The more similar the processes at study and test, the better memory will be.

In a similar vein, some memory accounts distinguish between data-driven and concept-driven tasks. Data-driven tasks during the memory test depend heavily on nonsemantic (i.e., perceptual, surface, or motor) processing. Consequently, the memory revealed on such tasks will be greatest if the study task also engaged the same nonsemantic information processing. On the other hand, concept-driven tasks during the memory test depend heavily on conceptual processing (i.e., meaning, semantic, categories). Consequently, the memory revealed on such tasks will be greatest if the study task also engaged the same conceptual information processing.

Content

Repetition priming is thought to facilitate processing due to recent experience with the same or similar information. Repeating the exact same stimulus produces the most priming. Why? Repeating the exact same stimulus repeatedly activates the same processes and representations (i.e., memory contents). This content could be perceptual, conceptual, or semantic, or all of these.

Perceptual

Perceptual implicit memory has been revealed by changing perceptual processing. On a data- versus concept-driven account, perceptual repetition priming will be revealed best when data-driven tasks are used for the memory test. For example, on perceptual identification tasks, a word or object is presented very briefly (e.g., 50 ms). People try to read the word or name the object. Performance on such tasks is typically less accurate than when people have unlimited time (e.g., <70% correct). Repeating the same word or object can increase this accuracy. The implicit memory driving the priming is perceptual to some extent. This is because the priming effect is larger when the perceptual form of the item remains the same between the study and test phases than when the perceptual form changes. For example, when reading a word again, priming is greater if the font has stayed the same than if the font now differs from the original experience. Likewise, when categorizing an object, priming is greater if one's viewpoint is the same as before than if one is now viewing the object from a different angle. Nonetheless, repetition priming typically does not drop to zero even when the perceptual form changes substantially as long as the core concept of the item remains the same between repetitions. For example, the word 'dog' printed in lowercase and uppercase ('DOG') still means the same, and a dog seen from above or the side is still the same object. The priming effect remaining after a change in perceptual form from study to test is thought to reflect conceptual implicit memory. Thus, when

exactly the same item is repeated, it is likely that both perceptual and conceptual implicit memory drive the repetition priming effect.

Conceptual

By the data- versus concept-driven account, conceptual implicit memory will be revealed best when concept-driven tasks are used for the memory test. For example, when the perceptual form of the item changes between the study and test phases, any priming effect must depend upon aspects of the item that remain the same despite these perceptual changes, such as the meaning of the item. Conceptual implicit memory has been demonstrated when the modal (i.e., sensorimotor) form of the item changes from study to test. For example, repetition priming has been found when a picture of an object is studied and then its name is presented at test, and *vice versa*, though picture to word priming is often larger and more robust than the reverse.

Semantic

Semantic priming can be considered a special case of conceptual priming in the sense that conceptual information or meaning drives the effect. However, both perceptual and conceptual implicit memory are revealed using repetition priming paradigms, and both can be long-lasting. By contrast, semantic priming paradigms all involve immediate repetition. No other items and only a brief time of typically 1 s or less intervene between the prime (i.e., study phase item) and the target (i.e., test phase version of the repeated item). Indeed, semantic priming effects do not typically last for more than a second or at most a few seconds.

On semantic priming tasks, the critical prime and target stimuli share no perceptual features, only some aspect of meaning. For example, the priming word 'nurse' may be presented 500 ms before the target word 'doctor.' Subjects may read the priming word and then perform a lexical decision task on the target letter string. They decide whether the letter string is a real English word or not (e.g., a nonword like 'XPFQNV' or pseudo-word like 'BRILLIG'). Semantic priming is demonstrated when response times to target words are faster when they are related than unrelated to the prime words. Semantic priming effects depend upon the associative links among aspects of knowledge in a cortical neural network.

Brain Basis of Implicit Memory

Theories

Convergent evidence for dissociations between implicit and explicit memory and other varieties of memory led to the multiple systems theory of memory. By this account, different types of memory depend upon different brain systems. The implicit system supports implicit memory, and the explicit system supports explicit memory. The most important evidence for the multiple systems theory has come from dissociations between measures of implicit and explicit memory in patients with brain damage. However, convergent evidence from other methods (i.e., behavioral, neuroimaging, and brain potentials) is required to establish a memory system based on at least three criteria. (1) Double dissociations must establish that different brain systems are necessary for two different memory systems. For example, for implicit and explicit memory, damage to the

implicit system impairs implicit but not explicit memory, whereas damage to the explicit system impairs explicit but not implicit memory. (2) Class-inclusion operations must be established, showing that the memory system operates on diverse information (e.g., words, objects, faces, places, visual, auditory) during a particular class of tasks (e.g., categorization *vs.* recall). (3) A list of properties of the system must be specified that also describes how the system relates to other systems. All such evidence has been found to establish an implicit memory system in the neocortex outside of medial temporal lobe regions. Nonetheless, it is important to realize that single process accounts, including computational models, have been proposed that use a single memory system. Such single process accounts can explain findings of differences between different memory phenomena, such as priming and episodic recognition. This can be taken as evidence against the multiple systems theory. However, to date, support for these single system alternatives primarily constitutes evidence that they can, in principle, explain dissociations between memory phenomena and other results; positive evidence for single process accounts has not yet been compellingly provided.

A possible exception could be single process accounts emerging from grounded (embodied) cognition theory. By this account, memory depends upon modality-specific systems for sensory processing (i.e., vision, hearing, touch, taste, smell) and motor action processing, as well as introspective states (e.g., emotion). In this view, memory, including implicit memory, also involves the cortical processes of mental simulation that recapitulate prior processing. During a mental simulation, prior information processing of the study item is activated again when a repeated item is processed later. This simulation takes place in the divergence–convergence zones of the cortex beyond the primary sensorimotor areas. The critical difference between the theories lies in the organization of the semantic memory system, which is part of the explicit memory system. Specifically, the multiple systems theory proposes an amodal system that lies apart from any sensorimotor areas and supports conceptual knowledge and semantic memory for word, object, person, and place meanings. This amodal semantic system underlies semantic and conceptual varieties of implicit memory. In contrast, the grounded cognition framework says that modal information (sensorimotor, emotional, and mental state) processing areas underlie semantic memory, either wholly or partially in partnership to an amodal system. Thus the distinction between perceptual and conceptual implicit memory in the multiple systems account disappears in a grounded cognition account, which would instead have a single implicit memory system embodied in the modal processing (e.g., sensorimotor) systems. While some grounded cognition theories posit a single memory system for all types of memory (e.g., both implicit and explicit varieties), other versions of grounded cognition also make no perceptual–conceptual distinction but are otherwise compatible with (or identical to) the multiple systems theories of memory.

Neuropsychological Evidence

Implicit memory in medial temporal lobe amnesia

The first clues about the brain basis of implicit memory came from cases of neurological patients with memory problems due to amnesia. These amnesic patients have medial temporal

lobe damage and are impaired severely on direct memory tests of recall and recognition. Korsakoff, the eponymous neurologist, recorded the earliest anecdotal evidence of implicit memory in his Korsakoff syndrome patients. One such amnesia patient was given an electric shock but failed to recollect this experience. Nonetheless, upon seeing the same device, he thought that the doctor might shock him. Likewise, Claparade pricked an amnesic with a pin. This patient later refused to shake the doctor's hand, despite having no recollection of the earlier unpleasant event.

Studies of patients with amnesia syndrome have provided perhaps the most important information about implicit memory. This is because these patients can be considered examples of people who have a selective impairment in explicit memory but spared implicit memory. As mentioned, an indirect memory test used to reveal implicit memory, in principle, also can be contaminated incidentally with explicit memory. For example, when categorizing an object repeated from a prior study episode, a healthy subject will do the task faster and more accurately with old than new objects, demonstrating repetition priming. However, they may also incidentally consciously recognize that they saw the object earlier in the experiment, demonstrating conscious episodic explicit memory for the prior study experience. In contrast, a patient with medial temporal lobe amnesia will be severely impaired on the latter conscious recognition process. Consequently, in contrast to healthy people, in amnesia, any implicit memory measure is minimally or not contaminated with episodic explicit memory. Amnesic patients can thus provide potentially the purest behavioral measures of implicit memory. However, this advantage of amnesia research was not realized until studies of the famous patient Henry Molaison (HM) who had exceptionally severe memory problems following bilateral medial temporal lobe removal in 1953. Research with HM since the 1960s demonstrates remarkably intact abilities to improve performance on some tasks with repeated experience, despite failing to recollect having experienced the materials before or recognize them as familiar. This was taken to demonstrate spared nonconscious memory, that is, implicit memory, in amnesia. Since then a large body of research has aimed at defining the memory preserved in amnesia, which is working memory, implicit learning, and implicit memory.

The large body of research with HM and other amnesics has demonstrated long-term memory without conscious awareness for a wide variety of perceptual and conceptual repetition priming tasks and for semantic priming. Most of these studies used materials that were already known to the subjects, mostly real words and real objects. In contrast, evidence for spared implicit memory in amnesia is more mixed when novel materials are used that are not meaningful or include information with no preexisting representation, such as nonwords, novel visual patterns, or unrelated word pairs. Some studies show priming in amnesia, while others do not. The evidence suggests that implicit memory for novel information depends on the task and perhaps also the severity of the amnesia.

While damage to the medial temporal lobe can produce amnesia for episodic explicit memory, it is important to note that the rest of the brain is intact, including the rest of the neocortex and subcortical structures. Consequently, spared implicit memory in amnesia indicates that implicit memory

depends upon these spared structures. In particular, the implicit memory that supports priming depends upon the neocortex, particularly secondary and associative areas beyond primary sensorimotor regions.

To avoid the circularity of defining any memory preserved in amnesia as implicit memory, it is important to obtain convergent evidence from other methods, of which evidence is substantial, though not without controversy. The vast literature on priming from studying normal subjects in cognitive psychology experiments using behavioral measures provides one set of evidence. Other evidence comes from other areas of neuroscience beyond neuropsychological work on amnesia.

Impaired implicit memory with cortical lesions

The gold standard in neuropsychology is to obtain a double dissociation. Impaired explicit memory with spared implicit memory in amnesia constitutes a single dissociation. To demonstrate a double dissociation, patients also need to be identified who show spared explicit memory with impaired implicit memory, preferably in the same experiment. Indeed, this has been found. Patients with lateral occipital cortex damage or disconnection between right and left occipital cortex show spared episodic explicit recognition and spared conceptual implicit memory but impaired perceptual repetition priming. Patients with lateral anterior temporal lobe lesions show spared explicit memory and perceptual implicit memory and spared episodic explicit memory. Alzheimer's disease damages the medial temporal lobe plus higher association areas, especially in the temporal lobe, including lateral parts. These patients have impaired episodic explicit recognition and recall, as well as impaired conceptual implicit memory, but relatively spared perceptual implicit memory. Altogether, such dissociations implicate occipital cortex in perceptual implicit memory, anterior temporal cortex in conceptual implicit memory (and semantic implicit memory), and the medial temporal lobe in episodic explicit memory. Transcranial magnetic stimulation (TMS) disrupts neural processing transiently and has been used to show that disruption of processing in left ventrolateral prefrontal cortex (VLPFC) reduces both the cortical and behavioral effects of repetition priming during a categorization task. Consequently, VLPFC may be necessary to express implicit memory behaviorally in a priming paradigm.

Neurophysiological Evidence

Neuronal repetition effects in non-human animals

The best candidate for defining the neurophysiological basis of implicit memory is neural repetition suppression. For example, neurons in inferior temporal cortex along the ventral visual pathway are selective for object shape, and activity of these neurons decreases with repetition. This neuronal repetition suppression occurs whether the repeated stimulus is the target stimulus for the behavioural task or is instead a non-target for the task or is merely passively viewed (i.e., no overt task on any stimulus). This suggests that repetition suppression is automatic, as would be expected for the neuronal mechanism of implicit memory. However, most of this research in animals has involved short-term or immediate stimulus repetition. Further, many studies used pictures of objects, scenes, or faces that would be unknown to these nonhuman subjects. In contrast,

most human implicit memory studies use meaningful word stimuli or other known and meaningful stimuli. The extent to which nonhuman animal findings can explain the neuronal mechanisms of human implicit memory, especially long-term varieties, thus remains unclear. So far, evidence suggests that short-term repetition suppression involves an input-fatigue mechanism in which the synaptic inputs to a neuron reduce their efficacy with repetition. However, several other mechanisms have been proposed to explain neuronal repetition suppression and implicit memory and may apply to other types of implicit memory (e.g., long term). After all, like the human behavioural phenomenon of priming, neuronal repetition suppression varies with delay between first and repeated presentations and duration of the stimuli. Both also vary with the similarity between the test and study items, consistent with transfer appropriate processing and encoding-specificity accounts of memory.

Repetition suppression in human functional neuroimaging reveal the brain location

Functional brain imaging suggests similar neurophysiological effects in humans (i.e., neural repetition suppression effects) by measuring changes in regional blood oxygenation or flow related to neural activity. Relative to the activation level in response to new items, repeated items show a reduced response, known as the neural repetition suppression effect (**Figure 1(c)**). This effect is sometimes referred to as functional magnetic resonance adaptation (fMR-A) when the paradigm involves immediate repetition or very short delays or interstimulus intervals between first and second presentations. Notably fMR-A uses suppression to infer the representational characteristics of perceptual processing areas (e.g., representation of view, position, size). This is analogous to the visual cognition approach of using priming to infer how objects are represented (e.g., parts or multiple views of an object). However, human and animal evidence indicates that the neural mechanism differs between different varieties of priming (e.g., immediate, short- and long-term). Mechanisms proposed for long-term implicit memory may not apply to short-term varieties, and conversely. This important consideration has, however, not yet been addressed systematically, leaving the neural mechanism unknown for the many neuroimaging studies involving repetition suppression.

Nonetheless, some recent work has started to address this, and some general principles about repetition suppression have emerged. Neural suppression occurs in secondary and associative cortex as opposed to primary sensorimotor cortex. For example, in the visual modality, early studies of priming-related suppression implicated only the ventral visual stream beyond primary visual cortex. This was consistent with multiple systems accounts of memory, which implicated only the ventral visual stream in perceptual implicit memory. Recent work, however, shows that short- and long-term suppression occurs along both the ventral and dorsal visual streams (**Figure 1(d)**). Evidence also indicates that suppression effects increase as processing proceeds from posterior to anterior visual processing areas. This is consistent with the larger priming effects found behaviorally for conceptual priming (e.g., involving more anterior temporal areas) than for perceptual priming (e.g., involving more posterior occipitotemporal

areas). Like behavioral priming measures of implicit memory, neural suppression can show perceptual specificity, especially in posterior perceptual processing areas. For example, suppression in object processing areas along the ventral stream becomes smaller when objects repeat from different viewpoints or under different lighting conditions.

At a network level, the brain regions that show suppression effects are parts of the active task network implicated in selective attention and working memory. This network also includes secondary perceptual processing areas, lateral prefrontal cortex, and intraparietal sulcus. Activity in this network is anticorrelated with activity in a default mode network implicated in episodic explicit memory, mind wandering, and internally directed attention. The default mode network includes medial prefrontal cortex, cingulate cortex, retrosplenial cortex, lateral posterior parietal cortex, and superior temporal gyrus. Consistent with anticorrelation between these networks, the default mode network shows the opposite repetition effect. They show repetition enhancement, that is, greater activation for old than for new items. This is typically observed on episodic memory tests (e.g., recognition of an item as old and familiar).

As can be the case with behavioral priming, neural suppression can show task specificity. For example, when the task changes between the study phase and the memory test phase, suppression is reduced, especially in prefrontal regions and fusiform gyrus in the left hemisphere. This finding can be considered an example of violation of the transfer appropriate processing principle of memory, which predicts that processing differences between study and test will reduce memory. The task changes that reduce suppression can include inversions of the decision (e.g., Larger than a shoebox? *vs.* Smaller than a shoebox?). Even inversions of the response key mapping may reduce behavioral priming (e.g., yes and no mapped to 1 and 2 keys *vs.* 2 and 1 keys, respectively). However, whether decision or motor-related aspects of the response are the locus of the stimulus–response mapping effect remains to be established. Nonetheless, the effect of switching response clearly increases with repetition, as the reduction is substantial with multiple repetitions and less or none with a single repetition. Notably, most research on implicit memory and behavioral priming has involved a single repetition and so cannot depend substantially on stimulus–response learning. Consistent with this, studies with amnesia patients indicate that stimulus–response learning effects depend upon the medial temporal lobe system for episodic explicit memory. Intriguingly, this suggests that stimulus–response mapping influences on repetition priming are more properly considered an episodic memory phenomenon in which episodic memory incidentally influences priming, instead of a characteristic of the implicit memory system. After all, indirect memory tests can recruit not only implicit but also explicit memory. This also suggests that stimulus–response learning cannot explain the remarkably spared priming effects established in amnesia patients. Nonetheless, studies of stimulus–response mapping and neural suppression have indicated that top-down processing from prefrontal cortex to other brain regions has a role in the task switching effect on behavioral priming. Transiently disrupting processing in the VLPFC reduces stimulus–response learning effects, demonstrating a causal role.

Neuronal mechanisms

Altogether, human neuroscience findings implicate multiple different mechanisms for repetition suppression in priming paradigms. The first mechanism, referred to here as the tuning account, is the classic explanation. This account suggests that neural repetition suppression depends upon sharpening or tuning of neuronal receptive fields due to learning. The neural representation of the stimulus becomes more precisely tuned to its preferred stimulus (e.g., the shape of a particular dog from a specific view) with experience with that stimulus. Such effects show perceptual specificity such that memory decreases with changes in the perceptual form between the learned version of the stimulus (e.g., a different view of the dog or a different type of dog, say, poodle instead of collie) and the memory test version of it. Suppression due to neuronal tuning probably occurs in posterior perceptual processing areas implicated in perceptual representation or knowledge systems. Tuning-related suppression can also occur, to some extent, in more advanced stages of stimulus processing, such as in anterior temporal cortex for visual stimuli, implicated in conceptual knowledge about stimuli (e.g., meaning of a word or object). However grounded (embodied) theories of cognition would implicate both posterior and anterior stimulus processing areas because sensorimotor processing areas support not only perception and action but also meaning and memory. However, tuning-related suppression seems to have a limited relationship with priming of behavioral performance on tasks that require processing stimulus meaning, such as categorization.

Consequently, a second mechanism has been proposed more recently following new evidence that VLPFC has a causal role in behavioral priming that is response-specific. This account was motivated by the stimulus–response mapping findings that switching the task decision mapping from study to test reduces priming and repetition suppression. By this account, top-down inputs from prefrontal cortex onto other brain regions influence behavioral priming. Prefrontal cortex is implicated in cognitive control, attention, and working memory. These control processes can become more automatic with increasing experience with an item. Consequently, the association between the stimulus and these control processes becomes stronger. This learning results in memory and behavioral priming that is response-specific. However, as mentioned, this mechanism clearly applies to priming after multiple repetitions, but evidence so far suggests its involvement after a single repetition is minimal or none.

Another explanation uses a perceptual memory-based caching system to explain short-term priming with meaningless perceptual patterns, which does not show stimulus–response learning. By this computational account, perceptual processing results in perceptual representations. While meaningful stimuli engage processes related to categorizing and verbally labeling the stimulus, meaningless perceptual patterns do not; instead, they engage other perceptual processes based on the task requirements, such as the size of the object. A short-term perceptual memory process (i.e., the ‘cache’) briefly stores the binding of the percept and other task-specific perceptual information. In posterior cortex, this caching mechanism could presumably operate along with the tuning mechanism to explain implicit memory and priming, regardless of a task switch from study to test.

At the neuronal level, several mechanisms may underlie repetition suppression. Three examples discussed so far are the input-fatigue mechanism (for adaptation with immediate repetition) and the tuning and caching system mechanisms (for long-term perceptual repetition suppression). However, other mechanisms are possible and could also explain response-invariant suppression. Like the input-fatigue version, a firing rate-dependent fatigue mechanism (for adaptation) suggests that neuronal responses decrease with use (i.e., the neuron becomes fatigued). However, in this case, repetition suppression is proportional to the firing rate elicited in response to the first presentation. Evidence so far has not favored this account. By contrast, a facilitation model suggests that the time course of the neuronal response (i.e., onset latency and/or duration) decreases with repetition. While neuroimaging has provided some support, this can be assessed better using neurophysiological measures with temporal precision within the range of neuronal activity (milliseconds). In humans, electromagnetic brain potentials have supported facilitation models of long-term repetition, as category knowledge is activated about 50 ms earlier for repeated than for new objects.

Repetition effects on human electromagnetic potentials reveal the timing

Event-related electrical potentials have defined the time course of memory processes. This evidence indicates that, for everyday cognition, long-term implicit memory starts relatively late in information processing, after the initial bottom-up activation through perceptual processing areas. Brain potentials show that long-term repetition effects are observed only after about 200 ms (**Figure 1(b)**). The repetition effects are relatively long-lasting, until around 400 or 500 ms or so after the stimulus appears, indicating that implicit memory effects on information processing typically last for about 300 ms or longer. In particular, repetition typically affects mid-latency negativities between 200 and 500 ms that reflect activation of knowledge about words, objects, and faces. Negativity is typically reduced for repeated relative to new items. With meaningless stimuli, these effects are minimal or none. This is consistent with the idea that implicit memory substantially affects perceptual and conceptual knowledge representation systems. While priming can occur for nonsense stimuli, such effects are short-term and response-invariant, and explained using the caching mechanism. By contrast, long-term implicit memory of meaningful stimuli involves facilitation, tuning, and perhaps stimulus-response mapping mechanisms of neuronal suppression. The time course evidence indicates that all these mechanisms, under most circumstances, involve top-down inputs from prefrontal to posterior perceptual and conceptual processing areas and/or feedback inputs among the processing areas themselves. For example, by 200 ms, electrical potentials have been recorded intracranially from human prefrontal cortex. Brain potential evidence thus indicates that long-term implicit memory that supports behavioral priming is associated with neural repetition suppression. This neural mechanism for this implicit memory involves top-down from prefrontal cortex to other posterior information processing regions.

Nonetheless, a handful of studies have shown repetition effects on earlier brain potentials not only for short-term but also long-term repetition. These effects are found on transient

potentials related to the initial feedforward pass through perceptual processing areas, as well as automatic recurrent and feedback within these areas. The input-fatigue mechanism has been implicated in short-term and adaptation (immediate repetition) effects. The long-term effects are related to perceptual priming, regardless of meaning, and have been found with meaningful and meaningless stimuli. At last one such early repetition effect has been clearly linked to perceptual grouping processes. However, to observe effects of long-term implicit memory early in processing, the task may need to focus attention on perceptual details. For example, one study required subjects to determine whether a nonsense visual pattern had a loop or not. Another study made stimulus categorization highly challenging visually by presenting fragmented line drawings very briefly (for 20 milliseconds).

Notably, convergent evidence from cognitive psychology, neuropsychology, and neuroimaging suggests that implicit memory can influence explicit memory performance on recognition tests in which people decide whether an item is old and familiar from a prior study experience or is a new item. For example, electrical potentials during explicit episodic memory (recognition) tests have revealed repetition effects between 200 and 400 ms. This is found when people can recognize items with some accuracy but report being unaware of retrieving memory and just guessing. This has been taken as an implicit memory process that influences recognition performance but without awareness.

Other Priming Phenomena and Their Mechanisms

Masked Priming and Short-term Implicit Memory

In immediate repetition priming paradigms (e.g., semantic priming), when the study item is presented very briefly (e.g., for 50 ms) and masked, this prime stimulus is typically not reported by people. The prime is thus taken to have been processed only unconsciously. While it is as problematic to establish that the prime is unconscious as it is hard to establish that implicit memory is unconscious, clearly the prime is minimally available to conscious report under these masking conditions. In the standard paradigm, masking involves presenting a perceptually similar stimulus immediately before the prime (e.g., for 500 ms). This is the forward mask. The target item, which constitutes the memory test, is presented immediately after the prime (e.g., for 500 ms) and also serves as a backward mask, though some studies use an additional backward masking stimulus similar to the forward mask. In studies of perception, such masking seems to minimize or eliminate influences of top-down feedback from the frontal lobe on posterior processing. Elimination of this feedback is thought to be the reason why the prime is processed largely or wholly outside of conscious awareness. Using the masked priming technique, early perceptually specific repetition effects have been found on electrical potentials as early as 100 ms after the appearance of the item. Overall, priming effects from these studies reveal contributions from bottom-up processing in posterior secondary and association cortex to sensory feature, orthographic, lexical, and conceptual levels of word processing and perceptual and conceptual levels of object processing. This variety of implicit memory, however, depends upon recent activation of the knowledge network by the prime

that is ongoing when the target item appears shortly thereafter, as opposed to tuning or facilitation mechanisms. The fatigue mechanisms may also apply. Repetition suppression has been associated with masked priming in neuroimaging studies.

Antipriming

Priming studies use new items as the baseline condition to assess memory. Responses to new items are compared to those for repeated (old) items. However, recent evidence suggests that a new item that has been intermixed with old items is not an entirely neutral baseline control. Instead, these new items reflect not merely processing of the novel item but also small antipriming effects on these new items as a by-product of the previous experience with the repeated items. Antipriming happens because objects are represented in perceptual systems in a distributed, overlapping fashion organized according to feature similarity. Further, individual neurons are tuned broadly to sets of features of objects, and a population code of sparse sets of neurons represents each object. Consequently, when an object is experienced, its representation becomes strengthened, consistent with tuning and facilitation mechanisms. However, the process of strengthening this representation also weakens the representations of other objects with which it shares features. For example, a dog has a head, body, and four legs. Experience with a dog strengthens its representation while also weakening the representation of other objects sharing one or more of its features (e.g., other animals with similar head, body, and/or leg features). Crucially, when an item with these overlapping features is later presented as a new item (mixed with repeated items) on a priming test, its neural activity is actually greater (than for repeated items) as part of a late process of connecting its relatively weaker representation back up. Electrical potentials indicate that this effect occurs after 1100 ms, which is over 200 ms after the behavioral response, and well after earlier perceptual and conceptual implicit memory and even after any incidental episodic recognition of the item. Instead, antipriming effects reflect a very late relearning effect, essentially encoding of new information into memory. However, in neuroimaging studies, due to the long time course of the blood response on which they depend (i.e., several seconds), neural repetition suppression effects likely reflect some combination of perceptual and conceptual implicit memory plus a small contribution of antipriming effects, at least in the left inferotemporal and left and right lateral occipital areas where antipriming effects appear.

Implicit Memory Can Result from Implicit Learning

Memory results from learning. Consequently, implicit learning (i.e., skill learning, procedural learning, motor learning, perceptual learning) can lead to implicit memory. This is not typically included as implicit memory proper, which instead focuses on priming phenomena. While memory following implicit learning could be explicit and revealed on recognition or recall tasks, it could also be implicit. Indeed, the typical method for demonstrating that learning has occurred in an implicit learning experiment is to test memory indirectly. Moreover, to demonstrate that learning is implicit, the memory that results from this learning must be demonstrated to be implicit. To do so, both indirect tests and direct tests (i.e., recognition, recall) of memory are used.

The indirect tests measure changes in performance for old relative to new information. The difference measured is not referred to as priming but, nonetheless, does fit the definition. The main exception is that implicit learning effects can be observed only after more than one experience with the repeated information. In fact, typically, many experiences are required to observe implicit learning effects. By contrast, repetition priming occurs routinely following a single presentation of the item at study (i.e., during learning). In fact, typically many experiences are required to observe implicit learning effects.

For example, one of the most widely studied implicit learning tasks is the serial response time (SRT) task. In the spatial version, people see different locations on a computer screen light up one at a time (e.g., one of four boxes will light up). People press a key corresponding to the location on the screen that is lit. Locations light up either in a repeating sequence or a new order (e.g., random locations). Faster responses to repeated than new locations demonstrate implicit learning. This can be taken as a kind of location priming that demonstrates implicit memory for the repeating sequence of locations. If direct memory tests also indicate no conscious awareness of memory for the repeating sequence, then the implicit memory demonstrated on the task is taken to indicate that learning has occurred implicitly. Consistent with this, the large body of research with HM and other amnesics has also demonstrated memory without conscious awareness for perceptual, cognitive, and motor skills (e.g., mirror-reversed reading), rule learning, and SRT task learning. However, amnesic patients are impaired on implicit SRT task learning, if higher-order associations among multiple locations must be learned. Further, neuroimaging of normal subjects has demonstrated learning-related activation in the medial temporal lobe during implicit learning, despite no conscious awareness of having learned anything. This is observed during the early phase of implicit learning of higher-order associations when the most new information needs to be encoded. Evidence for medial temporal lobe involvement without awareness of memory has also been found for probabilistic classification learning and context learning. Thus the role of the medial temporal lobe is not in conscious (explicit) memory per se (but rather can have a role in some types of implicit learning and memory). Instead, the computational demands of the learning task determine whether the medial temporal lobe is recruited (e.g., for higher-order associations, sequence disambiguation, or contextual associations). In contrast, the basal ganglia, which connect in closed circuits with the cortex, have an established role in implicit learning. Neuroimaging demonstrates basal ganglia activation during implicit learning on a wide variety of tasks. Further, patients with Parkinson's disease have basal ganglia dysfunction and impaired implicit learning with spared episodic memory, whereas amnesic patients have impaired episodic memory and relatively spared implicit learning (and consequent implicit memory). This demonstrates a double dissociation between implicit learning and memory versus explicit memory.

Conclusion

Perceptual, conceptual, and semantic varieties of implicit memory prime behavior. This nonconscious, effortless, automatic memory affects performance at immediate, short, and

long delays and can last for years. Implicit memory can result from implicit or explicit learning. However, implicit memory is specific for the sensory modality and perceptual features of the stimuli and the task response. Implicit memory is related to neural repetition suppression and depends upon in neocortical information processing areas that lie outside the medial temporal lobe and primary sensorimotor areas. While short-term varieties may involve neural fatigue during bottom-up processing, some long-term types involve top-down inputs to posterior cortex occurring after about 200 ms of processing. The brain basis of implicit memory varies with the cortical areas involved and the delay between study and test.

See also: Amnesia and the Brain; Associative Learning; The Brain; Classical Conditioning; Electroconvulsive Therapy and Transcranial Magnetic Stimulation; Electroencephalography; Episodic and Semantic Systems of Autobiographical Memory; Episodic Memory; Event-Related Potentials (ERPs); Memory, Neural Substrates; Memory; Mental Imagery; Neuroexecutive Function; Neurotechnologies; Perceptual Development; Primate Cognition; Psychology of Reading; Semantic Memory; Subliminal Perception; Visual Perception; Word Retrieval.

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Impression Formation

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Glossary

Brain lesion studies Studies in which the function of an area of the brain is inferred from behavior that people can no longer perform after their brain is damaged in that region.

Event-related potentials (ERPs) Electrical potentials that are generated in the brain as a consequence of the synchronized activation of neuronal networks by external stimuli. They can be noninvasively recorded by placing electrodes on the scalp.

Functional magnetic resonance imaging (fMRI) A noninvasive imaging technique that measures oxygen levels in the brain's blood vessels. Based on the assumption that brain regions recruit more oxygen the more active they are, recording differences in oxygen levels can be used to localize brain activity.

Impression formation The process by which one integrates various sources of information about a target person into an overall judgment.

Ingroup/outgroup A terminology that originates from social identity theory. Ingroups are social groups toward which an individual feels loyalty and respect, usually due to membership in the group. In contrast, outgroups are groups that an individual does not belong to.

Mentalizing A term referring to the process by which humans make inferences about the unobservable mental states of other social agents.

Point-light animation studies In work of this kind, movement is portrayed via a small number of point-light markers that are positioned on the head and the joints of a person's body. From the assembly of moving lights, naïve observers can readily recognize a human shape and its actions.

Introduction

In 1946, the American social psychologist Asch examined, in an impressive series of studies, how people combine various pieces of information about another person into a holistic impression. His work set the stage for over 60 years of active impression formation research. The enduring interest may not be surprising given the topic's immense relevance for everyday life: When we choose a flatmate or a partner, register with a doctor, trust a sales person, or ask a stranger for help, our decisions and actions are likely to be determined by our impression of the individual in question. Importantly, these impressions tend to be not only descriptive (e.g., Mark can play the violin) but also evaluative (e.g., I really like Mark). As such, they can become powerful forces that fundamentally shape the course of social interactions. But how exactly do humans form impressions about each other?

The famous reminder not to judge a book by its cover is indicative of two sources of information that humans can use when forming impressions: On the one hand, the outer appearance of books and people alike seems to invite spontaneous evaluative processing. Daily experience attests that within the briefest of glances, we can easily extract information about another person's facial features and expression, hairstyle, gaze direction, head and body orientation, posture, and choice of apparel. From these visual cues alone, one can quickly draw inferences about a person's sex, age, race, emotional status, attractiveness, personality, and social attention. On the other hand, however, neither the content of a book nor the character of a person may be reflected in what easily meets the eyes.

Beyond the person information that can be gleaned from merely looking at someone, a wide array of additional information about others can be gathered by interacting with them.

For example, within a very short encounter the timbre of a target's voice as well as his or her accent, way of expression, and mannerism can be encoded. In addition, prolonged and repeated interactions allow for experiencing someone's behavior over time and across different types of situations. Not surprisingly, these additional person cues can greatly enrich the impression formation process.

Importantly though, forming impressions about others is not only influenced by the appearance and the attributes of the target person or the duration of an acquaintance, but also by characteristics of the perceiver. Expectations, variations in mood or attentional state, as well as aspects of similarity between perceiver and target can profoundly influence the type of person inferences drawn during an encounter. Therefore, the purpose of the present article is to provide an overview on target- and perceiver-related factors that shape the course and products of the impression formation process.

Impression Formation at First Glance

Consider for a moment the last time you strolled through a supermarket. Besides thinking about what to buy and which aisle to visit, observing other people in the store can be a constant source of distraction. For example, depending on the time of day, one is likely to see happy couples grabbing a pizza for a quiet night in, stressed businessmen hunting for microwavable food, or a desperate homeless person stocking up on cigarettes and cheap wine. But how is it that one comes to know these things about other people? What does it take to discern that someone is happy or stressed, desperate or in love, homeless or a businessman in the absence of any interaction with them? Research exploring the visual cues that humans

rely on when forming impressions of others suggests that a person's physiognomy (i.e., facial features), outer appearance (i.e., clothing), or demeanor (i.e., posture, style of walking) are of particular importance. But exactly what sort of impressions are we capable of creating on the basis of such visual information alone?

Inferring Personality Traits

It comes as no surprise that people readily draw personality inferences when perceiving others. Such spontaneous trait judgments can have far-reaching consequences in many domains of everyday life. Evaluations of competence based on a target's facial appearance, for instance, have been found to be predictive of people's political voting decisions. In addition, increased body height – a feature that tempts observers to ascribe social dominance to others – has been demonstrated to be positively related to increased occupational success. Moreover, wearing revealing clothes, a signal of immodesty and apparent promiscuity, has been shown to cause lay people, judges, police officers, and prosecutors alike to hold victims of rape to be responsible for their assault. These brief examples illustrate how fundamentally the appearance of others can determine our impressions of them.

Interestingly, people often agree on the traits and qualities they infer from visual person cues, a phenomenon that has been termed consensus at zero acquaintance. Notwithstanding this observation, certain traits seem to be more inferable than others and elicit higher consensus across perceivers. For example, while judging a person's extraversion and conservatism from appearance cues elicits high consensus across perceivers, judgments of neuroticism or openness reveal little or no agreement. Research also indicates that people are particularly inclined to judge others according to their agreeableness (i.e., how warm and friendly they are). Nevertheless, perceivers seem to be particularly bad at making this verdict. Put differently, what people typically judge during first encounters is often something that they are not able to judge with much success.

Given people's tendency to infer traits from visual cues alone, an obvious question arises: Exactly which features do people use to guide their judgments? At present, this issue is poorly understood, although it is apparent that the selection of features is clearly trait-dependent. For example, people are deemed to be highly extraverted when they have a round face and stylish hair, wear extravagant clothing, show a friendly expression, display frequent and rapid body movements, and walk in a relaxed manner. In order to further elucidate the process of trait ascription following person perception, recent studies have explored the persistence of these inferences and the extent to which they can be drawn under impoverished viewing conditions. This work has demonstrated that a mere 100 ms exposure to an unfamiliar face is sufficient for participants to draw likeability, trustworthiness, competence and aggressiveness inferences about the target that are similar to those generated under longer viewing times. Beyond facial features, initial work using point light displays has revealed that inferences regarding a person's extraversion, warmth, and trustworthiness can also be drawn from patterns of body movement alone.

Inferring Emotional States

Besides determining personality traits at one glance, forming impressions about others has also been tightly associated with inferring their emotional states. According to the famous expression 'laugh and the world laughs with you, weep and you weep alone,' people tend to prefer others who radiate positivity. Also, by observing someone's emotional responses to events in his or her environment (e.g., Does Mark feel sad for a friend who lost his job? Does seeing a sunset make him happy?), perceivers can draw inferences about the person's character. Many studies suggest that a whole range of static and dynamic person cues is routinely used to understand the emotional states of others. For instance, humans are able to recognize at least seven basic expressions of emotion (i.e., happiness, fear, surprise, anger, sadness, disgust, and contempt) with high accuracy and consistency from facial expressions alone (more details on this topic is dealt elsewhere within the encyclopedia). In addition, successful emotion recognition is also enhanced by processing a person's bodily posture such that facial expressions of emotions are recognized most rapidly when they are paired with emotionally congruent body postures. Furthermore, although perceivers can read emotions from static images of people, motion cues significantly enhance emotion recognition. Even the motion of isolated body parts, such as the manner in which an arm is moved while drinking, waving or lifting, can be sufficient to infer the emotional states of others. For example, movements that accompany anger or elation tend to be faster, more energetic, and spatially expansive than those that signal passive emotions such as contempt, sadness, and boredom.

Inferring Social Attention and Intention

A person's direction of gaze can also play a prominent role in processes of impression formation. For instance, perceivers seem to profit from using gaze information when trying to decipher the emotional states of others. Expressions of anger are perceived more accurately, categorized more quickly, and rated as more intense when eye gaze is directed 'toward' than 'away from' the perceiver. Interestingly, the opposite is true for expressions of fear. Findings such as these suggest that the perception of facial emotions is influenced by the potential behavioral intent of the cue provider to approach or avoid the perceiver. According to this line of reasoning, while direct gaze is thought to enhance the detection of approach-oriented emotions such as anger and joy, averted gaze is assumed to enhance the recognition of avoidance-oriented emotions such as fear and sadness.

Moreover, gaze cues can also readily signal whether an object of significance has appeared in someone's immediate environment or if one is the target of another person's attention (e.g., Is Mark looking at me or at the attractive person over there?). It has been demonstrated that under conditions of direct gaze, the processes supporting person perception are optimized. One of the consequences of mutual gaze is that faces with direct compared to averted gaze are more likely to be attended to and to be remembered. Also, faces with a neutral expression and direct gaze are rated as more likeable than faces with an averted gaze. Given the role that eye gaze can play during processes of emotion recognition and social attention,

it does not come as a surprise that perceivers are highly accurate at decoding the gaze direction of others. The structure of the human eye facilitates just such a task. Comprising a small dark area (i.e., the pupil and iris) surrounded by a region of white (i.e., the sclera), human eyes are well adapted to signaling where they are looking.

Inferring Group-Based Characteristics

In order to form impressions about others rapidly and without investing too much time in getting to know them, perceivers also regularly rely on categorical knowledge structures to simplify the impression formation process. As a result, evaluations of others are influenced not only by a person's specific appearance, but also by stereotypic expectations. As consensual beliefs about individuals based on knowledge of the groups to which they belong, stereotypes are engrained in the very fabric of society. Dominant stereotypes in Western society, for example, target a person's sex, race, and age and typically comprise beliefs regarding the traits and behaviors associated with membership in these groups. Compared to men, women are believed to be less intelligent, competent, and ambitious. However, if they are communal and conform to traditional female roles, women are deemed to be wonderful. Similarly, African Americans are stereotypically assumed to be lazy, criminal, and uneducated but also musical and athletic, whereas Asian Americans are considered to be intelligent, industrious, conservative, and shy. In addition, stereotypes about age groups suggest that lovable, dependent, and weak infants will turn into belligerent, moody, and irresponsible adolescents, before they suffer physical and mental decline including tiredness, forgetfulness, and self-pity by the time they reach old age (more details on this topic is dealt elsewhere within the encyclopedia).

Importantly, the likelihood of stereotype activation and application during impression formation is sensitive to the extent to which individuals possess features that are deemed to be typical of the groups to which they belong. In this respect, faces with more Afrocentric features have been shown to elicit stronger activation and application of the African-American stereotype than faces with less prototypical features. This form of feature-based stereotyping has also been observed in criminal-sentencing decisions, such that targets with very obvious Afrocentric features, for instance, are punished most severely. Of course, perceivers also can determine a person's typicality for a respective social category based on cues other than a target's facial appearance. Information about age typicality, for example, can be gleaned from people's movements, for instance, individuals are believed to be stronger and happier when they display a youthful gait rather than when their gait resembles that of an elderly person. In addition, clothing has been shown to signal a target's typicality. Depending on whether a Black individual is encountered in prison dressed as a criminal or a lawyer, the typical pattern of racial stereotyping can even be reversed. Importantly, research has also shown that category-based first impressions are highly susceptible to situational influences. Viewing an Asian woman performing a typical female activity (e.g., applying cosmetics) or a typical Asian activity (e.g., eating with chopsticks), for example, was found to be sufficient to prompt either the sex or the race of the target, respectively, to dominate the associated impression

formation process. In a similar vein, forming an impression about a Black target based on African American stereotypes was found to be more likely when the target was encountered in expected rather than unexpected settings (e.g., street corner vs. outside a church).

Impression Formation over Time

The impression formation process is not usually aborted as soon as we have had a brief glance at another individual. Especially, if we encounter someone repeatedly, our observations of his or her behavior over time and across situations will continually shape our thoughts and feelings toward the individual. Thus, as time elapses additional aspects of the impression formation process can begin to unfold.

Multiple Categorization

Several influential social psychological models suggest that the starting point of the impression formation process is often a target's social category memberships that are easily gleaned from visual facial and bodily markers such as sex, race, and age. Indeed, recent evidence indicates that such category-based construal of others is easily and frequently done – primarily when people are encountered for the first time. However, people do not usually belong to only one social category, and many social categories they belong to are not always easily gleaned from their appearance (e.g., religion, nationality, political views). Through prolonged observation and/or repeated interaction, however, perceivers are likely to learn about the multiple group memberships of others. Imagine Fred, for example, who is an adolescent vegetarian from Italy aspiring to become a lawyer. Or Susi, a middle-aged Black school teacher and animal rights activist from Sweden. When forming impressions, perceivers seem to find some conjunctions of categories easier to integrate than others. Depending on the specific combination of categories, completely new impressions may be formed about a person. A Harvard educated carpenter, for example, may be judged to be nonmaterialistic, even though this trait would not be spontaneously used to describe a Harvard graduate or a carpenter. Thus, especially surprising category combinations seem to cause the ascription of completely novel traits to others.

Person Individuation

Apart from trying to integrate multiple group memberships into a holistic impression of a person, repeated encounters can also lead to a fundamental shift from mainly category-based judgments about others toward more individualized assessments. Thus, over time perceivers often begin to consider a target not only as a random instance of various generic social categories but rather as a unique entity. Increasingly individuated impression formation is likely when perceivers pay particular attention toward another individual either because he or she is of heightened relevance or importance to them or because the target consistently fails to conform to category-based expectations. Once individuating information is taken into consideration, perceivers are likely to develop complex

theories about the person in question. The resulting lay theories about significant others are then used to explain and predict their behavior. For example, under the assumption that my friend Lucy is very insecure and shy, I will not be surprised to find her not talking easily to others at a party.

Attribution Theories

How exactly the transition from a group-based to a more individuated impression takes place and how categorical and person-specific information become integrated is still a matter of debate. It appears to be the case, however, that a single category-inconsistent behavior is not sufficient to modify a category-based impression. In this respect, one rational decision by Anne will not easily tempt us to assume she is a rational person, given that we know that women are quite emotional per se. In contrast though, temporally consistent behavior seems to have the potential for permanently overriding category-based judgments. According to attribution theories, observing and interacting with others elicits the constant attempt to understand whether their behavior reflects their character or is merely the product of normative or situational forces. In order to decide whether a certain behavior is really reflecting a person's personality, perceivers seem to use consensus, consistency, and distinctiveness information. Put differently, the more unusual a behavior is, the more often it is displayed, and the more a person shows this behavior across a wide range of different situations, the more likely it is assumed to be related to a person's character (more details on this topic is dealt elsewhere within the encyclopedia). By using such attribution strategies, initial impressions of others can be validated or falsified over time.

Biases in Impression Formation

Despite most people's intuition that their impressions of others are unbiased and reliable, accumulating evidence has shown that their judgment of others often suffers from systematic short-comings. Below the most prominent biases are described in alphabetical order.

The Accessibility Bias

The enhanced accessibility of certain constructs due to frequent or recent use has been found to fundamentally shape the impression formation process. For instance, exposing people to positive or negative trait items (e.g., adventurous vs. reckless) causes them to interpret ambiguous behavior of others soon afterward as correspondingly positive or negative, depending on the meaning that has been primed. In a similar vein, it has been shown that activation of the construct sex can influence how perceivers construe others. In a study set up to investigate this effect, male participants were asked to view a series of advertisements. Half of the participants were shown adverts that had women displayed in sexual postures, while the other half was presented with sexually neutral spots. Afterward, all individuals were asked to conduct an interview with a female student for a job as a research assistant. It turned out that those participants who had seen the arousing spots chose

to sit closer to the woman, asked her more personal questions, and judged her more likeable but less competent after the interview than those that had seen the neutral spots. More generally speaking, such research demonstrates that the temporal accessibility of certain constructs can majorly influence the in which manner in which information about others is sought out and used for forming impressions about them.

The Babyface-Overgeneralization Bias

Adult faces that are round and comprise large eyes, high eyebrows, small nose bridges, thick lips and a high forehead as well as a short chin tend to be perceived as babylike. Research has demonstrated that adults with a babylike facial appearance are often considered to have childlike traits such as being naïve, submissive, weak (physically, socially, and intellectually), warm and honest as well. The consequences of such a babyface-related trait judgments have been found to be far reaching. Babyfaced individuals, for instance, are favored for jobs that require agreeableness, but they are very likely to be passed over for mentally challenging tasks and leadership positions.

The Beauty-Is-Good Bias

Attractive people are generally seen to possess more desirable characteristics than their less attractive counterparts. The force of being considered more outgoing, socially competent, powerful, and healthy can be clearly quantified across the life span. Attractive kids elicit more attention and affection, and are punished less severely than unattractive children. In adulthood, heightened attractiveness is related to increased mating opportunities, better employment prospects, advantageous work evaluations, increased earning potential, and longevity. But what exactly does heightened attractiveness mean? Although recent work provides evidence that personal taste significantly impacts judgments of beauty, it appears that specific facial attributes have consistently been linked to enhanced attractiveness. Besides bilateral facial symmetry, facial averageness (a facial configuration close to the population mean), sexual dimorphism (i.e., high femininity in female faces and high masculinity in male faces), a healthy skin and dental appearance, a pleasant expression, youthfulness, and good grooming, bodily information also contributes to assessments of attractiveness. This becomes most apparent when considering evaluations of the overweight. Men and women who deviate from societal standards of bodily attractiveness by being overweight are seen as flawed not only in their appearance, but also in terms of their personality. Participants ascribe more negative traits (e.g., lazy, incompetent, boring, undisciplined) to overweight than average-weight individuals, an outcome that precipitates serious discrimination in health, work, and educational settings.

The Categorization Bias

The mere categorization of humans into groups tempts perceivers to judge identical behavior of others differently, depending on the social groups to which they belong. For instance, a classical study revealed that when white students watched a

heated discussion between two men that ended in one man shoving the other, the observed action was considered more aggressive when the shove was delivered by a Black relative to a White man. In addition, studies have shown that perceivers tend to attribute positive behaviors of ingroup members to advantageous dispositions and negative behaviors to situational factors, while positive and negative acts of outgroup members are explained in the opposite way. Also, members of the same group are considered to be more similar (i.e., within-group assimilation) and members of different groups to be more different from each other (i.e., between-group contrast) than when they are seen as mere individuals.

The Correspondence Bias

Humans are inclined to attribute the behavior of others to their inner dispositions rather than the consequence of social roles or situational constraints – a phenomenon termed the correspondence bias. For instance, when women are encountered in roles that call for nurturing and supportive behaviors (i.e., as nurses) and men in roles that require independence and assertiveness (i.e., as managers), perceivers are likely to infer that persons enacting those roles have corresponding dispositions rather than that they display efforts of role fulfillment. In consequence, the influence of normative or situational factors on the observable behavior of others is often underrated, resulting in biased personality attributions.

The Familiarity Bias

Sometimes targets are encountered on numerous occasions, yet no specific target-related knowledge is acquired (i.e., the woman one sees on the bus every morning). Perceivers seem to regard perceptually familiar people as more likeable, intelligent, and warm-hearted compared to unfamiliar targets, an effect that is likely driven by the misattribution of positive affect elicited by increased perceptual fluency. Recent work also suggests that perceptually familiar individuals are construed in a stronger stereotype-based manner than unfamiliar others, perhaps reflecting perceivers' need to make sense of frequently encountered targets.

The Negativity Bias

Negative information about others has been found to be unusually influential in guiding our impressions of them. This bias has been explained by the enhanced distinctiveness and diagnosticity of such information. For example, if one is trying to determine whether another person is honest, learning that he or she is faithful to his or her partner is less informative (because such a behavior is normative) than learning negative information such as that the person is cheating (which is often considered unusual). Thus, negative information has a powerful impact on impression formation because it is more useful for distinguishing between alternative interpretations of a person's behavior. In addition, evidence suggests that impressions that are initially negative tend to be more stable than positive impressions because negative experiences decrease the probability of future interactions that would allow the sampling of additional information about a person.

The Physical Resemblance Bias

People we encounter for the first time occasionally resemble friends, family, celebrities, or acquaintances in their appearance or mannerisms. A consequence of this similarity can be that these strangers are ascribed the same traits, attributes, and characteristics as the targets they resemble. For example, when the face of a stranger reminds one of a good friend, traits descriptive of the friend are readily attributed to the unknown other. In a similar vein, a study has shown that people express a preference for a stranger whose face resembled that of someone who treated them kindly rather than irritably.

Self-Fulfilling Prophecies

The term self-fulfilling prophecies refers to the observation that sometimes our beliefs about others can lead us to treat them in such a way that they subsequently become what we expect them to be. Originally, the effect was demonstrated in the classroom and called the 'pygmalion effect.' In a seminal study, teachers were told at the beginning of a school year that certain of their students were potential late bloomers, who would be expected to excel during the school year under proper guidance. Even though there was nothing in actual fact that set those students apart from their colleagues, several months later their schoolwork had improved considerably. Since this initial observation, numerous similar investigations have testified to the robustness of the effect with regard to both, positive and negative expectations. Follow-up studies also demonstrated that perceivers sometimes unintentionally transmit their expectations through nonverbal signals. In a mock interview situation, for instance, it has been shown that when an interviewer's negative expectation about another person was reflected in his or her nonverbal behavior (i.e., keeping more physical distance), the interviewee actually performed more poorly (more details on this topic is dealt elsewhere within the encyclopedia).

Serial Position Effects

Accumulating evidence also suggests that the order in which individuals learn information about others can fundamentally shape the impression formation process. In his original study Asch, for instance, asked his participants to read a list of adjectives about another person and found that the same words could yield very different overall judgments, depending on their order of presentation. When adjectives with more positive meaning were presented first, followed by attributes with less positive meaning, the participants tended to rate the person more positively than when the order of words was reversed. Subsequent research found further evidence that information acquired while beginning to form an impression is particularly potent in influencing one's overall judgment – a phenomenon referred to as the primacy effect. Additional work has also revealed that the last information acquired can have a particularly strong impact on one's overall impression – an observation termed the recency effect.

The Similar-to-Me Bias

This bias describes the human tendency to judge people whom we consider similar to ourselves more positively than those we

consider less similar. For example, strangers who resemble one's own appearance often receive elevated ratings of trustworthiness. Furthermore, employees tend to trust their superordinates more and act more honestly around them, if they consider them to be similar rather than dissimilar to themselves. At this point, it remains uncertain which dimensions are of particular importance when determining someone's similarity (e.g., whether it refers to shared attitudes, habits, or demographics). Initial evidence suggests, however, that even similarity on a completely irrelevant dimension, such as being born on the same date, can elicit enhanced positive evaluations.

Perceiver-Driven Biases

Researchers constantly add to the list of factors that can modulate and even bias aspects of the impression formation process. In this respect, evidence is accumulating that shows that the eye of the beholder fundamentally shapes the way information used to infer the personality of others is encoded. For example, emotion recognition has been found to be influenced by the sex and age of perceivers. Men appear to be less accurate at recognizing emotions than women and as adults get older, they display decrements in their ability to identify emotions from visual cues. Intriguingly, a perceiver's own emotional state also influences recognition performance such that congruent emotions are identified most readily in others. Moreover, judging the attractiveness of others has been found to be dependent on the characteristics and status of the perceiver. For example, a person's preference for specific personality traits can elevate the attractiveness of faces that appear to display the desirable characteristics in question. In addition, hormonal changes in men and women can modulate ratings of the attractiveness of potential partners. Also, the link between person perception and stereotype-based impression formation has been found to be moderated by preexisting prejudiced beliefs. Compared to prejudiced persons, egalitarian individuals seem to rely less on stereotypes when forming impressions of others. Taken together, this body of work confirms that the manner in which people construe others is shaped not only by the available information about them, but also by a host of perceiver-related characteristics that moderate the course and products of the impression formation process.

Automatic and Controlled Aspects of Impression Formation

What is perhaps most striking about the impression formation process is that judgments about others are often made without perceivers' intention or conscious awareness. For example, recent work suggests that personality traits such as trustworthiness are gleaned from faces regardless of the goals or intentions of the perceiver. Similarly, it has been shown that even under conditions in which no explicit evaluation of an individual is required, heightened attractiveness elicits feelings of positivity. In addition, research has demonstrated that impression-related consequences of physical resemblance can take place outside of awareness. In this respect, when exposed to photographs of a few short-faced professors who were known to be fair

and a few long-faced professors who were considered to be unfair, college students were found to subsequently judge an unknown short-faced professor to be more reasonable than an unknown colleague, even though they were unaware of the relationship between facial length and fairness. Observations such as these suggest that impressions can be elicited rapidly and unintentionally.

Despite the fact that many aspects of the impression formation process are shaped by relatively automatic and unintentional perceptual, evaluative, and interpretative processes, researchers have begun to show that the extent or impact of typical biases on the impression formation process can be limited as well. For instance, according to numerous studies, impressions about others are likely to become more accurate once perceivers invest time in getting to know them rather than relying on their immediate responses. Furthermore, judgments tend to be less flawed when humans predict specific behaviors (e.g., Mark does not like greeting people) rather than global personality traits (e.g., Mark is unfriendly). Additionally, the motivation to be open-minded and accurate can dramatically change the way impressions of others are formed. In this respect, being aware of one's own expectations as well as stereotypes and actively searching for disconfirming rather than confirming information is likely to result in a more accurate judgment of others. Nevertheless, further investigations are necessary to elucidate which aspects of the impression formation process can be reliably influenced by deliberate mentalizing.

Neural Correlates of Impression Formation

Social psychologists have recently begun to complement classic impression formation research by using data from neuroimaging, event-related brain potentials, and lesion studies. Through the adoption of neuroscientific methods, the researchers are trying to further elucidate how faculties and processes in the human brain differ depending on whether humans form impressions about conspecifics rather than inanimate objects or nonhuman creatures. Converging evidence indicates that when looking at others, a dynamic representation of an individual's facial and bodily appearance can be achieved through the combined effort of five localizable cortical regions. Two face-specific areas, the occipital face area (OFA) in the posterior inferior temporal sulcus as well as the fusiform face area (FFA) in the posterior fusiform gyrus, show increased activity when humans look at faces of their conspecifics compared to other common objects and nonsense stimuli. Similarly, two body-specific areas, the extrastriate body area (EBA) in close proximity but slightly superior to the OFA and the fusiform body area (FBA) situated adjacent to and overlapping with the FFA, display selectively enhanced activity to human bodies. While these four brain regions encode static facial and bodily features and their structural configuration (i.e., person snapshots), an additional brain region – the posterior superior temporal sulcus (pSTS) – integrates dynamic person-related information. Robust pSTS activity occurs when people watch facial as well as whole-body or body-part motion relative to motion of nonhuman stimuli. Together, these data indicate that human faces and bodies are reliably discriminated from other object categories early in the visual processing cascade (more details on this topic is dealt elsewhere within the encyclopedia).

Most importantly in the context of impression formation, however, further work indicates that the generation of inferences based on these person percepts depends on the recruitment of additional brain regions in concert with the core person perception regions. One of the neural substrates found to be most diversely involved in such person inferences is the amygdala. Although still poorly understood with regard to its functional contribution, the amygdala has been found to be activated by processes of social categorization, trustworthiness perception, emotion recognition, and the identification of familiar others. For instance, neuroimaging studies have revealed that, compared to neutral faces, emotional faces elicit not only an increased response in core regions of the face processing system, but also a concomitant increase in activity in the amygdala. Furthermore, faces that are considered to be particularly untrustworthy seem to elicit an elevated amygdala response, and patients with damage to this structure have a tendency to consider trustworthy faces (as rated by healthy individuals) to look quite untrustworthy. Amygdala activity has also been found to track with a target's racial status (i.e., it exhibits increased responses to faces that do not match the perceiver's own race) when participants are asked to judge a person's sex or age. Finally, a weaker amygdala response has been noted to accompany the perception of familiar rather than unfamiliar faces – a difference in activation that has been argued to reflect lower levels of vigilance toward familiar others than strangers.

In contrast to the amygdala, the orbitofrontal cortex (OFC) seems to have a highly specific role during person-based inferences. As a brain region dedicated toward tracking attractiveness, it potentially contributes toward the widely spread beauty-is-good-bias. Interestingly, while attractive male faces elicit stronger OFC activation in heterosexual women and homosexual men than attractive female faces, in heterosexual men and homosexual women, attractive female faces evoke stronger OFC activation than attractive male faces. These findings suggest that the OFC responds not only to the attractiveness of a person per se, but also to the attractiveness of others who are sexually relevant for a particular perceiver.

In addition to the amygdala and the OFC, perceiving the others in action (i.e., during the exhibition of intentional motor behavior) and trying to understand the intentions behind these actions has been tightly linked to activation in the premotor and parietal cortices. Studies that have elicited the temporal deactivation of this frontoparietal network have shown that such a disturbance significantly impairs people's ability to discriminate and understand what others are doing. Thus, the functional significance of the frontoparietal network seems to lie in making sense of the behavior of others. It has been argued that one strategy that people can adopt to interpret the actions of others involves the use of their own 'motor knowledge' as a guiding framework. That is, incoming bodily-related visual information from others is mapped onto one's own motor system (i.e., motor simulation). As it turns out, the premotor and parietal cortex are involved in both the perception and execution of action. There is also evidence that activity in the critical frontoparietal network is elevated when perceivers observe actions that can be easily mapped onto their own motor representations. Specifically, individuals show stronger activity in premotor and parietal cortices during the perception of actions they regularly perform themselves compared to actions they rarely enact.

In this respect, evidence that action perception can be subserved by motor simulation has begun to accumulate.

Finally, one of the most important regions in the extended person processing system is the anterior temporal lobe (aTL). Neuroimaging investigations have repeatedly demonstrated that the perception of familiar others, either because they are personal acquaintances or famous celebrities, is associated with elevated activity in the aTL. Most tellingly, following damage to this structure the ability to identify familiar faces deteriorates dramatically. Although this converging evidence suggests that the aTL plays a pivotal role in the detection of identity, it remains uncertain how it does so exactly. It has been speculated that the crucial contribution of the aTL toward person perception is based on its representations of specific semantic and biographical knowledge about others that is accessed once a familiar person is encountered.

Interestingly, even though first insights have been gained in how the human brain accomplishes a few specific person inferences such as encoding the attractiveness, personality, emotional status, group membership, or familiarity of other social agents, how these subimpressions are combined into an overall judgment remains uncertain at this point. Initial evidence suggests, however, that various types of person-based inferences result in enhanced activity in the dorsomedial prefrontal cortex (DMPFC). In particular, increased DMPFC activation is observed when people are explicitly asked to form impressions about others, and also when they are required to judge whether specific attributes (e.g., *assertive* vs. *seedless*) can be descriptive of them, or when they need to infer the mental states or intentions of other social agents. Such findings indicate that the DMPFC may act as a binding site that enables us to integrate various sources of person knowledge into a holistic judgment.

Summary

Based on the pioneering work of Asch, a field of study dedicated toward elucidating how people form impressions of each other has begun to flourish over the last few decades. The outcome of many studies to date indicates that the impression formation process commences as soon as we lay eyes on others. By encoding facial and bodily person cues, perceivers are inclined to spontaneously judge a target's race, age, sex, emotional status, social attention, and personality. In addition, person-specific characteristics are inferred from people's behaviors using consensus, consistency, and distinctiveness information. But it is not target attributes alone that modulate the impression formation process. Characteristics of the perceiver also shape the course and outcome of person judgments. In this respect, forming impressions of others is an inherently subjective process that is likely to be biased by numerous factors. Given that these biases can result in serious discrimination, uncovering and understanding biasing influences enables people to limit their impact and thus avoid unwarranted person judgments.

See also: Attribution; Facial Expression of Emotion; Prejudice, Discrimination, and Stereotypes (Racial Bias); Self-Fulfilling Prophecy.

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Individual Differences in Temperament: Definition, Measurement, and Outcomes

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Glossary

Behavioral inhibition A distinct temperamental category, originally identified by Kagan, involving excessive fear and wariness in response to social and nonsocial forms of novelty.

Brain electrical activity Fluctuating patterns of voltage generated by the biophysical mechanics of thousands of synchronously activated neurons. Measured as continuous electroencephalogram (EEG) activity or discrete event-related potentials (ERPs; phasic brain responses to presentation of stimuli).

Endophenotype An intermediate phenotype; an inherited characteristic (e.g., insulin resistance) that is normally associated with some condition but is not a direct symptom of that condition (e.g., diabetes).

Gene–environment interaction The developmental effect of a particular genetic variant that differs depending on environmental conditions, or of a particular environmental effect that differs depending on genetic factors.

Genotype The complete genetic make-up of an organism that determines or regulates a specific characteristic or trait.

Neurotransmitter A chemical substance (e.g., norepinephrine, dopamine) that is released

across the gap between neurons, thereby mediating communication between neurons.

Phenotype The manifestation/expression of a specific trait (behavioral, anatomical, or physiological characteristic of an organism), resulting from a genotype, environmental influences, gene–environment interactions, and stochastic influences.

Polymorphism A naturally occurring genetic variation that gives rise to distinct forms or phenotypes within the same population (e.g., human blood types) and appears in >1% of the population.

Probabilistic epigenesis A principle in developmental psychobiology holding that genes are not autonomous agents of development but rather, there are bidirectional influences among multiple levels of analysis: genetic, neural, behavioral, and environmental. In contrast, predetermined epigenesis postulates unidirectional information flow from genes to structure to function.

Temperament A persisting pattern of behavioral and emotional traits that appear early in life and have strong links to physiological and biological processes.

Introduction

Understanding the basis for individual differences in temperament has been a focus of human inquiry from ancient to modern times. This interest stems from the curious observation that individuals have unique ways of responding to any given experience, and maintain a certain consistency in their responses across situations and time. Most contemporary investigators agree that temperament refers to inherited variation in the expression of emotion and patterns of behavior that is consistent over time (see Table 1). Individual differences in these domains provide the platform on which personality begins to develop and crystallize. The purpose of this article is to address five questions: (1) What is temperament? (2) How is temperament measured? (3) What determines temperament? (4) How does temperament predict developmental outcomes? (5) What does the future hold for the field of temperament research?

What Is Temperament? Psychological and Physiological Perspectives

The oldest Western classification of temperament we know was outlined in Greek civilization more than 2000 years ago. The early philosopher–physicians Hippocrates and Galen described

temperament in the context of the dominant biomedical model of their time that was based on four fundamental bodily fluids. Temperament was believed to reflect the relative balance among the fluids, resulting in sanguine, choleric, phlegmatic, or melancholic types of people. These types were consulted up until the nineteenth century, and endured in recognizable form into the twentieth. After a long and rich history, the physiological basis of temperament remains part of its working definition to the present day.

Modern temperament researchers vary in their predilection for theory driven approaches to the study of temperament or data-driven views. For example, Rothbart has focused on psychological sources of data to understand individual differences in reactivity and self-regulation, and the moderating influence of experience on temperament. Complex, person-centered concepts such as social behavior, effortful control, and conscience have been derived largely from the application of sophisticated, statistical tools (e.g., factor analysis) to subjective ratings gathered from parental, teacher, peer, and self-report questionnaires.

By contrast, physiological concepts such as arousal level and neurotransmitter availability operate at the level of biological processes assumed to be causal in the maintenance of observed temperamental variations. This distinction does not imply that those temperament researchers who rely primarily on psychological concepts wish to deny that temperament has

Table 1 Criteria for core temperament characteristics as viewed by contemporary investigators

Individual differences in domains related to emotional reactivity and behavioral responding are as follows:
Apparent in the first few years of life
Rooted in and proximal to a biological level of analysis (i.e., genetics, neurophysiology, and neuroanatomy)
Relatively stable and enduring across life
Apparent across different cultures
Observed in other nonhuman animals, such as primates and some social mammals

a strong biological foundation. Indeed, there is near universal acceptance among contemporary researchers that temperament incorporates processes that are much more proximal to a biological level of analysis than are other important features of human psychology (e.g., intelligence, personal motivations). However, these two approaches to the study of temperament begin from different starting positions and each leads to a conceptualization of temperament that differs from the other in important respects. A current challenge is to reconcile these approaches in a way that demonstrates a nuanced and sophisticated appreciation of their complex and complementary contributions.

Psychological Approaches

Over seven decades ago, Allport described temperament as the “characteristic phenomena of an individual’s emotional nature . . . susceptibility to emotional stimulation . . . strength and speed of response, the quality of his prevailing mood and . . . fluctuation and intensity in mood.” Then there followed a two-decade-long gap during which learning models prevailed in developmental psychology and much of mainstream psychology. Individual characteristics such as temperament were largely ignored until Thomas and Chess initiated the New York Longitudinal Study (NYLS) in 1956. From factor analysis of parental reports of infant behavior, nine dimensions of temperament were derived. These included activity level, attention span/persistence, distractibility, bodily rhythmicity, adaptability, intensity of reaction, approach/withdrawal tendencies, sensory threshold, and mood. Scores for each dimension were computed from responses to individual items in questionnaires. Further analysis of these responses grouped infant temperament into three types labeled ‘easy,’ ‘difficult,’ or ‘slow to warm up.’ The difficult temperament was at the greatest risk for subsequent psychological problems and therefore, the object of much study. However, because what is termed ‘difficult’ may vary depending on parental values and child-rearing practices, Thomas and Chess emphasized the interaction between infant temperament and its environment, that is, the ‘goodness of fit’ between the infant’s characteristics and the reactions of its caregivers. Optimal development was likely when parenting needs and the child’s temperament matched.

Subsequently, Bates questioned whether the ‘difficult’ construct reflected qualities pertaining only to the child. As assessment of temperament was derived from parental reports, he argued that the description of a child as ‘difficult’ was partly based on the parents’ perceptions. Nonetheless, parental

attributions might be very important to the child’s development and social functioning in the long run through their influence on parent–infant interactions. In this respect, Bates located risk and resilience in the context of the family, an idea that shared considerable conceptual ground with goodness of fit.

Contemporaneous researchers Buss and Plomin viewed temperament as a constellation of four independent attributes – emotionality, activity level, sociability, and impulsivity (EASI). To be considered an aspect of temperament, a trait must occur in infancy, be reflected in nonhuman primates, and demonstrate continuity across time. Traits that were observable in the first year or two of postnatal life were assumed to have a genetic basis. Genetic influences were believed to determine emotionality (particularly with respect to negative emotions such as fear and anger), activity level, and sociability, i.e., the infant’s responsiveness to others and interest in shared activities. Impulsivity was later removed because it did not appear as a reliable individual difference until school age and only some of its components were replicable in factor analyses.

Representing another school of thought, Rothbart and colleagues conceptualized temperament as individual variation in two broad characteristics: a child’s constitutionally based tendency to (a) emotional reactivity, and (b) self-regulation. In this formulation, temperament was assessed in terms of reactive behaviors (fear, amount of smiling and laughter, and activity level), and regulatory behaviors (frustration with limitations, soothability, and duration of orienting). Reactive behaviors such as fearful inhibition and unrestrained approach were thought to generate increased arousal in somatic, affective, autonomic, and endocrine systems. Over the course of development, however, these behaviors were increasingly modulated through effortful control. High levels of effortful control related positively to social competence, elicited the approval of others, and simultaneously served to reduce children’s risk for externalizing and some internalizing disorders. The development of effortful control depended crucially on the efficiency of neurobiological networks in frontal regions of the brain supporting attention, inhibition, approach/withdrawal, and self-soothing, processes that together lead to optimal alertness, arousal, and interpretation of information.

A psychological view of temperament representing all of these theoretical positions has been summarized by McCall as ‘the relatively consistent, basic dispositions inherent in the person that underlie and modulate the expression of activity, reactivity, emotionality, and sociability. Major elements of temperament are present in very young children, and those elements are likely to be strongly influenced by biological factors. As development proceeds, the expression of temperament increasingly becomes more influenced by experience and context.’

Physiological Approaches

The modern era of temperament research and its physiological basis began with Pavlov. Pavlov’s early contribution to temperament resulted from his discovery of individual differences in the classical conditioning of dogs, namely, the marked variation in the speed and strength with which dogs associated neutral stimuli with food rewards. To explain these differences,

Pavlov theorized that individual variation in nervous system functioning was important to understanding the degree of adaptation to various classes of stimuli.

Pavlovian concepts exerted a considerable influence on subsequent generations of Soviet and eastern European scientists studying temperament. Beginning in the late 1950s and continuing into the 1980s, Soviet scientists explored the biological bases of temperament with respect to neuronal excitatory–inhibitory dynamics. These investigators studied ‘involuntary reactions’ of the nervous system (e.g., differential susceptibility to fatigue or conditioning), which were believed to be relatively uncontaminated by higher order sociocognitive influences. The emphasis on a physiological approach was rooted in both the intellectual tradition of Pavlov and political currents in the Soviet state. In Soviet intellectual culture, ‘mentalistic’ (i.e., psychological) constructs in the description of human behavior were explicitly eschewed and biological concepts strongly favored. Investigators such as Teplov, Nebylitsyn, and Strelau made important contributions to this approach by applying Pavlovian ideas of nervous system function to humans.

Certain concepts investigated by this group were revisited and elaborated by Eysenck and Gray. Balance between neural excitation and inhibition is central to Eysenck’s hypotheses that extraversion reflects the degree of biological arousal in the brainstem reticulocortical activating loop, and that neuroticism is related to the threshold for excitability in the limbic lobes of the brain. These ideas are alive and well today. Similarly, Gray’s approach–withdrawal theory extended basic notions of neural energetic interactions to systems that mediate behavioral activation (BAS) or behavioral inhibition (BIS). Several decades later, Cloninger and Zuckerman updated the ‘biochemical bases of individuality’ proposed by Nebylitsyn, relating the activity of diffuse neurotransmitter systems to individual differences in novelty seeking (dopamine) and harm avoidance (serotonin).

It is important to note that the works of investigators like Eysenck, and Gray address issues of adult personality. While a distinction between temperament and personality is warranted (with the latter consisting of various social influences in addition to constitutional bases), the line between these concepts is admittedly fuzzy. Eysenck, in fact, did not differentiate between temperament and personality. Indeed, the list of criteria outlined by Eysenck for basic personality traits – appearance early in life, strong biogenetic basis, similarity with traits observed in nonhuman animals, and stability – is remarkably similar to the criteria outlined by Buss and Plomin for temperamental traits.

An additional principle in developmental psychology concerns the timing of any developmental process. Kagan addressed this by adopting longitudinal research strategies in studies of behavioral inhibition. Behavioral inhibition/fearfulness is probably the most well established temperament in both humans and nonhuman animals. In their seminal book *Birth to Maturity*, Kagan and Moss identified a group of 3-year-olds who exhibited fearful and withdrawn behaviors in response to novelty, many of whom became timid and cautious young adults. Kagan’s insight was to connect these behavioral observations with an emerging neuroscience literature. The amygdala was identified as a key brain structure in the manifestation of fear. In rats, the capacity to associate innocuous stimuli

(auditory tones) with threat-related information (electric shock) was shown to depend on the function of amygdalar circuits. Hypothesizing that a behaviorally inhibited temperament in humans reflected a lowered threshold for amygdala responsivity, Kagan tracked autonomic, hormonal, and brain patterns in a group of infants who exhibited highly negative reactions to novelty. By following longitudinal cohorts, Kagan and others showed that patterns of physiological activity remained relatively stable across development and, moreover, predicted later behavioral adjustment problems, especially at the extremes of behavioral inhibition.

Kagan’s combined psychological and physiological approach helped to focus attention on constitutional factors residing within the child, using objective indices of behavior and biology obtained in controlled laboratory settings. This approach shifted the field from accounts of temperament that were mainly descriptive toward an appreciation of their causal underpinnings.

How Is Temperament Measured? Subjective, Behavioral, and Physiological Measures

The types of data most often used to assess temperament come from subjective reports (e.g., parental ratings in questionnaires), behavioral observations, and physiological measures. Each of these approaches possesses particular strengths and limitations.

Subjective Report

Of the three approaches to assessing temperament, parental report has been the most commonly used. Ease of administration is certainly a factor in the proliferation of studies using temperament questionnaires, but the real advantage of this method lies in the richness of its data source. Parents and caregivers are in a unique position to assess how their child behaves in a wide variety of circumstances, and across multiple occasions. Temperament questionnaires average parental responses about the frequency or quality of their children’s behavior in common situations during a recent, specified period of time. The situations vary with the target age of the child being assessed. For example, the Infant Behavior Questionnaire (IBQ) asks a parent to rate how often in the last week their 3–12-month-old cooed and vocalized for 5 min or longer. The Toddler Behavior Assessment Questionnaire (TBAQ) on the other hand, asks how often their 12–24-month-old ran through the home or climbed over the furniture during the last month.

Statistical analysis of the responses reveals relations among some traits and not others, grouping them into a small number of independent, superordinate dimensions (factors). The number of factors must be relatively small because large numbers of factors are unlikely to be conceptually independent. Only two of the nine dimensions originally identified by the NYLS – attention span/persistence and soothability – were validated in an early factor analysis.

Most temperament questionnaires have undergone revisions since their original introduction and new editions appropriate for older ages have been added that are consistent with

the theoretical viewpoint of the investigators. The Colorado Child Temperament Questionnaire has combined NYLS dimensions with the EASI dimensions of Buss and Plomin. Rothbart's original IBQ assessed children on six dimensions, but its revision (IBQ-R) added to these vocal reactivity, sadness, perceptual sensitivity, pleasure, cuddliness, soothability, and rate of recovery from distress. The revised TBAQ now measures inhibitory control, attention, object fear, sadness, soothability, and sensory defensiveness, in addition to social fearfulness, the tendency to express pleasure, anger proneness, and interest/persistence. From the scale names, it is clear that there are commonalities in the constructs assessed, despite the plethora of available instruments. A selection from the most widely used questionnaire assessments is presented in [Table 2](#).

One major difficulty with the use of subjective reports is that parents are vulnerable to certain biases concerning their children, such as contrast effects. Behavioral characteristics of a child may be amplified or diminished in the parent's mind as compared to another child in the family. Other problems affecting informant accuracy include memory biases, inadequate attention to instructions, social desirability considerations, and any parental interpretations of a child's behavior that may be unwarranted. For these reasons, agreement between parental ratings and ratings based on laboratory observations is typically low. The question of whether questionnaire responses reflect the child's behavior or characteristics of the parent also remains an important issue to be addressed by temperament researchers. This situation can be improved by aggregating responses from multiple raters (e.g., from teachers or other caregivers as well as parents), on grounds that individual biases tend to cancel each other out. In addition, validation studies between parent reports and home

observations have found substantial enough agreement to assure correspondence between questionnaire results and objective measures of a child's behaviors.

A second difficulty in subjective reports concerns item characteristics. Questionnaires tend to avoid asking invasive questions and necessarily select vocabulary that can be understood by a majority of respondents. The reasons for these limitations are obvious, but they have the unintended effect of restricting what can be measured by the questionnaires. This issue is important because investigators' conclusions are typically based on factor analyses of item responses. A critical constraint of this statistical approach is that the variance explained by any factor depends on the number of items in the questionnaire reflecting it. Excluding some issues from the initial input will necessarily influence the number and type of factors generated.

Finally, there is unease over the fact that temperament questionnaires have not been normed on diverse ethnic and cultural groups. This concern is reasonable, as particular temperament traits may be more highly valued in one culture than in another. For example, a shy and timid demeanor is often discouraged in Western societies but receives approval in Eastern ones. There is evidence that this concern is now being addressed. As a case in point, the Rothbart questionnaires (e.g., IBQ-R and Early Childhood Behavior Questionnaire) have been translated into multiple European and Asian languages, and validation is ongoing.

Taken together, the evidence for and against the use of questionnaires in measuring temperament suggests that they are convenient and helpful, provided that their limitations are taken into consideration. The problem of conceptual interdependence among factors can only be addressed by continuing research and the appropriate refinement of questionnaires. However, problems associated with reporter bias and item characteristics may be reduced if subjective reports are used in conjunction with temperament measures from the other two approaches, described next.

Table 2 Selected index of questionnaires used to measure temperament

Bates:
ICQ: Infant Characteristics Questionnaire
Buss and Plomin:
EASI: Emotionality, Activity, Sociability, Impulsivity Temperament Survey
EAS: Emotionality, Activity, Sociability Temperament Survey
CCTI: Colorado Childhood Temperament Inventory
Carey and McDevitt:
EITQ: Early Infancy Temperament Questionnaire
ITQ: Infant Temperament Questionnaire
RITQ: Revised Infant Temperament Questionnaire
TTS: Toddler Temperament Scale; 1–3 years
BSQ: Behavioral Style Questionnaire; 3–7 years
MCTQ: Middle Childhood Temperament Questionnaire; 8–12 years
Rothbart et al.:
IBQ: Infant Behavior Questionnaire
IBQ-R: Infant Behavior Questionnaire, Revised
TBAQ: Toddler Behavior Assessment Questionnaire
ECBQ: Early Childhood Behavior Questionnaire
CBQ: Children's Behavior Questionnaire
TMCQ: Temperament in Middle Childhood Questionnaire
EATQ: Early Adolescence Temperament Questionnaire
EATQ-R: Early Adolescence Temperament Questionnaire, Revised
ATQ: Adult Temperament Questionnaire
Thomas and Chess:
PTQ: Parent Temperament Questionnaire
TTQ: Teacher Temperament Questionnaire

Behavioral Observation

Laboratory assessments allow for precise control of the experimental parameters that elicit participant responses. Assessment of a child in a laboratory situation provides a unique source of objective information that cannot be obtained by other means. The researchers who administer them typically have no relationship with the child, thereby providing data that are unbiased by parental aspirations or the child's relationship with the parent. Observations are often quantified in terms of rate or frequency of response, duration of response, and intensity of response. Because laboratory assessments are expensive and time-consuming, however, they are usually limited to one or two occasions. Thus, they can provide only a brief sample of a child's behavior in an unusually controlled environment. In addition, response parameters need to reflect the development of more complex and organized behaviors that appear in the repertoire of older children.

Better correlations may be obtained with researcher observation of the child in a naturalistic setting that is familiar, such as the home. A familiar environment has the advantage of ensuring high ecological validity, while maintaining observer objectivity. Limitations remain though, as the setting and

sequence of events are not standardized, and there may be confounds between the features of child behavior and features of the home. Aggregating home observations across multiple sessions will improve the concordance between laboratory observations and parental report.

Physiological Measures

As the observational approach supplements the use of questionnaires, the measurement of physiological processes involved in temperament is meant to work in conjunction with behavioral assessment. Physiological measures provide additional evidence about the state of the child that allows inferences about the biological bases of overt behavior. Relatively noninvasive measures have been used with pediatric populations to assess central, autonomic, and neuroendocrine functioning.

Measures of central brain activity

Electroencephalographic (EEG) activity is a relatively noninvasive measure of central nervous system physiology that can be related to individual differences in temperament. By recording at the scalp, researchers can measure patterns of neuroelectric voltage generated by thousands of synchronously firing brain cells. The electrical oscillations they produce may be measured as tonic levels of firing in resting conditions or phasic changes in firing during information processing. The magnitude of spectral power (computed as the amount of electrical energy in specific frequency bandwidths of the signal) reflects underlying brain activation in a given condition.

Davidson and Fox developed a theoretical model of brain function that reflects individual differences in approach and withdrawal. This model, based on evidence from numerous sources, suggests that frontal brain regions are specialized for distinct types of emotional responding. The left frontal cortex is specialized for appetitive, approach responses and the right frontal cortex is specialized for withdrawal-related emotional responses. Greater relative activity of left frontal regions is correlated with an exuberant emotional style, whereas greater relative activity of right frontal regions reflects an inhibited emotional style.

Infants who exhibit stable patterns of greater resting right frontal brain activity across the first 2 years of postnatal life are more behaviorally inhibited than infants who show stable patterns of greater left frontal brain activity. Furthermore, asymmetrical brain activity predicts continuity of behavioral inhibition up to 4 years of age. Similarly, infants who were highly reactive to novelty and inhibited as toddlers exhibit more resting right frontal activity into late childhood. Shy and withdrawn individuals exhibit resting right frontal EEG asymmetry even in young adulthood. Temperamentally shy children also exhibit greater increases in right versus left frontal brain activity during affective challenges.

In order to effectively track real time brain processing, investigators cannot rely solely on classical EEG measures, but must employ event-related techniques instead. Event-related potentials (ERPs) are short epochs of EEG activity that are time-locked to discrete stimuli or responses. The use of ERPs in temperament studies is relatively recent. With this approach, researchers have found that individual differences in the way the brain processes information also reflect

temperamental variation. For example, infants selected for inhibited temperament at 4 months of age exhibit enhanced evoked brainstem responses to auditory stimuli at 10–12 years of age. Interestingly, the brainstem regions that are highly reactive in these children receive reentrant nerve projections from the amygdala, consistent with Kagan's hypothesis of amygdala sensitivity in temperamentally inhibited children. Further evidence of atypical sensory processing in socially withdrawn children comes from examining differences in the brain's responses to sensory change. Most recently, ERP researchers have shown that electrocortical measures reveal differences in preferences for novelty that in turn reflect temperamental approach or withdrawal tendencies. Infants who tended to react positively to stimulation showed greater ERP responses to complex forms of novelty, whereas infants who react negatively to stimulation oriented to milder forms of novelty, and showed little electrocortical response to more complex forms of novelty.

Measures of brain electrical activity are not without limitations, some of which relate to the difficulties involved in recording sensitive electrical signals from children, and the fact that children's ERP components may not be fully mature. Investigators also need to be aware of the inferential context within which EEG and ERP measures are used to derive conclusions about psychological significance. Many brain and behavior relations remain tenuous, especially in developmental populations. For this reason, investigators should be cautious about drawing inferences from brain measures that are not supported by behavioral observations or, if possible, self-report data. However, if these caveats are addressed, electrophysiological measures can provide invaluable information about brain processing and will continue to provide original insights in temperament research.

Autonomic measures

Variation in autonomic reactivity is of interest to developmental researchers because of associations between heart rate control and the behavioral style associated with inhibited temperaments. To assess cardiac autonomic regulatory capacity, continuous cardiac electrical signals are collected over a period of minutes while the child is relaxed or attending to a mild stimulus. Heart rate and measures of heart rate variability such as respiratory sinus arrhythmia (RSA) are usually calculated offline. RSA is the naturally occurring variability in the length of time between heart beats that is coordinated with the respiratory cycle. It is often used as an index of parasympathetic control. During rest, cardiac output is dominated by activity in the parasympathetic division of the autonomic system through the vagus nerve. Typically, when environmental demands increase, parasympathetic outflow is withdrawn, reducing RSA and allowing heart rate to increase. The ability to successfully disengage and reengage the 'vagal brake' at an early age in response to changing environmental contingencies is associated with greater capacity for emotional regulation. Measurement of autonomic reactivity also includes assessment of sympathetically mediated measures such as skin conductance reactivity, prejection period, and pupil-size, in addition to blood pressure and baroreflex sensitivity.

For infants, high levels of resting RSA and greater RSA reactivity have been linked to positive developmental outcomes, good preschool adjustment, fewer behavior problems

in toddlerhood, and social engagement. Infants with high resting RSA and those who competently reduce RSA during common physical or mental challenges also soothe more easily and are able to maintain attention longer. Kagan and colleagues have shown that behaviorally inhibited children have faster and less variable heart rates than do uninhibited children, suggesting that autonomic control may be less flexible in these children, with possible consequences for emotional and social development. The mechanism underlying positive associations between RSA and developmental outcomes may lie in the contribution RSA makes to cardiorespiratory efficiency. Alternatively, RSA may reflect the functional capacity of a set of brain structures, including prefrontal cortex, that support physiological and emotional regulation.

While positive or negative psychological or developmental states may be associated with a given level of RSA, RSA cannot be construed as a biological 'marker' for these states without additional information. Strong inferences about psychological states such as behavioral inhibition cannot be made from RSA alone. Converging evidence from additional sources is needed to create a stable physiological profile that may be related to a given psychological state. It is also important to note that RSA represents only a portion of heart rate variability; that is, it represents the variability mediated by activity of the parasympathetic system. Other sources of variability include postural changes, physical activity, respiration and activity of the sympathetic system. Measurement of RSA must be made in light of these restrictions, with participants maintaining the same posture across conditions and minimizing movement during recording.

Neuroendocrine measures

Variation in cortisol production is of interest to developmental researchers because high levels of cortisol have traditionally been associated with temperamentally inhibited behavior styles. Produced by the hypothalamic-pituitary-adrenocortical (HPA) system, cortisol is considered a 'stress hormone.' Released in response to environmental challenges, cortisol mobilizes the body for behavioral response by temporarily boosting energy metabolism and suppressing immune activity. As such, cortisol production may be seen as a regulatory response that helps with the management of severely challenging situations, rather than as a panic reaction to stress. Indeed, in some circumstances, cortisol protects the nervous system and facilitates cognitive processing. Cortisol is generally assayed from samples of saliva, plasma, or urine and measured as the difference between some basal level and the level obtained in conjunction with a stressor condition. Basal levels of cortisol are highest in the morning and lowest some hours after sleep onset.

Behaviorally inhibited children are known to have higher baseline levels of cortisol activity as well as higher resting heart rates than uninhibited children. However, in recent research, Schmidt and colleagues found that baseline salivary cortisol levels varied significantly among inhibited children, indicating that a shy temperament is a necessary but not sufficient condition for elevated cortisol production. Over time, environmental factors also influence cortisol levels. Under conditions of chronic stress, the HPA system may downregulate its activity. Early chronic stress may lead to hypocortisolism, in which morning cortisol production is markedly suppressed and cortisol reactivity is dampened as a result.

Researchers have noted that it is often difficult to activate the HPA system within the context of controlled laboratory settings. Subtle psychological stimuli in the laboratory are often not potent enough to elicit significant cortisol production. Additional concerns involve apparent inconsistencies in the relations between temperament and cortisol levels or HPA reactivity. For example, shyness in children may be correlated with higher basal levels of cortisol, yet HPA reactivity to anxiety-provoking events in the laboratory may be no greater in shy children than in nonshy children.

What Determines Temperament? Behavioral and Molecular Genetic Investigations

The concept of temperament presumes a level of continuity in behavioral style across the lifespan. Although behavioral repertoires change with development, the underlying motivation or mechanism for the expression of particular behaviors remains largely consistent. An 'inhibited' infant who displays fear when confronted with a novel stimulus is likely to be shy in childhood, and may suffer from heightened levels of anxiety in adulthood. In genetic studies, such a behavioral phenomenon is referred to as a behavioral phenotype. Most recently, in the attempt to understand how behavioral phenotypes arise, temperament researchers now investigate genotypes and their interactions with the environment in studies of behavioral and molecular genetics.

Behavioral Genetic Studies

The contribution of genetic versus environmental factors to behavioral phenotypes has been investigated in twin and family studies. Studies of twins strongly suggest that both behavioral inhibition and biological regulation of development are heritable. Indeed, the direct contribution of environment to the development of temperamental traits appears to be relatively small. However, these conclusions rest on the assumption that it is possible to isolate the contributions of biology and experience to complex traits. Recent advances, reviewed next, suggest that this separation is no longer tenable.

Molecular Genetic Studies

Studies in molecular genetics have begun to link neural and psychological outcomes to genes that code for variation in brain chemistry. A decade ago, researchers found an association between increased neuroticism, anxiety, and inhibition in adults and a short polymorphism of the transporter gene (5-HTT) for one of the brain's neurotransmitters, serotonin. Around the same time, orienting in infants, attention in typically developing children and those with clinical disorders (ADHD), and novelty-seeking in adults were associated with long variants of the gene that controls the expression of dopamine receptors (DRD4), and therefore the efficiency of dopamine processing in the brain. However, very small effect sizes and frequent failures to replicate these links have raised questions about whether there are direct linear relations between single genes and behavioral expressions of temperament.

Despite such setbacks, molecular genetic studies have highlighted very important concepts. A major theme to emerge is that genes and environmental factors are inextricably linked in producing complex behaviors. Relations between genes and environmental factors take the form of gene by gene and gene by environment interactions. Where one gene may confer risk, this may be offset by resilience conferred by a different gene, or moderated by an environment that includes social support or self-coping mechanisms. A gene may even have a different role depending on the environmental influences to which the person is exposed. Children carrying a particular genetic variant may be at increased risk of negative outcomes if they are raised in maladaptive environments, but at the same time, more likely to experience positive outcomes if they are exposed to positive environments. For example, the long-repeat DRD4 polymorphism that promotes externalizing behaviors in the presence of insensitive parenting has been shown to produce the least externalizing behaviors in the context of sensitive parenting. Three-way interactions among genes and environmental factors have also been demonstrated.

The fact that multiway interactions, rather than specific genes, are better predictors of complex behavioral phenotypes implies that behavior is the product of probabilistic epigenesis, a concept specifying multiple and bidirectional influences in the relations among genes, structure, and function. Indeed, one can safely assume that main effects of single genes are extremely unlikely. This state of affairs has profound implications for predictions of behavior, with the potential to influence medical diagnostics, insurance practices, and stigmatization based on genetic endowment. Whereas constitutionally based difficulty or inhibition can predict (to a degree) developmental outcomes and lifelong consistencies in behavior, predictions from genotype to temperament or behavior are necessarily indirect, and belong to a different level of analysis that involves far greater levels of complexity.

This concept points away from genetic predictions of complex behavioral phenotypes or personal traits, and suggests instead that a given polymorphism may influence the regulation of biological systems that form the substrates for temperamental traits. By predicting its endophenotype, that is, the biological substrate it codes for, a polymorphism may affect the full spectrum of a particular ability rather than a specific disorder at the extreme end of a continuum.

In addition, researchers need to reconsider the meaning of environment in studying developmental processes. Traditionally, environmental factors have been conceptualized as purely exogenous (e.g., maltreatment, family dynamics). However, recent studies have shown that the internal milieu or endoenvironment (including, e.g., frontal electrocortical asymmetry) may also moderate the effects of genes on behavioral outcomes. Long recognized by plant physiologists and embryologists, endoenvironmental considerations have, until recently, been overlooked by developmental psychologists.

How Does Temperament Predict Developmental Outcome? Risk and Resilience

Thomas and Chess initially argued that variability in temperament conferred differential susceptibility to future psychopathology. Children with difficult or inhibited temperaments

were presumed to be at greater risk for developing psychological and behavioral problems, while a child with an easy temperament was considered to possess resilience in coping with life's stressors. However, Thomas and Chess qualified this stance by emphasizing that the fit between a child's temperament and his/her environment was critical to determining the child's developmental trajectory. Constitutional factors do not predict increased risk for psychopathology across the board. Only some children with a difficult temperament go on to develop externalizing disorders or major depression. Therefore, environmental factors would appear to moderate the effects of temperament on development.

Today, the notion of 'goodness of fit' can be expressed in light of new knowledge involving genes, environments, and complex outcomes. The interplay between constitutional factors (temperament) and environmental contingencies is now examined in genetic studies. If some polymorphisms confer risk, the implication is that alternate polymorphisms of the same gene confer protection. Even genetic risk may develop into psychopathology only for children in adverse circumstances, or for those with particular experiential histories, that is, for those who possess a vulnerable genotype and also grow up in a poor-fitting environment. Improving the environment can offset a high-risk constitutional predisposition. Adjusting parental behavior or adding social support, for example, reduces the risk of the 'difficult' child's developing aggressive or antisocial behavior. In addition, recent longitudinal studies by Eisenberg and Kochanska have shown that the development of effortful control – a temperamental dimension that encompasses capacities for focusing and shifting attention, as well as motor control – protects against deficits in a wide range of socioemotional domains. Clearly, prediction of developmental outcomes will require the simultaneous consideration of constitutional and environmental factors for risk and resilience.

What Does the Future Hold? Moving Forward

Temperament is a natural phenomenon that is not determined by factor analyses, but is imperfectly reflected by them. Questionnaires provide a rich and unique source of data, but they are primarily descriptive and should not be relied on as the sole arbiters of scientific truth. It has become apparent that the reliability of findings is strengthened when, in addition to questionnaire data, complementary evidence concerning temperament is gathered from direct observations of behavior and physiology. An ideal strategy would be to collect data from multiple sources, including subjective report, behavior, physiology, and genetics, to provide converging evidence on the nature and mechanisms of temperament. Multimethod studies, employing measures that span different levels of analysis will be important in advancing the field of temperament research beyond where it stands today.

Genetic studies are likely to continue testing the sorts of higher-level dynamics (e.g., gene by gene by endo- and exoenvironment interactions) that approximate the complexities involved in linking specific genes to temperamental outcomes. Researchers will need to focus on relating genetic polymorphisms to endophenotypic processes that are upstream from final behavioral expression. There appear to be diminishing returns

in the search for simple linear effects of genes on behavior. Of interest, nonhuman animal models may suggest important biological mechanisms that result in temperamental differences, although interpretations across species must necessarily remain cautious.

Finally, because development is time sensitive and different principles operate across the various stages of ontogeny, questions of development may not be fully answered by cross-sectional studies. Small studies do not provide conclusive answers to the gene-environment intricacies that underlie variation in temperament. Therefore, despite the expense of conducting large, longitudinal studies, they will continue to be a gold standard for research in the field of temperament.

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See also: [Electroencephalography](#); [Molecular Genetics and Human Behavior](#); [Personality Development](#); [Temperament and Individual Differences](#).

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Individualism

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Glossary

Collectivism A constellation of daily practices, public artifacts, lay assumptions, and folk beliefs that is based on a model of the self as interdependent.

Independent self A prototypical model of the self that is conceptualized as separate from others and primarily defined by its internal attributes.

Individualism A constellation of daily practices, public artifacts, lay assumptions, and folk beliefs that is based on a model of the self as independent.

Interdependent self A prototypical model of the self that is conceptualized as interconnected with others and primarily defined by its social relations.

Individualism

Individualism, the love of enterprise, and the pride in personal freedom, have been deemed by Americans not only as their choicest, but their peculiar and exclusive possessions. (Bryce, 1888)

As the quote above illustrates, Americans are often described as individualists. They are said to have strong preferences for freedom, uniqueness, autonomy, and personal goal pursuit. Implicit in this assertion is that many other peoples in the world outside of the United States are not as individualistic. In fact, they are said to be more collectivistic. That is, they are in favor of social harmony, interpersonal similarities, duty, and group goal pursuit. This observation has its counterpart in the last two decades of research in cultural and cross-cultural psychology. Much of this literature is organized in terms of individualism and collectivism and the parallel constructs of independence and interdependence. The role of these constructs has been so dominating in the field of research that Steven Heine, a cultural psychologist, went as far as to claim that the individualism–collectivism dimension ‘may ultimately prove to be the most important dimension for capturing culture variation.’

In this article, we define individualism as a constellation of daily practices, public artifacts, and folk beliefs that is based on a model of the self as independent. Individualism is contrasted with collectivism, which may be defined as a constellation of daily practices, public artifacts, and folk beliefs that is based on a contrasting model of the self as interdependent. In what follows, we elaborate on these definitions first. We then discuss psychological consequences of engagement in the divergent cultural patterns of practices and beliefs. Much of the currently available evidence comes from systematic cross-cultural comparisons between people from Western cultures including European American cultures and those from Asian cultures. This discussion is followed by an examination of antecedent conditions for individualism and collectivism. We conclude by discussing some future directions of research.

Defining Individualism and Collectivism

Models of the Self as Independent and Interdependent

Every society offers some unique constellation of daily practices, public artifacts, folk beliefs, and corresponding psychological tendencies. It has been argued that these constituents of a society or culture are patterned in some systematic way and, furthermore, that this patterning follows certain socially shared models of the self. Markus and Kitayama have distinguished between two prototypical models of the self.

In many contemporary Western societies and cultures, including European American middle class cultures, there is a strong belief in the self as independent. The self is conceptualized as bounded and separate from others. As such, it is defined by its internal attributes such as traits, abilities, intentions, and desires. The self is affirmed when these internal attributes are recognized and valued as positive. According to this model of the self, other individuals are also defined in terms of their own internal attributes. Social relations are therefore derived from each person’s preferences and choices. This model of the self is illustrated in [Figure 1\(a\)](#). This model influences a variety of values, practices, and activities. A content analysis of 27 existing scales of individualism or independence found that these scales tap on seven distinct, although related, aspects including (1) valuing personal independence, (2) personal achievement, (3) self-knowledge, (4) uniqueness, (5) privacy, (6) clear communication, and (7) competition.

In contrast, in many non-Western societies and cultures, especially East Asian cultures, a far greater emphasis is given to social relations. The self is regarded as interdependent and fully embedded in relationships with others. According to this model of the self, social relations, especially those with in-group members are indispensable elements in defining the self rather than options one can choose to have or not to have. Thus, acting in line with social roles, norms, and expectations of others is centrally self-defining. The self is affirmed when the encompassing relations are affirmed as positive, as when one’s company, boss, or manager receives a public recognition. This model of the self is illustrated in [Figure 1\(b\)](#). According to the content analysis of the existing scales for collectivism or interdependence noted above, at least eight facets are included in the

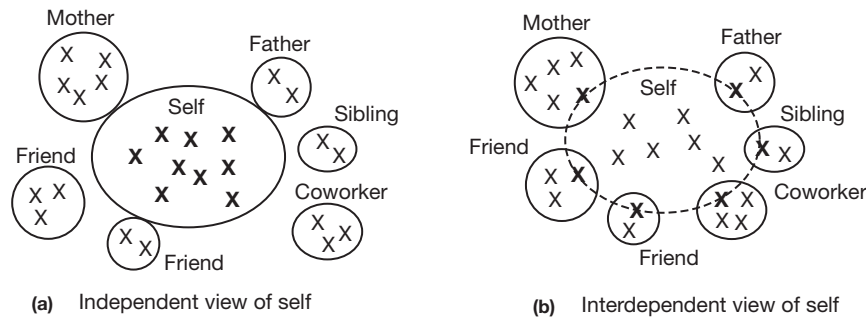


Figure 1 Conceptual representations of the self. (a) Independent construal and (b) interdependent construal. Reproduced from Markus HR and Kitayama S (1991) Culture and the self: Implications for cognition, emotion, and motivation. *Psychological Review* 98: 226.

interdependent model of the self: (1) sense of duty to group, (2) relatedness to others, (3) seeking others' advice, (4) harmony, (5) working in groups, (6) sense of belonging to a group, (7) contextual self, and (8) valuing hierarchy.

Social Environments Reflecting Independence and Interdependence

The cultural models of the self as either independent or interdependent are not only internalized but are also out in the world. They are reflected in, fostered, and maintained by various elements that constitute the cultural environment such as daily practices and institutions, public artifacts, and folk beliefs.

For example, parental practices vary widely across cultures. Parents in Western countries are likely to encourage their children to be independent, assertive, self-reliant, and autonomous. These values, however, are not emphasized in Asian families at least to the same degree. Rather, child-rearing practices in Asia tend to promote interdependence, social harmony, sympathy, as well as filial piety – one central virtue in Confucian ethic that stresses social hierarchy. A similar observation has been made in respect to educational practices. It has been observed that whereas education is considered as a way of improving one's personal benefit and self-respect in Western cultures, it is seen as a tool to join higher social status groups in Asian cultures. In Western classrooms, adversarial discussion and debate is rather commonplace and, to a large extent, positively sanctioned, but social harmony tends to receive a greater emphasis in Asian classrooms. Researchers have pointed out that effective leadership in the workplace also varies across cultures. Leadership trainings in US companies focus on the needs of individuals who seek to maximize their interests, goals, and plans. Obligations toward group goals and group interests are less emphasized. In Asian companies, however, group interests tend to be emphasized relatively more than individual interests, and loyalty and duty to the in-group are strongly sanctioned.

Public artifacts that are displayed in a variety of media such as TV programs and magazines also vary across cultures. In a recent content analysis of advertisements in American and Korean magazines, it has been observed that American ads feature themes of uniqueness such as choice and freedom, but Korean ads emphasize themes of conformity such as group harmony and respect. In another study, researchers

analyzed the coverage of the 2000 and 2002 Olympics Games by Japanese and American media and found that American media highlights athletes' personal attributes such as their strengths and personalities whereas Japanese media attends to a broader set of factors including athletes' backgrounds and experiences such as difficulties, stress, hardships they had in preparing for the games (e.g., his mother passed away before the Olympics), or other people's influences (e.g., it was my dad's dream that I win gold). A similar cultural difference extends to the content of textbooks. One recent study finds that values of independence (e.g., autonomy, power, and self-reliance) are emphasized more in American elementary school textbooks than in Japanese textbooks, but a reversed pattern is evident for values of interdependence (e.g., social harmony, group norm).

Cultural Variation in Mentality

Various psychological tendencies may be shaped by each individual's active engagement in his or her culture. Consistent with this general proposition, the last two decades of research in cultural psychology has documented numerous cross-cultural differences in basic psychological processes such as cognition, emotion, and motivation. Evidence is growing that the psychological effects of culture can be understood in terms of the culturally shared models of the self as independent (dominant in Western cultures) or as interdependent (dominant in Eastern cultures).

Cognition

Cultural variations in the model of the self (i.e., interdependence vs. independence) are likely to entail corresponding variations in cognitive style. Three characteristics of cognitive style are worthy of note: focused versus holistic attention, dispositional bias in person perception, and analytic versus holistic reasoning.

Focused versus holistic attention

Independent versus interdependent social orientations may foster divergent modes of attention. Because social relations are more important and self-defining for interdependent people, these individuals are likely to allocate attention more broadly to the social relations. Their attention may become

more holistic as a result. In contrast, social relations are also important for independent people, but they are seen as important as far as they are relevant to their personal goals and desires. These individuals are then likely to allocate attention primarily to objects and events that are relevant to their personal goals and desires. Their attention may become more focused as a result.

The last two decades of cross-cultural work has supported this analysis. Overall, people engaged in independent Western cultures tend to focus their attention on focal objects in lieu of situational context, but those engaged in interdependent Eastern cultures tend to be more holistic, extending their attention to situational context. In one study, when shown animated vignettes of underwater scenes and asked to describe the scene, European Americans tended to start their stories with focal objects (e.g., 'there was what looked like a trout swimming to the right') whereas Japanese tended to start theirs by referring to a context that defines the scene at issue (e.g., 'there was a lake or pond'). Further, a recognition memory task revealed that Americans represented focal objects separate from their contexts, whereas Japanese represented them in conjunction with the contexts. Additional evidence comes from an eye tracking study, which has found that European Americans direct their gaze more frequently to focal objects, but Asian Americans direct their gaze more frequently to stimuli in context. A similar attentional bias has been demonstrated with geometric stimuli. The cultural variation in attention, then, appears to be ingrained into basic perceptual processing.

Dispositional bias in person perception

A similar cultural variation has been documented in the domain of social perception. Extrapolating from the findings from the cultural variation in attention, we may anticipate that independently oriented individuals (e.g., European Americans) may attend more to a person as a figural object, with relatively scant attention paid to the context. In contrast, interdependently oriented individuals (e.g., Asians) may be more likely to extend attention to the whole scene that includes the focal person. Consistent with this reasoning, European Americans show a strong cognitive bias to explain another person's behavior in terms of the person's dispositions while discounting available situational factors. This bias has been called the correspondence bias or the fundamental attribution error. However, Asians and Asian Americans may attend more holistically to situational constraints on the focal behavior. Indeed, they are less likely to show the dispositional bias.

In one earlier study, when asked to explain either prosocial or antisocial behaviors of their acquaintances, Americans produced more dispositional reasons. In contrast, Indians produced more situational reasons than Americans did. This cultural difference became more pronounced among adults than among younger children, suggesting that the cultural bias in attribution becomes enhanced with enculturation. In a subsequent study, researchers analyzed attribution patterns of American and Chinese young adults and observed that Americans are more likely than Chinese to make strong dispositional (vs. situational) attributions. Similar cultural variations have been repeatedly observed so that we can now be confident that the dispositional bias in social explanation is robust and replicable in Western,

independent cultural contexts, but probably not in Eastern, interdependent cultural contexts.

There is a small, but growing body of cross-cultural literature on attitude inference. When observing another person making an attitudinal statement, people may assign an attitude that corresponds to the statement of the person. It has been repeatedly demonstrated among European Americans that this phenomenon occurs even in the presence of a blatantly clear situational constraint on the person. It appears that people tend to ignore the constraint even when it can be used to fully account for the behavior (i.e., attitudinal statement). As may be expected, however, the dispositional attribution bias or the correspondence bias in attitude inference is substantially weaker among Asians and Asian Americans. When the situational constraint is made highly salient and indisputably clear, Asians rarely show any tendency for correspondence bias, whereas European Americans show the bias even under this same condition. This finding is quite consistent with the evidence noted above that Asians are more holistically attentive to situational constraints. They may not draw any strong corresponding inferences upon observing another person's behavior.

Analytic versus holistic reasoning

If attention is focused primarily on a central object in lieu of its context, individuals may scrutinize the object, identify its distinctive features, and use them to categorize the object. They may then rely on the categorical knowledge to draw further inferences on the object. Reasoning, therefore, tends to be linear and rule-based. This mode of thought is called analytic. In contrast, if attention is applied to the whole scene in which the object is embedded, individuals may be attuned more to the relationships among various elements in the scene. Their reasoning, therefore, tends to be thematically based, dialectical in the sense that balance of various elements, rather than linear logical relationships, is highlighted. This mode of thought is called holistic.

Evidence for the hypothesis that independent people (e.g., Westerners) tend to be more analytic and interdependent people (e.g., Asians) tend to be more holistic in reasoning is quite substantial. In one task, participants are presented with a target flower and asked to judge to which of the two groups of flowers the target belongs (see [Figure 2](#)). The target has a much greater family resemblance with one of the two groups (Group A), but there is no single feature that is common to both – all the flowers of this group and the target. Flowers in the other group (Group B) do not bear any overall resemblance to the target flower, but there is one feature (e.g., straight stem) that is common to both – all the members of Group B and the target. If participants use overall resemblance as the classification criterion, they should judge the target as belonging to Group A, but if they use any simple rules, they should judge the target as belonging to Group B. It has been shown that Asians tend to use overall resemblance in classification judgment whereas European Americans tend to be rule-based.

Another related study examined whether people preferentially use category versus thematic relatedness as the basis of classification. Participants are presented with sets of three pictures and asked to choose which two of the three in each set will go together. The pictures could be grouped by either

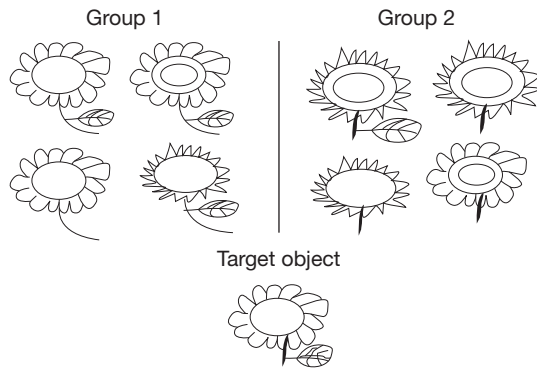


Figure 2 An example of stimuli in Study 2 of Norenzayan et al. (2002). Reproduced from Norenzayan A, Edward SEB, Kim J, and Nisbett RE (2002) Cultural preferences for formal versus intuitive reasoning. *Cognitive Science* 26: 664.

thematic relatedness (e.g., monkey and banana) or category membership (e.g., monkey and panda). As predicted, European Americans tend to prefer category membership to thematic relatedness, while Asians tend to prefer thematic relatedness to category membership.

With the analytic mode of thought, people may assume that the world is governed by simple rules, and thus, various relations are linear. With the holistic mode of thought, people may assume that various elements of the world are connected with one another and thus they are dynamically related to maintain balance. In one study, researchers provided European American and Chinese participants with a description of a certain event (e.g., global economic growth), which either linearly increased or decreased over a certain period of time (say, past 10 years). The participants were then asked to estimate what would happen in the future. Whereas European Americans tended to predict that the same trend (i.e., increase or decrease) would continue, Chinese tended to predict that the current trend would taper off and even reverse itself.

Emotion

Cultural variations in the model of the self (i.e., interdependence vs. independence) are likely to give rise to culturally distinctive emotional experiences. Three replicable patterns of cultural variation in emotional experience have been reported: socially engaged versus disengaged emotions, predictors of happiness and life satisfaction, and ideal affect.

Socially engaged versus disengaged emotions

First, people in different cultures may experience different emotions because of their commitment to the cultural values or normative requirements of independence or interdependence. Attaining goals or failing to achieve them can result in a variety of different emotions. However, exactly what emotions are experienced appears to depend on the nature of the goals at hand. When independent goals are achieved, people can be assured of positive characteristics of the personal self or they may be content with the relative superiority of the self over others. In these cases, they are likely to experience socially disengaged positive emotions such as pride in the self or feelings of confidence in the self. When the individuals fail to

achieve independent goals, however, they are likely to be frustrated and, as a consequence, they may feel sulky and even angry. These emotions, which typically produce a motivational drive to restore the thwarted sense of independence, are called socially disengaged negative emotions. The parallel distinction can be drawn for interdependence. When interdependent goals are achieved, people can be assured of their belongingness to the relevant social relationship or they may be content with the harmoniousness of the relationship. In these cases, they are likely to experience socially engaged positive emotions such as communal feelings or feelings of closeness to others. When the individuals fail to achieve interdependent goals, however, they are likely to feel guilty, shameful, or feel indebted to others. These emotions, which entail a motivational push to restore the thwarted sense of interdependence, are called socially engaged negative emotions.

It is reasonable to anticipate that Westerners are chronically oriented more toward independent goals than toward interdependent goals, but Easterners are chronically oriented more toward interdependent goals than toward independent goals. It would follow that the corresponding cultural variation should be observed in the relative salience of socially engaged versus disengaged emotions. In one demonstration of this point, European American, German, British, and Japanese participants were presented with ten mundane social situations (e.g., waiting to be seated at a restaurant) and asked to remember the most recent experience that fitted the description. They then reported how strongly they experienced each of ten different emotions that vary in both valence (i.e., positive vs. negative) and social orientation (i.e., engaged vs. disengaged). As may be expected, North Americans reportedly experienced disengaged emotions more strongly than engaged emotions across the ten situations. However, the pattern was completely reversed for Japanese, with engaged emotions reportedly experienced more strongly than disengaged emotions. The two European groups fell between the two extremes.

Predictors of happiness and life satisfaction

Second, if people habitually seek to realize either independent or interdependent goals, they may feel happy, content, or satisfied when the corresponding goals are achieved. The four country comparison study discussed above confirmed this prediction: Americans' happiness was better predicted by the experience of disengaged positive emotions whereas Japanese's happiness was better predicted by the experience of engaged positive emotions. Further, the patterns for the two European countries fell in-between. Other studies provided parallel evidence by using personality measures of social engagement and disengagement. The correlation between measures of social disengagement (self-esteem and personal control) and life satisfaction is typically positive. Importantly, however, the correlation is higher in independent cultures (e.g., North America and Western Europe) than in interdependent cultures (e.g., Asia). Measures of harmonious or stress-free social relations such as relational harmony, perceived social support, and sympathy to others tend to predict life satisfaction and other measures of wellbeing better in interdependent cultures than in independent cultures.

Although the direct effect of social engagement on measures of wellbeing tends to be weaker in North America, this does

not mean that social relations are unimportant for European Americans. Indeed, across many cultures, availability of social capital (e.g., engagement in local communities, marriage, and coresidency with one's own children) has been identified as a major protective factor of health and wellbeing. It is possible, however, that in independent cultures social relations may be beneficial only to the extent that they are useful in affirming one's sense of independence and self-worth. Thus, once the effect of social disengagement (e.g., self-esteem or sense of control) has been controlled, there might remain little variance uniquely explained by social engagement.

Ideal affect

A third set of findings that deserve discussion concerns cultural variation in ideal affect. Research has documented that Western cultures normatively sanction high-arousal positive emotional states such as excitement, enthusiasm, and elation. In contrast, Eastern cultures normatively sanction low-arousal positive emotional states such as calmness, peacefulness, and serenity. Highly arousing, energizing states may be culturally valued more in independent cultures because these emotional states are congruous with the cultures' normative expectation that one must actively influence other people and events. In contrast, interdependent cultures emphasize attunement to social cues and attendant effort to adjust to social expectations. Calm states may then be culturally valued because of their congruity with the strong value the cultures place on social attunement and adjustment.

The foregoing analysis on cultural variation in ideal affect is consistent with an observation that European Americans tend to prefer rigorous leisure activities (e.g., surfing, running, and rollerblading) whereas Asian Americans prefer less active ones (e.g., sightseeing, picnicking). It has also been observed that relative to their American counterparts, Japanese adolescents tend to prefer relaxing and calm music. Further, culturally variable ideal affect might influence drug use: stimulants such as cocaine and amphetamine (which elicit excitement) are more widely abused in the United States, but the illicit drugs of choice in much of Asia are opiates (e.g., heroin) that induce relaxation.

Motivation

Cultural variations in the model of the self (i.e., interdependence vs. independence) are also likely to entail corresponding variations in motivational processes. Even when people engage in a seemingly identical behavior (e.g., making a choice or decision), this same action can bear different psychological meanings because the action is necessarily made meaningful within a larger framework informed by a cultural model of the self. There are three notable themes of research that pertain to motivational processes: propensity toward uniqueness, self-enhancement, and choice.

Propensity toward uniqueness

Independent selves are defined by personal features that are distinctive and unique to them (e.g., personal preferences), but interdependent selves are defined by socially shared features (e.g., group membership). It may then be anticipated that independent people value, prefer, and seek uniqueness of the

self to a greater extent than interdependent people do. In one recent study, researchers went to one of the major US international airports and asked both Asian and European American travelers to fill out a short questionnaire and then offered a pen as a token of appreciation for their cooperation. The travelers were presented with five pens and asked to choose one of them. One or two of the five pens had a color that was different from the rest. As predicted, European American travelers were more likely than Asian travelers to choose a pen with the unique color. The greater liking for uniqueness over conventionality among European Americans relative to Asians or Asian Americans has been replicated with a standardized questionnaire.

Self-enhancement

One pervasive psychological tendency or bias observed among European Americans is self-enhancement or self-serving bias. People are motivated to maintain positive views of the self in a variety of different ways. Although often regarded as universal, this tendency may be rooted in an independent model of the self. If individuals believe that they are independent and separate from others, they may be strongly motivated to establish the positivity of this personal self by cognitively elaborating and emphasizing positive features of the self while, at the same time, dissociating the self from any potentially negative features. If, however, individuals believe that they are interdependent and closely connected with others, they may be motivated to fit in to significant relations. As a consequence, they may have little or no strong need to establish the positivity of the personal self. Moreover, in order to fit in to any given relationship, it is often advantageous to take a self-critical and disciplined stance to the self. Self-criticism or effacement may be a basis for positive evaluations from others in the relationship. These evaluations may accord honor or face on the person. It is also important not to stand out too much so as to remain as a good member of the relationship. In short, Asians and Asian Americans might sometimes show a self-critical or self-effacing psychological bias.

In one study, American and Japanese participants were presented with a number of situations involving success or failure and asked to estimate whether and to what extent their self-esteem would increase or decrease in each situation. To test the idea that the expected psychological tendencies of self-enhancement among Americans and self-criticism among Japanese might be encouraged by ways in which mundane social situations are defined and made meaningful, the situations had been preselected so that half of them were common in the United States and the other half were common in Japan.

Figure 3 shows the relative estimated self-esteem change – that is, the extent to which self-esteem is estimated to increase in success situations relative to the extent to which it is estimated to decrease in failure situations. The means are positive for Americans, indicating that they reported that their self-esteem would increase more in success situations than it would decrease in failure situations (i.e., self-enhancement). In contrast, the means for Japanese tend to be negative, suggesting that they estimated that their self-esteem would decrease more in failure situations than it would increase in success situations (i.e., self-criticism). The culturally dominant biases of self-enhancement and self-criticism were

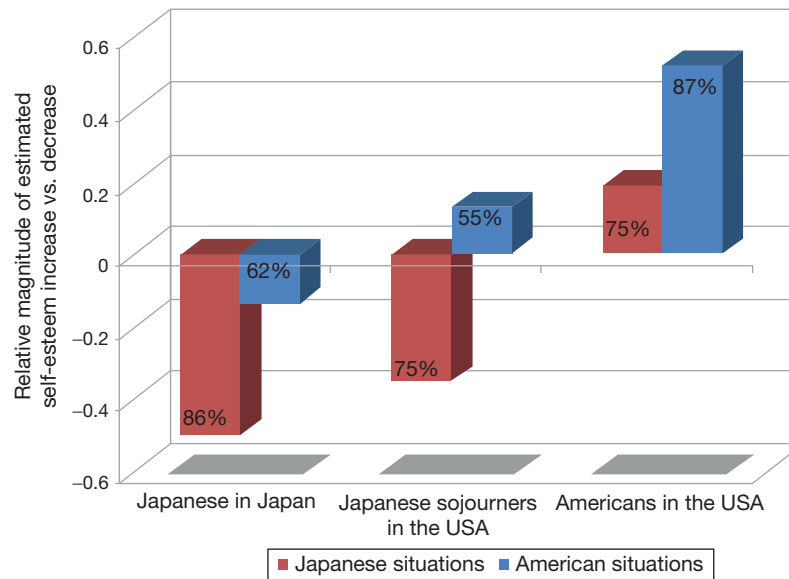


Figure 3 The relative magnitude of estimated self-esteem increase versus decrease as a function of participant culture and situation culture. Positive (negative) scores show that self-esteem is estimated to increase (decrease) more in success (failure) situations than it decreases (increases) in failure (success) situations. The percentage within each bar represents the proportion of participants who show an effect that is congruous with the central tendency observed in the condition. For example, when responding to Japanese situations, Japanese in Japan as a group estimated that their self-esteem would decrease more in failure situations than it would increase in success situations. This effect was observed, in varying extents, among 86% of the participants in this group. Reproduced from Kitayama S, Markus HR, Matsumoto H, and Norasakkunkit V (1997) Individual and collective processes in the construction of the self: Self-enhancement in the United States and self-depreciation in Japan. *Journal of Personality and Social Psychology* 72: 1245–1267.

much more pronounced when the participants were responding to the situations that were common in their own cultures. Thus, nearly 90% of the Americans tested showed self-enhancement when responding to American situations, and conversely, nearly 90% of Japanese showed self-criticism when responding to Japanese situations. One clear implication is that the culturally dominant psychological biases are afforded, that is, being supported and reinforced, by certain ways in which mundane social situations are constructed and made meaningful. This study is noteworthy in yet another way. It tested Japanese sojourners in the United States. As shown in **Figure 3**, the results for these sojourners fell right between the European Americans and the Japanese in Japan. This pattern could be due to acculturation (i.e., influence of resocialization in the American culture), self-selection (i.e., greater likelihood of independent Japanese coming to the United States), or both.

Choice

The cultural models of the self may also moderate motivational effects of choice. Given an independent model of the self, a choice will be experienced as expressive of the self when it is unconstrained by any social concerns. If, for example, one helps someone out of a concern for social reciprocity, the help may not be experienced as genuine and internally motivated. The social imposition of this kind on choice can be very subtle. One recent study finds that when asked to make a choice while being watched by others, European Americans report that their choice is more constrained and less self-expressive. However, the foregoing effect of choice on motivational processes may take a different form among those with

Asian cultural backgrounds. Given an interdependent model of the self, choices that are made in the absence of any social context will not be experienced as self-relevant because such choices have little bearing on the interdependence of self. For example, Asians would perceive a help they offer to their neighbors as genuine and internally motivated when the help is prompted out of a concern for social reciprocity (and thus their social reputation). Likewise, for choices to be meaningful for the self, they should be situated in certain social contexts. It may then be anticipated that Asians and Asian Americans will be motivated by their choice, but only if the choice is made in the presence of witnessing others.

One early study observed that European American children were more strongly motivated to perform an anagram task if they had chosen the task by themselves rather than if the task had been assigned to them by the experimenter. However, the effect was significantly weaker for Asian American children. Of importance, this study included a condition in which a choice was made, not by the participants themselves, but by their in-group member (i.e., their mother or classmate). Because of their psychological identification with the in-group member, Asian American children might perceive the in-group member's choice as no different from what they would make. Further, the choice in this case is obviously public. As may be predicted, Asian American children in this condition were more strongly motivated by the task chosen by the in-group member even in comparison to the task they themselves had chosen.

Also consistent is a vast body of literature on cognitive dissonance. When making a choice between two equally attractive objects, the choice often leads to conflicting cognitions

(e.g., desirable attributes of a rejected item or undesirable attributes of a chosen item), which in turn produce negative arousal (dissonance). To reduce this dissonance, people try to justify their choice by increasing their liking for the chosen object and reducing their liking for the rejected object. Evidence is quite clear that for the justification effect to occur, the choice must be perceived as personal and internally motivated for European Americans. However, among Asians the dissonance effect can rarely be observed in the absence of witnessing others, but this effect is quite robust in the presence of such others.

Antecedents of Individualism and Collectivism

So far, we have examined psychological consequences of individualism (or independence) and collectivism (or interdependence). However, what factors can explain such cultural values and the attendant cultural models of the self? Why is it, for example, that Asian cultures are more collectivistic or more oriented toward interdependence or, conversely, why is it that European American cultures are so individualistic or independently oriented? In this section, we address these questions by reviewing available evidence for some antecedent conditions for individualism and collectivism.

Ecology and Subsistence Systems

Independence and interdependence are likely to be constrained by certain ecological conditions insofar as such conditions make certain forms of living far more feasible and realistic than certain others. Traditionally at least, herding is common in relatively dry highlands that are sparsely populated. Herding, in turn, is likely to encourage various values of independence such as self-reliance, assertiveness, and self-promotion. In contrast, traditionally farming is quite common in fertile plains with substantial precipitations and high temperature. Furthermore, agriculture supported emergence of large sedentary societies. Because farming requires a high degree of social coordination, it may foster values of interdependence such as social harmony, group duty, and social cooperation. In one classic study, farmers in East African culture were found to be more interdependent than herders in the same region. In support of the general hypothesis that social interdependence gives rise to holistic (vs. analytic) mode of reasoning, farmers have been shown to be more holistic in cognitive style than herders.

Pathogen Prevalence

One recent proposal in evolutionary psychology is that humans have evolved behaviors that can protect them against pathogen infections. In regions or communities that suffer from higher pathogen risks, individuals may develop behavioral tendencies that enable them to minimize potential contact with pathogens. For example, they may make a sharper distinction between in-group members and out-group members and avoid the latter, insofar as there may be some non-trivial risk to be exposed to unknown pathogens through contact with outgroup members. Likewise, there may be tighter

normative regulations of hygiene control. In short, the community as a whole may become less individualistic and more collectivistic under the conditions of pathogen risks. One recent study finds that indicators of both historical and contemporary pathogen prevalence correlate positively with measures of collectivism and negatively with measures of individualism. More research is required, however, because there are obvious exceptions in history. For example, England had very high rates of plague and tuberculosis in the late-medieval period and yet is one of the most individualistic cultures today. It remains to be seen if an exception like this could be accounted for once certain local historical factors are duly taken into account.

Social Resources: Economic Development and Social Class

A cultural psychologist, Harry Triandis, suggested that affluence leads to social independence, since it enables people to do 'one's own thing.' Social forces that emphasize economic independence, in turn, lead people to seek a sense of autonomy and to value personal choice and self-expression. These individualistic orientations have become increasingly widespread in advanced industrial societies. In support of this analysis, across numerous countries of the world today, individualism is highly correlated with the gross national product (GNP) ($r = 0.82$). In another related study, self-expression values – a component of individualism – is closely linked to economic prosperity.

If wealth and other related tangible and symbolic resources are linked to independent orientations across countries, the same relationship might also hold within each country. In fact, social class, as defined by income, occupational prestige, and educational attainment, has been shown to predict the level of independence (vs. interdependence). Large-scale survey studies have shown that middle class (vs. working class) standing is associated with higher levels of self-directness, self-efficacy, and personal mastery. Further, social class has been shown to influence more behavioral aspects of independence versus interdependence. In one recent study, college-educated (middle class) Americans tend to express their uniqueness more than high school-educated (working class) Americans. Likewise, middle class Americans seek to distinguish themselves from others when making a choice; but working class Americans seek to accentuate their similarities with others when making a choice.

Occupational and Residential Mobility

By definition, independent individuals are not tied up to any particular social roles or geographic locales in the way interdependent individuals might be. In a recent series of studies, researchers have found substantial evidence for the predicted association between independence (as typically defined in terms of self-definitions based on personal vs. social attributes) and residential mobility. Similar evidence exists for occupational mobility as well. It is reasonable that both residential mobility and occupational mobility foster an independent sense of the self. Equally likely, however, is the reverse causation wherein independent people are more likely to be on the move.

Voluntary Frontier Settlement

Worldwide, settlement in sparsely populated and uncultivated lands (the frontier) has occurred from time to time. The frontier appears to combine several factors that induce independence, including low population density, relatively low pathogen risk (due to low population density and, in many cases, relatively dry and cold climate), and social mobility, among others. It would seem quite reasonable to anticipate that voluntary frontier settlement is a major factor for independence and individualism.

A recent review shows that European Americans are more independent even as compared with their European counterparts. Within the United States, individualistic values tend to

be endorsed more in regions with longer frontier periods (e.g., Mountain West) than in those with relatively short such periods (e.g., New England). This pattern has been replicated with the likelihood of giving unconventional names to new babies as an index of individualism. Scatter plots presented in Figure 4 illustrate the point. When the year in which statehood was achieved was plotted on the x-axis and the percentage of babies receiving one of ten most conventional names was plotted on the y-axis, it is evident that the state-wise percentage of both baby boys (a) and girls (b) with conventional names tends to decrease as a function of the year of admission into the United States. It is also observed that, with this index, countries settled

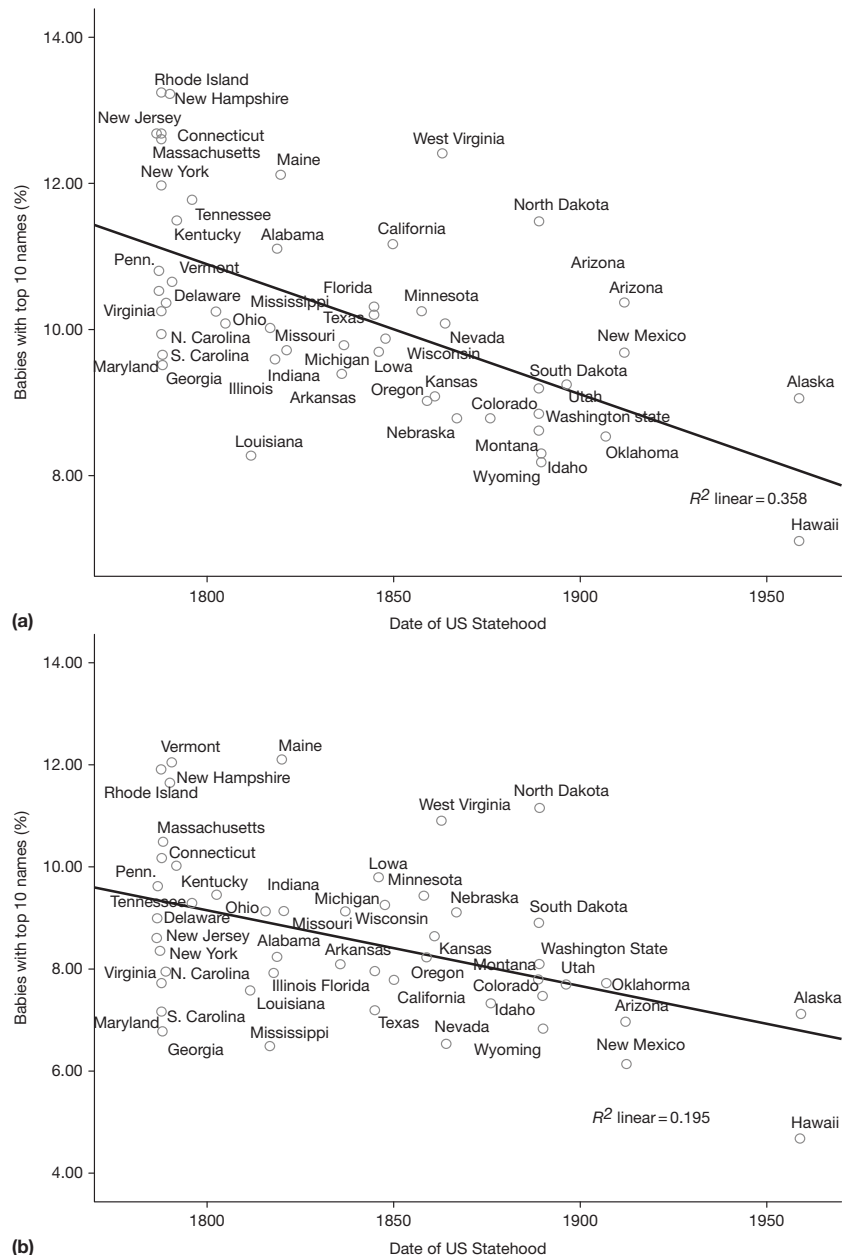


Figure 4 State-wise proportion of baby boys (a) and girls (b) with conventional names as a function of the year of admission of the state into the United States. Reproduced from Varnum MEW and Kitayama S (2011) What's in a name? Popular names are less common in frontiers. *Psychological Science* 22: 179.

by Europeans (e.g., New Zealand and Canada) are higher in independence than the corresponding European countries. A similar finding exists outside of the West. A northern island of Japan called Hokkaido has undergone a relatively recent 100-year old history of settlement by ethnic Japanese. As may be expected, there is evidence for enhanced independence among Hokkaido residents relative to their mainland counterparts. The frontier is characterized at least in part by high-risk, and high-return payoff structures. Similar payoffs may be often associated with large city cosmopolitan centers such as New York and San Francisco in the United States, Berlin and Paris in Europe, and Tokyo, Seoul, and Shanghai in Asia. A recent study has shown that these city centers tend to attract independently minded individuals much more than regional, provincial cities do.

Conclusions

The last two decades of research in cultural psychology has provided substantial evidence for the proposition that cultures vary considerably in terms of individualism (vs. collectivism) and the corresponding model of the self as independent (vs. interdependent). Initially suggested by large-scale cross-cultural surveys, this hypothesis has been used to account for cultural variations in many distinct psychological tendencies. As compared to people in interdependent cultures (i.e., collectivists), those in independent cultures (i.e., individualists) tend to be more focused (vs. holistic) in attention, more dispositional in person perception and social explanation, more analytic in reasoning, socially disengaged (vs. engaged) in emotional experience, self-enhancing, and motivated more by private (vs. public) choices. Antecedent conditions for individualism (vs. collectivism) include herding economy, reduced pathogen risks, wealth and prestige, residential mobility, and frontier settlement.

Future work may focus on effects of engagement in multiple cultures, given that conditions will become increasingly common and widespread in many parts of the world. It has been suggested already that frame switching across different cultural assumptions and models is not only possible, but also, in fact, quite common. Moreover, switching back and forth across different cultural frames might in fact induce creativity and higher executive functions. Further research is justified to investigate implications of multiculturalism on socioemotional development and identity formation.

It is important to recognize that the currently available evidence for the effect of culture on psychological or neural processes comes, in large part, from a systematic comparison between Western and Eastern societies and cultures. This comparison has provided a model case for cultural psychologists just like rodents have defined a model animal of choice for a number of animal psychologists. As such, it has provided a number of invaluable insights into the nature of cultural influences. Yet, the field should now be pushed forward in various different directions by examining different subgroups or regions, or looking at different occupational groups or age groups.

Another important avenue of research would be to investigate brain processes underlying the behavioral effects of culture reviewed in this article. It seems plausible that environmental influences that are associated with culture are not only

reflected in our behaviors but also in our neural activities. Recent work on neural plasticity, for example, has suggested that nongenetic, environmental factors, such as repeated practice for acquiring a certain skill (e.g., abacus use), can lead to dramatic changes in neural connectivity of the brain. This emerging literature underscores the significance of cultural experience in neural development. Cultural neuroscience research will make great contributions to broaden our understanding of intricate interactions between culture, mind, and brain.

Last, but not least, with recent developments in population genetics, it has become reasonable to hypothesize that at least some of the cultural differences discussed here might be traced back to genetic differences across cultural groups. It has been established that gene expressions are contingent on environments, which could include cultural environments. Further, genes themselves (particularly, frequencies of very simple mutations called single nucleotide polymorphisms) are likely to be influenced by cultural conditions. These considerations will open up an exciting theoretical possibility that there are dynamic mutual influences among behavior (and the brain), culture, and genes. This general topic will constitute one important frontier of human behavioral sciences.

In sum, the notion of individualism (vs. collectivism) has been highly instrumental in the last two decades of research in cultural psychology. As the present review testifies, a substantive body of empirical knowledge has been accumulated. We anticipate that during the next decade this work will continue to grow by identifying different cultural patterns that cannot be reduced to individualism or collectivism, exploring multiculturalism, examining neural processes underlying known cultural differences in cognition, emotion, and motivation, and establishing, in greater detail, antecedent conditions for the cultural patterns that are identified.

See also: [Attention; Decision Making \(Individuals\); Individual Differences in Temperament: Definition, Measurement, and Outcomes; Social Exchange.](#)

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Inner Speech

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Glossary

Ecological validity The degree to which the thoughts recorded in a study reflect the thoughts that actually occur in natural settings.

Inner speech The activity of talking to oneself in silence.

Left inferior frontal gyrus Also known as Broca's area, the brain region that gets reliably activated during inner speech production.

Predicativeness The syntactically compressed, condensed, abbreviated quality of inner speech. In inner speech, the speaker tends to only articulate the predicate, not the subject, for example, 'hungry' as opposed to 'I am hungry.'

Private speech Self-directed speech emitted out loud by children for self-regulatory purposes.

Rebound effect Rebound effect occurs when attempts at suppressing unwanted thoughts actually lead to experiencing them more often.

Scaffolding Scaffolding is adult assistance only on those tasks that are beyond children's skills.

Self-regulation Consists in altering one's behavior, resisting temptation, changing one's mood, selecting a response from various options, and filtering irrelevant information; also includes setting immediate and distant goals, problem-solving, planning, and decision-making.

Working memory System that keeps a small quantity of information in an active state for a short period of time.

Zone of proximal development The difference between what children can and can not do by themselves.

Overview

Definition

Inner speech is the activity of talking to oneself in silence. It is often equated with the phonological loop portion of short-term memory, which gets recruited when one needs to hold auditory information in an active state for a short period of time. However, inner speech does much more, as it plays a central role in self-regulation (e.g., planning, problem-solving, self-motivating), normal language functions such as reading and writing, task-switching performance, remembering the goals of action, rehearsing person-to-person communicative encounters, and self-awareness, which includes mental time travel into the past and the future. People report that around one-fourth of their conscious waking life consists of inner speech, indicating that it most certainly constitutes a significant human mental activity.

Related Terms and Manifestations

Typical expressions used to designate inner speech are self-talk, self-directed speech, subvocal, covert, or acommunicative speech, auditory imagery, speech-for-self, propositional thought, self-verbalizations, internal dialog or monolog, subvocalizations, self-statements, and silent verbal thinking. Jean Piaget used the term egocentric speech when discussing self-talk produced aloud by children in social situations. He proposed that egocentric speech served no function at all and was the manifestation of children's cognitive immaturity. Lev Vygotsky insisted rather that egocentric (private) speech served an important self-regulatory function. In Vygotsky's view, speech-for-self emitted out loud by children reflected intellectual development, not egocentrism.

Young children engage in echolalia when they repeat others' words in an automatic manner for language learning purposes or for the simple pleasure of using words. They emit

crib speech when producing soliloquies before falling asleep. The idiom-embedded private speech refers to adults' use of private speech during public talks in order to restructure the lecture or to self-regulate (e.g., OK, let's now move on to the next point). Inner speech writings represent hastily recorded memos for self in notebooks, personal journals, on shopping lists, etc. These messages may consist in single words or phrases, or full paragraphs written in a very condensed and often obscure style meaningful only to the self.

Theoretical Themes

Thought and Language

There exist two main views on the connection between thought and language (which includes inner speech): language basically *is* thought and thought can exist without language. Plato, an advocate of the first position, wrote that "When the mind is thinking, it is simply talking to itself, asking questions and answering them." Following John Watson's lead, behaviorists also held that thought is identical to inner speech. Charles Darwin seemed to agree with this theory when he proposed that "A long and complex train of thought cannot be carried on without the aid of words, whether spoken or silent, than a long calculation without the use of figures or algebra." Vygotsky concurred and suggested that thought is not expressed in words – it comes into existence through them. An alternative formulation of this first position is the Sapir-Whorf hypothesis, which suggests that the use of vocabulary that is unique to one's native language shapes one's view of the world. To illustrate, color terms within a language influence color perception. Present work shows that using interrogative language (e.g., Will I?) as opposed to declarative speech (I will) increases motivation and goal-directed behavior.

The Wurzburg's school of thought founded by Oswald Kulpe in the late 1800s was a major proponent of the second

theory: pure thought can exist without language (or inner speech); thought can be wordless. Experiments tentatively supporting this position were conducted by Karl Buhler at the beginning of the twentieth century. Participants listened to a proverb and then were asked to press on a button once they understood it. Most volunteers claimed that the button pressing was not accompanied by verbal thoughts or images, suggesting that understanding (i.e., thought) precedes language.

None of these two extreme views are embraced by modern cognitive scientists and linguists. Instead of asking if language creates thought or if thought causes language, the question being currently examined is: how does language affect thought processes?

Vygotsky's Position

Numerous theories of inner speech have been formulated. Vygotsky's theory, which emphasizes culture, language, and internalization, arguably represents the most complete, original, and coherent view available. In Vygotsky's system, children's cognitive development is affected by culture in two ways. First, children acquire most of their knowledge (the contents of thought) through culture. In addition, not only does culture teach children what to think but also how to think. Intellectual growth emerges out of a dialectical process in which problem-solving experiences are shared with parents, teachers, siblings, peers, etc. Children can solve some problems by themselves, yet other more challenging problems require help from social agents. Vygotsky named the difference between what children can and cannot do by themselves as the zone of proximal development. He insisted that not respecting this zone, either by helping children on tasks they can complete on their own, or by not helping enough on difficult tasks, impedes cognitive development. Ideally, people interacting with children initially should guide most of the problem-solving process and eventually transfer this responsibility to the child. Language represents the core type of interaction which allows social agents to convey information to children. Gradually, children's *own* language becomes their principal tool of intellectual growth, first as speech-for-self emitted aloud (private speech) to guide and control their own actions and eventually as silent self-talk (inner speech). Vygotsky called this internalization – the process of using an instrument of thought (*inner* speech) that was at first located outside children (*social* speech). Much of Vygotsky's theorizing has led to empirical predictions and most have received support.

Methodology of Research

Like other internal cognitive processes, inner speech cannot be directly observed but only indirectly inferred. Not surprisingly, early efforts aimed at assessing inner speech were based on introspection. Alfred Binet, for instance, would have his two daughters work on various tasks and would ask them what strategies they employed. He noted that the daughters often reported thoughts such as "I *told* myself this ..." or "I *said* to myself that ...". From these observations, Binet deduced that most thinking recruits inner speech.

Private Speech

Vygotsky held that studying the spontaneous production of private speech in children was the most reliable way to tap into inner speech. Although they both are not identical, private speech, nonetheless, retains some characteristics that inner speech is postulated to possess, and importantly, it is objectively measurable and quantifiable. Indeed, private speech has been extensively studied in natural settings (e.g., in the classroom) and in more controlled environments in numerous situations (e.g., with others vs. alone). Private speech is typically measured by calculating the total number of raw utterances, the number of verbalizations per minute, or the ratio of social to private speech. Private speech units are coded and classified into different categories. Typical categories are task-irrelevant private speech (e.g., word play, emotional release, conversations with imaginary others), task-relevant private speech (e.g., vocalizations about the task or the child's current or future task-related actions), and partly internalized private speech consisting of inaudible muttering, whispers, and silent lip movements. The frequency and content of private speech are then correlated with behavior or performance.

Only children's private speech has been used as a window into inner speech. Adults also engage in private speech, but only when alone and thus much less frequently than children. However, adults' private writing has been investigated. Private writing (also called introspective or inner speech writing) refers to scribbling that people write on a piece of paper (e.g., a grocery list) or on the margins of a book, as well as in a notebook (e.g., a writer's thoughts). Private writing is consistently condensed (like inner speech) and cryptic to others because it is uniquely addressed to the self.

Production Methods

Production (or self-revelation) methods usually entail the externalization of ongoing inner speech as a task is being performed; most are thus introspective, as opposed to retrospective. With the think-out-loud technique, recordings of adults' verbalizations are made as they are working on a given task; volunteers are clearly encouraged to vocalize their thoughts. It is assumed that the collected speech will mirror genuine inner speech, or at any rate will supply a representative sample of it. To reduce the likelihood of having participants produce a biased or unnatural sample, instructions explicitly specify not to edit thoughts or to worry about being understood. The videotape reconstruction method consists in showing participants video recordings of their behavior in precise situations (e.g., during task performance) and asking them to recall (reconstruct) inner speech content. A variation of this technique is the interview immediately following the execution of a given task, where volunteers are probed for inner speech use during task completion. With the thought listing technique, participants are asked to list their subvocal activity once a task has been completed. The thought-sampling method intends to collect a representative sample of people's inner speech in natural settings. Subjects wear a beeping apparatus that produces audio signals at random intervals throughout the day. Volunteers are asked to report the content of their inner speech upon hearing the beep. All measurement

techniques reviewed above include coding and classification of inner speech units into different categories that are then correlated with behavior or task performance.

Self-Reports

The most frequently used instrument to assess inner speech is questionnaires made up of self-statements along a variety of domains – for example, anxious versus nonanxious (This is so stressful; I will make it), positive versus negative (I feel fine; I just want to die), or social phobia (People don't find me interesting). Participants are invited to rate the frequency of their self-talk using a Likert-scale. The main advantage of questionnaires is that they can easily and quickly be administered to large groups of people. Conversely, because these scales consist of premade self-verbalizations, they significantly restrict the scope of natural inner speech that volunteers could otherwise describe. Q-methodology is also used to estimate the content and/or functions of inner speech. Participants are invited to sort out cards that depict inner speech units according to the extent of agreement. Another approach, called the cued recall technique, consists of eliciting self-reports of inner speech use by presenting cards containing cue words to participants.

More ecologically valid methods exist. Researchers may use an open-format question to gather spontaneously occurring inner speech in people's natural environments (e.g., When you talk to yourself, what do you typically say to yourself?). Compared to the random-sampling method, the open-ended format approach suffers from being retrospective (and thus potentially unreliable), but is not as limiting as the questionnaire. Slightly less retrospective is the use of diaries (or first-person narratives), which can also produce rich inner speech content.

Electromyographic Recordings

Alexander Sokolov wrote an entire book on the use of electromyographic recordings of movements of the lips and tongue to assess inner speech incidence during problem-solving tasks. Electromyography allows one to evaluate and record physiological characteristics of muscles. This is done with an electromyograph that measures the electrical potential created by muscle cells when these cells contract and are at rest. Movements of the lips and tongue observed during overt speech are also produced (with much less intensity) during covert speech. These movements represent an objective external expression of subvocal speech activity. Suction electrodes placed on the tongue, sublingual horseshoe electrodes located under the tongue, or surface electrodes attached to the lower lip are used to record the target articulatory movements. It is thus possible to infer inner speech activity (but not content) during completion of various cognitive tasks such as mental calculation, silent reading, listening to speech, recall of verbal material, and manipulation of graphic-visual information.

Articulatory Suppression

As seen above, articulatory movements accompany inner speech. Logically, interfering with those movements (articulatory suppression) will lead to inner speech interruption. In a typical experiment, participants are invited to complete a task while

concurrently reciting verses or mentally counting backward from 100. The forced articulation produced by the recitation or counting blocks any other articulation that would be otherwise required when spontaneously engaging in inner speech. Performance deterioration implies that the task normally benefits from inner speech use, although some argue that the deterioration could be due merely to the extra attentional demands. Articulatory suppression clearly does not assess inner speech per se but informs the researcher as to what types of cognitive work cannot be accomplished without inner speech.

Brain-Imaging

Recent advances in brain-imaging techniques such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) make it possible to record brain activity of participants performing various cognitive tasks. Activation of the left inferior frontal gyrus (LIFG) can be taken as evidence of inner speech activity during task completion because the LIFG is reliably recruited during the silent generation of words or sentences (see [Neuroanatomy](#) section below). It will be possible in the near future to identify which mental activities rely on inner speech, as well as to dress a list of those which do not or partially do so. To illustrate, preliminary work examining self-referential activity suggests that focusing on one's personality traits or remembering personal past episodes engage inner speech, whereas recognizing one's face on a photograph does much less so. The latest brain-imaging tool that has been developed is repetitive transcranial magnetic stimulation (rTMS), which temporarily interrupts normal cortical activity. Current experiments are looking at the effects of applying rTMS on the LIFG. Brain-imaging techniques do not allow access into the content of inner speech – only its presence or absence is being objectified.

Summary

Each measurement technique described above presents specific advantages and disadvantages. Ultimately, it is the type of problem being studied that should determine what method to select. For instance, in a preliminary stage of an investigation, it would be reasonable to employ an open-format or thought-sampling approach to collect self-generated statements from depressed patients. In a second part of the study, a validated questionnaire could be created based on these vocalizations and administered to larger clinical and nonclinical samples. Several assessment techniques should be used to aim for convergent validity. For example, in three independent studies on inner speech in anxious people, one could use diaries (thus collecting self-generated content), the videotape reconstruction procedure following anxiety-producing social interactions, and a questionnaire administered to anxious and nonanxious participants. Results would then be integrated into one broader research report.

Development of Inner Speech

Social Origins

Vygotsky postulated that inner speech grows out of one's social environment. This hypothesis is supported by the fact that there exist high positive correlations between rates of social

interaction and private speech in children. Children immersed in cognitively and linguistically stimulating environments (situations more frequently observed in higher socioeconomic status families) start using and internalizing private speech faster than children from less fortunate backgrounds. Indeed, children raised in environments characterized by low verbal and social exchanges exhibit delays in private speech development.

Development of Private Speech

Cross-sectional and longitudinal studies support Vygotsky's original view that the frequency of children's private speech follows an inverted-U relation with age. Private speech use peaks at 3–4 years of age, decreases at 6–7 years of age, and gradually fades out to be mostly internalized by age 10. As private speech diminishes, one can observe more and more frequent whispering and inaudible muttering – typical manifestations of partially internalized inner speech. Intellectually gifted children tend to internalize private speech into inner speech earlier than their average counterpart, and girls usually show a faster private speech development than boys. Before the age of 4, children are largely unaware of engaging in private speech. The above trends seem to be universal and not sensitive to cultural differences. One study examined private speech in British and Saudi Arabian children and found no differences in frequency of private speech.

Vygotsky suggested that fully internalized inner speech does not reemerge as private speech. This assertion has recently been challenged. Healthy adults have been observed to engage in external speech when alone for self-regulatory purposes, as well as for spatial navigation and search, concentration, and emotional discharge and control. Ninety-six percent of all adults report sometimes talking to themselves aloud.

Verbal Self-control

Alexander Luria conducted a set of experiments on verbal mediation, aimed at determining the extent to which both social and self-generated speeches effectively control children's behavior. Participants were instructed to press a rubber bulb as they were told by the investigator to start, stop, or synchronize presses with a flashing light and with his own speech. At 1.5–2.5 years, the instigating function of speech by the adult (start) was successful but not the inhibiting function (stop). Self-initiating and inhibiting functions of speech at that age were lacking. At 3–4 years, both the initiating and inhibiting functions of the experimenter's speech and the initiating function of the child's own verbal activity were objectified but not the self-inhibiting function. The complete regulating function of the child's own speech was observed at 4.5 years.

The investigation of natural self-regulatory private speech in children shows that it first follows behavior, then it accompanies action, and finally it precedes it. Use of private speech for self-regulatory purposes significantly increases between 3 and 4 years of age. Social agents who actively include children in a collaborative effort to solve problems facilitate the development of self-regulatory private speech. Joint work on common problems helps children to internalize coping strategies and produce individualized vocalizations adapted to solving problems encountered when alone.

The Private Speech Transition

A significant shift in children's spontaneous use of private speech occurs between the ages of 3 and 4. Three-year-old children emit self-talk across a very large array of situations (e.g., goal-directed and unfocused activities), whereas 4-year-olds' private speech tends to be observed almost exclusively during self-selected but focused, sustained, goal-directed activity. This indicates that 4-year-old children start engaging in private speech in situations in which it is mostly required for self-regulatory purposes.

Characteristics of Inner Speech

Fully internalized private speech transforms into inner speech, and it takes a life of its own with distinctive characteristics that differ from those of social speech. The semantic aspect of speech becomes most prominent as its syntactic and phonological dimensions move to the background. Unlike social speech, inner speech is predicative: it is syntactically compressed, condensed, and abbreviated. The context of speech being always known to the self-talker, there is no need to explicitly identify the subject of a thought. In inner speech, sense prevails over meaning. The private significance of words becomes more salient than their conventional meanings. Agglutination refers to the creation of hybrid words that constitute complex and uniquely personal concepts. The predicative nature of inner speech explains why it is experienced as a series of fragmented units – not as a smooth sequence of fully developed verbal images. This actually accounts for the observation that the rate of inner speech is significantly faster than that of overt speech.

Inner speech often exhibits a dialogic quality because it grows out of social speech, itself being mostly a dialog between two persons. Inner speech is regularly described as including a speaking self (the inner voice) and a self talked to (the inner ear). Indeed, inner speech frequently adopts a format that approximates social verbal interactions, with a series of alternating lines, questions, and answers. Various acoustic qualities of overt speech perception (e.g., sex, loudness, accent, and language) are not reported during internal speech.

Neuroanatomy

Experiments employing PET and fMRI scans show that the LIFG is more active during inner speech production elicited by tasks such as silently articulating sentences or single words. The LIFG is also recruited when subjects undertake working memory tasks involving covert repetition of verbal material. The LIFG corresponds to Broca's area, which constitutes the neurological foundation of both overt and inner speech generation. The LIFG is also referred to as the left ventrolateral prefrontal cortex or left frontal operculum; it encompasses Brodmann's areas 44, 45, 46, and 47. Additional brain areas are activated during inner speech use, including Wernicke's area, supplementary motor area, insula, and superior parietal lobe on the left side, as well as right posterior cerebellar cortex.

Neuropsychological findings are consistent with brain-imaging studies: accidental damage to the LIFG disrupts inner

speech. rTMS applied to the LIFG interferes with internal speech. rTMS applied to the motor cortex of the left hemisphere, which is known to control mouth and tongue muscles, also inhibits inner speech – an observation in line with the view that covert speech necessitates articulation. The LIFG is not uniquely activated during inner speech production. Its activation can also be recorded during cognitive control (the orchestration of thoughts and actions in accordance with internal goals), working memory (temporary storage and manipulation of information), selection among competing alternatives to guide response, and interpretation of others' behavior. Note that naturally occurring inner speech, with its condensed and dialogic qualities, has never been imaged; what has been measured so far is inner speech defined as mental recitation.

Functions

Self-regulation

Overview

Fundamental human activities such as setting immediate and distant goals, problem-solving, planning, and decision-making are all part of a more global capacity called self-regulation. Private speech in children and inner speech in adults have been shown to be of critical importance for effective self-regulation. Not surprisingly, the expression verbal self-guidance is often used to designate self-regulation. Self-talk significantly increases performance on tasks that entail the creation of complex behavioral sequences and the concurrent judgment of multiple behavioral choices. Four main groups of effective self-verbalizations during problem-solving tasks have been documented: (1) a clear definition of the problem; (2) an efficient approach to the problem; (3) sustained concentration on the problem; and (4) regular assessment of progress that includes self-encouragement or strategic refocusing.

Private speech

Private speech use in children gradually increases as tasks become more challenging. It is most often observed when participants work on tasks that require executive control in the absence of regulation offered by adults. Representative tasks found in research reports are puzzles, memory tasks, picture classification and discrimination, and sequencing tasks. The following situations increase the likelihood of private speech use for self-regulatory purposes: (1) completion of goal-directed, academic, or problem-solving tasks as opposed to free play or other activities; (2) working on difficult yet achievable problem-solving tasks instead of easy tasks; (3) being either alone or with peers in contrast to being with a verbally regulating adult; and (4) working with an encouraging as opposed to highly controlling adult. This is referred to as scaffolding, which consists in adult assistance only on those tasks that are beyond children's skills.

That private speech use increases with task difficulty does not automatically imply that it actually improves performance. Two factors that need to be considered are task complexity and concurrent versus future performance. Private speech will most likely impede performance if the task is too difficult. It will enhance performance if the task is within the child's zone of proximal development – that is, if it is within the child's ability range. Also, private speech use is more beneficial on the long

term (future) than on the short term (concurrent). Increased performance following private speech use is delayed (diachronic) instead of instantaneous (synchronic). Better performance is typically observed during task sessions following the time at which private speech was produced.

Self-talk use in sports

Numerous studies have examined the self-regulatory use of self-talk in athletes while training and competing during sporting activities such as water-polo, skating, golf, gymnastics, wrestling, and basketball. Self-verbalizations have been shown to be superior to other mental strategies (e.g., mental imagery) in enhancing sport performance. Dimensions of self-talk that are usually measured or manipulated in studies are valence, overtiness, self-determination, self-instruction, self-motivation, and frequency. Valence refers to the emotional content of self-statements. While negative self-talk is associated with poorer performance, positive self-talk does not significantly increase it. Positive self-verbalizations are defined as those that help to concentrate on the present, not on past errors or a remote future. Negative self-statements constitute inappropriate, irrational, counterproductive, or anxiety-producing thoughts. Another quality of self-talk is overtiness, as opposed to covertness. It has been suggested that overt self-talk is more effective at improving performance because it allows the athlete to reproduce situations where his or her coach verbally guides performance aloud. Self-determined (i.e., self-selected) self-talk is postulated to possess more motivational power than preformulated self-talk assigned by a trainer. How-to-perform self-talk is called self-instructional talk and is especially effective in practice situations, whereas I-can-do-it talk represents motivational self-talk and is more appropriate in competitive settings. Frequency of self-talk often increases across various periods of a sporting season and is linked to superior performance, although extreme frequency (called paralysis by analysis) worsens it.

Language

Inner speech underlies basic language functions such as reading, writing, speaking, and calculating. Deterioration of inner speech caused by brain injury consistently produces language disorders such as aphasia, agraphia, alexia, acalculia, as well as reduced verbal short-term memory. Current studies indicate that speakers monitor their own subvocal speech to identify and correct phonological, lexical, or grammatical mistakes before they are spoken. Inner speech and crib speech are often recruited when one spontaneously practices pronunciation and thinks about grammatical correctness. Significant lip movements are observed during silent reading, and patients with frontotemporal dementia and Gilles de la Tourette's syndrome, who exhibit a loss of control over inner speech which manifests itself in coprolalia (emitting unwanted vocalizations in social situations), also cannot read in silence. These two lines of evidence strongly suggest that inner speech and silent reading are deeply associated.

Links between inner, oral, and written speech, reading, and composing

As seen earlier, because inner speech is solely addressed to the self, it is telegraphic, densely meaningful, fluid, dynamic,

idiomatic, agglutinative, elliptic, and predicative. Written speech, however, is produced for others and thus is fully expanded, maximally elaborated, and orthographically explicit. Composing refers to the process of putting ideas and words onto paper; inner speech allows the writer to engage in mental rehearsal, or planning, to determine what to write. Oral speech lies in between inner and written speech – it is more spontaneous and involuntary than written speech, it requires an interlocutor, like inner speech it is dialogic, and it is made up of actual sounds. Social speech develops first, followed by inner speech, then both written speech and reading. But relationships between inner and written speech are bidirectional. On the one hand, inner speech serves as an internal rough draft for oral and written speech. On the other hand, the very structure of written language forces an analytic (metalinguistic) stance on inner speech. The sophisticated, elaborated qualities of written speech encourage a less spontaneous and involuntary use of inner speech. Not only does inner speech constitute the basis of written speech but also underlies reading. In contrast with inner speech, writing and reading require much more voluntary attention to the phonological, syntactic, and semantic aspects of speech.

Language without inner speech?

One scientific article describes the case of a patient who retained normal language functions despite being incapable of inner speech. This evidence seems to contradict the claim that language functions require inner speech. However, careful neuropsychological assessment showed that the patient was using mental imagery to compensate for the absence of inner speech. That is, instead of verbalizing words to himself, the patient could create clear images of words when talking to himself – thus engaging in inner imaging as opposed to inner speech. Apparently, this visual communication with oneself effectively replaced inner speech and other language functions such as reading and calculating.

Do deaf people talk to themselves?

Individuals born deaf never experience hearing sounds and thus do not develop normal language skills, including inner speech. Simply put, since deaf people would never have heard spoken words, they cannot speak with or think in words. Can they nonetheless engage in a form of wordless self-talk? The answer is yes, with sign language. Use of sign language in deaf individuals activates the LIFG – the brain area known to sustain inner speech. As seen before, articulatory suppression interferes with performance on tasks that benefit from inner speech use in orally proficient individuals. A comparable deterioration in task performance is obtained in sign users by having signers hold objects firmly in their hands, which inhibits self-sign language use. Also, deaf individuals tend to wave hands when working on difficult tasks – the nonverbal equivalent of private speech.

Memory

Working memory

Inner speech plays an important role in memory functions, particularly in working memory. Working memory allows one to keep a small quantity of information in an active state for a short period of time. It is involved in numerous complex

cognitive abilities that include reasoning, decision-making, problem-solving, and language understanding. Verbal and spatial information are manipulated differently in autonomous neuroanatomical systems. Each system is made up of three functional parts with unique neural correlates. One component stores information, another one rehearses – reactivates, refreshes – it, and a third component (the executive one) controls the overall processing of information in working memory. Inner speech is synonymous with the rehearsal component, at work, for example, when one mentally repeats a phone number to assist later recall.

Autobiographical memory in bilinguals

Inner speech has also been shown to be involved in autobiography, the memory of one's own past. Phenomenological inspection makes it clear that images are often used when we store and recall personally relevant events. However, a recent study suggests that autobiographical information is also encoded and retrieved in words, or in narrative form. A related issue is: in what inner language do bilinguals recall their past? One cross-cultural study assessed inner speech of autobiographical memory in Polish people who emigrated to Denmark 30 years ago. Participants indicated retrieving personal memories in Polish for the decades prior to immigration and in Danish after immigration. This observation thus suggests that autobiographical material stored in one language is more easily retrieved in the same language. All immigrants spent 30 years in Denmark, but early immigrants (on average 24 years old at the time of immigration) indicated using more Danish inner speech, while late immigrants (about 34 years old at the time of immigration) reported more Polish inner speech use.

Self-awareness

It is becoming increasingly evident that fully developed human self-awareness depends on inner speech use. Self-awareness refers to the ability to analyze the self and to build a self-concept. It includes focus on private and public self-aspects and consists in self-definition, self-recognition, self-evaluation, self-esteem, mental time travel, and death awareness, to name a few self-referential processes. Inner speech allows one to identify and label various self-aspects – it makes it possible for a person to represent internal states and reflect on them. There is considerable empirical support for the notion of inner speech participation in self-awareness. Multiple validated questionnaires measuring frequency of self-focus and use of inner speech strongly correlate. Healthy participants claim to rely significantly on inner speech while thinking about their future. Brain-imaging studies of self-referential processing often report activation of the LIFG and thus, most probably, inner speech use. Brain injuries that produce a loss of inner speech are associated with self-awareness deficits. The development of theory-of-mind, which consists in thinking about others' mental states, is linked to private speech use in preschoolers.

Additional Functions

Inner speech does not uniquely play a role in self-regulation, language, memory, and self-awareness. It is also involved in

task-switching performance, the ability to switch back and forth between two cognitive operations such as multiplying and dividing numbers. Children learn to differentiate their own voice from those of others by repeatedly hearing their own voice through private speech use. People also talk to themselves when mentally preparing an upcoming social encounter. Inner speech is also activated when one focuses attention on a given target, forms concepts, remembers the goals of actions, or expresses emotions such as anger. Some have proposed that praying engages inner speech.

Dysfunctional Inner Speech

Overview

Ruminative inner speech that focuses on real or imagined negative self-aspects may amplify preexisting morbid conditions such as test anxiety, bulimia, anorexia, lack of assertiveness, insomnia, social anxiety, agoraphobia, sexual dysfunctions, low self-esteem, and depression. Inner speech may also accompany less severe and temporary negative states such as worry, guilt, and shame. The content-specificity hypothesis suggests that the aforementioned maladaptive conditions underlie negative self-talk associated with specific dysfunctional topics. To illustrate, anorexia triggers inner speech revolving around weight and physical appearances issues (e.g., I must lose weight), and low self-esteem is linked to self-worth cognition (e.g., I'm insignificant). Accordingly, compulsive gamblers have irrational thoughts about control of the game (e.g., I'm going to bet on those rows again, this is a good game).

Asymmetry Between Positive and Negative Self-verbalizations

There exists an important and counterintuitive asymmetry between positive and negative self-statements. Negative inner speech has a significantly more dysfunctional influence than positive self-talk on coping. Simply put, imagining the worst through pessimistic inner speech (e.g., failing an exam) has more negative impact than thinking positively (passing an exam). This fact clearly goes against the fashionable belief of positive thinking and suggests that eradicating negative verbalizations might be more efficient than formulating positive ones. Healthy functioning is associated with a 1.7:1 ratio of positive to negative self-verbalizations; maladaptive thinking is characterized by a 1:1 ratio. Studies that measure cognitive change following psychotherapy confirm that negative thoughts tend to decline while positive thoughts do not increase. Negative verbalizations (e.g., disfigurement) increase heart rate, but positive ones (e.g., harmony) have no significant effect.

The Rebound Effect

Also perplexing is the observation that trying to suppress undesirable thoughts in inner speech (e.g., I must stop thinking about this) makes the thoughts more accessible (they are experienced more often) and leads to increased anxiety, depressed mood, and lower self-esteem. This paradoxical phenomenon is called the rebound effect.

Hearing Voices in Schizophrenia

The most plausible explanation for auditory verbal hallucinations in schizophrenic patients is that they cannot properly monitor their own self-generated inner speech. There is little doubt that the voices are the result of patients' own subvocal activity. Indeed, the LIFG is active when schizophrenic patients are experiencing verbal auditory hallucinations, suggesting inner speech production. The precise underlying mechanism is unknown, but one view implicates a verbal self-monitoring deficit. Speech production in normal individuals generates a corollary discharge that sends a message to the left temporal lobe where verbal thoughts are identified. Basically, the message tells the brain that it just produced speech and thus the voice heard is one's own inner speech. This communication between the frontal and temporal lobes is postulated to be deficient in schizophrenic patients. Brain-imaging studies support this hypothesis: patients with auditory hallucinations show activity in the LIFG when engaging in inner speech but fail to exhibit activity in the left temporal cortex. That verbal hallucinations would be caused by an inner speech dysfunction per se is improbable. Performance on short-term memory tasks that require inner speech use is normal in patients experiencing severe auditory hallucinations.

Hyperactivity

Initial explanations of hyperactivity in children involved the notion of insufficient self-regulatory private (and inner) speech causing poor self-control. Cognitive-behavioral psychologists designed various techniques to increase the use of verbal self-guidance. A typical approach consisted of gradual stages producing the internalization of self-regulatory speech – for example, modeling, overt external guidance, overt self-guidance, faded overt self-guidance, and covert self-guidance. This method has recently been reevaluated, and most agree that it is actually ineffective. First, the aforementioned approach focuses on short-term results that apply to precise tasks; what would be needed is a technique leading to long-term gains that would generalize to broad academic and interpersonal behaviors. What used to be taught was self-control (i.e., copying adults' commands) instead of authentic self-regulation (i.e., self-generating flexible plans for action). Second, in point of fact, hyperactive kids produce adequate self-regulatory private speech. The nature of the deficit does not lie in lack of verbal self-guidance – it is most likely neurobiological.

Conclusion

Inner speech constitutes a fundamental cognitive activity not limited to working memory (the phonological loop) but including self-regulation (initiating, shaping, guiding, and controlling behavior), language functions, self-awareness (e.g., autobiographical memory, mental time travel), emotional release, task-switching, preparation for upcoming social encounters, and more. Various methods exist to measure inner speech, some easy to administer but limiting (e.g., questionnaires) and others more ecologically valid but time consuming (e.g., thought sampling). The general agreement is that inner

speech is social in origin, it is preceded by private speech, and once internalized, it becomes mostly abbreviated and predicative. Although various brain regions underlie inner speech production, the LIFG seems to represent the most important area. Inner speech resembles a double-edged sword – on the one hand, it is associated with positive consequences such as self-regulation, yet on the other hand, negative and ruminative self-talk may lead to or maintain psychological disorders such as anxiety and depression. Inner speech, nonetheless, remains neglected compared to other important psychological concepts. To illustrate, what people actually talk to themselves about is largely unknown and current work is precisely aiming at answering that and other exciting research questions.

See also: [Agraphia and Alexia](#); [Aphasia](#); [Autobiographical Remembering and the Self](#); [Bilingualism and Multilingualism](#); [Language Development](#); [Planning](#); [Problem Solving](#); [Psychology of Reading](#); [Schizophrenia](#); [Social Cognition](#).

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Intellectual Disabilities

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Glossary

Adaptive behavior The set of behaviors necessary for individuals to function safely and appropriately in the range of activities and environments presented in daily life.

Autism spectrum disorders A spectrum of developmental disorders manifested by impaired social interaction and communication, as well as stereotypic behaviors.

Behavior skills training Training in a behavior or skill that involves teaching, modeling, rehearsal, and feedback.

Cognitive behavioral therapy Therapeutic treatments, based on cognitive and behavioral theories and research, used to address various mental health disorders.

Down syndrome A genetic disorder caused by the presence of an extra chromosome 21.

Dual diagnosis Comorbidity of intellectual disability and mental health disorder in an individual.

Etiology The cause or origin of a disability; in this text, the genetic cause of an intellectual disability.

Inclusive education Placement in the general education classroom with individualized supports and accommodations.

Intellectual disability Significantly subaverage intellectual functioning which leads to impairments in adaptive behavior, all of which are first manifested during childhood.

Prader-Willi syndrome A genetic disorder caused either by a deletion of a certain part of the chromosome 15 contributed by the father, or from having two chromosome 15s from the mother.

Psychopathology Behaviors symptomatic of mental illness or psychological impairment.

Task analysis The delineation of component steps required to complete a more complex task.

Williams syndrome A genetic disorder caused by a deletion on one of the chromosome 7s.

Issues Related to Intellectual Disabilities

Although long considered a less interesting or exciting area, the field of intellectual disabilities is beginning to hit its stride. Spurred by findings that are important to many disciplines, the past two decades have seen a growing interest in individuals with intellectual disabilities. Correspondingly, there has been a rapid expansion in our nation's disability-related service and training structures, the inauguration of several new journals, and the start of many research and clinical networks. In future years, we expect even greater numbers of sophisticated, interdisciplinary research projects and increased services to these individuals, all performed by professionals who have received academic, research, and clinical training focused on persons with intellectual disabilities and their families.

To appreciate these new developments, one needs only to juxtapose present advances with those in prior years. Until the early 1960s, the field of intellectual disabilities was in its infancy. Few studies existed, few professionals were trained in intellectual disabilities, and disability-related infrastructure was virtually nonexistent. But with the presidency of John F. Kennedy (himself the brother of a woman with intellectual disabilities), a formal field began to take shape. The Kennedy administration is generally credited with founding the National Institutes of Child Health and Human Development (NICHD), the United States' main supporter of biobehavioral research in typical and atypical development. Similarly, the Kennedy Administration started the movement to develop University Centers for Excellence in Developmental Disabilities to help in service delivery, as well as programs to provide training in intellectual disabilities to medical and nonmedical professionals.

More recently, the field has contributed to advances in genetics and biomedicine. Over 1000 different genetic conditions have now been associated with intellectual disabilities, but more importantly, certain genetic etiologies have been found to predispose individuals to specific maladaptive behaviors, profiles of cognitive-linguistic strengths and weaknesses, and medical or other conditions. Across many disciplines, researchers have begun to appreciate that individual genetic conditions may constitute model systems that may help in understanding specific cognitive processes, psychiatric diagnoses, or medical conditions.

Defining and Classifying Intellectual Disability

Formerly referred to as 'mental retardation,' intellectual disability has a long history of debate as to how it is best defined and classified. Here, we discuss the main system used to diagnose individuals with intellectual disabilities, as well as the several ways in which professionals have classified these individuals.

Three-Pronged Definition

While the field continues to debate the appropriate way to define an intellectual disability, at least in broad outline the definition of intellectual disabilities has remained relatively stable over time. According to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition-Text Revision* (DSM-IV-TR), a three-pronged definition characterizes intellectual disability: (1) having significantly subaverage intellectual functioning that leads to (2) impairments in adaptive behavior, all of which are (3) first manifested during the childhood years.

First, in order for a diagnosis of intellectual disabilities to be warranted, the individual must have subaverage intellectual functioning. Subaverage intellectual functioning is operationalized as a score of 70 or below on an appropriately standardized, individually administered IQ test.

Second, individuals must show impairments in everyday adaptive behavior. Thus, individuals with intellectual disabilities often have difficulties in performing age-appropriate skills of daily living (i.e., caring for themselves and their environments); of communicating with others via expressive, receptive, or written communication; or of getting along with others and following rules. This second criterion highlights that intellectual disabilities are not solely related to intellectual deficits, but they are also associated with concurrent deficits in everyday functioning. To be diagnosed with intellectual disabilities, then, individuals must also display impaired adaptive behavior.

Third, individuals must also first exhibit deficits in both intellectual and adaptive behaviors prior to 18 years of age. Thus, an intellectual disability is not an appropriate diagnosis for individuals showing deficits related to accidents, illnesses, or aging that originate during the adult years.

While most would agree with these three diagnostic criteria, controversy abounds regarding how each is operationalized. In addition to the general criticisms leveled at IQ tests, all agree that few differences exist between individuals slightly below versus slightly above IQ 70 (the IQ cut-off line for intellectual disabilities). Similarly, professionals debate which specific skills should constitute adaptive behavior; even the field's main professional organization, the American Association on Intellectual and Developmental Disabilities, has changed the numbers and names of adaptive domains in subsequent definitional manuals. Concerns also exist regarding appropriate measures of adaptive behavior, the relation between adaptive and intellectual functioning, and the potentially limited opportunities that certain individuals have to develop adaptive skills. Still, while each issue has received varying attention over the years, most would agree that the combination of subaverage intellectual functioning, concomitant deficits in adaptive behavior, and onset during the childhood years, all characterize those with intellectual disabilities.

Classification: Level-of-Impairment Approach

Just as most would agree to the three-pronged definition of intellectual disabilities, so too do most agree that individuals with intellectual disabilities differ one from another. The problem, however, concerns how best to differentiate within this population.

A first perspective has been referred to as a level-of-impairment approach. That is, individuals with intellectual disabilities are differentiated by their level or degree of intellectual impairment. The most common level-of-impairment categorization is by IQ score: mild (IQ between 50 and 69), moderate (IQ between 35 and 49), and severe/profound (IQ between 0 and 34) levels of functioning. Another categorization – most often used by the school system – differentiates students into those who are Trainably Mentally Handicapped (TMH) or Educably Mentally Handicapped (EMH); this categorization would then direct the placement and instruction for the individual.

Another categorization is by the level of services that the individual needs. Technically, this system is not a level-of-impairment classification system, in that two individuals with the same IQ score might have different service needs. Still, particularly for those individuals at the moderate and severe-profound levels, a strong correlation exists between IQ and service needs (correlations are weaker for individuals with IQs in the mild range). The support needs noted by this system include: intermittent, limited, extensive, and pervasive. Intermittent support refers to occasional support, whereas limited support refers to a day program or sheltered workshop. Extensive support refers to daily, ongoing support, whereas pervasive support involves support for all activities of daily living (possibly including nursing care).

Classification: Etiological Approach

First begun by Edward Zigler in the late 1960s, the second approach to classification concerns the cause or etiology of the person's intellectual disabilities. In earlier years, researchers distinguished between those persons who had a clear cause of their intellectual disabilities from those who did not. Thus, Zigler and others wrote of persons who showed 'organic' intellectual disabilities, or disabilities that could be traced to any of hundreds of pre-, peri-, or postnatal causes. This 'organic' group was contrasted with a group of individuals whose intellectual disabilities could not be attributed to any clear causes. This latter group of individuals, called by a wide variety of names (familial, cultural-familial, sociocultural familial), have also been the subject of different theories with regard to the cause of their intellectual disabilities.

Over the past two decades, the group with 'organic' intellectual disabilities has been further divided into those with different genetic causes. At the last count, over 1000 different genetic causes of intellectual disabilities were identified, and many show etiology-related behaviors as well as medical and other characteristics. Such personal characteristics, in turn, have proven extremely interesting to professionals in a variety of disciplines.

Genetic Etiology

Before providing examples of three genetic etiologies, we first provide some background. First, a genetic disorder predisposes individuals to show a particular behavior, although not every individual with that disorder necessarily exhibits the behavior. Thus, not every person with Prader-Willi syndrome engages in hyperphagia (overeating), and not every person with Williams syndrome has relatively strong linguistic and weak visuospatial skills. Second, not every genetic condition is associated with its own unique outcome; indeed, several disorders may show a single behavioral characteristic or set of characteristics. Finally, there are many etiology-related outcomes. Some involve a specific pattern of cognitive, linguistic, or adaptive strengths and weaknesses; others pertain to certain times during development when rapid or slowed development occurs; still others predispose individuals to displaying one or more maladaptive behaviors. In addition to such behavioral outcomes, different genetic syndromes also predispose children and adults to specific physical characteristics and medical problems (e.g., heart disease, leukemia, Alzheimer's disease).

With this brief background, we now discuss three genetic syndromes: Down syndrome, Prader–Willi syndrome, and Williams syndrome. We have chosen to highlight these because each syndrome features a fair amount of behavioral research, and is associated with several interesting behavioral characteristics. Each in its own way helps to make intellectual disabilities interesting to researchers in various areas of psychology, psychiatry, and other behavioral sciences.

Down Syndrome

The most common genetic–chromosomal disorder causing intellectual disability, Down syndrome occurs in about 1 per 800 births. Caused in most cases by the presence of an extra twenty-first chromosome, Down syndrome is associated with distinct physical and behavioral characteristics. These individuals are often affected by poor muscle tone, congenital heart defects, thyroid problems, vision and hearing problems, leukemia, and other health issues. By age 40, all persons with Down syndrome are thought to have the plaques and tangles characteristic of Alzheimer’s disease, even though the dementia normally associated with Alzheimer’s disease appears only in some adults (usually by age 50). Although life spans have risen rapidly over the past few decades, the median age of death for individuals with Down syndrome is now about 60 years (some 15–20 years less than the life expectancies found in the general population).

Generally associated with intellectual disability in the mild to moderate range, individuals with Down syndrome also demonstrate a specific behavioral profile. Most persons with the syndrome show relative strengths in visual (as opposed to auditory) short-term memory, with relative weakness in several linguistic tasks. With only a few exceptions, most children and adults with Down syndrome struggle with expressive language and articulation, as well as with consistent use of grammatical morphemes (e.g., ‘-s’ for plural, ‘-ed’ for past) and other aspects of grammar.

In terms of personality, individuals with Down syndrome are often described as being cheerful, friendly, and eager to please. However, this commonly accepted description does not include other characteristics also frequently observed among individuals with Down syndrome. For example, some children and adults have been described as active, distractible, and stubborn. As with all behavioral profiles, variation exists and some individuals may exhibit these personality characteristics, while others may not.

Although maladaptive behaviors are found at lower rates than among others with intellectual disabilities, researchers nevertheless estimate that 13–15% of children with Down syndrome engage in maladaptive behaviors, such as stubbornness, defiance, and aggression. Also, children with Down syndrome have been found to exhibit repetitive, compulsive-like behaviors in more extreme forms and more frequently than typically developing children. However, like typical children, the frequency of these behaviors decreases as age increases. Also, individuals with Down syndrome may be affected by attention-deficit hyperactivity disorder (ADHD), oppositional and conduct disorders, and anxiety disorders. Such psychiatric conditions typically manifest during childhood and adolescence; researchers generally report higher prevalence rates among adolescent populations.

As individuals with Down syndrome reach adulthood, they may become more vulnerable to depressive disorders. Approximately 6–11% of adults with Down syndrome are thought to experience depression and affective disorders, including characteristic features such as being passive, apathetic, and withdrawn. Adult depression may originate in adolescence and early adulthood and may be confused with the early signs of Alzheimer’s disease, which often has a similar presentation.

Recent research has also described a change during adolescence among some individuals with Down syndrome, who became increasingly underactive and overweight. Likewise, as compared with their behavior during childhood, some adolescents may exhibit increasingly secretive tendencies and preferences to be alone. Even compared with other young adults with intellectual disabilities, young adults with Down syndrome may benefit from increased activity and engagement in community life. Negative physical and behavioral changes among adolescents with Down syndrome warrant attention, as they may anticipate depressive symptoms in adulthood.

Prader–Willi Syndrome

Occurring in about 1 per 15 000 births, Prader–Willi syndrome results from two distinct causes. Most cases (70%) result from a deletion on the long arm of the paternal chromosome 15. The remaining individuals diagnosed with Prader–Willi syndrome result from maternal uniparental disomy of chromosome 15, in which both chromosome 15s are contributed by the mother. Common to both causes is the absence of the paternal contribution to chromosome 15. Individuals diagnosed with Prader–Willi syndrome are often categorized in the mild range of intellectual disability (IQ scores averaging around 70), and show relative strengths in daily living skills.

The most notable behavioral characteristic of Prader–Willi syndrome is hyperphagia, or compulsive overeating. Hyperphagia, which begins in most children sometime between 2 and 6 years and continues throughout life, is thought to involve the hypothalamus and is characterized by incomplete satiation (hence the motto of the Prader–Willi Syndrome Association of the United States: “Always hungry, never full”). Behaviors associated with hyperphagia include food-seeking, foraging, and hoarding. If left unchecked, individuals with Prader–Willi syndrome become morbidly obese, and some adults can weigh 300 pounds or more. As might be predicted, obese individuals with Prader–Willi also experience heart disease, diabetes, and sleep apnea. Dietary interventions are critical to avoid these health risks and to decrease the prevalence of early death related to obesity.

Beyond hyperphagia, individuals with Prader–Willi syndrome also often display high rates of other maladaptive behaviors. Many engage in tantrums and aggressive behavior, and may be described as emotionally labile and stubborn. Individuals with Prader–Willi are also often described as underactive and lethargic, further contributing to health concerns.

These individuals also show high rates of obsessive and compulsive behaviors. Although such obsessions and compulsions often relate to food, individuals with Prader–Willi syndrome also engage in obsessive–compulsive behaviors unrelated to food, such as hoarding objects, performing rituals, and obsessive cleaning. Similar to their food-related obsessions,

other obsessive and compulsive behaviors typically emerge during the preschool years. The tendency toward these behaviors among individuals with Prader-Willi syndrome indicates the increased risk of obsessive-compulsive disorder (OCD) in this population.

While originating in childhood, obsessive-compulsive behaviors typically intensify in adolescence and adulthood. Awareness of this trend should inform the administration of assessments and development of interventions to address various compulsions and maladaptive behaviors. Additionally, the severity of behavior among individuals with Prader-Willi syndrome, particularly related to eating, often warrants highly restrictive interventions (e.g., dedicated 'Prader-Willi-specific' group homes with locked kitchens). Understanding both the trajectory of these maladaptive behaviors and their typical levels of severity can help professionals effectively intervene to benefit the physical and mental health of individuals with Prader-Willi syndrome.

Williams Syndrome

Williams syndrome results from a deletion on one of the chromosome 7s that includes the gene for elastin, a protein in connective tissue that supplies strength and elasticity to the organs. Occurring in about 1 in 10 000 births, those with Williams syndrome are often affected by health problems related to elastin insufficiency, such as cardiovascular disease. Individuals with Williams syndrome are also typically affected by hypercalcemia, as well as by musculoskeletal and renal abnormalities. Individuals with Williams syndrome also often experience hyperacusis, or an oversensitivity to certain sound frequencies.

Most notable to behavioral researchers has been the syndrome's characteristic cognitive-linguistic profile. Most individuals with Williams syndrome have limited visuospatial skills such that they have great difficulty in drawing and performing visual tasks on IQ tests. However, they are generally able to recognize faces, as well as understand and respond to facial emotions. In addition, most individuals with Williams syndrome show relatively strong abilities in expressive language, with well-developed vocabularies (often including atypical or low frequency words), use of relatively advanced syntax and semantics, and at times advanced prosody and story-telling skills.

Persons with Williams syndrome also often display an affinity for music. Although much has been made of musically talented individuals with Williams syndrome, such individuals are relatively rare. In contrast, most individuals with the syndrome are highly interested in music; these individuals seem to have exaggerated emotional responses to music that are currently being examined by researchers using functional MRI, ERP, and other real-time brain measurements.

In terms of personality, individuals with Williams syndrome are often described as unusually friendly, engaging, pleasant, and interpersonally sensitive. At the same time, however, many of these individuals are also described as impulsive, hyperactive, and inattentive, with a tendency to be socially disinhibited. Together, these behavioral characteristics often lead the individuals with Williams syndrome to be strikingly but indiscriminately social; as a result, many adolescents and adults with Williams syndrome have difficulties in developing

and maintaining friendships. Furthermore, their indiscriminately social behaviors may make these individuals more vulnerable to exploitation.

Recent research also highlights the tendency among individuals with Williams syndrome to become highly anxious, worried, fearful, and to have perseverative thoughts. Indeed, compared to those with other types of intellectual disability, persons with Williams syndrome are more prone to experience anxiety, and such fears and anxieties increase during adolescence. Many fears are about future events and health concerns. While many individuals with Williams syndrome experience some level of anxiety, it is unclear how this tendency relates to phobias and other psychiatric conditions.

In addition to appropriate medication, interventions to address anxiety among individuals with Williams syndrome might be developed based on the relative strengths of this group. Given the high verbal abilities of most individuals, interventions might prove particularly helpful when they involve talking to a therapist or participating in group therapy sessions. Finally, given most individuals' affinity for music, therapies involving music may be particularly helpful in addressing anxiety and other behavioral issues experienced by many persons with Williams syndrome.

Dual Diagnosis

Beyond the specific maladaptive behaviors and psychiatric conditions found in individuals with Down syndrome, Prader-Willi syndrome, and Williams syndrome, generally higher rates of maladaptive behavior-psychopathology occur within the overall population of those with intellectual disabilities. Until recently, this statement was in itself controversial, in that parents and advocates wanted to distinguish the interests and needs of those with intellectual disabilities from those with psychiatric diagnoses but who did not have intellectual disabilities. Recently, however, the field has realized that it needs to pay greater attention to the amounts, types, and treatments needed for those who are 'dually diagnosed,' who have both intellectual disabilities and emotional/behavioral problems.

The first issue relates to the sheer amount of mental health issues among those with intellectual disabilities. At present, estimates vary widely, with the prevalence of comorbid intellectual disabilities and mental health issues estimated to be as low as 10% and as high as 70% in all individuals with intellectual disabilities. Though imprecise, the median number, about 40%, indicates that many of these individuals have significant mental health concerns.

A second issue relates to the types of problems these individuals experience. It may, for example, be the case that persons with intellectual disabilities are at higher risk for certain kinds of psychopathology but not for others. Although this issue is difficult to resolve, so far most work has focused on several specific psychiatric diagnoses. For the sake of space, we discuss here the diagnoses of autism spectrum disorder, anxiety, and depression.

Individuals with intellectual disabilities who have autism spectrum disorders (ASD) may have higher rates of behavioral problems. ASD is a spectrum of developmental disorders manifested by impaired social interaction and communication,

as well as stereotypic behaviors. Prevalence rates for the dual diagnosis of intellectual disability and ASD range from 2% to 41%. Compared to those with an intellectual disability alone, individuals with both ASD and intellectual disability have higher levels of problem behavior, including stereotypy, aggression, and self-injurious behavior. Additionally, individuals with ASD and intellectual disability (vs. those with intellectual disability alone) have higher rates of pica (eating nonedible items) and sleep disorders.

As a second issue, individuals with intellectual disability are at a higher risk for anxiety. Prevalence of anxiety among individuals with intellectual disabilities has been estimated to be as low as 1.5% to as high as 24% of this population. As noted above, individuals with certain genetic conditions (vs. those with other genetic conditions or with unknown etiology) may be more likely to have heightened anxiety. For example, individuals with Williams syndrome are more likely to have anxiety, including generalized anxiety or worry about the future.

Like anxiety, depression is thought to be more prevalent among individuals with intellectual disabilities. Also similar to the literature on anxiety, the prevalence estimates of depression within this population vary widely, ranging from 1.5% to 30% of all individuals. Though rates of depression are higher among individuals with (vs. without) intellectual disabilities, prevalence patterns mirror those of the general population: women are more prone to depression than men, and adolescents/adults are more likely to experience depression than children. Additionally, certain genetic disorders may be at a higher risk for depression. Thus, individuals with Down syndrome seem more vulnerable to depression, particularly during the adolescent and adult years.

Assessment

For several reasons, mental health professionals have difficulty in assessing psychopathology among individuals with intellectual disability. First, professionals have historically allowed the diagnosis of intellectual disability to overshadow a potential diagnosis of psychiatric disorders. For example, if an individual with intellectual disabilities displays symptoms of depression, anxiety, or a behavioral disorder, a clinician might simply attribute these behaviors to the person's intellectual disabilities, rather than assessing the individual for a psychiatric diagnosis. In this way, diagnostic overshadowing can lead to the lack of appropriate assessments and diagnoses for individuals with intellectual disabilities.

A second issue concerns the degree to which traditional diagnoses apply to individuals with intellectual disabilities. As described in the DSM-IV-TR and the ninth or tenth edition of the International Classification of Diseases (ICD), diagnoses are often based on information gathered during psychiatric interviews. When interviewing persons with intellectual disabilities, professionals have raised concerns about the validity of such interview responses for several reasons. First, persons with intellectual disabilities often display an acquiescence bias, telling the interviewer what he or she wants to hear. Second, some individuals with intellectual disabilities have difficulty with expressive language and with communicating abstract thoughts and feelings. Finally, some individuals may struggle with reporting accurate information about the nature and duration of their symptoms.

To address these problems, mental health professionals have developed alternatives to typical psychiatric interviews. For example, the Psychiatric Assessment Schedule for Adults with Developmental Disability was developed specifically to assess individuals with intellectual disabilities. Additionally, the National Association for the Dually Diagnosed (NADD) and American Psychiatric Association (APA) have recently adapted the criteria for diagnoses in the DSM-IV-TR, tailoring them for use with individuals with intellectual disabilities. These adapted criteria are detailed in the *Diagnostic Manual – Intellectual Disability* (DM-ID).

In addition to these assessment adaptations related to formal psychiatric diagnoses, other tools are available to assess the behavior of individuals with intellectual disabilities. Checklists and screeners developed expressly for this purpose include the Aberrant Behavior Checklist, the Reiss Screen, and the Developmental Behavior Checklist. In addition, conducting a Functional Behavioral Assessment (FBA) is an excellent way to observe the nature, duration, and functions of particular problem behaviors performed by an individual. Using the FBA, professionals can identify patterns in an individual's problem behavior, and identify interventions that may effectively decrease this behavior.

Interventions

To address areas of concern for individuals with intellectual disabilities, several interventions are available. These relate to academics, social and adaptive behavior, mental health, and family supports.

Academic Interventions

Prior to 1975, individuals with intellectual disabilities were either not educated at all or educated in segregated settings solely for individuals with intellectual disabilities. Since its passage in 1975, however, the Individuals with Disabilities Education Act (IDEA) has mandated that schools provide services to students with intellectual disabilities. Furthermore, IDEA requires that students with intellectual disabilities be educated in the least restrictive environment: to the maximum extent appropriate, these students are educated with their peers without disabilities. The most inclusive setting these students could participate in is the general education classroom with supports and modifications.

Research overwhelmingly supports the inclusion of students with intellectual disabilities in general education classrooms. When educated in inclusive settings (as opposed to segregated settings), students with disabilities have higher levels of academic achievement and social competence. Furthermore, there have been no negative effects upon the instructional time of students without disabilities; these students also benefit from inclusive schooling as it allows them to take on different academic roles (e.g., peer tutor) for their classmates with disabilities.

While prior to the 1997 reauthorization of IDEA most instruction for students with intellectual disabilities focused on functional skills, recently the instructional focus has been academic skills. Regarding reading, systematic prompting, and

fading have been found effective in teaching sight words to students with intellectual disabilities. These instructional developments have been critical to advancing the literacy of these students. To give one example, students with Down syndrome were historically not considered capable of learning to read, with many doubting that these students could gain phonemic awareness (i.e., the ability to break down words into sounds). Given appropriate instruction, however, many students with Down syndrome can acquire phonemic awareness and, eventually, literacy skills. Changes in instruction along with inclusive education have advanced both the academic achievement and community integration of individuals with intellectual disabilities.

Another intervention used to support the academic achievement of students with intellectual disabilities involves universal design. The purpose of universal design is to deliver instruction in multiple ways to ensure that all students can access the material. The curriculum is designed to give multiple representations of content, multiple options for expression, and multiple choices for engagement. Instruction using universal design principles could include using a lower reading level, using visual representation for words, and embedding auditory cues within text. These strategies can allow learners of all ability levels to access academic content.

Social and Adaptive Skill Interventions

In addition to academic interventions, there is also a need for interventions related to adaptive behavior and social skills. For example, an individual with an intellectual disability may have difficulty with self-determination: making choices and advocating for oneself. During childhood and into early adulthood, many choices are limited or unavailable to individuals with intellectual disabilities; instead of choices, these individuals are often given directives. For these reasons, it is important to explicitly teach individuals with intellectual disabilities about decision-making. One way to do this is through a task analysis. A task analysis breaks down the steps involved in a specific act into teachable units. By clearly delineating the steps needed to make a certain decision, the individual may be better able to make decisions.

Another issue related to self-determination among individuals with intellectual disabilities is safety and vulnerability. Compared to those without intellectual disabilities, individuals with intellectual disabilities are more likely to experience exploitation or victimization. During childhood, children with (vs. without) disabilities are four to ten times more likely to experience physical and sexual abuse, and neglect. Similarly, adults with intellectual disabilities are twice as likely to experience crimes committed against them. In response to such statistics, behavior skills training – teaching and modeling safety skills and then role-playing the learned skills – has proven an effective teaching method for this population. Such skills are further developed and generalized when behavior skills training sessions are combined with assessments in which the individual practices the safety skills in the community.

Related to their deficits in choice-making and higher likelihood of victimization, individuals with intellectual disabilities also have trouble with social adaptation. Specifically, some individuals with intellectual disabilities have poor

perspective-taking and poor social skills. Consequently, these individuals have difficulty recognizing and interpreting non-verbal and contextual cues. One way to address these social deficits is through social stories: by reading or hearing a story, the individual learns the social cues specific to a certain situation and the ways in which he or she should respond. By repeatedly reading the social story, the person with disabilities can learn the appropriate social response to a specific scenario.

Mental Health Interventions

Treatment of dually diagnosed individuals may include pharmacological interventions as well as cognitive and behavioral therapies. As with all patients, professionals should exercise caution in recommending pharmacological treatments for individuals with intellectual disabilities. There are, however, several issues of special relevance that must be considered.

First, many mental health professionals do not receive adequate training in working with individuals with intellectual disabilities; beyond their training years, most only work with this population occasionally. This lack of training and experience may result in diagnostic overshadowing, or in inappropriate diagnoses. Insufficient training and experience can also lead to inappropriate prescriptions for these individuals. Clearly, mental health professionals should exercise caution in diagnosing and treating persons with intellectual disabilities.

In addition to pharmacological interventions, individuals who are dually diagnosed may benefit from cognitive behavioral therapy. This type of therapy has been used to treat individuals with a variety of mental health issues, including depression and anxiety disorders. Using cognitive behavioral therapy to treat an individual with an anxiety disorder might involve relaxation and mindfulness training. Additionally, it might include gradual exposure to the object of fear or anxiety. Cognitive behavioral therapy alone, or paired with appropriate medication, offers potential for addressing the needs of individuals with intellectual disabilities.

Family Support

In earlier times, all families of individuals with disabilities were considered to have high levels of problems. Since the mid-1980s, however, researchers have appreciated that having a child with disabilities simply involves an added stressor on the family system. Like moving, changing jobs, having a child, or getting sick, such stressors can lead to either good or bad effects on the family overall and on each member. Following this realization, researchers changed in their perception that all of these families were in trouble, to the view that some families were doing well, others poorly. Henceforth, the emphasis shifted to identifying those characteristics – of the child with disabilities, the parents, siblings, or family as a whole – that might promote optimal family functioning and identifying those families in need of additional help.

In this vein, some supports seem needed by virtually all families, others by only a few. Faced with the birth and early development of a child with intellectual disabilities, all families require information about various social service systems, ranging from early intervention programs to medical services. Later, parents must learn about schools, individualized education

program (IEP) meetings and federally guaranteed rights. As the child reaches the end of their federally guaranteed public education, parents need to learn about their state's adult-service system, and how to negotiate for their offspring.

In addition to learning about the service system, parents and families also require specific knowledge of their child's condition. Such information is often provided by knowledgeable local professionals, as well as by national, state, and local chapters of various parent support groups. Increasingly, such information can be found via many different modalities, including federal, organizational, and parent-group websites.

In addition to education about services and their child's condition, many parents value the chance to meet and talk with parents of children with similar problems. Parent support groups are especially effective for new parents, who realize that they are not alone in parenting a child with a specific condition. Parents also begin to see older children with the condition and realize that their child may be capable of more than they had imagined. Parent groups may also empower parents to advocate for their child with school, medical, and social service personnel.

One also must consider the needs of siblings. In contrast to the thinking from earlier years, most siblings of individuals with intellectual disabilities fare well. Adverse outcomes are nonexistent, affect only a few nondisabled siblings, or show only 'small effects' in group-difference studies. Although positive outcomes have been less-often studied, many individuals benefit from being the sibling of a person with a disability. Such siblings consider themselves to have grown because of this experience, and siblings often remark that they now better appreciate differences among individuals, are open to new experiences, and appreciate life's true meanings.

A final issue relates to the longevity of individuals with intellectual disabilities. In most industrialized countries, individuals with intellectual disabilities are living increasingly longer lives, even as the majority (about 60%) of such individuals live their adult years in their parents' home. The presumed future caregiver for most aging adults with intellectual disabilities will thus be a nondisabled sibling, in most cases one of the female siblings. Many, maybe even most, of these women need information about the needs of their sibling with a disability and the various systems that might provide support. Unfortunately, most state service systems are ill-equipped to handle the growing numbers of aging individuals with disabilities; sibling caretakers need information about how best to navigate this system to secure needed services.

Conclusion

Historically an area of less interest or excitement, the population with intellectual disabilities is increasingly gaining in importance within a wide variety of fields. Much of this interest stems from connecting findings on those with different genetic disorders to specific cognitive-linguistic, medical, or other conditions. Those with genetic disorders are increasingly serving as models for how specific behavioral or medical outcomes might arise.

Persons with intellectual disabilities and their families also have characteristics and needs that are only now being understood. For example, over the past decade we are gradually

appreciating just how often intellectual disabilities and mental health problems co-occur. Likewise, only now are questions being asked about how best to match characteristics of these individuals and their families to current or future service-delivery systems.

We are, in short, at an exciting time in the field of intellectual disabilities. Over the past decade, growing numbers of diverse professionals – from neuropsychologists and developmental psycholinguists to pediatricians, cardiologists, and oncologists – have all been drawn to subgroups within this population. Service systems and training structures have also grown and become more sensitive to the characteristics and needs of these individuals. Although we clearly have a long way to go, individuals with intellectual disabilities and their families are increasingly the focus of research, clinical-outreach, and training efforts.

See also: Academic Achievement; Anxiety Disorders; Autism and Pervasive Developmental Disorders; Behavior Analysis; Behavioral Genetics; Childhood Mental Disorders; Cognitive Behavior Therapy; Developmental Psychopathology; Phobias.

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www.aaidd.org – American Association for Intellectual and Developmental Disabilities.
www.aucd.org – Association of University Centers on Disabilities.
<http://www.cec.sped.org/> – Council for Exceptional Children.

<http://idea.ed.gov/> – Individuals with Disabilities Education Act.
<http://www.nichcy.org/> – National Dissemination Center for Children with Disabilities.
<http://www.ndsccenter.org/> – National Down Syndrome Congress.
<http://www.ndss.org/> – National Down Syndrome Society.
<http://www.rarediseases.org/> – National Organization of Rare Disorders (NORD).
<http://www.pwsausa.org/> – Prader–Willi Association, US.
<http://www.thearc.org/> – The Arc of the United States.
<http://www.thenadd.org/> – The National Association for the Dually Diagnosed (NADD).
<http://www.williams-syndrome.org/> – The Williams Syndrome Association.

Intention

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Glossary

Alien hand syndrome A neurological disorder in which individuals perceive their limb(s) as autonomous agents performing actions independent of their own conscious volition.

Faux pas The unintentional violation of cultural norms or etiquette rules.

Joint attention The process of drawing another person's attention to an object nonverbally, often by looking to the person, then to the object, then back to the person.

Mentalizing The ability to connect overt behavior to subjective mental states.

Phantom limb The illusory sensation that a body part that has been amputated is still attached to the body.

Readiness potential Neural activity occurring in the movement-related areas of cortex ~1 s prior to voluntary muscle movement, and ~350 ms before the conscious desire to move.

Theory of mind (ToM) One's construal of the mental states of others. The development of a ToM requires the understanding that others have subjective mental states (beliefs, desires, intentions) and that these unobservable mental states are linked to their observable behavior.

Introduction

As Justice Oliver Wendell Holmes famously put it, "even a dog knows the difference between being stumbled over and being kicked." Intentions, rather than actions, are most informative about the character and likely future behavior of others. Accordingly, intent comprises the primary determinant of legal culpability for common-law crimes, such as murder and theft, in many legal systems. The Supreme Court affirmed in *Morrisette v. United States*, "The contention that an injury can amount to a crime only when inflicted by intention is no provincial or transient notion. It is . . . universal and persistent in mature systems of law . . . [and] is almost as instinctive as the child's familiar exculpatory, 'But I didn't mean to.'" At the same time, scientific findings suggest that the relationship between intention and action is more complex than our intuitions might suggest. This article examines the study of intention from the developmental milestones that give rise to an understanding of intent to the nature of the relationship between intention and action.

Understanding the Intentions of Others: Developmental Milestones

Attending to Eyes

We come into the world hardwired to find other people interesting. From birth, newborns attend more to faces than to any other object. Within the face, newborns seem to find the eyes especially interesting, as they stare more at the eyes than at any other facial feature. Researchers have argued that this attentional bias occurs because the eyes are a useful source of information regarding what a person might do next. Indeed, at as young as 3 months of age, infants not only look preferentially at the eyes, but also track eye gaze direction. By the time they are 9 months old, infants will use their gaze to get another person to look at an object with them. This is accomplished by looking first at the person, then at the object, and then back

at the person. This form of communication, and the ability to respond in kind, is called 'joint attention.' Joint attention appears to be an early precursor to an understanding of intent. At this age, infants cannot fully understand intent, as they have not yet developed a concept of another mind, but they are beginning to learn that gaze and behavior are linked. That is, by 9 months of age, infants have learned that looking at an object often precedes acting on that object. Even if joint attention may not indicate a true understanding of other minds, it appears to be foundational to this ability. Impairments in joint attention are among the earliest signs of autism. Moreover, the degree of individual impairments in joint attention predicts the intensity of an individual's autistic symptoms, responsiveness to therapeutic interventions, and long-term social outcomes.

Understanding Action Goals

Within the second year of life, children begin to understand that other people have goals and desires. One study by Andrew Meltzoff showed 18-month-old infants' videos depicting unsuccessful actions. In one such video, an adult tried to separate a dumbbell but his hands slipped. The infants were then given the same dumbbell. The authors' empirical question concerned whether the infants would mimic the adult's actual movement by letting their hands slip off of the dumbbell or attempt to separate the dumbbell. Only attempting to separate the dumbbell would suggest that the infants had understood the actor's goal. The infants' behavior indicated that they did indeed understand the goal of the action. This finding was later replicated with 15- and 12-month-old infants but not with 9-month-old infants, indicating that an important developmental change in action understanding occurs at approximately 1 year of age.

Although understanding the goals of actions may seem tantamount to understanding intentions, psychologists have pointed out a key difference – the inference of another mind. Action goals can be ascertained without considering another mind using the simpler metric of object-directedness. In the dumbbell example, it is likely that the motions employed to

separate the dumbbell indicated effort and directedness while the slipping of the hands did not. Thus, the infants may have inferred which motions were related to the goal and which were not without having to represent the adult's mental state (i.e., his or her intention). An analogous process may occur when adults consider the actions of robots. The action goal of a Roomba, for example, is understood perfectly well from its observed action (vacuuming dirt). Inferring that the Roomba's action was mentally driven (intended) would be unnecessary and absurd. Inferences of intention go beyond understanding action goals, as they involve the attribution of an unobservable cause: a mind.

Mentalizing

Mind attribution is central to successful social functioning. The capacity to represent the contents of others' mental states is referred to as 'theory of mind' (ToM). An important component of ToM is the ability to understand that others have subjective desires. Wellman and Woolley demonstrated that 2-year-old boys possess this capacity using a 'Finds-Wanted' paradigm. Children in this study observed characters looking for target objects, and had to make judgments about the characters' feelings and subsequent actions in three conditions. The character either found what they were looking for in the first location ('Finds-Wanted'), found nothing ('Finds-Nothing') or found an attractive object that was not the particular object they had been searching for ('Finds-Substitute'). Children were asked to predict whether the character would continue to search, and how the character felt in each of the three conditions. By and large, the 2-year olds in this study performed well on the task. For instance, the children could infer that the character would continue to search for the desired object if he had not found it in the first location, and that the character would only be satisfied after finding the particular object he desired. These results suggest that children as young as 2 understand that the desires of others are subjective. The ability to understand desires that conflict with one's own, or to represent beliefs that conflict with reality, however, seems to arise later in development.

Children typically first demonstrate the ability to represent the beliefs of others as distinct from objective reality at around of 3 or 4 years of age. This developmental landmark has been delineated based on studies using false belief tasks. Success on such tasks often requires participants to solve an 'object transfer' problem in which the characters possess beliefs that differ from reality. A particularly popular false belief task is the Sally-Anne task (Figure 1), consisting of a simulated interaction between two dolls, Sally and Anne. Anne has a box, and Sally has a basket. Sally places a ball in her basket before leaving the scene briefly. While Sally is gone, Anne removes the ball from Sally's basket, and places it in her box. Then Sally returns. The participant observes all of this, and is then asked, "Where will Sally look for the ball?" Adults tend to respond that Sally will look in her basket, an answer that requires understanding that Sally holds a false belief. However, children younger than 4 years of age tend to predict that Sally will look in Anne's box, suggesting that prior to the age of 4, children lack the ability to understand that Sally has a belief that differs from physical reality. Developing a theory of mind is a critical

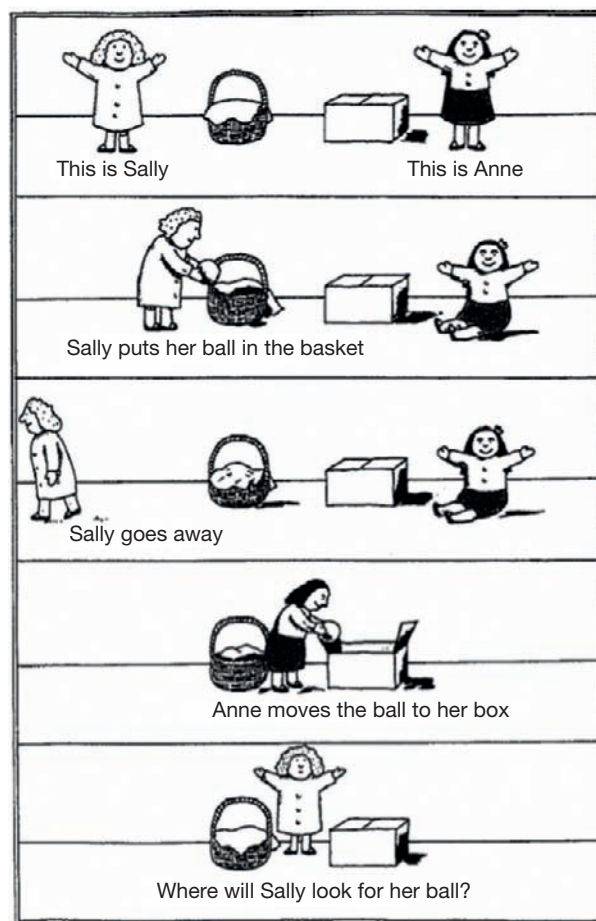


Figure 1 Illustration of the Sally-Anne paradigm. Drawing by Axel Scheffler reproduced from Frith and Frith (1999).

milestone toward understanding intention because it enables a child to model another mind; a mind that is privy to different information, has a different psychological history, and may desire different things than one's own.

Advanced Mentalizing

As any parent would agree, understanding other minds is not perfected by kindergarten. It is not until at least 5 years of age that children can consider second-order mental states such as 'what Billy thinks that Sally thinks.' It is not until the age of 8 that children begin to develop an understanding of faux pas, the unintentional violation of a social norm. One recent study followed children from the age of 3 to the age of 12, measuring their levels of social understanding. In one task, the researchers used clips from the TV comedy 'The Office.' As the lead researcher, Dr. Yuill, explained, the boss character "is a typical example of someone who is very insensitive and reads social situations incorrectly. We cringe to watch it because we are embarrassed by his complete lack of social understanding." It was not until age 8 that children in the study began to cringe, rating scenarios with faux pas as more embarrassing than those without. By the age of 12, children in the study demonstrated as sophisticated an understanding of faux pas as their mothers.

Thus, understanding the nuances of social errors requires cognitive mechanisms that are not fully developed until late childhood. By the time they are teenagers, children have developed the understanding that a person's intentions are often more informative than, and can be contrary to, a person's actions.

In summary, a full understanding of intention requires a protracted development. Early on, babies monitor eye gaze direction. Later in development, young children exploit this attentional cue in order to infer and communicate intention. At around 1 year of age, infants differentiate goal-directed action from hapless mistakes, imitating only the former. By 2, children understand that the desires of others are subjective, and by 4, children understand that people can have thoughts that are distinct both from one's own and from objective reality. Theory of mind increases in sophistication over the childhood years, culminating in the understanding that nuanced social offenses can be committed unintentionally. Thus, by the teenage years, people have learned that actions are usually, but not always, preceded by intentions. Importantly, teenagers are able to detect and understand exceptions to this imperfect rule (e.g., *Roombas*, *faux pas*). The belated learning of these few exceptions underlines the utility and strength of the widely held intuition that intentions precede actions. However, science suggests that this link may be more tenuous than it may seem.

Understanding Our Own Intentions

A Social Psychological Perspective

According to Wegner and Wheatley's theory of apparent mental causation, an action feels intentional to the extent that it satisfies three criteria referred to as priority, consistency, and exclusivity. Specifically, we perceive ourselves as having intended to do something if we previously entertained a thought (priority) in line with the ensuing action (consistency), and if that thought appears to be the sole likely cause of that action (exclusivity). According to this view, the feeling of will is argued to be an inference that relies on the very same principles that govern our perception of causality in the external world. This position is not entirely new. Hume argued long ago that the belief that our intentions cause our actions is a mere perception, possibly rooted in fallacious inductive logic:

Some have asserted, that we feel an energy, or power, in our own mind . . . But to convince us how fallacious this reasoning is, we need only consider, that the will being here consider'd as a cause, has no more a discoverable connexion with its effects, than any material cause has with its proper effect . . . In short, the actions of the mind are, in this respect, the same with those of matter. We perceive only their constant conjunction; nor can we ever reason beyond it. No internal impression has an apparent energy, more than external objects have. (1888: 400–401).

According to Hume and the theory of apparent mental causation, we perceive an action as intentional when we interpret a thought as the cause of that action.

If actions are interpreted as intentional based on the presence of a few key features, then manipulating those features should engender a false feeling of intent. Just such a manipulation was attempted in the following illustrative study. In this study (Figure 2), a participant and a confederate (a research assistant



Figure 2 Experimental setting from the 'I Spy' study. Image reproduced from Wegner DM and Wheatley TP (1999) Apparent mental causation: Sources of the experience of will. *American Psychologist* 54: 480–492.

posing as another participant) manipulated the location of an onscreen cursor by moving a computer mouse together in sweeping circles while watching various objects displayed on the same screen (taken from the children's book 'I Spy'). The task, as it was explained to the participants, was to move the mouse together, stopping approximately every thirty seconds. Both wore headphones. The participant heard words related to the objects depicted onscreen, ostensibly as a 'mild distraction.' The participant was led to believe that the other participant (the confederate) heard different words. In actuality, the confederate heard instructions to force the cursor to stop at certain times. These stops were engineered to occur on specific objects at specific time intervals after the participant had heard a word related to that stop. For example, if the participant heard 'swan' the confederate might be told to force the participant to stop the cursor on the swan depicted on the screen. Following every stop, participants rated how much they had intended to make the stop relative to their partner on a one hundred-point scale.

In line with the principle of consistency, when participants heard a given word a few moments before the confederate forced a stop on a related object, they perceived that they themselves had engineered the stop. Consistent with the principle of priority, this held true only if the related word was heard a few moments before the forced stop engineered by the confederate, and not if the related word was heard well in advance of, or following, the forced stop. These results suggest that we can erroneously interpret an externally engineered event as intentionally caused by ourselves if we are made to think about that event immediately before it occurs.

Just as the 'I Spy' experiment demonstrates that we can experience will without performing an action, reports from clinical studies demonstrate that it is also possible to perform an action without experiencing the sensation of will. The uncoupling of conscious intention and action is the unfortunate everyday reality for individuals suffering from many psychological and neurological conditions. Schizophrenic patients often perceive their own subvocal speech as externally generated, or as if they are 'hearing voices,' and perceive that their own thoughts have been 'inserted' or controlled by others. Consistent with the general principles of causality outlined above, it has been suggested that this perception is rooted in a mismatch between these patients' conscious goals for thinking and behavior and their actual

thoughts and behavior. Additionally, those suffering from alien hand syndrome perceive that their own 'alien' limb is in fact autonomous, acting according to a will of its own. The rogue limb is often perceived to be malicious, or possessed by an external force. Conversely, patients sometimes consciously will limbs lost to paralyzing injury or amputation to move to no avail in order to relieve unpleasant sensations in these 'phantom limbs.' Patients suffering from the later stages of Parkinson's disease also find their limbs frustratingly unresponsive to their motor intentions.

Anecdotal experiences from everyday life suggest that the uncoupling of action and intention does not only occur in specialized patient populations or in social psychology experiments. We often feel that we did not 'mean to' perform mindless gestures or habits, perhaps because we did not consciously hold a thought consistent with that behavior before engaging in that behavior. The fact that the perception of action and the sensation of intent can be carefully decoupled in experiments, are consistently dissociated in those suffering from a variety of medical disorders, and are imperfectly aligned in the behavioral minutiae of everyday life, suggests that Hume may have been correct. Intention and action may be merely correlated rather than causally linked.

A Neuroscientific Perspective

Neuropsychological research investigating the temporal relationship between brain activity and subjective conscious experience has also called the nature of the intention-action link into question. In a seminal study on this topic, Benjamin Libet asked participants to extend their right index finger whenever they 'felt the urge' to do so (his description of intent) while fixating on a rotating clock-hand. Participants were asked to note, and later report, the position of the clock-hand at the moment when they first felt the intention to move. Participants' reported feelings of conscious intention to move preceded the actual movement by approximately 200 ms. However, using electroencephalography (EEG) to measure event-related potentials (ERPs) on the scalp, Libet demonstrated that preparatory activity in movement-related brain areas precedes movement by a full second. Libet interpreted the finding that this preparatory neural activity – or 'readiness potential' – occurs well before the conscious experience of will as evidence that we may not consciously initiate our actions.

More recently, Chun Siong Soon and colleagues have suggested that the temporal relationship between brain activity and the conscious experience of intention may be even more remote than Libet's findings initially indicated. Reasoning that the readiness potential reflects activity in brain areas associated with relatively late stages of motor planning, these authors used functional magnetic resonance imaging (fMRI) to assess activity throughout the entire brain while participants completed a self-paced task with multiple possible behavioral outcomes. Participants watched a stream of letters that changed every 500 ms. Participants were told to press one of two buttons with either their left or right index fingers whenever they wanted to do so. Participants were then asked to report which letter was present on the screen when they had decided to move. Using statistical pattern recognition techniques to analyze fMRI data recorded throughout the whole brain, Soon and

colleagues were able to predict which button a participant was going to push based on distributed patterns of brain activity measured between 7 and 10 s prior to the participants' conscious awareness of that 'decision.'

These findings have been taken by some to constitute evidence that the brain 'decides' to move well before the decision to move enters awareness. That is, conscious awareness of the decision to act may not be causal to the decision to act. Others have maintained that conscious awareness is causal to the decision to act, pointing out that the early patterns of neural activity observed in these experiments could merely reflect general anticipation of performing the task, or the preconscious beginnings of intentions. The early neural firing that constitutes the readiness potential, for example, might simply initiate a cascade of brain activity that prepares the brain to make a free, conscious decision. No currently available data can settle which interpretation is correct, and thus, whether or not conscious intentions play a causal role in action execution. However, the observation that action-related neural activity precedes awareness of a desire to make an action is a robust finding that must be incorporated into any contemporary model of conscious intention.

The readiness potential reflects a specific intention to move a particular body part within the next few seconds. This is, of course, a very narrow definition of intention. Humans are deliberative creatures who often plan courses of action well beyond the next 7–10 s, and certainly beyond a few 100 ms in advance. We also plan courses of action at levels of description far more nuanced and abstract than raising an index finger. Sometimes we have purely propositional intentions that lack specific action plans. For example, we may intend to 'go to college one day' or to 'be a good person.' We may also intend to 'get a cup of coffee,' an intermediate intention that launches a series of more specific motor plans toward that goal. Although neuroscientific research has focused largely on intentions to perform specific movements (e.g., finger raises) and associated cortical activity, recent evidence suggests that parietal and frontal regions may subserve intermediate and long-term plans, respectively.

A long-term, propositional intention, such as 'intending to retire early' requires imagining a time in the future when that intention will be realized. This ability to mentally time travel may be unique to human beings. While other animals are focused on here and now, as human beings, we spend much of our time remembering the past and wondering about the future. Consistent with the relative uniqueness to humans of mental time travel, long-range intentions are thought to be subserved by a region of the brain that is disproportionately larger in humans than other animals: the prefrontal cortex. Summarizing the evidence for the expansion and reorganization of prefrontal cortex in the course of human evolution, Flinn and colleagues suggest that this brain region is associated with self-awareness and the ability to project oneself into the future. This brain region also supports executive processes, such as reasoning and working memory, which may be critical to this kind of counterfactual thinking. Developmental evidence also points to the maturation of prefrontal cortex between the ages of 3 and 5 years as critical for the cognitive development of the ability to make plans, delay gratification, and understand intent.

A neural circuit that links the prefrontal cortex with the inferior parietal cortex may help translate propositional intentions in the prefrontal cortex into action plans in the parietal cortex. Activation of this prefrontal-parietal circuit may underlie the feeling of agency for a particular course of action. When Desmurget and colleagues stimulated the parietal cortex of epilepsy patients, they experienced an endogenously generated wish to move. That is, patients felt that they had spontaneously desired to create a movement. This phenomenology stands in contrast to stimulations of supplementary motor area (SMA), a region associated with the readiness potential. Stimulation of subdural electrodes in SMA causes an 'urge' to move that may also be described as the feeling of being 'about to move.' A strong stimulation of SMA, but not parietal cortex, will lead to actual movement. This suggests that SMA may play a key role in the feeling of being about to move while parietal cortex may play a key role in the feeling of generating an intention. Clearly, the word 'intention' belies its diversity. There are multiple levels of intention that range from long-term plans ('go to college') to specific motor plans ('pick up the cup'), which are subserved by distinct but interacting brain regions.

Failures of Intention

Try as hard as you can to not think of a white bear for the next 5 min. Go ahead. Were you successful? If you are anything like the participants in thought suppression experiments, you were dramatically unsuccessful, with thoughts of white bears popping into your mind every few seconds. Intending not to think or do 'x' can have the ironic effect of making 'x' more likely to occur. This is particularly true when we are tired or distracted. Wegner's ironic process theory accounts for this phenomenon by proposing that intentional control of the mind employs two processes: an operating process that directs conscious attention to whatever thought or action is intended and an automatic monitoring process that looks for failures of that intention. Stress, fatigue, and distraction have a disproportionate effect on one's ability to attend to something consciously, thereby disabling the operating process more than the monitoring process. The result is an unchecked monitoring system continues to search for failures of intention, continually bringing to mind the most unwanted thought. This ironic process has been used to explain the obsessive nature of unwanted thoughts and the tendency of athletes to 'choke' in a big game.

This article has focused on how intentions relate to actions and how an understanding of this relationship develops. However, most budding intentions never become actionable for good reason. Failures to inhibit intentions are just as damaging as failed intentions. Consider how much time people spend daydreaming; musing about everything from the motivational (e.g., wanting to advance in a career) to the wicked (e.g., wanting to hurt one's spouse). Not only do humans mentally time travel, they also wonder counterfactually what it would be like to do something different than whatever it is they are doing now. Playing out an intentional course of action in the mind's eye can be useful. It can help one realize, for example, that the long-term consequences of hitting one's boss would outweigh any ensuing short-term satisfaction.

Inhibition at this early stage of intention affords a reasoned decision about which intentions become actionable and which should stay in the realm of fantasy. This requires considerable inhibitory control from the frontal cortex.

Patients with damage to orbitofrontal cortex (OFC) lack this inhibitory control. To these patients, having the thought to act and acting on that thought are largely synonymous. No lesion is as damaging to social behavior. The personality changes of OFC patients have been described by many writers. Perhaps the earliest account was by Dr. John Harlow in 1868. Harlow was the doctor who attended to Phineas Gage after Mr. Gage was involved in an accident that sent a metal tamping iron of the size of a walking stick through one eye and out of the top of his head. The accident did not kill him but decimated his OFC, giving scientists the first window into the function of this brain region. The accident did not compromise Phineas Gage's memory, sensory perception or language, leading to early reports that he survived mentally unscathed. However, Gage's friends noticed that his personality had changed radically. His lesion resulted in massively disinhibited behavior, allowing instinctual urges and transient impulses to become realized in action. The Country and Western song that thanks God for 'unanswered prayers' should add 'unrealized intentions.' The ability to quell 'bad' or inappropriate intentions is as beneficial to social relationships as realizing 'good' and appropriate intentions.

Summary

Intentions are good predictors of behavior most of the time. While simple intentions and actions have been decoupled within the context of carefully controlled experiments, they are strongly correlated. Further, it is unclear how this decoupling in the lab generalizes to the way we think about intention in everyday life.

Whether or not intentions are perfectly causal to our actions, they are consistently correlated with our own and others' behavior, and thus, are useful markers of what we might do next. Therefore, it is no wonder that a nuanced understanding of intention receives a prioritized, protracted development. The intuition that intentions cause behavior is an extremely useful heuristic in most circumstances. In sum, a thorough understanding of intention requires two things: (1) an appreciation of the general rule that conscious intention predicts behavior, and the concomitant pragmatic and legal uses of that rule and (2) a recognition of the empirical and neurological examples that show that this relationship is far from simple.

See also: [Attribution](#).

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Internet Behavior

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Glossary

Avatar A digital representation of an individual that he or she can manipulate within a virtual world, online community, simulation, computer game, or other online environments.

Blog Contraction of 'web log,' in which an individual or organization regularly posts comments about various subjects with links to other blogs or web pages. Posts appear in reverse chronological order.

Global positioning system (GPS) Allows small receivers embedded in mobile devices to determine and report the device's physical location by interpreting signals transmitted from orbiting satellites.

Microblogging A type of blogging in which the content of the posts is much shorter with very small file size. Twitter is an example of a site that supports microblogging.

Multiuser dungeon (or dimension) (MUD) These were real-time text-based virtual worlds for role-playing games and online chat.

Social network A set of social entities that can include people and organizations connected by meaningful relationships, and who interact with one another online, face-to-face, or both.

Social networking site A Web site in which individuals create profiles of themselves with posts, photos, and videos, and link to profiles of friends and colleagues to form interlinked social networks.

Spoofing Forging an email header to make it appear to the recipient that the email came from a different source.

Virtual world A type of online community in which members create avatars to interact with other people and objects in the graphical environment.

Introduction

Launched as a distributed computer network for the government and academia in the 1960s, the Internet has become a fundamental part of people's lives. The net's open architecture and standard technical protocols support countless innovations, most of which were never imagined by its designers. Collaborative features and quick communication underlie the growth of the Internet as an environment for social interaction with family, friends, acquaintances, colleagues, and total strangers. Indeed, for a growing number of people, online interaction plays some role in almost every human relationship.

The Internet's capacity to facilitate interaction, participation, and contribution has exploded with Web 2.0 technologies and approaches. It has been transformed well beyond an information source, a shopping outlet, publishing platform, or text-based communication venue. Web sites supporting social networking or other collaborative venues offer an array of new tools to manage impressions, interact with other people, form friendships, and work in teams. With mobile technologies, in particular, people can engage in technology-mediated social interactions anywhere, anytime, and not just when they are sitting in front of a computer. The social interaction environments now encompass smartphones, wireless devices, netbooks, video consoles, and more.

Together, these varied devices, transmission media, and the applications they support comprise information and communications technologies (ICT), which collectively open many new avenues for social interaction. For the purposes of this article, online environments are broadly defined to include any ICT-supported environment in which the interactions are not face-to-face, but mediated by technology. They offer people a dazzling array of choices when they want to interact with others, from a

one-line text message to a live interactive video conference, and much more.

Demographics and Social Use of ICT

Worldwide, access to the Internet is available to at least one-fourth of the population, with much higher rates in the developed countries. The fastest growth rates, however, are in the Middle East and Africa, where wireless communications technologies are playing a major role in building up the infrastructure in cost-effective ways. Mobile phones, both as a communication device in their own right and as a means to access Internet services, are playing an increasingly important role in technology-mediated social behavior. While low-cost versions support voice and text messaging, more capable smartphones support email, web browsing, global positioning system (GPS), and a growing variety of applications, many of which are oriented toward social interaction. The use of these devices to access Internet services is not generally captured by studies on net access, so statistics on Internet usage are probably underestimates, particularly in the case of developing countries in which ownership of mobile phones far outpaces computer purchases.

Who actually engages in online social interaction? Although worldwide statistics are not easily available, the Pew Internet and American Life Project conducts surveys on the US population, charting the ways in which Americans use technologies by age, gender, ethnicity, and other demographic variables. The trends show that the young lead the way, both in the extent to which they depend on ICT for social interaction and the variety of tools they use. For example, teens flock to the social networking sites such as Facebook or MySpace, where they connect with friendship networks. In 2009, 73% of teens who had access to

the net used an online social networking site. Teens and young adults are often the primary early adopters of other innovations that support social interaction, from online gaming and micro-blogging to wikis and virtual worlds. Nevertheless, people of all ages use these sites and older adults are the fastest growing population on Facebook.

With respect to personality measures, studies generally confirm a relationship between extraversion and online social interaction. Outgoing people tend to use email, text messaging, social networks, and other online tools more frequently, largely to enrich their existing friendships and relationships. Shy or socially anxious people, however, also take advantage of the online world. Research indicates they are more likely to prefer technology-mediated communications as a substitute for face-to-face interactions.

Early research suggested that high levels of Internet use may be associated with social isolation and depression, partly because the people using the net in such circumstances were mainly interacting with people they had never met in person. But the net continues to evolve, along with how people choose to use it for social interaction. Online social environments are widely used to maintain and extend existing relationships, even when those relationships already have a strong face-to-face component. The environments continue to support interactions not only with distant and unknown strangers, but also among working groups, virtual teams, friendship networks, family ties, virtual communities, online classes, and romantic connections. Many online settings support anchored relationships, in which people are easily identified, well known, and often not geographically distant.

Types of Online Social Environments and Tools

The range of technology-mediated social environments has expanded considerably since the 1990s, when the primary venues were email, discussion forums, MUDs, and text-based chat networks. These early systems, most of which continue to exist in some form, primarily support text-based communications, either synchronous or asynchronous. Interactions rely heavily on the written (typed) contributions of the participants – an important element in the way these environments affect behavior and group dynamics. Much research has been conducted to better understand how social behavior unfolds in such settings. The findings have helped identify areas for technological improvements, especially to reduce or eliminate some of the most troublesome features that hinder smooth social interaction. Current systems incorporate images, video clips, interactive audio and video, networking tools, awareness of presence indicators, location indicators, rating systems, abuse reporting tools, reputation systems, shared whiteboards, avatar-based interactions, virtual classrooms, collaborative document editing, and many other features that greatly improve the ways in which people can work and play together online.

Technological tools to support more fluid synchronous social interaction are improving considerably. For example, some environments include awareness of presence icons that users can control, indicating whether they are currently available for real-time interaction. Others add collaborative features such as shared whiteboards, making it possible for people at a

distance to view, discuss, and annotate the same document, as though they were all standing in front of an actual whiteboard. Although text-based chat systems are still widely used, interactive video and audio add to the media richness of social interactions.

Within the social networking sites, new tools are emerging constantly to help people manage their self-presentations, and build, maintain, and extend their social networks. Sending a request to join someone's network involves a simple click, for example. The sites provide many innovative incentives to encourage people to stay in touch via the network and invite others to join. Some, for instance, offer to invite everyone in your email address book to join your social network.

The ratings and reputation systems are especially important to the explosive growth in user-generated content, in which social interactions revolve around evaluations of particular products or services. People engage in brief social interactions as they rate and share their views on hotels, books, editorials, news items, contractors, or other services. The more useful comments that people contribute, the more valuable the site becomes for everyone, attracting more users.

Location-aware technologies add another dimension to technology-mediated social behavior, one that overcomes the lack of geographic placement. In many online social interactions, the participants do not know one another's physical location, a factor that can affect the way they interact. However, location data is available and is being added to many social tools, such as Twitter. Smartphones equipped with GPS can pinpoint the sender's location, and include that as part of the message.

Avatar-based environments such as Second Life add a sense of physical presence in the shared space, especially when people can customize the avatar to their liking to better manage the impression it makes. Gathering with other people's avatars in the same virtual world is another step that enriches the online social environment.

These technologies continue to improve, not only with engineering advances, but also with more research on the nature of online social behavior. As we learn more about how people prefer to use these technologies, how their behavior is affected by them, and what kinds of risks they present to privacy or human relationships, we will see a better match with what humans actually need for rich, technology-mediated social interaction.

Psychological Aspects of Online Social Environments

Online social environments differ from face-to-face environments in several important psychological dimensions that affect social interactions. They also differ from one another, given the enormous range of tools available and the wide variety of online social environments. This section summarizes those characteristics and the following sections explore how they affect different kinds of online interactions.

One critical variable is anonymity, that is, the extent to which people can identify others with whom they are interacting. People who participate in ongoing discussion forums or online games, for instance, may have little or no knowledge about the identity of other members of the group. A nickname,

such as 'MaryTheMom,' might indicate gender or other characteristics the participant cares to share. But in many of these environments, the perception of anonymity can be high, especially compared to face-to-face interactions.

The degree of anonymity for people in online social environments can vary widely. Regarding sites designed to support a working group, for instance, the members often meet in person and are fully identified online. On eBay, the buyers and sellers use nicknames, but once an auction is over they must have accurate information about one another in order to complete the transaction. In the comment section for an online newspaper, a person who wishes to comment may have no idea about who else is joining the discussion, other than nicknames.

A closely related characteristic is identifiability, which refers to the participant's sense of how anonymous he or she feels, and whether others will be able to individually identify him or her. Depending on the environment, identifiability may be low but rarely zero. For the newspaper comments, for example, the others who comment may not know who the poster is, but the news agency may require more detailed information. From a technical perspective, the identity of a person who participates in an online social environment can usually be determined, or at least the identity of the device they use.

Physical isolation is the third characteristic that typically distinguishes online social interaction from face-to-face interaction. Although there are occasions in which people gather in the same physical space to engage in online social interactions – to play multiuser computer games, for example – most online social interactions involve people who are not physically present in the same space.

Other characteristics are becoming increasingly important as the tools become more powerful. For example, these environments offer opportunities to control self-presentation in ways that are far beyond what an individual might do in any face-to-face setting. For text-based environments, swapping genders or changing professions involves little more than typing a new nickname, switching 'PhilosopherBob' to 'AnnietheActress.' But social networking sites add rich multimedia features, controlled by the user, who can select and tweak the images. These sites also display information about a person's friendship networks. Self-presentation thus includes not just information you release about yourself, but about whom you know and have friendship ties with. This feature adds a new psychological dimension to online social interactions as the people with whom you interact form impressions of you in the context of your social ties.

Microblogging sites such as Twitter, while lacking rich multimedia capabilities, allow users to send out frequent, short text messages to their followers' cell phones, creating a kind of ongoing connectedness that transcends distance. Avatar technology adds yet another level to self-presentation. The ability to construct highly detailed avatars that enter online social worlds adds many more possibilities to the way people choose to present themselves to others.

Knowledge about the nature and size of the audience or group is another characteristic that differentiates online and face-to-face settings. In a public discussion forum, for example, participants may have an idea of how many people are engaged in the discussion, but not of how many are viewing it or

forwarding favorable posts to their colleagues. Even in social networks, in which individuals choose their 'friends' and thus know their own audience, they know far less about their friends' network of friends. Without knowing the details of a friend's privacy settings, a person might post a humorous note on a friend's wall which could be visible to that person's entire network. There may be individuals in that audience, like parents, employers, or old girlfriends, who might not expect or appreciate that humor.

Effects of Online Social Environments on Behavior

People do behave differently online, and social interactions are affected in subtle ways by the differences between online and face-to-face settings. For example, in text-based environments people often become disinhibited, expressing themselves more bluntly, abruptly, or aggressively compared to what they might say in person. In many discussions, they can be more task-oriented, and their messages often lack nonverbal cues or those verbal softeners that smooth conversations. Instead of 'I'm not certain I agree with that,' they might simply say, 'I disagree.' Tenser and more controversial interactions, especially ones in which people are relatively anonymous, lead to heated discussions. Participants who would never think of themselves as particularly aggressive engage in furious 'shouting' matches, name-calling, foul language, and sarcasm. Attitudes can become polarized and people can take quite extreme positions.

The online social environment can also bring out another side of disinhibition: intimacy and self-disclosure. In certain circumstances, people are not necessarily abrupt or blunt. Instead, they are more intimate and disclose more personal details about themselves than they would in person. They also reveal information more quickly, without necessarily waiting for the communicating partner to reciprocate.

These seemingly contradictory findings show that the effects of the online social worlds on human interaction and behavior are certainly real, but they are not straightforward. Drawing especially on research in social psychology and communications, various models have been proposed to account for these nuances and better understand how these effects play out in different circumstances.

One early proposal emphasized the impoverished of text-based interfaces, and their inability to support much transmission of nonverbal and paralinguistic cues. With just the ASCII keyboard to work with, people lacked social presence and their partners had little to go on. People could add a smiley face emoticon to hint at a joke, but even these are quite easily misinterpreted without knowledge about the tone of voice, volume, vocal patterns, body posture, facial expression, and physical distance. Effective communication, according to this 'cues filtered out' approach, requires verbal and nonverbal cues, the richer the better. The fewer cues available, the more difficult it would be to develop any meaningful relationship.

As it became clear that people did indeed develop strong social ties online despite the sparse social presence, other proposals were offered. The hyperpersonal model explains how the paucity of cues, especially visual and nonverbal ones, could actually contribute to the creation of strong social bonds between people who interact online. With the tools they

have, people selectively craft their presentations with a minimum of cues and the partner idealizes and imagines the rest. This relative lack of information makes whatever is available more valuable. Selective presentation, combined with imagined and exaggerated perceptions, acts together over time, making it possible for people who interact online to feel quite close.

Another model that focuses particularly on the role of anonymity in online social influence is SIDE, which stands for social identity model of deindividuation effects. Drawing on research on how people tend to become depersonalized in crowds, SIDE predicts that online behavior depends partly on how anonymous people are and also whether the setting tends to promote greater salience for the social or personal identity. Under anonymity, people who identify with a social group are more likely to adhere to the group's norms and agree with its positions. SIDE also helps explain why intergroup differences can grow larger and more contentious when people from two groups interact online and the anonymity is high.

These models were initially developed to explain some of the surprising findings on how social behavior unfolds in text-based environments, particularly among people who had not met in person. However, online social behavior now encompasses a much wider range of activities, locales, and group memberships. For example, over 90 million people use social networking sites with their rich multimedia tools, photo and video albums, social games, group memberships, and wall postings. In most cases, a social network includes only people the individual knows in person or those who are known to one of the individual's friends. Nevertheless, many of the psychological characteristics that affect text-based interactions are still important in these environments, though they play out in somewhat different ways.

Managing Impressions

Just as people try to put their best foot forward in face-to-face settings, they devote some effort to the impression they make when they go online to interact. The difference is that instead of focusing on fine grooming, clothes, a smile, and a firm handshake, people use keyboards, mice, cameras, and camcorders. For the most part, people use the tools they have to create a persona that is not too distant from their true selves, but they do try to refine and polish it to highlight the positive.

Impressions can be quite difficult to manage online. People can easily miscalculate the impression they make and also make mistakes as they form impressions of others. One reason for online impressions going awry involves social cognition and social categories. People tend to use a short list of categories to form impressions quickly, relying especially on age, gender, and ethnicity. The stranger's actual behavior is less important and more time consuming to unravel as a means to form an impression. In a face-to-face interaction, those three characteristics are normally quite easy to discern. But online, especially in a text-only environment, they could be far less apparent. For some, this characteristic of the online world is liberating as it frees people from the overwhelming influence of the usual social categories and facilitates interactions based

on the communications themselves. A very bright high school student might engage in online interactions with scientists, for example, whose responses would be based on the student's actual remarks, not his or her age.

As multimedia tools are added to social environments, the most important feature people use to form an impression in face-to-face settings returns to online interaction. This is physical appearance, from which age, gender, ethnicity, physical attractiveness, and much more can be ascertained instantly. The impression people make, when they post photos on their Facebook profile, for example, is dominated by the photo, just as physical attractiveness dominates impressions in real life. Attractive people are perceived as more likable, more confident, and as possessing a number of positive characteristics compared to unattractive people. Showing an attractive photo makes it more likely that Facebook visitors will be interested in meeting you. But displaying an unattractive photo turns people away, even more so than showing no photo at all. This conforms to the hyperpersonal model, as visitors exaggerate positive qualities of the person showing the attractive photo, or the negative qualities of the less attractive person. A profile with no photo at all leaves room for imagination, and exaggeration as well.

Online worlds let users craft an appearance with avatars, and these tools offer much broader opportunities to reinvent the persona and manage an impression. The new avatars can affect social interactions in subtle ways, not only because of their effects on the others in the virtual world, but also by virtue of their effects on the person behind the avatar.

As expected, an attractive avatar is perceived more favorably. The positive response of others can then affect the behavior of the person who is behind that avatar as social interactions take place in real time. He or she may become more confident and assertive in a process called behavioral confirmation. The person may behave in ways that conform to the expectations of others about how an attractive person typically acts. Indeed, just donning an attractive avatar heightens the person's own self-perception and affects behavior. As though the person is looking at himself or herself from the outside, expectations about how an attractive person would act can influence the way the person behaves.

Adjusting the avatar's height also affects social interactions. In face-to-face settings, taller people are perceived to be more confident and powerful, and they often come out ahead in negotiations. But a short person can become a tall avatar in a virtual world, and the new appearance may affect the way that person behaves. In experiments that manipulate the avatars' heights, the people behind those avatars behaved as expected. Regardless of the participants' real height, short avatars tended to lose the negotiation. These height effects also appear in interactions using video chat and webcams. People who appear shorter because of camera position also tend to be in a disadvantageous position.

These transformed social interactions may have longer lasting effects on behavior and social interactions, even after people leave the virtual world and resume the management of their real-world impressions. Controlling a tall or attractive avatar for a while may indeed help build confidence in some circumstances, but more research is needed to clarify what happens if the virtual world spills over into other social contexts.

Online Deceptions

Online, especially when identifiability is low and the perception of anonymity high, it is easier to deceive. One might craft a deceptive persona that is quite far afield from a person's true self or misrepresent the facts in an attempt to deliberately mislead. The individual may swap genders, alter his or her appearance, make up new personality traits, change professions, or lie about age, location, citizenship, income, nationality, or anything else. Many high-profile cases in which people succeeded in elaborate online masquerades, often becoming deeply involved in relationships under the cloak of their false persona have been documented.

Several types of deceptive tactics play out online. Masking, for example, involves the elimination of cues to erase crucial information, something that is quite easy to do online. A profile photo might show the person from the neck up only, failing to disclose other physical characteristics. Photos can also be easily edited to eliminate scars, wrinkles, and other flaws.

The reasons people engage in online deception are complex and varied. Some experiment with their identities to find out how people react to them if they present themselves quite differently. Many others slip into deception in an effort to best manage their impression, greatly exaggerating or lying about their positive qualities and masking negative ones. Much of the increasing online deception, however, involves fraud and other kinds of criminal activity, with greed being the primary motive. The most common deceptions occur in online auctions in which sellers try to sell merchandise they do not have or buyers receive goods they have no intention of paying for.

The psychological characteristics of the online world greatly amplify the scope of fraudulent deceptions and facilitate new types as well. They influence human behavior such as the truth bias, which is the tendency to overestimate others' truthfulness. In most situations, people presume that incoming information is truthful unless they have evidence to the contrary, which is partly why online scams can be so effective. For example, scammers can spoof valid email addresses of a person's trusted associates and send messages that appear to come from them to obtain private information. Few question the source of an email without specific alerts.

More sophisticated technology opens up new avenues for deception. Photo and video editing software, for instance, is widely available and used to enhance online impressions as well as deceive. Different manipulations can have various effects on social behavior. For example, people tend to be attracted to others perceived to be similar to themselves, and digital tools can simulate this effect by morphing one person's photo with another, subtly blending their features. People tend to prefer images of strangers made to look more like them because of morphing. Researchers find that voter attitudes can even be influenced by such digital manipulations. When a political candidate's image is morphed with an undecided voter's image without the person's knowledge, the voter begins to prefer that candidate.

Deception has taken on new forms online because of the psychological characteristics of the Internet, with its heightened sense of anonymity and lower identifiability, and its reduced sense of physical presence. It is further enabled by growing technological capabilities, such as the ability to edit

or fake images, Web sites, videos, or email. Together, these features interact with aspects of human behavior to amplify the risks. People are not particularly expert at spotting deceptions in person and they appear to be even less so online.

Online Group Dynamics

When a group of people with a common purpose conducts some or all of its activities online, the characteristics of the online world can affect group dynamics, often in surprising ways. The features that affect other aspects of interactions also influence the way online groups develop norms, establish a group identity, discuss topics, air arguments, achieve consensus, and carry out tasks.

Group norms, for example, are important to establish a group identity and expectations for group members. Yet developing those norms and finding ways to encourage conformity are challenging in online social settings. The physical distance associated with online interactions can reduce the effects of group pressure, and higher levels of anonymity would reduce them further. Nevertheless, groups do establish norms, often by using more explicit statements about what is expected, such as terms of use agreements.

Members also learn norms from one another, just as they do in person, by watching what others do. For example, in social networks, the choice of privacy settings is affected by what an individual believes other members of his or her network are choosing. If it appears most friends are revealing their cell phone numbers to their networks, that same privacy setting is more likely.

Enforcing norms can be more difficult without the benefit of immediate feedback, both verbal and nonverbal. An arched brow or a deep sigh might be a clear signal that norms are violated in person, but online, other tactics prevail. Often they involve more explicit statements of reproach or warning, either privately or in public. Virtual teams, for instance, often develop teamwork plans that include very specific conflict resolution agreements that spell out the consequences for noncompliance.

Online groups sometimes show a status equalization effect, in which people with lower status are able to contribute equally with higher status members. In most face-to-face settings, status will be apparent in a group, based on characteristics such as company position, expertise, age, wealth, fame, tenure, or athletic prowess. High-status individuals do more talking and have the most influence on group decisions. Online, a person's real-world status may be less apparent and sometimes not visible at all. In such groups, contribution levels and influence tend to be more equalized. The online decision support tools used to brainstorm new ideas rely on this effect. The software hides the origin of each contribution and even as the ideas appear on the screen, visible to all group members, the source is unknown. This feature encourages lower status members to contribute candidly and minimizes the dominance of the boss. When anonymity is low or absent, however, status effects creep back and higher status members have more influence.

Another aspect of group dynamics that touches on status involves settings in which status is earned online and real-world status has little meaning. The reputation systems used in many discussion forums or product review sites display

this effect, as people earn social recognition through their contributions. On Amazon, for example, book reviewers gain reputation as shoppers rate the quality and usefulness of their reviews and Amazon's software make each reviewer's status quite apparent. On the massive multiplayer games, players earn their status by gaining levels and experience; so, a 10-year-old with a powerful, high-level avatar and extensive knowledge of the game will have higher status than a 30-year-old newcomer with a Ph.D.

Disinhibition effects are particularly important in the group dynamics of online support groups. Many of these are still text-based and they provide people with a venue to discuss very personal issues with others who are in similar situations. Support groups exist for almost any kind of problem, from HIV/AIDS, to knee surgery, parenting, divorce, and depression. These groups are especially valuable to people whose problem is stigmatizing in some way, making it more difficult for them to discuss issues with people they know in real life. The disinhibiting effects that support self-disclosure, combined with higher anonymity, increase the value of these support groups.

As the SIDE theory suggests, online group settings can facilitate polarization, particularly if the setting promotes group identification and anonymity is relatively high. This is to some extent the reason why there appear to be few moderate voices in many online text-based forums with high anonymity, particularly in forums dealing with controversial subjects. The discussants reinforce one another in a kind of echo chamber, and views that might contradict or moderate their conclusions are ignored, vilified, or driven out of the group. An 'us' against 'them' approach can arise easily in such settings. This characteristic of online group dynamics, combined with the ease with which people can find others of like mind on the net, helps explain why online extremism is a major concern.

Mobile phones offer capabilities that affect online group dynamics in new ways. As a mobile is a device that is constantly on and available, it is widely used to micro-coordinate activities, depending on text messages or Twitter feeds. During a social protest in Iran, for example, people used Twitter to broadcast messages and coordinate group movements. The location-sharing capabilities of smartphones also heighten identifiability, so that group members not only receive messages from one another but also see each person's precise location. The effects these features have on group dynamics is not yet well understood and is still evolving, though they appear to strengthen group identity by increasing the sense of connectedness.

Conclusions and Looking Ahead

The Internet has become a fundamental part of human relationships, supporting interactions that could not have existed in the past and enriching connections with those we see frequently in real life. The devices that connect to it, from computers and laptops to smartphones, video game controllers, and televisions, continue to increase, making online interaction available anytime, anywhere. ICT offers countless new tools people can use to manage the impressions they convey and interact with others, such that choosing among them is no simple task. A wall posting on a social network site carries a meaning that is different from a tweet, and both are quite different from an email or an interactive video session.

Deciding where to set the webcam to conduct a video chat, or whether to turn it on at all, is another choice confronting people who interact online. The characteristics of all these environments affect how we behave and how people perceive and interpret our behavior.

While early online social environments were awkward to use and primarily text-based, current ones offer rich features that better support social interactions. The early environments offered little commercial potential. But as the value of large, loyal communities grows, developers launch feature-rich, engaging social sites in the hope of attracting large numbers, both to increase advertising revenue and to gain access to data that can be used for targeted marketing. Sites such as YouTube, Facebook, Yahoo, eBay, Baidu, Foursquare, Yelp, and many others compete for people's attention and participation, driving even more innovations designed to encourage people to stay active in the community and bring their friends along.

For example, a wildly popular application on Facebook called Farmville engages over 80 million players and the developers draw heavily on social psychology to make it a compelling environment that promotes socializing. The game continuously provides incentives, not just for advancing in levels, but also for sending gifts and inviting friends to participate. A lost digital kitten might suddenly appear and the player is encouraged to invite real-world friends to the game to help find her a home.

While increased commercial value has led to the development of many free, lively social venues offering a breathtaking array of communication tools, it also presents greater risks to privacy. Default privacy settings on these sites lean heavily toward making each individual's contributions widely available. Although users can change settings, many do not take the time, leading to numerous cases in which information intended only for a small group of friends was made available to a much wider audience. Combined with disinhibition and the tendency to self-disclose online, the failure to attend to privacy settings and consider the audience poses very serious risks.

What will tomorrow's Internet look like and how will it affect human behavior? Privacy issues are emerging as a major theme as technologies advance to track even the faintest digital footprints. Mobility will be another theme and the pros and cons of having a device that connects you to the net at all times will become clearer. Virtual reality will blossom and we will learn far more about transformed social interactions among cleverly crafted avatars. Beyond these, tomorrow's Internet no doubt holds many surprises ahead for human behavior and our social lives.

See also: [Media Influence on Behavior](#).

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- <http://www.oii.ox.ac.uk/> – Oxford Internet Institute, University of Oxford.
- <http://www.pewinternet.org/> – Pew Internet and American Life Project.
- <http://vhil.stanford.edu/> – Virtual Interaction Lab.

Interpersonal Perception and Communication

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Glossary

Account-making The development of a story-like narrative about a life event in order to gain a sense of control or meaning around the event.

Attribution The process of inferring causality or responsibility for events observed in the social or physical world.

Empathic accuracy The ability to accurately interpret another's mood or emotion based on nonverbal behaviors observed.

Implicit personality theory A set of beliefs that an individual holds about how personality traits are manifested in behaviors or about how personality traits predict behavior.

Impression management The selection of certain appearance, behaviors, and messages intended to portray a desired image to others.

Interpersonal perception The process by which people form judgments of others and interpret their verbal and nonverbal behaviors.

Self-disclosure Communicating personal information about oneself to another person.

Self-monitoring The extent to which someone monitors social cues in the environment and is able to adjust the presentation of self to match those cues.

Stereotype threat The fear of being perceived by observers as someone who fulfills a negative stereotype.

Nonverbal Communication

Nonverbal behavior conveys information about another's intentions, moods, and sincerity. One of the most powerful and obvious forms of nonverbal behavior is facial expression. Theories about how people interpret facial expression go back to Charles Darwin, and research into the intricacies of facial movements continues today.

Scholars agree that facial expression of emotion is a universally recognized form of nonverbal communication. There appear to be six major emotional expressions that are displayed similarly across cultures: anger, happiness, surprise, fear, disgust, and sadness. It is easy to recognize these facial expressions in others, regardless of background or culture. Very young children also begin displaying these recognizable expressions quite early in their development, even before they are fluent in language. Behavioral scientists hypothesize that recognizable displays of these six emotions must have been particularly adaptive for humans; they must have helped us to communicate urgent needs in ways that enabled us to survive and thrive. Contemporary emotion research suggests that there may be individual and cultural differences, however, in the perception of more complicated expressions that blend two or more emotional states or of more subtle emotions, such as anxiety or contempt.

Other than providing information about mood and emotion, nonverbal behavior also helps to regulate interpersonal communication and demonstrate the level of intimacy in relationships with others. For example, gestures can help illustrate communications, change the pace of interactions, or show understanding of another. Eye contact can signal beginnings or endings of interactions, communicate intimacy, or signal dominance. Other nonverbal cues, such as interpersonal distance or posture, also inform us about the nature of interaction.

Empathic accuracy describes the ongoing ability to assess a communication partner's emotions accurately and spontaneously.

The level of accuracy a perceiver can achieve in any situation is dependent on two things: how clearly the communication partner reveals cues to mood and emotion, and how much empathic skill the perceiver has. In general, empathic accuracy tends to be higher with people we know than with strangers, probably for two reasons. First, people know more about their family and friends and have observed their responses in different types of situations. Second, when interacting, people tend to be more open in communication with those they know than they would be with strangers. Thus, they reveal more unambiguous nonverbal and verbal cues to their emotions, making it easier to be accurate in judging them.

Empathic accuracy also improves when the perceiver is highly motivated. For example, if the observer desires to develop a positive relationship with a communication partner, empathic accuracy is likely to increase, probably due to increased effort and attention. On the other hand, people are also sometimes less motivated to be accurate, and may even prefer to be inaccurate in empathetic judgments. For example, if a romantic partner's inattention or annoyance threatens the stability of a relationship, this may be easier to ignore than to acknowledge. This motivated inaccuracy can usually only persist as long as the partner's emotional cues are somewhat ambiguous.

Regardless of motivation, some people tend to be more sensitive to nonverbal cues than are others. Many studies indicate, for example, that women are better at noticing and interpreting nonverbal behavior than men. However, research has also demonstrated that people are generally poor judges of their own empathic abilities. This blindness to empathic deficits can be especially problematic in situations where one person is oblivious to signals that he or she is hurting another person because of the inability to read signs of distress or displeasure.

While facial expression is obviously one of the more powerful types of nonverbal communication, studied in terms of its

universal qualities, people use other nonverbal cues as well to communicate a variety of emotions and responses to others. The ability to empathize and read others' nonverbal signals seems to be due partly to individual skill, but it may also be affected by motivational factors. Using nonverbal information well, though, depends also on the ability to communicate empathy. People not only read nonverbal signals, but use nonverbal behavior to express empathy for another. Matching another's facial expression, leaning toward someone in sympathy, winking to express mutual amusement across a room, all these are ways in which we can communicate shared understanding of a moment or emotion using nonverbal behavior.

Attributions for Others' Behaviors

People routinely observe the behavior of others and have a need to explain the reasons for what they observe. Attributions are these explanations or reasons we create for events or behaviors we observe in the world around us. Making attributions sometimes involves a great deal of critical thought and analysis, as when trying to explain another's behavior that is confusing or hurtful. Other times, when the behavior has relatively little impact, the attributions may be almost automatic. How people create attributions has been one of the most actively pursued questions in interpersonal perception research.

Attributions can be roughly broken down into two types: dispositional or situational. In other words, we have a tendency to explain others' behaviors as arising either from their own personalities (dispositional attribution) or from the pressures of the situation (situational attribution.) For example, when waiting for someone who is late to an appointment, one might make a dispositional attribution by thinking the latecomer to be irresponsible or disrespectful. Thinking that the person must be caught in traffic or held up at work would be making a situational attribution for the same behavior.

Whether we attribute causality to dispositional or situational influences may depend in part on whether we are the actors or the observers of a behavior. When we observe our own behaviors, we have a tendency to attribute more of our actions to the influence of the situation, especially if those actions are somewhat negative. We lost the game because the referee was unfair. I was late to the meeting because there was no place to park. The opposite is true for attributions of observed behavior. We have a tendency to attribute the behavior of others to their personalities or dispositions. He lost the game because he is not very good at it; she was late to the meeting because she is unorganized.

One explanation for this actor/observer difference is that when we are acting as observers, our attention is captured more by the people in the scene rather than the environment surrounding them. So, making a dispositional attribution for another's behavior is simpler than searching for a situational explanation. When we ourselves are the actors, however, our attention is consumed by the factors in the environment around us. Therefore, it is far easier for us to come up with situational attributions for our own behavior. This tendency to make correspondent inferences, assuming that a person's actions correspond to his or her personal qualities, is so prevalent that it is sometimes called a correspondence bias.

Psychologists also often refer to this tendency as a fundamental attribution error because it can cause us to make inaccurate judgments about others.

Correspondent inference allows us to make attributions quickly. But with time to process another's behavior, we may be more likely to use logical deduction in making attributions. When given the time and information, observers might make attributions based on the covariation of three factors: consistency, consensus, and distinctiveness. If your business associate was late to a meeting, for example, this model assumes that you would ask yourself three questions: Has this person been late to meetings before (consistency)? Are other people also late to this meeting (consensus)? Is this person late to other kinds of events as well (distinctiveness)? If the answers to the above questions are yes, no, and yes, then you might comment on how unreliable your associate is (dispositional attribution). If, on the other hand, this person has never been late before (less consistency), or if many others are also late to this meeting (greater consensus), you might be more inclined to wonder what had happened to delay everyone's arrival (situational attribution). Covariation and correspondent inference models of attribution continue to resonate in social psychological research.

Logical analysis of another's behavior often requires more time, cognitive effort, and attention than people have to spare. As a result, individuals often rely on cognitive shortcuts in order to make judgments quickly. The exploration of these shortcuts or biases is part of social cognition, the study of how thought processes, such as memory or attention, affect our perceptions of other people and social interactions.

Several of these cognitive shortcuts are worth mentioning here, however, because they have powerful effects on interpersonal communication. One of the most common is the correspondence bias described above. A related bias is our tendency to ignore the importance of base rates, or the real-world probabilities of events. We are largely unaware of how often certain behaviors or attitudes occur. This also leads us to assume that others are more similar to us than they actually are: a false consensus effect. For example, a busy working mother sees another woman looking rushed. The first woman may assume the other is a mother trying to balance work and home life, just as she is. The observing woman is also likely to assume the stranger shares her own opinions and has similar concerns.

We are also biased by our need to make sense of the world and to believe that it operates in a just manner. This, combined with the fundamental attribution error and our lack of base rate knowledge, can lead us to blame others for events which may be out of their control. For example, we often assume victims of crimes have been incautious or provocative in some way. This quick judgment of others' suffering allows us to continue to believe that the world is fair and also affords us the comforting belief that we can avoid being victims of these kinds of unfortunate events ourselves. We sometimes use communications with others to further confirm these beliefs. If I experience a trauma of some kind, an acquaintance might ask what I could have done to prevent it. Our cognitive biases can lead us to sometimes directly accuse injured people of negligence, or speculate on why a sick person did not take better care of himself or herself.

An additional and important form of attributional bias involves stereotyping. Stereotyping is the process of making

assumptions about others' behaviors based on their presumed membership in a particular group. Stereotypes allow us to ignore individual differences between people and make attributions about their behaviors with little effort. Like other forms of attributional bias, stereotyping can lead to inaccurate judgments about others.

Attributions have a direct effect on interpersonal communication. Our attributions for others' behaviors affect the way we may subsequently interact with them. If I interpret a sales clerk's smile as a genuine wish to help me, I may be friendlier and spend more money than if I attribute it to a desire for a higher commission. Secondly, our very purpose in communicating with another may be to clarify our attributions. For example, I may confront someone to demand an explanation for a behavior, accuse him or her of a particular motivation for a behavior, or raise a question about why the behavior occurred. Finally, people communicate excuses for committing various social errors, like being late or not returning a phone call, in order to control the attributions that others might make for those behaviors.

Social scientists have examined the interplay between attribution and communication most frequently in close relationships, especially marital relationships. Partners in stable, positive relationships tend to make dispositional attributions for behaviors that enhance the relationship, and situational attributions for behaviors that are more negative. The reverse appears to be true for partners in distressed relationships. Both verbal and nonverbal communication between partners is affected by the partners' attributional patterns. Couples with relationship-enhancing attributional patterns are likely to reinforce those patterns with positive nonverbal behaviors and open discussions about problems. A more negative attributional pattern is more likely to lead to negative communication between partners, such as blaming, rejection, and refusal to accept responsibility for problems. The kinds of attributions made by interaction partners can thus lead to an overall pattern of communication that can strengthen or weaken the relationship.

In brief, people make attributions for the events they see around them, but often make them quickly and under the influence of preconceptions or cognitive biases. These attributional complications affect the way in which we communicate and interact with others around us. A wife may interpret a husband's comment as a criticism and withdraw in resentment. A teacher can misinterpret a child's confusion as lack of attention and scold him or her. Two coworkers might each form different impressions of a supervisor's offer of assistance and respond positively or negatively. The tone, manner, and intimacy with which we approach and communicate with others can be directly affected by the attributions we make about their behaviors.

Person Perception and Communication

When people form judgments about others, they draw conclusions not only about others' behaviors but also about personalities. Some research has shown that people reach conclusions about another's personality even when they have seen that person's face for only a fraction of a second. What we believe about another person will affect the way we choose to

communicate with that person; therefore, our judgments about personality have consequences.

Early research into personality perception examined how accurate people were in their judgments of others' personalities. This work was problematic, however, because of the nature of accuracy in personality assessment. Making an accurate evaluation of another's personality depends in part on comparing that person's personality characteristics to the norms for those personality traits in the general population. For example, it is difficult to judge how extroverted someone is without comparing him or her to others. Because most people do not have that kind of broad knowledge about personality norms in the population, those who generally make more conservative judgments of others appear to be more accurate in their evaluations than those who are more extreme in their opinions of others. Thus, it is hard to separate accuracy from natural caution in judgments. Because of this difficulty, much research into person perception has focused less on the accuracy of judgment than it has on the process of how we develop theories about others' personalities.

One theory of person perception hypothesizes that people collect pieces of different information about someone in order to form an overall impression. In this model, people sum or average another person's favorable versus unfavorable traits in order to calculate an overall impression. Though there is evidence that people weigh the value of various traits in reaching an opinion, the process appears to be more complex than simply averaging impressions.

Considerable research demonstrates that one unifying characteristic or trait can shape someone's overall impression of another. These central traits are characteristics that seem so important that they overwhelm or color other information about another person. An example is the personality trait of being warm versus cold. Research has demonstrated that if we hear someone described as a warm person, we then have a strong positive impression of that person that influences everything else we subsequently hear about him or her. The reverse is true if we hear the person described as cold.

These initial conclusions about certain central personality characteristics can lead to other assumptions about a person's overall personality. For example, I might associate warmth with honesty or helpfulness. If I meet a person who appears warm, or has been described to me as being a warm person, I might be more inclined to trust him or her, based on my automatic association of warmth with honesty. These networks of assumptions we have about people's personalities are implicit personality theories. Each individual probably has a unique implicit personality theory, based on his or her own previous experiences, but there seem to be some commonalities. Two central traits appear to be crucial to most people's implicit theories: warmth and competence. We seem to evaluate people first on the dimension of warmth by assessing aspects of their personality like friendliness, humor, and sincerity. Then we look for traits related to competence, like intelligence, persistence, and reliability.

There are other personal and situational factors that affect what we pay attention to about others when we are seeking to form an impression of them. For example, research has demonstrated that membership in a specific population group (e.g., ethnic background, gender, age) influences our

evaluations of another. This research has had significant effects on theories of prejudice and stereotyping. Our recent pasts also bias our evaluations of others. When we have recently been exposed to very unpleasant behavior, for example, we may judge people who are neutral as more positive in contrast. This contrast effect works in reverse as well, making us more critical of Allen when we have been recently exposed to extremely pleasing or positive behavior by Barry.

Our judgments of others' personalities are also biased by their physical attractiveness. Specifically, we have a tendency to assume that attractive people are happier, more successful, and warmer than are less attractive people. In this way, physical attractiveness may operate much like a central trait in affecting our subsequent judgments.

Given all the factors affecting our impressions, can we possibly be accurate in these personality judgments? Some contemporary research into person perception has circled back to examine this question. Researchers have compared people's first impressions of strangers to the personality descriptions given by the strangers' friends and family members. These first impressions often correlate with the ratings made by those who knew the targets well. Although this work is complicated by the factors mentioned earlier, it seems to indicate that people can be fairly reliable at judging some basic characteristics of personality, even after a relatively short exposure to another's actions.

This process of impression formation affects the way we communicate with other people. As individuals interact, they attend to cues and form impressions of each other. Physical attraction affects our responses to others. Social interactions with others will also be affected by the social cues we receive, like those related to gender or authority. Next, an individual might look for nonverbal clues as to the other's personality, such as facial expression or posture. Finally, any attributions made about the person's personality characteristics are factored into the equation. The summary of these perceptions affects not only the observer's interpretation of the person and the world but also his or her subsequent verbal and nonverbal responses.

The ability to make these assessments affects one's skill at appropriate social interactions. Communication competence is expressed in the ability to display sensitivity to an interaction partner while also achieving one's own goals for the interaction. Various factors affect communication competence, including aptitude for reading others' nonverbal behaviors, various biases in making attributions, and judgments of the other's personality. We are more likely to achieve our communication goals if we are attentive to others' responses and accurate in judging them.

Because communication competence in part depends on knowledge of others, we are less secure communicating with partners about whom we know very little. Uncertainty reduction theory considers how people strive to gather this kind of information in a new interpersonal situation. Communication scholars interested in uncertainty reduction explore how people probe for information when interacting with others, test out their new conclusions in subsequent interactions, and make decisions about further communication.

But when we interact with others, we are not just observing them. We are influencing them as well. As we form impressions

of others and then strive to reduce our uncertainty about them, we may inadvertently cause them to produce reactions that confirm our initial impressions. A man who is told a particular woman is extroverted will ask questions of her and engage her in conversation that assumes her to be outgoing and social. He is thus more likely to elicit responses from her that confirm this initial expectation. His communication style has influenced hers and strengthened the first impression of her personality.

In summary, we often make very quick judgments not only about others' behaviors, but also about their personalities. These judgments might be based on an analysis of various actions we have seen others display, but they are likely heavily affected by our impressions of central traits like warmth and competence. Our initial impressions may be biased by another's membership in a particular group or level of physical attractiveness, and they are influenced by the implicit theories of personality that we have developed through time and previous experience. These initial judgments of personality are powerful because they may affect the way we choose to communicate with others. Those communication choices may influence others' responses. This creates an interaction spiral of initial perceptions, attributions, subsequent communication, other's response, and confirmation or revision of the initial judgments. It is through a continuing series of these interactions that we build relationships and intimacy with others.

Communicating About Oneself to Others

Sharing information about oneself, or self-disclosure, is a central avenue of interpersonal communication and another way to create intimacy in relationships. Self-disclosure is defined as personal information about oneself that is communicated to another. Disclosure differs in terms of its breadth, depth, and duration. Breadth refers to how many different topics are covered in the disclosure, depth to how personal or intimate the level of disclosure is, and duration to the length of the actual disclosure.

A common way for people to disclose information about themselves is to construct an account. An account is a package of impressions, perceptions, attributions, emotions, and description, formed into a story. Someone would develop an account about an event in his or her life in order to gain a sense of control and meaning around the event. Sharing that account with others is a way of giving out information about yourself, helping others to understand you, or influencing others' impressions of you. People may construct accounts about other people's behavior as well and share those accounts for the same reasons: to give out information about the leading players in those accounts or to influence others' impressions of either the account maker or the actors in the story.

Self-disclosure is a key concept in social penetration theory. Social penetration theory describes the process by which people develop relationships. As two people get to know each other, there is usually a social exchange as people take turns disclosing. One person's mild disclosure often triggers this exchange. The second person in the interaction can then choose to disclose in return or not. If so, there may be a continuing spiral of increasing intimacy between the two people. These disclosures gradually become more intimate and

involve more depth. Through this process, the communication partners uncover information about each other, developing a multilayered understanding of the other that serves as a foundation for the relationship. Thus, one major purpose of disclosing personal information is establishing friendship or intimacy with another.

A second use of self-disclosure is as a social strategy, revealing or withholding information in order to obtain a goal. For example, you might share a sympathetic story about yourself in order to get someone to assist you in a task or to talk your way out of a negative consequence of some kind. In contrast, you might disclose your pride in a success in order to make a good impression at a job interview.

Disclosure can also be used as a catharsis, or a venting of emotion. There is research demonstrating that disclosure of this kind can be therapeutic, if an empathetic listener receives it. Early theories of self-disclosure assumed that this type of disclosure was always beneficial and that the willingness to self-disclose was a sign of mental health. Now, however, it is clear that disclosure is more complex than this, and that there are several risks involved in the decision to self-disclose. There is a risk of rejection by the listener, loss of personal control over the information shared, and of embarrassing the listener.

Self-disclosure is a discretionary behavior; that is, people control how much, to whom, and when they wish to disclose. Self-disclosure can also be a goal-oriented behavior; it can be used for different purposes in different situations. There is risk attached to self-disclosure. For all of these reasons, perceptions of others are crucial to decisions about disclosure. The impressions and attributions we have formed regarding others affect the extent of our willingness to disclose to them and the circumstances under which we are willing to disclose. We may be more likely to disclose to people who appear warm, receptive, and trustworthy. We may also disclose more to those who appear to have advantages to offer us in return for our disclosures. For example, someone is likely to self-disclose more readily to a prospective romantic partner who is both attractive and congenial than to one who appears to be either cold or personally unappealing.

Individuals manage their communication and disclosure with others to further their social goals. A major theoretical perspective related to this idea is that of self-presentation or impression management. This research assumes that people take on different roles in their daily lives, much like actors on a stage. Individuals select certain appearances or behaviors intended to convey a particular image for others.

One person may have a variety of roles or images he or she can portray, depending on the situation or the social goal of the moment. Some strategic methods of self-presentation that have been identified by researchers include emphasizing one's strengths or accomplishments, advertising one's moral superiority, portraying oneself as a helpless victim, ingratiating oneself through flattery and admiration, and appearing aggressive or intimidating. Individuals may rely on one particular self-presentation method in most of their interactions with others, or may vary their self-presentation based on the needs of the situation.

Different people are more or less motivated to change their self-presentation to suit the social requirements of different situations. Self-monitoring is a term used to describe the

awareness of changes in social situations and the desire to alter one's self-presentation in order to better fit into those situations. People who are high self-monitors have many different images they are able and willing to present; people who are low self-monitors are more consistent in their self-presentation across many different situations. People also vary in how anxious they are in social situations; this can affect how well they manage their self-presentation. Extroverted people are generally more at ease with self-presentation strategies than are introverts; however, this appears to be mainly due to some introverts' anxiety over social interactions rather than a lack of skill in impression management.

The growing use of technology as a communication medium creates new questions about person perception and self-disclosure. In the past decade, much research has focused on the increasing use of the Internet as a medium for interpersonal communication. Because these types of communications tend to be relatively brief and made at a distance, communication partners often do not have the benefit of nonverbal or emotional expression in order to reduce uncertainty or help form judgments about the other. Early studies seemed to confirm that communicating through media such as e-mail, chat rooms, or cell phone text messages had the expected negative effect on communication effectiveness and social intimacy.

However, newer research findings are more equivocal. Some research indicates that communication via Internet increases openness in self-disclosure, promotes positive feelings about communication partners, and allows frequent interaction with friends and family. It is possible that as these technologies have become more established and accepted as useful communication tools, people have adapted their patterns of communications and social judgments as well. One hypothesis is that people who suffer from anxiety in face-to-face social encounters may be more at ease communicating by computer and thus able to have more satisfying social interactions. Social scientists have only begun to explore the effects of technology on interpersonal perceptions and communication. It is not clear as yet what the full impact of newer technologies will be on patterns of interpersonal communication.

How much one communicates to others about oneself is a complex social decision. This self-disclosure may serve several purposes: social penetration, social manipulation, or emotional catharsis. People often build accounts about themselves to use specifically in telling their stories to others. They may also strategically balance how much they reveal in order to maximize social benefits through self-presentation while minimizing the inherent risks in disclosing personal information. To do this well, people must make judgments about the receptivity, trustworthiness, or helpfulness of others. Thus, disclosure decisions are linked to the process of interpersonal perception.

Expectancy Effects

People form initial impressions of others rapidly and these impressions can be important influences on subsequent interactions with those others. The judgments or attributions made about another's actions lead to expectations about that person's subsequent actions. These expectations about others

affect interactions, regardless of whether those expectations are based on accurate or inaccurate judgments.

Once we have formed a judgment about someone else, we are vulnerable to a confirmation bias. This is a tendency to notice only information that will confirm our previous judgment. For example, if we have previously concluded that Susan is a bad parent, we will tend to notice her children's behaviors that confirm that belief but ignore those that do not. This bias in what we attend to will strengthen our previous expectations. If we have judged John to be an impatient and angry person, we will interpret his every fidget as a sign of that impatience; this will further confirm our previous assessment of him. Our beliefs about others then are likely to persevere, even in the face of contradictory evidence, because we are unlikely to take notice of that evidence.

We increase our confidence in our own judgments, not only by ignoring conflicting information but also by acting in ways that support our previous conclusions. We avoid people with whom we have had negative interactions, which can lead to few opportunities to change our impressions. If we must interact with them, we may view the situation as unpleasant, which again reinforces our opinions of them. If we enjoy our initial interactions with someone, however, we may seek him or her out. Moreover, we will seek that person out with positive intentions and expectations and treat him or her as though we expect a pleasant interaction.

Positive or negative expectations of someone can lead to a self-fulfilling prophecy. This occurs when a perceiver forms a strong expectation about another that affects the perceiver's behavior. The target of this behavior responds in a way that reinforces the expectation. If that cycle continues, the target begins to fulfill the expectation, regardless of whether or not the perceiver's initial beliefs were accurate. For example, if Allen has a negative expectation about his interaction with Barbara, he may approach her defensively. Barbara is annoyed by Allen's defensive behavior and responds aggressively. This reinforces Allen's opinion of her and he continues to treat her in a negative way. If this interaction pattern persists, Barbara may become consistently as unpleasant as Allen always expected her to be.

The initial and most influential work on self-fulfilling prophecies was originally done in educational settings. Research seemed to demonstrate, for example, that if teachers were led to believe that certain children were more capable of improvement than others, those children would in fact show greater performance improvements. The teachers' expectations appeared to be responsible for the children's successes. Evidence over the years seems to indicate that these types of specific expectations in the classroom may not have as big an impact as originally thought, but do exist.

Other important research in this area involves whether or not people are aware of the expectations that others have of them. Stereotype threat is the fear that others have expectations of you related to your membership in a stereotyped group. One example might be a fear that others expect that you would struggle with certain academic subjects because of your gender or race. Research has documented that when students are made aware that teachers or test administrators know the negative stereotypes pertaining to their racial or

gender group, those students suffer anxiety about confirming those stereotypes. This anxiety interferes with their academic performance.

Stereotype threat is most likely to occur when someone feels that he or she will be compared with others who are not members of the stereotyped group. One method of countering stereotype threat is to remind people of positive attributes they share with all the others in the situation, for example reminding them that they were all selected because they were the best applicants for a job. Some research shows that reducing anxiety in general also reduces the negative effects of stereotype threat. Other researchers have found that simply explaining what stereotype threat is and how it might affect members of stigmatized groups can reduce its impact on individuals.

Some people may be less susceptible to expectancy effects than are others. People who generally have a clear sense of self, and those who are less anxious about social evaluation may be more resistant. When someone is very confident and also has considerable experience regarding a personal ability or characteristic, he or she may be less likely to be influenced by a perceiver's expectations.

In conclusion, the processes of interpersonal perception and interpersonal communication directly affect each other. Both processes also affect our personal interactions and relationships in everyday life. People form impressions of others rapidly, making judgments and attributions about their personalities and behaviors. These perceptions influence the way people then choose to communicate with others and what they choose to disclose about themselves. As people's expectations and perceptions change their behaviors and communications toward others, they may produce self-fulfilling sequences that actually create change in others' subsequent behaviors. The relationships that people build with each other are therefore based on these structures of perception and communication. The ongoing dynamics between perception and communication is the foundation for interpersonal relations.

See also: Attribution; Facial Expression of Emotion; Nonverbal Communication; Personal Relationships in Everyday Life; Prejudice, Discrimination, and Stereotypes (Racial Bias); Self-Fulfilling Prophecy; Sex Roles; Social Cognition.

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Interpersonal Psychotherapy

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Glossary

Anhedonia A marked decrease in interest or satisfaction from participating in once pleasurable or rewarding activities.

Complicated grief A deviation from the normal or typical response to loss such that the grief reaction is prolonged, more complex, and profoundly disrupts healthy functioning. Particularly difficult or tragic manners of death of significant others (e.g., suicide, homicide, and accidents) may pose a significant barrier to healthy resolution or acceptance of the death.

Depressive episode The (potentially recurrent) experience of a severely depressed mood state, and/or anhedonia, which is manifested by several of the following over a 2-week period: disturbances in sleep, appetite, concentration, psychomotor activity, energy, feelings of self worth, and/or thoughts of death, suicide, with or without a suicide plan or attempt.

Grief The normal (and typically transient) response to the loss of someone or something loved or prized, which incorporates a range of reactions and adjustments across several dimensions (i.e., social, cognitive, and emotional).

Internal working model (IWM) From early-life experiences with a primary caregiver and close others, children develop a set of expectations about how they should be treated, the responsiveness and sensitivity of others, as well the likely outcomes of various interpersonal interactions. The IWM is theorized to be formative in the development of self-esteem and other self-views.

Interpersonal deficits The lack of effective or healthy relationship building or maintaining skills, which may result in boredom or loneliness in the absence of a supportive social network.

Interpersonal disputes Conflicts with significant others while in stages of renegotiation or dissolution, or when a conflict reaches an impasse.

Role transitions A marked change in an individual's life or relationship status in response to the beginning, end, or passage from one life or relationship stage to another.

Selective serotonin reuptake inhibitors (SSRIs) Individuals suffering from psychiatric disorders, particularly mood and anxiety disorders, may be prescribed antidepressants alone or in combination with psychotherapy. Selective serotonin reuptake inhibitors (SSRIs) are a class of commonly prescribed antidepressants which are often preferred over monoamine oxidase inhibitors (MAOIs) and other classes of antidepressants. SSRIs such as Fluoxetine, Citalopram, and Fluvoxamine help regulate levels of serotonin, a neurotransmitter implicated in the development of depression and other mental illnesses.

Treatment phases Stages in the therapeutic process that build upon one another and may focus on different issues or problem areas as a patient progresses with treatment. Specific strategies or tools may be implemented during these stages to help achieve therapeutic goals and reduce symptoms of psychopathology.

Interpersonal psychotherapy (IPT) is a time-limited, diagnosis-specific psychotherapy originally developed for the treatment of major depressive disorder (MDD). It was initially developed for a clinical trial, testing the maintenance treatment of MDD using drugs and psychotherapy alone and in combination. In 2007, a simplified guide for clinicians was released, based on the original book which describes the basic techniques and strategies. This guide and an updated version of the original book presents scripts for carrying out the procedures, provides case material, and includes updated efficacy data. IPT draws its principles from interpersonal and attachment theories, which hypothesize the connection between life events, interpersonal interactions, and the development of psychopathology. Empirical evidence has since demonstrated the close association between the onset of depression in biologically vulnerable individuals as a function of interpersonal events.

IPT has been tested in comparison and in combination with medication for the treatment of MDD. It is designated by the American Psychiatric Association and Primary Care Practice Guidelines in 1993 as a recommended treatment for adult

depression. It is included in evidence-based practice guidelines of depression by the Royal College of Psychiatrists and the National Institute of Clinical Excellence (NICE) for residency training. IPT is also part of the clinical practice guidelines for depression in the Netherlands. The IPT manual has been translated into French, German, Japanese, Spanish, Italian, Danish, and Portuguese.

This article delineates the theoretical substrates which contribute to the nature, onset, and maintenance of depression according to IPT and supporting research. It also describes the treatment techniques and session content of IPT. An illustrative rather than exhaustive review of international IPT adaptations is included. A comprehensive description of IPT concepts and procedures is available in the current IPT published manual.

Depression

Depression is classified as a mood disorder by the *Diagnostic and Statistical Manual of Mental Disorders* (4th edition) and the

International Classification of Impairments, Disabilities, and Handicaps (10th revision). It is a prevalent, yet treatable psychiatric illness with a lifetime prevalence of ~10% for men, and 25% for women. Depression poses significant costs to society in terms of productivity loss and healthcare costs, with a mortality rate of 10–15%. The Hamilton Depression Rating Scale and the Beck Depression Inventory are valid measures used to assist diagnosis as well as monitor depressive symptoms. Diagnosis of depression must include either depressed mood or loss of interest (anhedonia) for most of the day for more than half the days in a 2-week period. Appetite changes (weight gain or loss), sleep problems (insomnia or hypersomnia), loss of energy, poor concentration, psychomotor retardation, feelings of worthlessness or guilt, and/or recurrent thoughts of death or suicidality, may also be present. At least four of these symptoms in the same 2-week period are required for a diagnosis of depression.

Theoretical and Empirical Background

Sullivan's Interpersonal Theory

The principles of IPT are based in part on Sullivan's interpersonal theory, which connects the development of psychopathology to the quality of interpersonal contexts, with special focus on the formative years. Sullivan suggested that individuals, particularly those suffering from mental disorders, were less aware of patterns involved in their interpersonal experience, known by the process of selective attention. Selective attention was integral to his investigation of psychopathology, such that information regarding patients' unique interactional and affectual patterns were necessary for diagnosis and designing a therapeutic strategy. The emphasis on the relational approach to case conceptualization and its usefulness for elucidating processes behind psychopathology have endured as influential aspects of interpersonal theory. IPT, however, focuses on current interpersonal difficulties and significant life events, rather than early formative experiences.

Bowlby's Attachment Theory

Another important theoretical source of IPT is Bowlby's attachment theory, which explains that the primary caregiver and child dyad represents the most elementary of human relationships. The charge of the caregiver, therefore, is to provide the child with the necessities for surviving and adapting to an environment, while shielding from harm. Ainsworth and colleagues discussed this dynamic process wherein the caregiver functions as a secure base for the child to explore his or her environment. This concept was developed in response to the strange situation research which explored children's reactions to several experimental manipulations involving the disappearance and return of their caregivers. From these studies emerged two main styles of attachment behavior: secure, and insecure (anxious and anxious-avoidant).

Bowlby incorporated his theory of internal working models (IWMs) to explain the centrality of early relationships and their influence on relational expectations. Some of the most integral adaptational processes, such as predicting outcomes in one's environment and engaging in survival techniques (e.g., seeking

social support), are guided by the IWM formed by early attachment. Bowlby suggested that disruption in the development of a healthy IWM, due to neglectful or inconsistent caregiver behavior, may lead to vulnerability to psychopathology in later years. Adult attachment style has been delineated by Bartholomew and colleagues to resemble four main prototypes as a function of high or low relationship avoidance and anxiety: secure (low avoidance and anxiety), preoccupied (low avoidance and high anxiety), dismissing (high avoidance and low anxiety), and fearful (high avoidance and anxiety). Insecure attachment in adulthood has been linked to depression and substance abuse, highlighting the vulnerability of adults with dysfunctional IWMs. However, research suggests that attachment style in adulthood is malleable in response to newly incorporated information into the IWM. This process may ameliorate relational problems and ultimately reduce risk for psychopathology. Preliminary research suggests that attachment style may help predict important aspects of the therapeutic relationship, including time necessary to form a patient–therapist alliance, treatment response, diagnostic features, and treatment course.

Life Events

IPT addresses current episodes of illness by relating mood states to present interpersonal problems. Research on depression and its psychosocial triggers have guided the conceptualization of relational issues into four main categories: role transitions (e.g., motherhood and marriage), interpersonal disputes (e.g., conflict-driven marriages), grief (i.e., complicated bereavement), and interpersonal deficits (e.g., social isolation and loneliness). In IPT, each domain is addressed by a range of therapeutic strategies designed to foster positive interpersonal interactions and elevate mood.

Depression literature has long suggested that life events affect the onset of a depressive episode. Yet, recent theories propose that different types of life events make the relationship with depression more complex. The psychological impact of events originating from sheer coincidence (e.g., natural disaster and automobile accidents) is contrasted with events that involve a severed relationship (e.g., divorce and job loss). Consistent with psychosocial research, depression associated with stressful relationship-oriented events has been associated with the onset of a future depressive episode. When events of sheer coincidence are implicated in the onset of a depressive episode, they have failed to show an association to future episodes. Events that involve humiliation or strong social disapproval are closely linked to the development of a depressive episode. Similarly, neuroticism (the tendency to interpret events through a negative or emotional lens) influences the perceived impact of an event before a depressive episode. This illustrates the role of personality and outcome expectation on the development of an illness episode. This notion is demonstrated in studies of recurrent depression in which the development of a depressive episode after two or more episodes was found to be unrelated to life events. The techniques of IPT adapted as a maintenance therapy are amenable to treating recurrent episodes of depression.

Life events may be subjectively interpreted and appraised. Therefore, the reaction to life events varies between individuals. Selye differentiated between negative stress (i.e., distress) and

positive stress (i.e., eustress). The concept of eustress delineates the nature of stress such that positive life events may also cause significant disruption in individuals' lives. The challenges of life transitions typically assumed to be positive (e.g., marriage and childbirth) have the potential to be as problematic as negative life events (e.g., death of a loved one). Some individuals may suffer a depressive episode in response to such life events, whereas others may be relatively unaffected by their influence.

Recent genetics research has demonstrated a possible biological interaction between life events, genes, and psychopathology, highlighting individual differences in vulnerability to depression. Caspi and colleagues conducted a prospective-longitudinal investigation in which the experience of stressful life events and depressive episode were linked by genetic variability. The serotonin transporter gene, 5-HTT, affected by a functional polymorphism was isolated as a moderator of the influence of stress from life events on the onset of a depressive episode. That is, experience of stressful life events is causally related to the onset of a depressive episode in vulnerable individuals. Individuals with two or more copies of a short allele affected by the 5-HTT polymorphism comprise 60% of the population. Of these individuals, those who experience a stressful life event(s) may compose the bulk of patients seeking treatment for depression. Undoubtedly, in the future, other genes and their pathways and interactions will be identified. This study conveys the need to address current life stressors as a facet of treatment for depression in biologically vulnerable individuals. These empirical findings validate IPT's focus on present life events and current stressors as a method of reducing depression symptoms.

Focus and Techniques of IPT

IPT assumes the patient is not responsible for the onset of a depressive episode. In this way, a diagnosis of depression removes guilt. In the first sessions of IPT, the therapist educates the patient about the nature of depression, explains that it is ego-dystonic, and defines its symptoms. Patient assumptions about personal weakness or failure are absolved by educating patients about the symptom course of depression, as well as treatment availability. This perspective also assists therapists with instilling hope in patients and demystifying depression. To help achieve its goals and foster a collaborative therapeutic alliance, IPT utilizes the sick role concept. Sociologist Talcott Parsons defined the sick role as a formal excusal from normal duties while undergoing medical treatment. In IPT, the sick role fosters the motivation necessary for patients to take steps to restore their former social roles and healthy functioning.

Therapeutic Strategies

IPT is principally concerned with the current triggers of a depressive episode. Therefore, IPT's main strategy involves linking stressful life events and interpersonal problems to changes in mood. By helping the patient recognize and understand the interaction between symptom onset (i.e., depressed mood) and interpersonal triggers, action can be taken to reduce its maintaining factors. In active collaboration with the IPT therapist, the patient can work to resolve issues and improve their situation, leading to depressive symptom reduction.

In IPT, interpersonal difficulties are conceptualized as the main activating factors of a depressive episode, which generally fall under four categories: grief, interpersonal disputes, role transitions, and interpersonal deficits. Typically, the therapist and patient work jointly in an effort to determine the most impactful life event and/or the main problem area triggering the depressive episode. This integral step is completed in the first phase of treatment and may be revised or refined as necessary as progress is made. In the middle phase of IPT treatment, the therapist implements therapeutic strategies designed specifically for the isolated problem area.

Techniques

IPT relies on techniques that are common to psychotherapy. When focusing on interpersonal disputes or deficits, the therapist needs to acquire a sense of the problem and the communication styles of the patient and their significant others. Therefore, a communication analysis is accomplished by recreating an interaction that has caused distress for a patient or has affected their emotional state. Mainly, this strategy is used to determine problematic content.

In order to work collaboratively toward a defined and realistic goal in IPT, the therapist helps the patient reconcile the wishes and actual options for his/her interpersonal problems. The patient is encouraged to reveal his/her hopes for the most desired outcome for his/her interpersonal situations. The therapist and patient discuss how to achieve the patient's wishes within the context of realistic options offered by his/her interpersonal relationships.

After defining the goals of treatment, it is crucial to explore and determine the best options for reducing depressive symptoms. To work toward these goals, it is necessary to navigate interpersonal issues as they arise. A decision analysis is implemented to help the patient generate possible options and determine the solution most likely to foster his/her larger goal(s).

An important therapeutic strategy of IPT is the use of role play. This technique is employed when a patient learns a new skill or tactic for solving interpersonal problems and rehearses its implementation. This is a valuable strategy for treating patients with interpersonal deficits who may gain comfort from practicing new skills before introducing them in real-world situations.

The diversity of tools in IPT, in contrast with psychodynamic therapies, primarily focuses on the present, namely the here and now, rather than early-life experiences, dreams, or instances of transference. IPT also assumes that patients can be taught to recognize their emotions in connection to events, rather than unearthing suppressed emotions or unconscious conflicts. Moreover, IPT invokes the medical model perspective which eliminates patient guilt or responsibility for illness while instilling hope in the patient as an agent for change.

Comparison of IPT to cognitive-behavioral therapy (CBT) demonstrates that IPT sessions are less structured than CBT sessions and rely less on specific homework tasks. Furthermore, CBT fosters the recognition of dysfunctional or unrealistic cognitions as they relate to mood or action. However, IPT's strategies focus on linking mood to event as the essential mechanism for depressive symptom alleviation. In IPT, several overlapping goals within the four major problem areas may be addressed

simultaneously. Despite these theoretical differences, both approaches utilize the concept of the here and now and strategies such as role play to promote reduction in the syndromal constellation.

Treatment Phases

In acute treatment form, IPT comprises three phases in a 12–16-week schedule. However, length of IPT treatment is not standardized and can vary considerably. The time-limited nature of treatment is explained and the time span is defined in the initial phases, which can be renegotiated later, but with specific goals for an extension of treatment. The following is a delineation of the typical IPT treatment phases for MDD. As described earlier, IPT has been modified for several mood and nonmood disorders, as well as a maintenance therapy for depression, all of which would deviate to some extent from this clinical illustration. In these cases, the appropriate diagnosis would be substituted and explicated by the therapist in the first phase. The content and therapeutic strategies during the middle phase would be adapted to the presenting diagnosis and appropriate symptomology, with additional modifications based on developmental concerns or culture.

The main focus of the IPT intervention is the patients' current interpersonal context rather than past relationships or experiences. Therefore, IPT does not address issues of personality during treatment. Personality issues are difficult to tease apart in the presence of an Axis I disorder and require further work beyond this time-limited therapy.

Initial Phase

The first phase of IPT typically covers the first session through the third session. The necessary standardized diagnostic evaluations are completed at this stage. In addition, a complete psychiatric history is collected which includes the interpersonal inventory. This schedule compiles information about the patients' current social context, significant others, as well as their level of social functioning. Information regarding the most closely linked interpersonal event to the onset of the depressive episode begins to emerge at this stage. The therapist gathers data on changes (e.g., relocation) or conflicts (i.e., marital strife) in the patients' relationships and is keen to developing themes of emotional content. The interpersonal inventory also includes information about both the therapist and patients' outcome expectations for treatment. Thus, a crucial aspect of the first phase is setting the appropriate framework of treatment based on the information garnered by these tests and inventories. After a diagnosis of depression is confirmed, the therapist reviews with the patient the symptomology and typical illness course to demystify the diagnosis.

An integral aspect of the first phase of treatment is the conferring of the sick role. This symbolically excuses the depressed patient from performing duties they find difficult as a result of the challenges presented by the depressive episode. The sick role further serves as a verbal contract ensuring that the patient will take the necessary steps agreed upon during the sessions to restore their healthy functioning.

It is crucial in the first phase to assess for patient suicidality based on ideation, plans, or recent attempts. Referral to an

intensive level of care at a psychiatric hospital or clinic equipped to handle issues of suicidality may be necessary. The need for medication should also be considered at this stage with reference to symptom severity, psychiatric and medication histories, and response to previous treatments, if any. After thorough psychoeducation about the diagnosis, IPT treatment, and medication, the patient is encouraged to discuss his/her preference for adopting a medication regimen, if suggested. Before the treatment moves to the next phase, the patient chooses from the four problem areas on which he/she wants to focus. This choice is a careful consideration of the proximal interpersonal issues that were developing around the time of symptom onset. It is imperative that the most pertinent issues are clearly and coherently defined. Treatment begins on a weekly basis, which may shift to once every 2 weeks. This determination should be based on symptom improvement and must be agreed upon by both the therapist and patient.

Middle Phase

In the middle phase of IPT treatment, the therapist begins the implementation of the therapeutic strategies suited for the patients' interpersonal problems, as previously described. As the therapist and patient work toward the mutual goals, symptom improvement begins to occur as a function of interpersonal progress. Goals can be altered as necessary as new information is gathered.

Grief

Patients whose depression is triggered from the death of a loved one must focus on facilitating grief. Also known as complicated bereavement, abnormal reactions to the death of a significant other precludes patients from experiencing the normal phases of the mourning process. The therapist assists the patient in accepting the loss while exploring both positive and negative feelings about the deceased. Facilitation of the delayed grieving process is guided by the therapist while methods of breaking social isolation are discussed and implemented. An adaptation of IPT for depression occurring during the normal grief process is underway.

Interpersonal disputes

If the focus area is interpersonal disputes, problems stem from overt or covert conflicts with significant others (e.g., spouses, friends, family members, or coworkers). These conflicts usually relate to situations in which one or more persons involved have nonreciprocal expectations about the relationship. Significant distress may be felt from loss of perceived control over the future of the relationship, diminishing hope for improvement or reconciliation, and/or lowered self-esteem. In many cases, lack of productive communication habits may perpetuate disputes. Here, the therapist helps the patient examine the relationship and the phase of the dispute with possible options for resolution. In the instance that reconciliation reaches an impasse, renegotiating the problem or ending the relationship is considered.

Role transitions

The problem area of role transitions references Selye's conceptualization of stress such that both positive and negative life changes and personal growth may cause significant disruption.

Patients in whom depression is related to life status changes can include milestones such as marriage, graduation, and childbirth, as well as job promotion, career change, or diagnosis of an illness. In these cases, the therapist assists the patient in mourning the loss of a previous role and accepting the challenges or life changes posed by the transition. A realistic perspective on past and future roles is fostered through exploring the positive and negative aspects of each experience. Additionally, patients may benefit from developing new interpersonal skills which may assist them in the new role.

Interpersonal deficits

Some patients presenting for treatment for depression, particularly those with recurrent depressive episodes, are likely to have chronic problems relating to the initiation or maintenance of healthy relationships. Lack of social skills often thwarts the development of healthy social functioning, as well as maintaining an optimal level of social contact. Issues of boredom, loneliness, low self-esteem, or lack of relationship skills are likely indicators of patients with interpersonal deficits. For patients who exhibit problems initiating or sustaining relationships, the goal of IPT is to reduce social isolation and promote the generation of new relationships. It is important to relate the patient's depressive symptoms to social isolation and to discuss the adaptive benefit of social support. The therapeutic relationship can be used to demonstrate how the patient typically relates to others, and the use of role play can assist in the development of social skills.

In IPT, patients' experience of stressful life events affects negative mood states and the onset and maintenance of depression. IPT's goal of helping patients recognize the connection between mood and current life events is crucial for the alleviation of depression symptoms. Therefore, the focus on the here and now is paramount to discussing problems suffered in childhood or other developmental issues. To this end, the therapist serves as a supportive guide in fostering understanding of the mood-event link. IPT therapists begin sessions with the question: "How have things been since we last met?" This opening question directs the patients' attention to recent events and their impact on their experience of positive and negative affect. This technique also teaches patients to mentally catalog a short history of events that have affected their mood states to discuss in an upcoming session.

The role of the therapist in these discussions is to serve as a source of hope and strength in the face of pessimism or perceived helplessness on part of the patient. In IPT, it is understood that patients' hopelessness about life clouds the exploration of possible options for change. Therefore, another major goal of the therapist is to help the patient generate these possibilities for positive change in a nonjudgemental manner. It is important for the patient to try different options for change with significant others to determine the best methods of increasing mood and reducing depression-maintaining situations.

Final Phase

The last few weeks of IPT treatment for acute depression is considered the final phase, or termination. This phase should be discussed throughout treatment. Positive and negative feelings about treatment end are fully explored at this stage.

Sadness about ending treatment is contrasted with the experience of depressed mood. A major objective for termination is that the patient and therapist comprehensively review the gains made during treatment. The changes made in the patients' interpersonal domains are identified as they relate to their depression remission. The independence and sense of control which develops in the patient is recognized. In an effort to sustain these changes, the therapist and patient anticipate events that may potentially trigger depressive symptoms in the future. In these instances, a plan is created and steps are outlined that would help the patient problem-solve in the face of future stressors. There is an option for maintenance therapy sessions based on patient preference. For continuation therapy, sessions are usually conducted weekly for ~8 months, or as needed. Sessions for maintenance therapy have been conducted monthly for up to 3 years. In the instance that the patient has not significantly improved, the therapist helps the patient understand that the treatment has not fully addressed his or her issues and that the patient is not responsible for failing at treatment. A disclosure of other effective treatment methods is made for the patient to consider at this stage.

Efficacy Review

Numerous controlled clinical trials have demonstrated that IPT is efficacious as a treatment for both acute and recurrent MDD. Indications for the utility of IPT have been shown for its modifications, including: depressed adolescents, ante and postpartum women, HIV/AIDS patients, geriatric patients, primary care patients, as well as depressed patients in developing countries. A few contraindications have been found for IPT in clinical trials, including a study which investigated treatment for patients with psychotic depression. Never intended as a treatment for psychotic disorders, this study found that IPT was not effective for patients in the absence of a medication regimen.

Generally, patients presenting for depression treatment with comorbid acute drug use do not receive additional benefit from IPT. This is due to the insight and cognitive focus necessary to fully participate and collaborate with the therapist. Thus, patients with acute drug use disorders are encouraged to seek treatment for these conditions before beginning IPT or another depression treatment. Three clinical trials have failed to show IPT's benefit for depressed patients receiving methadone maintenance therapy or during cocaine abstinence.

IPT trials as well as recent novel applications have been included in the following presentation. However, the following is not a comprehensive report of all the studies of IPT. Yet, it is a selective review of several IPT adaptations. A complete review of studies and their associated authors can be found in the current IPT manual.

Acute Major Depression

The robust effectiveness of IPT was first shown in a randomized 16-week trial comparing IPT and the medication, amitriptyline, for acute MDD. Eighty-one outpatients received IPT alone or in combination with pharmacotherapy, compared against a nonscheduled control treatment. IPT and medication groups

did not differ at treatment end and all monotherapeutic and combination treatments were superior to the control condition. Results demonstrated that the combination treatment (IPT-amitriptyline) was most effective overall. At a 1-year follow-up, patients in IPT condition maintained the benefits of treatment (i.e., improved psychosocial functioning). These results were not observed in the medication condition or at the time of treatment end. This study highlighted the necessity of further IPT treatment following the initial treatment, which was addressed by maintenance therapy, discussed later.

Another study comparing IPT to other therapies was conducted by the National Institute of Mental Health's Treatment of Depression Collaborative Research Program (NIMH-TDCRP). Two-hundred and fifty outpatients with depression were randomized into four groups for a 16-week treatment. Patients received weekly sessions of either IPT or CBT, or were placed on an imipramine regimen. Treatment groups were compared against a clinical management and placebo control condition. At the end of treatment, all patients with less severe depressive symptoms (defined by the Hamilton Depression Scale) improved across all the four conditions. However, patients on a medication regimen benefited from a more rapid improvement in depressive symptoms compared to placebo. IPT and medication were most effective in treating patients whose symptoms were more pronounced. Relapse rates collected at an 18-month follow-up showed that patients who remitted by the end of treatment and were treated with IPT or placebo experienced the fewest recurrences. However, these findings suggest that monotherapies with maintenance treatment may be insufficient for long-lasting recovery.

Maintenance Treatment for Recurrent MDD

IPT was originally developed for a maintenance trial for MDD. A sample of 150 women previously treated for acute MDD with an amitriptyline regimen were randomized into three conditions. Over the course of 8 months, patients received either IPT alone, IPT with amitriptyline, or placebo. After 6–8 months, the benefits varied such that IPT most comprehensively increased social functioning, yet medication most reliably prevented recurrence of a depressive episode. The greatest outcomes were observed from the IPT-amitriptyline condition, which highlighted the benefits of combined treatment for maintenance therapy.

In the longest maintenance trial of MDD to date, 128 outpatients who previously suffered at least three acute depressive episodes were placed in a 3-year treatment study. The patients were randomized into monthly IPT maintenance sessions with or without high-dose imipramine (20 mg), placebo, or regular clinic visits. Results showed that the imipramine dosage proved highly effective in preventing relapse. A significant effect of IPT in preventing recurrence at 1 and 3 years was also observed. These findings demonstrated that monthly IPT sessions were effective in prolonging onset of a new depressive episode in patients with recurrent depression not following a medication regimen.

Depressed Adolescents

When considering treatments for adolescent depression, there is significant concern surrounding the use of medication in

youth. In response, an adapted version of the IPT intervention for MDD in adolescents was created. This modification incorporates parent and school teacher involvement as the therapist sees fit. This adaptation also accounts for salient developmental issues pertinent in the lives of adolescents which may serve to maintain depression (e.g., peer pressure). Practice of skills and interpersonal techniques acquired during therapy are framed as work-at-home, which is contrasted with homework (which may have negative connotations for adolescents).

The IPT intervention for depressed adolescents was investigated in a trial of 63 patients randomized to either 12-weekly IPT sessions or treatment as usual (TAU) in school-affiliated clinics in low-income urban neighborhoods. Supervised social workers who had no prior psychotherapeutic experience administered the IPT after a didactic course. Results demonstrated that patients in the IPT condition experienced the greatest improvements in depressive symptoms and social functioning, as well as significant improvements in problem-solving, evident at 8 and 12 weeks posttreatment.

Late-Life Depression

Patients with late-life, or geriatric, depression have a tendency to report more physical complaints (e.g., pain, bowel problems). It has been estimated that mood disorders are the most prevalent psychiatric disorders in elderly populations, with a staggering suicide rate. To address this growing problem, a 3-year maintenance study was conducted with a sample of geriatric-depressed patients receiving IPT, IPT-nortriptyline, or nortriptyline alone. A number of modifications were instituted, including shortened sessions to optimize attention and comfort of the elderly patients. The inclusion of early-life issues as discussion topics was implemented due to patient interest in addressing lifelong issues. Therapists also used techniques that fostered the acceptance of issues that were not likely solved by psychotherapy (i.e., lifelong experiences of psychopathology). Findings demonstrated that patients' whose quality of sleep improved near the beginning of treatment had an 80% reliability of maintaining symptom improvement for the first year of treatment, across all conditions. The researchers suggested that the greatest gains for functioning were found in the combination treatment group, IPT-nortriptyline, highlighting the benefit of a comprehensive approach to late-life depression.

Depressed Primary Care Patients

In this study of depressed primary care patients, no major modifications of the IPT intervention were necessary. The efficacy of IPT was compared with pharmacotherapy for ambulatory medical patients with MDD. Two-hundred and seventy-six patients were randomized to receive 16-weekly treatments followed by 4-monthly maintenance sessions of IPT, nortriptyline, or regular physician care. Results demonstrated that compared to TAU, patients in the IPT and nortriptyline conditions experienced more rapid improvement in depressive symptoms. At the end of treatment, more patients in the IPT intervention group met recovery criteria compared to patients who received clinical management only. This application found efficacy for IPT in a primary care setting, yet management of symptoms by a psychiatrist in primary care settings

may not be cost-effective. This study supports some recent international efforts to train nurses and other primary care professionals in IPT to address depression in patients receiving ambulatory treatment.

A recent study evaluated the effects of IPT and a selective serotonin reuptake inhibitor (SSRI; Citalopram) with patients with coronary artery disease and concurrent MDD. Five hundred and sixty-eight participants were randomized to 12-weekly IPT sessions and clinical management or clinical management alone and then to either a 12-week regimen of citalopram or placebo. Results demonstrated that IPT did not offer a clinical advantage over clinical management with or without the addition of citalopram.

Ante- and Postpartum Depression

Addressing ante- and postpartum depression with psychotherapy may be an important alternative to a medication regimen. A flexible adaptation for this population was developed which adjusted the time course and session duration of IPT treatment. These modifications allowed for the consideration of child care issues, doctor visits, bed rest, and other logistical concerns. In addition, sessions were able to accommodate breast-feeding with hospital visits and telephone sessions completed as required.

Depressed HIV/AIDS Patients

A modification of the IPT intervention was developed to address the unique needs of HIV/AIDS patients, with special emphasis on issues of death, grief, and role transition. In a 16-week trial, patients were randomized to the modified IPT intervention, a similarly modified CBT intervention, supportive counseling, or supportive counseling with an imipramine regimen. Results showed that, regardless of condition, depressive symptoms were significantly reduced. However, IPT and imipramine alone produced the greatest improvements in depressive symptoms when compared to the other treatments. The focus on the mourning process and navigating life stresses might have been the mechanisms for the robust effectiveness of IPT in HIV/AIDS patients.

Depression in Developing Countries

An adaptation of the IPT intervention was conducted in rural Uganda with depressed community members. Traditional healers expressed that they were not equipped to treat depression where medication is costly and there is an extreme paucity of medical doctors. The adaptation required a 2-week training of local practitioners in a simplified version of the IPT intervention. Treatment length was extended to 18 weekly sessions of 90 min. Maintaining cultural norms, treatment was segregated by gender and completed in groups. Two initial sessions were conducted individually and used to describe the treatment and diagnosis.

One-hundred thirty-seven patients were recruited from 30 villages and allocated to either the IPT condition or TAU (hospitalization for severe cases which involved psychosis or suicidality). At the end of treatment, as well as at a 6-month follow-up, patients in the IPT condition exhibited greater

improvements in social functioning and experienced extensive symptom reduction compared to the TAU. Adaptations of the IPT manual and training of health care workers have been undertaken in Romania, China, Goa, and Japan.

Practical Training in IPT

Several IPT training programs have been assembled across Europe and bring IPT to clinical practice. Accreditation programs recognized by local societies, which incorporate a 3-day workshop and require supervision for at least two treatment cases, have been established in the Netherlands and the United Kingdom.

IPT can be taught through manualized treatments, didactic courses, videotapes, and even telephone supervision. Clinicians with previous experience using psychotherapy can utilize these resources to implement IPT in their individual practices (training media available through verdelih@childpsych.columbia.edu). Yet, supervision is strongly recommended, especially in the context of credentialing programs.

A gap still exists between research evidence and clinical practice for psychotherapy in the United States as only a few training programs in psychiatry, psychology, or social work offer training in IPT.

See also: [Cognitive Behavior Therapy](#); [Depression](#); [Stress and Illness](#).

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Relevant Websites

<http://www.interpersonalpsychotherapy.com> & <http://ipt-institute.com> – Institute for interpersonal psychotherapy.

Jealousy

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Glossary

Constructivism Theory of emotion that argues all emotions are constructed by society according to its fundamental needs at a time.

Courtly love Literary praise for platonic love, in the fourteenth to fifteenth centuries.

Darwinian psychology Study of emotions from perspective of evolutionary utility.

Dating Informal courtship associated with entertainment outside the home; began to become common, particularly in the United States, after about 1918.

Early modern period Sixteenth to eighteenth centuries in European history.

Freudian psychology Psychology based on the theories of Freud, emphasizing unconscious impulses and their conscious control.

Honor Code of conduct demanded of worthy people.

Open marriage Marriage with approval of multiple sexual partners.

Prescriptive literature Books or articles written to advise people on proper standards of behavior, family life, etc.

Siblings Brothers and/or sisters.

Spock, Dr. Benjamin The leading popular writer on child-rearing in the second half of the twentieth century.

Unwritten law Idea that a man has a right to attack a wife's or fiancée's lover.

Victorian Middle-class culture in nineteenth century Europe and the United States.

Jealousy constitutes the emotional reaction to a real or imagined loss or threat of loss of a valued object, quality or person, to a rival. It is most commonly seen, in modern West European and United States society, in terms of sexual or love relationships, when individuals become jealous of a partner's interest in or involvement with someone else. Jealousy can also arise simply because such interest and involvement are imagined, in which case the emotion helps cause perceptions as well as results from them. Another common instance of jealousy involves relationships among children. At least some forms of sibling rivalry stem from a child's jealous response to the attentions lavished on a new baby, which seem to constitute a loss of parental love for the child himself or herself. A great deal of the scholarly work on jealousy applies primarily to a Western context, including comparisons within the West; but developments associated with globalization are raising new jealousy issues in other societies as well, which amplify the possibilities for comparative work and suggest strong emotional responses to change in gender relations.

Definitions of jealousy in current scholarly literature, at least in the West, routinely emphasize the negativity of the emotion and its relationship to personal insecurities. Other cultures, however, evaluate somewhat differently; so the assessment is best kept more open. Strong emphasis also rests on sexual jealousy, which again may be a culturally limited focus. A larger assessment of jealousy must not only embrace important recent scholarships, but also a wide cultural approach that allows for sometimes unexpected comparisons.

Sociobiologists have hypothesized that jealousy serves a basic function in assuring the paternity of one's offspring, but this tends again to narrow jealousy to a limited focus and to stress male over female jealousy though the latter is quite common; above all, it founders on the fact that many cultures

do not place a high valuation on identifying paternity. Debates over issues of this sort call attention to the continued scholarly tensions in assessing what jealousy is all about.

Problems in Defining Jealousy

Jealous responses vary greatly among individuals in a given culture. Many studies of jealousy, for example, among American college students, reveal such variations. Clinicians, such as marriage counselors dealing with jealousy as a problem in couples, note such variations as well, not only in the United States but also in Germany and elsewhere. A lover's flirtation may be easily tolerated by one partner, while provoking an intensely jealous reaction in another. Some psychological studies in the 1930s hypothesized that variations in jealousy stemmed from different childhood experiences, depending on whether earlier threats of loss were cushioned by emotional support. Many psychoanalysts continue to argue that jealousy experiences in childhood are absolutely unavoidable, but that many individuals suffer losses without support while others learn that loss – for example, a parent's death or a separation from a close friend or relative – may be compensated by other fruitful relationships. Individuals in this second category, according to this argument, will be able to deal with adult threats to affection with little or no jealousy. The explanation is plausible, and many therapists do explore childhood background in dealing with intense jealousy. But no rigorous or systematic correlations have been demonstrated.

Recent psychological research, paying renewed attention to jealousy, has discounted the explicit childhood origins of jealousy. Differences among individuals are vitally important, and indeed new categories extend the differentiation. Thus 'suspicious jealousy,' provoking jealous reactions because of internal

pressures within an individual, is distinguished from 'reactive jealousy,' which responds to a definite threat. But why some individuals are suspicious, and why some react more than others to the same threat, is attributed to broader personality factors and to an overall emotional style that is not easy to explain. Jealousy often results from a larger sense of personal insecurity, an older belief reemphasized in recent research, but here too the ultimate causation problem is pushed back more than accounted for save insofar as it clearly depends on more general traits.

Jealousy is a social emotion. That is, it arises in interactions among people and it affects the way people operate in social situations. Jealousy also depends to some degree on social sanctions. Some cultures tolerate or even encourage jealousy, while other cultures disapprove. The social aspects of jealousy and its dependence on particular cultural contexts have determined much recent research on the emotion, bent on determining jealousy's results in interpersonal relationships and on understanding why jealousy varies and changes depending on place and time. Even psychologists who assume fairly standard emotional reactions thus note different triggers and different responses (jealous Frenchmen get angry, jealous Dutch get sad) depending on cultures.

The most obvious difficulties in pinpointing jealousy, however, arise from the fact that it is an amalgam of a number of emotions, or as one psychologist puts it, serves as a 'blended emotion.' Only a few recent definitions argue that it is a basic emotion. While animals may display something like jealousy – for example, the pet that mopes at the arrival of a new baby or another pet in the household because of a resentment against deprivation of attention, or the male animal that displays aggression against a sexual rival – it is not clear how useful it is to perceive jealousy in humans as an innate response. Again, the considerable variations among individuals and differences in cultural guidelines complicate the issue. Jealousy, when it is intensely experienced, expresses a sense of grief at loss plus anger at the individual seen as responsible for the loss (a lover's lover, for example). It may involve not only anger but also aggression, when the cause of jealousy is attacked either outright or in imagination. Or, like grief, it may occasion passivity, sadness, and self-doubt. Perceived or anticipated jealousy may also embody fear or impending loss. The mixture of emotions and responses involved complicates any easy definition of jealousy itself.

Jealousy is also close to envy. Technically, to be sure, the two emotions are quite different: jealousy involves reactions to loss or threat of loss, and envy a desire to have what someone else has. Envy may lead someone to take something belonging to another, thus causing jealousy. In practice, jealousy and envy are not always distinguishable, and some scholars have found in the twentieth century United States a growing confusion of the two terms. Most Americans, thus, while able to define envy, rarely use the word, terming themselves jealous instead. Teenagers who say they are jealous of so-and-so's hairdo are in fact envious. Their use of the term jealous, however, may be revealing of some new emotional configurations, and thus may be open to explanation. Both envy and jealousy involve hostility, and one major study finds the only emotional difference between them is that jealousy is more intense. The proximity between the terms and the experiences of

jealousy and envy unquestionably add another complication to any definition; again, jealousy is an amalgamated emotional experience.

Jealousy is normally defined as an unpleasant emotion. Certainly it is so regarded in contemporary Western culture. A German therapist writes in the 1980s of "how agonizing, how galling, how unbearable even 'completely normal' jealousy can be. Anxiety, disquiet, and an incessant compulsion to brood about the immediate situation endanger, even prevent, one's ability to conduct one's life as usual." Most commentators on jealousy have similarly noted its potentially consuming qualities. In some cultures, however, jealousy's pain is accompanied by a feeling of invigoration, and jealousy is not regarded simply as disagreeable. This is true in some honor-based cultures, for example. Recent psychological research, turning to the coping mechanisms jealousy generates, begins to turn from the dysfunctional, often violent results of the emotion in certain instances, to potentially constructive translations. Thus jealous individuals have more stable marriages on average than less jealous because they learn how to win the commitment that will allow them to avoid emotional pain. Here too, basic definitions are complex.

Meanings of Jealousy and Methods for Its Study

Some of the complexity of jealousy as an emotional response and potential spur to behavior emerges from consideration of its various meanings. The word in English derived from the same Greek stem as the word for zeal, and at least until recently elements of this definitional linkage persisted. The Christian God, in the West European language versions of the Bible, was a jealous god, which implied resentment of any threats to position – worship of false idols, for example – but also a vigorous defense of legitimate prerogatives. Attached to the divinity, jealousy has obvious positive connotations. Similarly, references to a jealous defense of rights, suggested a commendable and justifiable energy, not a narrow unwillingness to share. Jealousy as a goad to righteous and useful action enters into the usage of the word in many circumstances, although it no longer forms the dominant evaluation.

Jealousy also early acquired its more common meaning, of possessive alertness and response to threat. Jealousy in love was a prominent theme in the courtly literature of late-medieval Europe. Part of the enthrallment with a highly stylized love, according to the troubadours, involved subjection to the woes of jealousy, as suitors (by implication usually male) fended off rivals and coped with the flirtations of their adored.

Jealousy's meaning has also embraced implications of both strength and weakness. Jealous defense of rights, honor, or property – including God's jealous wrath against impure worship – generated strength. Jealousy in these areas was indeed a motivation for forceful action and could be associated with larger virtues of manhood. Jealousy played a considerable role in inspiring defenses of family honor, when men sought to avenge an insult or sexual transgression against a wife or sister which caused the family to lose its appropriate control over female virtue. On the other hand, jealousy has often been associated with pettiness and weakness. Here, the emotion can appear as a last-ditch attempt by enfeebled

people to cling to some object or relationship. Natalie Davis, a historian of France in the sixteenth century, has noted that in appeals for official pardon after a conviction of crime men often argued that they had acted in anger – a clearly aggressive emotion associated with power – whereas women more commonly pleaded that they had been overwhelmed by jealousy, a reaction more suitable for the less powerful gender. In this category too, word usages suggest a considerable range for jealousy's interpretation by individuals invoking the emotion and by other people observing a jealous response.

Jealousy has long served as a literary theme because of its relations to honor and love and because of its capacity to consume those who experience it and on occasion drive them to extreme acts. The dramatic quality of the emotion, in Western culture, extends from the Old Testament to contemporary American films. A mixture of jealousy and envy frequently turned brothers against each other in the stories of the ancient Jews. Shakespeare's *Othello* focused entirely on the insane frenzy generated by groundless jealousy, a cautionary tale against the uncontrollable qualities of the emotion in those whose folly made them susceptible. Some of the same qualities made jealousy a frequent subject for comment by moral philosophers. Thus, the French aphorist La Rochefoucauld opined, in discussing the links between jealousy and love: "It resembles hate more than friendship." Alexander Pope termed the emotion 'hateful,' following the much earlier lead of St. Paul who condemned the effects of selfish jealousy in his comments on marriage.

Other, more scientific vantagepoints for examining jealousy began to emerge only in the later nineteenth century, as an outgrowth of Darwinian interest in considering the evolutionary implications of common emotions. A number of Darwinian psychologists, including G. Stanley Hall in the United States, studied jealous reactions among children or adolescents. The studies generated significant data on jealous responses. They also produced some general claims about jealousy's functions. Most evolutionary theorists argued that jealousy served a purpose in helping to form and defend families, converting romantic or sexual interests into definite commitment because of a fear of rivals or because of reaction to a partner's expressions of jealous concern. Some popularizers added that jealousy helped turn love into marriage. This evolutionary school generally contended that women displayed more jealousy than men because of their role in forming and protecting families from outside threat and because of their own dependence on family for survival.

The rise of Freudian psychology created a second general approach to jealousy, though relatively few Freudians directly commented on the emotion. Freudian beliefs in inevitable competition for parental affection, including the famous Oedipal conflict between a child and his same-sex parent, called attention mainly to aggression and withdrawal. Freudian concern for the early stages of childhood did encourage more direct studies of jealous interactions among young children themselves, though not cast in an explicitly Freudian mold. Further, one writer, Melanie Klein, wrote about the inherent envy of infants toward the mother as giver or withdrawer of breast, formulating a generalized psychological dynamic relevant to presumably universal manifestations of

jealousy. Other scattered psychological research has studied displays of childhood jealousy, seeking to define inherent components across cultures.

The rise of sibling studies in the 1920s and 1930s formed the next major empirical approach to jealousy, focused of course on jealous disputes among young children over parental attention and related material possessions provided by adults. A large number of observations on interactions among siblings and young children piled up empirical evidence about the frequency of sibling jealousy, though one study argued that it was far from normal; more general findings indicated a slight preponderance of girls over boys in sibling strife. The sibling studies related to a larger psychological literature that assumed the necessity of successful management of sibling disputes, on the assumption that these disputes were dangerous to young children themselves and, if unresolved, could produce distorted jealous personalities in later life, incapable of successful personal or work relationships. These extensions of the sibling studies were not, however, scientifically researched. Finally, while sibling research trailed off after the 1930s, a renewed set of studies in the 1980s disputed many earlier findings, calling the research into question methodologically and contesting the findings of frequency. Recent sibling research argues that severe jealousy is far from common among siblings, who often bond quite positively. According to some recent research, the relationship that most regularly produces sibling rivalry (though technically envy more than jealousy) occurs when the oldest child is a boy. Otherwise patterns are quite random and unpredictable and, as noted earlier, not necessarily significant in the late adult response.

After the more concentrated spate of sibling studies in the 1930s, jealousy research has become increasingly fragmented, with few clear lines of inquiry and relatively little theoretical structure. Essays on jealousy have reemerged, particularly from scattered feminists ruminating over their tense relationships with mother or lovers.

These aside, the most frequent inquiries into jealousy in the past 30 years have emphasized its social context or its psychological components, with insufficient bridging between the two approaches. On the social side, some anthropologists have inquired into jealousy patterns in different cultures, though this has not been a major emphasis. Several social psychologists have compared jealousy reactions in various societies on the basis of questionnaire research. Questionnaire research also figured strongly, even before the 1970s, in inquiries into male and female jealousy in dating contexts, particularly among American college students. In the 1970s, when jealousy standards were undergoing considerable revision, both social psychologists and a new breed of sociologists of emotion looked into standard definitions of jealousy through questionnaires and also inquiries in special settings such as communes and other centers of experimental sexuality. The result of this research has been a considerable exploration of widely accepted norms concerning jealousy and also the tensions these norms can produce in cotemporary settings. Finally, two publications in recent years have explored jealousy from a historical standpoint – another largely social and cultural context – and problems of jealousy as a vital theme in modern marriage counseling.

Psychological research has reflected concern for social context; recognizing jealousy as a genuine, if blended, emotion brings attention to cognitive appraisals of jealousy-producing situations, which in turn involves cultural standards. The surge of psychological interest involves more attention to how jealousy fits with other models of emotion, why and how individuals differ, and what strategies are used to deal with jealousy when experienced. Psychological studies of jealousy focus almost exclusively on romance, which raises questions about the emotion's broader scope. They rely heavily on questionnaires administered in laboratory settings, which produce replicable results but also raise questions about actual experience in lived relationships. Some follow-ups on correlations between jealous personalities and marital history begin to bridge the gap in part. In addition to distinguishing among types of jealousy and insisting on the links between jealousy and other emotional responses in an individual personality, the psychological research traces the emotional channels jealousy may take once aroused – anger, withdrawal, embarrassment – and the overall intensities involved. As they move beyond classification schemes, recent studies particularly emphasize the importance of jealousy in producing coping strategies and the potentially fruitful nature of some of the strategies. Jealousy, in other words, remains an active emotion, shaping individual lives and contacts with others. While some responses can be quite dysfunctional, leading to violence or to devastating emotional collapse, others work well in causing individuals to reassess problems, including lack of self-confidence, or in inducing their partners to provide needed reassurance.

Jealousy, in sum, is only beginning to command the kind of scientific interest devoted to a number of other emotions. It has been part of several theoretical frameworks, and research has generated important (though sometimes also disputed) data. The current emphasis on jealousy as part of social interactions lacks grand claims about jealousy's theoretical place in a larger emotional arsenal, but it has produced growing understanding about the evolution of contemporary standards in relation to functional results of jealousy in interpersonal contacts – particularly, in terms of recent literature, among adult lovers, married, or otherwise.

Less attention has been paid to reactions to jealousy, but logically these form an important part of the topic, dependent both on cultural and on personal proclivities. Some cultures encourage signs of jealousy as part of a demonstration of true love – this was part of the courtly love culture of medieval Europe. Modern American culture tends to denigrate jealousy not only as a sign of immaturity but also an attempt to interfere unduly in someone else's relationships or past relationships. The cues for reception of jealousy deserve exploration in their own right and lead logically to comparative analysis.

Jealousy in Comparative Perspective

One of the huge gaps in current knowledge involves any systematic sense of differences in evaluation and uses of jealousy from one culture to another. Yet the fact of such variation is well established, and several larger possibilities invite

attention. Jealousy seems particularly attached to cultures that place strong emphasis on possession of property and, by extension, on women treated as property (and also to identifications of paternity). Less property-conscious societies, such as certain Eskimo groups or the Tahitians, manifest a willingness to share possessions, children (as in common adoption practices with parental consent), even sexual partners (before and sometimes after marriage), in ways that reflect either an unusual absence or jealousy or a distinctive targeting of the emotion. The connection between jealousy and possessiveness is obvious, but the cultural and historical circumstances that generated a rather low level of both have not been probed. Possibly jealousy, for all its potential intensity, is a culturally constructed emotional amalgam that developed rather late in human prehistory – a line of argument that, though speculative, would bear some interesting relationship to a larger constructive approach to emotions.

Among propertied societies, cultures that generate a particular attachment to personal honor also generate unusually fierce versions of jealousy. Jealousy serves as an emotion that motivates defense of honor against threat and also revenge when honor has been violated. In some instances, it seems more freely indulged in upper classes, where honor codes may relate to family power and military prowess, than in the population at large. In other instances, however, jealousy and honor concepts alike spread widely. This seems particularly true in Mediterranean cultures (both Muslim and Christian) and in some of the American cultures heavily influenced by Spain. Thus, a jealous response to affronts to honor or to the sexual purity of a family's women remains particularly vivid in these cultural areas. The quick jealousy of Arab men has often been noted (though not systematically studied), and the frequency of jealousy-derived crimes of passion, directed against sexual rivals, contributes to unusually high murder rates in a number of Latin American and Caribbean societies. Though slightly less marked, a disproportionate rate of jealousy-induced murders in the American South (compared to other regions of the United States, in the nineteenth and twentieth centuries alike) reflects a similar cultural complex. Emphasis on honor generates particular social utility for jealousy. Jealousy, in turn, helps create both the emotional vividness often associated with attacks on rivals and the sustained grievance essential to longer-term campaigns for revenge. Some of these same cultures that elevate jealousy also attempt particular arrangements of controlled seclusion for women, as in traditional Arab cities, in order to express not only the legitimacy of possessiveness in social habits, but also to reduce the occasions for active exercise of jealousy in day-to-day routine.

Recent concerns about the impact of rapid social change and globalization in certain regions create other opportunities for examination of jealousy in comparative context. The significant increase in accusations of infidelity or outright violence against a presumably errant partner (almost always a woman) seem to result from jealous reactions not just to real or entirely imagined actions, but to a broader shift in the economic and educational opportunities for women and to international gender imagery. Jealousy here results from a sense of threat to established gender norms, but it can be deeply experienced by individuals. Even knowingly false accusations,

by involving legal problems and social shunning for women, serve to express this diffuse by intense jealousy. There may be some correspondence here to justifications of violence in the later nineteenth century United States, also the scene of rapid social change and unusually open uses of jealousy in courts of law.

Opportunities for more extensive and focused comparative research, that would more fully explain cross-cultural differences in promptings toward jealousy while also exploring jealousy's role in motivating social patterns, are obviously considerable. A wide-ranging anthropology of jealousy has yet to be offered.

Jealousy and the Law

One point of focus, relevant to comparative analysis of jealousy's social functions, has already attracted some attention. Legal treatment of jealousy, closely related to jealousy's presumed role in actual crime, is an important variable. Informal notions that jealousy's consuming qualities might excuse certain crimes seem to have developed early in Western culture; the link between jealousy and weakness also might have legal relevance.

French courts long accepted jealousy as an excuse for what would otherwise be murder, on the part of men and women alike. The American legal culture of jealousy was slightly different. In the United States, formal allowance for jealousy in the law emerged after 1850. Between 1859 and 1900, about 30 homicide cases invoked what was called the 'unwritten law' in defense of a jealousy-inspired murder of the lover of a fiancée or wife. With urbanization, community sanctions against adultery declined. This provided a context for ingenious lawyers to argue that jealous outrage so legitimately and intensely consumed an offended husband that he was rendered temporarily insane and so not responsible for his acts. As one attorney argued in 1870, "For jealousy is the rage of a man; therefore he will not spare in the day of vengeance . . . Those who dishonor husbands are here warned of their doom . . . Jealousy . . . enslaves the injured husband, and vents itself in one result, which seems to be inevitable and unavoidable." Several trials invoking this new defense were highly publicized, and acquittals often produced extensive popular approval from men and women alike. Women were not allowed the defense; only men could be swept away by this uncontrollable passion in the eyes of the law. Nevertheless, the new interest in jealousy as a legal excuse shows an important connection between law and emotional norms, in a society that was developing new concerns about appropriate sexual behavior particularly for women.

Equally important, however, was the fact that this connection did not prove permanent. By 1900, many state courts were rejecting unwritten law defenses, on grounds that they merely encouraged violence. Jealousy could and should be restrained, according to this new thinking. Some states experimented with compromises between old and new, holding that killings committed in the 'heat of passion' should be regarded as manslaughter, not murder. Several southern states, particularly, continued to grant some tolerance to murders resulting from

momentary but blinding jealousy. But by the 1970s, even southern states were moving away from this thinking. A 1977 Georgia ruling argued that

In this day of no-fault, on-demand divorce, when adultery is merely a misdemeanor . . . any idea that a spouse is ever justified in taking the life of another – adulterous spouse or illicit lover – to prevent adultery is uncivilized. This is murder; and henceforth, nothing more appearing, an instruction on justifiable homicide may not be given.

Clearly, in less than a century, jealousy in the United States had moved from serving as a logical response to sexual infidelity on the part of women, to becoming (if not suitably restrained) uncivilized. This example shows the potential importance of jealousy in influencing not only social norms but also criminal jurisprudence; it also demonstrates the possibility of substantial change, with jealousy open to redefinition depending on larger cultural norms.

Jealousy in Social History: Traditional to Victorian

Much recent work on jealousy, by sociologists, social psychologists, and historians, uses changes in social standards concerning jealousy as a basic frame of reference for dealing with the emotion. Particular attention rivets on the widespread disavowal of the legitimacy of jealousy by the vast majority of middle-class Americans by the 1970s. This disavowal was important, even if a number of the people questioned admitted problems in living up to the standards they believed in. The disavowal was also new, which meant that its emergence requires some essentially historical treatment and explanation.

The earlier history of jealousy in Western society is by no means entirely clear. The emotion had acknowledged function, in relationship to defense of honor and of rights. Its danger was also widely noted, for the potential intensity of jealous passion was extensively criticized. The result, studied most clearly in work on French literature in the early modern period, was a definite ambivalence. While many authors and essayists highlighted the risks of jealousy, others noted its importance to love. As a French courtly love author put it: "Real jealousy always increases the feelings of love . . . Jealousy, and therefore love, are increased when one suspects his beloved." For many West European dramatists in the seventeenth and eighteenth centuries, jealous wives formed an uncomfortable but diverting thread in romance, so long as they were kept within bounds. A few religious writers, finally, tried to reconcile the ambivalence: "There is a just and an unjust jealousy. Just, is with married partners, who mutually love each other; there is with them a just and prudent zeal lest their conjugal love be violated." Unjust love, in contrast, involved loss of control or a suspiciousness totally out of the proportion to any real threat.

The standards of nineteenth century middle-class society in Western Europe and the United States were more clear-cut, though the existence of legal allowance for jealous crimes indicates some ongoing ambivalence. Because concepts of honor declined in middle-class culture, and because greater emphasis was placed on romantic love, jealousy was rethought – and in principle condemned. True love was not supposed to involve

jealousy, for the latter was a selfish and obsessive passion that would only sully the high ground of real romance. Women, particularly, were warned against jealousy, not only of other people but of their husband's work. At the same time, however, jealousy was not seen as a major problem in most instances, and some prescriptive literature recognized that modest expressions of jealousy (mainly from women, now assumed to be particularly liable to jealous reactions) could usefully recall men to their proper attentiveness. Women's focus on domesticity, part of Victorian emphases on 'respectability,' also reduced concern about jealousy.

The Twentieth Century Dynamic: The Sibling Jealousy Crisis

Jealousy began to assume problem proportions early in the twentieth century, and it was at this point that the essential background to contemporary Western standards started to take shape. The outpouring of concern about sibling rivalry that emerged by around 1920 was one index of the new identification of jealousy as a major emotional issue. The leading child-rearing manuals routinely advised that "Few emotions are experienced ... which from a social point of view are more important than jealousy ... The jealous person becomes an object of dislike." A few advice manuals retained a vestige of older attitudes, in urging that a bit of jealousy could be useful as motivation for children. In general, however, the overwhelming message stressed dire warning. "Unless the parents recognize that jealousy will normally appear, and are prepared for it, strong feelings of hostility often develop which continue to make life miserable for both [rivalrous] children over many years," one popular pamphlet intoned.

The same child-rearing materials recommended a number of remedies. Dr. Spock's 1945 bestseller, urging that 'a lot of effort' was essential, summed up the standard advice. Prepare a child for a new baby carefully. Spend extra money on a separate room for each child, and on separate toys and clothes, to reduce jealous potential. Teach grandparents and other visitors not to make a fuss over a new baby, but rather to pay greater attention to the older, jealous sibling. Above all, in various ways, reassure of love, while conveying understanding of any feelings of hostility. "I know how you feel, dear. Come on over and I'll give you a hug and we'll see if that doesn't help." Or, in a similar recommended parental antidote: "I know how you feel; you wish there were no baby; I love you just as always." The goals of these strategies were to prevent outright conflict among children themselves, now assumed to be natural enemies because of inevitable jealousy, and to use wise management of sibling jealousy to prevent jealous personalities in adulthood. These twin goals, regarded as difficult but essential, gave urgency to the parental task. Large numbers of American parents, by the 1930s, dutifully listed their concern about sibling rivalry as one of their chief worries.

The rise of the sibling jealousy campaign is a fascinating chapter in the history of jealousy. The emotion was hardly new, but it had never before been identified with such anxious fervor. Two factors prompted the change in outlook. First, shifts in family life may actually have heightened jealousy among young children. The decline in the birth rate, the

disappearance of adults other than parents from the normal household, and emphasis on intense maternal affection may well have created more childish anxiety about the arrival of a new sibling than had been common before. Even more obviously, adults grew more hostile to the potential impacts of jealousy in their lives and more impatient with signs of the emotion in their children; hence, the acceptance of a major socialization effort. The sibling campaign itself became more routine by about the 1940s in the United States. The inevitability of traumatic jealousy among young children was downplayed, but at the same time, more parents took for granted the need for some of the reassurances that their own parents needed to be taught. Efforts to prevent jealous personalities through careful child-rearing on the whole continued.

The sibling jealousy crisis forms a vital link in examinations of jealousy that blend an understanding of common emotional tensions with cultural context. Although contemporary psychological experts are confident that their more relaxed view of sibling jealousy is more accurate than the near-hysteria of the 1930s, full exploration of sibling interactions remains to be accomplished. Also important, and as yet undone, is comparative work. There is evidence that large families generate less sibling rivalry than small, because in the former, children band together against parents rather than competing with each other for parental favor. This finding has both cross-cultural and historical significance, given changes and variations in birth rates and family size.

Adult Jealousy: New Standards

In the United States and Western Europe, concern about sibling jealousy was closely linked to an unprecedented attack on the emotion in adult relationships. Marriage counselors, for example, almost uniformly urged against jealousy by the 1920s. "Jealousy kills love. It is a symptom of weakness and of selfishness. Wanting a suitor, or a wife, or a husband to pay exclusive attention to one has nothing in common with real devotion." Or in another marriage-expert sally: "We may even blight and blacken our happiness by jealousy, which is really an admission of our own inferiority, of our own cowardice and conceit." Accepted wisdom now held that adult jealousy, almost exclusively defined from the 1920s onward in terms of love relationships, resulted from inadequate childhood socialization: jealousy was immature.

These new standards had two major sources. First, while their intensity of concern and the attribution of immaturity were new in the twentieth century, the idea that jealousy marred love had developed in the nineteenth century, with some roots even earlier in Western culture. Second, the growing attention paid to jealousy followed from a decline in the domestic seclusion of women. With women participating increasingly in coeducational schools, politics, work (albeit as inferiors to men in most respects), and leisure activities, jealousy reactions almost had to relax in Western Europe and the United States. Add to the increasing interaction between men and women a growing interest in sexual expression – another development taking shape in the 1920s – the need to encourage adults to play down jealousy became virtually essential from a functional standpoint. Young men and women who

began to date fairly regularly, with a considerable variety of partners, were thus urged to avoid jealousy or to conceal it if avoidance broke down. Married couples who began to socialize more informally, with more interactions with the spouses of others, earned the same advice. Here was the context for the considerable outpouring of popularized advice, in books directed toward young people and in popular magazines: "Jealousy is a terrible emotion, one of the extreme forms of psychological cruelty." This was the context, also, for the shifts in criminal law, which assumed that jealousy could and should be controlled even in extreme provocation.

The general trend toward firm prescriptions against jealousy gained additional ground in the 1960s, when sexual standards in Western society loosened further. Many experimental sexual situations, including 'open marriage,' were predicated explicitly on an ability to keep jealousy under wraps. Urging a variety of sexual partners, advocates of open marriages noted that "Jealousy has no place in open marriage. The fact that it is so prevalent in closed marriage does not mean that love and sex must always be accompanied by this dark shadow." Couples in open marriages or visiting promiscuous reports – couples interested in what 1960s Americans called 'swinging' – were taught strategies to deal with unwanted jealous impulses, including wishing their partner a good time as he or she went off for an evening with someone else. Jealousy workshops opened in several American cities, directed to the upper middle class and designed, according to their founders, for "those who are strongly motivated to outgrow jealousy."

Most adults in the West did not, of course, participate in the most extreme sexual experiments. Some of those who did found themselves sorely tested, caught between their cognitive belief that jealousy was immature and the fact that they felt very uncomfortable with a partner's 'swinging.' Jealousy increasingly produced shame: one woman told a sociologist, "I think it comes from possessiveness and I'm trying to grow away from that." Most middle-class Americans, if they felt jealousy at all – and polls taken in the 1970s suggested that about a third really did not experience much sexual jealousy – sought to minimize it or to deny it. A comparative study revealed that Americans were far more likely to try to conceal jealousy than were West Indians, Asians, or Africans. Women were a bit franker than men in discussing jealousy problems that cropped up despite good intentions. American male culture urged at least a claim of superiority to jealousy, along with vigorous resentment against jealous, nagging women. Women's culture was a bit more ambivalent, and concern about men's infidelity was correspondingly considerable. The vast majority of middle-class Americans, both male and female, professed to find jealousy uncivilized and unacceptable. There was no significant gap between the standards urged in emotional advice literature and those disclosed by adults. And while American jealousy was particularly examined in this regard, every indication suggests that a similar middle-class culture had developed in Britain, Germany, and elsewhere. Indeed, the proscriptions against admitting jealousy even in cases of outright adultery may have been even greater in European society than in the United States, in the wake of the sexual revolution of the 1960s.

The development of new and strongly disapproving standards for jealousy, and indications that many people internalized these standards, color most of the research and comment

on jealousy in recent years. The historical approach permits some understanding not just of what the current standards are, but also of how they developed and what caused them. The current standards themselves, however, raise at least four additional questions essential to a wider understanding of jealousy as a social emotion:

1. Has the evolution of jealousy standards in the West been matched by changes in other cultures? The scant comparative work available suggests that contemporary Western efforts to evade jealousy are unusual, but no full exploration has been ventured. The rise of jealous outbursts in some contemporary societies suggests the impact of differential timing in social change and its emotional impact. A few psychologists claim to find basic uniformities in sexual jealousy across culture, but the data are limited.
2. Within Western society itself, have the jealousy standards been as widely accepted in fact as in principle? Here the answer is clearly negative. Groups outside the middle class may not fully accept the disapproval of jealousy in the first place – though subculture differentiation has not been explored systematically. Gender differences are also salient. American women use jealousy to terminate a relationship more often than men do, and they (surprisingly) more commonly seek to reinforce loyalties to deal with their jealousy. A variety of evidence suggests that if middle-class people themselves of both genders experience a jealousy of which they disapprove, their guilt or embarrassment in some instances actually complicates their reaction, making constructive adjustments more difficult. This is an important theme in marriage therapy, and it is a struggle that a number of individual writers (mainly women) have also documented, in dealing with their extremely complex reactions to what is even by itself a troubling emotion. It is probable that fewer people feel intense jealousy than was the case a century ago, at least in comparable behavioral circumstances; altered standards do correspond in part to altered emotional experience. Nevertheless, the very disapproval of jealousy makes reactions to it – always somewhat diverse – both subtle and difficult.
3. Has the twentieth century culture persisted since the 1970s? Some popularized literature by the 1980s, at least in the United States where fear of AIDS and correspondingly enhanced sexual conservatism ran particularly strong, suggested that jealousy might again become more acceptable as an emotion useful in defending sexual fidelity. Psychological research on jealous personalities and on successful coping strategies returns attention to the important role jealousy can play in mature relationships. It is certainly possible, given what we know about the frequent oscillations in cultural standards applied to jealousy and their dependence on larger social functions, that more public acknowledgement of at least limited utility for jealousy is developing. But the prospect, however logical, remains uncertain.
4. What has happened to jealousy in other contexts? Modern Western culture, beginning in the nineteenth century, increasingly associated jealousy with love – love for parent and expectation of parental love in return, love of suitor or spouse. The decline of explicit recognition of jealousy in

relation to wider concepts such as honor paralleled this narrower definition. But jealousy relates to other relationships as well, and here scattered findings suggest some interesting manifestations in recent decades. It is, further, possible (though not proved) that as jealousy was combated in romance, individuals who experienced it might seek other outlets. Jealous children, for example, were urged explicitly to turn their attention to a new toy or some other material possession. This could serve as the basis for later jealous competitiveness in consumer interests, with individuals relieving an unacknowledged jealousy by trying to surpass others through acquisitions. Jealousy in school and work formed other expressions, providing emotional spur to a sense of rivalry. Many school children, eager to claim in interviews that they had outgrown sibling jealousy at home, more freely expressed jealousy of classmates' looks, athletic prowess, or good grades. Work authorities generally urged that jealousy be downplayed in the interests of smooth bureaucratic functioning, but jealous rivalries were common.

None of this was necessarily novel, and again a full exploration of contemporary jealousy outside romance has not been attempted. The apparently growing confusion, in normal speech, between envy and jealousy was nevertheless significant in this context. The jealousy that was most freely admitted – of school or work rivals – was in fact primarily envy – that is, resentment of something someone else possessed. But perhaps because Americans sought outlets for jealousy, perhaps because they viewed certain expectations as such an intimate part of their person that another's achievement provoked a sense of threat or loss, and hence real jealousy, the increasing confusion of envy with jealousy was exceedingly suggestive. Here, evaluation of the meaning of jealousy may be a central ingredient in understanding contemporary emotional life and definitions of self. In using the term jealousy for their reactions, some Americans may have heightened the emotional charge of their reactions to other people's possessions or attributions.

Conclusion

Jealousy is a complex emotional amalgam. It can be overpoweringly intense, even compulsive in some instances, particularly in societies that find some jealousy functional and that value emotional intensity generally. It plays a direct role in motivating certain behaviors, including violence, and several forms of rivalry. It may also motivate a desire to excel competitively, though this is not clearly acknowledged in contemporary American culture. The emotion is social, in that it takes shape in social relationships. It is also social in its dependence on social or cultural norms for its frequency, its vigor, and its manifestations. Variations in jealousy, ranging from qualified approval to blanket hostility form a vital part of understanding the emotion in terms of particular cultures and also in terms of significant changes over time. It is also true, however, that within any given culture jealousy is clearly variable from one individual to the next. Societies that encourage some

jealousy encounter diverse response, with some individuals being less jealous and more forgiving than they are 'supposed' to be. Contemporary Western society, that rigorously discounts the emotion at least in love relationships, certainly generates variety, from individuals who apparently experience no sexual jealousy, to people who experience jealousy but manage to conceal or displace it, to people profoundly troubled by their inability to live up to what they recognize is a widely shared emotional norm. The same standards often influence researchers' assumptions about the motives and causes of jealousy.

Clearly an emotional variable, jealousy can be understood in large part through the various social functions it serves, and the disadvantages it entails. Cultural divergences and significant changes in these social formulas provide the most explicit entry to jealousy's meaning beyond their purely individual level. Jealousy's obvious mixture of several discrete emotions helps explain the different roles it can provide, and the different kinds of action – from dire revenge to embarrassed self-doubt to a recementing of a threatened relationship – it can generate.

See also: Attention; Birth Order, Effect on Personality, and Behavior; Bullying; Love and Intimacy; Self-Esteem; Sexual Behavior; Visual Neglect.

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Judgment

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Glossary

Availability heuristic The tendency to judge the likelihood of an event based on the ease with which exemplars of the event are accessed in memory.

Framing effects A situation where the perceived value of an outcome is influenced by details associated with, but not directly related to, the outcome.

Gain-loss asymmetry The tendency for the psychological value of a loss to be perceived as greater than the value of gaining exactly the same amount (the absolute value of losing \$100 is greater than the value of winning \$100).

Heuristics Quick mental shortcuts used in problem solving that simplify processing of complex information, but can produce cognitive errors due to oversimplification.

Psychophysics Techniques and tools intended to reveal the relationship between the size or intensity of physical stimuli and the resulting mental representation.

Representativeness heuristic The tendency to judge the likelihood of an event based on the degree of similarity between the event and internal exemplars of the event.

Signal detection theory A widely used model describing the mechanisms underlying our judgments, based on signal and noise distributions that are represented by bell curves and a decision criterion.

Temporal discounting The tendency for delayed outcomes to be viewed as psychologically less valuable than if they were to occur immediately.

Making judgments about stimuli and events is a critical component of mental life. Whether we are judging the speed with which we are approaching the car in front of us or attempting to judge the likelihood that the defendant in a murder trial is guilty, making a judgment requires that we collect information, evaluate it, and make a decision about how to respond to this new information. For example, a person who hears an unexpected noise while walking home on a dark night must judge whether the sound was threatening or simply unexpected. The psychological interpretation of this event is dependent both on the characteristics of the stimulus and the context surrounding the event. A person walking home from a relaxing dinner party with friends will react differently to an unexpected noise than will an individual returning home from watching a thriller/horror movie. This process of input-and-evaluate information within the current context occurs across all levels of human cognition.

Experimental psychologists interested in mental information processing (cognition) commonly distinguish between lower level processing that includes such things as sensation, perception, and attention, and higher level processing mechanisms that include decision making and problem solving. Quite often, principles that constrain lower level mechanisms are also relevant for higher level mechanisms. This similarity across levels is particularly relevant to our understanding of judgments about events. To illustrate this point, consider the well-known Ebbinghaus illusion depicted in [Figure 1](#). The disk surrounded by smaller disks (upper left) is *physically* the same size as the disk surrounded by larger disks (lower right), but *perceptually* their sizes are different. The Ebbinghaus illusion compels us to conclude that perceived size is a function not just of physical size, but the stimuli surrounding the target item (context).

The role of surrounding stimuli can be extended from lower level perception to describe such higher level concepts as the perceived size of monetary rewards. For example, how would

you feel about a 1% raise in salary? Before deciding, you might first investigate the raises given to your colleagues. You would probably feel slighted if most of them were given a 2% raise. However, if you later discover that a friend from the neighborhood did not receive any raise at all, you might suddenly feel better about your 1% raise. Just as with the Ebbinghaus illusion, the perceived size of the raise depends not just on its actual magnitude, but on additional surrounding information. The remainder of this article will consider the mechanisms involved in lower level perceptual judgments and then move on to higher level judgment heuristics.

Psychophysics

Imagine that you were helping a friend move from one office to another, during which you were straining to hold up one end of a heavy desk. Would you notice any difference in weight if someone dropped a stick of gum on the desk? On the other hand, would you notice the extra weight if the stick of gum were dropped onto an exam booklet you were holding? Although the weight change is the same in both cases, you would be less likely to notice it when added to the desk than when added to the exam booklet. In the late nineteenth century, Ernst Weber looked at whether people could distinguish between the weight of one object and another that weighed about the same. Small weight differences were undetectable if the magnitude was less than what Weber called a just noticeable difference (JND). As can be seen in the example of the desk and exam booklet, JND varies along with context; a weight change that is unnoticeable when added to a heavy object might be noticeable when added to another, lighter object. Thus, JND does not have a single fixed value, but is better expressed as a ratio. When holding one object, an addition of about 1/40 of the original object's weight is just noticeable.

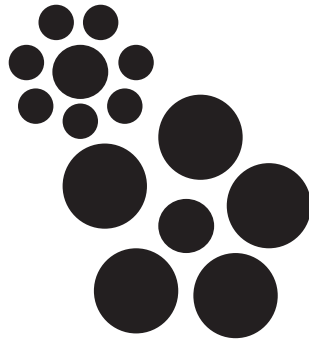


Figure 1 In the well-known Ebbinghaus illusion, the disk surrounded by smaller disks and the disk surrounded by large disks are physically of the same size, but they appear to be of different sizes.

A contemporary of Weber's, Gustav Fechner was working in the tradition of René DesCartes, the mathematician and philosopher who had proposed that body and mind are composed of two different kinds of stuff. Whereas physical things can be felt and measured, it seems incoherent to ask how big or how heavy is a mental entity such as the idea of a chair. While Fechner agreed with DesCartes' assertion that the physical and mental worlds are distinct, he sought to discover the relationship between the two, and referred to the science that he inaugurated as 'psychophysics.' Fechner recognized Weber's work as a key contribution to his project, and formalized Weber's findings into a mathematical equation that has become known as Fechner's law: $S = k \log R$. Here S represents the sensation, R represents the strength of the physical stimulus, and k represents a constant. In other words, perceived intensity does not increase linearly with the intensity of the physical stimulus, but increases less quickly (the law of diminishing returns).

Upon becoming acquainted with psychophysics, it is tempting to think of JNDs as sharp boundaries such that we either sense a stimulus or we do not. In fact, the boundary between those stimuli that are easily sensed and those that are never sensed is surprisingly fuzzy. In an experiment, a psychophysicist will select several levels of a stimulus that lie very near participants' JND threshold. For example, participants might be asked whether they sense a dim light, hear a quiet sound, feel a flower petal falling on their skin, taste any sugar in a weak solution, or smell a drop of perfume. Some levels of the stimulus will reliably induce a sensation and others will reliably fail to induce a sensation. In between these extremes, the tendency to sense the stimulus typically increases smoothly along an S-curve, as depicted in Figure 2. Because there is no sharp break-point along this curve, threshold is often defined arbitrarily as the intensity of stimulus that was sensed 50% of the time.

Signal Detection Theory

One way to think about this fuzzy boundary might be to imagine carrying on a conversation at a crowded cocktail party. While concentrating on your own conversation, would you notice if someone in another conversation said your name? The background noise would mask the sound of your

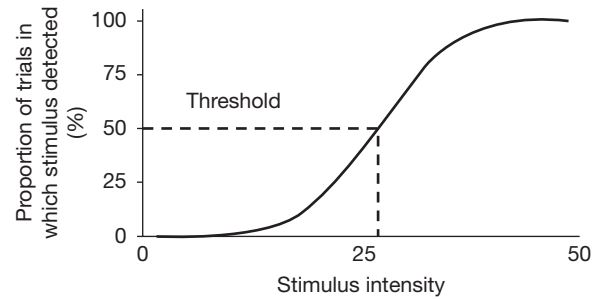


Figure 2 The likelihood of detection between stimuli that are never sensed and stimuli that are easily sensed increases smoothly along an S-curve; the threshold of detection is often defined arbitrarily as the stimulus intensity that is sensed in 50% of trials.

name so that you would not always notice it. In the cocktail party example, 'noise' refers specifically to random auditory information, but to someone interested in signal transmission 'noise' refers more generally to any random activity. Because some neural activity will always be spontaneous, there will always be uncertainty in our sensory judgments. Nevertheless, in some cases we are more sensitive than others. During the Second World War, radar engineers developed methods for determining the sensitivity of signal transmission devices. After the war, psychophysicists realized that these tools and techniques could profitably be used to describe sensory judgments.

To see how signal detection theory applies to sensory judgments, consider the case in which someone at the cocktail party has actually said your name, creating a signal to be detected among the chatter. In this case, sometimes your name clearly pops out from the background, and at other times it is obscured. If we could count the number of times that a signal is easily detected, the number of times that it is obscured, and the number of times that it comes somewhere between the two extremes, a resulting frequency plot would look like a bell curve; extreme values are relatively infrequent and moderate values are relatively frequent. What about if nobody has said your name, so that there is not actually a signal to be detected? Even in the absence of a signal you might feel as if you hear your name embedded among the chatter (most people have experienced thinking they were called or heard their name when it was not actually spoken). As with the signal case, sometimes you can clearly hear your name among the noise, sometimes you cannot, and sometimes the sound of your name lies between the two extremes so a resulting plot also generates a bell curve. In Figure 3(a), the x-axis represents how clearly your name can be discerned so that at high values your name is clearly heard and at low values it is not heard at all, and the y-axis represents the proportion of times when a given level of clarity occurs. Because the mean of the signal distribution is higher than the mean of the noise distribution, your name is more often heard when someone actually did say your name (signal) than when nobody said your name (noise). The means of the signal and noise distributions depend on the strength of the signal relative to the strength of the noise. Thus, at a rowdy party, the mean of the signal distribution just slightly exceeds the mean of the noise distribution (Figure 3(b)), but at a quiet dinner party the mean of the

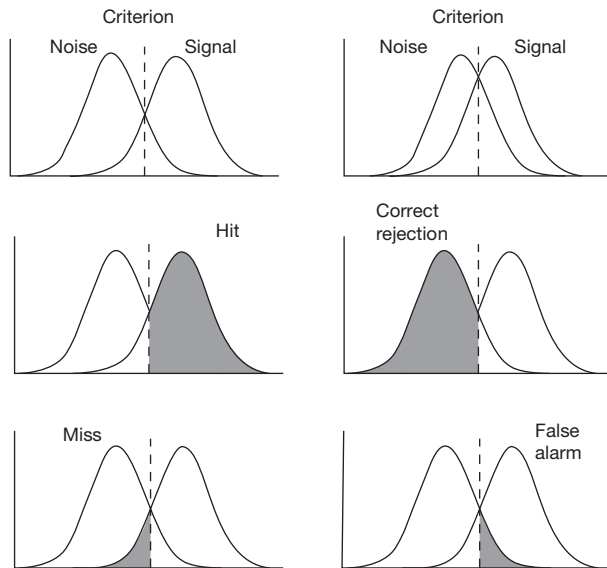


Figure 3 Signal and noise distributions, and a criterion set halfway between the means of the signal and noise distributions. When signal and noise distributions overlap slightly (a), sensitivity is relatively high, but when there is more overlap (b), sensitivity is relatively low. (c, d) The sensation matches the physical stimulus, so that a signal is detected (hit), or the lack of a signal is not detected (correct rejection). (e, f) The sensation does not match the physical stimulus, resulting in an error. Either a signal is not detected when one is present (miss), or is detected when none is present (false alarm).

signal distribution greatly exceeds the mean of the noise distribution (Figure 3(a)). The amount of overlap between signal and noise represents how sensitive you are to the stimulus: as the overlap between signal and noise increases, sensitivity decreases. These distributions represent how your ears transmit a signal to your mind, but how do you decide whether anyone has said your name?

To make this judgment, you need to set a decision cutoff or criterion along the x -axis so that you will respond as if you heard your name in all cases that exceed the criterion, and respond as if you did not hear your name in all cases that fall below the criterion. While the distributions are determined by factors outside your control (e.g., the strength of signal relative to noise), you get to decide where to set the criterion. Where should you place it? A reasonable place to start might be halfway between the means of signal and noise, but a more prudent method for determining where to place the criterion must acknowledge the fact that every criterion will cause errors and that some errors are more costly than others. If we set the criterion halfway between the means of signal and noise as in Figure 3, notice that generally, but not always, the criterion will allow you to make the right decision. That is, most of the signal distribution exceeds the criterion and most of the noise distribution falls below the criterion. Noticing a signal when it is present is called a hit (Figure 3(c)) and failing to notice a signal when it is absent is called a correct rejection (Figure 3(d)). Unfortunately, sometimes you will make an error. Failing to hear your name when it has been said is called a miss (Figure 3(e)) and hearing your name when it has not actually been said is called a false alarm (Figure 3(f)). If signal

and noise overlap at all, it will be impossible to eliminate both sources of error. Because the costs of errors are often not equal to each other, a judicious placement of the criterion will reduce the more costly type error while allowing the less costly error to occur more frequently. In everyday life, the effect of changing criteria can be seen when an individual anxiously awaiting news of an upcoming promotion reacts to every occurrence of words sounding similar to his/her name (high false alarm rate) while a coworker anxiously engaged in conversation with a coworker fails to hear another colleague calling his/her name (high miss rate).

A vivid example of differential criteria can be seen in the criminal justice system in the United States. Police officers often gather evidence that leads them to suspect that some person was the perpetrator of some crime. Because no piece of evidence is perfectly reliable, even in the face of apparently iron-clad evidence a suspect may be innocent. Nevertheless, a police officer would likely think that a guilty person evading capture (i.e., a miss) would be much worse than arresting an innocent suspect (i.e., a false alarm). Police are typically reputed to set their criteria accordingly low. In contrast to police officers, the judicial system is built on the assumption that falsely incarcerating an innocent person is much worse than letting a guilty person free. That is, the courts have an opposite view of the relative cost of errors such that false alarms are worse than misses. For the courts, the relatively high criterion is enshrined in the well-known maxim that people are presumed innocent until proven guilty beyond a reasonable doubt. By this example, we can see that, while signal detection theory is most commonly associated with low-level cognition, it also describes our most exalted and important judgments.

Higher Order Judgments

The preceding sections discussed the process of making psychophysical judgments about sensory events. The processes of making judgments about sensory information frequently take place on an automatic, subconscious level. For example, it is difficult to describe how a baseball player correctly judges the angle and speed of an incoming ball, but the high level of accuracy with which the ball is caught indicates the ability to make these decisions. However, judgment also plays a significant role in higher level cognition for subjective outcomes such as monetary gains or losses, social interactions (who would make a good friend or mate), and physical activities. Economists often refer to the values calculated through judgments concerning these types of subjective outcomes as *utilities*. The process of calculating utilities for possible outcomes is a critical step in the decision-making process.

Similar to the workings of Fechner's Law of Psychophysics, Kahneman and Tversky's Prospect Theory demonstrates that the law of diminishing returns applies to utilities. According to their model, as the absolute magnitude of the outcome increases, the rate of change in psychological value decreases. For example, consider the change in perceived value (utility) as a monetary gain changes from \$0 to \$10 compared to the change in value from \$1 000 000 to \$1 000 010. In both cases the value changes by \$10, but the change seems more

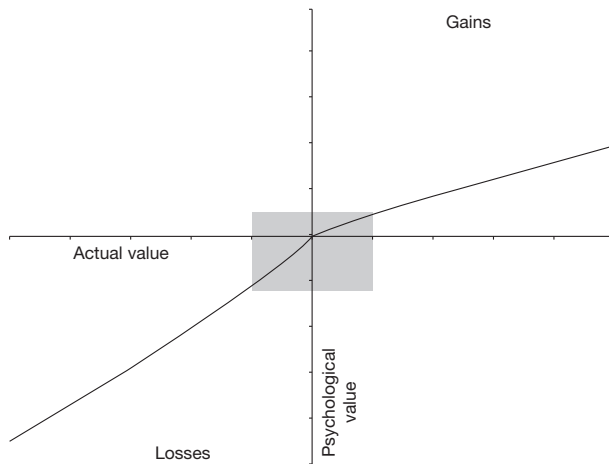


Figure 4 Kahneman and Tversky's utility function demonstrates that both gains and losses show decreasing rates of gain in psychological value as the absolute magnitude increases. The gray box demonstrates that the loss function in the lower-left quadrant has a steeper slope than gains (upper-right quadrant).

significant when going from \$0 to \$10 (see the top section of Figure 4).

The negatively accelerating shape of the value function has two important implications. First, the larger the outcome being evaluated, the greater the change that is needed to produce a similar psychological change in value to that seen for smaller outcomes. To best understand this, consider the following choice situation:

- (a) A TV costs \$500 at a store 1 mile from your home.
- (b) The same TV costs \$450 at a store 5 miles from your home.

Given the choice between (a) and (b), would you be willing to drive the extra distance to save \$50? Most people would be willing to do so. Now consider the following:

- (c) A computer you want is advertised for \$1500 at a store 1 mile from your home.
- (d) The same computer is advertised for \$1450 at a store 5 miles from your home.

Would you drive the extra four miles to save \$50 on the computer? While the savings for driving farther is the same in both scenarios, more people are willing to drive further to save \$50 in the first scenario than in the second scenario. The observed shift in preference is due to the difference in relative value between the outcomes; that is, in the first scenario the discount is a larger percentage of the overall cost of the item. In order for the two scenarios to be viewed as similar, the difference in price between (c) and (d) would have to be greater (say \$1500 and \$1350).

A consequence of the shape of the value function is that the presentation of 'bundled' outcomes is viewed as more valuable than presenting the same absolute magnitude as a single outcome. Imagine the choice between receiving two \$500 checks or a single \$1000 payment. While both options result in a net gain of \$1000, due to the shape of the value function, the summed value of the two \$500 outcomes is perceived as greater than that of the single payment.

A second characteristic of the typical value function (as shown in Figure 4) is that a similar value function describes negative utilities (losses). Similar to the curve for gains, the value function for losses is negatively accelerating such that the difference in perceived change between a loss of \$10 compared to no loss is greater than the change experienced between a loss of \$1 000 000 to a loss of \$1 000 010 (see the bottom-left section of Figure 4). As with gains, the bundling of losses produces larger perceived losses than a single loss (receiving two \$500 fines is perceived as worse than a single \$1000 ticket). However, while the gains and losses curves are similar in shape, they are not symmetrical. A critical difference is that the absolute value of losses is typically about two times greater than for gains (this difference is illustrated by the shaded gray box in Figure 4). The asymmetry in the valuation functions for gains and losses is often summarized as: losses loom larger than gains (or gain-loss asymmetry).

The principle of gain-loss asymmetry is illustrated in the following gamble: Imagine that a fair coin is flipped into the air. If the coin falls on heads, the player wins \$100. If the coin lands on tails, the player loses \$100. Would you play this game? You would be in the majority if you declined. However, according to standard economic theory, the outcome of this gamble should be viewed as neutral, producing a feeling of indifference toward the gamble. Indifference is predicted because the chance of the coin landing on heads, and thus paying \$100, is the same (50%) as the chance of the coin landing on tails, thus costing \$100. Most people, however, do not view the gamble as neutral. Rather, due to the increased psychological attention paid to losses, the possibility of losing \$100 outweighs the potential benefits of winning \$100. As losses are typically viewed as twice as significant as gains, the outcomes in the 'coin-flipping' procedure described would have to be around \$200 for a heads compared to \$100 for a tails before preference would start shifting in favor of the gamble.

A third major characteristic of utility judgments is that they are strongly influenced by a reference point. When asked to judge the magnitude of an outcome, the process does not start from 0 and move up or down accordingly, but rather participants start from their current perceived wealth and adjust from this point. To illustrate this, consider the following two situations:

- (i) You are originally told that you were selected to win a \$1000 prize, only to learn later that the actual value of the prize is \$500.
- (ii) You are originally told that you were selected to win a \$250 prize, only to learn later that the actual value of the prize is \$500.

Note that in both (i) and (ii) you are experiencing a gain of \$500. However, the reference point for the two situations is very different. For (i), your reference point is set at \$1000 so that the actual \$500 prize is perceived not as a gain, but rather as a loss. In (ii), your reference point was set at \$250 so that the change to \$500 represents a financial gain. In practice, people would write in protest to the sweepstakes over (i) while bragging to friends about their good fortune in (ii).

The role of reference points in making psychological judgments is best understood through the *framing effect*. Framing

occurs when information associated with, but not directly relevant to, an outcome influences its perceived value. For example, choices (i) and (ii) above should be viewed as identical, as both produce a financial gain of \$500. However, due to the information surrounding the outcomes, the \$500 outcome is viewed differently. Similarly, a medical procedure that is 97% successful is not viewed as identical to one that is 3% unsuccessful, despite the fact that the two are mathematically identical (the use of success rates focuses attention on positive outcomes while talking about the number of unsuccessful surgeries puts the emphasis on possible losses).

In summary, the three major characteristics of Kahneman and Tversky's *utility curve* are (1) negatively accelerating curves, (2) the slope of the losses curve is steeper than the curve for gains, and (3) judgments start from subjective rather than absolute reference points.

Judgments and Decision Making

Determining the value, or utility, of an outcome is the first step in decision making. When evaluating between two possible outcomes, the active decision-maker has to form a judgment of the value of each choice items before a comparison can be made between the items. When the items are similar along all but one dimension, this process requires very little effort. For example, if deciding between two vehicles that are completely identical (same price, financing, features, color, and so forth), except one is held by a dealer that is 5 miles away and the other is 10 miles away, it is easy to choose which to purchase: the vehicle that is held by a nearby dealer. Unfortunately, it is rare that choice outcomes vary along a single dimension. Instead, most decisions require some form of integration across multiple dimensions. When we seek to purchase a new vehicle, the available vehicles typically differ in cost, financing, color, options, and so forth.

In order to compare outcomes that differ across multiple dimensions, the decision-maker must simplify the elements into a single value judgment. Judgments of value across commodities that differ along multiple dimensions often involve two processes: (1) reducing cognitive load by ignoring highly similar or subjectively less important dimensions and (2) weighting the remaining dimensions and computing a 'value' estimate.

When computing the value of a multidimensional outcome, those characteristics that are shared across choice outcomes and/or those that are viewed as personally unimportant are ignored. For example, most modern cars come with floor mats, power steering, and a heater, so these shared characteristics are not considered when evaluating possible auto purchases. Modern vehicles also come with many different engine sizes and characteristics. As many consumers are unfamiliar with the role of torque and horsepower, they frequently ignore this information as they focus on better understood features such as fuel efficiency. The process of ignoring shared or subjectively irrelevant information can be viewed as a form of mental economy. Unfortunately, this gain in mental efficiency may be offset by losses in quality due to undervaluing important dimensions; the consumer who lives in a mountainous area may find they made a poor choice in automobiles

when they select a vehicle with a small, light engine over a more powerful, heavier engine, despite getting better fuel economy than the smaller vehicle.

After selecting which information is deemed relevant to determining the value of the outcome, the value (or utility) is calculated. While several theories (prospect theory, expected utility theories) present detailed mathematical models for calculating the utility of an outcome, they all take the general form of:

$$V = \sum (w \times v)$$

In this equation, V is the value of the outcome after summing across the perceived value, v , of each outcome times the weight, w , attached to each of the possible outcomes. The product of this mental arithmetic is the psychological value of the outcome. This process is repeated for each exemplar in the choice situation (each car under consideration for purchase) and then a decision is made after comparing these values. Like most psychophysical judgments, the weighting of characteristics and calculation of value often occur outside of conscious awareness. Often a decision-maker can identify which exemplar they prefer, but is unable to identify the 'why' behind this preference.

Judgments Concerning Probabilities

While decision weights are often subjective, studies using risky choices (situations where both the outcome and the probability of the outcomes are known) demonstrate how decision weights, like value judgments, are often nonlinear. When making risky-choice judgments, the expected value of the outcome is equal to the absolute value of the outcome multiplied by the probability of the outcomes occurrence. If decision-makers weighted probabilities linearly, the outcome of the probability weighting decision would be equal to the outcome's expected value. However, the actual decision weights assigned to outcomes differ significantly from the mathematical prediction of the expected value due to nonlinear weighting of probabilities.

When evaluating probability, decision-makers tend to overweigh the extremes while changes in value for mid-range probabilities are underweighted (see [Figure 5](#)). For example, people are willing to engage in very low probability behaviors, such as purchasing lottery tickets, due to the fact that the small chance of winning is overvalued. At the other end of the spectrum, people are hesitant to select an option that involves a small risk over a less preferred option that comes with a guarantee.

Judgments Concerning Delays

Just as changing the likelihood of an event's occurrence changes the judgment weights attached to the outcome, so does changing the time until the outcome's occurrence. In general, increasing the delay to the occurrence of an outcome decreases the perceived value of the event, a phenomenon known as temporal discounting. For example, a \$100 check you receive today is worth more to you than a \$100 check you are scheduled to receive in a month. A frequently used model (though it is important to note that both economics and

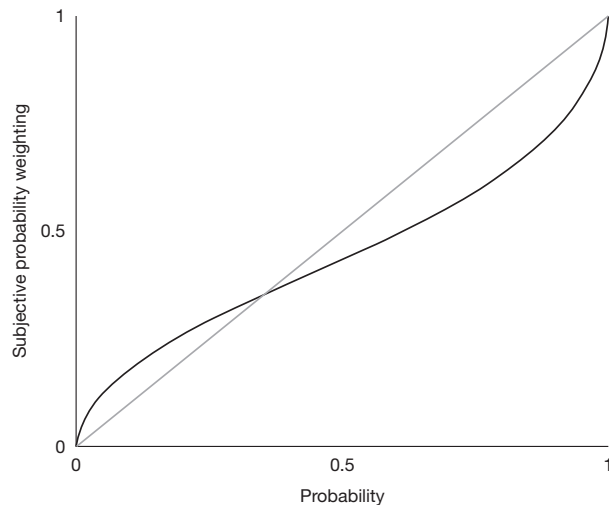


Figure 5 When determining the value of probabilistic outcomes, the weight given to probabilities is not linear, as shown in the black S-curve shown here. The straight gray line shows the expected change if probabilities were evaluated linearly. Note that the curve is sharpest at the low and high end of the x-axis, indicating greater weight for these probabilities compared to the relatively flat middle of the curve.

psychology include other mathematical models of the relationship between delay and value) that describes this relation is

$$V_p = \frac{A}{1 + kD}$$

In this model, the current value, V_p , of a commodity is a function of the absolute value of the commodity, A , divided by the number 1 plus the free parameter, k , times the delay to the outcome's availability, D . The number 1 in the denominator allows the delayed value of the commodity to approach the absolute value of the commodity as the delay approaches 0. The free parameter k is included as an individual index of temporal sensitivity. The larger the value of k , the greater the reduction in value as the delay is increased. The k parameter is typically referred to as the discount rate.

A unique characteristic of the hyperbolic discounting model is that the rate at which the commodity loses value decreases as the length of the delay increases. For example, with a discount parameter of $k = 0.1$, a commodity that is worth \$100 today would lose 9.1% of its value after a delay of 1 day, 8.3% between day 1 and day 2, and 7.7% between day 2 and 3. The decreasing rate of discounting as delay increases can help provide a logical explanation to seemingly irrational preference reversals often seen in human choice (such as preferring not to order dessert before arriving at the restaurant but actually ordering dessert at the end of the meal, and preferring the long-term results of good grades but choosing to attend parties rather than study).

In order to understand the role of discounting in preference reversals, consider the following two choice options:

- (a) \$100 available in 100 days
 - (b) \$80 available in 80 days
- and
- (c) \$100 available in 20 days
 - (d) \$80 available now.

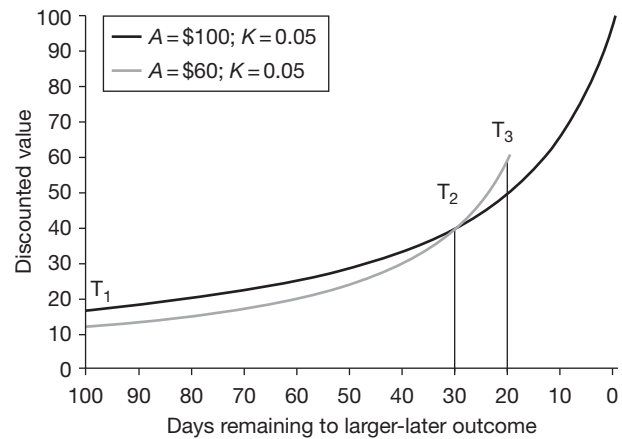


Figure 6 Hypothetical discounting curves. The hyperbolic discount curves predict that, when the delay to outcomes is long (T_1), the discounted value of the larger outcome will be greater than that of the smaller but more immediate outcome. However, when the delay is relatively short, the discounted value of the sooner outcome is greater than that of the larger outcome. The shift in preference occurs at the point where the discounted value of the outcomes is the same, which is the indifference point (T_3).

These two choice pairs present identical monetary outcomes (\$100 compared to \$80) with the same delay between the outcomes (20 days), but with a different shared delay between the two outcomes (80 days and no delay). What impact does the extra 80-day delay have on preference across these situations? Typically, option (a) is selected over choice (b) while option (d) is preferred to option (c), indicating a reversal in preference across these choice pairs. The differences in preference across the choice pairs can be described as follows: when the delay to both outcomes is large, participants prefer 'more,' but as the outcomes become temporally closer, preference shifts to 'sooner.'

But why does preference shift across these choice situations? To understand this, consider the hypothetical discounting curves shown in **Figure 6**. When the delay to both outcomes is large such as in (a) and (b) (marked as T_1 in **Figure 6**), the value of the larger outcome is greater than that of the smaller, more immediate, outcome, producing a preference for outcome (a). However, due to the hyperbolic shape of the discounting curves, as we move closer to the occurrence of the two outcomes (right along the x-axis), the value of the sooner of the two outcomes gains faster than the value of the delayed outcome. At some point in time (marked as T_2 in **Figure 6**), the two discounting curves cross. When the smaller outcome is immediate, as in choice pair (c) and (d), the value of the small immediate outcome is greater than the value of the delayed larger outcome (as seen at T_3 in **Figure 6**), producing preference for outcome (d).

An important implication of the hyperbolic discounting function is that there is an indifference point (T_2 on **Figure 6**) where the psychological (discounted) values of the sooner smaller and later larger outcomes are the same. Increasing the delay to both outcomes beyond the indifference point will produce preference for the larger later outcome (self-control). Decreasing the delays to both outcomes ahead of this

indifference point produces preference for the smaller sooner outcome (impulsivity). The predicted shift in preference from the larger delayed outcome to the smaller immediate outcomes is seen in human behavior. A real-world preference reversal is evident in human behavior when dieters and problem drinkers make commitments to avoid the dessert table or the bar before arriving at dinner, but show a strong preference for dessert/drinks once in the restaurant. When the 'temptation' to engage in problem behavior is in the future, the rewards of the dessert/drink are small compared to the larger but more delayed rewards of controlled weight or sobriety. However, once in the immediate context of the restaurant (delay to dessert/drinks is near 0), the immediate outcomes loom larger than the still more delayed rewards of health and sobriety. Consistent with this example, observed discount rates (the speed with which the value of delayed outcomes decreases) are greater in substance abusers than in non-substance-abusing controls.

Heuristics

Unfortunately, evaluating uncertain outcomes, even when the probability of the outcome can be accurately estimated, is cognitively expensive. To best understand this, imagine a contestant on the game show *Deal or No Deal*TM. The participant is considering an offer from the banker of \$10 000 or playing for the chance of winning a case containing \$1, \$50, or \$35 000. Which should the contestant choose? The rational decision-maker would calculate the expected cost of the gamble (\$11 566.84) and the value of the banker's offer (\$10 000) and select the option with the higher value. This calculation, though, requires significant cognitive effort. Rather than invest the effort needed to make these decisions, people frequently rely on rules of thumb, or heuristics. The game show participant might think, 'A bird in the hand is worth more than two in the bush' or 'it's better safe than sorry' and take the banker's offer (and many in the audience would applaud the decision!).

Heuristics are simple rules that aid in decision making under uncertainty. Uncertainty occurs when the probability of an event's occurrence is unknown, requiring the decision-maker to estimate these probabilities before calculating the value of the event. While the probabilities of many events can be accurately determined, the search for accurate information is costly. Under these conditions of uncertainty and demands, decision-makers often turn to their memory to develop the needed likelihood estimates. To better understand the role of heuristics in developing likelihood estimates from memory, consider the functioning of two well-known heuristics: representativeness and availability.

Representativeness Heuristic

The example that is most often used by experimental psychologists to illustrate the representativeness heuristic is so well known that it has become known simply as the Linda problem. A hypothetical woman named Linda is described as being 31 years old, single, outspoken, and very bright. In college, she majored in philosophy, was deeply concerned with issues of social justice, and participated in antinuclear demonstrations. Given all this information, which of the following do you think is more likely:

- (A) Linda is a bank teller
- (B) Linda is a feminist and a bank teller.

To find the correct answer, you would first decide how likely it is for Linda to be a feminist, how likely she is to be a bank teller, and then multiply the two to find the likelihood that she is both a bank teller and feminist. Given the fact that the probability that Linda is a bank teller is less than 1 (i.e., not every woman is a bank teller) and likewise for feminism, the product of two numbers less than 1 will be less than either of the original numbers. Thus, a simple multiplication will yield the answer that B is less likely than A. In practice, however, most people believe that B is *more* likely than A (a cognitive error known as the conjunction fallacy), indicating that they must not be carrying out this simple calculation. Instead, when asked to consider whether A or B is likelier, we first form mental images of Linda, a bank teller, and a feminist bank teller. After building these mental images, we compare Linda's image to the other two images, and then decide that the third image better resembles Linda than the second image; in other words, Linda is more representative of feminist bank tellers than she is of bank tellers in general.

Whereas the Linda problem seems to show how poorly our minds work, in fact it shows that we tend to prefer strategies that are quick and that yield the correct answer under most circumstances. For example, you might hear about two women, one of whom has two children, both sons, and another that has 20 children, all boys. Which is more surprising? Most people would correctly say that having 20 all-male children is more surprising. In this example, two boys is more representative of pairs of children (one out of four possible pairs) than 20 boys is of 20-children groups.

Availability Heuristic

A second automatic judgment occurs when the likelihood of an event is determined by how easily exemplars of the event are drawn from memory. The easier the event is to recall from memory, the greater the perceived likelihood of the event's occurrence. For example, which is more dangerous to have in a home: a pool or a handgun? As most people do not know accident statistics, they reference their memory with the simple query of, 'Do I remember any deaths/accidents involving pools? What about handguns?' Most people find it easier to recall information concerning handguns, gun control, gun safety, and so forth, than to recall information concerning pool safety (when was the last time a group launched a campaign for a constitutional amendment on pool control?). Given the ease of recall for gun-related information, the frequent, yet incorrect, answer is that guns are more dangerous to have in homes than in-ground pools (although in actuality more child deaths each year are the result of drowning than shootings).

Similar to the representativeness heuristic, the availability heuristic is partially a by-product of the brain's normal and correct functioning. The brain is designed to respond to novelty in the environment. Stimuli/events that are predictable and consistent do not typically signal danger. Novel and unexpected events are frequently signs of upcoming trouble. Accordingly, the brain is wired to pay particular attention to

low-frequency events. When asked to make likelihood judgments about these events, the brain then errs on the side of caution and overestimates the likelihood of the infrequent event's occurrence.

Conclusion

Judgment is the process of making rapid decisions concerning stimulation or information from the environment. Whether focusing on low-level sensory processing or higher order decision making, the brain extracts information from the world and determines the likelihood of the information being important. As illustrated by the representativeness and availability heuristics, while the brain is extremely well suited for its general tasks, occasional systematic and predictable errors occur in the judgment process.

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Jury Psychology

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Glossary

Availability heuristic The tendency to answer a question of probability by asking whether examples come readily to mind. What we recall becomes what we believe will be likely.

Belief perseverance The tendency to prefer and shield personal or preexisting beliefs despite irrefutable evidence that they are incorrect.

Challenges for cause Challenges that occur when jurors do not meet specific statutory qualifications.

Confirmation bias Seeking out only those sources of information that support preexisting beliefs or theories and actively neglecting all contrary evidence or sources of information.

Exempt Jurors on the venire who are unable to serve.

Exhibits Evidence, records, or testimony shown to the jury in court.

Jury A group of men and women lawfully selected, convened, and sworn to inquire into a legal dispute and render an impartial finding of legal fact.

Jury consultant Someone who works with legal professionals, mainly attorneys, to assist in various aspects of case preparation, including jury

selection, development of case strategy, and witness preparation.

Peremptory challenges Challenges that are exercised by attorneys where they see fit.

The CSI effect A particular set of biases caused by the portrayal of forensic science on fictional and pseudodocumentary programs like CSI, Forensic Detectives, and Forensic Files.

The primacy effect A cognitive bias in which those ideas or arguments that come first are given more credibility than those that come later.

The recency effect A cognitive bias in which those items, ideas, or arguments that come last are remembered more clearly than those that came first.

Venire A list of potential jurors within a particular jurisdiction created by drawing individuals from voter registration lists, driving license lists, and supplemental lists when necessary, including public phone directories and those on welfare.

Voire dire An in-depth examination to determine the suitability of jurors for service on a particular case. This process allows attorneys to ask specific and often personal questions about individual juror backgrounds, lifestyle choices, relationships, and views.

Rendering the Venire

In an adversarial justice system, the burden of proof is on the prosecution. The prosecutor must prove the defendant's guilt beyond a reasonable doubt rather than the defense being required to prove any degree of innocence. However, the defense must demonstrate a reasonable doubt with respect to the prosecution's theories regarding their client's guilt. Ironically, these controversial legal standards are commonly left to the subjective interpretation of regular citizens serving on a jury.

A *jury* is a group of men and women lawfully selected, convened, and sworn to inquire into a legal dispute and render an impartial finding of legal fact (adapted from Black, 1990). Trial by jury is the constitutional right of US citizens, preserved by the Sixth Amendment to the US Constitution (Starr and McCormick, 2001).

Preserving the right to an impartial jury involves the assumption that juries are capable of impartiality or objectivity. This assumption is problematic at best. There are many elements that work against the formation of an impartial jury and its subsequent objective efforts. As discussed subsequently, most of them hinge on an understanding of those circumstances that affect jury psychology and cognition.

The Jury Pool

The initial makeup of the 'jury pool' in a given legal jurisdiction and how it is subsequently molded by the courts in

individual courtrooms has a bearing on the capabilities and biases of those who are ultimately allowed to serve.

Jurors are meant to be selected in an impartial and random manner from a representative cross-section of the community. In the United States, a *venire* (also known as jury panel: a list of potential jurors within a particular jurisdiction) is created by drawing individuals from voter registration lists, driving license lists, and supplemental lists when necessary, including public phone directories and those on welfare. This master list is then pared down, as not all citizens are able to serve.

Those jurors on the venire who are unable to serve are referred to as *exempt*. The nature of these exemptions creates a final jury pool with a particular ethos, a character that is defined by those who are allowed to sit as well as by those who are excluded and why. Prospective jurors are commonly exempt from service for the following reasons:

1. They are not citizens.
2. They are not old enough (e.g., under 18).
3. They are too old (e.g., well beyond retirement age and unwilling to serve).
4. They have not lived in their current judicial district long enough to establish residency (e.g., less than a year).
5. They do not speak English or lack sufficient literacy to complete a juror qualification form.
6. They are not mentally or physically capable of the requirements of jury duty.

7. They have been charged with, or previously been convicted of, a felony.

It should be noted that in many instances, jurors serve despite the existence of one or more of these disqualifiers, as background checks are not standard. Prospective jurors are often simply taken at their word that they meet the requisite qualifications and possess none of the automatic disqualifiers. Even in cases where they are honest about a disqualifier, the presiding judge may simply choose to ignore it. This means that felons, the illiterate, and the mentally infirm can and have served on juries in criminal trials – sometimes with the court's full understanding and approval.

Other hardship and occupation-related exemptions exist that can further shape the character of the jury pool, including the following:

1. Jury service would create a financial hardship.
2. Recent injury or illness prevents capable service.
3. Jury service creates a child-care hardship, especially with mothers of children who are still breast feeding.
4. Active military service or deployment prevents service.
5. The prospective juror is out of town attending college.
6. The prospective juror is a licensed, practicing attorney.
7. The prospective juror is a current or former law enforcement officer.
8. The prospective juror is related to, or friends with, one or more of the parties involved in either side of the trial.
9. The prospective juror is a violent crime victim, especially those involving attempted murder, sex crimes, or domestic violence.
10. The prospective juror has a history of negative experiences with one side or the other that creates bias (e.g., prior false arrest, prior wrongful conviction, general dislike for defense attorneys).

Applying such exemptions fairly and consistently is a task that every court is charged with. Imposing jury service on those with hardships creates animosity toward the justice system, as well as distracting the attention of the juror well away from their appointed court-related tasks. Allowing the service of those with a clear bias toward or against either side of the case reduces the overall impartiality of the jury that they ultimately serve on. The failure of the court to properly exempt or disqualify jurors when building the jury pool can allow bias to enter the legal system before the facts of any case are heard.

The strong cultural bias that exists when allowing a former or active law enforcement employee to serve on any jury where law enforcement sits in alignment with either side should be self-evident. Though it should be sufficient cause for automatic exemption, this is not the case in every jurisdiction. As discussed in [Gershman \(1997\)](#), the issue of law enforcement testimony weighed too heavily by those jurors who are prolaw enforcement in their orientation is cause for judicial concern (p. 259):

When the prosecution's case rests heavily on the testimony of law enforcement agents, the refusal to inquire at the defendant's request whether prospective jurors would give added credence to the testimony of a law enforcement agent simply because of his position may be an abuse of discretion. The error is not cured by a court's extensive inquiry concerning a prospective juror's acquaintance or relationship with law enforcement personnel.

However, an extraordinary and undeniable bias against the accused is inherent among those law enforcement officers employed by the arresting police agency, let alone those officers specifically charged with building the ongoing court case. Impaneling such a juror is therefore fraught with ethical peril.

Judges have great discretion on matters related to jury selection and therefore a duty to ensure that both sides receive a fair hearing of their case. The authors are aware of many instances involving judges who have no problem taking the time to discharge these duties fairly and reasonably. Similarly, there is no shortage of examples where judges have failed outright.

Consider an extraordinary instance of impromptu jury selection in Lane County, OR. Judge Mary Ann Bearden faced the start of three major felony trials along with a juror shortage brought on by two converging circumstances: the failure of some citizens to show up for jury duty (summonses for jury duty are routinely ignored by even the most law-abiding citizens) and the nature of the crimes themselves, involving sexual assault and domestic violence. Not enough prospective jurors showed up, and some that did were disqualified by virtue of experiencing domestic violence, sexual abuse, or child abuse personally or in their families. In order to make up the difference, Judge Bearden invoked *Oregon Revised Statute 1.235 (4)*, which reads: "If there is an immediate need for additional jurors, a judge of the circuit court for the county may direct the clerk of court, sheriff or other officer to summon a sufficient number of eligible persons to meet that need. Those persons shall be summoned as directed by the judge." In accordance, she directed deputies to go out onto the street in front of the courthouse, grab the first 12 US citizens over the age of 18, and put them in the jury pool – which they did ([Rillos, 2008](#)).

Pretrial Publicity

Some events and related courtroom matters achieve a high level of media coverage and even an undeniable celebrity all their own because they involve bizarre or salacious facts, a victim or defendant of some celebrity, or because of the pretrial tactics of attorneys on either side. Pretrial publicity can be so intense and overwhelming that it taints prospective or empaneled jurors in favor of the emotional tones being drummed. Historically, the media has been quite capable of exerting this kind of inappropriate influence over the pool of prospective jurors in a given community, as was demonstrated by the defense in the infamous case of *Sam Sheppard v. Maxwell* (1966):

Petitioner's wife was bludgeoned to death July 4, 1954. . . . His trial began October 18 and terminated with his conviction December 21, 1954. During the entire pretrial period virulent and incriminating publicity about petitioner and the murder made the case notorious, and the news media frequently aired charges and countercharges besides those for which petitioner was tried. Three months before trial he was examined for more than five hours without counsel in a televised three-day inquest conducted before an audience of several hundred spectators in a gymnasium. Over three weeks before trial the newspapers published the names and addresses of prospective jurors causing them to receive letters and telephone calls about the case. The trial began two weeks before a hotly contested election at which the chief prosecutor and the trial judge were candidates for judgeships. Newsmen were allowed to take over almost the entire

small courtroom, hounding petitioner, and most of the participants. Twenty reporters were assigned seats by the court within the bar and in close proximity to the jury and counsel, precluding privacy between petitioner and his counsel. The movement of the reporters in the courtroom caused frequent confusion and disrupted the trial; and in the corridors and elsewhere in and around the courthouse they were allowed free rein by the trial judge. A broadcasting station was assigned space next to the jury room. . . . Despite his awareness of the excessive pretrial publicity, the trial judge failed to take effective measures against the massive publicity which continued throughout the trial or to take adequate steps to control the conduct of the trial.

The defense appealed their case all the way to the US Supreme Court and, on June 6, 1966, Sam Sheppard's initial murder conviction was reversed and his case remanded for a new trial.

In keeping with this decision, the US Supreme Court has continued to argue that (*Patton v. Yount*, 1984): "adverse pretrial publicity can create such a presumption of prejudice in a community that jurors' claims that they can be impartial should not be believed." So not only can pretrial publicity shape the opinions of jurors, the impact is intellectually and emotionally overwhelming to the point that they may be incapable of being truthful about it. This is something that cognitive psychologists have known for years: people cannot be relied upon to objectively observe and assess their own bias. As the Federal Court explained in *US v. Davis* (1978): "The juror is poorly placed to make a determination as to his own impartiality."

With the advent of the Internet, social networking sites, and the 24-h news cycle, what is said about a criminal prosecution in the morning may be heard around the world within minutes. Prosecutors and defense attorneys alike are well aware of this reality and of the influence such media exert over public opinion and respective jury pools. This can be felt every time an attorney for either side issues a press release or even provides interviews to the media – in many cases before charges have even been filed. There can be no mistake that such conduct by legal advocates is an overt attempt to influence eventual jurors through the manipulation of public opinion toward their point of view. This is true whether it is a series of heartfelt denials by the representative of a soon-to-be defendant or the release of police documents directly to the media along with inflammatory accusations by a zealous prosecutor.

These collective circumstances, with lawyers, pundits, and even judges giving interviews on every major case that catches the public eye, serve to compound the possibility of inappropriate media influence over potential jurors. However, with all sides benefiting from the press and the exposure, it is rare that any party remains far enough above the fray to complain without appearing hypocritical. We would do well to remember the warning provided in *Gershman (1997)*: "...where a prosecution may be the subject of widespread media attention, trial courts have been admonished to conduct their *voir dire* carefully, to strongly consider questioning jurors individually."

A Jury of One's Peers

Those unfamiliar with the law will no doubt take notice of the absence of the phrase 'Jury of One's Peers' in the preceding discussion. This is not a mistake. Culturally, we have been

generally misled by fictionalized accounts of courtroom 'drama' which bear limited resemblance to the real thing. Among the many myths propagated by the entertainment industry is that of the accused's right to a trial by a jury of one's peers. This is not precisely correct.

In *Lockhart v. McCree* (1986), the US Supreme Court held that an individual jury need not be a truly representative cross-section of the community. As explained in *Cooley (2004)*, in a discussion of *Lockhart* (p. 299):

The Supreme Court discarded the Eighth Circuit's cross-section analysis by holding that the cross-section requirement applies only to venires and not petit juries. The Court held that the "point at which an accused is entitled to a fair cross section of the community is when the names are put in the box from which the panels are drawn." Moreover, the Court expressed that providing a truly representative petit jury to every criminal defendant would be nearly, if not entirely, impossible.

Subsequently, while the final result of sampling the venire may not be a jury that is demographically representative of a particular community, the representative standard is argued to have been met if the *venire* itself is drawn from initially representative sources. Moreover, the diversity of the venire is argued to help foster overall impartiality, as multiple views and voices will be represented and, hopefully, even each other out (*Cooley, 2004*).

The initial formation and subsequent molding of the 'master' jury pool have an undeniable and cumulative impact on the character, capacity, and overt bias that can be present in a final jury that is empanelled for service. Ideally, it is meant to be free from prejudice and predisposition; it is meant to be representative of the community it serves; and it is meant to discharge its duties without fear of undue influence. In order to serve as a check against such concerns when the court has not adequately addressed them, attorneys from each side are afforded an opportunity to participate in the final process of jury selection. However, this awesome power is not always wielded ethically.

Jury Selection

The intended goal of the jury selection process is to render a qualified jury that is free of prejudice and bias (*Frederick, 2005*). However, most jury pools will be populated with unqualified or biased individuals that the court has failed to screen. It subsequently falls upon attorneys from both sides to interview and challenge the suitability of the juror for service.

Voir Dire

Citizens who respond to a summons for jury duty, and who are not exempted from service by the court, must submit to more in-depth examination to determine their suitability for service on a particular case. This process, known as the jury *voir dire*, allows attorneys to ask specific and often personal questions about individual juror backgrounds, lifestyle choices, relationships, and views. Attorneys may interview jurors individually or in groups, as dictated by the rules in a given court. This presents attorneys with their first chance to probe individual

juror bias and also to make a first impression with jurors who will eventually serve on their case. The judge both presides over and participates in this process.

Challenges to Juror Service

Federal statutes provide that “no citizen shall be excluded from jury duty because of race, color, religion, sex, national origin or economic status” (O’Malley et al., 2009: 1). However, jurors may still be stricken from service during or subsequent to voir dire. This filtering process consists of exercising *challenges for cause* and *peremptory challenges*.

Challenges for cause occur when a juror does not meet specific statutory qualifications. Because the failure of a judge to remove a juror for cause may result in a reversible error, attorneys are allowed an unlimited number of such challenges.

Peremptory challenges are distinct because they give attorneys the freedom to exercise challenges where they see fit – and without a stated cause (Frederick, 2005). The number of such challenges is limited, depending on legal statutes and the seriousness of the crime (Gershman, 1997: 248). As explained in Cooley (2004: 287): “After questioning prospective jurors, counsel may then attempt to exclude those individuals who have expressed views unfavorable to their client’s case.” In these instances, when attorneys fail to find cause, they may use one of their peremptory challenges to have a juror excused.

The peremptory challenge is considered vital to the overall fairness of jury selection, allowing attorneys on either side to eliminate those with extreme views. However, it may also be argued that such challenges are open to abuse, allowing attorneys to strike jurors for ‘race, color, religion, sex, national origin, or economic status’ in violation of the law. Additionally, the court’s recognition of the need for challenges without cause suggests a corresponding admission that the jury pool itself is not a representative cross-section of the community.

Jury ‘Profiling’

Although jurors are selected to give their verdict according to the evidence, it is widely understood that some jurors enter the courtroom with preexisting biases or characteristics that influence their ability to vote objectively. The predisposition to vote a certain way and for inflexible personal reasons supports the growing industry of jury consultants. They are meant to assist in the strategic use of peremptory challenges as well as with the development of trial strategy that may be effective with manipulating or influencing the personalities on a given jury.

A *trial consultant* or *jury consultant* is a broad term that can be defined as “someone who works with legal professionals, mainly attorneys, to assist in various aspects of case preparation including jury selection, development of case strategy, and witness preparation” (Roesch et al., 2010: 324). Those who specialize in jury selection “attempt to determine who among potential jurors will be most and least receptive to a client’s case, and devise strategies to pick and challenge those jurors” (Jonakait, 2003: 159). They focus on the scope of potentially influential factors, such as personality traits, and demographics, including race, gender, education, and socioeconomic status (Donner and Gabriel, 2009; Strier and Shestowsky, 1999).

The demographic characteristics of jurors have been studied largely because they are easily observed. Socioeconomic status and sex are two examples of demographic characteristics that are associated with juror bias in favor of defendants, when those traits are also present in the defendant (Donner and Gabriel, 2009).

Socioeconomic Status

According to a rather dated study by Adler (1973), when the difference between juror and defendant socioeconomic status increased, so did the likelihood of conviction (as cited in Donner and Gabriel, 2009). That is to say, jurors were more likely to convict those who they felt were more or less advantaged than themselves. This suggests an historical class bias in jury decision making.

Sex

Another rather dated study conducted by Nagel and Weitzman (1972) found that sex influenced the verdicts of jurors. In civil cases, male-dominated juries tended to award higher damages to male plaintiffs, whereas female-majority juries tended to award larger sums to female plaintiffs (as cited in Devine et al., 2001). This suggests a same-sex bias once harm has been established and the need for damages is deemed appropriate.

A more contemporary study of rape trials by Fischer (1997) found that juries composed mostly or entirely of women tended to convict male defendants more often than juries with a low proportion of women (as cited in Devine et al., 2001). This study contradicts conventional rape-trial wisdom that suggests female jurors are actually less sympathetic to female complainants (often second-guessing their role in events), while male jurors are more quick to convict male defendants for fear of seeming tolerant or accepting of rape in general.

In general, Devine et al. (2001), a meta-analysis of multiple demographic studies, noted that when the evidence against the defendant was weak or ambiguous, juries that were demographically similar to the defendant tended to be lenient; however, when the defendant’s culpability was clear, juries tend to be harsher. This suggests a bias against like defendants, with juries desiring to make an example of those among their own who are found guilty.

While the aforementioned research suggests that jurors with specific characteristics are predisposed to voting a certain way, it is impossible to suggest that these general propensities will apply to specific jurors. Jury consultants have published almost no data to support that jury verdicts are predictable under any conditions, and social science studies have consistently found that the overwhelming determinant of verdicts is the evidence presented to the jury (Jonakait, 2003). Moreover, according to Strier and Shestowsky (1999), there appears to be no way to assert with certainty that a successful verdict in an actual trial is directly attributable to jury selection. This may be because “the client who can afford a trial consultant is usually the same client who can afford the best attorneys, and the best expert witnesses and the best investigators” (Strier and Shestowsky, 1999: 12).

The involvement of jury consultants in the process of jury selection also presents ethical concerns, as their role is to purposefully manipulate the outcome of the jury's decisions. In fact, trial consultants have even been known to help deliberately lead to a mistrial or delay the goals of the legal system (Posey and Weightsman, 2005). Additionally, jury consultants are expensive. The minimum fee for meaningful work has been put at around \$50 000, with higher-end services going for around \$500 000. As a result, only those with sufficient resources can afford them, which in effect may be said to at least help buy a favorable verdict when the facts alone do not merit it (Jonakait, 2003).

Courtroom Influences

Once the jury and their alternates have been empanelled for a particular case, the court's influence over their behavior and emotions focus sharply. They are generally ordered to refrain from forming opinions until they have heard all the facts, to avoid any media coverage of the trial, not to research the trial independently, and not to discuss the trial among themselves or with anyone else. In short, they are required to conduct themselves, and to reason, in a way that is generally foreign to their everyday experience. In extreme cases, they may be sequestered to avoid any contact with the outside world throughout the trial.

While the number of influences over the jury is reduced during trial, their imposed isolation necessarily causes those influences to have an increased importance on their perceptions, emotions, judgments, and decision making. As a consequence, the jury sees events unfold from a very unique perspective. It is fair to say that the trial they are watching is not the same trial that anyone else is watching – it is filtered.

The Judge

During trial, the judge is the single greatest influence over the jury. The judge makes the rules and doles out any sanctions for infractions. Beyond the controls already mentioned, the judge also dictates when jurors must arrive, where and when they must wait, when they should take breaks and eat, whether and when they may have contact with friends and family, and how late they must stay in court every evening. This can create internal pressure and stress on jurors in a situation that is already going to have too much of both from everyone else involved.

The judge also rules on the admissibility of facts, evidence, witness testimony, and permissible case theory. In essence, he/she has the power to direct the narrative or 'story' that either attorney may use when arguing his/her side of the case. By the time the jury hears arguments and testimony, or sees evidence, the volume has been greatly reduced and reshaped from its original form. This profoundly changes the character of the trial that the jury sees and is allowed to consider, as opposed to the facts that are generally or publicly known.

The judge further controls the jury by deciding whether jurors may take written notes, and which evidence, records, or testimony they may take with them into their deliberations (referred to as *exhibits*). Human memory is frail and

imprecise. In cases where jurors are not allowed to take notes, they must rely on that memory when forming arguments to support their vote. In cases where note taking is permitted, those jurors who take the most complete set of notes have an inordinate sway over others. And jurors tend to take more notes in the beginning and less over time as the trial progresses. This issue becomes increasingly important in lengthy trials that involve complex fact patterns and relationships or require an understanding of how to interpret complex physical evidence. The judge ultimately controls whether and how the jury is allowed to recall what they have experienced during the trial and the mechanism by which they may refresh their memory when important details become a matter of dispute.

Apart from imposing many procedural influences over the jury that affect their capability and temperament, the judge also wields tremendous influence over the emotional content of the courtroom by virtue of his/her own professional conduct. The judge is the only person in court who can speak to anyone and everyone at any time and often in any manner that he/she sees fit. A judge's manner and tone, intentional and otherwise, can improperly telegraph his/her personal agenda or preferences to the jury. This can be the result of general intolerance and impatience with attorneys resulting from a strained relationship, as he/she tends to see the same legal players playing the same legal games despite numerous advisements from the bench. This can also be the result of an improper prosecution bias, as many judges are former prosecutors themselves.

Judges may conduct themselves improperly toward the defendant or defense witnesses. This includes assuming the role of the advocate (acting as a backup prosecutor); openly conveying skepticism or disbelief, active disinterest (such as sleeping through or otherwise ignoring testimony); or disparaging remarks; and obvious character attacks. This also includes improper remarks that disparage witness credibility; the use of sarcasm and ridicule; and racial, ethnic, or other derogatory remarks (Gershman, 1997). When this kind of judicial behavior takes place in front of the jury, the message is undeniable: the defense and their witnesses are deserving of the court's admonitions and hostility and are therefore less credible. If the judge treats the defense and its case as less credible, then the jury may find it difficult to perceive them in any other way.

The judge may also engage in improper conduct toward the prosecution and its witnesses by virtue of eliciting favorable proofs, acts of advocacy for the prosecution, vouching for character or testimony, or any other form of obvious favoritism (Gershman, 1997). If this type of judicial behavior takes place in front of the jury, the message, again, is all too clear: the prosecution is deserving of favor and therefore is deserving of preferential treatment, which equates to greater credibility. If the judge treats the prosecution as more credible, then it will likely be viewed by the jury in the same fashion because of the power structure inherent in their relationship.

These examples of improper judicial conduct are prejudicial in nature. In some cases they are almost impossible for even the most objective jury to ignore. Such misconduct from the bench consequently subverts the defendant's right to a fair trial and an impartial verdict. These are just some of the

many examples of how a judge can influence and even subvert the behavior, emotions, attitudes, and ultimate decision making engaged in by jurors.

The Prosecution

Adversarial justice systems are premised on a presumption of innocence, where the state has the burden of proving a defendant's guilt. In reality, however, the prosecution often enters the courtroom with a tremendous amount of bias in their favor.

First, the fact that a criminal defendant has been investigated and arrested by law enforcement creates a 'guilty bias.' This is because a majority of the public maintains the false belief that law enforcement only arrests guilty individuals. This can extend to the flawed reasoning that even if the defendant is not guilty of the charges at hand, they must be guilty of something, and therefore a guilty verdict of some kind is warranted despite any holes or weaknesses in the evidence being presented. This is often referred to as 'the prosecutor's fallacy.'

Next, there is a 'moral bias' present. We the people regularly experience cultural and institutional pressure to view law enforcement and the prosecution as the morally 'right' side of any argument and the defense as the morally 'dark side.'

Additionally, some in the general public do not want to believe that law enforcement or prosecutors are capable of anything other than professionalism, competence, and truthfulness. Therefore, whatever they present in court must be believed. If what they present cannot be believed, then the justice system cannot be trusted and nobody is safe from wrongful prosecution. Such a reality is undesirable for many to contemplate. This inability to view law enforcement and the prosecution in a negative fashion creates a proauthority bias stemming from fear or apathy.

It is important to acknowledge that in some legal jurisdictions, and among some groups, these prosecution biases have been upended. This can result from highly publicized or systemic patterns of police and prosecutorial misconduct and abuse. It can also result from certain groups or communities experiencing a consistent history of negative contact with law enforcement in the lawful performance of their sworn duties. Any of these circumstances can create a collective animosity against law enforcement and the criminal justice system in general. This may provide for a local jury pool that is skeptical if not completely biased against local authorities, and some among them may even be looking for payback through jury service.

The prosecution often seeks to influence the jury through emotional appeals. This is especially effective with cases involving sympathetic victims or horrific fact patterns. Depending on the nature of the crimes charged, members of the jury may feel the strain of psychological or moral imperatives to hold someone responsible and prevent an injustice. The prosecution may feel a corresponding need to meet perceived umbrage and outcry on an equal footing.

Common prosecutorial appeals to emotion include repeated focus on sensational or grotesque details of crime, to the point of distortion if not exaggeration and falsity; focus on victim suffering and innocence, again to the point of distortion; inappropriate attacks on defendant character, including the misuse of prior conduct, arrests, or convictions;

and inappropriate attacks on the character of the defense and their witnesses, referring to them as criminals or liars (Gershman, 1997). Prosecutorial appeals to emotion can also be found in inflammatory conduct, including name-calling; appeals to 'law-and-order' and public safety issues; insinuations of violent threats against witness; appeals to racial prejudice; appeals to nationalism or religion; appeals to wealth or class prejudice; and appeals to jurors as parents (Gershman, 1997). Prosecutors may also warn the jury regarding what might happen if they fail to convict – the consequences to the community, and future victims, of an acquittal.

Less commonly known is that many prosecutors, keenly aware that their manner of dress is carefully scrutinized by members of the jury, adopt a very particular courtroom 'uniform.' Rather than consistently dressing according to their means, some will dress up or down in their professional attire depending on the jury. This panders to the jury's perceived class, creating the false impression that they share common socioeconomic origins and values.

These examples are but a few of the many ways that prosecutors can influence the behavior, emotions, attitudes, and ultimate decision making engaged in by jurors. In many cases, they are a form of prosecutorial misconduct and must be objected to by the defense to preserve their right to appeal. Such misconduct from the prosecution can subvert the defendant's right to a fair trial and an impartial verdict from the jury.

The Defense

Unless prosecution biases have been upended in a particular legal jurisdiction, as discussed in the previous section, the defense enters the courtroom under the weight of tremendous prejudice. They are, in general, considered to be on the wrong moral and legal side of any courtroom. This circumstance alone provides a tremendous jury bias against any case theories that the defense seeks to advance. In some jurisdictions, this will be made worse by the arrangement of the courtroom, where the defense must sit at a long distance from the bench, subordinate to its bailiffs and well away from the jury. Under extreme circumstances, the judge may even require the defendant to wear handcuffs, shackles, or even prison clothing – telegraphing a context of guilt for all to see.

The way defendants look and conduct themselves in court is also among those subjective measures used by the jury to gauge a defendant's character and subsequent guilt, whether conscious or not. This involves observing how the defendant dresses and grooms, and whether this seems too contrived or vain. It also involves a subjective assessment of the defendant's reactions to court proceedings, to the point where the smallest look or gesture, even note taking, may be interpreted as a sign of guilt. Nothing is overlooked, when looking is all that the jury can do. Experienced defense attorneys know this, and commonly advise their clients to sit still, react to nothing, and take no notes. Ironically, this advice may backfire, as many jurors have claimed that the absence of defendant emotion or reaction weighed in their mind as evidence of bad character, general criminality, or even direct wrongdoing.

The character of the defense attorney is also on trial before the jury, as likeability and trustworthiness are always important factors. If the jury does not trust the messenger, they will

not trust the message. Trust is gained through professionalism, honesty (being forthcoming), and sincerity. Any attorney, defense or otherwise, can lose the trust or support of the jury by misstating evidence; harassing victims or witnesses; putting on an insincere show or a spectacle; making rude, derogatory, or offensive remarks; or withholding evidence. Some defense attorneys confuse this with dressing for success in high-end suits that telegraph financial success. While this may cause some jurors to perceive increased competence and professionalism, others may perceive this as evidence of success at being deceptive and getting off 'bad guys.' As with any subjective criterion, it merely tends to be used for reinforcing views that are already formed rather than creating new impressions.

Jury Psychodynamics

There are many psychological facets and relationships that have influence over decision making, and we have shown that jurors deliberating as to guilt or innocence are not especially immune to their complexities.

The Availability Heuristic

As defined in Tury (2008), the *availability heuristic* refers to the (p. 76): "tendency to answer a question of probability by asking whether examples come readily to mind. What we recall becomes what we believe will be likely." This is how many people reason – including many jurors. They do not actively listen, they do not try to learn, and they have no interest in reaching beyond what they already know so they tune out when required to try. Their first point of reference for understanding and solving any problem is going to be experience or movies or television, and not necessarily in that order. When explanations go beyond their experience, they tend to be cynical and even mistrustful. The less education, intelligence, and critical thinking possessed by individual jurors, the more their decision making is influenced by their own subjective availability heuristic.

The Primacy Effect

The *primacy effect* is a cognitive bias in which those ideas or arguments that come first are given more credibility than those that come later. In other words, whoever or whatever comes first is right: the first to present evidence and opinions, the first to make an argument, and the first to make their case. This creates a tremendous bias in favor of the side that presents their case to the jury first – namely, the prosecution.

The primacy effect is reduced when information is presented too quickly and is increased when information is presented slowly. This would seem to be highly relevant to how evidence arguments should be presented to the jury, depending on the desired outcome.

The Recency Effect

The *recency effect* is a cognitive bias in which those items, ideas, or arguments that came last are remembered more clearly than those that came first. The more recently heard, the clearer

something may exist in a juror's memory. This is common when information is given in lists – the last thing heard is recalled, while those at the beginning and in the middle may be forgotten. As a result, the party delivering the final closing argument – the defense – has an advantage.

The recency effect is increased when too much information is presented too quickly, and it is reduced when coupled with other tasks. With respect to jury memory, allowing note taking could also reduce both primacy and recency effects.

Belief Perseverance

Belief perseverance is the tendency to prefer and shield personal or preexisting beliefs despite irrefutable evidence that they are incorrect. This is related to *confirmation bias*, which involves seeking out only those sources of information that support preexisting beliefs or theories and actively neglecting all contrary evidence or sources of information. This means that when someone has strongly held personal beliefs, it is likely that he/she will be immune to facts or evidence that disprove him/her. Jurors are no different, and it is therefore important for those beliefs to be revealed during the *voir dire* process when they are relevant to issues at trial.

The 'CSI' Effect

All of the previously mentioned biases and influences contribute strongly to what has been referred to as *the CSI effect* and its impact on juror expectations and decision making. Named after the popular television franchise, this particular set of biases is caused by the portrayal of forensic science on such fictional and pseudodocumentary programs as CSI, Forensic Detectives, and Forensic Files. In these programs, forensic evidence is gathered, examined, and interpreted quickly by armed police investigators who convey moral umbrage and confront criminals directly with laboratory findings. As explained in Cooley (2007), religious viewers of such programs (p. 471) "come to believe or blindly assume three broad themes regarding the forensic science community: (1) crime labs are pristine scientific sanctuaries, which always have the most up-to-date forensic technology; (2) crime labs only employ the most skilled and imaginative 'scientists' who make few, if any, errors; and (3) forensic scientists are actually practicing and engaging in legitimate science." The reality is that forensic evidence examination, testing, and interpretation is a lengthy process involving scientists, not police officers, many of whom work in less than ideal conditions with limited budgets and training, and are surrounded by many biasing influences – to say nothing of error rates for evidence testing being generally unknown. This means that, too often, there is no science in forensic science (see generally The NAS Report – Edwards and Gotsonis, 2009).

The CSI effect can impact the juror in two ways. First, it can create unreasonable expectations for the prosecution – that physical evidence will always be collected, tested, and examined in every case, even when the resources do not permit it or the facts of the case do not require it. Second, it can create an unreasonable bias against the defense, as the evidence that is presented by the state's forensic examiners may be presumed

infallible or more certain than it actually is. This is especially problematic when attorneys and forensic scientists intentionally distort their arguments and testimony to meet the expectations created by the CSI effect, in essence leaving false impressions behind in the minds of jurors.

Jury Deliberation

When both sides have closed their arguments, the jury is sent back to deliberate and render a verdict in accordance with the instructions provided by the court. It is rarely as simple as finding the defendant 'guilty' or 'not guilty.' The court decides the charges that may be considered, and jurors are also given rules, referred to as jury instructions, relating to legal issues that have been raised throughout the trial. They are admonished to follow these carefully.

Jury deliberations are conducted in secrecy, under guard by the court's bailiffs, and without outside intrusion. The only exception is that the jury can ask questions of the judge, passed through the bailiff in the form of written notes. They may want to look at particular exhibits, to read particular testimony, or to have a matter of law clarified. The judge has broad discretion to grant or deny these requests.

Jurors are not allowed to consider anything outside of the trial as fact or evidence in their deliberation. They may not conduct their own research or their own investigations. They must rely only on what has been presented in the courtroom to make their decisions. Jurors who violate this covenant may be removed from service and replaced with one of the several alternatives that will have been serving simultaneously. Outside communication may also result in a mistrial, where the entire case must be tried again with a new jury.

Jury deliberations may take hours or they may take weeks, as there is no set time limit to this process. Experienced jurists believe that the longer the jury is out, the better it is for the defendant. This indicates that their findings are not certain and debate is ongoing. Similarly, a speedy verdict is said to be bad for the defendant as is sending a case to the jury on a Friday, as some feel that the jury may rush to judgment to avoid deliberating over a weekend. In truth, this is all just speculation. Every jury in every jurisdiction is different; each deliberates in accordance with the composition of their members. There is no predicting how long they will take or what that means for either side.

If a jury is deadlocked or unable to reach a verdict, they must inform the judge. In turn, the judge may refuse to accept their lack of a verdict and send them back to deliberate further, advising them of the cost of a new trial. If a jury is hopelessly deadlocked, with insufficient votes to meet the threshold of guilt or innocence, then a hung jury is declared and the case must be retried in front of a new one.

Conclusion

Individual juries do not represent an unbiased cross-section from a given community. They are carefully screened for service, first by the court and then by the attorneys involved. They are exempted from service based on who they are, what they believe, and whether they are perceived as helpful or

threatening to the arguments and evidence that may be presented.

Once empanelled, jurors are caught in a three-way tug-of-war between the court, the prosecution, and the defense. Each side plays to its biases, prejudices, and frailties for its own advantage. Jurors are manipulated with respect to the facts and evidence they see, how they feel, and ultimately how they may reason.

Despite the persistence of these many biases, frailties, and other psychological influences, there remains no reliable predictor of jury outcomes. They think the way that they do, and judge the way that they do, in a manner those observing from outside have yet to fully understand or reliably anticipate. This includes those of us who have served on a jury ourselves.

See also: [Attitude Formation](#); [Cognition and Personality](#); [Cognitive Bias](#); [Decision Making \(Individuals\)](#); [Human Intelligence](#); [Media Influence on Behavior](#); [Memory](#); [Prejudice, Discrimination, and Stereotypes \(Racial Bias\)](#); [Reasoning](#).

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Relevant Websites

- http://www.ajs.org/jc/juries/jc_decision_research.asp – American Judicature Society.
- http://www.ncsconline.org/d_research/cjs/ – The Center for Jury Studies.

Kinship

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Glossary

Alliance theory The theory that a key to understanding kinship systems is how they distribute marital alliances by dividing kin into marriageable and unmarried.

Coefficient of inbreeding The probability that maternally and paternally derived copies of a gene are identical by descent in their offspring (measured relative to a background population).

Coefficient of relatedness The probability that a gene at a given locus is identical by descent in two organisms (measured relative to a background population).

Descent theory The theory that a key to understanding kinship systems is how they assign individuals to groups based on descent from a common ancestor (sometimes limited to descent through the male line – patrilineality – or the female line – matrilineality).

Generalized reciprocity Distribution of goods without definite expectation of balanced return. The common mode of distribution in families and many larger kin groups.

Kin selection A form of natural selection in which a trait is selected not just because of its consequences for the bearer of the trait, but because of its consequences for the bearer's genetic relatives.

Kin terminology (vs. kin terms) How kin types are split or merged (vs. the actual words used for kin types). For example, it is a fact about English kin *terminology* that the words for father's sister and mother's sister are the same; it is a fact about English kin *terms* that the word for father's sister is 'aunt.'

Westermarck effect A lack of erotic interest in adulthood resulting from coresidence in childhood. A proposed evolved mechanism for avoiding inbreeding.

Two disciplines have, more or less independently, taken up the study of kinship: evolutionary behavioral biology and cultural anthropology. Evolutionary biologists argue that much animal social behavior tracks genetic kinship, while cultural anthropologists from the beginnings of the discipline have found kinship to be central to human social organization.

However, there are deep disagreements between evolutionary and cultural approaches to kinship – disagreements regarding the relationship, if any, between nonhuman and human kinship, and between biological and cultural dimensions of kinship among humans. There are further disagreements within cultural anthropology itself: some anthropologists nowadays are skeptical about whether kinship is really important or even well defined for many societies. As a result, it is impossible to present a consensus view of this subject. This article follows a different path. The following sections compare and contrast evolutionary and cultural approaches to three bundles of topics in the field of kinship: (1) altruism and amity, (2) mating and marriage, and (3) the recognition and categorization of kin. Each section begins with a summary of theories and findings from biology. It then introduces anthropological approaches, and considers arguments that humans are special in ways that may require modification or even rejection of evolutionary approaches. A final paragraph considers the prospects of reconciliation.

Kinship and Kindness

It is no accident that 'kin' and 'kindness' are etymologically related; the association of kinship with altruistic behaviors, sentiments, and norms is a commonplace observation. It is also a major topic for both evolutionary biologists and anthropologists.

Kin Selection and Altruism

When Darwin began exploring the logic of natural selection, he was struck by "one special difficulty, which at first . . . appeared insuperable." Members of sterile worker castes among ants, bees, and other social insects have instincts and physical structures that differ from those of their fertile conspecifics but are still fine-tuned to their environments. How could natural selection, which depends on differences in reproductive fitness, produce adaptations limited to sterile organisms? How could natural selection favor sterility itself? Darwin eventually realized that plant and animal breeders had already supplied the answer to these questions. Breeders face the problem that some desirable traits, like vegetable flavor and meat quality, can only be assessed post mortem. Because breeders cannot select these traits directly, by selecting from the plants or animals set on the table, they must work indirectly, breeding from surviving family members, who are likely to be correlated on the selected traits. As Darwin put it, "selection may be applied to the family, as well as to the individual."

This insight anticipated what would come to be called the theory of *kin selection*. A trait associated with reduced fitness in one organism can be favored by selection if it is associated with sufficiently increased fitness among relatives likely to share the trait.

The behavior of social insects in provisioning and protecting their nests is a particularly extreme example of biological *altruism*. From an evolutionary perspective, an animal is behaving altruistically if its behavior is adapted to raise the fitness of other organisms, while lowering its own. For example, in many species, giving an alarm call in the face of a predator is altruistic: neighboring animals are warned, but the caller is more likely to be attacked by the predator. The commonest variety of altruism is parental care, with parents promoting the

survival and reproduction of existing offspring at the cost of producing fewer offspring.

The development of population genetics in the twentieth century allowed a more precise formulation of the relationship between kinship and altruism. The foundational work dates to the 1960s. William Hamilton demonstrated that, given some simplifying assumptions, altruism toward genetic kin is favored by natural selection as long as the condition $c < rb$ is satisfied. In this inequality, c stands for the cost of a behavior to the organism performing it and b for the benefit of that behavior to a relative of the first organism, with costs and benefits measured in terms of fitness – expected reproductive success. The term r is called the *coefficient of relatedness*. The coefficient of relatedness is a measure of the genetic similarity between two organisms resulting from common descent (over and above any genes the two have in common simply by virtue of belonging to the same wider population). The coefficient of relatedness is a regression coefficient. Given the presence of an allele in Organism 1, the expected number of copies of that allele in Organism 2 is $r(1-p) + p$, where r is the relatedness of Organism 2 to Organism 1, and p is the frequency of the allele in the population as a whole.

The coefficient of relatedness of an individual to a parent, child, or full sibling is $1/2$. Relatedness to a half-sibling, parent's sibling, sibling's child, grandparent, or grandchild is $1/4$. Relatedness to a first cousin is $1/8$, to a second cousin $1/32$. These coefficients assume the standard Mendelian rules for inheritance of autosomal genes. They may not work for genes on sex chromosomes, or for non-Mendelian inheritance. For Mendelian inheritance, in the absence of inbreeding, the relatedness of B to A equals the relatedness of A to B. In some other systems of inheritance, such as those found in some social insects, this symmetry does not hold.

The coefficient of relatedness can be used to define a quantity called *inclusive fitness*. Take the individual fitness of an organism – its expected reproductive success. For each relative whose fitness is raised or lowered by that organism, take the resulting change in fitness and multiply it by r . Sum these quantities. The result is called inclusive fitness. Inclusive fitness is a measure of an organism's success in getting copies of its genes into the next generation, either through its own reproduction or through assisting the reproduction of relatives sharing its genes. Under a wide range of conditions, natural selection favors genes that raise the inclusive fitness of their carriers.

In the inclusive fitness approach, fitness is divided into two components: the individual fitness of an organism and its effects on the fitness of its relatives. There are other ways of partitioning fitness that provide an alternative perspective on kin selection. The *multilevel selection* approach, pioneered by George Price, divides fitness into within-family and between-family components. The within-family component of fitness is the fitness of an organism relative to the mean fitness of its family. The between-family component is the fitness of the organism's family relative to the mean fitness of the population. In the case of kin selection, an altruist has lower fitness than the nonaltruist members of her family, but the increased fitness of her family relative to other families is enough to allow the spread of genes for altruism. This framework draws attention to the fact that kin selection requires selection

between families to operate, because the coefficient of relatedness is defined relative to a background population. In a population consisting of only one family – Adam and Eve and their children, say – selection would favor spite rather than altruism toward kin. It is important to note that inclusive fitness and multilevel selection approaches are two different ways of doing the bookkeeping, not two rival theories.

Kin selection is the subject of an enormous literature in animal behavior. This work demonstrates the importance of kinship to affiliation and altruism, and shows how kinship interacts with other factors in the evolution of a wide range of phenomena, including cooperative breeding, conflict within families, communication, group formation, and population structure.

The Axiom of Amity

In the mid-nineteenth century the study of kinship by scholars like Henry Lewis Morgan and Henry Maine helped to inaugurate the establishment of anthropology as a scholarly discipline. The rise of anthropology marked a break with earlier philosophical speculation about the origin of society from a state of nature. Anthropologists investigating social organization in nonstate societies did not find autonomous individuals creating order by drawing up a social contract. Instead, they found themselves in a world where relations among kin were central to social organization, a world of lineages and clans, cross-cousins and parallel cousins, genealogical and classificatory kin. Sorting out the principles underlying variation in kinship both in tribal and state societies became a major occupation in anthropology over the next century and a half. This section introduces some of the basics of human kinship by comparing and contrasting it with kinship as understood in the theory of kin selection.

The connection between kinship and altruism has been noted by a number of anthropologists. Meyer Fortes argued that an *axiom of amity* is a central presumption of kinship: kin are expected to share with one another simply because they are kin, without necessarily expecting an exact return. A similar observation was made by Marshall Sahlins, who documented an association between kinship and a principle of *generalized reciprocity*. In generalized reciprocity, goods, and favors are distributed to a large extent on the basis of need. (With *balanced reciprocity*, by contrast, which commonly prevails among nonkin, a quid pro quo is expected.) The principle of generalized reciprocity may be expressed through *demand sharing*, in which individuals are allowed to demand goods or favors from others, or through *pooling*, in which goods are pooled and then redistributed by a representative of the group. Generalized reciprocity is universally familiar as the chief mode of distribution within families; in many societies it also applies to wider groups. Generalized reciprocity is widely, but not exclusively, tied to kinship.

It is tempting to suppose that the anthropologist's axiom of amity is just the biologists's kin-selected altruism in another guise, but the two seem to be different in important respects. Many cultural anthropologists argue that culturally defined kinship often does not map well onto genetic relatedness. Discrepancies between cultural and biological kinship take several forms. In some cases individuals known to be

biologically unrelated, including adopted or adulterine children, are incorporated into kin groups and counted as kin when genealogies are reckoned. In some cases, individuals are assigned places in the kinship system based on *classificatory kinship*, which may be different from genealogical kinship. For example, if a man is classified as 'brother' to my mother, I may know that his child should be classified as my 'cousin' without being sure about the actual genealogical connection between the two parents. And in some cases, relatives at equal genealogical distance are distinguished based on the sex of connecting relatives: a mother's brother may be classified and treated as a different type of relation than a father's brother.

How serious a problem these discrepancies pose for an evolutionary account of human kinship is a matter of dispute. On the one hand, considerable evidence, amassed by both mainstream cultural anthropologists and evolutionary anthropologists, shows that adoptive and classificatory kinship do not simply erase consciousness of genealogical connections. Adoptive, step, and foster children are commonly treated differently from biological offspring, and in most premodern societies they keep up some connections with their birth parents. And natives will generally treat a 'real' sister differently than a classificatory one. On the other hand, current evidence does not support the view that these varieties of culturally defined kinship are just window dressing which people ignore in favor of biological kinship; they can be shown to have observable and measurable effects on behavior. For example, in many societies, principles of generalized reciprocity are extended to a culturally defined kin whose actual genetic relatedness is too low for much altruism to be expected on the grounds of inclusive fitness.

A further difference between 'kin altruism' governed by the axiom of amity and 'kin-selected altruism' concerns the motives for altruism. Anthropologists often note a distinction between the *domestic* and *jural* spheres of kinship. Kinship in the domestic sphere operates mainly in smaller social units, and especially among family members. In the domestic sphere, altruism toward a kin is an individual choice, motivated by the sentiments of the donor toward the recipient. Kinship in the jural sphere operates among more distant relations. In the jural sphere, altruism toward a kin is a duty, motivated by a concern for proper behavior and for reputation among a larger circle: how one person treats his or her kin is everybody's business. This normative aspect of kinship is a complication usually missing from standard kin selectionist accounts.

Many of the discrepancies between biological and cultural kinship seem to reflect the fact, often noted by cultural anthropologists, that human kinship is not just about relationships between individuals, but about relationships between groups. Membership in a group often entails obligations that run counter to personal inclinations. The group side of kinship is the focus of *descent theory*, pioneered by Robert Lowie, A. R. Radcliffe-Brown, E. E. Evans Pritchard, and others. Descent theory begins with the observation that, although the genealogical connections established by biparental reproduction – so-called *bilateral kinship* – can be used to situate each individual in the middle of a network of near and distant kin, they do not, barring close inbreeding, divide a population into bounded, nonoverlapping groups or categories. Constructing groups out of the network of kin requires that some of an

individual's closest genealogical links, but not others, be used to assign group membership. For example, in *patrilineal descent*, a child belongs to his or her father's – but not mother's – descent group or category. *Matrilineal descent* is the sex-reversed version of patrilineal descent, with group membership following the female line.

Groups defined by *unilineal* (patrilineal or matrilineal) *descent* play a variety of social roles in many societies (although bilateral kinship is always important as well). These groups may have proper names. Their members may share property rights. They may have common social obligations: to share with one another, avenge attacks on group members, or refrain from fighting with one another. They may have common rituals, gathering to commemorate or worship their founding ancestor, for example.

Descent groups as conceptual entities often do not match up perfectly with effective social groups. Groups that conceptualize themselves as matrilineal or patrilineal may in practice recruit members in other ways as well, and those entitled by descent to claim membership in a group may not exercise that claim. Also, some societies have groups based on *cognatic descent*, allowing an individual to claim membership in *either* father's or mother's group. These societies generally need some mechanism for deciding conflicting membership claims when mother and father belong to different groups, although this problem is lessened to the extent that individuals marry within the cognatic group.

Most, but not all, of the tribal societies studied by anthropologists attach some importance to unilineal descent, rather than treating kin connections through males and females as interchangeable. The mode of descent – patrilineal, matrilineal, other, or neither – shows some correlation with mode of subsistence: both patrilineality and matrilineality are common among tropical horticulturalists, while herding peoples are overwhelmingly patrilineal. But kinship organization is a conservative trait, and also has a strong historical component. Unilineal descent groups are important to this day over large areas of Africa, Asia, and Oceania.

Kinship, Mating, and Marriage

Kindness to kin need not extend to copulating with them. Animals, including humans, commonly avoid inbreeding with close kin, and humans often elaborate incest taboos and marriage proscriptions and prescriptions to cover more distant kin.

Inbreeding Avoidance

Genetic relatedness (see previous section) and genetic *inbreeding* are related concepts. Genetic relatedness implies that genes are identical by descent in two different organisms. Genetic inbreeding implies that genes are identical by descent in one organism, as a result of mother and father being related. If mother and father are not themselves inbred, but are related with a coefficient of relatedness of r , then the *coefficient of inbreeding* – the probability that maternally and paternally derived copies of a gene are identical by descent in their offspring – is $F = r/2$. F is smaller than r because not all genes shared by parents are passed on to their offspring.

Inbreeding may have both immediate and long-term disadvantages. Some alleles, called deleterious recessives, are harmless in a heterozygous condition (one copy of the allele from one parent), but harmful when homozygous (two copies of the allele, one from each parent). The immediate disadvantage of inbreeding is that inbred organisms stand an elevated chance of having two copies of deleterious recessive alleles. Two related parents are no more likely to carry deleterious recessives than unrelated parents, but they are more likely to carry *the same* deleterious recessives, and to produce offspring homozygous for those recessives.

There are also long-term disadvantages to inbreeding stemming from reduced genetic variation consequent on accelerated genetic drift. Inbreeding negates the advantages of sexual reproduction in producing varied offspring.

The short-term disadvantage of inbreeding can be measured by the number of *lethal gene equivalents* per individual. For example, if an individual is carrying 20 deleterious recessives, each of which, in a homozygous state, would reduce fitness by 10%, then the number of lethal equivalents is $20 \times 0.1 = 2$. Estimates of this number for human populations vary widely depending on the population and the research methods, ranging anywhere from 0.4 to 5 according to one review.

Given the likely fitness costs of inbreeding, one might expect that natural selection would favor inbreeding avoidance, and there is considerable evidence that animals in the wild commonly avoid potentially fertile matings with close relatives. In primates for example, there is strong evidence of avoidance of parent–offspring and maternal half-sibling matings. Evidence is weaker for inbreeding avoidance between paternal half-siblings, presumably because of the difficulty of assessing paternity. Inbreeding avoidance plays a major role in shaping mammalian social organization. In many species, one sex or the other or both typically leave their natal group upon reaching sexual maturity to avoid mating with close relatives.

Incest Taboos and Marriage Rules

If incest is defined as full sexual relations between closely related adults – parents and offspring, or full brothers and sisters – then incest is quite uncommon relative to nonincestuous sex in the great majority of human societies. (This conclusion might be different if incest were defined more broadly, to include sexual acts short of adult intercourse, and/or more distant relations or step-relations.) Of the varieties of heterosexual nuclear family incest, mother–son incest is least common and father–daughter incest probably most common.

Nuclear family incest has been an accepted practice in a few societies. In some cases, including Pharaonic Egypt, Inca Peru, and traditional Hawaii, dynastic politics led to high frequencies of brother–sister marriage among royal families. In Zoroastrian Persia, father–daughter, brother–sister, and mother–son marriages were encouraged for religious reasons, and seem to have been moderately common. Among Greeks in Roman Egypt, census returns show that brother–sister marriage was an accepted and common practice for several centuries. These cases are unusual, but sexual relations and marriage involving more distant relations are not so uncommon. Marriage between uncles and nieces and between paternal

half-siblings are acceptable in some societies; marriage between cousins is widely allowed or encouraged.

Incest avoidance has to be distinguished from incest taboos. In many societies where incest is uncommon, the possibility is regarded as bizarre or ridiculous, not disgusting and immoral.

Social scientists have proposed a number of theories to account for incest avoidance and taboos. Incest might be tabooed in societies where people have observed its deleterious genetic consequences. Incest might have undesirable social consequences, encouraging fighting and sexual jealousy within families, or limiting friendly connections between them. This last factor might contribute to explaining the extension of incest taboos outside the nuclear family (see below on alliance theory). But the likeliest explanation for nuclear family incest avoidance – and a partial explanation for incest taboos – was proposed almost a century ago, by the anthropologist Edward Westermarck. While conducting fieldwork in Morocco, Westermarck observed that cousins brought up as children in the same extended family household were often reluctant to marry even when encouraged to do so. He proposed that a kind of negative sexual imprinting takes place in childhood, resulting in “a marked lack of erotic feeling between children raised together from infancy.” This has come to be called the *Westermarck effect*.

As Westermarck realized, there is a likely evolutionary basis to this effect. Natural selection will favor avoidance of sexual relationships among children raised together as long as children raised together are usually close genetic kin. The result will be inbreeding avoidance even if the individuals involved are unaware of the genetic costs of inbreeding.

There is overwhelming evidence from many nonhuman animal species that the Westermarck effect affects mate choice. With humans, there are obvious practical and ethical barriers to testing Westermarck’s hypothesis, but it is strongly supported by several natural experiments. In early Israeli kibbutzes, children were raised together in communal nurseries. Sexual relations and marriages between children raised in the same nursery groups turned out to be relatively infrequent. There was no social pressure against such relationships, but limited sexual interest. In early twentieth century Taiwan, a common marriage arrangement involved a girl being adopted at a young age into the family of a prospective groom. The subsequent marriages had high failure rates, with low levels of sexual interest between partners, low fertility, frequent extramarital relationships, and high divorce rates. These effects were stronger when girls were adopted at younger ages.

A common objection to Westermarck’s hypothesis has been that it explains incest avoidance but not incest taboos. Why taboo something people do not want to do anyway? Westermarck addressed this issue, in the course of developing a more comprehensive theory of human moral development. He argued that the incest taboo was part of a more general pattern in which people have an aversion not just to performing disgusting or polluting acts but to others performing them as well.

Many cultures extend incest taboos, by custom or law, to kin outside the nuclear family. There is a great variation across cultures in how incest taboos are extended, and in related marriage rules. In one common pattern, taboos extend bilaterally to kin out to a certain genealogical distance. In most states in the United States, for example, marriages between first

cousins are illegal or invalid. In other societies, the sex of a linking relative is important, and principles of unilineal descent – instead of or in addition to bilateral kinship – govern the extension of incest taboos. In traditional Chinese society, for example, where patrilineal extended families and clans were important institutions, members of one's father's clan were off-limits for marriage, while equally close nonpatrilineal relatives could be acceptable. Incest taboos may thus cover varying combinations of relatives – bilateral kin, or kin having patrilineal or matrilineal connections with self, father, mother, or more distant relations. Incest taboos also sometimes cover step-kin and in-laws. They can also cover more exotic 'relations,' such as those who are linked through a wet nurse, a godparent, a natal village, a surname, or a guru.

Societies that proscribe marriage to one class of kin (negative marriage rules) may encourage or prescribe marriage to other classes of kin (positive marriage rules). Thus one common family of marriage rules, found in many of the native societies of Oceania, Southeast Asia, South India, and the Americas, bars marriages between parallel cousins (linked through same sex parents, father's brother's child, or mother's sister's child) while treating cross-cousins (linked through opposite sex parents, mother's brother's child, or father's sister's child) as allowed or preferred marriage partners. At its simplest, cross cousin marriage may result from sister exchange, in which two men marry one another's sisters. If sister exchange is repeated in the next generation, with the sons and daughters of one couple marrying the daughters and sons of the other, the result is symmetrical cross cousin marriage or *direct exchange*.

Many permutations are possible. In asymmetrical cross cousin marriage or *indirect exchange*, if men from family or marriage class A marry women from B, then men from B cannot marry into A, but must find wives in another family or marriage class. Some versions of cross cousin marriage 'skip a generation' so that people marry into the same marriage sections as their grandparents rather than their parents. And cross cousin marriage is often marriage between distant relatives who can be classified as cross-cousins, but whose actual genealogical connections may be unknown.

The motives behind these marriage rules are disputed among anthropologists. According to *alliance theory*, pioneered by Claude Lévi-Strauss, Louis Dumont, and others, marriage rules establish exchange relations between families and other social segments. The Arapesh of New Guinea express the logic of alliance theory when they say that a man should not marry a woman of his own clan, just as he should not eat yams or pigs from his own garden: it is better to establish relations of reciprocity with others by exchanging women and food. Lévi-Strauss argued that the principle underlying the various rules of *exogamy* (out-marriage) across cultures is the disposition to establish social relations through exchange, which he called a 'fundamental structure of the human mind.' It is worth noting, however, that many tribal societies do not have positive marriage rules, and those that do tend to have high frequencies of *polygyny* (men with multiple wives), suggesting that these rules may serve as much to regulate conflict over marriageable women as to promote friendly relations between groups.

In stratified societies, other considerations come into play in rules and strategies of marriage. Marriages between close kin,

and *endogamy* (in-marriage) within lineages, castes, or classes may be a device for conserving and concentrating land and other physical capital, as well as the intangible social capital of honor. These considerations led to high levels of cousin marriage in some of the traditional societies of Eurasia. Lineage endogamy is particularly common in the Islamic Middle East. Today in many Middle Eastern countries, half or more of marriages are between first or second cousins. Conversely, political and religious institutions have often sought to increase their own power at the expense of extended kin groups by limiting close kin marriages. In parts of Europe, the Catholic Church's wide injunctions against cousin marriage, and its opposition to arranged marriage, helped to weaken the hold of larger kin groups on individuals and nuclear families.

Kinship in Mind

In order to help their kin, or avoid mating with them, organisms must have mechanisms that discriminate kin from non-kin. Some organisms go beyond recognizing their own kin to recognizing kin relations among others. And humans go even further, using kin concepts recursively (e.g., mother's brother's child) and devising theories of kinship.

Kin Recognition and Cognition

Work on kinship in nonhuman animals suggests four major mechanisms whereby animals might recognize their genetic relatives: the *green beard effect*, *spatial proximity*, association (especially *developmental association*), and *phenotype matching*.

Theoretically, a single gene or linked set of genes might code both for a phenotypic trait – a green beard, say – and for discriminating altruism toward carriers of that trait. However, most current evidence points to more indirect mechanisms, which depend on learning cues reliably associated with kinship. Spatial cues are important in some species: many birds follow a simple rule of feeding any offspring they find in their nest. This can have surprisingly maladaptive consequences, in some cases leading to birds feeding nest parasites of another species like their own offspring. Developmental association is probably the most important mechanism of kin recognition in mammals. Animals reared by the same mother will commonly show kin-related affiliative and other behaviors in adulthood (see discussion of Westermarck effect above). Finally, organisms may learn their own phenotype, or that of associated organisms, and treat those with similar phenotypes as kin. Such phenotype matching may be tied to visual, auditory, or olfactory cues. Phenotype matching may allow organisms to recognize kin they have never encountered before, and to discriminate coefficients of relatedness – between full and half-siblings, for example – where no associational cues are available. Evidence for phenotype matching has been harder to come by, but now exists for a number of animal species.

Members of intelligent social species may go beyond recognizing their own kin to recognizing the kinship relations of others. This has been studied in a number of species of Old World monkeys, including vervets, savannah baboons, and macaques. Consider, for example, the widespread phenomenon of redirected aggression. A monkey attacked by another

sometimes retaliates, not against her attacker, but against the attacker's sibling or other close relative. Fights between monkeys increase the probability that their relatives will fight. This would seem to require using mental representations corresponding to the proposition 'A is the sister/matrilateral relative of B.' Experiments on captive macaques also support the conclusion that monkeys may grasp that different mother-daughter pairs have something in common that distinguishes them from other female pairs. Apparently, monkeys keep track not only of the characteristics of other individuals, but of kin and rank relations between them, and use this relational knowledge in social inference.

Human Kin Cognition: Psychology, Conceptual Structure, and Culture

Turning to how humans recognize kin and conceive of kinship, we find more varied evidence but less agreement than for other animals. Below we consider three sources of evidence: psychology, anthropological linguistics, and ethnographic fieldwork.

In psychology, kinship is a relatively neglected topic. Psychologists who have studied kinship and cognition have often been more interested in concept formation than in kinship per se. But research to date does support some conclusions. Kin relationships rank with sex and age as fundamental social categories, durably encoded and relatively immune to forgetting or confusion. Kin terms are acquired early in development. Sex, relative generation, and family membership/nonmembership are the earliest dimensions along which children differentiate kin types, with other distinctions acquired later. Knowledge of kinship is abstract and not purely experience-driven: young children understand that their kin may include people they do not live with and seldom encounter, and children without siblings are not delayed in understanding sibling terms.

Several mechanisms may be at work in establishing connections to primary kin. Evidence from a number of species, including some nonhuman primates, suggests that the immediate postpartum period is a *sensitive period* for mother-infant bonding, mediated by neuroendocrine changes. Some evidence, albeit controversial, suggests this may be true in humans as well. For sibling recognition, two separate associational cues may be involved: duration of childhood coresidence and maternal perinatal association. The latter operates when older siblings witness infant siblings being cared for by their mothers. The first cue is available to siblings regardless of relative age; the second is only available to older siblings with respect to younger siblings. Each is independently associated with attachment to siblings, and aversion to incest. A role for visual phenotype matching in kin recognition is supported by research showing that facial images are perceived as more trustworthy, but less sexually attractive, when artificially manipulated to resemble subjects' faces. The role of olfactory phenotype matching in kin recognition is supported by research showing that humans prefer the odor of potential mates who differ at the major histocompatibility (MHC) locus.

Kinship linguistics is a universe of its own within kinship studies; some of the findings in this area have broader implications for how humans conceptualize kinship. The

linguistics of kinship can be subdivided into the study of *kin terms* (words for kin), *kinship semantics* (the meaning of kin terms), and *kin terminology* (how kin terms are related to one another).

Kin terms themselves are largely arbitrary, like the rest of the lexicon. There are a few exceptions: across cultures, the nursery words for mother or father – words used by children, and between children and adults – are often some version of 'ma' or 'mama' and 'pa/ta' or 'papa/tata.'

Semantically, kinship belongs to the wider semantic field of possession: consider the underlined English possessive constructions in 'your mother,' 'Wendy's sister,' 'father of the bride,' and 'she has a daughter.' Clearly each of these constructions applies to a far wider range of possessive relationships than just kinship. However, cross-linguistic comparison shows that, in the universe of possession, kinship is special. Many languages make a distinction between inalienable (intimate, inherent, inseparable) and alienable (accidental, acquired, transferable) possession; when these distinctions are made, kin terms and body-part terms are the two semantic classes of nouns most often treated as inalienable. Conceptually, having kin and having a body are the two most prototypical, inherent kinds of having.

Further information about the conceptual status of kinship comes from kin terminology. Kin terminologies are not the same kin terms. It is a fact about English kin *terminology* that the words for father's sister and mother's sister are the same, while the word for mother is different, but it is a fact about English kin *terms* that the word for father's sister is 'aunt.' Many languages (Japanese, for example) have the same terminology for parents' siblings as English, lumping, and splitting kin types in the same way, even though the words of course are different.

On the surface, kin terminology shows enormous variation across cultures. Taking just mother and aunt terminologies, there are four major variants: *lineal* (like English, father's sister = mother's sister ≠ mother), *generational* (father's sister = mother's sister = mother), *bifurcate collateral* (father's sister ≠ mother's sister ≠ mother), and *bifurcate merging* (father's sister ≠ mother's sister = mother). There are also subvariants, since some languages make further distinctions based on whether the sister is older or younger than the linking parent. Extending the analysis to more distant kin allows for even more exotic possibilities. In some languages, some types of cousin are equated with mother or father, in others, with grandparents and grandchildren.

Yet kin terminology is actually a highly structured domain. Some terminologies are repeatedly reinvented, while many more logical possibilities are rare or nonexistent. Different schools of analysis of kin terminology have zeroed in on some major conceptual/linguistic principles that seem to be involved. First, *componential analysis*, pioneered by Ward Goodenough, Kimball Romney, and others, has identified a modest number of distinctive features present in the world's kin terminologies. In English, these distinctions include sex (e.g., sister/brother), lineal versus collateral (mother/aunt), near versus distant generations (parent/grandparent), senior versus junior generations (mother/daughter), and consanguineal versus affinal (sister/sister-in-law). Additional distinctions, absent in English but common in other languages include relative age (older sibling/younger sibling), and several varieties of cross versus parallel distinction. Many important

social facts fall outside the conceptual universe of kinship and are seldom or never encoded in kin terms, like relative wealth (rich uncle/poor uncle).

Second, *markedness* theory, developed by Joseph Greenberg, Per Hage, and others, grows out of the observation that along several of the axes identified by componential analysis, kin terms may be divided into linguistically unmarked and marked, where unmarkedness is a linguistic indicator of cognitive prototypicality. This takes several forms. In English, for example, parents are unmarked relative to grandparents, since the latter are labeled with an extra morpheme, 'grand,' (a *mark*), rather than getting a word to themselves. Brothers and sisters are unmarked relative to cousins, since there is a sex distinction among the former which is neutralized among the latter. Both of these examples illustrate a generalization which holds across languages, that near kin are normally less marked than far kin, or at least not more marked.

Third, *reduction rules*, developed by Floyd Lounsbury, and *kinship algebra*, developed by Dwight Read, are two approaches reflecting the recursive nature of kin categories, in which a core set of close kin types can be recombined to generate categories covering more distant relations.

There are important differences between these approaches. Of note here is what, in combination, they suggest about the conceptual structure of kinship. Underlying the kaleidoscopic variation of kin terms, there seem to be a modest number of conceptual primitives of social organization, including genealogical distance, seniority, and social rank, and in-group and out-group status – a finding broadly consistent with the developmental evidence.

A final source of evidence regarding kinship and cognition, ethnographic fieldwork in cultural anthropology, is both the richest and the most contentious. Here we can do no more than briefly introduce a controversy that continues to roil cultural anthropology.

For most of the history of kinship studies, although anthropologists might note that native ideas about conception, generation, and paternity were at odds with the facts of life, they generally forged ahead studying kinship systems without worrying too much about what it was that they were studying. Recent decades, however, have seen a full scale attack on the idea that kinship even exists as a proper object for cross-cultural comparison. One of the most influential kinship skeptics was David Schneider. Schneider carried out research on kinship both in the United States and on the Micronesian island of Yap. He eventually concluded that the American idea of kinship as resting on shared biogenetic substance – shared blood or genes – is missing on Yap. He claimed, for example, that Yapese did not recognize the role of intercourse in paternity, and that the father–child relationship on Yap was based on economic interests – or, more provocatively, that there was no such thing as a father–child relationship in Yapese culture.

This line of argument has been taken up by a host of anthropologists, who have documented an enormous array of beliefs about what 'kin' have in common. In Malaysia, it has been claimed, sharing food and hearth are as important as pregnancy and parturition in establishing kinship. In New Guinea, coresidence and commensalism are said to turn even genealogically unrelated individuals into kin. In some

societies, pregnancy is said to be possible without insemination, in others, semen from multiple men may be helpful or necessary to make a fetus, so that a child can grow up with several fathers. This variation has led some anthropologists, including Janet Carsten, Jane Collier, and Sylvia Yanagisako, to suggest that the whole enterprise of kinship studies is defunct, or at least that the study of kinship needs to be recast as the study of *cultural relatedness*, where cultures may have widely differing ideas about how individuals come to be related. The attack on traditional kinship studies is part of a broader intellectual movement which has claimed that maleness and femaleness, reason and madness, and racial categories are *socially constructed*.

These claims about kinship have not gone unchallenged; however, some anthropologists have raised sharp questions about the quality of the ethnographic evidence said to undermine traditional approaches to kinship.

Even setting aside the skeptical attack on kinship studies, we find a deeply divided field, at least where humans are concerned. Resolving the disagreements will probably require both advances in theory and new kinds of evidence. On a theoretical level, the evolutionary approach to kinship has proven fruitful in investigating human altruism, inbreeding avoidance, and kin recognition in the domestic sphere. But theories devised for nonhuman animals may require significant elaboration and revision to handle some uniquely human aspects of kinship: the importance of socially enforced moral codes in regulating altruism, incest, and exogamy; the recursive character of kin categorization; the symbolic elaboration and cultural transmission of the theories of kinship. On an empirical level, perhaps the most underdeveloped area of kinship studies is the cross-cultural psychology of kinship. Some important work has been done in the area of kinship and developmental psychology by John and Beatrice Whiting and their students, but a lot more could be done. Growing this field and strengthening its connections with evolutionary and cultural approaches could be an important step in developing a unified account of evolved mechanisms of kin recognition, universal core concepts of kinship, and culturally specific theories of kinship.

See also: Altruism and Helping Behavior; Animal Cognition; Birth Order, Effect on Personality, and Behavior; Child Abuse; Cultural Psychology; Evolutionary Developmental Psychology; Evolutionary Psychology; Evolutionary Social Psychology; Human Mating; Marital Dysfunction; Mate Selection; Moral Development; Moral Emotions; Parent–Offspring Conflict; Primate Cognition; Sexual Behavior; Social Cognition.

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Language Development

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Glossary

Grammar Is the component of language that contains the rules that dictate how words are combined into sentences to convey complex ideas and intentions.

Language Is a code with structural properties, characterized by a set of rules for producing and comprehending utterances through the use of arbitrary symbols.

Neurolinguistics Is the study of the manner and location of the processing of linguistic information in the brain.

Phonology Is the sound system of a language and involves the rules that govern the structure, distribution, and sequencing of speech sounds.

Plasticity Refers to the ability of the human brain to change and adapt in response to environmental stimuli.

Semantics Is a system of rules governing the meaning of words and word combinations.

Language is a code with structural properties, characterized by a set of rules for producing and comprehending utterances through the use of arbitrary symbols. Often assumed to be synonymous with language, speech is a specific type of motor output for the production of language. Language may also be produced through gestures and writing. Language and its various modes of production fall under the much broader concept of communication, which is the process of sharing or giving information, feelings, and attitudes. A large number of individuals from the behavioral and biological disciplines have spent decades attempting to study and understand the nature of language development. This brief overview of language outlines recent and historical attempts to study the origins and development of language.

The Components of Language

Language is a complex system that is generally divided into four primary components: phonology, semantics, grammar, and pragmatics. Phonology is the sound system of a language and involves the rules that govern the structure, distribution, and sequencing of speech sounds. There are approximately 3000 languages in the world that use 50 or fewer sounds produced by the human vocal tract called phonemes. Phonemes are the smallest units of sound that are significant to a native speaker of a particular language (i.e., consonant and vowel sounds).

Semantics is a system of rules governing the meaning of words and word combinations. Semantics is a system in which words of a specific language represent objects, actions, events, and concepts that exist in an individual's daily life, although words are not necessarily analogous to their referents. Word meanings, or vocabulary, are hierarchically structured and are linked to each other through a semantic network.

Grammar is the component of language that contains the rules that dictate how words are combined into sentences to convey complex ideas and intentions. Grammar is composed

of two smaller aspects called syntax and morphology. Syntax refers to the rules that govern the ordering of elements of phrases, clauses, and sentences, while morphology is concerned with the use of morphemes (i.e., the smallest units in language that convey meaning). For example, in English, plural endings vary according to the last sound of the word stem.

The final component of language, pragmatics, involves the rules that guide the use of language in a social context. Pragmatics is often referred to as communicative competence because it represents the ability to use language appropriately across different social situations for the purpose of expressing one's intent and accomplishing various ends.

While each of these components can be described in isolation, successful expression of each component relies on aspects of the others. Further, although these four components may develop at different rates throughout the life span, their development is continuous and interrelated.

Language Development Over the Life Span

Infancy

Language development is fascinating and complex. One of the reasons why language development is so remarkable is that it is never explicitly taught to young children. Language is learned primarily through immersion in a linguistic environment. Even before children are born, they are exposed to linguistic information and are learning in utero. As young as 4-day-old infants prefer listening to their own language to that of a foreign language. Young infants also show the ability to distinguish between phonetic elements of speech. By 6 months, infants evidence canonical babbling represented by repeated consonant/vowel combinations.

Even before children say their first word, they communicate their intentions through gestures, smiles, eye contacts, and vocalizations. At around 12 months of age, most children can produce 10 spoken words and can comprehend as many as 50. By their second birthday, children move from the use of one-word

utterances to communicate through the use of telegraphic speech which is characterized by two-word phrases that only contain important words.

Preschool Years

By 3 or 4 years, children acquire the major elements of their native language. During the preschool years, children learn two to four words a day. It is estimated that by the time a child is 5 years old, she will have learned approximately 6000 words. This amazing ability to learn words at such a fast rate is attributed largely to the idea of fast mapping. Fast mapping involves a child's ability to form a hypothesis about the meaning of a word after only hearing it once or twice.

At around 30 months of age, children's syntactic skills become more complex and they begin to put together simple, but grammatically correct sentences. Coupled with this, the understanding and use of language in a social situation develops dramatically. During this time, children develop appropriate requesting skills and the ability to adjust speech to different social contexts. Children's ability to carry on and contribute to extended conversations also improves significantly.

Language and Literacy in the School Years

During the school years, children develop metalinguistic awareness, or the ability to understand that language is an object that can be manipulated. A major hallmark of language development in the school years is the ability to use decontextualized language. Children increasingly develop the ability to talk about things that do not exist in the immediate context. They are able to share past experiences and talk about future events. It is not until adolescence that more figurative language concepts such as metaphors and sarcasm are fully developed.

By the time a child enters kindergarten, he or she will have mastered much of the pragmatic use of language. As a result, peer relationships become increasingly important and influential. Interactions with peers are frequent, represent extended discourse, and are charged with emotional content. These interactions are important because they are different from those entered into with adults and provide a developmental context that encourages the development of important communicative skills such as storytelling, social interaction competence, and turn taking.

The rate of vocabulary development during the school years slows, and the bulk of vocabulary knowledge is learned through literacy activities rather than exposure to the spoken language. Literacy instruction occurs long before the child enters the school setting. Children are exposed to a number of different activities that foster the development of print awareness and print use conventions. Further, literacy skills are based on early oral language skills. An important oral language skill necessary to successfully learn to read is phonological awareness. The ability to understand that words are composed of smaller phonetic elements is important when learning to understand that orthographic patterns represent the sounds of speech. Reading, however, is a complex, multicomponent process that involves a number of motor, cognitive, and

linguistic skills to coordinate simultaneously for the recognition and decoding of words and the comprehension of written sentences.

Language Development in the Adult Years

Opinions have changed concerning the age at which language learning is complete. It is now generally acknowledged that language development continues throughout the life span. The average adult with a high school education has a vocabulary store of approximately 60 000–80 000 words. In contrast, an adult who is an avid reader has a mental lexicon of approximately 120 000–160 000 words. It is clear that those individuals who are exposed to advanced educational experiences and are actively exposed to print continue to learn new words.

In addition to vocabulary development, the social use of language continues to change in the adult years. Gender-linked speech styles continue to develop and women use language more to establish rapport, while men use it more to convey factual information. Further, increased competence is seen in the area of adjusting speech and language characteristics to fit work and socially specific situations.

In older adults, linguistic abilities begin to diminish as a result of the natural aging process. Although this population may have a large mental lexicon, access to this vocabulary becomes more difficult, and many older adults report word retrieval difficulties. Further, the ability to understand complex linguistic utterances, and the ability to produce complex syntactic forms, decreases. These linguistic declines are often exacerbated by other physical and health declines that co-occur during the aging process. In fact, it may be difficult to differentiate between actual linguistic declines and declines in linguistic competence due to physical health complications. Comprehension of spoken language can be disrupted due to declines in memory, and hearing loss can contribute significantly to poor comprehension of spoken language. Older adults also may experience declines in the speed at which they can process linguistic information, which can lead to problems in comprehension.

While these linguistic declines in older age appear to be inevitable, research indicates that staying linguistically active can slow the decline of linguistic ability. Further, developing strategies such as writing notes as thoughts occur can help with accessing and using linguistic information.

Language in Special Populations

Given the central role that language plays in both an individual's development and his/her integration into a social world dependent on language, the impact of various forms of language impairment is significant. Studying the language behavior of individuals with language difficulties offers a unique view to our understanding of the key elements needed for language and its development. A number of congenital disabilities (e.g., autism, cerebral palsy, deafness, mental retardation) may result in language development that is described as delayed or disordered. Many factors, such as the child's age at identification, the severity of the disability, the child's environment and experiences, all combine and affect the child's language development.

In the past three decades, substantial progress has been made in creating and delivering services to children with significant language acquisition difficulties. Advances in computer technology, coupled with strong language teaching models, have resulted in significant language learning gains. One area of language intervention for individuals with complex communication needs is augmentative and alternative communication. Augmentative and alternative communication systems are designed to offer another route for communication by individuals who cannot speak. Alternative output modes, such as the use of voice technology, allow this interface with the auditory world. Children who use speech output systems, along with proven intervention strategies, can develop their language skills and use them for communication. Educational and later employment opportunities have also increased as a direct result of these language and communication gains.

Theories of Language Development

The study of language and language development extends as far back as seventh century BC. Formal theories concerning language acquisition, however, have not come into existence until relatively recently. A number of different theories have been put forth to try to explain language acquisition. For a theory to successfully explain language acquisition, it must not only describe language at different ages, but it must also generate testable hypotheses and put forth an effort to explain how children eventually talk like adults. These requirements, combined with the complexity of language behavior, have resulted in the failure to develop one theory that completely explains the nature of language acquisition. As a result, portions of competing theories are often used to explain language acquisition. Three of the most influential traditional theories are behavioral theory, linguistic theory, and cognitive developmental theory.

Behavioral Theory

Behavioral theory has its roots in classical conditioning that was formalized and applied to language development by B.F. Skinner in the late 1950s. Skinner believed that all behavior, including language, was a learned response. This theory minimized the influence of mentalistic explanations of language behavior. According to Skinner, behavior was modified or changed through forming associations with certain stimuli in the environment. A major tenet of behavioral theory is operant conditioning, which suggests that likelihood of a behavior occurring is increased or decreased as a result of reward and punishment. Behavioral theory assumed that language is a special case of behavior only because it is a behavior that is reinforced solely by other individuals. As children are learning language, they try to produce language that is similar to adult language because it is rewarded through praise and response, while inappropriate language is ignored or corrected.

Linguistic Theory

Linguistic theory was formed by Noam Chomsky who described language as having a grammar that is largely independent of language use. Unlike behavioral theory, linguistic theory argues

that language acquisition is governed by universal, underlying grammatical rules that are common to all typically developing humans. Across many different cultures, there are a number of linguistic developmental similarities. Chomsky argues that these similarities are due to the presence of an innate language acquisition mechanism housed in the brain called the language acquisition device (LAD). According to Chomsky, the LAD is a specialized language processor that contains universal underlying linguistic principles that provide children with the innate knowledge to speak and learn language. The environment only serves to activate the maturation of the LAD. Chomsky believed that only humans were born with the LAD and that language was species-specific and unique to humans.

Cognitive Developmental Theory

Falling in between the strictly environmental account of language acquisition posed by behavioral theory and the strictly innate account posed by linguistic theory, Jean Piaget's cognitive developmental theory represents a more interactionist approach to language development. Though Piaget's cognitive developmental theory emphasized internal structures as the primary determinants of language acquisition, it was the interaction with the environment that actually shaped the development of language. Unlike Chomsky, Piaget did not view language as a separate construct. Instead, he believed that language was one of the many symbolic functions that resulted from cognitive maturation. Thus, language acquisition was driven by the interaction between the child's level of cognitive functioning and the child's linguistic environment. Piaget argued that a child's cognitive functioning constrains language development because language is based on general cognitive functioning and changes in this functioning as a child matures. As a result, the sequence of linguistic developmental milestones is determined by the sequence of cognitive development.

Sociolinguistic Theory

More contemporary theories of language acquisition emphasize the interactive nature between cognitive and social factors originally proposed by Piaget. Recent theoretical debates concerning language acquisition no longer fall along lines of biological innateness versus environmental explanations. The debate is now confined to the degree of involvement of these two factors and the nature of the interaction between them. Sociolinguistic theory posits that children are born with certain biological capacities that facilitate language development, but it is the interaction with sensitive linguistic partners that allows the linguistic system to develop successfully. This theory emphasizes the importance of social interactions, especially early in the language acquisition process. A key component of this theory is child-directed speech (CDS). CDS is characterized by simple sentences combined with exaggerated speech sounds and is representative of how parents interact with infants and young children. Through repeated interactions, children are able to map meaning onto the linguistic code evidenced in the parents' speech. Thus, while the child brings important biological predispositions to the interaction, parents and more skilled linguistic partners provide the types of language experience necessary for development.

Connectionism

Connectionism is a set of approaches that attempt to represent mental or behavioral phenomena through the use of models that imitate the neural structures of the brain. It was originally known as parallel distributed processing and emphasizes that information processing in the brain occurs on multiple levels at the same time and across a number of different processing mechanisms. Further, the functions of the domains like language are not carried out by dedicated, innate, and domain-specific neural systems. Connectionism argues that we are born with certain innate processing constraints that result in specific areas of the brain being better at processing certain kinds of stimuli and negates the idea that we are born with brain structures that are innately specified to produce language. As the brain is exposed to environmental stimuli (speech for most language learners), those areas that can most efficiently process the information are activated. Over time, the interaction between these areas in the brain and exposure to linguistic stimuli in the environment leads to these brain areas becoming specialized for processing linguistic information.

According to connectionism, there are three types of innate processing constraints. The first are representational constraints. It is theorized that mental representations are patterns of activations across neurons. The form of these patterns is determined by the nature of the connection between the units (i.e., synapses). The second type of constraint is the architectural constraint, which includes the specific properties of neurons, the circuitry layout of the brain (e.g., the number of layers in the brain, the density of cells, the degree of interconnectivity), and connections at the larger level between brain areas and regions. The final constraint suggests that the timing of the development of different brain areas can be important in determining the specialization of brain regions for specific functions. This is often referred to as critical or sensitive periods in development when specific areas in the brain develop optimally when exposed to the appropriate environmental stimuli. Connectionism, therefore, uses the term innate to refer to aspects of brain structure rather than to genes or the genetic code.

The Biological Bases of Language

The uniqueness of the properties of human language has led many researchers to conclude that there is a biological base for language development. Two primary lines of inquiry that have emerged from this conclusion are the examination of the characteristics that distinguish human language from animal communication systems and the examination of the relationship between language and its correlates in the brain.

Animal Communication

When examining animal communication systems, it is important to specify what differentiates language from the broader concept of communication. Debate exists about what specific criteria must be met for a form of communication to be considered language. Three criteria, however, are generally agreed upon. The first is productivity and represents the ability to make new and unique utterances that have not been heard before.

The second is that communication must be symbolic in that it represents objects, ideas, and events. The final criterion is that the information being communicated does not have to be associated with the current situational context (i.e., displacement).

One line of research attempting to understand the communication systems of animals is examining the way different animals communicate under normal circumstances. Early ethologists attempted to study the communication system of insects, in particular, the communication of bees. It was discovered that bees returning to the hive after finding flowers bearing nectar will perform a 'dance' for other bees in the hive. This dance indicates the direction and distance of the flowers. The dance is a recreation of the route to the flowers and, therefore, is not a symbolic 'conversation' and is limited in its conversational topic (i.e., directions to the flowers). As a result, this dance fails to meet many of the requirements of human language.

Unlike bees, dolphins and birds use vocal calls to communicate intentions. Both birds and dolphins have been found to have signature calls that identify themselves. Further, it has been shown that dolphins can imitate the vocal calls of other dolphins. The exact purpose of this call matching is unclear, but it is thought to serve as a way to gain the attention of a certain dolphin in large groups. Some birds have evidenced a variety of calls that have specific meanings. For example, it has been shown that a bird in the crow family has courting calls, calls that initiate flight and calls signaling to fly home. Again, while these communication systems resemble human language in many ways, they lack aspects of productivity, symbolism, and displacement.

A second line of research examining animal communication systems involves attempting to teach animals human language. Research with gray parrots has produced some intriguing results. Gray parrots have demonstrated that they can learn to label objects with explicit instruction. Further, one gray parrot has shown evidence of learning to recognize objects, colors, and shapes. He even has been successful at answering questions about these objects, colors, and shapes posed to him with spoken language. Though these studies suggest that gray parrots are able to learn to symbolically represent ideas, they are not able to learn in a passive environment or communicate about ideas that are not in the immediate context.

Research that has shown the most promise in teaching animals human language involves the study of nonhuman primates like great apes. Early nonhuman primate studies failed because of their effort to teach chimpanzees to speak. Chimpanzees do not have the vocal mechanisms necessary to produce speech. Later primate research focused on teaching apes (i.e., gorillas, orangutans, chimpanzees, and bonobos) to produce complex manual signs or use visual-graphic symbols.

Apes who have been taught American sign language have demonstrated the ability to learn hundreds of signs and combine them into meaningful communications. Further, there is evidence that some apes have generalized known words to unfamiliar objects in their environment (e.g., labeling a dog they have never seen before as a dog). The primary critique of these studies is that it is unclear whether the apes were able to spontaneously generate communicative signs or whether their signs were due to prompts from their trainers. Research utilizing visual-graphic symbols as a mode of communication, however, has produced some convincing evidence that

chimpanzees and bonobos are capable of acquiring word meanings and use this visual-graphic symbol system to communicate with each other and with humans. Currently, the best example of apes demonstrating the capacity to learn human language comes from research conducted with bonobos. One young male bonobo was found to learn symbols solely through observation with no direct instruction or external reward. Most striking, however, is that he demonstrated the ability to understand spoken words and novel word combinations. Subsequent studies with other bonobos have replicated these original findings and suggest that humans may not be the only species that is capable of spoken language comprehension. Overall, results from studies with bonobos suggest that they have the ability to learn language skills that are equivalent to those of a 3- or 4-year-old child.

Results from research on animal communication have led to two general conclusions concerning language development. The first is that although many different species appear to have developed systems that allow them to communicate ideas and concepts, humans are the only species to develop the complex system of language without specific instruction. The second general conclusion is that given specific instruction, certain animal species have shown the ability to learn some components of language to varying degrees of competency.

Neurolinguistics

In contrast to the nonhuman animal population, human brains have areas that are specialized for the production and comprehension of language. The study of the manner and location of the processing of linguistic information in the brain is called neurolinguistics. It is estimated that 98% of the human population is left-lateralized for language, that is, language processes are located in the left hemisphere of the brain. This percentage encompasses almost all right-handed people and 60% of the left-handed population (only about 10% of the population is left-handed). For most people then, the left side of the brain is responsible for most of the processing of linguistic information. This does not mean that the right hemisphere is not involved in language processing. For example, the right hemisphere is responsible for processing the emotional content of speech and is activated when the left hemisphere processing capacity is taxed. In addition to this hemispheric specialization, evidence from autopsies on individuals with brain insults (e.g., stroke, brain injury) and studies using functional magnetic resonance imaging (fMRI) techniques have identified specific areas of the brain that are related to specific language behaviors.

Broca's area is located in the frontal region of the brain near the part of the motor strip that is responsible for controlling the tongue and lips. This area of the brain is associated with language production, and damage to this area results in Broca's aphasia. In general, aphasia refers to the loss of previously acquired language skills because of damage to the brain. There are different types of aphasia that are based on the location of the brain damage and the skills retained by the individual. Broca's aphasia is characterized by naming difficulties, telegraphic speech (i.e., speech that contains only important words), and pronunciation difficulties. Comprehension of language, however, is retained.

Wernicke's area is found in the posterior temporal lobe and is associated with the comprehension of language. Damage to this area results in poor comprehension of speech and neologisms (nonsense words) combined with fluent and grammatically correct speech.

While specific areas of the brain have been shown to be related to specific language behaviors, there is debate as to how directly these brain structures are related to language behavior. It is possible for damage to occur in the areas and result in no discernable linguistic problems. Additionally, the brain is a large interconnected network with many cortical and subcortical areas involved in the processing of linguistic information.

Plasticity

Plasticity refers to the ability of the human brain to change and adapt in response to environmental stimuli. This ability is important not only for general development, but also for intervening with populations with language disabilities. It was previously thought that the brain lacked the ability to adapt or change after the onset of puberty and that if language was not acquired by this event, it would never be acquired. While there is evidence that the brain becomes less plastic as we age, these critical periods of development are now conceptualized as sensitive periods in which there are optimal times during development for key linguistic skills to develop.

It is estimated that 8–10% of the school age population evidences some type of developmental language difficulty that can be considered a language disability. Some of the major causes and patterns of language disabilities include hearing impairment, mental retardation, autism spectrum disorder, speech and articulation disorders, and reading disabilities. Research across a number of these areas is consistent in indicating that early intervention efforts are associated with better language development outcomes. The ability of the brain to change in response to intervention techniques intended to remediate language difficulties is believed to be responsible for these positive outcomes. Supporting this belief are studies that use imaging techniques like fMRI to compare the brains of atypically developing children with their typically developing peers. For example, brain imaging studies conducted with children with reading disabilities have shown that the brain anatomy of these children is different from that of children without reading problems. When exposed to a reading intervention, however, the brain structures of these children change to become similar to those of children who do not evidence difficulties with learning to read.

Brain plasticity has also been observed in individuals who have acquired language disabilities. Such language impairments may result from stroke, traumatic brain injury (TBI), or progressive neurological diseases. As with individuals with congenital language disabilities, positive outcomes have resulted from intervention and rehabilitation efforts. Individuals who have experienced a stroke may completely lose the ability to produce speech. Through intensive rehabilitation efforts, many of these individuals learn to speak again.

The most striking example of brain plasticity, however, comes from individuals who have undergone a complete hemispherectomy. There are rare cases of people who experience numerous epileptic seizures in a day. These repeated seizures

are so debilitating to daily life that it may become necessary to remove an entire hemisphere of the brain to stop the electrical imbalance causing the seizures. After the removal of the problematic hemisphere, the remaining hemisphere must take over all of the functions previously served by the removed hemisphere. Even individuals who are left-lateralized for language and who have had the left hemisphere removed can relearn and functionally use and understand language.

The concept of plasticity has two important implications for language development. The first implication is that the brain develops in response to experience with the environment. Thus, the more enriched the linguistic environment a child is exposed to during language development, the better a child's later linguistic outcomes. The second implication is that language difficulties that result because of biological (e.g., developmental disabilities) or environmental (e.g., TBI) reasons can be remediated, at least partially, through appropriate intervention efforts.

Genetics

Recent research on the genetic makeup of humans has led to the identification of a specific gene, FOXP2, that appears to be related to language. The complexities of acquiring language skills, along with the clear requirement that infants must be immersed within interactions that give them experience with spoken language, indicate that a single gene is not solely responsible for the development of language skills. More recent research that studies language and reading disorders has focused on identifying other candidate genes and offers a possible multiple gene model to explain the problems seen in those disorders.

Conclusion

In conclusion, the development of language is a highly complex process that continues throughout our life span. Our understanding and knowledge of the biological bases of language and its lifelong developmental phases continue to increase. The use of sophisticated methodologies and cutting-edge techniques has yielded important sources of information about language behavior, its origins, development, and use. Future scientific research will continue to explore, and explain, the intricate processes of human language acquisition.

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See also: [Social Development \(Attachment, Imprinting\)](#).

Further Reading

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Leadership

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Glossary

Leadership A multilevel leader–follower interaction process that occurs in a particular situation where the leader and followers share a purpose and jointly accomplish things willingly.

Leadership antecedents Precursors or predictors of leadership; fundamental human processes underlying leadership approaches.

Leadership consequences Outcomes or criteria of leadership; leadership effectiveness resulting from leadership approaches.

Levels of analysis Entities or objects of study; persons/individuals, dyads, groups/teams, and collectives involved in leadership.

Multilevel leadership approaches Leadership views (theories, models, styles) that include multiple levels of analysis in theory building (conceptualization) and theory testing (methodology).

Introduction

Leadership is one of the most widely discussed and researched topics in all of human behavior, cutting across the social, behavioral, and physical sciences and the disciplines of psychology, management, political science, anthropology, sociology, and biology as well as evolutionary studies. Leadership is a key topic in the popular media and the managerial and practice world, and what is sought in corporate, government, military, and not-for-profit realms. While it is one of the most studied topics in human behavior, leadership is also one of the least agreed upon, with literally thousands of definitions of and approaches to leadership in existence. As such, leadership is both a broad and deep field of study.

The purpose here is to present a multilevel overview of the leadership literature. To accomplish this, first, a working definition of leadership – one that encompasses multiple levels of analysis (person, dyad, group, and collective) involved in leadership – is developed and elaborated. Then, general and foundational notions about leadership processes that are incorporated in most approaches to leadership are discussed. Next, organized around four general categories of leadership approaches – classical, contemporary, alternative, and new wave views – numerous multilevel leadership views are described in detail to highlight the breath and depth of the field. Finally, some implications of these approaches for leadership practice and application are presented to enhance understanding of leadership in organizations.

What Is Leadership?

A working definition of leadership that includes multiple levels of analysis and encompasses the leadership approaches described here is: leadership is a multilevel (person, dyad, group, collective) leader–follower interaction process that occurs in a particular situation (context) where the leader (e.g., superior, supervisor) and followers (e.g., subordinates, direct reports) share a purpose (vision, mission) and jointly accomplish things (e.g., goals, objectives, tasks) willingly.

Leadership is one of the most important things in the realm of human behavior because literally nothing gets accomplished without it. Leadership may be formal and occurs at all levels of management or organization and not just at the top; and it may be informal, so it is not solely bestowed by title or position. Leaders can be appointed (or hired), anointed (by connections), elected (by stakeholders), and emergent (by acclamation).

Are leaders born or made? Yes, all leaders are born and all leaders are made! Leaders typically have a base level of skills with which they begin, generally linked to heredity and early life experiences (born), and they then add to or enhance those skills throughout their later lifetimes and experiences in various realms (made). In short, regardless of where leadership skills begin, leadership can be learned, developed, trained, and coached.

Leadership and Levels of Analysis

To more fully comprehend leadership and various leadership approaches, however, an understanding of levels of analysis and multilevel notions is necessary. In much leadership work, interest is in human beings (entities) in work organizations. Levels of analysis are the entities or objects of study. Entities are typically arranged in hierarchical order such that higher levels (e.g., groups) include lower levels (e.g., individuals) and lower levels are embedded in higher levels. Four levels of analysis of human beings are relevant for leadership approaches that are examined here. First, human beings in organizations can be viewed as individuals or persons, independent of one another. In this case, focus can be on a leader or a follower/subordinate, or how leaders or followers differ from one another. Individual differences are of interest. At the individual/person level, the focus is primarily on focal leaders' traits or characteristics, leadership style, vision, charisma, and the ability to transform others (followers) for the greater good.

Second, human beings in organizations can be viewed as dyads or two individuals who are interdependent on a one-to-one basis. Dyads are a special case of groups, a two-person

group. In this case, focus can be on superior-subordinate dyads, leader-follower dyads, or interpersonal relationships, independent of the formal work group. At the dyad level, the focus is primarily on leader-follower exchanges or transactions and the empowerment and development of followers.

Third, human beings in organizations can be viewed as groups or teams. While there are some potential differences between groups and teams, they are viewed similarly here, as a collection of individuals who are interdependent and interact on a face-to-face or virtual (non-co-located) basis with one another. Formal work groups or teams generally consist of a leader and his/her immediate direct reports. At the group/team level, the focus is primarily on leadership styles displayed toward the group or team as a whole. Tasks (initiating structure and concern for work) and relationships (consideration and concern for people) are the central notions here, with participation, delegation, sharing of duties, and interdependence as key issues.

Fourth, human beings in organizations can be viewed as collectives. In this case, the focus is on clusterings of individuals that are larger than groups or teams and who are interdependent based on a hierarchical structuring or a set of common or shared expectations. Collectives can include groups of groups, departments, functional areas, strategic business units, networks, and organizations. Collectives often do not involve direct interaction among people (as in groups and teams), but are held together by echelons or hierarchies. At the collective level, the focus is primarily on management, including managerial philosophy, and supervision as well as setting the strategic mission and goals and energizing the collective effort overall.

Beyond these single levels of analysis (i.e., individuals/persons, dyads, groups/teams, or collectives viewed separately), a key issue is that of multiple levels of analysis. In other words, levels can be viewed in combination or simultaneously. In these cases, concern is with multilevel or cross-level effects, as well as mixed determinants and mixed effects. Multilevel models depict relationships between independent (predictor, e.g., antecedents of leadership) and dependent (criterion, e.g., consequences of leadership) variables that operate at different levels of analyses. Cross-level models are those where patterns of relationships are replicated across multiple levels of analysis (e.g., hold or occur for both individuals and groups). Mixed effects models are those in which a single variable of interest (e.g., leadership style) may have effects at multiple levels with multiple criteria of interest (e.g., performance of both individuals and groups). Mixed determinants models are those where multiple predictor variables at various levels of analysis (e.g., leader personality traits, leader-follower interpersonal relationships) affect a single criterion at a single level of analysis (e.g., leadership effectiveness in a group). The leadership approaches described here have these multilevel characteristics.

Leadership Antecedents and Consequences

In addition, the leadership approaches highlighted below often include similar or analogous antecedents and consequences. As such, a general way to view the leadership process, summarized in the aforementioned working definition and

typically endorsed by the leadership approaches described here, is antecedents → leadership → consequences.

Most approaches and views consider similar antecedents or precursors of leadership which are essentially underlying fundamental human processes. At the person level, affect and cognition are important fundamental human processes. Affective processes include rapid formation of general liking or disliking of leaders and followers. Cognitive processes include how leaders and followers think about things – obtain, store, retrieve, categorize, and use information. There also are some linkages among personality – especially represented by the Big Five of neuroticism, extraversion, or surgency, openness to experience, agreeableness, and conscientiousness – and various forms and aspects of leadership.

At the dyad level, attraction and exchange are important fundamental human processes. For example, similarity or a match on a mutual interest or characteristic can lead to mutual liking of one another. At the group and team level, climate and norms are important fundamental human processes. A key group or team norm is that leaders are predetermined or emerge and fulfill certain functions and create positive climates. At the collective level, organizational culture and values are important fundamental human processes. Various elements of culture and values can impact or influence the appointment and emergence of various types of leaders and the organizational leadership philosophy and approach. In terms of multiple levels of analysis, communication is an important fundamental human process that cuts across levels. The methods, media, and technology of communication are critical to the formation, development, and use of leadership.

Most leadership approaches and views are interested in similar multilevel consequences or outcomes of leadership which are essentially aspects of leadership effectiveness (e.g., team building, performance, satisfaction, commitment, attachment, loyalty, absenteeism, turnover, stress, safety). At the individual level, high degrees of satisfaction, commitment, and loyalty (soft performance criteria) as well as effective and higher individual performance, lower absenteeism, and less turnover (hard performance criteria) are relevant factors. These variables can have conceptual linkages with various individual-level aspects of the leadership approaches.

At the group level, high degrees of cohesion, high morale, and positive climate (soft performance criteria) as well as objective, effective, and higher group/team performance and lower group absenteeism (hard performance criteria) are important. Team members' perceptions of the team cohesiveness and the nature of the climate are as important as the cohesiveness and climate *per se*. These variables can have conceptual linkages with various group- and team-level aspects of the leadership approaches.

At the organizational level, a positive culture, recognition of internal and external stakeholders, and a multifaceted mission (soft performance criteria) as well as objective, effective, and higher organizational performance (e.g., stock prices, sales, return on assets, return on equity – hard performance criteria) are important. These variables can have conceptual linkages with various organizational-level aspects of the leadership approaches.

At multiple levels, performance – including quantity and quality of performance as well as general and specific

performance – is perhaps the most crucial dependent (outcome) variable in leadership research. Leader performance, team performance, and, ultimately, the performance of the entire organization via multiple individuals and teams are a central concern. Affect and emotional contagion at both the individual and group/team levels can also be a key outcome for leadership. Stress also is relevant at both the individual and team levels and can be an outcome of various leadership approaches. Though some degree of stress may actually enhance performance, excessive degrees can have debilitating consequences. Conflict, both intraentities and interentities (e.g., groups) conflict, is relevant at both the team and organization levels and can be a consequence of leadership. Some degree of conflict may actually improve performance, but excessive amounts of conflict can be stifling and have dire consequences. Also, team members' perceptions of conflicts are as important as the conflicts themselves.

With these foundational and integrative notions of leadership (working definition, levels of analysis, antecedents, and consequences) in mind, five classical, five contemporary, four alternative, and four new wave views about leadership are considered in more detail. For each leadership approach, the primary level(s) of analysis, key ideas and constructs, and main multilevel effects are elaborated to highlight the range and richness of the leadership field for understanding human behavior.

Classical Leadership Views

The first classical view, *Ohio State* approach to leadership, includes two leadership styles, initiating structure (task-oriented and directive supervisory behavior) and consideration (friendly and interpersonally supportive supervisory behavior), that are predicted to differentially impact subordinate satisfaction and performance, given various situational moderators (e.g., unit size, job anxiety, role clarity, supervisory control). Initiating structure and consideration, as typically measured by the Leader Behavior Description Questionnaire, are relatively independent leadership styles, such that leaders can be placed on a continuum from low to high on each dimension. The effectiveness of low-low, low-high, high-low, and high-high consideration and initiating structure styles depends greatly on the type of performance assessed and various situational or contextual factors.

The second classical view, *contingency model* of leadership effectiveness, was an early multiple-level approach to leadership and one of the first models that was tested with multi-source data from leaders, followers, and the organization. The model predicts that two main factors determine a leader's effectiveness: a task or relationship style (motivational orientation), which is a leader attribute, and a leader's situational favorability (situational control). Leaders who have a task motivational orientation compared to those who have a relationship orientation are predicted to be more successful in high- and low-control situations. In contrast, relationship-oriented leaders, as compared to task-oriented leaders, are predicted to be more effective in moderate-control situations. Leaders are said to be in match in situations where the model predicts high group performance and are referred as out of match in situations of low group performance.

In the ideal contingency model approach, a leader's style or motivational orientation is measured at the individual (leader) level by the Least Preferred Coworker scale. Situational control or favorability comprises group climate, task structure, and authority, which are assessed via the group – or individual-level measures of group atmosphere or leader-member relations, task structure or type of job, and position power, respectively. Typical measures of leadership effectiveness, at the group, dyad, or individual level, include satisfaction, stress, and performance. Overall, the three situational control variables, with each rated as low or high ($2 \times 2 \times 2$), comprise the classic eight-cell view of moderators of the relationship between leader attribute/style and end result/performance.

A third classical view, *participative leadership*, is a normative model of leader decision-making to understand a leader's choice of autocratic versus participative behaviors. The model guides the leader's choice among five decision processes (two autocratic, two consultative, one joint or group) on the basis of 11 decision heuristics that are grouped around the notions of improving decision quality, improving decision commitment, reducing decision costs and time, and increasing subordinate development. Overall, the appropriate decision styles that result in effective leadership are autocratic, consultative, and collaborative sharing (either joint or delegative), but the choice of these styles differs from situation to situation.

A fourth classical view, *path-goal leadership*, is a means-end motivation explanation of the effects of leader behavior on subordinate satisfaction, motivation, and performance. Dimensions of leader behavior such as leader initiating structure, consideration, authoritarianism, hierarchical influence, and closeness of supervision are analyzed in terms of path-goal notions such as expectancy (probability that effort will lead to performance), instrumentality (probability that performance will lead to outcomes), and valence (value of outcomes). The approach also specifies some of the situational moderators on which the effects of specific leader behaviors are contingent. There are two legacies of path-goal leadership – substitutes for leadership and charismatic leadership – and a reformulated path-goal approach specifies eight classes of leader behavior that enhance subordinate empowerment and satisfaction as well as work unit and subordinate effectiveness, subject to several contingency moderators. The essence of path-goal leadership is a meta-proposition that leaders, to be effective, engage in behaviors that complement subordinates' environments and abilities in a way that compensates for deficiencies and is instrumental in subordinate satisfaction and individual and work group unit performance.

A fifth classical view, *vertical dyad linkage* approach to leadership, was the first one to recognize that leaders treat subordinates within the same work group differently. This notion was radical when introduced, as prior approaches to leadership assumed that leaders treated all followers or subordinates in a group similarly. Using the key variable of negotiating latitude, leaders can create differentiated dyads within work groups, such that some subordinates are members of the in-group (cadre) while others are members of the out-group (hired hands). Two legacies of the vertical dyad linkage approach are the leader-member exchange and individualized leadership approaches, both of which are described in the following paragraphs and involve different variables, constructs, and alternative levels of analysis.

Contemporary Leadership Views

A first contemporary view, *charismatic leadership*, in the management and psychology literature, is generally defined in terms of the leader's influence over followers and the nature of the leader–follower relationship. Key leader behaviors include articulating an appealing vision, communicating high performance expectations, displaying self-confidence, role-modeling exemplary behavior, expressing confidence in followers' abilities to achieve goals, and emphasizing ideological aspects of work and collective identity. Other key aspects of charismatic leader behavior are articulating an innovative strategic vision, displaying unconventional or creative behaviors, taking personal risks, and showing sensitivity to follower needs and environmental constraints, opportunities, and threats. The effects of these charismatic behaviors are numerous: followers develop trust in, respect for, devotion to, loyalty to, unquestioned obedience to, commitment to, and identification with the leader; develop confidence in their ability to achieve goals and exceed expectations; and develop radical changes in their beliefs and values.

Socialized charismatic leadership includes the development and empowerment of others, a basis for egalitarian behavior, and indicates that the leader disregards his/her self-interest in favor of the collective interest. Socialized charismatic leaders are characterized by a high need for power with high activity inhibition (restraint), low Machiavellianism, non-authoritarianism, strong internal beliefs, and high self-esteem. Such leaders are also called authentic transformational leaders. Personalized charismatic leadership, in contrast, includes exploitation of others, personal dominance and authoritarian behavior, and serving the leader's self-interest and self-aggrandizement. Personalized charismatic leaders are characterized by a high need for power with low activity inhibition (restraint), high Machiavellianism, high narcissism, external beliefs, and low self-esteem. Such leaders are also called pseudo-transformational leaders.

Charismatic leaders form a unique emotional and value-based bond with their followers. They achieve their charismatic effects by engaging and implicating followers' self-concepts. Through role-modeling behaviors and frame alignment, charismatic leaders develop followers' values and beliefs to be congruent and complementary with the leaders' ideology, goals, and activities. In particular, charismatic leaders are able to increase followers' intrinsic valence of effort and goal accomplishment, effort-accomplishment expectancies, and prospects and hopes for a better future state. Charisma is often viewed as a unique, distinct element and the only aspect of leadership that is extraordinary.

A second contemporary view, *transformational leadership*, in management and psychology research, is generally defined in terms of the leader's behaviors and effect on followers. Different from transactional leadership (defined as an exchange process to motivate follower compliance with a leader's requests and organizational role requirements), transformational leadership involves an underlying influence process that motivates followers by encouraging them to transcend their self-interests for the sake of the organization and goal accomplishment. Followers, through transformational leadership, are motivated to do more than originally expected and feel trust, loyalty, respect, and admiration toward the leader.

Transformational leaders raise followers' levels of awareness and consciousness about the value and importance of key outcomes and their accomplishments. They alter followers' portfolios of needs and wants, expanding and raising these in terms of the need hierarchy. Moreover, transformational leaders encourage and help followers transcend their self-interests for the enhancement of the group, team, organization, or larger interests of society.

There is a generally, though not universally, endorsed distinction between transformational and charismatic leadership: A leader may be charismatic without being transformational in that little or no influence to change followers is exerted. As such, charismatic leadership is viewed as only one component of transformational leadership, along with inspirational motivation, intellectual stimulation, and individualized consideration. While charismatic leadership is perhaps the key component of transformational leadership, charisma is a necessary but not sufficient element of transformational leadership. Very closely related views to transformational leadership are labeled authentic, ethical, and servant leadership; all of which are essentially transformational-like in orientation, description, and application.

A third contemporary view, *leader–member exchange*, is a relationship-based approach to leadership that developed from the vertical dyad linkage approach to leadership. The leader–member exchange literature is quite extensive and has evolved through four research stages. In stage one, research found that leaders developed differentiated relationships with their subordinates. In stage two, research focused on these differentiated relationships of the leader within the work unit and the nomological network of leader–member exchange-related constructs. In stage three, the focus of research was on how leaders work with each person/subordinate on a one-to-one basis to develop a partnership with each of them. In stage four, dyadic relationships are expressed in terms of how they are organized into larger collectives within and beyond the organizational system.

At the core, leader–member exchange is a transaction-based relationship between a leader and a follower. More specifically, leader–member exchange is a system of components and their relationship involving both members and interdependent patterns of behavior as well as sharing mutual outcomes. It differs from vertical dyad linkage (which focuses on negotiating latitude) and individualized leadership (which focuses on support for self-worth), both of which seem to have a clear level of analysis focus. In leader–member exchange, a leader and an individual follower develop a relationship as they influence each other and negotiate the follower's role. This exchange relationship takes one of the two general forms: the in-group is a special exchange relationship with a small number of trusted subordinates who serve as assistants or advisors; the out-group is the remaining subordinates with whom the exchange relationship is more formalized and based on role requirements and job descriptions. Over time, leader–member exchange relationships can develop from stranger (low exchange) to acquaintance (medium exchange) to maturity (high exchange) in a life cycle of leadership making.

A fourth contemporary view, *shared leadership* approach, focuses on the entire team or group and how they operate collectively and share responsibility. Especially in high-performing

teams, there is a strong reliance on shared mental models (shared knowledge and cognitions) within the team. In shared leadership, no one member of a team stands out always and everywhere as a leader; rather, leadership roles and responsibilities are shared and distributed throughout the team depending on the issue, circumstance, expertise needed, and time constraints. The need for shared leadership is driven by the new, complex demands of work situations, technology, and new patterns of interdependence and coordination required among team members. No one person can likely have all the knowledge, expertise, and skills needed to meet goals and accomplish tasks successfully in cross-functional and multi-functional situations.

Through team processes of communication, face-to-face interaction, and collaboration, there is considerable knowledge acquisition and sharing in teams. Knowledge and information sharing lead to cognitive elaboration where new knowledge structures are created and old structures are modified. Over time, cognitive convergence occurs where team members gradually acquire enhanced overlap among their cognitive structures. Shared cognitive structures and knowledge (shared mental models) then can reduce variance in team performance, enhance cohesiveness, build a positive team climate, and promote successful goal accomplishment. These shared mental models are similar, overlapping, compatible, or complementary knowledge or belief structures that represent features of the context (such as task-specific knowledge, task-related knowledge, knowledge of team members, and attitudes and beliefs). Shared and overlapping knowledge and belief structures support the alignment of expectations that permit rapid and smooth coordination of behavior, availability, and access to a larger pool of information for problem solving and task completion, enhance the creation of new knowledge, enable team innovation and learning, and foster faster agreement on problem definition and strategic decisions.

These elements result in enhanced team effectiveness and efficiency based on teamwork with high levels of expended collective effort and high-quality interpersonal relationships. Highly effective teams are characterized as having a clear focus or vision when members are willing to sacrifice individual goals and accomplishments for team mission fulfillment. Team members identify so well with the team purpose and mission that they are willing to make individual sacrifices for the team and to enhance other team members' potential and capabilities. By developing a shared belief structure, teams develop a shared climate and culture that includes understanding of their behaviors, values, and ideas, and that develops a sense of cohesiveness and a set of expectations that facilitate learning and the ability of the team to lead itself.

A fifth contemporary view, *strategic leadership*, attempts to infuse a philosophy, set of values, mission, goals, and objectives throughout the entire organization. This may signal the influence of a CEO, top management team, and/or various department or unit leaders. Strategic leadership focuses on executives who have overall responsibility for an organization. The characteristics, behaviors, and impact on organizational outcomes of top individuals (e.g., CEOs) and top groups (e.g., top management teams, boards of directors) are considered to be of prime importance. The strategic leadership approach is concerned with strategic leadership per se, organizational form

or conduct (strategy, structure, and processes), environment or stimuli external to the organization (such as industry structure), and organizational effectiveness or firm performance.

Strategic leadership occurs at the highest levels of management, and regardless of the level of analysis or focus (e.g., CEO as an individual, top management team, philosophy, and values for the organization), involves dealing with organizational culture and effectiveness, the highest degrees of cognitive and behavioral complexity and decision-making, critical tasks that include strategy, vision, and organizational design, and the longest time spans (often 20 years and beyond). Strategy is the means-end package of the organization, typically expressed in terms of the vision of the CEO and/or top management team. Organizational design includes an overall configurational characterization (e.g., tall vs. flat) and various combinations of dimensions such as size, formalization, and centralization.

For organizations to be effective, there should be a consistency between the organization's strategy and structure. Behavioral and cognitive complexity, another aspect of strategic leadership, is essentially an individual's (e.g., CEO's) cognitive power, the sophistication of organizing processes, the skill to differentiate and integrate multiple cognitive elements, and the ability to engage in and effectively perform multiple roles and wide-ranging behaviors required by an organization in its environment. This includes creating, defining, and managing the organizational culture. Culture is multilayered (i.e., visible artifacts, deeper shared values and beliefs, and even deeper shared basic assumptions), with potentially numerous subcultures, and dimensions of culture that may vary both within units (intensity or agreement within) and between units (integration or agreement between). All strategic leadership elements impact numerous indicators of organizational performance and effectiveness, as valued by various internal and external stakeholders.

Alternative Leadership Views

A first alternative view, *substitutes for leadership* model, differs from previous leadership approaches that suggested that leadership styles will be effective regardless of the situation. Rather, it posited that particular individual, task, and organizational variables could substitute for or neutralize leadership, thereby negating a leader's ability to positively or negatively influence subordinate attitudes and effectiveness. Neutralizers create an influence vacuum and reflect characteristics that make leadership effects impossible. On the other hand, substitutes not only can affect which leader behaviors are influential, but also will tend to impact criteria.

A subordinate's need for independence, professional orientation, and indifference toward organizational rewards would tend to neutralize relationship-oriented leadership. Similarly, intrinsically satisfying tasks, cohesive work groups, no control over rewards, and the spatial distance between the subordinate and the superior also would neutralize relationship-oriented leadership. Subordinate characteristics such as the need for independence, professional orientation, indifference toward rewards, and ability and experience tend to neutralize task-oriented leadership. Similarly, routine tasks, highly standardized tasks, tasks that provide their own outcome feedback, cohesive

work groups, no control over rewards, the spatial distance between the subordinate and the superior, highly specified staff functions, and organizational formalization and inflexibility also would neutralize task-oriented leadership. Thus, substitutes can moderate the leader behavior–outcome relationship for all categories of substitutes, that is, person knowledge, skills, and abilities; dyadic informal relations; group and team cohesion and potency; and collective structure, formalization, job descriptions, and standard operating procedures.

A second alternative view, *influence tactics approach*, examines specific types of behavior used to exercise influence, rather than focusing solely on power as a potential source of influence. Influence attempts, based on legitimate power, that are reasonable, relevant to the mission, and the target person knows how to do, tend to be the most successful. The key categories of influence tactics, or proactive influence behaviors, are rational persuasion, inspirational appeals, consultation, ingratiation, personal appeals, exchange, coalition tactics, legitimacy tactics, and pressure. The directional use (up, down, or lateral) and effectiveness of these tactics varies across situations and targets (subordinates, peers, or supervisor).

A third alternative view, *information-processing and implicit leadership*, is a person-perception based approach that relies on both affective and cognitive processing strategies. These mechanisms determine followers' perceptions of leaders and play an important role in the formation, often rapidly, of liking or disliking of a leader. Follower affect and cognitions result in leadership perceptions that can be recognition-based or inference-based. Stereotypes and implicit theories of followers or subordinates about effective leadership determine the perceived relevance of various types of leader behavior. Followers and subordinates also use information about the situation and past events to draw conclusions about effective leadership and judge a leader's intentions.

A fourth alternative view, *pragmatic leadership*, focuses on the leader and his/her style and also on the style of others in a group or team who have some form of leadership responsibility. Sometimes labeled as functional and problem-solving leadership, this is leadership where influence is exercised by identifying and communicating solutions to significant social problems, working through elites (e.g., authorities) in solution generation, creating structures to support solution implementation, and demonstrating the feasibility of these solutions. The pragmatic leadership approach asserts that effective leadership behavior fundamentally depends upon the leader's ability to solve the kinds of complex social problems that arise in teams and organizations.

Leaders begin to address complex issues by defining the problem and formulating a solution framework or set of ideas to understand the problem and develop initial solution strategies. The focus here for leaders is on the problem per se, its significance, origin, and potential solutions. Experience, knowledge of the job/tasks, and understanding of the environment shape the way the leader represents the problem, the kinds of information sought, and the type of concepts applied. Capabilities such as wisdom and knowledge, perspective-taking, creative problem solving, and social judgment skills enable leaders to go beyond themselves to assess how others react to a solution, identify restrictions, develop plans, and build support for implementation.

Performance ultimately depends on the implementation of a plan which occurs in a social context where the leader depends on the efforts of others for making proposed solutions happen. Social cognition and knowledge of peers, subordinates, and superiors are critical for solution implementation. Flexibility and adjusting plans as dictated by the changing social environment and the ability to communicate a vision, establish clear and achievable goals, monitor progress, and motivate others to implement a given solution, also are seen as critical skills. General cognitive abilities, crystallized cognitive abilities, motivation, personality, and prior career experiences – all influence a leader's problem-solving skills, social judgment and social skills, and knowledge. Pragmatic leadership requires careful observation of people and social systems to identify needs, objective analysis of the situation to identify restrictions and intervention points, and development and implementation of solution strategies designed to maximize benefits at low cost.

New Wave Leadership Views

A first new wave view, *multiple linkage* model, builds on prior models of leadership and group effectiveness. Using four types of variables – leader behaviors, intervening variables, situational variables, and criteria – the model proposes interacting effects of leader behavior and situational variables on intervening variables that determine work unit performance. In this model, leader behaviors include various managerial behaviors such as supervising, planning, organizing, controlling, coordinating, consulting, and administering. The intervening variables include subordinate effort, role clarity and task skills, organization of work, cohesiveness and cooperation, resources and support services, and external coordination. Situational variables include neutralizers, substitutes, and various other factors. The model proposes that leaders institute short-term actions to deal with deficiencies in the intervening variables and positively impact group performance in the long term.

A second new wave view, *multilevel and leaderplex* approach, is the integration of behavioral complexity, cognitive capacity, and social intelligence. Behavioral complexity is represented by roles (mentor and facilitator, innovator and broker, producer and director, monitor and coordinator) based on competing values (collaborate, create, compete, control). Cognitive complexity or capacity assumes that cognitively complex individuals process information differently from and perform selected tasks better than cognitively less complex people because they use more categories to discriminate among stimuli and see more commonalities among these categories. Relatedly, cognitive capacity or cognitive power connotes those mental processes that tap the scale and complexity of the world one is able to pattern and construe. This is the raw mental power enabling one to sustain increasingly complex mental processes. Social intelligence, another leader characteristic, is the ability to notice and make distinctions among other individuals; in particular, among their moods, temperaments, motivations, and intentions. Beyond this ability is managerial wisdom and the skill to act based on an understanding of others.

In multilevel leadership, the focus is on conceptualizing hierarchical organization levels in terms of the amount of

cognitive capacity/power required at each of these levels, or groupings of levels, into domains: systems leadership, the very highest organizational levels; organizational leadership, middle to upper middle levels; and production leadership, lower levels. Thus, at increasing hierarchical levels or domains, the time span of decision-making increases until these time spans can be 10–20 years or more. As the time span requirements increase, a higher level of cognitive capacity/power is needed. Leadership is considered more effective the closer the match between time spans required and the leader's cognitive capacity to deal with the time span requirements.

A third new wave view, *individualized leadership* approach, focuses on the unique one-to-one dyadic relationship between a superior and a specific subordinate. Each relationship involves the superior's investments in and returns from the subordinates, and the subordinate's investments in and returns from the superior. Investments are what one party gives to another party. Returns are what one party receives from another party. Key variables involved in this dyadic exchange process are providing support for a subordinate's feelings of self-worth by a superior and providing satisfying performance to a superior by a subordinate.

The leadership process is individualized in the sense that each superior–subordinate dyad can be in agreement with regard to the degree of giving and receiving of these exchanged commodities. Leadership in this approach is defined as occurring when a superior is able to secure satisfying performance from a subordinate. One mechanism for securing leadership is for a superior to provide support for a subordinate's feelings of self-worth. A likely source of the initiation of individualized leadership is the leader's investment in a follower, as perceived by that follower, to enhance the follower's self-worth.

A fourth new wave view, *collective leadership*, focuses on units, teams, and networks, rather than solely on the skills of individual leaders, and draws on expertise from multiple sources in a timely fashion to arrive at an effective resolution of unique, rapidly emerging problems. Such leadership requires adaptability and the pooling of information and skills to accomplish missions; leadership becomes a collective or team- and network-based organization-wide enterprise. Collective leadership is a dynamic leadership process in which a defined leader, or set of leaders, selectively utilize skills and expertise within a network, and across levels of analysis and hierarchical levels, effectively distributing elements of the leadership role as the situation or problem at hand requires. In complex environments subject to rapid change, multiple leaders operating in a collective fashion and with team- and network-based approaches are critical to unit and organizational performance.

Beyond merely multiple individuals taking on different roles, sharing responsibilities and behavioral integration (including information exchange, collaboration, and joint decision-making which ultimately lead to some degree of attitudinal and/or behavioral influence) based on selective use of expertise within a broader network are important components of collective leadership. The collective leadership model includes key collective leadership constructs (i.e., leader skills, leader network, leader–team exchange, communication, problem setting, team performance parameters, team affective climate, and team network), baseline leadership and team processes (i.e., leader structuring and maintenance of group, mission, and team processes),

outcomes (i.e., team performance capabilities, immediate outcomes, and long-term outcomes), and the organizational setting and context (e.g., professionalism and expertise of the workforce, organizational structure, and work flow).

Communication is the currency of collective leadership. Leaders exchange information with their teams and networks, which helps to develop team and network parameters and affective climate and performance. Leaders involved could be formal or informal; teams involved may be formal or ad hoc; networks identified could be official (professional) or unofficial (personal or social). In collective leadership, there is meaning in the way information flows through specific patterns of team and network members; and it is conceivable that a team, network, or organization could develop their collective leadership capabilities such that the appropriate collective could be assembled rapidly in various situations.

Applications for Effective Leadership

Consideration of these numerous multilevel leadership approaches, while illustrating the breadth and depth of the leadership field, also leads to a general set of applications and guidelines for effective leadership practice in organizations regardless of whether the leader is a CEO, first-line manager, or an informal one. First, as leadership is multilevel in nature, leaders need to be cognizant of persons/individuals, dyads, groups/teams, and collectives in organizations. Ignoring any of these perspectives on human beings could create leadership problems and inappropriate solutions. Second, as leadership is multidimensional in nature, various elements and aspects must be implemented and practiced at multiple levels of analysis to be successful and effective.

In particular, at the individual/person level, leaders need to inspire followers, treat followers as individuals, spark followers intellectually, help followers become committed and interpret the meaning of events for them, pick a good person as second in charge, and try to eliminate their own job, thereby giving others a chance to develop and freeing the leaders to tackle new challenges. At the dyad level, depending on each follower's needs and wants, leaders ought to provide support, attention, time, resources, and challenging work to followers, encourage high follower performance, and develop and empower them one on one. At the group/team levels, leaders need to share responsibility, authority, and tasks to be completed; build cohesion and a welcoming climate; and foster cooperation and mutual trust among team members. At the collective level, leaders need to provide vision and direction; set the mission, goals, and objectives; be the moral and ethical compass and a model of integrity; and think long term (not only short term) for the entire organization. Finally, at multiple levels of analysis, because leadership titles create and set expectations for followers, leaders need to meet these expectations at the individual/person, dyad, group/team, and collective levels of analysis in organizations.

Conclusion

To summarize and integrate a vast and growing leadership literature, a broad-based working definition of leadership was presented at the outset. This integrative definition led to a

discussion of the foundational levels of analysis issues related to leadership and general leadership processes and ideas, including antecedents and consequences of leadership, which cut across a variety of leadership approaches. Numerous leadership approaches were then highlighted and detailed within the categories of classical, contemporary, alternative, and new wave leadership views. Lastly, a set of integrative applications and principles for effective leadership in organizations were presented. Regardless of the leadership approach that is considered or endorsed, the future of leadership research and application that takes a multilevel perspective on human beings holds great promise for a better understanding of human behavior related to leadership processes and practices in organizations.

See also: [Organizational Behavior](#); [Work Efficiency and Motivation](#).

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Learned Helplessness

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Glossary

Attribution theory A theory concerned with how one attributes causes to events and behaviors. In the original attribution theory, individuals may determine that the cause of an event was due to factors within themselves or outside of themselves. Key attributions include whether the cause was within an individual's control versus outside an individual's control, whether the cause is likely to be stable over time or not, and whether the cause can be applied only to the specific situation or can be applied broadly.

Depression A mood state characterized by feelings of sadness, hopelessness, being discouraged, and in many cases, greater irritability. In addition, other symptoms are often present such as loss of interest in a variety of activities, weight changes, insomnia, and fatigue. Cognitive deficits may appear as well in terms of inability to concentrate. Its worst cases warrant a clinical diagnosis with treatment.

Explanatory style Often also referred to as attributional styles, this is the type of causal attributions an individual commonly makes to an event. Individuals who typically attribute internal, stable, and global causes to an event have been described as having a pessimistic explanatory style that has been linked to learned helplessness and depression.

Learned optimism Representing the opposite of a pessimistic explanatory style, learned optimism describes individuals who have learned to employ an optimistic explanatory style (external, unstable, and specific attributions) to events. This manner of attributing causality appears to buffer against symptoms that often arise from a negative or stressful event.

Posttraumatic stress disorder (PTSD) Characteristic symptoms that often arise following exposure to an extreme stressor or traumatic event involving threat to oneself or others and in which the response involved fear or horror. These symptoms are present in the long term and often include reexperiencing the event in a variety of ways, emotional numbing and avoidance of stimuli related to the event, as well as increased physiological arousal.

Shuttlebox An experimental apparatus used in many of the first experiments on learned helplessness. It typically consists of a rectangular box with a series of metal bars on the bottom that serve as a platform for an animal to stand on and through which an electronic current can be passed to shock the animal. A small platform is placed in the middle of the box that the animal must jump over to relieve the shocks.

Definition

Learned helplessness is a theory that explains a particular response pattern that an organism has after experiencing stressful events for which there is no control. When an organism learns that it does not have control over a stressor, three primary behavior patterns can be observed. First, the organism will engage in fewer voluntary problem-focused behaviors. It will give up trying to resolve the situation. Second, the organism will display cognitive deficits. It will take a longer time for the organism to engage in an effective behavioral response, even if the organism has successfully performed the behavior previously. Third, because these effects can dissipate over time, the behavioral changes are influenced by emotional responses to the lack of control. If the organism learns the appropriate response to the stressor prior to loss of control, motivational and cognitive deficits do not occur. Modifications have been made to this theory, but these three response patterns remain defining hallmarks of learned helplessness.

Initial Findings

The theory of learned helplessness stemmed from studies in the 1960s and 1970s. In the first experiments, some dogs were restrained (in what is called a Pavlovian hammock) and then

shocked. The shocks occurred at unpredictable times and the restraint ensured that the dog could not escape or avoid the shock. One day afterward, the dogs were placed in a box with two compartments separated by a short barrier (a shuttlebox). While in the shuttlebox, the dogs were given light signals that indicated that the shocks would commence and 10 s later, the dog would be shocked until it jumped over the barrier. Dogs that jumped the barrier within those 10 s would not receive the shock. While most dogs that were not shocked prior to the shuttlebox trials jumped to the other side and quickly learned to do so in subsequent trials, the majority of dogs that had previously received shocks while under restraint did not jump to the other side. Furthermore, when these restrained dogs did jump across, they were slower to learn that jumping across relieved the shocks. Importantly, all dogs were able to effectively respond to other events (such as running out of the shuttlebox door once it was opened), indicating that these effects did not occur due to physical symptoms produced by the study procedure.

To test whether these deficits occurred due to a lack of control over the shock or due to the shock itself, a control group was added in which the restrained dog could press a bar to stop the shock. The unavoidable shock group was able to press the bar but this would not stop the shock. In this case, the dogs that experienced controllable shock did not show the same level of deficit (they were able to learn to jump over the barrier). Other variations on the experimental procedures

[†]Deceased.

demonstrated that the intensity, frequency, and duration of shocks could be varied with the same result. The same results could be obtained whether shocks were induced with a restraint or simply within the shuttlebox. Further experiments confirmed that, with few caveats, these effects were reproducible with other animals, including cats, rats, mice, birds, primates, humans, and even fish. These effects could also be produced using relatively innocuous stimuli (e.g., college students being asked to solve an unsolvable problem) and could generalize to other tasks (e.g., college students presented with uncontrollable noise subsequently having problems solving Anagrams).

The Initial Learned Helplessness Theory

In 1976, Maier and Seligman published a seminal paper in which they summarized this evidence and proposed the theory of learned helplessness to explain it. Essentially, the experimenters theorized that this response pattern arose specifically from the animal learning that behaviors are not paired with or otherwise do not produce expected outcomes. The resulting learned helplessness has three effects: First, the animal has a reduced motivation to perform later behaviors. Normally, the animal expects that its behavioral responses would produce relief from a stressor, but the animal has learned that this is not the case and therefore is not as motivated to perform behaviors. Second, the animal shows a cognitive deficit in the form of impaired ability to learn behaviors, even after it had performed the required behavior and observed the beneficial outcome. This was because the animal had already learned that the outcome was independent of their responses, and having this knowledge interferes with the possibility of arriving at the conclusion that the behavioral response actually did have an effect on the outcome. Third, a change in emotion occurs, characterized by behaviors indicating frustration, changes in appetite, and depressed affect, all of which were resolved after uncontrollable stimulus was removed. The characteristics required to produce these behavioral effects are (1) that the information the animal has at its disposal indicates that its behavioral responses cannot change the outcome and (2) that the animal has undergone some form of cognitive process to decide that this is the case. In the initial reports, researchers demonstrated that among a number of alternative explanations, learned helplessness was the best theory to explain these findings in both humans and animals.

Critique and Reformulation

Although the initial theory had explained much of the behaviors in animals, it quickly became apparent that the original learned helplessness theory was not able to fully explain human learning behavior. First, the theory as it was originally presented could not distinguish between responses that occurred when an individual decided that an outcome could not be changed versus it was possible to change the outcome but the individual was not able to do so. Such a person was described as having a low level of self-efficacy for changing the outcome. This distinction highlighted a limitation of the original theory in predicting actual responses: If an individual were

to decide that the current outcome was not controllable, then the only valid response would be one that changed the nature of the outcome (e.g., a change to the environment that gave the individual resources to control the outcome). However, if an individual were to decide that the outcome was controllable but that they cannot do so (such as an individual who believed that he or she was not competent enough to perform the required behavior), then the valid response would be to give the individual the tools needed to change the outcome. Such a distinction had important implications not only in predicting the ultimate response, but also in clinical settings in which different mechanisms of treatment would be employed based on the individual's beliefs. Second, although research indicated that learned helplessness from a stressor was often applied to further situations, the theory had little to say regarding how generalizable the response was or even in what situations that it would be broadly versus specifically applied. If a participant had undergone an experiment in which he or she was asked to solve an unsolvable problem and then was told during the debriefing that the problem was unsolvable, the original theory would have not predicted the result: Despite knowing that the problem was not solvable, the participant would not demonstrate learned helplessness to other events. Again, this distinction had important clinical implications because some situations would predictably produce a greater amount of learned helplessness and changes could be made to reduce learned helplessness. Finally, the theory did little to predict the degree of learned helplessness that an individual experienced when confronted with an uncontrollable stressor.

Researchers of learned helplessness resolved these discrepancies by using a modified form of attribution theory. When an individual was confronted with a situation in which he or she had no control, a number of attributions (i.e., decisions or judgments) were made regarding the level of control over the outcome. The individual essentially asked himself or herself why that uncontrollable situation happened. If an individual decided that as a whole, the situation was controllable but that he or she could not control it (analogous to low self-efficacy for changing the situation), then that individual was making an internal attribution or one of personal helplessness. Conversely, if an individual decided that nobody could have control over the situation, then that individual was making an external attribution or one of universal helplessness. Next, if an individual attributed the situation to uncontrollable factors, which may have been controllable in the future or given other circumstances, then that attribution was said to be unstable. However, if an individual attributed the situation to broadly uncontrollable factors that would not be controllable in the future, then that attribution was said to be stable. Last, if an individual decided that the factors involved in the uncontrollable situation were only really applicable to that situation, then the individual was making a specific attribution. However, if an individual decided that the factors were applicable to a wide variety of situations, then the individual is making a global attribution. Finally, the degree of learned helplessness was proposed to be based on the level of importance of the situation as well as the certainty that an individual had in his or her attributions. Through these attributions, an individual may have responded to learned helplessness in a variety of ways and across a variety of situations.

This revised model of learned helplessness allowed for prediction of situations in which individuals would respond more broadly and for longer periods of time. Consider an individual who attended a job interview but did not get hired. If that individual were to determine that he or she did not get the job because the position required a greater than normal degree of specialization (external attribution), the particular job was not a good fit compared to others (unstable attribution), and because he or she did not answer one interview question very well (specific attribution), then the individual may not have applied for another job at the same company but would probably not be discouraged from finding and applying for other jobs. Conversely, this same individual could have determined that he or she did not get the job because he or she was particularly unqualified (internal attribution), because he or she was not a good fit for any job (stable attribution) and because he or she was unable to answer interview questions well (global attribution). This individual would be more likely to have learned helplessness for a variety of jobs and over a variety of situations, thus causing that individual to drop out of the job hunt.

Researchers have developed the theory of learned helplessness further. In many cases, people have previous experiences available that allow them to make accurate attributions regarding an event. Sometimes, people do not have this, and must instead rely on their knowledge and response patterns. Therefore, in addition to the effect of attributions individuals have regarding specific uncontrollable situations, considerable research has been devoted to general response patterns individuals have toward a variety of uncontrollable situations. These attributional explanatory styles generally take the shape of optimistic attribution styles versus pessimistic attribution styles: Optimistic individuals generally attribute uncontrollable stressful events as external, unstable, and specific, while pessimistic individuals generally attribute uncontrollable stressful events as internal, stable, and general. Importantly, this is different from locus of control because this case deals with specific explanations made for past events, whereas locus of control involves expectations made toward future events.

In a natural extension of the attributional reformulation of learned helplessness, Seligman has coined the phrase learned optimism to explain the beneficial response that can occur when individuals make external, unstable, and specific attributions to events and therefore do not learn to be helpless. Instead, the individual is better able to cope with a wide variety of seemingly uncontrollable situations. In 1990, Seligman reviewed evidence on the protective effects that such an attribution and attributional style has on the individual compared to pessimism. In sum, the optimistic individual still experiences the negative situation, but the optimistic attributions allow the individual to bounce back faster or to be more resilient toward the various things that happen to the individual. Seligman asserts that individuals can learn to adopt a more optimistic attributional style through examining the evidence and disputing negative internal thoughts.

The Neurobiology of Learned Helplessness

Since the initial findings, a considerable amount of research has been devoted to finding the specific physiological

responses that were associated with the behavioral patterns seen in learned helplessness. Although some human studies exist, this research has primarily been conducted using mice and rats. Many use the learned helplessness paradigm as an animal model for depression or posttraumatic stress disorder (PTSD), and the vast majority of these studies focus on the original learned helplessness theory as opposed to the attributional reformulation. The information presented here is not comprehensive, and interested readers are directed to a 1995 book chapter by Peterson et al. devoted to this topic.

Rather than operating independently, a complex, interacting network of biological responses is involved to produce the behavioral response of learned helplessness. Researchers have found that induction of the paradigm (i.e., experiencing the inescapable stressor) produced an initial increase in catecholamine release, followed by a subsequent reduction in catecholamine (particularly norepinephrine) and a release in endogenous opioids throughout the body. Additionally, induction of learned helplessness produced decreases in the inhibitory neurotransmitter gamma-aminobutyric acid within the hippocampus that was related to the altered behavioral response and poorer learning produced by learned helplessness.

Recent studies have indicated that the responses exhibited during learned helplessness trials were of conditioned fear stemming from activation of the basolateral amygdala. Lesioning in this area prevented the conditioned fear response, resulting in a complete loss of response to learned helplessness trials: rats in the experimental group learned to escape just as readily as either of the control groups. At the neuronal level, a study showed that learned helplessness trials caused an acute reduction in synaptic activity at the hippocampus. It appeared that this at least partially controlled the behavioral response to learned helplessness because not only did injection of corticosteroids to the hippocampus produce the same reduction in synaptic activity and the same learned helplessness behavioral response, but blocking this synapse loss through use of a catecholamine reuptake inhibitor also prevented the learned helplessness behavioral response. In sum, the biological effect of inducing learned helplessness was varied and involved at least all of the following situations working in concert to produce the behavioral response: First, there was an overall reduction in catecholamine release. Second, there was a reduction in the inhibitory transmitter gamma-aminobutyric acid. Third, there was a release of endogenous opioids. Fourth, there was activation of the conditioned fear response within the basolateral amygdala. Last, there was inhibition of synaptic activity within the hippocampus.

Effects of Learned Helplessness

Although there has been a copious amount of research on the effects of learned helplessness in a number of different scenarios, the majority of the findings can be reduced to three main areas of research: physical health, depression, and posttraumatic stress. For physical health and depression, the majority of the research centers on the attribution reformulation of learned helplessness. However for posttraumatic stress, the majority of research focuses on the original theory. A brief summary of the findings follows:

Physical Health

Research on the health effects of learned helplessness has focused on the main component of lack of control, the behavioral aftereffects of lack of motivation, and the cognitive deficits. Human research has focused primarily on correlational studies using stressful life events and perceived daily hassles. The premise was that the degree of distress from life events (such as being involved in a car accident) and daily hassles (such as distractions from work) resulted from a perceived lack of control over the situations that caused those events. It has proved difficult to establish a direct link of health effects due to lack of control, but evidence supported the notion that worse health outcomes resulted when individuals employed a pessimistic explanatory style to determine the cause of stressful events. Employing an optimistic explanatory style, on the other hand, appeared to protect against the negative health effects of stressful events.

Lack of motivation resulting from learned helplessness has also been linked to decrements in physical health. Individuals with higher levels of learned helplessness fail to invest the time and make the required behavioral changes to prevent health issues. In one study, smokers who believed they would get sick by continuing smoking (had a high perceived susceptibility) were much less likely to quit if they did not believe that they could actually quit smoking. This relationship is especially problematic because the majority of deaths today are due to preventable lifestyle behaviors. Fortunately, many of these effects due to lack of motivation are readily treatable. Interventions have been designed to combat negative thoughts and perceptions that result in learned helplessness, thereby increasing motivation to make the lifestyle changes needed to improve.

A wider body of research is available to support the notion that differences in cognition serve to influence health. Specifically, the employment of optimistic or pessimistic explanatory styles has a direct influence on health. In one long-term longitudinal study, researchers tracked the influence of explanatory style on healthy men over the long term starting from college. They then analyzed participants' original open-ended responses to a question asking them to give specific details about things that had happened to them recently, looking for negative events combined with causal explanations for the events. The responses were coded to determine whether the individual employed overall optimistic versus pessimistic explanatory styles. The researchers found that individuals with an optimistic explanatory style had better health and individuals with a pessimistic explanatory style had worse health over 20 years after the explanatory style was measured. These psychological variables seemed to have their largest effect on health while individuals were between 35 and 50 years of age. Researchers have also assessed this relationship among a college population, using explanatory style to predict differences in the amount of time spent ill and visiting the doctor. Again, it was found that having an optimistic explanatory style was better than having a pessimistic explanatory style. Those who employed a pessimistic explanatory style spent more time ill and visited the doctor more than those who employed an optimistic explanatory style. In addition, the beneficial effects of an optimistic explanatory style have been demonstrated in an increased ability to survive and recover after a heart attack and in more favorable markers of immune system functioning.

Depression

Early in the development of the learned helplessness literature, it became apparent that the effects of learned helplessness mimicked depressive symptoms. The direct behavioral effects, a sort of maladaptive passiveness, were present in both. Furthermore, it had previously been known that a key symptom of depression was the feeling that the individual had no response available to overcome failure. It was therefore theorized that the symptoms of depression arose from such experiences, and some of the initial studies on learned helplessness in humans corroborated the theory. For example in an early study, participants were exposed to an uncontrollable noise and then asked to move their hand to the other side of a shuttlebox to stop the noise. These individuals experienced many of the same behavioral symptoms as those exhibiting depression. They were more likely to sit passively and listen to the noise than both those who were not exposed to uncontrollable noise and those who were exposed but could stop it.

However, it was also apparent to researchers that the theory was not completely adequate to serve as a model of depression in humans. One glaring example was that when individuals in this study were debriefed, symptoms of learned helplessness did not appear. The attributional reformulation was done, in part, to more effectively address the nuances in depression. Most of the research focusing on depression in humans has subsequently focused on the reformulated theory and, in particular, the attributional style subset of that theory. Research on this topic is abundant. In a recent meta-analysis, researchers found that among college students and psychiatric patients, having a pessimistic explanatory style in making causal attributions predicted greater symptoms of depression. This evidence was extended with a second meta-analysis in which researchers found that having a pessimistic explanatory style predicted symptoms of depression among children and adolescents as well. A number of correlational, longitudinal, and experimental studies have provided clear support that having a pessimistic explanatory style produced greater amounts of depression.

Some of the literature concerned with the effects of learned helplessness on depression has encompassed the construct of anxiety. It should be noted that anxiety is not necessarily the same as depression, especially in regard to expectancies. In anxiety, the individual was typically more concerned about the threat of future loss, whereas in depression, the individual was typically more concerned about the loss that had already happened. However, when considering that the main issue is lack of control, there was often little difference. Individuals who made internal, global, and stable attributions toward an event (i.e., made pessimistic attributions) were using information they had available to them to explain the event but were simultaneously extrapolating this information toward expectations to the future. Because of these shared effects, the anxiety literature has often been incorporated within depression.

Posttraumatic Stress Symptoms

Unlike for depression, the original model of learned helplessness has been used extensively to examine the occurrence of past traumatic stress symptoms. Experiencing a traumatic event over which the victim has little control is very similar to the inescapable shock paradigm. In addition, researchers have

noted similarities between animal models of learned helplessness and the human experience of posttraumatic stress. Many of the physiological and behavioral alterations seen in response to a traumatic or cataclysmic event closely mimic the effects of learned helplessness. The typical behavioral response involving hyperarousal and hyperreactivity, combined with a reduced capacity for responding effectively to surrounding events, is almost identical to the behavioral responses to learned helplessness seen in animal studies. Similarly, the physiological response of increased endogenous opioids and depletion of catecholamines is the same. Because of these similarities, the majority of research has progressed with the original model of learned helplessness.

However, learned helplessness may not be analogous to posttraumatic stress. Rather, it is possible that learned helplessness may play a mediating role in the development of symptoms of posttraumatic stress. In one study, researchers examined this role among those exposed to partner violence. The researchers found that displaying symptoms of learned helplessness increased the likelihood of exhibiting symptoms of posttraumatic stress. The attributional reformulation model is also important to consider because having a pessimistic explanatory style may contribute to further symptoms of posttraumatic stress. Researchers have shown that among individuals addicted to alcohol and gambling, having a pessimistic explanatory style predicted more symptoms of posttraumatic stress. Some researchers have found that learned helplessness can play roles through both mediation and attributions. For example, researchers have found a mediating role of coping styles between attributions and symptoms of posttraumatic stress among combat veterans, whereby when the veteran made pessimistic attributions, subsequently employing negative coping mechanisms as a result of these attributions predicted posttraumatic stress. Though the field has traditionally focused on the traditional model of learned helplessness for posttraumatic stress symptoms, evidence for alternative explanations has been increasing.

Assessing Learned Helplessness

There have been a variety of mechanisms to assess learned helplessness, but only a few are widely employed. The traditional learned helplessness paradigm is more typically assessed using experimental methods among animals in the laboratory. A shuttlebox is used paired with shocks as described in the initial studies. In animals, this box typically consists of a floor through which an electric current can be passed to shock the animal and a short wall or platform that the animal can jump across to stop the shock. For humans, the shock is typically replaced by a loud or unsettling audio tone. Many variations have been developed for use in specific samples. In rats, for example, the traditional shuttlebox mechanism does not adequately assess learned helplessness. For rats, learned helplessness is instead shown by creating more complex mechanisms for the rats to learn in order to stop the shock (e.g., pressing a bar 3 times).

In humans, there are two primary ways to assess learned helplessness through the attributional reformulation model. Both ways focus on attributional styles rather than attributions to specific events; there is no standard method to assess

attributions toward specific events. First, the Attributional Style Questionnaire is the most widely used method of assessing overall cognitive attribution styles. The self-report scale provides six positive and six negative hypothetical events and asks the individual to write down a major cause of the event. Then, the individual is asked to rate the cause that was written down along seven-point scales from internal to external, stable to unstable, and global to specific. In addition to the individual dimensions, the Attributional Style Questionnaire provides an overall assessment of optimistic to pessimistic attribution style.

In order to assess explanatory style in population samples that are either not able to fill out questionnaires or that has previously given written accounts of the event, another technique was developed. In this technique, called content analysis of verbatim questionnaires, trained coders extract identified events from written accounts. Like the Attributional Style Questionnaire, the content analysis of verbatim questionnaires was designed to assess attributions for both positive and negative events (the coder simply indicates whether the event was positive or negative). Then, the causal explanation for the event is extracted. Finally, the coder rates each cause along the same dimensions as in the Attributional Style Questionnaire.

Summary

Learned helplessness describes a particular response to an uncontrollable stressor that is characterized by a lack of motivation and behavioral responses, cognitive deficits in the ability to learn the correct responses, and an emotional response. This theory was initially formed to describe the seeming lack of ability that animals exhibited in solving simple puzzles to avoid being shocked after they had received uncontrollable shocks. Typical physiological responses involve decreases in catecholamine release and gamma-aminobutyric acid, increases in endogenous opioid release, activation of the basolateral amygdala, and inhibition of synaptic activity at the hippocampus. Taken together, these response patterns of learned helplessness have been shown to negatively impact physical and mental health. The theory and its reformulation have subsequently been used as the basis for several human conditions, particularly depression and PTSD. According to the attributional reformulation of the theory, individuals come to feel helpless through learning to attribute internal, stable, and global causes to a variety of events. This theory provides important implications for treatment especially for mental health problems such as depression. The phrase 'learned optimism' is used to describe the opposite explanatory styles as a way to buffer against negative symptoms. The Attributional Style Questionnaire and content analysis of verbatim questionnaires are the two most widely employed ways of measuring learned helplessness in humans. In animals, learned helplessness is typically induced experimentally through variations of the original procedure in which the animal is exposed to an uncontrollable stressor and then placed in a situation where the same stressor is controllable by performing some simple behavior. Based on these findings, Seligman and other researchers have developed a number of effective interventions designed to prevent the effects of learned helplessness. Interventions such as those designed to promote resilience among school children and among soldiers in combat have shown promise in

increasing physical health as well as reducing symptoms of depression and posttraumatic stress subsequent to being confronted with uncontrollable stressors.

See also: Attribution; Coping; Depression; Hope and Optimism; Positive Psychology; Posttraumatic Stress Disorder.

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Glossary

Enjoyment The experience of satisfaction and achieving something important.

Freedom Having the opportunity and ability to choose what one wants to do. All freedom, however, is perceived and generally relative, given that along with the freedom to choose also come responsibilities to self and to others.

Leisure Meanings that people attach to enjoyable activities freely chosen generally during their unobligated time.

Leisure education Helping individuals, families, communities, and societies to achieve a suitable quality of life and good health and to use leisure time intelligently and develop and cultivate physical, emotional, spiritual, mental, and social aspects related to the aims of education.

Leisure industry The agencies, organizations, and businesses that provide facilities, programs, services, or areas for people's enjoyment in their free time.

Play Activity undertaken by children and adults that includes characteristics of spontaneity, purposelessness, and the creation of an imaginary world. Play is almost always pleasurable, self-expressive, and can range from disorganized activity to structured involvements.

Quality of life The degree to which a person enjoys the important possibilities of life that reflect the interaction of personal and environmental factors.

Recreation Activities undertaken because of conscious or unconscious enjoyable end results.

State of being/state of mind A psychological experience whereby leisure is perceived as having characteristics including being freely chosen, not compulsory, and done for its own sake.

Work Activity undertaken for economic gain or social redeeming value.

Everyone knows what leisure is. All people have a notion of what it means and whether or not individuals feel they have enough leisure. Sometimes the idea results in laughter, when someone, like the author herself, says they do research about leisure. Leisure, however, is a huge industry across the globe. Further, many individuals find great meaning in their lives with people's self-identity often revolving around their leisure. For some people, however, leisure is illusive and they never have enough of it. Others sometimes experience boredom when they have too much *free* time. The term is sometimes associated with recreation, although recreation tends to have a specific activity focus such as sports, arts, outdoor activities, or hobbies. Play is also associated with leisure for both children and adults. Playing sports, going to plays, and other forms of play behavior are all a part of leisure. Leisure, recreation, and play are ubiquitous and the terms are sometimes used interchangeably.

Leisure obviously can be bountiful for some people and quite illusive on many levels for others. Further, leisure can be seen as a frivolous undertaking (e.g., when juxtaposed to work or other 'productive' activity) or it can be regarded as highly serious (e.g., individuals who define themselves by a leisure activity such as running or being an amateur musician). Leisure activities are important and when most people look back at their lives, they talk about wishing they had spent more time in activity (alone or with friends and family) rather than worked more. If you ask people what is on their 'bucket list' for their lives, almost everything mentioned is about leisure.

Thus, as an idea, leisure is both mysterious and powerful. It has many meanings generally associated with positive outcomes, but not always.

A *leisure age* was forecast over 40 years ago by the French sociologist Joffre Dumazedier as well as the American leisure studies pioneer, Charles Brightbill. At that time, leisure with all its possibilities was also seen as a potential problem or challenge if people had too much leisure. Concerns were raised in the mid twentieth century about whether people could handle leisure for their own good and for the good of their communities. The idea that leisure was becoming a commodity accessible for everyone was positive and yet problematic at the same time. Would people know how to use their leisure wisely? Would leisure have positive meanings for them? Can leisure be universally understood? What does, or what should, leisure mean?

Scholars who have studied dimensions of leisure over the years have lamented its definitional confusion. Definitions and meanings are not necessarily the same, but they are important dimensions of leisure. This realization of years of discourse without coming to universal agreement seems both disheartening and heartening at the same time. The definition and meaning of leisure may be just as misunderstood today as in the past. However, because leisure continues to have many meanings and interpretations, perhaps it has escaped the chains of modernity and as Rojek suggested:

In struggling to achieve that longed-for state of freedom, choice, and life-satisfaction, we find ourselves trapped in new, unanticipated obligations and chains . . . Things always seem less than they could be. It is the fate of modernism to regard these responses as subjects to be remedied; and it is the condition of postmodernism to perceive the remedy as the problem. By committing ourselves to decentering leisure we emancipate leisure from the modernist burden of *necessarily* connoting freedom, choice, life-satisfaction, and escape with

*Portions of this entry are used by permission from an article by the author appearing in *Loisir et Societe* (2009, Volume 31, No. 1, pp. 15–30) entitled, "Expanding the Meanings of Leisure in a Both/And World".

leisure [original italics]. We recover what the illusions of modernism have concealed. (p. 192)

Perhaps a uniqueness of leisure is that it always has been a postmodern notion that never could fit well into the modern age. Further, in abandoning a mandate to find a single meaning, leisure has been liberating for many groups of people. Uncovering *meanings* is more appropriate than articulating single definitions. For many individuals, especially in industrialized societies, 'finding' leisure is much more important than 'defining' it.

This encyclopedia entry describes meanings of leisure by illustrating discussions that have evolved over the years. Abandoning the search for a meaning in favor of multiple meanings provides challenges but also a plethora of opportunities for understanding the potential of leisure both as a subject of research and a way to enjoy life. After briefly examining the ubiquity of leisure throughout history, ways of explaining the meanings of leisure will be examined from five nonmutually exclusive frameworks that seem evident in the latter half of the twentieth century and into the twenty-first century: time, activity/recreation, state of mind, places and spaces, and cultural contexts. The variety of meanings of leisure offers many ways to understand broadly how leisure does (and sometimes does not) contribute to the quality of life of individuals, communities, societies, and the world.

A Brief History of Leisure

The history of leisure is also the history of informal education. Broadly defined, education is the process of giving instruction to impart knowledge, build skills, and develop character in humans. The outcomes of leisure often include learning, expressing oneself, and experiencing enjoyment. The history of leisure is often begun with a discussion of the Greek philosophers with explicit empirical demarcation evident with the beginning of the industrial age. Leisure, however, has been omnipresent in all cultures since people first began to inhabit the earth. Certainly notions about 'play' exist in many contexts including among animals. Further, leisure has not necessarily been learned but has been embodied in culture.

Adam and Eve in the Garden of Eden surely had all the leisure they wanted. The 'curse' that God put on them was to toil instead of to leisure. Hunting preserves and gardens were evidenced in ancient Egypt and China, and in historical Europe. Primitive cultures around the world have left evidence of games and 'sports' played. Certainly, traveling has been common throughout history. The Eastern cultures in the Tao Te Ching also talk about a notion of leisure:

There is a time for being ahead,
a time for being behind;
a time for being in motion,
a time for being at rest;
a time for being vigorous,
a time for being exhausted;
a time for being safe,
a time for being in danger . . . Mitchell. (trans., 1992, selection 29)

All religions emphasize elements of leisure and recreation in their teachings. For example, from Judaism the concept of

'Sabbath' is emphasized in letting the body rest. Christians stress notions of right action in *all* that people undertake. Islam focuses on remembrance and the importance of work and play experiences within the moral law. Hindus teach the value of karma and the law of cause and effect regarding any action. Buddhism focuses on the interdependence (i.e., yin-yang) of what people do (e.g., leisure-work). The World Leisure International Centre of Excellence advocated that even though the leisure is understood differently around the world, leisure is a part of all time periods, places, and societies.

Westerners usually point to the Greek philosophers with their first written discussions of leisure as the aristocratic ideal of human activity. Aristotle is credited as being the first Western philosopher to describe the relationship between leisure, education, and work, and he asked the question whether the end of education is culture or whether it is to fit people for the business of life. From Aristotle's perspective, leisure did not denote rest or recreation but was meant to be engaged with highest capacities of the soul.

The value of leisure is usually focused on the 'good' that it provides and how leisure contributes to the quality of individual and community life. Nevertheless, leisure has been and continues to be a site where both positive and negative social, political, educational, and cultural relations are visible. Recreation and leisure are learned experiences within cultural environments. Leisure has been described in many ways but most often related to time, activity, state of mind, places and spaces, and cultural context.

Time

The definition of leisure as time has been most evident in an industrial modern society that dichotomizes work and leisure. Time was initially defined simply as free time that typically meant nonwork time or unobligated time. This definition tends to define leisure as what it is NOT rather than what it is. Within the notion of time, leisure has also been described as unobligated time. Unobligated time denotes nonpaid work as well as other obligations one has in life such as personal care, social support, and other activities that are not necessarily 'free.'

Time dichotomized between paid work and nonpaid work is relatively easy to measure. Some feminists including me and my colleagues have objected to the definition of leisure as nonwork time because it assumes paid work. Some women, as well as some men, are not part of the work force; so considering leisure only as the opposite of paid work negates the important activity that is unpaid such as maintaining a household, childrearing, community volunteer activities, and personal care. Unpaid activities that are obligatory are not done in free time. Increasingly, however, work is defined as having both economic and social benefits suggesting that not all work is paid in monetary terms.

Time-use studies have been conducted regarding how people use their time. They have been coded primarily related to work and nonwork efforts and were focused on ascertaining the amount of leisure time people have. In the United States, the amount of work Americans do has been an ongoing debate. Some people believe that Americans work more

hours than ever before, and therefore, have less free time. Others argue that people have a good deal of free time, but because they are always tethered to technology and have dwindling amounts of large blocks of time, they do not perceive that they have more leisure time.

Leisure as free time continues to be an important definition given that time is often a prerequisite for any activity. However, free time as a simple measurable way to describe leisure raises questions that should be considered in understanding the meanings of leisure. Some questions relate to the distribution of work and leisure. People with higher levels of education often work longer than those with less education. Yet, evidence suggests that people with higher education make more money and spend more money and time on leisure. Further, how much time is spent working related to 'at work' is also an issue to consider. Sometimes work and leisure are hard to separate, since they may offer some of the same states of mind. Changes in the workplace such as flexible work schedules as well as electronic communications that both offer work as well as personal play experiences in the workplace blur the lines. Although individuals in some jobs may spend 8 h at work, the amount of time they are actually working sans personal internet time, breaks, and office interaction may not constitute work. Numerous examples exist today in large companies of work time spent in purposeful 'fun' activities among (mainly pink and white collar) workers to increase morale (i.e., food functions, birthday parties, and casual Fridays) and make workers more productive. These activities also blend work and leisure.

Nevertheless, time will continue to be an important meaning attached to leisure, since many people feel they never have enough time. However, only examining hours attached to leisure leaves out the meanings associated with priorities for time use, opportunities available, the perceived and actual amount of time available, how an individual feels about the value of his/her time, and social mores (e.g., guilt) that may play into the enjoyment of free time. Leisure as time is a necessary element in understanding other dimensions of leisure.

Activity/Recreation

Defining leisure as activity, which can be synonymous with defining it as recreation and play, is another common meaning associated with leisure. This activity generally is pursued for its own sake and for fun and enjoyment, although many activities that might be considered leisure also have secondary health benefits. Leisure activities have typically been categorized into activity sets with particular characteristics such as competitive sports, outdoor pursuits, cultural endeavors, and social interactions. Defining leisure as activity assumes that time is available and that these types of opportunities exist.

Leisure as activity has been commonly examined regarding participation and frequency of involvement in specific activities. These findings have been largely applied to recreation programmers, managers, and businesses to determine what people want to do, or what activities can be consumed or commodified, and therefore, marketed. Many of the common meanings of recreation activities connote physical movement or some type of external environment such as a ballfield, an

arts center, or a park. Research about recreation has moved from broad examinations of types of recreation activities to focusing on what particular activities contribute such as in the benefits based management approach, which today also relates more specifically to the outcomes of participation in activities.

Leisure as activity can be examined in terms of being an end or a means. An activity can be undertaken for its own sake or it can have intentional instrumental value. Activity such as fitness can be a means to an end if the goal is better health or perhaps weight reduction. When leisure activities serve as both ends and means simultaneously they are often perceived as being the most enjoyable.

The scope of leisure as activity has expanded as new activities have been added and meaningful activities have been redefined. For example, the focus on extreme sports has added more opportunities for this sports and outdoor specialization. Further, the recognition that nontraditional recreation activities such as texting on the phone, shopping, surfing the internet, or participating in religious endeavors may be leisure for many people is important.

Play is an area that has been studied in and of itself as well as for a foundation for leisure activity. Play is linked most to children, and yet adults play when play is defined as spontaneous and expressive activity done for its own sake. According to one of the first play theorists, Huizinga, play has common characteristics such as spontaneity, self-expression, and enjoyment. He described the elements of play related to purposelessness as well, which may make it somewhat different from some recreation activities such as competitive sports. Another play theorist, Michael Ellis, explained why people play from the perspective of physiological, psychological, sociological, and contemporary theories. Ellis seemed to lay the groundwork for play as a postmodern interpretation in that it has numerous elements that contribute to its value.

Another particular element of activity that relates to recreation as well as other fields is the focus on recreation and physical activity as a means to promote health. Because many people are not physically active, numerous chronic health issues have emerged. Although physical activity can be found in nonrecreation activities, recreation activities are generally an enjoyable and purposeful way to maintain health and well-being. Research shows and it makes intuitive sense that people generally continue to do (healthy) activities that they enjoy.

Leisure as activity is fairly easy to measure when checklists of activities are used and when people consider a particular activity to have outcomes that are enjoyable. However, what some people consider to be leisure activities may not be how others would define them. For example, some people love to run and gain great value from this activity, while other people find no enjoyment in a recreation activity such as running or jogging. Further, the personal, social, economic, and environmental outcomes of certain types of activities for individuals as well as communities may vary greatly. Nevertheless, leisure as play or involvement in particular recreation activities is highly important whether these activities are casual, serious, or somewhere in between. The recognition of the range of recreation activities and other less-structured activities that constitute leisure continues to expand in the twenty-first century.

State of Mind

Sebastian DeGrazia wrote about leisure during the early 1960s when the idea was gaining great momentum. He is most often associated with espousing the contemporary idea that leisure is a state of mind. Psychologists such as John Neulinger further measured this state of mind in the form of examining perceived freedom and intrinsic motivation. When leisure is described as time or activity, psychological outcomes emerge such as motivation, freedom, and enjoyment. Leisure from a state-of-mind perspective includes free choice, something done for its own sake, and a sense of control. Csikszentmihalyi's idea of flow or the autotelic experience, which has been used relative to both leisure and work, is another example of the notion of state of mind focused on individual motivations and perceptions. With the idea that leisure is a state of mind, almost anything could be considered leisure depending how individuals interpret their experiences.

Neulinger underlined, however, that freedom is never complete and is always relative. Further, some type of intrinsic outcome is necessary for a 'true' leisure experience. In most ways, leisure like other elements of life is a relative freedom. People are never completely unobligated or free to do anything anytime they wish. Nevertheless, the idea of state of mind is central for the enjoyment of leisure.

Although a number of leisure scholars describe the notion of a state of mind related to leisure, measuring these ideas has been complex as evidenced by the pioneering efforts of Neulinger and Csikszentmihalyi. Scales have been developed to try to capture the subjective meanings of leisure as a state of mind, but many of these scales have been inadequate in addressing the meanings of leisure. Nevertheless, these quantitative efforts have been useful in understanding the psychological dimensions of leisure as a state of mind.

Another way to understand how individuals find meanings in leisure for themselves have been uncovered in some of the research undertaken using qualitative approaches. When individuals can articulate leisure as more than free time or specific activities, they can describe the feelings and satisfactions associated with meaningful aspects of their lives. For example, when my colleagues and I asked women about their leisure, they said they had none. They also could not always name typical recreation activities that they defined as leisure. Yet, they could describe pausing to watch the beauty of a sunset or the joy they experienced in watching their children play sports as deeply important. When further probed, many agreed that these experiences were like leisure for them. The subjective feelings that surround leisure are meaning-making for people. Regardless, some type of foundation is necessary for these experiences to occur and places and spaces related to leisure have emerged as a relatively new way to associate meanings with leisure.

Places and Spaces

Although the three typical perspectives of time, activity, and state of mind previously discussed are central to leisure, these ideas focus primarily on the individual and how he or she creates meaning. Leisure, however, is greatly impacted by

circumstances outside the individual. Some of the health professionals have recently referred to this idea as social ecology, which examines both the micro and macro aspects of behavior. The social situation, the demographic characteristics, the community as well as nature environment, government regulations, and policies affect leisure, and thus, how people experience and find meanings in leisure. One area that has received increased attention is the physical environment or the places and spaces that give leisure importance.

Space and place have been defined in many ways. According to Tuan, the concept of space has absolute and relative dimensions with concrete boundaries. Place is perceptually and socially produced by individuals. Thus, spaces become places when they mean something significant. Spaces exist where leisure occurs and these spaces often become special places when leisure is an aspect of them. A sense of place is often associated with an emotional and affective bond between an individual and a particular space and may vary in intensity from immediate sensory awareness to long-lasting deeply rooted attachment. A sense of place is often a quintessential concept in thinking about nostalgia, memory, and the images that are evoked. The physical place may be less important, however, than the meanings that people attach to places in their minds as they participate in leisure. Therefore, people can make interpretations of their psychological states regarding leisure based on physical realities. Thus, as Foucault noted, space cannot be disassociated from the practice of the people who use the space. A sense of placelessness often exists in today's society and a sense of place experienced through leisure can provide meaning whether it refers to a neighborhood Starbucks or a special mountain lake.

Places combined with a sense of time to enjoy, opportunity to participate, and an open state of mind contribute to many people's sense of leisure meaning. As noted, however, the leisure meanings attached to macro places usually are associated with the individual micro perceptions. The influence of the social situation or cultural context may or may not be evident.

Cultural Context

The traditional definitions of leisure as personally fulfilling can separate leisure from other aspects of human activity. Leisure, however, is in society and therefore connotes a greater social cultural context than suggested by some of the early individualized definitions of leisure.

A cultural context calls for an integrated view of leisure that occurs in time and space with various social connotations. Individual preferences are not independent of social and cultural influences. People often choose activities based on their previous social experiences as well as because of what others around them are doing. Leisure is never free from these social or moral norms. The symbolic meanings of leisure often come from socialization and opportunities as well as culture. Rojek indicated that leisure time and space are continually made and remade by the actions of people in their social worlds.

Some people are beginning to challenge the cultural issues that surround the typical Western concepts of leisure. Researchers such as Iwasaki and his colleagues described, for example, how problematic leisure is from a global, and

particularly linguistic, perspective. These researchers recommended that the term 'leisure' not be used particularly with people from non-Western cultures. They rationalized that leisure is differently defined by various cultures and that it is an ethnocentric term used mostly in North American and European thinking. They also believe the term evokes the dominance and intrusion of this Western thinking. Not using the term leisure, however, may be one way to resolve some misunderstandings, but not having a term may also make interpretations of the phenomenon of leisure difficult. The cultural context, however, cannot be ignored, since leisure has social and cultural dimensions that may be both explicit and implicit in the meanings that people attach to the notion of leisure. Definitions such as time or activity assume social implications, but for many people the essence of leisure lies in the relationships and identities that surround any meaningful undertaking.

Expanding Leisure Meanings

These five areas only touch the surface of other ways that leisure might be understood. Although an identified universal does not exist, leisure clearly has components of voluntary behavior and a sense of enjoyment. However, other scholars have also argued that leisure has enlarged in ways that focus primarily on economics. Globalization implies that the most obvious way to promote positive leisure experiences is to provide activities that can be experienced, bought, and consumed. Therefore the commodity of leisure and the way that it is consumed or experienced relates to the product 'sold'. If people are not satisfied with their leisure, then perhaps more and better opportunities are needed. The leisure industries that have evolved in industrialized countries over the past 50–75 years are based on the idea that people's demands for leisure create supplies of opportunities. However, the economic notion of leisure is also bound to time, the nature of activities, state of mind, place, and social context.

Meanings have also been proposed by scholars like Freysinger and Kelly who regard definitions of leisure to include perspectives about the quality of action (i.e., self-taking action in a defined environment, social construction, political, and as a dimension of life). They concluded that aspects of freedom run through most of this discussion of leisure as quality of action. Regardless, leisure is ever changing and cannot be approached with only the traditional concepts of freedom, individual choice, and self-determination.

The ideas of multiple identities, the reflexive self, the breakdown of clear divisions between work and leisure, and the ambiguous and contradictory aspects of postmodern existence resonate with leisure theorists such as Rojek as well as feminist leisure scholars like Wearing who have been critical of traditional definitions. These expanding ideas suggest the need to be wary of essentializing any explanation of any idea.

A tension remains, however, between recognition of expanded meanings and the idea of commonality of experience related to leisure. For some researchers, perhaps the concept of tension itself is an important and useful element that mediates leisure. Taking into account unique situations and subjectivities of individuals as well as the possibility of shared experiences among individuals socially and culturally continues to be a challenge worth addressing.

The numerous meanings of leisure are both strengths and weaknesses. For example, a 'definition' of leisure remains problematic not only for researchers but also for social understanding. On the other hand, an open-ended definition allows interpretations about the meanings of leisure socioculturally as well as in situ. A strength of most leisure perspectives focuses on positive benefits. On the other hand, leisure is not always ideologically good when it results in some individuals and communities receiving negative outcomes as evident in activities such as sex tourism, pornography, drug taking, smoking, gambling, and other risky behaviors. If leisure has the potential for good, it also has the potential for evil.

Another strength and weakness in examining leisure meanings is the juxtaposition of individualism and collectivism. The disciplinary application of social psychology in the United States has tempered the sole focus on the individual in leisure science research. On the other hand, an individual's control on his or her life is dependent on environmental factors and cultural contexts. Further, the changes occurring worldwide with the emphasis on the commodification of leisure and the market economy may tend to amalgamate collective ideologies and individualism.

Expanding Leisure Opportunities

Although no one can 'give' someone else leisure, opportunities for leisure can be facilitated in many ways. A variety of organizations exist that focus efforts on providing leisure opportunities. These organizations can be categorized into three primary sectors: public (i.e., governmental), not-for-profit private (nongovernmental organizations, NGOs), and commercial private (i.e., for profit) sectors. Each has a somewhat unique mission but all contribute together to providing leisure opportunities to facilitate leisure experiences.

Over the past 100 years, these sectors have paralleled one another somewhat in their evolution in addressing the importance of leisure and recreation for individuals, communities, and societies. Public leisure industries are governmentally supported and are theoretically available to all citizens of a community, region, or nation. The public funding of recreation is based on the idea that leisure and recreation are among the rights of citizens in societies. Not-for-profit NGOs are usually focused on a particular activity or group of individuals and are limited based on the mission of the organization. Private commercial organizations are aimed at satisfying, and often creating, a demand for leisure services and are focused on appealing to participants (i.e., customers) who will purchase a product. These organizations focus on the privileges that people have related to fulfilling their recreation interests. Private leisure industries are probably the fastest growing sector because of the commodification of leisure and the market-driven nature of the economy. All sectors share a common focus on providing leisure, sports, recreation, arts, or tourism opportunities and experiences. However, they differ in their philosophies, objectives, facilities, financing, and membership.

As indicated at the outset, leisure is often misunderstood and can be interpreted in many ways by individuals as well as groups. Nevertheless, a good deal of academic research has focused on understanding dimensions of leisure.

The well-known top English language journals are *Leisure Sciences*, *Leisure Studies*, and *Journal of Leisure Research*, which all focus on various multidisciplinary approaches such as sociology, psychology, economics, business, environmental, and related social science disciplines.

Further, professional education provides individuals and organizations the skills and opportunities to facilitate leisure, recreation, tourism, and play experiences in a structured and organized fashion. The first formal university programs in the United States that trained individuals to teach and lead recreation started in the 1930s. These professional programs grew relatively slowly until the 1960s when they exploded in North America and other parts of the world such as Europe, Australia, and New Zealand. Today Asian countries such as People's Republic of China, Taiwan, South Korea, and India all have academic units focused on the professional aspects of leisure research and facilitation.

The purpose of much of the formal education was and continues to be to prepare individuals to manage areas, facilities, and programs that will offer recreation opportunities for people in all types of communities. The focus may be on parks, outdoor areas, tourist attractions, health institutions, or community programs. As noted, the venues might be governmental, not-for-profit, or private/commercial entities.

Further, the term profession is not used loosely in the academic world of leisure studies. Areas related to leisure such as parks, sports, and tourism are continuing to evolve in meeting the criteria of a profession, which includes an alliance with a social concern (i.e., the belief that professionals have in the value of recreation and leisure opportunities for the quality of individual and community life), professional societies and associations (e.g., World Leisure, Leisure Studies Association, National Recreation and Park Association), a code of ethics, a specialized body of knowledge (i.e., research), professional education and training, and professional standards of accreditation, certification, and licensing.

The Potential of Leisure

Several years ago, the National Recreation and Park Association (i.e., the largest citizen and professional organization in the United States that advocates for the value of recreation) launched a campaign called 'Recreation, The Benefits are Endless.' This campaign aimed to show the importance of recreation by describing benefits associated with individuals, communities and their sociocultural context, the environment, and the economy. One of the buzz words to describe the value of leisure is that it leads to 'quality of life.'

Quality of life can be defined as the degree to which a person enjoys the important possibilities in his/her life, which has many dimensions related to leisure. The understanding of how leisure and recreation contribute to this quality of life, however, is not always evident in people's minds until the benefits that leisure and recreation offer are considered.

Among the common benefits of leisure to individuals include physiological or physical health, psychophysiological, and psychological or mental health. Driver and his colleagues have described many benefits of leisure. The physiological benefits of recreation are usually embodied in regular exercise

and physical activity that often occur in free time. Many of the benefits of physical activity have been documented scientifically regarding how regular physical activity reduces people's risk for heart attack, colon cancer, diabetes, and high blood pressure and may reduce the risk for stroke.

From psychophysiological as well as mental health perspectives, many of the physiological benefits result in reduced stress. Leisure can result in mental and physical relaxation as well as positive changes in mood. Other psychological benefits of leisure can relate to better mental health through enhanced self-competence, improved sense of self-worth, self-identity, and a better ability to relate to others as a result of being involved in leisure and recreation.

Recreation has been documented to contribute benefits beyond those focused on individuals. For example, an economic benefit as a result of recreation occurs in communities where tourism dollars are spent. The economic impact of travel and particularly emerging activities such as sport tourism can be huge. The value of leisure and recreation involvement may also result in healthier lives that can result in saving money due to lack of absenteeism on the job.

Environmental and community benefits from recreation and leisure also exist. Environmental protection has been an outgrowth of a commitment to saving outdoor recreation resources. Parks and recreation play a role in preserving green space and the biological diversity of areas. Further, examples of community benefits may result from recreation or leisure when people develop pride in their community and in an ethnic heritage as a result of being involved in a recreation opportunity such as an ethnic festival.

Leisure can result in numerous benefits and is a ubiquitous aspect of people's lives in all cultures. Leisure, however, is not inherently good and is not always beneficial depending on how it is embodied. Nevertheless, for leisure to be meaningful and empowering, a milieu of social, economic, cultural, and environmental contexts should exist that contribute to better understanding of issues such as physical and mental health, social capital, environmental degradation, and numerous other cultural manifestations important for social change agendas.

Leisure is both a means and an end. Leisure is a means for human development whether related to physical, social, or psychological outcomes. As an end, it is an enjoyable experience that is voluntarily undertaken. Leisure may be misunderstood sometimes, but continues to have numerous and evolving meanings that provide great potential to enhance the quality of life for individuals, communities, society, and the world.

See also: [Play](#); [Work Efficiency and Motivation](#).

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Relevant Websites

- www.academyofleisuresciences.org – Academy of Leisure Sciences.
- www.aahperd.org/aapar – American Alliance of Health, Physical Education, Recreation, and Dance.
- www.leisure-studies-association.info/lsaweb – Leisure Studies Association.
- www.nrpa.org – National Recreation and Park Association.

Logic: Development of Logical Operations

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Glossary

Abstraction (reflective) Abstraction is the extraction and learning of invariant patterns (types) and individually variable characteristics (tokens) from actual experience, within and across situations. Abstraction often occurs in levels, the upper levels abstracting from lower ones. This abstraction process is reflective in the sense that upper levels mirror (reflect patterns or characteristics of) lower levels.

Attention (mental) Attention is the brain capacity to enhance or boost the activation of some knowledge (information bearing) processes. Spontaneous attention is spontaneously driven by the input (perceptual processes); mental or effortful attention, also called focal or executive attention, is endogenously driven by the brain's own activatory processes. Mental attention is needed to boost task-relevant schemes and interrupt/suppress irrelevant schemes, particularly within misleading situations.

Constructivism, constructivist (or cognitive) learning It is the theoretical view that knowledge is not directly innate or directly acquired from experience, but is dynamically constructed via reflective abstraction. This constructivist or cognitive learning occurs spontaneously in facilitating situations but needs mental attention in misleading situations.

Facilitating/misleading situations A situation is facilitating when salient aspects (activated cues, habits, schemes) make it easy to attain the intended goals. A situation is misleading when salient situational aspects interfere with intended goals.

Functional structures (e.g., schemes) Internalized patterns of structured information, often reflectively abstracted from

the person's own (external or mental) actions. Schemes are internalized functional structures (via cognitive learning). Functional structures emerging from performance are not in the repertoire of the person until internalized into schemes.

Invariants (types) Invariants are probabilistic patterns found to be stable across situations. Pierce and others call them types (signs that often are symbols). They are complemented by variants/tokens – characteristics that change across situations or individuals.

Model (or mental model) A system of signs/symbols that stands for either complex entities in reality, or procedures (blueprints for action), or for both. Mental models are functional structures, often complex schemes.

Relations (of coexistence; complexity of) Relations are functional structural patterns that actually coordinate objects or aspects of experience. Their complexity depends on the number of objects that necessarily must be coordinated via reflective abstraction to internalize a given activity or state of affairs. Relations of coexistence are abstracted relations that express a set of objects or actions (i.e., schemes) that in a given situation are coactivated and work together to produce an intended result.

Representation (levels of) This is the classic term referring to reflective abstraction of experientially encountered invariants and stable variable aspects.

Resistances These are invariant or variable aspects/characteristics of situations that impose necessary constraints on the functional structure of actions or representations of a person, relative to some goals in a given type of situation. Resistances are often relative to each species within a given type of situation.

Logic is the discipline that studies whether and how knowledge and linguistic statements convey truth, and how to draw true inferences from statements or state descriptions. Truth is the capability of knowledge representations, and of statements, to express information (or fail to express, in the case of falsity) that is suitably accurate or appropriate for the object of knowledge.

We distinguish two sorts of logic. The first, such as found in mathematical logic, is constituted by a collection of generic systems that represent and analyze thought as synchronic (atemporal), formal (focussed on form, rather than content or local meaning), categorical, and systematic. These generic logical systems serve to formulate possible 'objective' relations found among meaning-bearing structures of inference in thought and language, characterizing them as true or false (for instance, suitably accurate/inaccurate vis-à-vis actual experience).

The second sense of logic is found in dialectical and other approaches to philosophical/epistemological logic and also

in Piaget's developmental psychology. This sort studies the temporal (diachronic) emergence and evolution of logical systems of the first type within the minds of humans who mature and develop – a nonsystematic sort of constructivist process analysis, which is often probabilistic and dynamic/dialectical. This constructivist logic serves to investigate how and why the organism might produce categorical logical systems of the first type: This is in fact, as Piaget pointed out, a psycho-logic or developmental epistemological analysis of the first type of logic.

As Piaget and Garcia indicate, the two sorts of logic should be distinguished because the first type, being systematic, categorical, and atemporal, cannot describe or explain the steps of change that lead to its emergence and to its developmental evolution within individuals. Such emergence and evolution must be formulated with a logic (psychologic) of the second type. In this article, we focus only on this second type of logical analysis, suggesting how growth of mental attention

(the major maturational component of working memory), along with other organismic generators (i.e., schemes and operators), constrains the emergence and evolution in humans of the first type of logic.

Classic theory of knowledge (epistemology) sees logic (the first type) as a discipline that studies how to ensure suitable accuracy of a representation (in the subject of knowledge) vis-à-vis the object of knowledge (expressed in actual experience). Such a formulation is not clear, however, because of the ambiguous reality status of actual objects. Objects can be represented only after acts of knowledge; so how could accuracy of knowledge be appraised by matching a person's representation with his/her experience of the object, if both are in fact subjective representations? The nature of representation, thus, needs clarification.

Pierce, the nineteenth century logician and founder of semiotics and pragmatism, formulated representation in ways that anticipated current views. Pierce thought that objects of knowledge are cognitively grasped, that is, represented to the person's own mind, by way of signs (semiotics is the logical study of signs). A sign is the product of a habit, that is, the durable mental coordination (or functional structure – see below) of four meaning-generating constituents: (1) the token sign itself, often manifested in the act of communication, such as the French word 'homme'; (2) the context or ground of meaning from which this sign stems – for example, awareness that this is a word belonging to the French language; (3) the referent or actual object for which the sign stands – that is, a two-legged rational animal, etc.; and (4) the semantic operative that integrates meaning of the three previous constituents, combining them into a single semantic-pragmatic entity that we call 'man.' As Johansen has indicated, Pierce often collapsed terms (2) and (4) into a single term called interpretant. This triadic relationship among sign (or symbol), its referent/object, and their interpretant (or interpreted meaning, i.e., semantic operative plus context) is often emphasized in semantic logic. What enables an internal-meaning sign to be interpretant of another external sign is the equivalence of representative functions that

relate each of the signs ('homme' and 'man' in this case) to the referent/object. However, as we shall see below, a formulation of this semiotic function in terms of the original four terms is much more revealing in cognitive development.

A symbol is a sign that is not fixed in meaning, but is instead semantically/functionally detached from its referent and its context, so that meaning can change with a change in context, etc. For instance, when a baby begins to use language, one of the first words he/she learns is 'mom,' which is used in relation to the mother (see [Figure 1](#)). At first, the sign in question is not a symbol but rather a signal (a sign that is not a symbol); so the uttered 'mom' sign has a fixed meaning irrespective of the context. For instance, if the baby learned to say 'mom' as the mother tried to feed her, the sign in question might have the fixed meaning of 'feed me'; if she learned to say 'mom' in the context of playing, this sign might have acquired the meaning of 'raise me in the air,' etc. At this point, the infant might be 8 or 9 months. When he/she grows older, after 12 months of age, the sign 'mom' will have changed into a symbol, carrying the meaning of 'feed me' in the context of feeding, and the meaning of 'raise me in the air' in the context of playing, etc. Notice that symbols and signals can replace each other as functional processes. For instance, under emotional stress (or with habitual practice), symbols can turn into signals: When an anxious, panicky person hears someone shout 'fire!' inside a movie theater he/she may not take it as a symbol, suggesting the possibility of an actual fire, but rather may take it as a signal and run in panic to the door as if he/she were getting burned.

Complex systems of signs may be combined into models. Models are symbolic systems of ideas (or external signs) that stand either for complex entities of reality (e.g., universities, airports, cities, transportation organizations – which constitute figurative or object models) or for complex blueprints for action (these are operative or action/transformation, or executive, models); or they might combine these two aspects into more complete mixed models (e.g., theoretical, perhaps causal, model accounts).

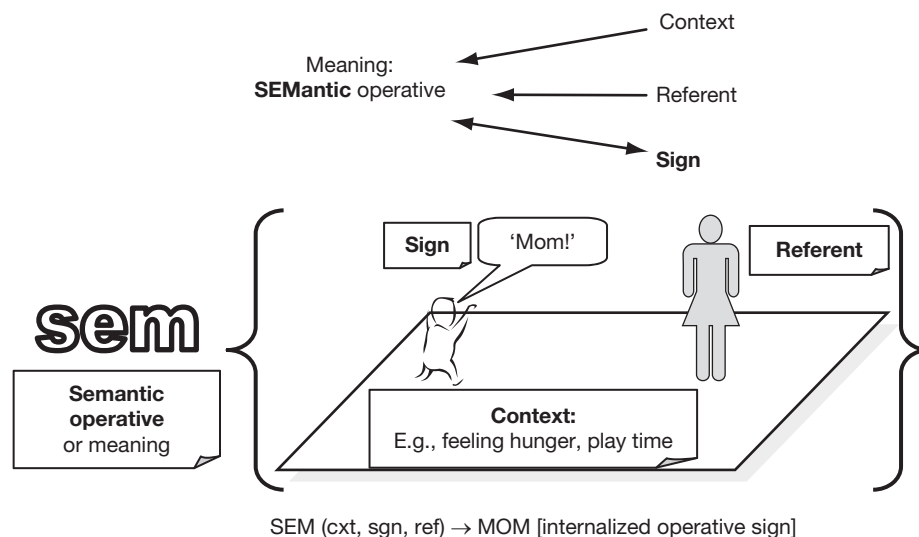


Figure 1 Schematic representation of constituents in a sign with illustrative example of baby calling his/her mother.

Logic relates the subject of knowledge (and epistemology) to the object of knowledge (and ontology) by studying the nature of truth, as well as languages and models used for representation. This observation, together with the fact that signs (semiotics) and truth are important aspects of logic, show logic's complexity. Relative to actual experience, which deals with particulars in the sense of entities that are grounded and concrete (i.e., offering resistances to action by imposing constraints), logic is mostly generic (representing kinds rather than concrete individuals) and often is organized in levels of representation, which become progressively more abstract. To provide insight on the psychology of levels of representation, we briefly discuss the problem of relations (descriptive and causal) between generic abstractions of knowledge and the particulars of actual experience; these relations were first expressed by Plato who unwittingly generated what we call 'Plato's problems.'

The Logic of High Cognition Versus Low Cognition

Plato's Problem

Plato was first to describe a dialectics between two modes of knowing/processing, whose dynamic interaction causes human experience and thought. For Plato, there were two worlds: the world of generic ideas (or being) and that of the senses. The world of ideas configured and categorized the world of the senses (or becoming) to make human knowledge possible. Humans partake of both worlds and use clear ideas to categorize and configure the confused world of becoming. Plato's way of formulating the problem of knowledge and its logic was oversimplified. There are not two distinct worlds, but rather many different levels or strata of knowledge, each serving as content to higher levels and giving form (informing!) knowledge of the lower levels.

Implicit in Plato's description, or in a description of nested levels, are problems that Plato did not solve and current cognitive science is facing. For instance, how to differentiate complementary but irreducible modes of cognitive processing: progressively more conceptual higher levels (i.e., generic, logico-mathematical, linguistic-logical, etc. – *high cognitive functions*) versus progressively more experiential low levels (concrete particulars, infra- or nonlogical, perceptual-motor and spatiotemporal processes, etc. – *low cognitive functions*)? How to differentiate between Plato's two modes (which translate into graded cognitive levels), while explaining both modes as emerging from common mechanisms? Indeed, interactions among innateness (maturation) and experience (learning, culturally mediated or direct) must be at the origin of both low and high cognition. How can these two sorts of knowledge processes be interfaced, maximizing adaptation to evolving realities, so as to embody in mental models the encountered changing resistances (reality constraints)? We attribute these problems to Plato because for him, the conceptual world of ideas was God given – it had causal sources distinct from those of experiential knowing. Some current neonativists, who think of conceptual knowledge as mainly expressing direct evolutionary acquisitions (logic and language largely explained by direct innate dispositions), might be seen as descendants of Plato.

Piaget's Reflective Abstraction

A better way to understand these two sorts of processing (low versus high cognition) is as a simplistic description of multiple nested functional levels resulting from cognitive learning – a process that Piaget called reflective abstraction. These cognitive levels occur as the brain constructively (i.e., level by level) represents to itself interrelations existing among packages of perceptual and/or mental experiences. This process occurs when experiences are sufficiently invariant (i.e., probabilistically replicable in approximate ways) from one situation to another, across space and/or time – whether experientially or during mental analysis. This cognitive learning is an abstraction because it ignores what is not probabilistically invariant, and then coordinates encountered invariants to create, in separate levels, progressively more complex objects and/or operative procedures. This learning is a reflective abstraction because packages of invariants at higher levels actually mirror/reflect general characteristics (patterns, configurations, or procedures) found at lower levels.

Reflective abstraction exists in many areas and content domains, but we illustrate it with a simple, intuitive example: the way a novelist might write a novel and a reader might come to appreciate its story, by integrating across chapters. The writer might begin with the gist of the story, a broadly formulated idea. Because the gist lacks concrete particular details and is restricted to general ideas, it qualifies as a high level of reflective abstraction. The writer would concretize and differentiate this idea by ordering in time general events and interactions that unfold in the story. He might divide the outlined story into chapters (chronological or not), creating lower levels of reflective abstraction. Progressively lower nested levels would emerge to differentiate events and happenings into more and more detailed concrete accounts, which progressively grow into different chapters. Finally, very concrete local details might be revised, at the lowest levels of reflective abstraction, to ensure emergence of local effects that express the concreteness of life experience. Whereas our writer proceeded predominantly top-down in the hierarchy of levels, often making bottom-up loops, the reader would proceed mostly bottom-up in the hierarchy, albeit with some reflective top-down loops. At the end, when the reader had constructed these levels of reflective abstraction in her own mind, she would have reached in intuitive completeness the gist with which the writer began, a gist level of abstraction that is on top of the hierarchy.

The novel might have, as life often does, circumstances that induce protagonists to err. These are misleading situations that often result from habits (automatized representations or actions) and may lead to error – that is, to represent or do something that contradicts intended goals or leads to misrepresentation. Salient but goal-misleading perceptual aspects may cause misleading situations. There are also facilitating situations caused by goal-relevant habits or perceptual salencies that induce persons to do what they must to attain their goal. These habitual and/or salient processes causing either misleading or facilitating situations typically exist at lower levels of reflective abstraction, and their activation dynamically hinders or facilitates goals formulated at higher levels of abstraction.

Piaget, who followed Kant in calling such processes schemes, emphasized these dynamic interactions among different levels

of reflective abstraction within a person's memory store or repertoire of schemes. Contemporary researchers on logical reasoning (e.g., J.S. Evans, P. Barrouillet, or D. Kahneman) have reached similar conclusions using different terminologies. They have contrasted two sorts of interacting processes (dividing the variation of levels into two categories, lower and upper, as Plato did): The heuristic processes (or reasoning system I) and the logical-analysis processes (or system II). These current authors think that misleading, or facilitating, situations occur when heuristic processes (which are more concrete, i.e., situated at lower levels and more habit-driven) hinder, or facilitate, implementation of more complex logical analyses that higher levels are attempting. To overcome misleading situations (problem-solving situations are often of this sort), higher level logical analyses that mobilize mental attention (working memory) and inhibit misleading lower-level heuristic processes may be needed.

Other Compatible Ways of Conceiving the Origin of Logic

Besides reflective abstraction, there are three other compatible ways of conceiving conceptual knowledge and logic: logic-as-structure-from-language, logic-as-structure-from-action, and logic-as-constructivist-invariant. Note that structure, a logico-mathematical notion, is defined by French epistemologists as a system of relations holding among constituent elements such that the system in question remains invariant (basically unchanged) as constituent elements are interchanged with other elements of similar kind. For instance, the relational system that identifies a face can be recognized, not only in animals but in designs using geometrical figures as eyes, nose, mouth, etc. A face is a visuospatial structure. There are also dynamic-system structures often found in executive procedures in business, in procedures of different games and sports, in language games we practice when communicating, and in logical operations we use in thought processes.

Within logic-as-structure-from-language one sees logic as a by-product of language and linguistic communication. This popular view, often called a rule-based or mental-logic approach to thinking, sees logic as main constituent of suitably accurate and/or valid reasoning, enabled by innate language characteristics refined and integrated using input from communication and cultural transmission. Language coexists with high cognition in high levels of abstraction, and many researchers think that high cognition emerges because of the power of synthesis afforded by language.

Piaget was perhaps the first research psychologist to have understood logic (and reasoning development) in terms of logic-as-structure-from-action (i.e., as internalized action). For him and many others, logic emerges by way of cognitive learning, as action-serving systems of representation and mental logical operations. These systems have functional structures that relate to actual experience (the truth function), such as relations of coexistence (see below) and/or ordinal relations among elements. They emerge as invariants in goal-directed activity addressed to the environment (i.e., praxis) – perhaps during problem-solving or analytical goal-directed thinking.

Consider now the third way: logic-as-constructivist-invariant approach, which in fact coordinates or integrates the other approaches. A current version of the levels approach given in the previous section, involves graded levels of reflective abstraction; this version helps to solve Plato's problems via cognitive learning. A liberalized version of the first approach (language and its structure as causal factors in logic and logical operations) is found in constructivist approaches. However, constructivism has also the second approach: mental activities of logic are seen as forms of *internalized action* (as current neuroscience has shown), that is, as dynamic interactions between internalized objects of experience (figurative processes) and operative processes – internalized procedures.

A Psychological Construct: The Organismic-Scheme Unit

Within a constructivist perspective, analysis of psychologic (logic embodied in functional structures of organisms, i.e., organismic logic) requires explicit formulation of psychological units – processes serving to relate high-level (abstract) functional categories to low-level concrete processes of life situations. Kant was the first to ask how to interface these abstract high-level concepts (logical structures) with concrete low-level processes representing particulars of experience. His answer was an interface of mediating processing units that he called schemes (or schemas). Within developmental constructivism, we define a scheme (Sch.) as a dynamic coordination of three components: (Sch.1) a functional component that embodies the scheme gist and expectancies of an outcome, that is, anticipation of consequences of the scheme application (representations, procedures, or operative effects); (Sch.2) a releasing component that has conditions that, when satisfied (matched) by features/aspects of a situation, induce the scheme to apply; and (Sch.3) an effecting component with effects (representations, operative procedures, etc.) that actually occur in the situation when the scheme applies. Notice that from a constructivist viewpoint representations, as much as operative actions, are effects; suitable conditions of the releasing component serve as the intermediaries between the input and the output (which is the effect). As Piaget often claimed, the coded stimulus (representation) is already a response. This empirical rationalist view is in sharp contrast with the radical empiricism of many scientists and philosophers, for whom figurative structures, such as objects, are already available in the external world; and the act of (figurative) knowing consists in making a copy of them as representations.

Consider our earlier example of the signal/symbol of mother, which 8-to-9-month-olds learn to use to control mother's activity by uttering the word 'mom.' As a signal, the scheme of mom might have the following definition in the infant (we use English language to describe the infant's feelings, which are not linguistic but experiential, i.e., low level): (Sch.1) gist: uttering 'mom' will get *Mother* to feed me (or play with me, or whatever concrete activity is at the origin of the scheme); (Sch.2) conditions: feeling hunger or wishing more of the particular food, seeing or hearing *Mother*; (Sch.3) effects: uttering 'mom,' looking at mother with the expectancy from

Sch.1 that she is going to feed baby in the usual way. The scheme embodies the signal 'mom' that baby can use as an *operant*, that is, a baby's operative action that will induce *Mother* to feed baby in the expected way when he/she wants. This is a low-level psychological structure acquired using simple associative learning. Notice that *Mother* is the baby's scheme representation of a protector-companion, which in part might be innate and species specific.

At 12 months or so, the baby begins quickly to produce symbols, that is, signs in which the meaning and/or the referent can change with the context because all constituents of the symbol, the sign (sgn), context (cxt), referent (ref), and meaning (sem – for semantic operative) are separate, distinct schemes that become coordinated as the symbol is formed (see Figure 1). In the case of the *Mother* symbol, sgn would be the utterance 'mom'; cxt would be the sort of situation, for example, the feeding context, the playing context, etc.; ref would always be *Mother*; and sem would be the actions of *Mother* that implement the operative intervention stipulated by cxt. Notice that this symbol coordinates the four schemes forming a spatiotemporal relation of coexistence among sgn, cxt, and ref thanks to sem. Such a complex, mobile coordination cannot be achieved with associative learning. It requires focused mental attention (i.e., working memory) and intentional, effortful activity: This is a high-level psychological reasoning that marks the origin of language acquisition.

This symbolic function serves to coordinate chosen schemes that functionally complement each other, which are reflectively abstracted into more complex, higher level schemes – eventually leading to the emergence of a mind. Logical operations are mobile and functionally complex symbolic processes that run mentally (internalized); they allow for reversible mental acts that exhibit adaptive variability. Preschoolers, and much more so school children and adults, produce this reversible and anticipatory symbolic processing, but other high primates (e.g., chimpanzees, orangutans) also can do it. However, mental processes of nonhuman primates lack mobility, reversibility, and combinativity relative to preschoolers, possibly because mental-attentional capacity of apes only compares to that of 26-to-35-month-old humans.

Consider, for example, chimpanzees' use of multiple tools (hammer-stone, anvil-stone, wedge-stone to stabilize the anvil) for cracking nuts, discovered by Matsuzawa and Yamakoshi. The logic of action in this behavior includes two nested functional components. First is an operative scheme (PLACE) for positioning the nut (*nut-food) on the anvil-stone (*anvil) during nut cracking (here figurative schemes are marked with a *). Second is another operative (CRACK) that uses the hammer-stone (*hammer) as tool and the nut as target (*nut-target). Although the schemes *nut-food and *nut-target both refer to the same actual object, in our method of task analysis they are distinct schemes because they belong to different contexts of use, that is, distinct functional activities or practical skills. To crack a nut, chimpanzees must coordinate at least these schemes:

CRACK(*hammer, PLACE(*anvil, *nut-food), *nut-target)
[1]

In English, this formula might be translated as follows: first the chimpanzee places the nut-food on top of, and supported

by, the anvil; then, always maintaining the nut in place, he cracks the nut by using the hammer-stone.

Because the situation is misleading (e.g., prior habit schemes should lead chimpanzees to take the nut to their mouth or ignore the stones), performance requires chimpanzees to boost all schemes with endogenous (i.e., mental) attention. Specifically, six distinct schemes must be simultaneously boosted in activation using mental attention. This is about the most complex symbolic coordination of schemes that great apes are capable of (six or seven perceptual-motor schemes), which places them on par with the mental-attentional capacity of 2- or 3-year-old children. This well-known example of problem-solving performance shows chimpanzees' symbolic anticipatory processing as well as their limitation. Processing is essentially perceptual-motor, cued by facilitating situations, and somewhat lacks mobility: Once habits are formed, great apes have a hard time in overcoming them within misleading situations. Although it is a logic-of-action operative coordination, this performance is indexing a relatively low level of reflective abstraction.

Consider now high-level mental processing in humans. We often encounter problems in which at least two variables interact in terms of certain relations of coexistence (i.e., definite states of the variables in which they either exist in the situation and appear together or do not, having some other relation of coexistence). The problem (perhaps a panel with buttons p , q , r , s , etc., some of which must be pressed to obtain or predict reward) might on a given trial be such that a desirable outcome, for example, a reward, occurs if variable p is present (or is acted upon) and variable q also is present (acted upon). However, when p but not- q , or q but not- p , or neither is present (acted upon), the desirable outcome is not obtained (note that not- p or not- q are, respectively, any buttons different from p or q). This particular pattern (or relation of coexistence) related to a suitably accurate (true) outcome is known in logic as a conjunction. What sort of mental process is needed to ensure that no error is produced when participants guess the outcome (e.g., when some buttons are pressed in the task just described)? A rational task analysis suggests that they must discover, and keep in mind, that only one possible truth state brings the good outcome: $p \& q$, that is, p is true (e.g., should be pressed) and q is true. Logicians may symbolize the same state of affairs by writing pq .

Sometimes the problem is more complicated. For instance, truth might occur (i.e., good outcome when buttons are pressed) in three different truth states: with pq , with $-p-q$ (i.e., not- p and not- q), and with $-pq$ (i.e., not- p and q); but not (false, or bad outcome when buttons pressed) when $p-q$ (i.e., p and not- q). Logicians call this state of affairs a conditional or implication relation, which they might represent as $p \rightarrow q$, meaning that the relation is such that true outcomes occur for $pq \vee$ (i.e., or) $-p-q \vee -pq$. (In psychology, the symbol ' \vee ' means 'or', the symbol '&' means 'and', and the symbol ' \rightarrow ' means 'if... then,' but only when the two terms p and q share meaning – i.e., are related by a semantic implication.)

A Venn diagram (i.e., a diagram in which circles represent all the individuals or objects that share, or fall under, stipulated predicates or propositional statements) can provide a clear figurative model for all possible relations of coexistence – all possible truth values – that relate p and q ; this is equivalent to

what has been called a truth table. In the four Venn diagrams of Figure 2, we symbolize with a dot areas of the diagram that are true for the state of affairs or atomic propositions being contrasted (i.e., p or q), and leave blank areas that are false for them. For instance, if in the upper-left Venn diagram, p stands for the predicate *father* and q for the predicate *man*, then the three dots found in this diagram show that pq (indicated by the upper dot area) is true for the two predicates; both $\neg pq$ (right-middle dot area) and $\neg p\text{-}q$ (lower dot area) are also true. Indeed, if a person is a father, he is also a man, but one can be a man without being a father or be neither a father nor a man. However, it is not possible to be a father without being a man, which renders $p\text{-}q$ (the left-middle dot area) false. These four cases exhaust all possibilities, making the diagram a pictorial representation of a complete truth table.

Under this diagram, we have written in symbolic notation the corresponding conditional (\rightarrow) operator, that is, $p \rightarrow q$ (often called implication, i.e., the propositional-connective *if... then*, in the language domain). This conditional operator translates into a description of truth states expressed by the formula $(pq \vee \neg pq \vee \neg p\text{-}q)$, where each truth state corresponds to one dot area in the diagram. The lower right diagram in Figure 2 corresponds to an inclusive disjunction operator ($pq \vee p\text{-}q \vee \neg pq$), interpretable in language as the connective *and/or*; which can be logically symbolized by $p \vee q$ (example: p is a *doctor* and q is a *man*; expressible in language by the sentence ‘The person is a doctor and/or a man’). The lower left diagram corresponds to a conjunction operator (pq), which in language corresponds to *and*, logically symbolized by $p \& q$ (example: p is *French* and q is *General* – ‘the person is a French General’). The upper right diagram expresses a biconditional operator ($pq \vee \neg p\text{-}q$), symbolized by $p \equiv q$ (example: p is a *medical doctor*, q has *completed studies in a Faculty of Medicine* – ‘The person is a medical doctor if and only if he/she has completed studies in a Faculty of Medicine’).

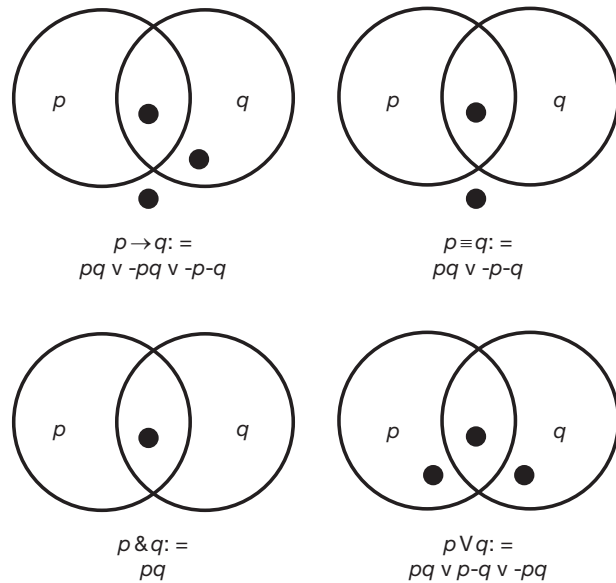


Figure 2 Venn diagrams (i.e., truth tables) of four logical operations: Implication, disjunction, conjunction, and biconditional.

In describing relations of coexistence between two (or more) variables, many logicians talk about (truth-) state descriptions if they mention only the truth states (i.e., the cases, areas with a dot in the Venn diagrams) that bring about truth; and they talk about truth tables when all possible cases (true and false) are given. In the current psychological literature, following Johnson-Laird’s theory of mental models, researchers on logical connectives may call a model each truth state (i.e., one dot area in a Venn diagram or one truth-table case). This usage contravenes use of this term in logic and much of science. We shall call model only the whole truth-table representation (all true or false cases) or the whole state description – which is just a truth table with false states left implicit. If we state all possible cases and identify true ($\$$) or false (\wedge) as values, the result is a logical truth table. We shall represent truth tables with the following notation:

$$\text{Conjunction [and]} : \wedge(\neg p\text{-}q \vee \neg pq \vee p\text{-}q), \$ (pq) \quad [2]$$

$$\text{Conditional or implication [if... then]} : \wedge(\neg p\text{-}q), \$ (pq \vee \neg p\text{-}q \vee \neg pq) \quad [3]$$

Notice again that these four cases (i.e., pq , $p\text{-}q$, $\neg pq$, $\neg p\text{-}q$) are all the possible relations of coexistence between two variables, and each variable can be either true ($\$$) or false (\wedge). Consequently, there are 16 possible different relations of coexistence, and each corresponds to a different logical connective that has its own linguistic form. Here are two other common connectives:

$$\text{Disjunction [and/or]} : \wedge(\neg p\text{-}q), \$ (pq \vee \neg p\text{-}q \vee p\text{-}q) \quad [4]$$

$$\text{Biconditional or equivalence [if and only if]} : \wedge(\neg pq \vee p\text{-}q), \$ (pq \vee \neg p\text{-}q) \quad [5]$$

In the case of conjunction ($p \& q$) problems, only the true state is spontaneously salient because its two variables, being positive, are easily processed at low level of reflective abstraction. This is due to the perceptual presence of positive values and people’s habit of ignoring negative values, focusing only on positive ones (these organismic biases are called heuristic factors in the literature). For this reason, the truth state in a conjunction is easy to remember. In contrast, in conditional ($p \rightarrow q$) problems, with a state description that has negative values in the variables (i.e., $pq \vee \neg p\text{-}q \vee \neg pq$), two of the true states will be difficult to remember because of the negative values. Problems involving the other two connectives we have mentioned, disjunction and biconditional, should be and are easier than those with conditionals, but harder than conjunctions.

This finding is well supported in the literature (see, e.g., the work of P. Barrouillet and his collaborators) but not clearly explained. The usual explanation rests on greater difficulty to process single negative values. In conditionals, negative values are found both in the true (pq , $\neg p\text{-}q$, $\neg pq$) and the false ($p\text{-}q$) values; however, in disjunctions and biconditionals, the truth states that contain one negation (i.e., $\neg pq$, or $p\text{-}q$) have the same value (false in the biconditional, and true in the disjunction). Thus by categorizing (recoding) them as states with only one negative variable, it is possible to treat both states together assigning the value they share. In contrast, in the conditional these truth states must be treated separately.

Piaget was aware of these differential degrees of difficulty among connectives. It has been shown that, developmentally, conditionals in problems are first treated as if they were conjunctions (e.g., by 8- or 9-year-olds); later they are treated as biconditionals (12-year-olds); and finally, older adolescents (14-year-olds) treat conditionals as conditionals. The current literature explains this finding in terms of heuristic versus logical analytical processes and of high working-memory demand in analytical processes. A much clearer explanation can be made by adopting a neo-Piagetian developmental approach, as we now briefly summarize.

Development of Logical Operations: Developmental Stages

Unlike Piaget's theory, in which qualitative logical characteristics of tasks are thought to determine developmental difficulty (i.e., age at which they first can be handled by children), current researchers tend to interpret tasks' difficulty as due both to their mental-processing demand (in the sense of working memory, i.e., mental-attention demand of the task) and their executive demand. Executives are neural processes that plan the logical operations to be carried out and control relevant schemes to be activated, as well as irrelevant or task-misleading schemes to be inhibited. Unlike many cognitive scientists, we separate mental attention (working memory and attentional interruption) from executives because tasks that control for executives (e.g., by teaching them) and that vary the demand for mental-attentional activation and inhibition, exhibit the developmental levels or substages that Piaget formulated (see Further Readings, for examples). In contrast, when the task demand on mental attention is kept reasonably constant, but the executive demand is increased by making the tasks procedurally longer or more complicated (while keeping the same mental demand), discontinuous developmental stages do not appear and instead performance level increases linearly with age. This happens whenever learning is the main causal variable because learning increases cumulatively with life experience.

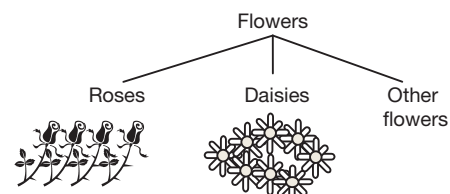
Piaget described four main stages or cognitive (logical-operation) levels found in normal development. Existence of these stages assumes that children have sufficient executive know-how and are presented with suitably misleading tasks that are novel for them. (1) First is the sensorimotor stage (from 0 to 30 months of age), which features nonsymbolic (signalic) coordinations of perceptual-motor activities. The power for constructing symbols develops, on average, at 12 months; at 18 months, coordination of symbols (symbols of symbols) begins. (2) The preoperational stage begins at 3–6 years of age, when more or less complex symbolic coordinations of activities occur; but only in the context of present (here and now) situations. (3) In the concrete operational stage (7–11 years), children show symbolic activities vis-à-vis future situations, not just present ones. (4) With the formal operational stage (11 years and older), abstract reasoning begins in novel (not practiced) situations with mental activities addressed to (formally) possible situations – in addition to present or future ones. A situation is formally (not just empirically) possible when it does not contradict any relevant known fact, and so might be true.

We omit the discussion of sensorimotor processes from this article. Jonas Langer discussed them in his article on Logic in the previous edition of this Encyclopedia; moreover, the reader may refer to the list of Further Readings. We emphasize again, however, that at about 12 months of age, the ability to coordinate four distinct schemes appears, using the newly expanded power of mental attention (working memory). This maturational growth of mental attention causes emergence of the symbolic function, which explains why babies learn language in accelerated ways after 12 months. Then, with further growth of mental attention, at about 26 months of age, children become able to coordinate six distinct schemes, thus reaching the working-memory capacity that most adult chimpanzees seem to have (as shown by the chimpanzees' use of multiple tools for cracking nuts summarized above).

Levels of Mental Operations According to Piaget and Neo-Piagetians

Logical operations increase in complexity with both the person's executive know-how (as a function of learning) and his/her mental attention or working-memory capacity. Current researchers differ on how to measure this capacity (see Further Reading), although all the methods seem to be related. Among them, the simplest current one, closest to Piaget's own logical method, is Zelazo's Cognitive Complexity and Control theory. It consists of examining the depth of hierarchical coordination (levels of reflective abstraction) needed to solve the task. Another method, proposed by Halford, is based on the Relational Complexity of logical operations involved. For Halford, complexity is a function of the number of variables that must be jointly coordinated to solve a task. He distinguishes unary, binary, ternary, and quaternary relations. A unary relation occurs when a conceptual category or a predicative scheme in perception is applied on a single logical argument (an object) to categorize it. For instance (we write logical operators or predicates with capitals and logical arguments in lower case), the expression $\text{DOG}(x)$ says that an uncategorized perceptual entity x is a dog; and $\text{DOG}(\text{Rover})$ says that Rover refers to a dog. The sentence, or empirical observation, that the small elephant is larger than the dog involves a binary relation because there are two arguments: $\text{LARGER-THAN}(\text{elephant: dog})$.

In contrast, a logical-problem question such as "if I have in my hand three roses and eight daisies, do I have in my hand more flowers or more daisies?" can be solved only by coordinating a ternary relation, as represented in Figure 3. Namely:



$\text{INCLUSION}^{L1} (*\text{flowers: } \{\text{*roses}\}_{L1, \text{sit}}, *\text{daisies} \leftarrow [\text{flowers non-roses}])$

Figure 3 Representation of the class inclusion conceptual hierarchy with the operator logic formula of our mental problem for solving inclusion problems.

INCLUSION (flowers: roses, daisies \leftarrow [flowers non-roses])
[6]

There are only three logical arguments (objects), because in this formula, the expression $\leftarrow[\dots]$ indicates that inside the brackets are predicates or characteristics belonging to the representation of daisies. This ternary relation expresses the coordination of two levels of reflective abstraction: the hierarchical relation between a superordinate class (flowers) and its subordinate classes (roses, daisies, etc.) as shown in Figure 3. As Piaget and Inhelder (originators of this inclusion-of-classes task) knew well, logical coordination of this semantic hierarchy solves the problem. The problem exists because young children see in the hand only roses and daisies, and linguistically tend to assume that the question ‘are there more flowers or more daisies?’ makes reference to only roses and daisies (i.e., ‘flowers’ is taken to refer only to roses). To solve this tricky question, the child must remember that daisies also are flowers but are not roses (i.e., he/she should recall the semantic hierarchy). The task is difficult because it is semantically misleading, although Piaget may not have intended it to be. Our research shows that misleading situations (as contrasted with facilitating situations, where no activated scheme is misleading) serve better for estimating mental-attentional demand (working-memory processing complexity) of tasks. Nonetheless, a distinction between misleading and facilitating tasks is still often missing in the literature.

Halford considers that unary relations are handled by 1-year-olds (i.e., when the symbolic function first appears); binary relations are handled on average (median age) by 1–2-year-olds. Ternary relations are handled, depending upon the task, at various ages, much later than binary relations; according to Halford and Andrews (see Further Reading), ternary-relation tasks are passed by 70% of 5-year-olds and 78% of 7–8-year-olds. They also report that quaternary-relation tasks are generally accessible to 11-year-olds (no passing rate is provided). Clearly, Halford’s relational complexity metric, and its developmental passing ages, cannot explain all the levels found in the well-studied substages described by Piaget (see Table 1), which do coincide with levels of reflective abstraction given by Robbie Case and others.

In contrast, our earlier-developed method, which includes significant aspects also available in Halford’s approach (but adds new important distinctions), makes measurement of complexity more precise. Our method explains the transition from one Piagetian substage to the next as due to an increase in attentional capacity, which is indexed to each complexity level. The third column of Table 1 gives the mental-attentional complexity level (i.e., capacity) children in each substage have been shown to have available, on average, when tested with misleading tasks. For instance, in low concrete operations, we expect a majority of 7- and 8-year-olds to be able to coordinate, using mental attention, three symbolic schemes plus e sensorimotor schemes (e is the mental capacity available at 26 months – a constant that does not need to be quantified when analyzing mental tasks); all to a total of $e + 3$.

Consider again the inclusion-of-classes task (see formula [6] and Figure 3). We represent the complexity of this task in formula [7]:

$$\text{INCLUSION}^{L1}(*\text{flowers} : \{*\text{roses}\}_{L1, \text{sit}}, * \text{daisies} \leftarrow [\text{flowers non-roses}]) \quad [7]$$

Table 1 Chronological age of Piagetian mental-processing substages and predicted mental-attentional capacity

<i>Normative chronological age</i>	<i>Piagetian substage</i>	<i>Expected mental-attentional capacity ($e + k$)</i>
3–4 years	Low preoperations	$e + 1$
5–6 years	High preoperations	$e + 2$
7–8 years	Low concrete operations	$e + 3$
9–10 years	High concrete operations	$e + 4$
11–12 years	Introduction to formal operations	$e + 5$
13–14 years	Low formal operations	$e + 6$
15 years to adulthood	High formal operations	$e + 7$

Note: k refers to the theory-estimated number of symbolic schemes that an individual can simultaneously boost in activation using her/his mental-attentional capacity.

Here the operative scheme is written in capitals. Figurative schemes are in lower case with an asterisk (*) preceding them, indicating that these are symbolic schemes/signs and not referents – real objects. We have added to formula [6] assumptions about perceptual salience and chunking (i.e., automatized logical-structural learning, or L-learning – L1 in formula [7]). The coordination operator for the inclusion of classes (i.e., INCLUSION) has chunked to it (this is symbolized by superscript/subscript L1) the figurative scheme (*) of roses – a perceptually salient aspect of the situation (symbolized by subscripted *sit*), so that when mental attention boosts with activation the inclusion operator (this boosting is symbolized in the formula by underlining INCLUSION, *flowers, and *daisies), the *roses get automatically boosted as well. Thus, as formula [7] shows, there are three symbolic schemes (all underlined) that need attentional boosting. The mental or working-memory demand of the task is therefore $e + 3$ on average, which predicts that a majority of 7- to 8-year-old children (low concrete operations substage) will solve this task. This is what Piaget, Halford, and many others have found, although degree of facilitation or misleadingness of a particular task version can make an important difference. Notice that the schemes we count as boosted with mental attention here (during stages of preoperations, concrete operations, and formal operations – Table 1) are symbolic. Signalic sensorimotor schemes usually are facilitating and boosted with sensorimotor attentional resources (the e component of $e + k$ of mental capacity, which functions as a constant after 3 years of age). In formula [1] and our earlier analysis of the symbolic function, the schemes were sensorimotor.

Let us now consider an example at the high concrete operations substage. We gave the logical formula (truth table) for a conjunction in formula [2], and we now add (see formula [8]) aspects needed to describe a mental model of children processing this sort of problem:

$$\text{CONJUNCTION}(\underline{(-p-q \vee -pq \vee p-q)}, \underline{\$(pq)}) \quad [8]$$

For simplicity, we omit the star (*) that would mark true/false states as being symbolic figurative schemes. The conjunction operation (symbolized with capitals) carries out coordination of all true/false states relevant as alternatives (\vee) to

evaluate a conjunction in a suitable task. This operative CONJUNCTION includes the knowledge that either true (\$) or false (^) evaluation will be present, but not both. We assume that false (^) states, that is, all states that contain $\neg p$ or $\neg q$, are spontaneously chunked together (L-structured via logical learning), because subjects have a strong tendency (due to automatisms or heuristics, i.e., low-level processing) to deemphasize or neglect, and treat together, negative states (e.g., $\neg p$, $\neg q$) and false values; but emphasize and attend to true values and affirmative states (i.e., p , q). As the four underlines show, there are four schemes (or chunks) to be boosted simultaneously to synthesize a valid response. Thus, as shown in Table 1 (line of $e + 4$), the task can be solved at about 9 or 10 years of age, as much data show.

The process analysis of other connectives given in formulas [3] and [5] should be selfexplanatory after discussing formula [8]:

$$\text{CONDITIONAL } (^{\neg}(p \rightarrow q), \underline{\$}(p \vee \neg p \vee \neg q)) \quad [9]$$

$$\text{BICONDITIONAL } (^{\neg}(p \leftrightarrow q), \underline{\$}(p \vee \neg p \vee q)) \quad [10]$$

As the underlines in the formulas show, formula [9] has a mental demand of $e + 6$ and formula [10] of $e + 5$. A look at Table 1 shows the expected age (and stage) of solution for these misleading problems (misleading due to the relative neglect of negative states). Predictions agree with empirical results. Notice that mental models of Barrouillet and of Halford, among others, are consistent with the ones given here, although they differ in that they do not examine in sufficient detail organismic/situational factors that make task items more or less misleading or facilitating – thus failing to be explicit enough about mental demand or differential processing complexity of the tasks in question.

Children who fail often neglect attending to false states and negative terms, which causes, when conditional problems are used, the emergence of a developmental sequence: First incomplete solutions appear based on the CONJUNCTION operative (for 9-year-olds); then incomplete solutions appear using BICONDITIONAL operative (for 11-year-olds); finally complete solutions appear using CONDITIONAL operative (for 13-year-olds). Such developmental sequence of faulty solutions prior to the correct solution in conditional problems illustrates well the concept of *accessibility* proposed by Kahneman. As our theory formulates it, any given strategy will be accessible to subjects only when one of two conditions are met: (1) the task is facilitating, and low-level (system I) processing suffices to solve it; (2) the task is misleading, and high-level (system II) processing is required, but the task's mental-attentional demand is well within the subject's mental capacity as given in Table 1. An important corollary is that when a task-adequate strategy is not accessible (often with misleading tasks, and when attentional capacity is lacking), degraded strategies will be used (as illustrated here with the strategy series conjunction-biconditional-conditional) to optimize proximity to a correct solution.

Logical Reasoning in Adolescence and Adulthood

In terms of mental-attentional (working memory) resources, the main difference between adolescents or adults and children is that the former can coordinate as many as six or seven

distinct symbolic schemes simultaneously, allowing them to solve tasks with very high mental demand. This estimate, however, comes from our method. Other methods, such as Halford's, find no capacity difference between late adolescents, adults, and 11-year-olds (all coordinate quaternary relations). Another factor high in adolescents/adults relative to children is their executive know-how. Halford might appeal to this factor (i.e., less executive know-how) to explain the inferior performance of 11- or 12-year-olds relative to adolescents and adults, in Piaget's formal operational tasks (particularly with regard to truth-preserving semantic transformations that later in this article we call meta-operations/meta-operators). Halford could give the same reason to explain children's lower performance in task items with a very high mental-attention demand (see Pascual-Leone and Johnson's recent work).

In terms of logical structures, the most striking difference between children and older participants is the latter's capacity for logical operations of the highest order, *meta-operations* (i.e., operations on operations), or symbolic operations of second order, as Piaget called them. A good illustration of this power of meta-operations is in the high-level coordinations that interrelate all 16 logical-connective operations between two variables (p and q) in late adolescents and adults, manifested in high-level strategies of logical reasoning for transforming logical expressions across connectives.

We will use the example of conjunctions and disjunctions (see Figure 4); however, all 16 logical connectives are similarly interrelated. The top part of Figure 4 shows two Venn diagrams, that is, two sets of intersecting circles that respectively signify possible truth values (the mental model) of logical connectives AND (e.g., 'Peter and Jill love the theater') and OR (e.g., 'Peter or Jill loves the theater'). If p stands for 'Peter loves the theater' and q stand for 'Jill loves the theater' then the Venn circles indicate sets of individuals for whom these sentences are true. The X sign imposed on the circles demarcates all four possible truth states (p , $\neg p$, q , $\neg q$); its dots highlight truth states that are actually correct for the

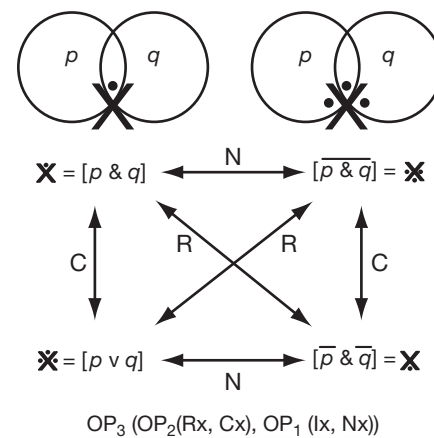


Figure 4 INRC system of logical connectives illustrated with transformations that relate conjunction ($p \& q$) formulas with disjunction ($p \vee q$) formulas. Meta-operations: I (identity), N (negation), R (reciprocal), and C (correlative). Double headed arrows indicate reversibility of these transformations.

particular connective (this homogeneous logical notation was proposed in the 1940s by McCullock and Pitts). On the left side, we represented the AND truth table, and on the right side OR.

The square frame in the center of [Figure 4](#) is a classic logical diagram adapted by Piaget. It shows the coordinated meta-operations of Piaget's INRC model: I is an Identity operation that leaves a truth state unchanged. For instance, application of I on the conjunction in the top left corner of the frame, that is, $I(p \& q)$ yields $p \& q$. N is a negation (inverse meta-operation) that negates the logical formula truth value: $N(p \& q) = \neg(p \& q)$, as shown in the top right corner of the frame. R is a reciprocal meta-operation that negates both terms (atomic sentences p, q): $R(p \& q) = \neg p \& \neg q$ (right bottom corner). Finally, C is a correlative meta-operation that adds or subtracts (whichever is possible) to the truth table of a formula the truth states that have an incomplete negation (i.e., $\neg p, q, p, \neg q$): $C(p \& q) = p \vee q = (p \vee \neg p \vee q \vee \neg q)$ (bottom left corner).

[Figure 4](#) shows that these four meta-operations interrelate (or intertransform) logical-connective formulas. In our example, conjunction (top left corner), disjunction (bottom left), incompatibility (top right), and joint denial (bottom right). Meta-operations can be used to interrelate all 16 connectives, which is important because these interrelations have closure and other properties of mathematical groups. Indeed, any number of applications of these four meta-operations to a two-term propositional-connective formula always is equal to the application of one of the four meta-operations, thus ensuring closure (i.e., the four meta-operations suffice to describe all possible transformations of coexistence of atomic sentences p, q). As readers can verify in [Figure 4](#): $CNx = Rx = NCx$; $RNx = Cx = NRx$; $RCx = Nx = CRx$; $NNx = RRx = Ix$; $RCNx = Ix$; etc. In reading these formulas, x might be interpreted as $p \& q$, or as any other of the 16 propositional connectives. Meta-operators always apply to x one by one and from right to left.

Piaget believed that when people have structures (enduring high-level schemes) for these concretized INRC models, they can easily understand correspondences among logical connectives and their interrelated truth values. For instance, they can understand that saying that 'Peter and Jill do not love the theater' ($\neg(p \& q)$, i.e., Nx) carries the same meaning (same truth value) than 'No Peter and/or no Jill loves the theater' ($\neg p \vee \neg q$, i.e., RCx). The INRC model just presented is Piaget's. In what follows we shall show how the emergence in brain processes of such a model can be explained by the ability to keep in mind (boost with mental-attentional activation), and coordinate, two distinct but interrelated and complementary systems of meaning, which when coordinated yield the semantic relations allowed by the INRC system. One of these two systems integrates truth claims (assertions and negations) that bear on the *semantic totality* (total relational state of affairs) or superordinate sentence (this is the I/N system). The other system integrates truth claims that correspond only to the subordinate relational states or atomic sentences – that is, the *structural constituents* of the semantic totality (this is the R/C system). Our analysis also will show that coordination of at least six distinct semantically complementary schemes may be needed for this R/C system's dynamic synthesis to take place.

System I/N, hereafter called OP1, is constituted by the interaction between I and N. I is an identity operator, which when applying on a propositional-connective formula x (for instance, $p \& q$) leaves it unchanged. Notice that ordinarily in predicate or propositional logic, identity is seen as a relation; however, in constructivist operator logic, to describe how meaning is transformed when one or another legal transformation is carried out, identity appears as an operator that leaves its object (logical argument) unchanged. N is a propositional (semantic totality) negation operator, which applying on any of these formulas x obtains its inverse (for instance, $\neg(p \& q)$ is the negation of the total proposition) and when applied again onto its effect cancels this effect ($NNx = Ix$).

System R/C, here called OP2, is constituted by the coordination of R and C. These two operators, defined relative to Ix , can transform Ix by acting on its constituents (atomic sentences) rather than on the semantic totality (total sentence) as N does. R is a reciprocal, which applying on Ix brings negation to its semantic constituents (i.e., $\neg p \& \neg q$); C, the correlative, adds or subtracts (whichever is possible) to the truth table of Ix the truth states that have an incomplete constituent negation (i.e., $\neg p, q, p, \neg q$). For instance, since $(p \& q) = pq$, $C(p \& q) = (pq \vee p \neg q \vee \neg p q \vee \neg p \neg q)$. Furthermore, C is the totality negation of R, and their joint application produces Nx (i.e., $RCx = CRx = Nx$). As [Figure 4](#) helps to clarify, the two operative systems OP1 and OP2 are functionally intertwined, because *all* operations are defined from the same given position $I(x)$, which for our example of [Figure 4](#) is in terms of $I(p \& q)$. They thus need to be coordinated, and this is done by the meta-system OP3. This functional structure appears in [formula \[11\]](#):

$$\text{OP}_3(\text{OP}_2^{L1}(\underline{Rx}, \underline{Cx}), \{\text{OP}_1\}_{L1}(\underline{Ix}, \underline{Nx})) \quad [11]$$

As in other formulas, the underlined symbolic schemes require boosting with mental attention. Notice that OP1 does not need to be boosted; it is chunked with OP2 ($L1$ superscripted/subscripted) because both have the similar function of coordinating two complementary meta-operators (either I,N or R,C). Formula [11] mental model predicts that one must simultaneously hold in mind six or seven symbolic schemes (or five, in the unlikely event that all operators, OP, are chunked), in order to abstract INRC systems. According to [Table 1](#), this achievement might not happen earlier than 13 or 14 years of age – as has often been found empirically.

These systems of meta-operations also occur outside linguistic logic, in experiential, spatiotemporal, and mechanical domains. [Figures 5](#) and [6](#) illustrate the example of a two-arm balance scale, with a central fulcrum and weights ($W1, W2$, etc.). Weights are placed on each arm at various distances ($D1, D2$, etc.). Participants must predict whether given configurations of weights, at various distances from the fulcrum, preserve or not the equilibrium, which can be altered by adding (MORE) or removing (LESS) weight or distance. Our mental model, underneath the balance scale in [Figure 5](#), shows a relational complexity similar to that of the INRC system of logical connectives, with a mental-attentional demand of six or seven. [Figure 6](#) unfolds this functional structure to show that there are two coordinated INRC systems, one for the left-hand arm of the balance ($W1, D1$) and another for the right-hand arm ($W2, D2$).

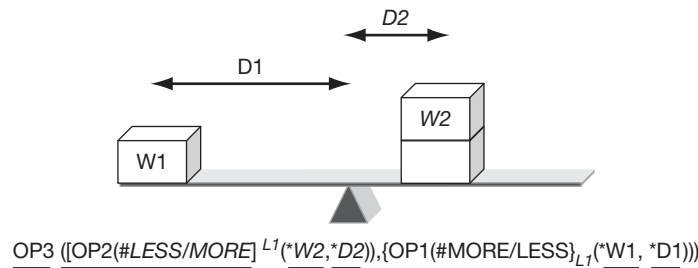


Figure 5 Illustration of Piaget's balance scale task. The coordination of weights (W) and distances (D) can be represented by one INRC system for each arm of the scale (see Figure 6). Formula shows the operative and figurative schemes that need to be coordinated for success in the task (six, with practice – L1). Task should be accessible at formal or late formal substages.

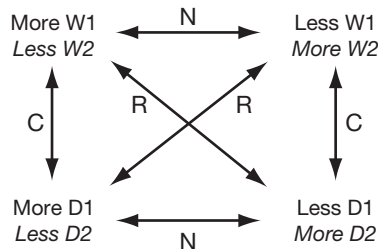


Figure 6 Coordination of two INRC systems in Piaget's balance scale task.

Final Summary

Logical operations serve to investigate truth with the help of systems of signs. We have analyzed signs and shown how two developmentally important sorts, signals versus symbols, can be defined in terms of schemes – psychological units of processing in the organism. Piaget pioneered the psychological study of logical operations. He emphasized that schemes are naturally organized into levels of reflective abstraction, which he often called substages. We have provided an overview of these levels of psychological abstraction and have analyzed in detail some logical-problem tasks, to illustrate how in task-misleading situations developmental growth of mental attention (a maturational component of working memory) may enable progressively higher levels of abstraction. Basic neo-Piagetian methods for assessing logical complexity converge with current logical research.

Our neo-Piagetian mental models of meta-operations, found only in adolescents and adults, explain known limits of children's logical operations. They might also explain, but this is beyond the scope of this article, the encompassing imagination and creativity in some adolescents.

See also: [Attention](#); [Chunking](#); [Reasoning](#).

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Relevant Websites

- <http://archivespiaget.ch/en/> – Archives of the Jean Piaget Society.
- <http://www.piaget.org/> – Jean Piaget Society.

Love and Intimacy

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Glossary

Affection and liking A sentiment of fond attachment.

Commitment A pledge or promise to another.

Companionate love The affection and tenderness men and women feel for those with whom their lives are deeply entwined.

Culture The shared attitudes, values, goals, and practices of a given religious, social, racial, or ethnic group, which are transmitted from one generation to another.

Equity theory Equity theory posits that in personal relationships, two concerns stand out: firstly, how rewarding are people's societal, family, and work relationships? Secondly, how fair and equitable are those relationships? According to equity theory, people feel most comfortable

when they are getting exactly what they deserve from their relationships – no more and certainly no less.

Intimacy A process in which a couple who feel close and who trust one another reveal personal information and feelings to one another. As a consequence, they come to feel cared for, known, and validated.

Passionate love A state of intense longing for union with another. Reciprocated love (union with the other) is associated with fulfillment and ecstasy. Unrequited love (separation) is associated with emptiness, anxiety, or despair.

Reinforcement theory Reinforcement theory posits that human behavior is shaped by the rewards and punishments people receive for performing various actions.

Defining and Measuring Love

Love is a basic emotion, which comes in a variety of forms. Most social scientists distinguish between two major kinds of love – passionate love and companionate love. Passionate love is a 'hot,' intense emotion. It is sometimes also labeled obsessive love, puppy love, a crush, lovesickness, infatuation, or being-in-love. Scholars have defined it as:

A state of intense longing for union with another. Reciprocated love (union with the other) is associated with fulfillment and ecstasy. Unrequited love (separation) is associated with emptiness, anxiety, or despair.

The Passionate Love Scale was developed to assess the cognitive, emotional, and behavioral components of such love.

Companionate love is a 'cooler,' far less intense emotion. It is sometimes also called true love or conjugal love. It combines feelings of deep attachment, commitment, and intimacy. Scholars have defined it as:

The affection and tenderness people feel for those with whom their lives are deeply entwined.

Psychologists have used a variety of scales to measure companionate love. The Companionate Love Scale was developed to measure how much companionate love, commitment, and intimacy couples possess.

Scientists have proposed other, more detailed typologies of love. Some scholars suggest that people may possess six different styles of loving. The Love Attitudes Scale was designed to measure these love styles: *Eros* (passionate, intense, disclosing love), *mania* (obsessive, dependent, insecure love), *storge* (friendship-based, steady, secure love), *pragma* (practical, logical love), *agape* (altruistic, giving, spiritual love), and *ludis* (game-playing, cool, playful love). Another scholar proposed

a triangular model of love. He argued that the various kinds of love differ in how much of three different components – passion, intimacy, and the decision/commitment to stay together – they possess. Passionate love (which he labeled infatuation) involves intense passionate arousal but little intimacy or commitment. Companionate love, on the other hand, involves less passion but far more intimacy and commitment. The most complete form of love is consummate love, which combines passion, intimacy, and commitment.

Passionate Love

Passionate love is as old as humankind. Buried among the Sumerians' clay tablets (in around 3500 BCE) is inscribed history's first known love poem – a poem dedicated to King Shu-Sin by one of his chosen brides. She wrote: "Bridegroom, let me caress you/My precious caress is more savory than honey." The Sumerian love fable, telling of Inanna and Dumuzi, was spun by tribal storytellers in 2000 BCE. The world literature abounds in stories of lovers caught up in a sea of passion and violence: Daphnis and Chloe (a Greek myth), Shiva and Sati (Indian), Hinemoa and Tutanekai (Maori), Emperor Ai and Dong Xian (Chinese), and the VhaVhenda lover who was turned into a crocodile (African). Passion and desire possess a very long lineage.

In recent years, scholars from a variety of disciplines have begun to speculate about the nature of love. Cultural theorists and historians point out that cultural and social considerations have a profound impact on how people view love, how susceptible they are to falling in love, who inspires love, and how passionate affairs work out. Neuroscientists, neurobiologists, and evolutionary psychologists point out that in spite of all its variations, passionate love and sexual desire are cultural universals – existing in all times and in all places.

Cultural and Historical Approaches

Researchers contend that cultural values may have a subtle influence on the meanings people associate with the construct 'romantic love.' In a series of prototype studies (which get at the meaning of various concepts), researchers found that Americans and Italians tend to equate love with happiness and to assume that both passionate and companionate love will be intensely positive experiences. Students in Beijing, China, however, possess a darker view of love. In the Chinese language, there are few 'happy-love' words; love is associated with sadness. Not surprisingly, then, Chinese men and women tended to associate passionate love with such ideographs as infatuation, unrequited love, nostalgia, and sorrow love.

Historians, too, remind us that love has been viewed very differently in different historical eras. At times it has been viewed as a bane, at other times as a boon. For 1500 years – from the earliest days of the Roman Catholic Church to the 16th Century Protestant Reformation and Catholic Counter-Reformation – the Church proclaimed passionate love and sex (even marital sex) for any purpose other than procreation to be a mortal sin, punishable by eternal damnation. In those early days, love was not expected to end well. Romeo and Juliet, Ophelia and Hamlet, and Abelard and Eloise did not make love, get married, have two children, and live happily ever after. Juliet stabbed herself. Romeo swallowed poison. Ophelia went mad and died. Hamlet was felled by a poisoned sword point. Peter Abelard (a real person) was castrated and his beloved Eloise retired to a nunnery. In Japan, love suicides have been an institution since the end of the seventeenth century.

Today, of course, in the West, passionate love is highly prized. People generally assume it is the basis of a happy life; it is associated with mental and physical well-being. For most, it is the *sine qua non* of marriage. We see then that through time, visions of love can markedly change.

Anthropological, Neuroscience, and Evolutionary Approaches

In spite of the fact that cultural differences may exist in the way people view love, most scholars agree that a desire for love may well be built into the architecture of the mind. Some theorists argue that emotional 'packages' are inherited, adaptive patterns of emotional experience, physiological reaction, and behavior. At every phylogenetic level, organisms face the problems of survival and reproduction. If they are to survive and reproduce, they must find food, avoid being killed, mate, and reproduce. Many theorists believe that passionate and companionate love are built on the ancient circuitry evolved to insure that animals mate, reproduce, and care for their young. Recently anthropologists, neuroscientists, and primatologists have begun to learn more about the universal nature of love.

Anthropologists were among the first to document that passion and lust are universal feelings. Drawing on a sampling of tribal societies from the *Standard Cross-Cultural Sample*, they found that in almost all of these far-flung societies, young lovers talked about passionate love, recounted tales of love, sang love songs, and spoke of the longings and anguish of infatuation. When passionate affections clashed with parents' or elders' wishes, young couples often eloped.

Social anthropologists have explored folk conceptions of love in such diverse cultures as the People's Republic of China,

Indonesia, Turkey, Nigeria, Trinidad, Morocco, the Fulbe of North Cameroun, the Mangrove (an aboriginal Australian community), the Mangaia in the Cook Islands, Palau in Micronesia, and the Taita of Kenya. In all these field studies, people's conceptions of passionate love appear to be surprisingly similar.

The joys of love

Two neuroscientists attempted to identify the brain regions associated with passionate love and sexual desire. They selected men and women who claimed to be 'truly, deeply, and madly in love' and who received high scores on the Passionate Love Scale. Participants were then placed in an fMRI (functional magnetic imagery) scanner. This high-tech scanner constructs an image of the brain in which changes in blood flow (induced by brain activity) are represented as color-coded pixels. The authors gave each participant a color photograph of their beloved to gaze at, alternating the beloved's picture with pictures of a trio of casual friends. They then digitally compared the scans taken while the participants viewed their beloved's picture with those taken while they viewed a friend's picture, creating images that represented the brain regions that became more (or less) active in both conditions. These images, the researchers argued, revealed the brain regions involved when a person experiences passionate love and/or sexual desire.

They discovered that passion sparked increased activity in the brain areas associated with euphoria and reward, and decreased activity in the areas associated with sadness, anxiety, and fear. Activity seemed to be restricted to foci in the *medial insula* and the *anterior cingulate cortex* and, subcortically, in the *caudate nucleus* and the *putamen*, all bilaterally. Most of the regions that were activated during the experience of romantic love were those that are active when people are under the influence of euphoria-inducing drugs such as opiates or cocaine. Apparently, both passionate love and those drugs activate a 'blissed-out' circuit in the brain. The *anterior cingulate cortex* has also been shown to be active when people view sexually arousing material. This makes sense since passionate love and sexual desire are generally assumed to be tightly linked constructs.

Among the regions where activity decreased during the experience of love were zones previously implicated in the areas of the brain controlling critical thought (i.e., the sort of mental activity involved when people are asked to make social judgments or to 'mentalize' – that is, to assess other people's intentions and emotions). Such brain areas are also activated when people experience painful emotions such as sadness, anger and fear. The authors argue that once we fall in love with someone, we feel less need to assess critically their character and personality. (In that sense, love may indeed be 'blind.') Deactivations were also observed in the posterior cingulate gyrus and in the amygdala and were right-lateralized in the prefrontal, parietal, and middle temporal cortices. Once again, the authors found passionate love and sexual arousal to be tightly linked.

The dark side of love: Anger, sadness, and misery

Joyous passionate love is only one-half of the equation, of course. Love is often unrequited. What kind of brain activity occurs when passionate lovers are rejected?

Researchers studied men and women who had just been jilted by their beloveds. First, they hung a flyer on the SUNY at

Stony Brook bulletin board. 'Have you just been rejected in love. But can't let go?' Rejected sweethearts were quick to respond. In initial interviews, researchers found that heartbroken men and women were caught up in a swirl of conflicting emotions – they were still wildly in love, yet felt abandoned, depressed, angry, and in despair.

But what was going on in their brains? To find out, the researchers followed the same protocol they had utilized in testing happily-in-love men and women – that is, they asked participants to alternately view a photograph of their one-time beloved and a photograph of a familiar, but emotionally neutral individual. In short, the authors found that jilted lovers' brains 'lit up' in the areas associated with anxiety, pain, and attempts at controlling anger as well as addiction, risk taking, and obsessive/compulsive behaviors. Jilted lovers did, indeed, appear to experience a storm of passion – passionate love, sexual desire, plus anguish, rejection, rage, emptiness, and despair.

Currently, a number of other neuroscientists are investigating the brain activity associated with the joy of passionate love (when reciprocated) or the feelings of emptiness, anxiety, and despair associated with unrequited love.

Companionate Love and Intimacy

If romantic relationships deepen, they may gradually evolve into a more serious, longer-lasting form of love – companionate love. In this section, we will focus on what scientists have learned about three of the components of such love – affection and liking, intimacy, and commitment.

Affection and Liking

In the eleventh century, St. Anselm of Canterbury argued that the will possesses two competing inclinations: an affection for what is to a person's own advantage *and* an affection for justice. The first inclination is stronger, but the second matters, too. Social psychologists, too, have highlighted the importance of self-interest as well as fairness and equity in people's lives.

Reinforcement theory

Many psychologists use reinforcement theory principles to explain why people love and like others. According to reinforcement theory, men and women come to care for those who provide them with important rewards and to dislike those who punish them. They may come to feel the same way about people who are merely *associated* with pleasure or pain.

One group of researchers, for example, contrasted the behavior of happily married couples with those who were distressed. Happy couples generally had positive exchanges. They smiled, nodded, and made eye contact. They spoke to each other in soft, tender, happy voices. They leaned forward to catch one another's words. Distressed couples had corrosive patterns of interacting. They tried to bludgeon one another into agreements by complaints and punishment. They sneered, cried, and frowned at one another. Their voices were tense, cold, impatient, whining. They made rude gestures, pointed, jabbed, and threw up their hands in disgust; or they simply ignored one another. As soon as one partner resorted to these tactics, the other began to respond in the same way, leading to an escalation of reciprocal aversiveness.

Unfortunately, as couples settle into a routine, kind words are often replaced by harsh evaluations, thoughtful courtesies by neglect. For some reason, married couples frequently treat one another worse than they treat strangers.

Equity theory

Equity theorists point out that couples care both about how rewarding their relationships are and how fair they seem to be. According to the theory, people feel most comfortable when they are getting exactly what they deserve from their relationships – no more and certainly no less.

A few theorists have argued that couples have very different ideas as to the nature of appropriate behavior in *communal* relationships (such as love relationships, family relationships, or close friendships) as opposed to *exchange* relationships (such as encounters with strangers or business associates). In communal relationships, they argued, couples feel responsible for one another's well-being. They wish to show their love and affection, and to help those they love. They expect nothing in return. In exchange relationships, on the other hand, acquaintances do not feel particularly responsible for one another. They care very much about 'what's in it for me?'

Most theorists, however, take the equity perspective. One group of researchers, for example, assumed that couples must be careful to ensure that their partners feel loved, rewarded, and fairly treated. Otherwise, love relationships will suffer and possibly dissolve. These authors devised a simple scale for measuring how fair and equitable men and women believe their relationships are. They simply asked them:

Considering what you put into your dating relationship or marriage, compared to what you get out of it . . . and what your partner puts in compared to what (s)he gets out of it, how does your dating relationship or marriage 'stack up?'

- + 3: I am getting a much better deal than my partner.
- + 2: I am getting a somewhat better deal.
- + 1: I am getting a slightly better deal.
- 0: We are both getting an equally good, or bad, deal.
- 1: My partner is getting a slightly better deal.
- 2: My partner is getting a somewhat better deal.
- 3: My partner is getting a much better deal than I am.

On the basis of their answers, persons were classified as overbenefited (receiving more than they deserve), equitably treated, or underbenefited (receiving less than they deserve).

There is considerable evidence that in love relationships, equity matters. Equity considerations have been found to be important in determining who gets into relationships in the first place, how those relationships go, and how likely they are to endure. Specifically, researchers find the following:

- The more socially desirable people are (the more attractive, personable, famous, rich, or considerate they are), the more socially desirable they will expect a mate to be.
- Dating couples are more likely to fall in love if they perceive their relationships to be equitable.
- Couples are likely to end up with someone fairly close to themselves in social desirability. They are also likely to be matched on the basis of self-esteem, looks, intelligence, education, and mental and physical health (or disability).
- Couples who perceive their relationships to be equitable are more likely to get sexually involved.

- Equitable relationships are satisfying and comfortable relationships; inequity is associated with distress, guilt, anger, and anxiety.
- Those in equitable relationships are more committed to their relationships than are those in inequitable relationships.
- Those in equitable relationships are less likely to risk extra-marital affairs than are their peers.
- Equitable relationships are more stable than are inequitable relationships.

Researchers may disagree as to how *important* equity is in determining whether or not couples remain together, separate, or divorce. Most agree, however, that it plays at least some part in such decisions.

Intimacy

The word intimacy is derived from *intimus*, the Latin term for 'inner' or 'inmost.' When scientists reviewed the way most theorists have used this term, they found that almost all of them assumed that intimate relationships involve affection and warmth, self-disclosure, closeness, and interdependence. Most people mean much the same thing by intimacy. Some scientists asked college men and women to tell them about times when they felt especially intimate with (or distant from) someone they cared about. For most people, intimate relations were associated with feelings of affection and warmth, with happiness and contentment, with talking about personal things, and with sharing pleasurable activities. What sorts of things put an impenetrable wall between couples? For most, distant relationships were associated with anger, resentment, and sadness as well as criticism, insensitivity, and inattention. Men and women seemed to mean something slightly different by 'intimacy.' Women tended to focus primarily on love and affection and the expression of warm feelings when recounting 'intimate moments.' They rarely mentioned sex. For men, a key feature of intimacy was sex and physical closeness.

Clinical psychologists developed the *Personal Assessment of Intimacy in Relationships (PAIR)* to measure intimacy. They identified five types of intimacy: emotional, social, intellectual, sexual, and recreational intimacy.

The components of intimacy

The threads of intimacy – affection, trust, emotional expressiveness, communication, and sex – are so entwined that it is almost impossible to tease them apart.

Love and affection

Men and women generally feel more love and affection for their intimates than for anyone else; such mutual affection is probably the first condition of intimacy.

Trust

People seldom risk exposing their dreams or fears unless they know it is safe to do so.

Self-disclosure

When men and women are able to reveal their inner feelings and experiences to others, relationships bloom. Caring and

trust may be the soil in which self-disclosure thrives, but self-disclosure, in turn, nourishes love, liking, caring, trust, and understanding.

One group of researchers reviewed a series of studies on the 'social penetration process.' They made two major discoveries: firstly, intimacy takes time. As couples began to get better acquainted, they began to disclose more. Secondly, acquaintances tend to match one another in how intimate their disclosures are. In some relationships, both participants are willing to reveal a great deal about themselves. In others, both confine themselves to small talk.

Intimates confide two very different kinds of information – facts and feelings – to one another. On a first encounter, acquaintances usually reveal only the bare facts of their lives; they talk little about their feelings. New acquaintances are careful not to reveal too much too soon and not to reveal much more than their partners do. Daters tend to warm up fairly quickly, however. After 6 weeks or so, people are already confiding in one another at about as high a level as they ever will. It is in long-term love relationships that intimates can be *most* relaxed and trusting. Once couples know each other well, the recital of mere facts counts for little; it is the communication of feelings that is critical to dating and marital satisfaction. In long-term relationships, moment-to-moment reciprocity becomes unimportant. Things can wait. When relationships are about to end, however, the pattern of self-disclosure changes. Now, words can be used to wound. In terminal relationships, couples often begin to spew out the ugly accusations that they have kept hidden. They begin to spill out years of hatred, anger, and exaggerated grievances. Couples may begin to talk through the night, trying to figure out what went wrong and if there is any chance to set things right.

Nonverbal communication

Intimates feel comfortable in close physical proximity. They sneak little looks at their mates to convey shared understandings, gaze at one another, touch, stand close, and even lean on one another. Of course, people can reveal how alienated and distant they feel from one another via the flip side of these same techniques. If one feels that a potential date one has just met is moving too fast and one is starting to feel cornered, one can reduce intimacy in several ways – by averting one's gaze, shrinking back, shifting body orientation, or simply by changing the subject and steering clear of intimate topics. We all know how enemies behave when they want to sever all contact. They glare, clench their jaws, sigh in disgust, or walk on ahead.

The development of intimacy

Developmental theorists have observed that young people must learn how to be intimate. One scholar pointed out that infants, children, adolescents, and adults face a continuing series of developmental tasks. If loved and nurtured, infants develop a basic trust in the universe. They develop the ability to hope. In early, middle, and late childhood, children learn to be autonomous, to take initiative, and to be industrious. They develop a will of their own, a sense of purpose, and a belief in their own competence. The next two stages are those in which we are primarily interested. In adolescence, teenagers must develop some sense of their own identity.

Only when adolescents have formed a relatively stable, independent identity are they able to master their next 'crisis' – to learn how to become intimate with someone, and to learn how to love. Mature relationships, then, according to scholars, involve an ability to balance intimacy and independence. People differ markedly in how much intimacy they desire. Attaining the 'right degree' of intimacy often requires a delicate balancing act.

Why people seek intimacy

It seems a bit odd to ask *why* people wish for intimacy. When scientists ask men and women what they most desire in life, they generally mention a close intimate relationship. People can feel sad and lonely for two very different reasons. Some lonely people are experiencing *emotional loneliness*; they hunger for one special intimate. Others are experiencing *social loneliness*; they merely lack friends and casual acquaintances. Of the two, it is emotional loneliness that is the more painful. Contentment is better predicted by the existence of intimacy (i.e., lack of loneliness) than that of popularity, the frequency of contact with friends, or the amount of time spent with acquaintances. Theorists contend that intimacy has three major beneficial effects.

(a) Its intrinsic appeal

One scholar found that if people were happily in love, over 90% of them were also 'very happy in general.' If they were generally unhappy, most thought that love was the one thing that they needed to be happy. So people long for intimacy for itself.

(b) Its links to psychological well-being

A number of studies document that intimacy and psychological health seem to go hand in hand. Intimacy has been shown to be associated not just with happiness, but with contentment and a sense of well-being, as well. Intimate marriages provide social support.

(c) Its links to mental and physical well-being

A number of medical researchers have confirmed that intimacy and mental and physical well-being are connected. Intimate relationships apparently buffer the impact of stress. Intimacy problems are closely linked to many mental health disorders. If persons have a chance to disclose emotionally upsetting material to someone who seems to care, they exhibit improved mental and physical health in follow-up physical examinations. Most of our knowledge about the ties between intimate relationships and physical health comes from studies of the impact of a husband or wife's death on the survivor's mental and physical health. Investigators find that bereavement increases the likelihood of a host of mental and physical problems. Bereavement increases vulnerability to mental illness; produces a variety of physical symptoms (these include migraines, headaches, facial pain, rashes, indigestion, peptic ulcers, weight gain or loss, heart palpitations, chest pain, asthma, infections, and fatigue); aggravates existing illnesses; causes physical illness; predisposes a person to engage in risky behaviors – such as smoking, drinking, and drug use; and increases the likelihood of death. Of course, a 'close' relationship filled with hatred and strife can be worse than no relationship at all for couples' mental and physical health.

Why people avoid intimacy

Given all the advantages of intimate relationships, why would people ever be reluctant to become intimate with others? Men and women admit that they are hesitant to get too deeply involved with others for a variety of reasons: Some people feared that if they get too close to someone they will end up 'stuck' with them; having to take care of someone worse off than themselves. Some people fear that if they begin to confide in others, they will end up feeling worse – aware of how sad, frightened, or angry they really are. Some fear that if they reveal too much about themselves, others will criticize them, be disappointed in them, or get angry at them. Some worried that if a relationship were to end, vindictive dates or mates would confide the innermost details of their lives to subsequent dates, mates, or business associates. Close relationship researchers developed the *Perceptions of Risk in Intimacy* scale to measure people's fear of intimacy.

Are there gender differences in intimacy?

Researchers have observed that there is a gap between men's and women's ideas of what constitutes intimacy. One researcher interviewed 130 married couples at the University of Texas. He found that for the wives, intimacy meant talking things over. The husbands, by and large, were more interested in action. They thought that if they did things (took out the garbage, for instance) and if they engaged in some joint activities, that should be enough. The researcher found that during courtship, men were willing to spend a great deal of time in intimate conversation. But after marriage, as time went on, they reduced the time for close marital conversation while devoting increasingly greater time to work or hanging around with their own friends. The researcher observed:

Men put on a big show of interest when they are courting, but after the marriage their actual level of interest in the partner often does not seem as great as you would think, judging from the courtship. The intimacy of courtship is instrumental for the men, a way to capture the woman's interest. But that sort of intimacy is not natural for many men. Women complain about men's 'emotional stinginess.'

The researcher suggested a compromise: couples should try to engage in the sort of intimate conversation which springs spontaneously from shared interests. This requires, of course, that couples share some interests – that they read books, or watch films, or plan trips to Europe together and so forth.

Another researcher pointed out that men are taught to take pride in being independent while women take pride in being close and nurturing. Researchers contend that as men mature, they find it easy to achieve an independent identity; they experience more difficulty in learning to be intimate with those they love. Women have an easy time learning to be close to others; they have more trouble learning how to be independent. There is considerable evidence that men are less comfortable with intimacy than women.

Researchers find that in casual encounters, women disclose far more to others than do men. In our culture, women have traditionally been encouraged to show feelings. Men have been taught to hide their emotions and to avoid displays of weakness. In a study of college students, social psychologists found that women's friendships were more deeply intimate than were

men's. Women placed great emphasis on talking and emotional sharing in their relationships. Men tended to emphasize shared activities; they generally limited their conversations to sports, money, and sex.

In their deeply intimate relationships, however, men and women differ little, if at all, in how much they are willing to reveal to one another. Researchers, for example, asked dating couples how much they had revealed to their steady dates. Did they talk about their current relationships, previous affairs, their feelings about their parents and friends, their self-concepts and life views, their attitudes and interests, their day-to-day activities? Overall, men and women did not differ in *how much* they were willing to confide to their partners. They did differ, however, in *the kinds of things* they shared. Men found it easy to talk about politics; women found it easy to talk about people. Men found it easy to talk about their strengths; women found it easy to talk about their own fears and weaknesses. Perhaps this is because this was the kind of thing that interested them; perhaps this is because this was the kind of thing they felt most comfortable talking about. Interestingly enough, traditional men and women were most likely to limit themselves to stereotyped patterns of communication. More modern men and women were more relaxed about talking about all sorts of intimate matters – politics, friends, their strengths, and their weaknesses.

Women receive more disclosures than do men. This is not surprising in view of the fact that the amount of information people reveal to others has an enormous impact on the amount of information they receive in return. In any case, both men and women seem to feel most comfortable confiding in women. Tradition dictates that women should be the 'intimacy experts.'

Some authors have observed that currently, neither men nor women may be getting exactly the amount of intimacy they would like. Women tend to desire more intimacy than they are getting; men may prefer more privacy and distance. Couples tend to negotiate a pattern of self-disclosure that is bearable to both. Unfortunately, this may ensure that neither of them gets what they really want. Of course, as men and women's roles become more alike, these differences in intimacy might be expected to decline.

A prescription for intimacy

Most humans appear to flourish in a warm intimate relationship. Yet, intimacy is risky. What then is the solution? What advice do social psychologists give as to how to secure the benefits of deep commitment without being engulfed by its dangers? A variety of therapists and researchers have developed programs to teach young people intimacy skills. Generally, they focus on teaching men and women four types of skills: (1) encouraging people to accept themselves as they are; (2) encouraging people to recognize their intimates for what they are; (3) encouraging people to express themselves; and (4) teaching people to deal with their intimate's reactions.

Commitment

Perspectives on commitment

It is not always easy for people to guess how committed they and their partners are to one another. Researchers argue that:

Decision/commitment refers, in the short term, to the decision that one loves a certain other, and in the long term, to one's commitment to maintain that love.

Marriage and family researchers sometimes use the *Broderick Commitment Scale* to assess dating couples' and husbands and wives' commitment to their relationships.

Researchers have begun to elaborate on how the commitment process works. Researchers proposed that a close relationship's cohesiveness (stability) can be defined as 'the total field of forces which act on the pair to keep them in the marriage.' According to one researcher, there are three kinds of forces that influence cohesiveness: (1) Attractiveness of the relationship. Is the relationship more (or less) rewarding than the couple expected? The more rewarding and the less costly the relationship, the more stable it will be. (2) Alternative attractions. Is this relationship more attractive than other relationships or than living alone? The more attractive the alternatives, the more likely the marriage is to dissolve. (3) Barriers against leaving the relationship. These are the 'psychological restraining forces' that keep people in marriages. They include religious, legal, economic, and social barriers as well as responsibilities to children. Another researcher proposed a similar model to explain who likely will persevere in a relationship as opposed to those most likely to separate or divorce. She argued that the more satisfied couples are, the more eager they will be to preserve their relationships; the more they have invested in their relationships (in time, money, and effort) and the more limited their alternatives, the more reluctant they will be to sacrifice everything by leaving.

Recently, scientists attempted to test the relative importance of the factors that attract people to relationships (love and reward) versus the factors that prevent them from leaving (feelings of commitment and a knowledge that they have invested a great deal in the relationship) in keeping couples together in times of stress. They found that although love and rewards are important, even more important are the commitments couples feel they have made to the relationship and the practical investments they have made in it.

The Endurance of Love

Most people assume that the passage of time will have a very different impact on passionate versus companionate love. Passionate love is said to decline fairly quickly, while companionate love is thought to remain fairly stable (or actually increase) over time. This hypothesis was tested in a number of studies, which interviewed dating, newlywed, and long-married couples. Respondents ranged in age from 18 to 82. They were asked how passionately and companionately they loved their partners.

What impact did time have on love? As predicted, time *did* have a corrosive effect on love – but to researchers' surprise it appeared to have an equally detrimental effect on *both* passionate *and* companionate love.

The conclusion one draws depends on whether one is an optimist or a pessimist. On the positive side: contrary to portrayals in the mass media, in *absolute terms*, older persons, married for a quarter of a century or more, still felt a great

deal of passionate love *and* companionate love for their mates. On the negative side, however, pessimists might point to the fact that with the passage of time, people felt less and less love, passionate or companionate, for their partners.

See also: [Equity Theory](#); [Nonverbal Communication](#); [Stress and Illness](#).

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Marital Dysfunction

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Glossary

Analog behavioral observation (ABO) A method of data collection in which an assessor designs, manipulates, or in some way constrains a situation such that verbal and nonverbal behaviors are elicited and observed.

Behavior genetics A scientific field that uses both quantitative genetics and molecular genetics to understand both the genetic and environmental contributions to individual variation in human behavior.

Diagnostic and statistical manual of mental disorders A manual published by the American Psychiatric Association

that provides criteria for the classification of mental disorders.

Diathesis-stress model A model for the etiology of mental illness, it suggests that an underlying predisposition (diathesis) is triggered by encountering a stressor.

Heritability The proportion of total variance in a behavior or trait that varies among individuals in the population that can be attributed to genetic influences.

Psychopathology The scientific study of mental illness, including causes, processes, and manifestations.

Introduction

Difficulties in marriage, variously referred to as problems, conflict, distress, dysfunction, and other terms, are ubiquitous; the nature and intensity of these difficulties vary within and between marriages. Marital dysfunction ultimately leads to divorce in more than 40% first marriages, and the likelihood of dissolution increases with each subsequent divorce. Even when distress does not lead to divorce, it is related to emotional and behavioral difficulties in both partners as well as in their children. Marital distress is also a risk factor for sexual infidelity and intimate partner violence. Therefore, researchers have spent a great deal of time trying to understand, prevent, and treat marital dysfunction. This article begins with a discussion of the myriad ways in which marital dysfunction has been defined, and the methods by which it is assessed in research and clinical practice. Next, findings on the impact of marital distress are reviewed. This is followed by a description of the risk factors most consistently associated with marital dysfunction and, finally, a review of the current research on prevention and treatment of marital distress is provided.

Defining and Assessing Marital Dysfunction

In the research literature, the terms marital satisfaction, adjustment, distress, dysfunction, and even conflict are often used interchangeably. The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) defines partner relational problems as “a pattern of interaction between spouses or partners characterized by negative communication (e.g., criticisms), distorted communication (e.g., unrealistic expectations), or non-communication (e.g., withdrawal) that is associated with clinically significant impairment” (p. 737). There are two noteworthy things about this definition. First, it focuses on communication, or the lack thereof, between partners. Second, it is silent as to what defines clinically significant impairment and how it should be assessed. In fact, the numerous self-report, interview, and observational methods for assessing marital dysfunction vary in the

scope and nature of what they measure, and there is no current ‘gold standard’ definition. Many researchers and clinicians rely on unidimensional, global measures that provide an overall score on satisfaction or adjustment. Others suggest that marital satisfaction is a multidimensional construct. For instance, factor analyses of the Marital Satisfaction Inventory-Revised (MSI-R) indicate two related but distinct factors subsumed under the general construct of ‘satisfaction’: *disaffection* is a measure of emotional distance and lack of positive affect, while *disharmony* indexes the amount of overt conflict in the relationship. A related issue is whether distressed couples differ both qualitatively and quantitatively from nondistressed couples. Some argue that relationship discord is an identifiable taxon that can be reliably and validly assessed.

Another difficulty with conceptualizing marital dysfunction is the overlap between ‘relationship distress’ as measured by, for instance, a self-report inventory, and the emotional, behavioral, and cognitive complaints reported by individuals in distressed relationships. Distressed couples report emotional problems, in particular reciprocity of negative relationship affect and lack of intimacy. These couples also display more communication problems, sexual difficulties, and physical aggression. Low-satisfaction couples also display a variety of negative cognitive biases, including assumptions, attributions, beliefs, and expectancies about their partner and the relationship as a whole. Thus, the true test of either a marital researcher or a clinician working with distressed couples is to tease apart the determinants of marital distress from the resulting effects. Often, cause and effect go hand in hand; for instance, whatever original deficits in communication skills and problem-solving might have triggered greater amounts of distress might have solidified into a pattern of negative reciprocity and withdrawal/demand patterns characteristic of unhappy couples.

Snyder and colleagues outline an evidence-based approach to assessment of couple distress, in which self-report, interview, and analog behavioral observation (ABO) can be used individually or in combination, to measure individual- and couple-level characteristics across multiple domains (relationship behaviors, cognitions, affect, etc.). Assessment of relationship distress often

begins with a clinical interview, to gain information on relationship history, the nature of the current conflicts, and the origins of these conflicts. Interviews can be a rich source of information about behaviors, feelings, and thoughts at the dyad and individual level. In fact, the multitudes of goals and domains covered in such interviews may limit the psychometric evaluation of clinical interviews. In comparison, behavioral observations are narrower in scope and have been subjected to a great deal of empirical rigor. There are now dozens of coding schemes developed for ABO, covering six major classes of behavior: affect, communication, everyday behaviors, power, problem-solving, and support/intimacy. Limitations of ABO include questionable generalizability to other cultures and the daunting investment necessary to be trained to reliability on one of the many coding systems available.

By and large, assessment of couple distress relies on self-report measures. Most questionnaires and inventories ask respondents to report on their subjective evaluation of the relationship as a whole, or various components that are thought to underlie relationship satisfaction (e.g., finances, amount of time spent together, intimacy/sexual relations). Some are relatively homogenous or 'pure' measures of marital satisfaction. For instance, the Quality of Marriage Index contains six items assessing global satisfaction, and the MSI-R contains one scale that measures overall relationship distress and ten other scales that measure satisfaction in various areas of the relationship. These global measures can be supplemented with other self-report measures that assess specific aspects of relationship functioning: the Personal Assessment of Intimacy in Relationships (PAIR) assesses several aspects of intimacy in the relationship; the Areas of Change Questionnaire (ACQ) measures a respondent's desire for change in their spouse along 34 different behaviors; the Frequency and Acceptability of Partner Behavior Inventory (FAPBI) asks individuals to rate how frequently their partner does each of 20 behaviors and how acceptable those behaviors are at that frequency; and the Communication Patterns Questionnaire (CPQ) assesses the communication behaviors couples use when they have a disagreement.

The bulk of the literature relies on either the Dyadic Adjustment Scale (DAS), the most widely used measure of relationship adjustment, or the Marital Adjustment Test (MAT). The MAT is a 15-item measure that includes an overall assessment of the relationship as well as extent of agreement between spouses on key areas of the relationship. The DAS is a 32-item expanded and updated version of the MAT. Factor analyses of the DAS demonstrate that a higher order factor of Adjustment is composed of four lower order factors of Satisfaction, Consensus, Cohesion, and Affectional Expression; this factor structure is invariant across gender, demonstrating that it measures the same concept in men and women. Both the DAS and MAT were designed to distinguish distressed from nondistressed couples; however, recent research indicates that both measures contain a high degree of error measurement and noise. Funk and Rogge recently conducted IRT analyses on a large pool of items from the most widely used relationship satisfaction measures, including the DAS, MAT, and QMI. They found that existing measures, particularly the DAS and MAT, assess relationship satisfaction well enough to reveal meaningful relationships with associated variables (e.g., communication, personality), but lack enough precision to make

meaningful distinctions between groups. The authors developed a new measure, the Couples Satisfaction Index (CSI), composed of items from existing measures. Data from the initial development study look promising, but still need to be validated in future studies, particularly in couple samples.

Ultimately, whatever combination of self-report, interview, and observational methods are used to assess marital dysfunction will be guided by the setting (e.g., research vs. treatment), the goals of the assessor and the couple, and the feasibility and availability of each method. Regardless of how marital dysfunction is defined, any competent assessment will cover the major domains that are impacted as a result of marital discord as well as the factors that may have led to and continue to contribute to current levels of distress. These factors are reviewed below.

Impact of Marital Distress

Psychological Distress

A substantial body of research now supports the association between marital distress and psychopathology. Large-scale epidemiological surveys show a clear and substantial link between psychiatric disorders and marital distress, particularly for mood and anxiety disorders. Low levels of marital satisfaction have been linked with alcohol use disorders, drug use disorders, and personality disorders. Marital discord is also associated with subclinical levels of psychopathology and overall psychological distress.

As one of the most significant social forces in a person's life, marriage will undoubtedly play an important contextual role in the etiology and maintenance of psychopathology. Following from the diathesis-stress model of psychopathology, there is theoretical and empirical evidence to suggest that conflict laden or unsatisfying marriages may act as an environmental stressor leading to the development of mental illness in vulnerable individuals. However, others have suggested that marital distress is subsequent to, and a consequence of psychopathology. It is likely that both models are equally valid, although the direction of causality may differ by type of pathology.

One method by which researchers may attempt to disentangle the causal directions between distress and psychopathology is through the use of genetically informative designs. Traditionally a method for estimating the genetic and environmental influences on phenotypes, behavior genetics may be useful in understanding the interplay between social and interpersonal processes like marital relationship patterns and psychiatric dysfunction. Marital satisfaction, like many putative 'environmental' variables, is moderately heritable; for instance, variation in marital satisfaction as assessed in the Midlife in the United States (MIDUS) sample was due largely to nonshared environmental influences ($e^2 = 0.76$) with moderate genetic influences ($h^2 = 0.25$). Research has also shown genetic overlap between marital quality and general indices of well-being and depressive symptoms, suggesting that the same genetic influences are impacting both the quality of the marriage and mental health. A recent study found evidence of gene X environment interaction between internalizing psychopathology and marital satisfaction, such that there were greater genetic influences on an internalizing factor at low levels of marital

quality. Future research will need to examine whether similar processes are operating for different types of psychopathology.

Physical Health

Much of the research on marriage and physical functioning has focused on whether and how marital status (i.e., being married vs. single, divorced, or widowed), as opposed to satisfaction, is related to many aspects of physical health. Married individuals are, on average, healthier than single, divorced or separated, and widowed individuals, after controlling for income and age. Marriage has been linked to reduced risk of morbidity and mortality, although this benefit may be reduced in women as compared to men. More recently, research has examined whether quality of the marital relationship may impact both objective and subjective measures of physical health. Low levels of marital satisfaction are linked to various physical health outcomes, including chronic health problems, physical disability, and poor perceptions of health. A study using data from older married adults in the MIDUS study found that marital disagreement was negatively related to number of physical symptoms, while negative spousal behaviors were related to physical symptoms, chronic health problems, disability and poor perceptions of health. Of note, none of these associations were moderated by gender.

Research suggests that marital discord may affect mortality and morbidity through its effect on physiological functioning. Marital conflict, often assessed through observed spousal discussions, has been linked to cardiovascular stress measures, endocrine changes, and immune system downregulation. For instance, wound healing was slower and cytokine production higher following a marital conflict interaction task compared to a social support interaction task, particularly in couples with higher levels of hostility. Heightened levels of cytokines have been linked with a variety of negative health outcomes, thus one possible pathway between marital conflict and poor mental and physical health outcomes may be through stress-related immunological changes. Other work has shown links between marital conflict and changes in cardiovascular and endocrine functioning. Women in particular seem to show greater physiological reactivity (in the negative direction) than men during these laboratory tasks.

Child Adjustment

There is a longstanding and robust association between interparental distress and conflict and psychological and behavioral problems in children. The effects of marital conflict on children's adjustment problems persist even after controlling for important family and parenting contextual variables (e.g., parental depression). Of note, behavior genetic research has shown that genetic influences mediate the association between marital conflict and conduct problems in children; in other words, children who are exposed to marital conflict inherit a genetic liability to antisocial behavior, and may perpetuate the cycle by in turn experiencing marital conflict and passing on genes that influence both marital conflict and psychopathology. However, many questions remain as to how, why, and under what particular circumstances marital conflict and distress is most detrimental to children's development. For instance, researchers

still need to better understand how children perceive and interpret marital conflict to make the distinction between constructive and destructive interparental communication. One potential mediating pathway between marital conflict and children's adjustment is the quality of parenting. Dimensions of parenting mediate the pathway between marital conflict and internalizing and externalizing behavior in children, possibly due to spillover processes from conflict to parenting, or because parents in highly distressed marriages have less energy to devote to parenting.

Determinants of Marital Distress

Based on a review of longitudinal predictors of marital distress and divorce, Karney and Bradbury proposed a vulnerability-stress-adaptation (VSA) model of marital satisfaction. According to the VSA model, the determinants of marital satisfaction and stability can be grouped into three, interconnected domains: (1) enduring vulnerabilities, or the individual differences that define each member of the couple, (2) adaptive processes, or the ways in which couples interact and communicate with each other, and (3) stressful events that the couple face together. This model is based in large part on the tenets of the behavioral theory of marriage; for instance, a reciprocal relationship between marital satisfaction and behavioral interactions between spouses is assumed. Further, the enduring vulnerabilities of each spouse, including personality traits, are hypothesized to affect both the stressful events that couples encounter and the types of behavioral exchanges that occur between spouses. In essence, a couple's satisfaction, and therefore stability, depends on how they adapt within the marriage, which is a reflection of both enduring vulnerabilities and stressful life events. Findings from each domain are reviewed below.

Enduring Vulnerabilities: Background and Individual Differences

Research on the intrapersonal determinants of marital distress goes back decades, to the pioneering work of Terman and colleagues, who examined how personality traits were associated with marital satisfaction. Certainly, each of the members comes into the marriage with a unique background, including ethnicity, culture, attitudes, values, education, and personality. Surprisingly, since Terman's early work, there has been little research on how individual difference factors may affect the level of marital distress. Possibly reflecting the inconsistent findings from research on marital interactions and communication, a greater focus has recently been placed on how background factors may play into the level and change in marital satisfaction among couples. One line of research in this area has focused on how family-of-origin variables may impact later marital satisfaction. Children of divorce are more likely to have distressed or unstable marriages, and this relationship is largely mediated by quality of parenting. Parent-child attachment and parents' own marital quality and stability have been linked to their adult children's relationship quality and stability. Hostility observed in interactions with family members prospectively predicts later marital conflict observed in adulthood.

Much of the work on enduring vulnerabilities has focused on personality traits of both spouses in relation to marital

distress. The reemergence of interest in personality variables as predictors of marital distress follows from several advancements in the personality field: (a) the expansion of knowledge regarding personality traits, including heritability, biological substrates, and relationship to social and psychological variables; (b) the creation of personality measures with sound psychometric properties and construct validity; and (c) statistical advances that allow examination of the joint influence and interdependence of couples on each other. Most researchers have utilized traits from the Big Five/Five Factor Model of personality (i.e., extraversion, agreeableness, conscientiousness, neuroticism, and openness). The strongest and most consistent results with regard to marital satisfaction have been found for neuroticism, or negative affect, the trait-like tendency 'to report distress, discomfort, and dissatisfaction over time and regardless of the situation.' Individuals with high levels of neuroticism report high levels of marital dissatisfaction, and high levels of neuroticism in one spouse predicts marital dissatisfaction in the other.

Research regarding extraversion is inconsistent; some studies report no relationship with marital satisfaction, others find that higher levels of marital instability and dissatisfaction are related to higher levels of extraversion. A recent meta-analysis concluded that higher levels of extraversion were related to *satisfaction* and *instability*. One study found that the strongest predictor of marital satisfaction for both sexes was agreeableness in their spouse. Further, higher self-reported extraversion, openness, and conscientiousness in husbands and wives was related to higher levels of satisfaction in their spouse. Notably, discrepancy between personality trait ratings of their actual spouse and an idealized mate did not explain any unique variance in marital satisfaction above and beyond personality of their actual spouse. Husbands who are low in agreeableness and high in neuroticism act in ways that are especially likely to upset their wives, including alcohol abuse, emotional constriction, self-centeredness, unfaithfulness, and abuse. Distressed husbands describe their wives as condescending, possessive, jealous, self-centered, and unfaithful.

In addition to the effect of self and partner personality on one's own level of marital distress, research has examined whether spousal similarity for personality affects marital satisfaction. One study found that personality similarity on the Big Five and measures of adult attachment were related to marital satisfaction in a newlywed sample. However, a different study found that greater personality similarity in middle and later-life couples who were married at least for 15 years was related to declines in marital satisfaction over a 12-year period. The authors explained the discrepancy in findings as reflecting the differences in life goals and tasks between younger couples and couples later in life.

Adaptive Processes: Communication and Behavior Patterns

Even with early promising work on personality traits associated with marital distress, marital research moved from a personality-based perspective to an examination of entrenched and dysfunctional interaction patterns. This line of research explicitly rejected the idea that studying individual spouses, particularly using spousal self-report, was informative in understanding the marital dysfunction of couples. Beginning with the classic work

of Harold Raush and colleagues, who asserted that "Studying what people say about themselves is no substitute for studying how they behave . . . We need to look at what people do with one another," researchers broadened the scope of inquiry beyond individual difference variables to a focus on communication and interaction between couples. The *interpersonal* approach proposes that it is the dynamic between the partners, how they interact with and learn from their experiences with each other, which contributes to the course, stability, and satisfaction of the marriage. The basic hypothesis was that communication problems and conflict that arises during problem discussions would predict marital distress and ultimately dissolution. Process research was also spurred by an effort on the part of psychologists to help married couples deal with distress, and as a result, many of the observational methods and the resulting coding schemes used to interpret behaviors focused on conflict discussion tasks.

Research across different coding systems, studies, and countries has revealed certain facts about behavior observed during marital conflict discussions. Couples who are more negative during interactions are more likely to experience worse marital outcomes over time. Distressed couples are generally more hostile, as indicated by both verbal and nonverbal exchanges (e.g., criticism, excuses, denial of responsibility, and complaints about their partner's personality). They also display more negative, and fewer positive, nonverbal and verbal behaviors than satisfied spouses, are more likely to reciprocate negative behavior, and display escalating chains of negative behavior. Distressed couples and couples with a greater likelihood of separation tend to have specific deficits related to communication and problem-solving; for instance, their interactions are marked by criticism, contempt, defensiveness, and withdrawal, and they tend to show the demand-withdrawal pattern, in which one person (usually the wife) attempts to engage while the other partner reacts by withdrawing.

However, despite decades of research with an increasingly sophisticated toolbox of methodologies and data analytic strategies, findings from research on couple processes are often confusing, contradictory, and generally lacking in consistency, particularly from a longitudinal standpoint. For instance, one study found that negative interaction behaviors (i.e., disagreement and criticism) were related to positive changes in relationship satisfaction over time. This is not an isolated finding; others have also found that negative behaviors are beneficial, and positive behaviors detrimental for relationships over time. In attempting to explain this conundrum, researchers found that the use of directive communication strategies (both positive and negative) to attempt to bring about change in a partner was related to lower concurrent perceptions of success but greater change in the partner *over time*. The authors concluded that direct strategies, whether positive or negative, are a clear signal to the target that something is wrong; while it is the relative amount of positive versus negative valence in the discussion, and the target's response to the demands of his or her partner, that will determine whether the positive and negative aspects of communication '(cancel) each other out.'

There are also methodological limitations to the process research that has been done, which may, in part, explain the lack of consistent support for a link between marital interaction and distress. Studies of this sort tend to be based on small

samples of predominantly white, middle-class couples in various stages of marriage, and have only limited longitudinal follow-up. This may inhibit the ability to determine whether interaction processes have main or moderating effects over the course of different stages of marriage. Two promising trends mark the more recent state of communication and behavior research. First, researchers are acknowledging the need to understand how contextual influences impact couple interactions. This has resulted in more studies that attempt to incorporate an examination of interaction patterns along with the other two main components of the VSA model, namely enduring vulnerabilities (e.g., personality, family history) and stressors (e.g., economic hardship, parenting, biological processes). Second, process research has now moved beyond a concentration on overt conflict and hostility toward a recognition that positive dimensions of interaction, including spousal support and positive affect may be just as important to the success of the marital relationship. For instance, Johnson and colleagues recently showed that high levels of positive affect buffered the impact of negative behavior on marital satisfaction.

Stress and Context

The final domain of variables that must be considered in relation to marital distress and stability are the environmental contexts and stressors. Young age at marriage and cohabitation before marriage are both associated with lower satisfaction and greater marital instability, although a recent meta-analysis suggested that cohabitation might not be as strongly associated with negative outcomes in other countries, particularly countries (e.g., Scandinavian countries) in which most individuals cohabit at some point in their lives. Researchers have tended to focus on major stressors and critical life events (e.g., chronic illness, economic hardship), but have recently turned toward understanding the stress involved in more minor everyday hassles, problems, or situations. Marital researchers typically focus on *dyadic* stress, defined as stressors that affect both members of the couple, either because the stressor concerns both parties (e.g., parenting), or the stressor originally affects only one partner, but eventually spills over into the dyadic relationship. The VSA model posits direct associations between the (dysfunctional) personality traits of each partner, the poor communication and interaction processes between partners, and the stressful events one or both partners encounter. An alternative model, the stress-divorce model, argues more specifically that relatively minor but chronic daily stressors arising from external sources are the most damaging forms of stress for couples' satisfaction levels. There is probably more in common between these two models than would differentiate them; both suggest that stressors like work problems spill over into couple functioning by decreasing positive time spent together, increasing negative communication patterns, and triggering emotional and behavioral difficulties in partners who may already be at risk based on dysfunctional personality traits. Even though the bulk of dyadic stress research in couples has focused on major, external stressors, the results are relatively inconsistent, possibly hampered by a reliance on self-report in cross-sectional studies. Data from studies on minor stressors are more consistent in demonstrating a significant, negative relationship with marital satisfaction and stability.

The stress associated with the transition to parenthood has been extensively studied in its effects on marital quality. Parents report lower marital satisfaction than nonparents, and there is a significant, negative relationship between number of children and marital satisfaction. Research shows that the birth of the first child leads to sudden decreases in marital satisfaction above and beyond the normal decreases in marital satisfaction for nonparents, and that this decrease continues for several years after the birth of the child, although planning for pregnancy and quality of the marriage before birth of the child moderate the level of decline. Even though research is consistent that the addition of a child leads to declines in marital quality, comparatively less is known about how parenting, particularly disagreements and conflict over parenting, is associated with marital distress, and how the presence of children in the marriage negatively impacts marital quality.

Summary

The VSA model nicely conceptualizes the many factors that have an impact on marital functioning, and ultimately marital stability. Many of these factors have been well-studied in isolation, but the challenge as the field moves forward is to examine the model as a whole. This will require intensive, multimethod assessment of couples, particularly over time. For some time now, researchers have been sounding the call for the need to move beyond cross-sectional research to focus on longitudinal studies of married couples. Longitudinal studies are the best method for examining within- and between-couple change in marital quality, and recent work has elucidated the appropriate statistical tools (e.g., longitudinal growth curve models for dyadic data) to examine this type of data. It is certainly possible that not only are there mean-level changes in marital quality for couples at different points in the life cycle, but that the factors affecting marital satisfaction differ at different ages. Older adult couples, for instance, have certain challenges (e.g., chronic illness, retirement) that do not affect young adult couples. There is a limited amount of research on marital functioning in older adults per se, including late-in-life marriages. This is an area ripe for future research.

Treatment of Marital Dysfunction

Marital and Family Therapy

Decades of research with clinical samples and randomized clinical trials have consistently supported the use of couples therapy in the treatment of marital distress. A recent meta-analysis found a mean posttreatment effect size of 0.84 for any type of marital treatment compared to control groups; thus, on average, couples who receive treatment are better off at the end than 80% of couples who do not receive treatment. There are many different forms of marital therapy, and research has demonstrated approximately equal effectiveness across several different types of treatment. Unfortunately, gains at follow-up tend to decline from immediately following treatment, and some couples will show no benefit from therapy. In fact, across type of treatment, between 30 and 70% of couples completing marital therapy will fail to show long-term improvement.

The most well-researched forms of therapy are variants of behavioral marital therapy. Traditional behavioral couple

therapy (TBCT) is based on social learning and behavioral principles, and focuses on increasing positive behaviors between spouses, decreasing negative behaviors, and improving communication and problem-solving skills between couples. Short-term follow-ups indicate that gains made from TBCT treatment tend to persist over the 6–12-month period following termination. There is less evidence for continued gains over 2 years after therapy.

Although frequency of behaviors are certainly important, several theoretical and empirical lines of research suggest that assessing and intervening with one's reactions to a partner's behavior is also important. Following from these findings, Jacobson and Christensen developed integrative behavioral couple therapy (IBCT), which focuses on emotional acceptance within the romantic relationship. IBCT differs from both behavioral and cognitive behavioral couple therapy in the formulation of a couples' problem and the goal of treatment. Unlike behavioral interventions, which focus on increasing positive behaviors and reducing negative behaviors, and cognitive interventions, which focus on changing maladaptive cognitions that lead to behavior, IBCT promotes emotional acceptance – helping distressed couples accept previously unacceptable facets of their partners. Thus, IBCT parallels the incorporation of acceptance into many types of psychotherapy for individuals. In the largest clinical trial of marital therapy to date, Christensen and colleagues compared the effectiveness of TBCT and IBCT over the 5-year period posttermination; both showed statistically and clinically significant improvement by the end of therapy and at 2-year follow-up. Notably, couples in both treatment groups evidenced substantial improvement from pretreatment marital satisfaction scores over the 5-year period posttreatment.

There are still many limitations to couples therapy and current research into the effectiveness of the various types of interventions. First, most of the behaviorally oriented forms of couples therapy followed directly from interpersonal process research, and its limitations. Positive aspects of emotions, behaviors, and social support have only recently been investigated, and future research will need to understand how to incorporate these aspects into couples therapy. Second, couples therapy still fails to fully account for how (1) individual differences in each member of the couple and (2) the individual and dyadic stressors facing the couple, impact the positive and negative dimensions of couple interactions. Third, much of the research on determinants of marital distress and couples therapy have been conducted with middle- or upper-middle-class white couples; it is largely unknown how couples therapy will translate to couples of different racial or ethnic backgrounds, couples from lower SES levels, homosexual couples, or cohabitating couples.

Marital Enrichment Programs

While empirical research on the effectiveness of couples therapy continues, a parallel effort is growing in which a burgeoning field of marital and relationship education (MRE) programs attempt to address problems before they begin. There is a great deal of heterogeneity in the couples who attend MRE programs; some programs specifically target couples at certain distinct transitions, including engaged couples or those

expecting a child. The one constant is that MRE programs are designed for couples whose problems have not escalated to the point of needing a therapist. MRE programs may often be led by marital therapists, but they are not included under the rubric of marital interventions. Many of these programs are designed for couples to complete prior to marriage, although they have also been used for couples who feel that they need a 'tune up.' MRE programs generally consist of two broad, inter-related components: (1) a focus on improving communication and problem-solving skills along the lines of behavioral interventions and (2) instruction on key components of marital quality, including attributions and beliefs about marriage.

In general, research suggests that these marital education and enrichment programs produce significant, although modest, gains in communication skills and relationship quality. A recent meta-analysis of MRE programs included 117 studies, with a majority of the studies focusing on general enrichment for married couples. Results indicated significant, moderate effect sizes for two outcome indices, relationship quality and communication skills. There was no evidence of gender differences in these effect sizes. A significant dose–response relationship moderated the effect of MRE programs, with moderate-dosage programs (9–20 h) producing better results than lower-dosage (1–8 h) programs. The limitations of couples therapy research generally extends to research on MRE programs, that is, a reliance on white, middle-class, heterosexual married couples, and a lack of long-term (over 12 months) follow-up.

Summary

The field of marital satisfaction research stands at an interesting crossroads, having accomplished much, but poised to expand even farther if certain challenges and limitations are dealt with. The quality of research into the determinants, consequences, and treatment of marital distress has improved dramatically in only the last few decades. The tools available to assess and study marital dysfunction are more technologically advanced than ever, ranging from behavioral coding, to physiological measurement, to even behavioral and molecular genetic techniques. These improvements run in tandem, not coincidentally, with improvements in both prevention and intervention methods for marital distress. Particularly in the wake of the Healthy Marriage Initiative, the federal government is poised to have a major impact on research into the factors that promote well-functioning marriages.

As research moves forward, the challenges will be fourfold. First, in this time of changing demography of family life in the United States, researchers will have to determine how research on marital distress *per se* translates to other forms of romantic relationships, including cohabitating and homosexual couples. Second, more work needs to be done on the conceptualization and definition of marital distress; more sophisticated statistical analyses, including latent class analysis and taximetrics may be particularly useful here. Third, researchers need to continue taking into account contextual effects when examining theoretical and empirical models of marital satisfaction. The VSA model has now been widely accepted in the literature, but few studies attempt to measure and model variables

from all three latent domains (i.e., enduring vulnerabilities, stress, and adaptive processes). Finally, marital research needs to greatly expand its focus on diversity, from using samples of varying ethnic, racial, SES, and age categories, to modifying (if necessary) prevention and intervention efforts and finding ways to deliver them to underrepresented populations.

See also: Love and Intimacy; Personal Relationships in Everyday Life.

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Relevant Website

<http://www.abct.org/Home/> – Association for Behavioral and Cognitive Therapies.

Mate Selection

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Glossary

Long-term mating Long-term romantic relationships (e.g., cohabitation, marriage).

Mate value One's value in the mating market, based on one's reproductive value as perceived by potential mates.

Minimum parental investment The amount of expenditure toward offspring that an organism or individual is physiologically required to make.

Ovulation In the human menstrual cycle, ovulation is when a mature ovum (egg) is released from an ovary and is therefore available to be fertilized.

Sexual dimorphism Differences in phenotype (physical appearance, behavior) between males and females within a species.

Short-term mating Engaging in sexual intercourse without commitment (e.g., one-night stands, casual sex).

Sociosexuality The extent to which an individual is open to and interested in short-term mating and the extent to which an individual is open to and interested in long-term mating.

Waist-to-hip ratio (WHR) The ratio of the circumference of the waist to that of the hips; an indicator of health and fertility in women, with a ratio of 0.7 (or lower) being ideal.

Introduction

The topic of mate selection is one that is intrinsically fascinating. Why do we choose who we choose? What makes them attractive to us? Certain features (e.g., breasts, hips, long hair, lips) are found alluring in women, while others (e.g., strong jaws, chiseled cheekbones, biceps) are found attractive in men. Men and women also seem to approach mating from different perspectives – generally, men are more interested than women in having short-term relations, while women are more interested than men in having long-term relations. A man seems to prioritize attractiveness in his partner, while a woman seems to prefer a partner who has a job that supports at least himself if not her as well (this is less of a concern to men). In what other ways do men and women differ in their mate preferences? In what ways are they similar? Why do these preferences exist? How did they come about? This article addresses these important questions. It (1) introduces social and evolutionary perspectives on mate selection (2) examines how individuals select mates for long- and short-term relationships, (3) presents empirical research on the effects of the ovulatory cycle on mate selection, (4) explores same-sex preferences, and (5) reviews studies on actual mate choices.

Perspectives

There are two prominent perspectives on why humans choose the mates they do. These perspectives are not mutually exclusive, but do have different foci. Some social psychologists focus on social role theory to explain mate preferences, while evolutionary psychologists focus on evolutionary adaptations. This article focuses on the evolutionary perspective, as most of the developments in mate selection have stemmed from predictions generated by this perspective. However, it briefly introduces both viewpoints here.

Social role theory argues that mate preferences are based on cultural expectations. That is, in each culture, there are generally held expectations for ideal male and female mates. Such

expectations, or social roles, are shaped by the values of a society, which in turn are shaped by various constraints. For instance, from a sociocultural perspective, women in most societies have less power socially and economically than men do. To gain better access to economic resources and upward mobility, women need to select marriage partners who have social status and income potential. Thus, these traits are an important part of the male social role. In contrast, men are not excluded from economic participation. Rather, they are free to pursue what society deems pleasurable, such as a person's physical attributes. As such, physical appearance is a large part of the female social role.

Why do those traditional sex roles exist in the first place? Evolutionary psychologists argue that it is because they were adaptive in our ancestral environment. From this perspective, human brains consist of problem-solving devices (i.e., adaptive mechanisms) that have been shaped over millions of years of natural and sexual selection. That is, psychologies that somehow aided ancestral humans in reproducing more successfully are likely to have been passed down over evolutionary history to the present day. Because men and women have different reproductive capacities and constraints, the sexes may have evolved different psychologies relating to mating and reproduction. In the following paragraphs, this theory is explored in greater detail.

Relationship Selection

What type of relationship to pursue may depend on an individual's sociosexual orientation, or willingness to have sex without commitment. Although both sexes seem to value long-term, committed relationships, men are significantly more inclined than women to engage in short-term (casual sexual) mating. Evolutionary theorists attribute this key sex difference to differential parental investment.

Evolutionary biologist Robert Trivers drew upon Darwin's writings on sexual selection as well as more recent research to formulate parental investment theory, from which many

hypotheses and fruitful studies have been designed. Trivers defines parental investment as “any investment by the parent in an individual offspring that increases the offspring’s chance of surviving (and hence reproductive success) at the cost of the parent’s ability to invest in other offspring.” In a species, the sex that makes the larger minimum parental investment typically evolves to be the choosier sex, whereas members of the less-investing sex compete among themselves for access to the more valuable sex. For humans and other mammals, females are physiologically required to make a much larger parental investment. In fact, because female sex cells (eggs) require more energy to produce and maintain than male sex cells (spermatozoa), when an egg is fertilized, females have already made more of an investment than males have. Mammalian females also incur the costs of a long period of internal gestation, birth, and subsequent lactation and nursing. In contrast, a male’s minimum parental investment may potentially end with the release of seminal fluid. This differential minimum required parental investment makes females more selective than males because females have more to lose from mating with a low-quality partner.

Another way to view this dynamic is to consider that men and women differ in terms of how partner number affects reproductive success. For men, each new sexual partner represents a potential increase in offspring. Women, however, are physiologically constrained by pregnancy and lactation and thus do not reproductively benefit from having numerous sexual partners. From the perspective of genes, upon which evolutionary processes operate, a gene or set of genes that promoted sexual promiscuity may have successfully propagated through males but not through females. It is important to note that genes, in order to propagate, do not require organisms, including humans, to be consciously aware of their operation. Just as a person does not need to be aware that eating contributes to the reproductive success of genes involved with hunger mechanisms, the individual does not need to be aware that he or she is propagating genes when choosing mates.

Several studies have shown that women are more cautious about engaging in short-term sexual relations. For instance, evolutionary social psychologists Norman Li and Douglas Kenrick recently performed an experiment to investigate the kinds of mates people would design if given varying ‘budgets’ of characteristics. When participants were asked whether they would enter into a long-term relationship if they encountered the ideal long-term mate they had designed, men and women were found to be similarly selective; however, women were significantly more selective when it came to short-term relationships. Women were more reticent than men to say they would engage in a short-term relationship even when they had a high budget to design an ideal partner.

In a classic field experiment, social psychologists Russell Clark and Elaine Hatfield found that when a female stranger asked a male university student whether he wanted to go to bed with her that night, 75% said yes. However, when a male stranger asked a female the same question, 100% said no. Evolutionary psychologists David Buss and David Schmitt asked people how many partners they would ideally like to have in a lifetime. For men, the mean was 18, whereas for women, it was 4.5. Men are also more likely than women to desire sex sooner after meeting a potential partner. In the same study, women and men were equally likely to have sex with

a potential partner after knowing them for 5 years; however, at every shorter interval of acquaintance (2 years, 1 year, 6 months, 3 months, etc.), men were significantly more likely to say that they would consent to sexual intercourse. This sex difference was replicated by Schmitt in a study of 52 cultures. Men also significantly lower their standards when it comes to short-term mating, while women do not. Additionally, men prefer women with sexual experience when engaging in short-term mating, but not long-term mating. The lowering of standards and the preferences for sexually experienced short-term partners make sense in terms of promoting sexual activity with a larger number of women and support an evolved preference for short-term mating in men. However, these findings could all represent how women prefer to be *seen* rather than their actual desires.

A recent meta-analytic review by Peterson and Hyde examined reports of 30 sexual behaviors and attitudes in 834 papers and 7 large national data sets between 1993 and 2007. Overall, men reported slightly more sexual experience and sexual permissiveness, but these effect sizes were small for everything other than pornography use and masturbation (for which there were medium effect sizes). However, even this difference might be explained by the fact that women underreport masturbation and pornography consumption, while men do not. While men were more supportive of casual sex and women were more supportive of sex with commitment, this latter point was the reverse of what Oliver and Hyde found in their meta-analysis of a similar nature that was conducted 20 years ago. This may reflect changes in social standards: it is now acceptable for a woman to engage in sex within a committed relationship, whereas 20 years ago, premarital sex was impermissible for a woman. The differences between males and females in sexual behavior and attitudes may not be as large as is often portrayed.

Which type of relationship is more prominent depends on the sex ratio. The more men versus women, the more a society leans toward long-term mating – less promiscuity and early marriage. The more women versus men, the more a society leans toward short-term mating – more promiscuity and late marriage. Thus, men’s preferred mating strategy is more likely when women are in greater supply, whereas women’s preferred strategy is more likely when men are in greater supply.

Long-Term Mate Preferences

When selecting for a long-term mate, men and women both make significant investments of time and resources, so there should be some similarities in their long-term mate preferences. Indeed, several studies have shown that long-term mate selection seems to be somewhat assortative. For example, Watson and colleagues recently investigated assortative mating in newlywed couples. They found that both sexes select for a mate with the same political inclinations, the same religion, and someone of a similar age. Moderate similarities have been found with respect to intelligence: people seem to prefer someone with a similar vocabulary, education level, and general IQ. It makes sense that people prefer mates who are similar to themselves, as similarity minimizes conflict in relationships while maximizing cohesion.

Although men and women are both selective and share similarities in what they seek in long-term relationship partners, there are also some key differences. Women care more than men about their partner's social status and ability to acquire resources, while men care more than women about their partner's physical attractiveness. Buss has shown that these differences tend to be found not only in the United States and other Western countries, but also across 37 different cultures worldwide. Buss and Kenrick have also shown that while couples tend to be similar in age, women are attracted to men who are their own age or older and men are attracted to women at peak fertility – that is, women in their 20s.

Physical attractiveness and resources are not only sex-differentiated, but they are regarded as necessities by men and women, respectively. That is, Li and colleagues found that when mating budgets are low, men tend to prioritize physical attractiveness above other traits in their long-term partners. In contrast, women tend to prioritize resource-related traits in their long-term partners. Once these traits are obtained in roughly average levels, both sexes tend to value other traits. In other words, both sexes ideally want a well-rounded mate who has it all. However, men seem geared toward ensuring that their long-term mates are not physically unattractive and women seem geared toward ensuring that their long-term mates are not destitute.

Multiple studies have suggested that aspects of females that are found to be physically attractive – breasts, buttocks, skin, hair, teeth, movement patterns, etc. – are related to youth, sexual maturity, and health, which impact a woman's ability to bear children. Less intuitive features that are found widely attractive, such as body and facial symmetry, are also cues to genotypic and phenotypic quality. In both men and women, low fluctuating asymmetry indicates better mental, cognitive, and physical health. Buss hypothesizes that the most compelling reason for men to pursue a long-term mating strategy is to monopolize a female's lifetime reproductive resources. If this is the case, then it makes sense to be particularly attracted to signals of fecundity and health, and also explains the common finding that men prefer younger women.

One particularly important measure of fecundity has been investigated by psychologist Devendra Singh: the waist-to-hip ratio (WHR). While preferences for body mass levels and weight vary across cultures depending on factors such as food scarcity, in most cultures, women with a lower WHR (generally in the 0.6–0.8 range) are found to be the most attractive. This has been found to be true in White-American, African-American, Hispanic, Indonesian, and British males, as well as in art and statues from around the world over the centuries, and more traditional hunter-gatherer societies such as the Aché. Investigating populations who live in conditions more similar to the ancestral environment showed that it is not necessarily the absolute WHR that matters, but rather that a lower WHR in comparison to the normal female range to which a man is exposed is found to be especially attractive. Direct relationships between WHR and fertility have been found, and it has been hypothesized that low WHR helps distinguish which females are of a fertile age and are not pregnant (pregnancy increases WHR). Furthermore, Hughes and Gallup recently found that females with low WHR had intercourse for the first time at an earlier age, reported having had more sexual partners, more

extra-pair copulations, and more instances of sexual relations with men already in a relationship. This provides further evidence of the attractiveness of a low WHR, but it also indicates a related issue: sexual infidelity.

As men tend to invest significant amounts of time and resources into long-term relationships, they may have evolved to ensure that their investment is not misdirected, by being sexually jealous and more interested in women who will be faithful to them. That is, men who invest in long-term relationships without regard to a partner's sexual fidelity likely do not leave any descendants. Buss and colleagues found that 60% of men would be more upset by sexual infidelity as opposed to emotional infidelity. Additionally, men find promiscuity acceptable in a short-term mate, but unacceptable in a long-term mate and, as mentioned earlier, find sexual inexperience to be an attractive quality in a potential long-term partner. These preferences support the idea that when a man selects a long-term mate, he may have an underlying need to ensure future paternity.

Women, on the other hand, have different concerns when it comes to selecting a long-term mate. A woman is always certain of her maternity because she is incubating and giving birth to the child herself. Instead, her concerns focus on a partner's investment, resources, and status. Through a long-term relationship with a man of high status who has a stable income, a woman can acquire direct resources for her children, as well as the indirect reproductive advantages that social and economic benefits can confer. Several studies have found that measures such as socioeconomic status (SES), social dominance, ambitiousness, or social status are valued and prioritized when women are selecting long-term mates.

Short-Term Mate Preferences

Men have similar criteria for selecting a short-term mate as for selecting a long-term mate. That is, for all of the reasons mentioned previously, physical attractiveness is especially valued in a short-term partner. Although women generally prefer long-term mating, some women do engage in short-term mating. Why would women engage in short-term mating when considering the potential costs? Beyond the sexual pleasure involved, the adaptive benefits for women have been hypothesized to include instantaneous resource acquisition (e.g., prostitution or 'gold digging'), better genetic quality, or being able to evaluate a mate for a long-term mating context. Li and Kenrick found that when women are selecting a short-term mate, they (like men) prioritize physical attractiveness. However, as opposed to looking for a fertile mate, women may be selecting good genes in a short-term mateship. That is, although a casual sexual partner may not contribute much in the way of income or resources, his genetic quality – which can be directly passed on to offspring – is relevant if pregnancy occurs. According to psychologist Steven Gangestad and biologist Randy Thornhill, a healthy set of genes and immune system provide resistance to pathogens that can adversely affect developmental stability. In addition to having negative health consequences, individuals who are not able to fend off pathogens during development tend to possess a greater degree of bilateral asymmetry (i.e., left-side development deviates from being

symmetrical to right-side development). Because testosterone suppresses the immune system, only men who have strong immunity are able to maintain high levels of testosterone and remain healthy. Thus, testosterone-related physical features, when present with symmetry, are honest indicators that a man's genes are resistant to pathogens. Consistent with this theory, women seem to prefer short-term mates who are symmetrical, muscular, tall, broad-shouldered, and have masculine facial features. Thus, whereas men seem to be seeking women who are capable of reproducing, women seem to be seeking good genes for their potential children.

Women, according to psychologists Steven Gangestad and Jeffrey Simpson, may have evolved to utilize short-term mating as part of a mixed mating strategy. That is, women want men who are strong and healthy, but they also want men who will invest and help raise children. However, this cannot always be found in the same individual, and such men, being high in demand, tend not to be loyal mates. So, although a committed relationship with a resourceful man who is also physically attractive is ideally preferred, most women have to choose between resourceful men for long-term relationships and physically attractive men for short-term relationships. As such, most women opt for the former. If the opportunity presents itself, some of these women may have sexual affairs with physically attractive men, thereby obtaining resources and investment from one man but genetic quality from another. Indeed, women's sexual affair partners tend to be more physically attractive and symmetrical than their regular partners.

Ovulatory Effects

Individuals vary in whether they utilize a short-term or long-term mating strategy. However, there is also important intra-individual variation. This section focuses on the way the ovulatory cycle affects women's own choices as well as men's attraction to women at different points in their cycle. It is one thing to say that men and women have unique preferences in the opposite sex in certain contexts, but quite another to think that a woman could be attracted to a certain type of man one day and a different type of man two weeks later. However, this has been found to be the case. Similarly, one generally thinks of a woman's physical attractiveness as being relatively stable; however, evidence shows that a woman actually varies in how attractive she is perceived to be based on the phase of her menstrual cycle. These processes are not conscious, but are rather driven by hormones and reactions to the hormones of others.

Women's Preferences When Ovulating

Ovulation is the most fertile phase of a woman's menstrual cycle. At this time, indicators of genetic quality become more important to women selecting mates. For example, Ian Penton-Voak and colleagues found that during phases of high conception risk, women preferred more masculine faces for short-term relationships. Consistent with the good genes theory mentioned previously, more masculine features might indicate genes that can resist disease, which would be beneficial for offspring. In contrast, when assessing attractiveness for long-term relationships, women choose men with more

feminine faces irrespective of the menstrual cycle, presumably because such men would be more likely to invest and less likely to have extramarital affairs. Additionally, when women are ovulating, they prefer the scent of men who are more symmetrical. Furthermore, they prefer the scent of men who scored high on a dominance scale when fertile or when currently in a relationship. Recently, Gangestad and colleagues found that women are more attracted to traits such as physical attractiveness, muscularity, and being confrontational when most fertile and when evaluating men as short-term mates. Anthony Little and colleagues found that women prefer facial symmetry in men during the most fertile phase of their menstrual cycle and also when they are in the midst of a long-term relationship. They also found an increase in preference for both symmetry and sexually dimorphic facial characteristics in women who consider themselves to be physically attractive. David Puts similarly found that lower frequency male voices were preferred by women for a short-term relationship over a long-term relationship, and were most preferred when women were ovulating. Additionally, preference for a deeper male voice was correlated with high self-reported mating success. Whereas women of low attractiveness or mating success might have a hard time keeping a high-quality mate, a woman of high attractiveness or mating success might be able to keep one or, even if he deserts her, find another man to help her raise her children.

Men's Preferences for Ovulating Women

Women are more receptive to short-term pairings during ovulation; they also judge themselves as more attractive and are judged as being more attractive by men during this time. Why might this be? In many mammalian species, females experience estrus. In these species, females only engage in sexual relations and can only be fertilized during this time. Females often display obvious signs of estrus, such as genital swellings or spontaneously elevating the hindquarters. Human females, like the other great apes, experience menstrual cycles rather than estrus cycles. This means that if no eggs are fertilized, the endometrial tissue is shed through menstruation rather than being reabsorbed. For many years it was thought that ovulation was entirely concealed in humans. As human females are sexually receptive throughout the menstrual cycle and do not show that they are ovulating (and might not even be aware of their own ovulatory patterns), it was thought that men would not be able to detect female fertility. It was also hypothesized that this might have evolved to extend investment from males and sexual interest throughout the entire cycle, encouraging monogamy. However, this mechanism would also enable females to cuckold males more easily because it would be more difficult for males to keep track of their partner's fertile window. In this way, it would have allowed women to mate with, and become impregnated by extra-pair men. However, more recently it has been shown that ovulation might not be as concealed as previously thought.

Recent laboratory studies have demonstrated that during the fertile phase of their cycles, women are more attractive to men. Women experience a decreased WHR, increased body symmetry, greater facial attractiveness, greater likelihood of wearing revealing clothing, more attractive scent, and even higher levels of creativity and fluency on high-fertility days.

Additionally, Kristina Durante and Norman Li found that higher estradiol levels (which fluctuate throughout the menstrual cycle and are higher during ovulation) were associated with higher ratings of self- and other-perceived attractiveness and the likelihood of mating. Furthermore, during ovulation women dress more provocatively, are perceived as trying to look more attractive, are guarded more closely by mates, and receive more attention and expressions of love from mates.

Recently, an innovative study by psychologists Geoffrey Miller and colleagues assessed the effects of the ovulatory cycle on tip earnings in lap dancers. Eighteen dancers recorded their menstrual cycles and reported on 296 cumulative work shifts over a period of 60 days. Participants who were not using any hormonal contraceptives earned US\$335 for each 5-h shift during ovulation, US\$260 during the luteal phase, and US\$185 during menstruation. Conversely, those using hormonal contraceptives earned only US\$193 per shift and experienced no ovulatory peak. This means that on average, normally cycling lap dancers make US\$80 more than those who use hormonal contraceptives each shift. This suggests that men, though almost certainly not consciously, are able to detect female ovulation in some way. However, the fact that women still make money during nonfertile phases suggests that this detection is imperfect. If infertile women were entirely unattractive, then they would make no money. This could be the result of an evolutionary arms race between men and women – women developing mechanisms to conceal ovulation in order to cuckold men and men developing mechanisms to detect ovulation in order to mate with fertile women.

Same-Sex Mate Preferences

Evolutionary psychologists rarely address same-sex attraction, mate selection, and relationships because the evolutionary function of homosexuality and bisexuality is still unclear. However, Alfred Kinsey found that ~10% of the male population have engaged in exclusively homosexual interactions for a period of 3 or more years. Estimates of female homosexuality are usually much lower; however, this may be because female sexuality is more fluid. Michael Bailey studied arousal patterns in men and women by measuring physiological arousal while watching different kinds of pornography. He found that men tended to be aroused either by watching lesbian and heterosexual sex or by watching homosexual male sex, but not both. Females, on the other hand, were equally aroused by homosexual male and female sex as well as heterosexual sex. Sell, Wells, and Wypij used a survey to measure the prevalence of homosexual attraction and behavior in the United States, United Kingdom, and France. They found that for men, the percentages of attraction and behavior tended to be similar, while for women, the percentage of females attracted to other females was higher than the percentage of those who had engaged in sexual behavior with other females. The important differentiation between attraction and behavior is discussed in a heterosexual context in the following paragraphs.

Several studies have suggested that there might be an innate component to homosexuality. This could be due to a gene that makes an individual more likely to become homosexual, and it could also be due to prenatal androgen signaling. If

homosexuality is heritable, why would that be? What benefits could it bestow for an individual's genes? One possibility is kin selection, whereby an individual is more likely to help his or her kin because they share a large proportion of genes. This means that benefits shared with kin indirectly benefit one's own genes and costs to kin are indirectly costly to one's own genes. The higher the proportion of genes shared, the more likely it is that an individual will help. Stated differently, genes can spread by inducing organisms to help their relatives, because relatives are likely to have copies of those helping genes. This has been demonstrated in species from ground squirrels to humans. So, if a homosexual individual helps to ensure the survival of his or her brothers' and sisters' children, that individual is also ensuring the survival of his or her own genes. This theory is consistent with the finding that having older brothers increases the likelihood of a male being homosexual. Anthony Bogaert found that each additional older brother increased the likelihood that the subsequent son would be homosexual by an average of 38%. However, evidence supporting this hypothesis is still inconclusive, and several alternative theories have been postulated.

Regardless of why homosexuals and bisexuals exist, it is clear that they do exist and they do show certain attraction patterns. While conclusions drawn from these studies are more tentative because they lack the replication of heterosexual studies, certain trends are still present. Bailey and colleagues performed a study comparing homosexual and heterosexual male and female participants, and found that sex had a considerably larger impact on their results than did sexual orientation. Men – both heterosexual and homosexual – were more interested in uncommitted sex and prioritized physical attractiveness more than women. However, there were some proclivities that were a bit more complicated. Men were much more interested in visual sexual stimuli than women generally, but lesbians were more interested than heterosexual women in pornography (though not as much as heterosexual men). Men were more likely to express that partner's status is unimportant, but lesbians were just as likely as heterosexual men to say the same. Men were more likely to be sexually jealous, while women were more likely to be emotionally jealous, but homosexual men were more similar to women than men in this case. Men were more likely than women to prefer a younger partner, but heterosexual males displayed a stronger preference than homosexual males (however, homosexual males were still more likely than females to prefer a younger partner). Finally, men had higher sociosexuality scores than women, but homosexual men had even higher sociosexuality scores than heterosexual men. However, this difference reflects differences in opportunity rather than motivation to engage in casual sex (the difference depended on the behavioral items on the Sociosexual Orientation Inventory). These collective findings suggest that generally, males and females vary more intersexually than intrasexually on these items and also that sexual orientation adds complex dispositions that should be further explored.

Actual Mate Choices

In a meta-analysis of gender differences in mate selection preferences, Alan Feingold rightly highlights that in mate selection research, experimenters rarely distinguish between attraction,

self-professed mate preferences, and actual dating/mating choices. What people say they want could be entirely different from what they are actually attracted to, which could still be different from who they actually end up with. There are three main paradigms which have sought to explore mate selection in the real world because of this problem: (1) Personal advertisements, (2) Marriage data, and (3) Speed-dating studies. Personal ads reveal, in a naturalistic manner, what potential partners want. Speed-dating studies tell us what aspects are important in a brief encounter that could lead to a date. Marriage data tell us who really ends up with whom.

Personal Ads

Personal ads are mate preferences revealed in competitive mating markets. Various studies have shown that advertisements are consistent with surveyed mate preferences. Women who promote themselves as being physically attractive make more demands for affluent mates. Additionally, women become less demanding as they get older, while men become more demanding. Younger women get more responses than older women and older men get more responses than younger men. This supports the idea that both men and women are able to pursue their preferred mating strategy when they perceive their own mate value as being high. More recently, a study of internet personal ads across the life span found that predictions from evolutionary psychology still hold true in this modern context: from 20 to over 75, men sought physical attractiveness and offered more status-related information; women sought more status than men did and were more selective. As men age, they look for progressively younger women; women look for men older than themselves until 75 and older, at which point they start to look for younger men. These measures seem to confirm past findings of sex differences in what men and women are looking for in a mate and the age of the preferred partner.

Actual Marriages

Collecting data using married individuals gives researchers a different perspective on mate selection – what kind of mates are actually selected for long-term relationships? Do higher-status men attain more attractive females? Is the male usually older than the female in a marriage? Several marriage studies have found that men with successful careers do indeed have more attractive wives. Indeed, a woman's physical attractiveness, as indicated by her high school yearbook photo, is a significant predictor (more so than her intelligence) of the social status of the man she marries.

Marital satisfaction studies have also supported evolutionary predictions. Glenn Weisfield and colleagues found that a woman is more satisfied with her marriage if her husband made most of the decisions (i.e., dominance is attractive), but excessive dominance reduced satisfaction (potentially getting to the point of making a wife scared of her husband). A man is more satisfied if his wife is more attractive than him. The notion that dominant men gain more attractive wives was also supported. Overall, marriage data support evolutionary hypotheses of mate selection and validate hypothesized sex differences.

Speed Dating

One of the ever-present difficulties of psychological research is attempting to maintain ecological validity while retaining experimental control, and this balance can be particularly hard to achieve in attraction and mate selection paradigms. Preferences that people state on questionnaires about what traits they are looking for in a partner can differ from who they actually choose. Speed dating helps bridge the gap between stated preferences and choices on who one actually wants to see again. Social psychologists Paul Eastwick and Eli Finkel performed an experiment to test whether stated preferences would prove true in an actual face-to-face dating situation by using a speed-dating paradigm. On a pre-speed-date questionnaire, men (more than women) reported that physical attractiveness would be an important characteristic when selecting for an ideal partner and for a speed date. Women (more than men) thought they would find earning potential to be an important characteristic when selecting for an ideal partner and for a speed date.

However, post-speed-date questionnaires that asked participants why they selected the specific people they did showed that, while physical attractiveness, good earning potential, and personable characteristics were all related to romantic interest, there was no evidence for sex differences in selecting for these characteristics. There was also no evidence suggesting that the lack of sex differences had anything to do with participants' long versus short-term mating preferences. Additionally, what participants thought they wanted and what they actually chose were largely independent (e.g., a participant might have said they thought physical attractiveness was very important, but then said in the postdating questionnaire that they selected their partner based on personality).

The lack of congruence between stated mate preferences and actual mating choices raises issues that deserve further study. For instance, are there really no sex differences in the importance of earning potential in mate choice, or can this be attributed to where the speed-dating study was conducted – a university campus, where most of the students are of a certain economic level as well as having a certain level of intelligence. Additionally, since most of the female participants were around 20 years old, a certain level of fertility could also be assumed. Thus, male and female participants may have less need to discriminate on the basis of earning potential and physical attractiveness, respectively. Instead, both can focus more on how well they get along with their potential mates.

Conclusion

Mate selection is a complex process that is influenced by biology as well as culture and the environment. Individuals look for long- or short-term mates, or both, depending on hormones, phase of life, and self-perception. In general, women seem to prefer long-term relationships, but still engage in short-term mating. Although most men end up in long-term relationships, most men seem to prefer short-term mating. These types of decisions are also influenced by sex ratios of available mates versus intrasexual competitors. A strategy becomes more desirable as a function of the number of

available mates responding to that strategy and the lack of many intrasexual competitors employing that tactic. Recent speed-dating studies have shown fewer differences between men and women than previous studies found with other methods (e.g. self-report). Whether this finding can be replicated in populations with more diversity in levels of attractiveness and SES, however, has yet to be seen.

Men and women seem to be more similar when it comes to what they are looking for in a short-term partner, but differ in what they desire in a long-term partner. Good looks are a requirement for short-term mating, and other factors are less important. However, when looking for a long-term mate, women prioritize status and resources, while men continue to prioritize physical attractiveness. However, only a certain level of these is necessary. Whereas a man with an average, stable job is much more highly valued than a destitute man, a man who earns a lot more is only slightly higher in desirability to most women. Conversely, women who are moderately physically attractive are strongly preferred over women who are clearly unattractive. However, further gains in attractiveness are associated with smaller increases in overall desirability. Beyond differences in what they initially prioritize, men and women tend to ideally prefer the same kind of long-term partner – a well-rounded individual who is attractive, smart, industrious, funny, creative, and kind.

Embracing an evolutionary viewpoint does not mean ignoring cultural and social factors. Evolutionary explanations tend to focus more on the ultimate origins of preferences and behaviors, and evolved adaptations are complex processes that can have different implications depending on environmental and cultural factors. Studying mate selection across cultures and across other contexts would allow a more intricate understanding of how adaptive mate selection processes shape and are shaped by environmental factors. Indeed, scientific research across cultures is becoming more common as the world grows smaller; this is an encouraging trend.

See also: Evolutionary Psychology; Evolutionary Social Psychology; Human Mating; Personal Relationships in Everyday Life; Sex Differences.

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- <http://www.davidbuss.com> – Site for Dr. David Buss.
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Media Influence on Behavior

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Glossary

Agenda setting The ability of news media to decide what it is newsworthy and how important the news story is.

Aggression Any behavior that is intended to harm another person who does not want to be harmed.

Aggressor effect The phenomenon wherein exposure to violent media can cause the viewer to also behave more aggressively.

Conditioning The pairing of stimuli with rewards and punishments.

Conscious-numbing effect The phenomenon wherein individuals who have been repeatedly exposed to violence in the media are no longer bothered by acts of violence in the real world.

Desensitization The process where constant exposure to a stimulus diminishes reactions to that stimulus.

Fear-of-victimization effect The phenomenon wherein increased exposure to violent media can cause individuals to believe they will become violence victims.

Framing The ability of the media to portray a topic in a positive or negative manner.

Habituation Overexposure to a stimulus such that it no longer elicits a novel reaction.

Identification Feeling a personal connection to some stimulus (usually a person) portrayed in the media.

Media The collective name for all forms of nonpersonal communication between individuals and/or groups.

Mimicry The immediate copying of an action after a single exposure.

Observational learning The act of learning and displaying more long-term behaviors after constant exposure.

Priming The activation of a concept in the neural network when exposed to an associated concept.

Script The cognitive map outlining what to expect and how to behave in particular situations.

Communication – the exchange of information between individuals and/or groups – has played an important role in the development of humanity. People have always employed various methods to convey ideas and meanings to one another. In the course of time gestures, sounds, and spoken language evolved into pictures and written words. The advent of printing technology allowed for the dissemination of books, newspapers, and other literature to new audiences. Electronic and digital advancements facilitated communication among great masses of individuals through the use of the radio, film, television, and Internet.

In modern society, the term media can be defined as the main means of mass communication. Generally, this includes both print media and electronic media. Numerous modes of communication are accessible to most individuals, and it is easier and simpler than ever to inform, persuade, and entertain people around the world.

The goal of the media is to impart information, and in so doing influence the behaviors of its audience. Such changes in behavior as a result of media influence have become a new area of academic study. Though communication is as old as humanity, the effects of the media have been seriously considered only in the last century. The field of media influence research examines the changes and effects the media brings about in everyday life.

What Is Media Influence?

Everyday we are bombarded with media messages, some as short as a commercial, others as long as a novel. Many

messages simply convey factual information, such as the date of a presidential address; others entice us to purchase a specific product or service; and still others attempt to entertain us or influence our opinion on some particular matter. Often, the media presents multiple messages, some obvious and some more difficult to extract. Messages, both noticeable and opaque, can even be unraveled in media meant as innocuous entertainment. For example, the children's television program *Power Rangers* may overtly communicate the importance of teamwork while at the same time implicitly endorsing the use of violence as a means to solve problems.

It is not unreasonable to believe that exposure to the media can affect a person's conduct. Concern over the possible influence the media may have on an individual's actions has prompted academic inquiry into how people and the media interact.

In the fields of psychology, sociology, and communications, media influence (also known as media effects) refers to the ways in which the mass media can affect the thoughts, feelings, and actions of its audience. Of particular interest are the ways in which media consumption can have an effect on subsequent behavior in both the short run and the long run. Researchers are also interested in the ways the media affects young children, and how such exposure can help shape their lives as adults. Numerous ways in which the media can influence behavior have been uncovered. For the most part, media effects research focuses on the influence of violence in media on later aggressive behavior. Further lines of research examine the media's influence on other behaviors, such as prosocial actions and learning, as well as how the media shapes attitudes (which in turn affect behaviors).

Media Influence Processes

How can exposure to the media affect a person's behavior? The media can influence a consumer's behavior both in the short term and the long term.

Short-Term Effects

Short-term effects occur immediately after exposure to some type of media. These effects primarily occur through the processes of priming and mimicry.

Priming

People hold ideas about how the world works. They have a complex network of links and associations between objects, concepts, and behaviors in their minds. Exposure to a stimulus can activate one idea in a person's mind, which can then trigger the activation of another idea. This process is called priming.

Priming is subtle; it usually occurs without conscious awareness. The content of the media can prime certain ideas, thoughts, feelings, and behavioral tendencies in memory. This makes it more likely that individuals will consciously experience those thoughts. This in turn increases the possibility that people will act on what they are thinking and feeling. For example, after watching a commercial about buying a house, the consumer may have different ideas about houses, after being primed. In addition to the idea of buying a house being activated in the mind, a different idea that might be associated with buying houses may be activated, such as the act of constructing houses for the homeless. The activation of this later idea may prompt the viewer to donate time to building homes for charity.

Mimicry

Mimicry is the act of copying the behavior of others. When a particular behavior is shown in the media, some people are likely to mimic it in other situations. This is especially prevalent with children. For example, a famous experiment by Albert Bandura showed that children who watched a model act violently against a doll in a TV program later mimicked the model's violent actions.

The propensity to mimic actions displayed through the media increases if observers identify with the character and want to become like the character. For instance, if a TV program shows a young African-American girl brushing her teeth, viewers are more likely to imitate that action if they are also young, female African-Americans. Not only physical qualities, but the attitudes and values of a character can also prompt identification. For example, young boys who want to be brave and smart like a cartoon superhero may identify with the character and mimic the character's actions.

Long-Term Effects

Long-term effects occur after prolonged exposure to the media. These effects take place over time and may require multiple experiences with the media content to develop. A prominent long-term effect is the altering of behavioral scripts (and subsequent behavior) through observational learning.

Observational learning

Mimicry and observational learning are similar but have an important difference. Whereas mimicry refers to the short-term copying of an action following its presentation (usually needing only one exposure), observational learning refers to the process of being exposed to the media repeatedly over a period of time, absorbing its message(s), and displaying the learned behavior. This new learned behavior may persist over time, rather than just occur once. In this manner, observational learning can be thought of as a more powerful extension of mimicry.

With observational learning, the observers modify scripts (ideas about what to expect in certain situations and how to interact with the world) according to what they have been exposed to in the media. These altered scripts can subsequently influence how they perceive situations and the types of behavior acceptable in certain situations. For example, repeatedly watching a television program wherein the main character says 'Bless You' after someone sneezes can lead viewers to alter their script about sneezing to include saying 'Bless You'. Later, when they see someone sneeze, they will have learned through the media to say 'Bless You.' Observational learning through the media plays an especially important role for children, as they learn to model their behaviors after media figures.

Effects of Violence in Media

A major line of research involves investigating the effects of exposure (especially, prolonged exposure) to violence in media. Violence in the media is fairly commonplace in the United States. For example, 60% of television programs contain violent content, as do 90% of video games. The Internet is rife with violent websites and games, many songs contain violent lyrics, and even newspapers tend to feature violent events that occur over the world. The media can portray various types of violent content, from descriptions of real-life fist-fights in news reports and videos of riots posted on the Internet, to the fictional murder of a person in a television crime drama or shooting enemies in a video game.

First, we need to define what we mean by the terms 'aggression' and 'violence' because researchers use these terms differently than lay people do. Lay people may describe a salesperson who tries really hard to sell you something as 'aggressive.' Most researchers define aggression as any behavior intended to harm another person who does not want to be harmed. Thus, researchers would not call a salesperson aggressive because the salesperson does not want to harm potential customers. This definition includes three important features. First, aggression is a behavior – you can see it. Aggression is not an emotion, such as anger. Aggression is not a thought, such as mentally rehearsing a murder. Second, aggression is intentional (not accidental) behavior. For example, a dentist might intentionally give a patient a shot of Novocain (and the shot hurts!), but the goal is to help rather than to harm the patient. Third, the victim wants to avoid the harm. Thus, again, the dental patient is excluded, because he or she is not seeking to avoid the harm (in fact, the patient probably booked the appointment weeks in advance and paid to have it done!). Sadomasochistic sex is also not included because again the

victim actively seeks to be harmed. Likewise, suicide would be excluded because the individual does not want to avoid the harm. Behaviors that are intended to harm others are still acts of aggression even if they do not actually harm them. For example, if a person shoots a gun at you but misses, that person still acted aggressively.

Laypeople and researchers also differ in their use of the term violence. A meteorologist might call a storm 'violent' if it has intense winds, rain, thunder, and lightening. When researchers use the term, *violence* refers to aggression that has as its goal extreme physical harm, such as injury or death. For example, one child pushing another off a tricycle is an act of aggression, but it is not an act of violence. One person intentionally hitting, kicking, shooting, or stabbing another person is an act of violence. The United States Federal Bureau of Investigation (FBI) classifies four crimes as 'violent': homicide, aggravated assault, forcible rape, and robbery. Researchers would also classify other physically aggressive acts as violent even if they do not meet the FBI definition of a violent crime, such as slapping someone really hard across the face. But a husband who calls his wife every name in the book would not be committing an act of violence by this definition. All violent acts are aggressive acts, but not all aggressive acts are violent (only the ones that cause extreme physical harm are).

Thus, violence in media depicts acts of extreme physical aggression. Constant exposure to violent media can lead to changes in how the viewer perceives and responds to the world. Two of these processes are the fear-of-victimization effect and the conscience-numbing effect. Together, these processes contribute to a third process, the aggressor effect.

Fear-of-Victimization Effect

Heavy television viewers (usually defined as individuals who watch at least 4 h of TV each day) develop the perception that the world is a hostile place and that others cannot be trusted. One consequence of this perception of the world is the fear that one will become a victim of violent crime. We call this the fear-of-victimization effect. It has been found in both adults and children as young as 7 years old.

What can explain the fear-of-victimization effect? When predicting the amount of violence they will experience, people tend to use information readily available to them. If they have been exposed to a great deal of violent content through the media, they may more easily think of instances of violence compared to people who are not exposed to much violence in media. Because heavy TV viewers can produce violent examples so easily, they may overestimate the amount of violence they will encounter in their everyday lives.

Conscience-Numbing Effect

As a person is constantly exposed to a stimulus, that stimulus may lose its novelty and become quite common. It is no longer as interesting and does not draw as much attention from the person. Eventually, the person may fail to react to the stimulus at all. This process is known as habituation.

Constant exposure to violence in the media can cause a kind of habituation. The more violence in media a person is exposed to, the less likely he or she is to become upset by it;

the violence becomes commonplace, normal, and expected. In effect, the viewer has become numb to violence. This conscience-numbing can have an enduring effect, lasting long after the experience of violence in media is over.

Research shows how people can become numbed by violence in media. The more violence in media a person is exposed to, the less physiologically aroused he or she becomes to subsequent exposures to violence. The diminished physical reactions indicate that the person is less bothered by the violence. One study by Bushman, Anderson, and Carnagey showed that constant exposure to violence in video games led to the players becoming desensitized to violence in the real world.

People who are exposed to a great amount of violence in media may also become less sympathetic to victims of violence – both to victims portrayed in the media as well as to the victims encountered in their daily lives. For example, in one study people who played violent video games gave less severe punishments to violent criminals than those who played nonviolent games, suggesting that they found the violent crimes to be less reprehensible. Along with decreased sympathy, exposure to violence in media may make people feel less empathy for violence victims. This reduced empathy renders people less willing to help real-life victims of violence.

Aggressor Effect

Perhaps most important, short- and long-term exposure to violence in media increases aggression. Over 300 studies have been conducted on this topic, and the findings are clear. Exposure to violence in media influences people to act more aggressively, both immediately after exposure as well as hours, days, months, years, and even decades later.

The tendency to act more aggressively is increased after short-term exposure. For example, immediately after watching violent media content, people are more willing to give painful electric shocks to others; children are also more likely to attack others.

Long-term exposure can alter belief structures, which in turn can affect behavior. Children, who are still developing their own beliefs about the world, are especially prone to changing their ideas and behaviors due to constant media exposure. Children who are exposed to high amounts of violence in media can come to believe that acting violently is socially acceptable. This belief can influence them to act more aggressively later in life. In one longitudinal study by Huesmann and colleagues, for example, it was found that men who watched violence in media as children were more likely to assault their wives and be arrested for crime 15 years later. Likewise, women who watched a lot of violence in media as children were more likely to throw things at their husbands 15 years later.

New forms of media such as video games may have an even greater effect on behavior than more traditional, passive forms of media such as TV and films. Violent games also explicitly reward players for violent acts. Constant reward for violent actions can condition players to believe that violence is good, and this can carry over to other real-life situations. The Internet also presents the opportunity for people to create and distribute their own content. If people receive positive feedback for posting violent content, they may continue to post violent content, which may negatively affect those who see it.

Other Media Effects

While much attention has been devoted to examining the influence of violence in media, other lines of research study the effects of nonviolent, more prosocial media; media influence on attitudes; and media effects on health.

Prosocial Effects

All media are not violent. Many kinds of media try to present positive messages that promote prosocial behaviors. Educational programs for children, such as *Sesame Street*, help children learn about the world. Many children's programs also attempt to instill positive values such as sharing. The media can also bring public attention to a topic (see section 'Public opinion') that otherwise might have gone unnoticed; for example, the newspaper accounts of the Nixon Watergate Scandal inspired political reform.

Newer forms of media such as the Internet have provided fresh avenues for creativity and self-expression. User-created content sites such as YouTube have presented people the opportunity to share their own personal media with the world. Media watchers can more readily become media producers, engaging with their audience on a more personal level. Online social networks (e.g., facebook) can provide additional methods of social support and social connections.

Effects on Attitudes

Body image and self-esteem

The inclusion of beautiful models and actors to endorse or sell a product is a tactic frequently employed by advertisers in the mass media. Magazines, commercials, television shows, and movies use beautiful models to appeal to the audience. Unrealistic expectations about body image can be fostered by exposure to the media. As people are exposed to these advertisements, distorted beliefs about beauty standards can develop. This effect is especially common among adolescent girls (and increasingly among adolescent boys).

When media watchers fail to achieve the high-impossible media standard of beauty, self-esteem can plummet. This lowered self-esteem can bring about negative effects in other domains, such as poorer interpersonal relationships and decreased ability to perform at work. In some severe cases, the media images of beauty can prompt adolescent women and men to fall prey to eating and/or exercise disorders.

Public opinion

The media plays an important role in educating the public about the world around them. Through the processes of agenda setting and framing, the media can shape public opinion.

News media, such as television programs and print and electronic articles, are pivotal in bringing matters to public attention. The media wield powerful control over what is deemed newsworthy. The news media must choose what is important enough to feature, as well as how much time or space to devote to the topic. This ability to decide what news is important and how important it is, is called agenda setting.

In addition to choosing newsworthy topics, the media can also portray the topic in a positive or negative manner, which is

called framing. Combining agenda setting and framing, the media can effectively determine what is worth knowing and how a topic should be perceived. Public opinion can thus be shaped – and following that, public action. For example, many believe that the media placed much emphasis on President Bush's plans to invade Iraq, and that this decision was portrayed in a positive light. This may have caused many people to be more supportive of the war in Iraq than they would have otherwise been.

Health

Exposure to the media – especially for extended periods of time – can influence the health of the consumers, both physically and mentally.

The information and entertainment provided by the media can be very alluring. Exposure to the media can be preferable to engaging in other activities; for example, a child might choose to play a video game inside rather than play hide-and-seek with neighbors outside. Prolonged media exposure can lead to physical inactivity and obesity.

Prolonged media exposure can also detract from time spent on other activities. This can be detrimental if the media interferes with work, home, or social responsibilities. Like gambling, some forms of media can be addictive, such as playing video games. Internet and video game addiction are relatively new research areas receiving significant attention.

On the positive side, the media (especially the Internet) can be a wonderful source of information about health issues. Many people first turn to the media when they want to learn about an illness.

Regulating Media Influence

The media can be a powerful influence on shaping the thoughts and actions of those who consume it. Most of the time, the influence of the media is subtle, and the messages it presents may not be easily recognized.

Awareness is the key to understanding media effects. If a person is knowledgeable about the ways in which media can influence him or her, then he or she may be more likely to carefully scrutinize media messages. Educating the public about media effects can help them become savvy media watchers.

Parents also have a responsibility to talk to their children about media content. Parents can put TV sets and video game consoles in a public location rather than in bedrooms. Parents can use ratings and reviews to select appropriate media for their children. Parents can also restrict the amount of time children spend on media. The good news is that parental mediation works. The bad news is that not many parents do it. Parents often use the media as babysitters. Unfortunately, the media can be shoddy babysitters.

Conclusion

The mass media provides many opportunities to improve or worsen the lives of those who are exposed to it. The field of media effects research has uncovered numerous ways in which the media can subtly guide thought and behavior.

It is important to understand the ways in which the media can wield its influence, so that the negative effects of the media can be mitigated and the positive effects encouraged. Knowledge about media is the key to regulating the effect the media can have on one's own behavior.

See also: Aggression; History of Film and Music; Internet Behavior; Social Development (Attachment, Imprinting); Violence.

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- <http://www.mediafamily.org/index.shtml> – National Institute on Media and the Family.
- <http://www.psychology.iastate.edu/faculty/caa/csv/index.htm> – The Center for the Study of Violence.
- <http://socialpsychology.org/> – The Social Psychology Network.

Meditation: The Science and the Art

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Glossary

Chakras An energy center of consciousness associated with the seven nerve centers (nerve plexuses) of the body and one with the psychoelectromagnetic field of the body, called the aura.

Kundalini Comes from the word 'kundal,' meaning coiled energy and the creative potential of an individual.

Meditation The art and science of how to manipulate the thought waves to achieve a state of thoughtlessness, wherein

the individual experiences both existence and nonexistence simultaneously, and where the field of consciousness then becomes a novel sensory experience, wherein new levels of awareness and new skills in the mental realm are developed.

Pranayama The yogic system of meditative breathing exercises.

Yoga An ancient science and art where the finite experiences the infinity consciously within oneself.

Introduction

According to the Oxford English Dictionary, the word meditation can have at least two meanings that are relevant here: (1) "The action or practice of profound spiritual or religious reflection or contemplation; *spec.* a variety of private devotional exercise consisting of the continuous application of the mind to the contemplation of a particular religious text, truth, mystery, or object." Or (2) "In Buddhism, Yoga, and other systems of religious or spiritual discipline: a practice of the mind (and body) aimed at achieving the eradication of rational or worldly mental activity." The latter definition is closer to the subject and intention for this article. A note on the historical origin, a brief overview of the scientific evidence supporting the efficacy of meditation, and a description of some techniques and how they can be applied are covered. Also, the yogic concept of consciousness along with the 'eradication of rational or worldly mental activity' as noted in the second definition is briefly discussed. The major focus of this article is on the techniques discovered in the original system of yoga referred to here as 'Kundalini Yoga as taught by Yogi Bhajan,' which was an integrated science before various individuals, groups, or lineages proceeded to selectively fractionate the system, or were later left with only the remnants of the original ancient teachings as a result of natural catastrophes and nomadic invasions. Descriptions of some of the other popular meditation techniques that are now taught are also included.

The exact time of the historical origins of the discovery of yogic meditation techniques remains controversial. However, the evolution of this ancient science was believed to have its origins long before the advent of the formal religions. This suggests that the initial experiential efforts and much of the experimental study that led to the development of these meditation techniques may go back to at least 7000 B.C.E. The people who participated in this ancient process of discovery, called the 'rishis' (people of power), are thought to have lived in the region of the Indus river valley. This ancient society is now called the Indus-Sarasvati civilization, which is believed to be the first civilization in the Indian subcontinent.

The Science of Meditation

The Western experimental scientific literature on meditation started in the 1960s. In 2005, the National Institutes of Health and National Center for Complementary and Alternative Medicine funded a systematic review of the scientific literature that was published in 2007. This is the most comprehensive systematic review to date and it was published as *Meditation Practices for Health: State of the Research*. This review was conducted by the University of Alberta Evidence-based Practice Center. Comprehensive searches were conducted in 17 electronic databases up to September 2005. Other sources of potentially relevant studies included hand searches, reference tracking, contacting experts, and gray literature searches. The studies had to be in English, be comparative, focus on any type of meditation practice, include more than 10 adults, and provide quantitative data on health-related outcomes. Studies on the different meditation techniques were then included for analysis in one of five broad categories, which were defined as mantra meditation, mindfulness meditation, yoga, Tai Chi, and Qi Gong. Evidence on the state of the research was provided from 813 predominantly poor-quality studies. Physiological and neuropsychological effects of meditation practices were also evaluated in 312 poor-quality studies. Meta-analyses of results from 55 studies indicated that some meditation practices produced significant changes in healthy participants. The authors conclude "Many uncertainties surround the practice of meditation. Scientific research on meditation practices does not appear to have a common theoretical perspective and is characterized by poor methodological quality. Firm conclusions on the effects of meditation practices in healthcare cannot be drawn based on the available evidence. Future research on meditation practices must be more rigorous in the design and execution of studies and in the analysis and reporting of results." However, this summation statement does not imply that high-quality and well-controlled studies demonstrating important health benefits for ill populations or unique findings in the healthy have not been published. The aforementioned conclusion is a generality. It provides a statement that is a 'mean' of the published studies. The problem with this review is analogous to an attempt to make a

description of all the organisms in the sea. There are so many different 'species' that it is difficult to conclude much more than that there are simply millions of different species in the sea. In meditation research, no two studies have been the same, that is, attempts to replicate previous findings per se have been almost nonexistent. There are variations in the techniques studied, age ranges, skill levels, healthy versus disordered populations, the parameters measured including variations of the scale(s) used, types of control group if any, length of the studies, testing conditions, etc. Also, this type of analysis does not focus on, or extract, the more unique and important findings of single studies.

However, several unique meditation studies that have shown important results are described here. Lazar and colleagues studied the brain's physical structure using magnetic resonance imaging (MRI) to assess cortical thickness. They looked at 20 subjects who had long-term experience with 'Insight meditation,' which involves a focus of attention on internal experiences. They found that brain regions, including the prefrontal cortex and right anterior insula, and other areas associated with attention, interoception, and sensory processing were thicker in the meditation practitioners compared to controls. They also found that differences in prefrontal cortical thickness were more pronounced in older practitioners, suggesting that meditation might offset age-related cortical thinning. Shannahoff-Khalsa and colleagues compared a unique multipart disorder-specific Kundalini Yoga meditation protocol for treating obsessive compulsive disorder patients against the classic mindfulness meditation technique and the relaxation response for a matched patient group. This was a randomized controlled trial, and after 3 months, the control group showed no efficacy on any of the six psychological measures used to assess psychological symptom severity; however, the Kundalini Yoga group showed a significant improvement on all six scales. The groups were then combined using the efficacious protocol, and after a 1-year trial, the patients showed a 71% improvement on the Yale-Brown Obsessive Compulsive Scale, the current 'gold standard' for psychological assessment of obsessive compulsive symptoms. To date, this clinical trial remains the most effective treatment result for all treatment modalities for this disorder. Tang and colleagues studied a traditional Chinese medicine meditation technique called integrative body-mind training (IBMT). They report that 11 h of IBMT increases fractional anisotropy, an index indicating the integrity and efficiency of white matter in the corona radiata, an important white matter tract connecting the anterior cingulate cortex to other structures. They conclude that IBMT could provide a means for improving self-regulation and perhaps reducing or preventing various mental disorders. Finally, Brefczynski-Lewis and colleagues studied 'concentration meditation' in which sustained attention is focused on an object such as a small visual stimulus or the breath. Using functional MRI, with age-matched participants, they found activation of a network of brain regions typically involved in sustained attention that showed an inverted u-shaped curve in which expert meditators had more activation than novices. They conclude that the hours of practice suggest a possible plasticity in these brain mechanisms.

Given the potential for new advances in healthy development, prevention, and for treating illnesses, only trivial

funding has been allocated to the field. In addition, this article is limited in length and cannot give adequate attention to the more noteworthy findings in the fields of both the basic sciences and clinical sciences. However, there are substantial new scientific insights in the understanding of the dynamics of mind-body relations, functions of the brain and peripheral nervous system, the natural endogenous mechanisms that have evolved in humans for the purpose of self-regulation. All these insights were based on the ancient teachings of the rishis. The variety of highly structured techniques described in the following sections suggests that the ancients had developed what may best be called a 'technology of the mind,' and indeed may provide us with very sophisticated insights for understanding the nature of human consciousness and the pathways for mental development.

Description of Kundalini Yoga Meditation Techniques

The following techniques in this section are all from the original and ancient system of 'Kundalini Yoga as taught by Yogi Bhajan.' From 1969 to 2004, Yogi Bhajan taught openly what had been kept secret for the last 3000 years; previously, it had been transmitted by a few masters to selected disciples. During these 35 years, he taught ~5000 different meditation techniques. Selected techniques are provided for their highly structured nature, complexity, and often disorder-specific or other benefits. Prior to being hidden in secrecy, these and many other techniques were practiced by both yogis and householders.

In the system of Kundalini Yoga as taught by Yogi Bhajan, there is a mantra that is chanted prior to practice, which is called 'tuning in.' This procedure helps to induce a protected meditative state of mind and helps to keep the system balanced and safe. This mantra is unique and only specific for this system.

Technique to Induce a Meditative State: 'Tuning in'

Description of the technique: Sit with a straight spine and with the feet flat on the floor if sitting in a chair. Put the hands together at the center of the chest in the 'prayer pose' – the palms are pressed together with 10–15 lbs of pressure between the hands (a mild to medium pressure, nothing intense). The area where the sides of the thumbs touch rests on the sternum with the thumbs pointing up (along the sternum), and the fingers are together and point up and out at a 60° angle to the ground. The eyes are closed and focused at the 'third eye' (imagine a sun rising on the horizon or the equivalent of the point between the eyebrows at the origin of the nose). A mantra is chanted out loud in a 1-1/2 breath cycle. Inhale first through the nose and chant 'Ong Namo' with equal emphasis on the Ong and the Namo. Then immediately follow with a half-breath inhalation through the mouth and chant 'Guru Dev Namo' with approximately equal emphasis on each word. (The 'O' in Ong and Namo is a long 'o' sound; Dev sounds like Dave, with a long 'a' sound.) The practitioner should focus on the experience of the vibrations these sounds create on the upper palate and throughout the cranium while letting the mind be carried by the sounds into a new and pleasant mental space. This should be repeated a minimum of three times.

The first meditation technique is included here because two clinical trials using it have shown significant efficacy in the treatment of obsessive-compulsive disorder (OCD) patients. This technique has also been studied using whole-head 148-channel magnetoencephalography brain imaging.

Meditation Technique for Treating OCD

Description of the technique: Sit with a straight spine in a comfortable position, either with the legs crossed while sitting on the floor or in a straight back chair with both feet flat on the ground. Close the eyes. Use the right thumb tip to block the end of the right nostril, the other fingers pointing up straight. Allow the arm to relax (the elbow should not be sticking up or out to the side creating unnecessary tension). A small cork or secure plug can also be used to plug the right nostril. Inhale very slowly and deeply through the left nostril, hold the breath in for a long time, exhale out slowly and completely through the same nostril only (left nostril), and hold the breath out for a long time. Every effort should be made to keep the four phases of the breath cycle of equal duration. The mental focus should be on the sound of the breath. Continue this pattern with a maximum time of 31 min for each sitting. Initially, begin with a comfortable rate and time, but where the effort presents a fair challenge for each phase of the breath. This technique should be perfected and has its greatest clinical benefits when the complete breath cycle is one minute in duration, each section of the cycle lasting exactly 15 s. This rate of respiration for the full 31 min can be achieved by most individuals within 5–6 months with daily discipline. The ancient yogis claimed that 90 days of 31 min per day using the perfected rate of one breath/min with the four 15 s per phase would completely eliminate all obsessive-compulsive disorders. The balance of equal times for the four phases is akey with this technique.

Gyan Mudra Kriya

This meditation was taught for when you do not know what to do, and it is claimed to be excellent for treating anxiety disorders and inducing a clear and stable state of mind. The claim is that “it is very simple, but very powerful if done correctly, that it coordinates both brain hemispheres, gives powerful insight, solves many complications, and coordinates the mystery of the spiritual phenomena into the mastery of the three bodies (physical, mental, and spiritual).”

Description of the technique: Sit straight, rest the back of one hand in the palm of the other with the thumbs crossing each other in one palm. If the right hand rests in the palm of the left hand, the left thumb rests in the right palm and the right thumb then crosses over the back of the left thumb. Either this hand orientation is acceptable or the reverse with the left hand resting in the palm of the right hand and then the right thumb is in the left palm covered by the left thumb. The hands are placed at the heart center level about two to three inches in front of the chest, but the hands do not touch the chest and the elbows are resting down against the ribs. The eyes are open but focused on the tip of the nose (the tip/end point that you cannot see). The breathing pattern has four parts that repeat

in sequence: first, inhale and exhale slowly through the nose only, and then with the second breath, inhale through the mouth with the lips puckered as if to kiss or make a whistle; after the inhalation, relax the lips and exhale through the mouth slowly; for the third breath pattern, inhale through the nose and exhale through the mouth (the lips are not puckered) the fourth breath pattern is inhaling through the puckered lips and exhaling through the nose. Continue this four-part cycle for 11–31 min.

Terhula Kriya – An Advanced Technique for Attaining Healing Powers and for Overcoming Phobias

This technique was taught for ‘achieving self-mastery and learning to heal others from a distance’ and it is one of the most advanced techniques in the system of Kundalini Yoga. Yogi Bhajan commented: “Terhula Kriya can make you a perfect master.” While it presents a challenge for learning, its benefits go far beyond the amelioration of phobias.

Description of the technique: Sit in an easy pose. Bring your elbows next to the ribs, forearms extended in front of you, with the hands in front of the heart center area, right over left, palms up. The hands are $\sim 10^\circ$ higher than the elbows. There is no bend in the wrists, the fingertips to the elbows form a straight line. The thumbs are extended out to the side of the hands, the fingertips and palms do not exactly line up, they are slightly offset. The eyes are closed looking at the backs of your eyelids. For the inhale, pull back on the navel and inhale through the nostrils and hold. Mentally repeat the mantra Har Har Wha Hay Guru as long as you are able to retain the breath. While you are doing this, visualize your hands surrounded by white light. For the exhale, exhale through the nostrils, and as you exhale, visualize lightning shooting out from your finger tips. When you have fully exhaled, pull mulband (pull in on the rectum, sex organs, and navel) and hold for as long as you can, again mentally repeating the mantra Har Har Wha Hay Guru. The maximum time is 62 min. Other comments by Yogi Bhajan include “It has been suggested that this meditation be done in a cool room or at night when the temperature is cooler, because it stimulates the Kundalini directly and generates a great deal of heat in the body. The word Terhula relates to the thunderbolt of Shiva, the ultimate deliverer. Terhula can heal everything. It is a self-healing process. This meditation is for the gunas. It brings the three nervous systems together. It also gives you the ability to heal at a distance, through your touch or through your projection. Many psychological disorders or imbalances in the personality can be cured through practice of this meditation. It is very helpful in getting rid of phobias and especially father phobia.”

Gan Puttee Kriya – A Meditation for Healing the Past, the Present, and the Future

Description of the technique: Sit with a straight spine, either on the floor or in a chair. The back of your hands are resting on your knees with the palms facing upward. The eyes are nine-tenths closed (one-tenth open, but looking straight ahead into the darkness, not into the light below). Chant from your heart in a natural, relaxed manner, or chant in a steady relaxed

monotone. Chant out loud the sound Sa (the *a* sounds like 'ah') and bring your thumb tips and index finger tips together quickly simultaneously; then chant Ta and touch the thumb tips to the middle finger tips; then chant Na and touch the thumb tips to the ring finger tips; next chant Ma and touch the thumb tips to the little finger tips; then chant Ra and touch your thumb tips and index finger tips; next chant Ma and touch the thumb tips to the middle finger tips; then chant Da and touch the thumb tips to the ring finger tips; now chant Sa and touch the thumb tips to the little finger tips; then chant Sa and touch your thumb tips and index finger tips; next chant Say (sounds like the word 'say' with a long 'a') and touch the thumb tips to the middle finger tips; then chant So and touch the thumb tips to the ring finger tips; now chant Hung and touch the thumb tips to the little finger tips. Chant at the rate of one sound per second. The thumb tip and finger tips touch with a very light 2–3 lbs of pressure with each connection. This helps to consolidate the circuit created by each thumb–finger link. Start with 11 min and slowly work up to 31 min of practice. To finish, remain in the sitting posture and inhale and hold the breath for 20–30 s while you shake and move every part of your body. Exhale and repeat this two more times to circulate the energy and to break the pattern of tapping, which affects the brain. Immediately proceed with focusing the eyes on the tip of the nose (the end point that you cannot see) and breathe slowly and deeply for 1 min. The sounds used in this meditation are each unique and they have a powerful effect on both the conscious and subconscious mind. The sound Sa gives the mind the ability to expand to the infinite, Ta gives the mind the ability to experience the totality of life, Na gives the mind the ability to conquer death, Ma gives the mind the ability to resurrect, Ra gives the mind the ability to expand in radiance, this sound purifies and energizes, Da gives the mind the ability to establish security on the earth plane, it provides a ground for action, Say gives the totality of experience, So is the personal sense of identity, and Hung is the infinite as a vibrating and real force. Together, So Hung means 'I am Thou.' The unique qualities of this 12-syllable mantra help cleanse and restructure the subconscious mind and heal the conscious mind to ultimately experience the super-conscious mind.

Medical Meditation for Habituation – A Technique for Curing Addictions

Description of the technique: Sit either in a chair or on the floor. Straighten the spine and make sure the first six lower vertebrae are locked forward. This means the lower back is pushed forward as if you are 'at attention.' Make fists of both hands and extend the thumbs straight. Place the thumbs on the temples and find the niche where the thumbs just fit. This is the lower anterior portion of the frontal bone above the temporal–sphenoidal suture. This place is usually sensitive to the touch, so do not apply pressure per se, simply touching is adequate. Lock the back molars together and keep the lips closed. Vibrate the jaw muscles by alternating the pressure on the molars. A muscle will move in rhythm under the thumbs. Feel it massage the thumbs. Keep the eyes closed and look at the brow point – the 'third eye' – the point where the top of the

nose meets the forehead. Silently vibrate the five primal sounds 'Sa Ta Na Ma' at the brow point (the fifth sound here is the sound 'ah' that is basic to the other four sounds. The effects of each syllable of the mantra have been described earlier in the technique called Gan Puttee Kriya. This mantra is claimed to put one's consciousness through the cycle of infinity, life, death, and rebirth. Continue for 5–7 min and slowly build the practice to a maximum of 31 min.

'Shabd Kriya' – A Meditation for Treating Insomnia, Regulating Sleep Stages, Promoting the Growth of Personality, and Mastering the Mental Realm

Description of the technique: Sit with a straight spine with both feet flat on the floor. Place the hands in the lap, palms up with the right hand over the left hand. The thumb pads, last joint, are touching together and point forward. Focus the eyes on the tip of the nose with the eyelids half closed. The tip of the nose is the point you cannot actually see, but if you use a finger tip to touch the end of the nose; this is where the eyes are focused. This is not an 'eyes-crossed' posture but may seem like it initially. The sides of the nose will look blurry during the focus, but a real cross-eyed posture makes the sides of the nose appear to balloon up, which is not the correct eye posture. Inhale through the nose only in four equal parts, mentally vibrating the mantra Sa Ta Na Ma (one syllable per part of the 4-part inhale). Hold the breath and mentally vibrate the 4-syllable mantra a total of four times for a total of 16 'beats', and then exhale through the nose in two equal parts mentally vibrating the mantra Whahay Guru, one word per part or beat. This equals a 22-part or 22-beat cycle. Continue for at least 15 min and work up to 62 min. When finished, relax completely and go to sleep. One of the caveats with this meditation technique is that it may disrupt sleep for several weeks when it is first practiced, prior to having its healing benefits.

The Jupiter Finger Chakra Meditation – A Meditation for Abused and Battered Children for Developing a Balanced Psyche

This meditation was originally taught by Yogi Bhanjan as a meditation for children, but it can also be practiced by adolescents and adults. It was claimed that anyone with past trauma resulting from abuse and victimization will benefit from this practice. Even someone without past trauma supposedly can improve the balance of their personality by its use. This meditation helps to balance the chakras and meridians in the body. It is an excellent meditation technique for children. It will evoke many feelings that have stuck with the individual since childhood. It will help adults get rid of the 'childhood syndrome,' a condition where they cling to something that is already finished. This syndrome can easily ruin and limit anyone's life.

Description of the technique: Sit with a straight spine either on the floor or in a chair. Place the left hand on the chest at the heart center with the fingers and thumb pointing toward the right. Use the index (Jupiter) finger of the right hand (keep the other fingers closed in a relaxed fist with the thumb over the other fingers) to touch in sequence the following

points – (1) the middle of the lower lip, (2) the tip (end) of the nose, (3) the outer skin area or edge/corner of the eye socket (the region of the skull bone near the outside of the eye), and (4) a point about three-fourths of an inch above the indent of the nose which is just below the forehead (a point that would be the midpoint between the eyebrows). Chant the following mantra (Sa Ta Na Ma) out loud in sequence with the touching of the respective points. Chant Sa as one touches the lower lip, Ta as one touches the tip of the nose, Na as one touches the outer edge of the eye socket, and Ma as one touches the forehead point. But since there are two eyes and thus two outer edges of the eye socket, the patient alternates sides each time they go up in the sequence. Start by touching the right side first. Each round of touching the points and chanting the mantra through takes about 4–5 s. Keep the eyes closed when doing this meditation. The maximum time is 33 min and it can be practiced for the full time the first time. Younger people may have to start with 11 min or even less. When ending the technique, inhale deeply and hold the breath, then while holding the breath, feel the ‘inner child’ by self-hypnosis, exhale, inhale, and hypnotize one’s self, picture oneself as a child in one’s own heart, where the left hand has been resting, concentrate, exhale, inhale, and repeat the picture of one’s self, bless that child, be that child, and let the breath go.

The Ultimate Pranayam – Sodarshan Chakra Kriya

The developmental stages of self-realization and awareness experienced through the practice of this technique were in part described by the ancients: “I am powerless, my power has been broken, my unstable mind has been stabilized, and my unadorned soul has been adorned. I drink in the Ambrosial Nectar. Within my mind, I utter the Name of the Primal Lord, the source of all virtue. My vision, that You and I are separate, has melted away. I worship the One who is worthy of being worshipped. I trust the One who is worthy of being trusted. Like water into water, I merge into the Lord. I meditate and contemplate the Luminous, Triumphant Lord. I am lovingly absorbed in the Nirvana of God.”

Yogi Bhajan comments: “If you can do this meditation for 62 min to start with, and develop it to the point that you can do it 2 1/2 h per day, it will give you ‘Nao niddhi, athara siddhi’ or the nine precious virtues and 18 occult powers. And in those 27 total virtues of the world lies the entire universe. When practiced 2 1/2 h every day, it makes a perfect superman out of you. It purifies, it takes care of the human life, and brings together all 27 facets of life and makes a human perfect, saintly, successful, and qualified. This meditation also gives one the Pranic power. This kriya never fails. It can give one all the inner happiness and bring one to a state of ecstasy in life. It will keep all the chakras open so you will not fall into any ditch. It is better to live a life of courage than to live many many years like a coward. Courage is in inner vitality, and if all your chakras are open, you will not be handicapped in vitality. You will get a grip on your life. No matter how bad circumstances are, your intuition will guide your way to happiness, and your vitality shall support you.”

This pranayama technique, as a single technique, is the ultimate in Kundalini Yoga meditation techniques. Its multiple facets make it a completely balanced technique. When

practiced alone, there are no other requirements for other techniques to achieve full human development. For example, the rate of respiration can eventually be reduced to less than one breath per minute during practice. This technique changes one’s perception of the self and the world. The practitioner develops a consciousness that becomes the living experience of the timelessness of life, transcending time and space. The negative patterns of the subconscious mind are eliminated. This technique helps to overcome the stumbling blocks of the inner world. It helps to cut through inner darkness, and it eliminates both neurotic and psychotic mental patterns. According to Yogi Bhajan: “You are cleaning your subconscious. You can clean it as fast or as slowly as you want. You have to decide how much time you want to devote to getting rid of the fear, anger, insecurity, etc., . . . the negative thoughts in your subconscious that block your success and prosperity.”

Description of the technique: Sit with a straight spine on the floor in a cross-legged position, or on a firm chair with both feet flat on the ground. The lower spine (lumbar region) is pressed forward slightly. This spinal posture signals the nervous system to remain alert by setting a ‘ready mode.’ The eyes are open and focused at the tip of the nose – the end that you cannot see. With eyes focused at the tip, the sides of the nose appear to blur. Some individuals are less able to achieve this eye focus, and practice over time can help to overcome this deficit. This eye position is called ‘Ajna Band,’ which means mind lock. Focusing the eyes in this way pressurizes the optic nerve and helps to stabilize thought processes. It is a common element with meditation techniques that are used to tranquilize the mind. Initially, the eye muscles may become sore due to a lack of use. The breathing pattern has three phases:

1. Use the right thumb tip to block off the right nostril (close the nostril by covering the end, not by pushing in the side); keep the four fingers of the right hand pointed up straight; and inhale slowly and completely fill the lungs.
2. While holding the breath, begin pumping the navel point in and out for a total of 48 pumps while mentally vibrating the sound Wha Hay Guru 16 times per 48 pumps, with one pump per Wha, one pump per Hay, and one pump per Guru, or 16×3 sounds = 48 pumps.
3. Then, slowly exhale through the right nostril by first closing off the left nostril with the end of the index finger. This three-phase cycle is repeated. (Note that the reverse pattern of inhaling through the right nostril, holding, and exhaling through the left nostril is not performed.) Yogi Bhajan recommended a counting scheme to maintain the exact numbers of pumps and ‘Wha Hay Gurus.’ “For counting 1–16 (Wha Hay Guru’s), one (with three pumps), two (with three pumps), three (with three pumps) is counted with the little finger moving slightly three times, four (with three pumps), five (with three pumps), and six (with three pumps) moves the ring finger three times, seven (with three pumps), eight (with three pumps), nine (with three pumps) moves the middle finger three times, ten (with three pumps), eleven (with three pumps), and twelve (with three pumps) moves the index finger three times, thirteen (with three pumps), fourteen (with three pumps), fifteen (with three pumps) moves the thumb slightly for three beats, and sixteen (with three pumps) brings the index finger over to close the left

nostril just before exhaling through the right nostril." When ending this meditation, after the last exhale, inhale and hold the breath for 5–10 s and mentally circulate the energy produced; then exhale. Then stretch and shake the entire body for 1 min to complete the exercise. The bija mantra *Wha Hay* Guru induces a state of great wonder, bliss, and ecstasy, an experience of the totality of the universe, the universal nature of consciousness, and the oneness and unity of creation. Eleven minutes is the first peak of accomplishment, followed by 31 min, 62 min, and 2 h and 31 min.

Descriptions of Other Popular Meditation Techniques

This section includes five popular meditation techniques called the Mindfulness Meditation, Sahaja Yoga Meditation, Transcendental Meditation®, Ujjayi meditation as taught by Swami Sivananda, and Zen Meditation. Other similar meditation techniques are also widely taught, including the Vipassana technique, the Relaxation Response by Herbert Benson, the four Art of Living meditations as taught by Sri Sri Ravi Shankar, and techniques by Swami Muktananda of the Siddha Yoga lineage, Swami Satchidananda of the Integral Yoga Society, Swami Rama of the Himalayan Research Society, and Swami Ramdev of the Divya Yog Mandir Trust. Most of these techniques are common to the Hatha Yoga meditation tradition.

Mindfulness Meditation Technique

The standard description for this meditation is the following: One can practice Mindfulness Meditation by sitting in an appropriate upright position, cross-legged, and by focusing on the breath or anything else, such as mental and physical processes which help the practitioners to become aware of their present thought patterns and inner state. The practice of Mindfulness Meditation focuses one's attention on one's thoughts, actions, and present moments nonjudgmentally. It does not encourage evaluating or thinking about past actions, nor does it take one's thoughts into the uncertain future. Mindfulness Meditation helps and trains the mind from getting distracted by outside disturbances and enables one to focus one's thoughts and relax the mind.

Description of the technique:

1. Find a quiet and comfortable place. Sit in a chair or on the floor with your head, neck, and back straight but not stiff.
2. Try to put aside all thoughts of the past and the future and stay in the present.
3. Become aware of your breathing, focusing on the sensation of air moving in and out of your body as you breathe. Feel your belly rise and fall, the air enter your nostrils and leave your mouth. Pay attention to the way each breath changes and is different.
4. Watch every thought come and go, whether it be a worry, fear, anxiety, or hope. When thoughts come up in your mind, do not ignore or suppress them but simply note them, remain calm, and use your breathing as an anchor.
5. If you find yourself getting carried away in your thoughts, observe where your mind went off to, without judging, and simply return to your breathing. Remember not to be hard on yourself if this happens.

6. As the time comes to a close, sit for a minute or two, becoming aware of where you are. Get up gradually.

Sahaja Yoga Meditation as Taught by Shri Mataji Nirmala Devi

Shri Mataji Nirmala Devi says on her Web site: "You can receive your Self Realization (connection with your Self) while sitting in front of your computer. The only condition is your sincere desire to have it."

Description of the technique (extracted from her Web site): "During the experience you will keep your left hand with the palm upwards on your lap and place the right palm on various parts of the body on your left side only with a specific sequence (see below), while keeping your eyes closed for the entire duration. This way you will be free of distractions and able to keep your attention inside. The sequence for placing your right hand during the guided meditation is the following (on left side only), first hold it with the palm against the chest at the heart center level, then on the chest below the nipple line, then just above the waist line, then against the side of the neck; for the next three positions, the right hand is held in the middle of the forehead, the back of the head, and then the top of the head. Now, after the end of the meditation, see if you are feeling relaxed and if your thoughts have slowed down or gradually disappeared. This is the first stage of meditation – thoughtless awareness – where you are fully alert but without any thoughts, in a state of pure and peaceful consciousness. Now see if you can feel a sensation of a gentle cool breeze in your palms and above your head. It might be warm in the beginning which is a sign that your Kundalini energy is purifying your chakras, but it will eventually cool down. You can verify it by placing your left palm 6–12 in. above your head, then trying with the right palm. If you are unable to feel it, you have probably not forgiven everyone. Say again from your heart, 'Mother, I forgive everyone,' a few times and check again if you feel the cool breeze above your head. This is the beginning of a fantastic journey into your own spiritual existence. It is a door opened to a new dimension of your awareness, which you can open and explore. If sustained through regular meditation, you will be able to feel your subtle centers (chakras) as well as the chakras of others on your fingertips, and correct them using your spiritual energy (Kundalini)."

Transcendental Meditation® Technique

Transcendental Meditation®, also called the "TM" technique, was formulated by Maharishi Mahesh Yogi. Some claims about the TM technique are the following: "The ordinary thinking process is said to be transcended (or gone beyond) as the awareness gradually settles down and is eventually freed of all mental content, remaining silently awake within itself, and producing a psychophysiological state of restful alertness." These periods are referred to as "pure consciousness or transcendental consciousness." Steps in TM® Meditation: Step 1, Sit comfortably; Step 2, Close your eyes; Step 3, Engage in effortless mental repetition of a special sound for approximately 20 min, twice daily. Note: The special sound in Step 3 is a Sanskrit mantra(s) that is claimed to be exclusive to the TM® tradition. These mantras are taught when a person pays

for the teachings and the recipient is instructed not to share his or her mantra with others.

Ujjayi Pranayam Meditation

The ujjayi meditation technique, as described here, along with its claimed attributes is one of at least seven different meditation techniques taught by Swami Sivananda. This technique is a standard practice in many Hatha Yoga traditions.

Description of the technique: Sit in your usual asana. Close the mouth. Inhale slowly through both the nostrils in a smooth uniform manner. Retain the breath as long as you can; do it comfortably and then exhale slowly through the left nostril by closing the right nostril with your right thumb. Expand the chest when you inhale. During inhalation, a peculiar sound is produced owing to the partial closing of the glottis. The sound produced during inhalation should be of a mild and uniform pitch. It should be continuous also. This Kumbhaka may be practiced even when walking or standing. Instead of exhaling through the left nostril, you can exhale slowly through both nostrils. Swami Sivananda comments on this technique. "This removes the heat in the head. The practitioner becomes very beautiful. The gastric fire is increased. It removes phlegm in the throat. Asthma, consumption and all sorts of pulmonary diseases are cured. All that arise from deficient inhalation of oxygen and diseases of the heart are cured. All works are accomplished by Ujjayi Pranayam. The practitioner is never attacked by diseases of phlegm, nerves, enlargement of the spleen, dyspepsia, dysentery, consumption, cough or fever. Perform Ujjayi to destroy decay and death."

Zen Meditation Technique

Zen Buddhist meditation originated in India and was introduced to Japan from China in 1191 AD. Sit on the forward third of a chair or a cushion on the floor. Arrange your legs in a position you can maintain comfortably. In the half-lotus position, place your right leg on your left thigh. In the full lotus position, put your feet on opposite thighs. You may also sit simply with your legs tucked in close to your body, but be sure that your weight is distributed on three points: both of your knees on the ground and your buttocks on the round cushion. On a chair, keep your knees apart about the width of your shoulders, feet firmly planted on the floor. Take a deep breath, exhale fully, and take another deep breath, exhaling fully. With proper physical posture, your breathing will flow naturally into your lower abdomen. Breathe naturally, without judgment or trying to breathe a certain way. Keep your attention on your breath while practicing this Zen meditation. When your attention wanders, bring it back to the breath again and again – as many times as necessary! Remain as still as possible, following your breath and returning to it whenever thoughts arise. Be fully, vitally present with yourself. Simply do your very best. At the end of your sitting period, gently swing your body from right to left in increasing arcs. Stretch out your legs and be sure they have feeling before standing. Practice easy Zen meditation every day for at least 10–15 min (or longer) and you will discover for yourself the treasure-house of the timeless life of zazen – your very life itself.

The Art of the Practice and the Application of the Techniques

Today, a majority of people practice meditation techniques for the purpose of achieving a calmer state of mind, reducing stress, and finding inner peace. Some practice to gain the experience of a greater or transcendental awareness. Many also seek a more natural approach to the treatment of psychiatric disorders and psychological issues, and for improving social relationships. However, in addition to self-healing, the ancients devised the science of meditation primarily for the purpose of exploring the unknown realms of the psyche and for mastering the realms of consciousness. They understood the possibility of devising a neurodevelopmental approach to awakening the dormant regions of the brain and developing unique mental powers, or what yogis called the siddhis.

The ancients apparently achieved a great understanding for the nature of consciousness. They discovered the chakras, the subtle energy centers that supposedly relate to the eight different levels of consciousness. This is a very foreign area for the western scientist who has at least two primary questions about the nature of consciousness: (1) Can consciousness transcend time and space? and (2) Is consciousness only an epiphenomenon of the brain? The ancients devised a practical and systematic view of consciousness that has eight discrete levels. Yogis viewed the chakras as repositories or centers for psychic or mental energy. They claimed that an individual's consciousness is then determined and affected by the amount of energy and the distribution of activity in the eight centers, and that this is related to the individual's behavior, personality structure, and level of awareness. Ultimately, meditation techniques are supposedly a means of healing the mind and also attaining higher levels of consciousness.

In addition to the more subtle nature of the chakras, each chakra also supposedly has a physiological correlate in the body. The first chakra is related to the area of the rectum (sacro-coccygeal plexus); the second chakra to the sex organs (sacral plexus); the third chakra to the navel point region (solar plexus); the fourth chakra to the heart center (cardiac plexus); the fifth chakra to the thyroid and parathyroid or throat center (laryngeal plexus); the sixth chakra, called the 'third eye,' to the activity of the pituitary gland; the seventh chakra, called the 'crown center,' to the pineal gland and cerebral cortex; and the eighth chakra is the aura or the psychoelectromagnetic field that surrounds the body.

The intensity of activity in any one chakra supposedly affects one's world perspective, understanding of cause and effect, and source of motivation and desire. An individual who lives mainly in the consciousness of the first chakra is concerned primarily with survival. His or her action and values are based solely on the need to survive. Fears and paranoia coincide with this center, as do instincts, concerns about elimination, destructive sexual activities, and habitual and addictive activities. Blocks and imbalances in this center can lead to a rigid and stubborn mentality and a range of diseases. Second chakra consciousness reflects a mentality directed mainly toward reproduction and sexual activities. Overactivity here leads to sexual neuroses, whether it is in the form of abnormal sexual indulgence or a 'puritanical' and abstinent mentality.

A balanced second chakra helps establish a creative and expressive mentality. The third chakra is the center of power, territory, and ego: the 'Me' mentality prevails to the exclusion of the well-being of others. This center is the source of physical well-being. When it is weak, deficiencies lead to a wide range of illnesses and a weak character, drive, and will power. The first three levels are claimed to be equivalent to the nature of the beast and all three of these levels also prevail throughout the animal kingdom. Much of society's ills are the result of an imbalance in the first three chakras. Yogis view development in going from the third level of consciousness to the fourth as the biggest step in human development. The fourth chakra, the heart center, embraces the human element of compassion, the attitude to nurture and give without consideration of the cost to one's self. This center is considered to be the first level of 'higher consciousness,' where the human can experience a true expansion in awareness. Love is born through activity in this center. When the heart chakra is not awakened, greed, selfishness, and ego dominate. The fifth chakra is the center for creative communication through expression. When this center is active, the individual can speak and live a blunt truth, and when it is blocked, that person will feel stifled and unable to be direct and truthful with others. A characteristic of 'higher consciousness' that supposedly manifests with this center is that of clairaudient awareness. The sixth chakra allows for both sides of the coin to be seen and here the dual nature of life is understood in the sums of the polarities rather than simply as 'right versus wrong.' This center is said to be responsible for intuition and clairvoyant abilities. Supernatural abilities are also said to be governed by this center. The seventh chakra is the center for saintly intelligence, and thoughtless awareness where actions are based on concern for the highest good for all. This center is called the 'thousand-petalled lotus,' and it is said to be the seat of universal consciousness where there is a clear realization of how all things are connected. The eighth chakra is the aura, and how it functions is representative of the relationship of all the other chakras. This chakra is said to act both as a shield against illness and calamity and as a source of attraction for events in one's life. Awareness in this center takes one's consciousness beyond the realm of time and space, into the realm where the past, the present, and the future merge. It is said that if an individual lives in the consciousness of this center too long, the world will pass them by.

The fully awakened yogi supposedly has the ability to consciously activate any and all chakras in any given combination for achieving the most effective outcome under any given situation. Supposedly normal individuals have one chakra that predominates to establish their primary personality, and over time, this center may change as a personality matures. This growth process is supposedly one of the benefits of some meditation techniques.

The Development of a Personal Practice

Some systems offer a single meditation with a supposed benefit or range of benefits, and some systems offer a few techniques that vary significantly in their overall effects and benefits. The original parent science of the yoga, called Kundalini Yoga, the Yoga of Awareness, as taught by Yogi Bhajan, has thousands

of different meditation techniques. Some are much easier than others to practice, and the approach for the beginner, novice, or intermediate practitioner should be based on what he or she hopes to achieve and how much time and effort he or she wants to commit. The best advice here is to experiment with a variety of techniques and to seek the direct guidance from a well-trained and talented teacher, regardless of the system that is chosen.

The Clinical Application of Techniques for Patient Populations

All the techniques described earlier are claimed to be of benefit for mental health purposes. However, the evidence presents a challenge because of the relatively poor overall quality of the published clinical trials. Some of the best- and well-designed randomized controlled trials that showed substantial efficacy still require replication by others. However, there is reason to be optimistic as yogis had discovered techniques that are supposedly 'disorder-specific.' These disorders include OCD, depression, generalized anxiety disorder, phobias, bipolar disorders, addictions and impulse control disorders, sleep disorders, ADHD and comorbid disorders, PTSD, schizophrenia, the variants of the personality disorders, the pervasive developmental disorders, and cancer. None of these disorders are new and yogis had recognized these disorders even in ancient times. Individuals who are interested in attempting to treat any of these disorders with meditation techniques should seek the assistance of those who are highly trained both with the specific techniques and the specific disorders. In time, clinical trials will likely test the efficacy of these techniques in well-designed studies and no doubt compare meditation techniques from different systems in 'head-to-head' trials.

Summary

The discovery of meditation techniques goes back to the time before the advent of the formal religions. Today, there are at least 5000 different meditation techniques that are known, discovered by the ancient yogis. However, only about six techniques are commonly practiced in the West. While hundreds of different scientific studies have been conducted, the majority have used the Transcendental Meditation® technique, the Mindfulness Meditation technique, the Relaxation Response, the Zen Meditation technique, and a variety of Hatha yoga meditation techniques. A recent systematic review of the scientific literature finds that there are many uncertainties about the practice of meditation, the scientific research does not have a common theoretical perspective, the work is characterized by poor methodological quality, and that firm conclusions cannot be drawn about the health effects based on the available evidence. However, since this research is only in its infancy and very little funding has been appropriated for this work, it is not surprising that little can be said about the positive virtues of the work. Nonetheless, there are a number of well-designed trials that show unique and important results. In addition, since there are so many different, highly structured, and complex techniques, along with the deep yogic

insights into the nature of consciousness, there are good reasons to be optimistic about the true richness of this topic for future study. A definition of meditation is offered – the art and science of how to manipulate the thought waves to achieve a state of thoughtlessness, wherein the individual experiences both existence and nonexistence simultaneously, and where the field of consciousness then becomes a novel sensory experience, wherein new levels of awareness and new skills in the mental realm are developed.

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- <http://www.sahajayoga.org/experienceitnow/default.asp> – Sahaja Yoga Meditation as taught by Shri Mataji Nirmala Devi.
- <http://www.siddhayoga.org/guru/muktananda.aspx> – Swami Muktananda for the Siddha Yoga Path.
- <http://www.swamij.com/index.htm> – Swami Rama founder of the Himalayan Research Society.
- <http://www.yoga4cure.com/> – Swami Ramdev, a founder of the Divya Yog Mandir Trust.
- <http://www.swamisatchidananda.org/> – Swami Satchidananda, the founder of Integral Yoga.
- <http://www.dlshq.org/> – Swami Sivananda and the Divine Life Society.
- <http://us.artofliving.org/> – The Art of Living as taught by Sri Sri Ravi Shankar.
- <http://www.umassmed.edu/cfm/home/index.aspx?linkidentifier=id&itemid=41252> – The Center for Mindfulness in Medicine, Health Care, and Society by Jon Kabat-Zinn, PhD.
- <http://www.tm.org/?gclid=CNjQ9Kur3J4CFRkJagodzG70KQ> – Transcendental Meditation as taught by Maharishi Mahesh Yogi.

Memory

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Glossary

Category An organized set of conceptual entities (objects, events, concepts, etc.) that are treated as similar to one another in some respect.

Episodic memory Memory for knowledge localized in time and place.

Explicit memory Memory that involves a deliberate and conscious act of remembering (e.g., recognition and recall).

False memories Belief in having a memory, when in fact, it did not occur or is altered from what was first encoded.

Implicit memory Memory that operates through unconscious mechanisms.

Long-term memory A large-capacity portion of memory where information is stored for long periods of time, possibly lasting a lifetime.

Memory The mental systems, representations, and processes involved in the retention of information.

Procedural memory Memory for performance activities, including stimulus–response associations (e.g., knowledge of how to ride a bike or drive a car).

Schema General world knowledge of well-defined common human experiences used to organize new information and reconstruct information that may have been forgotten.

Semantic memory Memory for encyclopedic general world knowledge which does not refer to a specific event in the individual's life.

Short-term memory A limited capacity portion of memory where information lasts for only a short period of time, sometimes referred to as working memory.

Spreading activation The idea that the activation or availability of one conceptual entity spreads to other related conceptual entities through a complex of associative pathways.

Introduction

Several characteristics of memory are of interest in how people encode, store, and retrieve information. The issues of concern include (1) the specification of different types of memories, (2) whether memories are permanent, and (3) how aspects of memory impact people's daily lives.

Ways of Understanding Memory

Memory holds information as widely varied as knowledge of people's faces, how to drive a manual transmission, phone numbers, the names of the countries of Europe, and the smells of good home cooking. A complete account of memory must specify how memories are created, their organization and influence on one another, and how they are retrieved. Because memory cannot be directly observed, theoretical accounts make use of metaphors. Models of memory used metaphors based on technological innovations, starting with a filing cabinet or bin system. Later, with the expansion of the telephone, memory was referred to as though it were a switch board. With the advent of the digital computer, models of memory adopted a computer metaphor, along with the processes involved in encoding, storing, retrieving, and operating on information. Late in the twentieth century, there was an effort to consider how information might be represented neurally, with people using a brain metaphor. More recently, there has been a focus on how memory is used for living. This is a more functional approach that assesses the influences of embodied or grounded cognition. In essence, these approaches look at how people interact with the environment and consider how

memory evolved and has been adapted to meet those environmental demands.

Types of Memory

Memory exhibits different characteristics under different conditions. For instance, a person might have trouble recalling the names of people met at a party a few weeks ago, but might remember how to ride a bicycle throughout his life. A person can often repeat back what was just said immediately afterward, but not a week later. Experiences such as these have led to the suggestion that there are different types of memory, and these types have different characteristics.

Short- and Long-Term Memory

Many conceptualizations distinguish between long-term and short-term memory. Traditionally, long-term memory contains a lasting record of information, whereas short-term memory exists for only a short period of time (<30 s) unless actively maintained or transferred to long-term memory. Moreover, only a limited amount of information can be actively processed in short-term memory, typically described as an average of 3, 4, or 7 units of information, depending on the particular theory. So, while long-term memory contains information that has accumulated over a lifetime, short-term memory's limited capacity allows only a small set of information chunks. More details on how memory and brain structures are related are discussed elsewhere in this encyclopedia. In contrast, some theories suggest that short-term memory is only a portion of

long-term memory that is currently active rather than a separate memory itself. In these views, the limit on short-term memory capacity depends on the amount of long-term memory information that can be called into consciousness at any one time.

A more elaborate idea over short-term memory that has emerged is that of a *working memory*. This includes not only a short-term store aspect, but also the active processing of information. Working memory itself may be divided into subcomponents, such as a phonological loop for linguistic information, a visual-spatial sketchpad for visual-spatial information, an episodic buffer for integrating information from various modalities and long-term memory, and an overarching central executive that controls information processing. These subsystems may be semiautonomous. So, while one subsystem is actively processing information, another might be available for other tasks. For example, it is easier to read a paragraph (a phonological loop task) if one is simultaneously trying to remember the location of a dot on a screen (using the visual-spatial sketchpad) than if one is trying to remember a set of words (another phonological loop task).

In general, information remains in short-term/working memory until something comes along to force it out. Because capacity is limited, new information is likely to push out the old, leaving only the most recently encountered information available. This process is called interference. This leads to what is called the recency effect in which the recently acquired information is more available than earlier information. For example, if a person is given a list of names and then recalls them, the names at the end of the list will have a better chance of being remembered because they have not impinged upon by further information.

Single versus dual processes

One concern about memory is whether retrieval involves a single process, or two separate processes. At the crux of this issue is the subjective awareness of what it is like to remember in different ways. In some cases, a person is consciously aware of having experienced something and is able to remember a number of details about an event, such as how it was learned, where people were, who told them, the sound of a person's voice, and so on. These vivid memories are called recollections. For example, if you can remember a lot of details about some event, such as a car accident you were in. Comparatively, in other cases a person may not remember many if any, details. The person simply knows that he or she knows something. For example, if you know what a platypus is, but have no memory of learning it, this would correspond to one of these types of memories.

According to a single process view, various parts of the brain act in concert in the service of a single unified search. The primary difference between recollections and known memories is how much information is recovered. The attraction here is that this has the advantage of being theoretically parsimonious. In contrast, for a dual process view there are two processes that operate in parallel to help retrieval. The first is a fast-acting heuristic-like familiarity process that assesses how strong a memory is. The stronger it is, the more likely a person will say it is known. This is a largely unconscious process. The second process is a slower, more deliberative search which

actively seeks various details in memory to consciously retrieve. These two types of memory processes may involve different neurological structures, and can be doubly dissociated. This suggests that memory uses different methods to retrieve different memories.

Organization of Long-Term Memory

Information in memory is often organized on the basis of both its content and the context in which it was presented. However, not all types of information are represented in the same way. Theories of long-term memory postulate different systems and subsystems, each of which is dedicated to different types of information, and each exhibits properties that are not found in the others. Endel Tulving's monohierarchy of memory provides a useful framework for conceptualizing how different types of information are organized and remembered. Other types of organizations will be considered at the point in which they conform to the different levels of this hierarchy.

Tulving's Monohierarchy

Tulving's monohierarchy is a three-level organization, with one system at each level, and the higher systems being dependent on the lower ones. These systems are procedural, semantic, and episodic.

Procedural memory

Procedural memory, at the most basic level of the monohierarchy, contains memories for how to perform activities, including stimulus-response associations. Examples of procedural memories are knowledge of how to ride a bike or drive a car, how to play the drums, how to solve a puzzle, and how to walk. The procedures contained here can be activated without conscious awareness. Thus, the procedural knowledge that governs driving a car is applied with minimal attention to the specific sequence of steps needed to do this. As this observation implies, information in procedural memory is often difficult to articulate, but lasts for quite a long time. In addition, procedural knowledge is relatively resistant to deliberate changes to add, modify, or rearrange various components.

Semantic memory

Semantic memory, the second level of Tulving's monohierarchy, contains general knowledge that does not refer to a specific event in the individual's life. As such it is an encyclopedic knowledge. The contents of semantic memory are retained for a long time. Semantic memory differs from procedural memory in that people can often articulate the information that is stored. Semantic memory is typically conceptualized as being highly integrated in which related concepts are functionally stored together. This organizational structure of semantic memory can be seen in its use. For example, it exhibits effects of relatedness. Information is identified faster if it is preceded by information that has similar content.

Some theories conceptualize semantic memory as an associative network of concepts. Each concept represents a separate entity that is associatively linked to other entities by pathways. Concepts that are more similar to one another are more closely

associated in the network. So, when information from one concept is used, other concepts that are associated with it are also brought to mind. There are also theories of semantic memory that suggest that it is composed of sets of features that define the nature of things, how they function, and how we relate to them. These feature-based views do not assume a structure to semantic memory, but assume that apparent structure is derived from how information is used. Two types of mental representations in semantic memory, schemas and categories, are worth noting. Further explanation on this is dealt elsewhere in this encyclopedia.

Schemas are semantic memory structures that help people organize new information they encounter. In addition they may help a person reconstruct bits and pieces of memories that have been forgotten. For example, if you remember going to a new restaurant, you may not actually remember reading the menu, but your schema for restaurant dining can fill this information in. Each schema is a structured representation of all the information that a person has, referring to a well-defined domain of common human experience, such as washing a car, applying to a school, or reading a newspaper. Schemas help people figure out things that they may have temporarily or permanently forgotten, or even missed entirely. Anyone who has begun watching a television show or movie from the middle of the story has had the experience of being able to figure out what has gone on previously without having actually seen it. People essentially fill in the gaps with what they know about similar situations. This reconstructive process can sometimes lead people astray. In James Bartlett's famous work on schemas, students in England were given a Native American folktale to read. This folktale possessed a structure quite different from the stories of English culture. Bartlett found that as time passed, the students forgot more of the details and structure of the original story. The forgotten portions were replaced with ideas that were Westernized transformations of the story. The students had filled in the gaps in their memory with schematic knowledge of what they knew about folktales and the topics covered in the folktale.

A special type of event schema, called a *script*, describes a temporally ordered sequence of events that frequently occur in the world and can be used both to explain new events one encounters and to predict future consequences. Moreover, they can be used as behavioral guides. For example, 'Asking for a menu' in a 'restaurant' script that precedes parts that pertain to ordering, eating, and paying the bill. So, the determinants and consequences of an individual's request for a menu can be inferred on the basis of the additional frames of the script that are used to interpret it. Moreover, one's own decision to leave a tip at a restaurant may be based on the perception that this behavior is appropriate, as implied by the same script.

In much the same way as people use scripts to benefit their memory, they also use categories. By having background knowledge about a category, people can use that knowledge to influence retrieval, or to fill in gaps in their memory. One example is to be able to guess what ran in front of your car on the road at night. With limited perceptual information people can make assumptions that the animal may have been a deer, or an opossum based on knowledge of what animals cross the road at night, or the category of animals that cross the road at night. Each category is a memory structure made up of

conceptual entities (objects, events, concepts, etc.) that are, in some respect, similar to one another. Categories help organize the various entities that are encountered. There are several different classes of theories of how mental categories are created and represented. A threefold classification of theories was proposed by Douglas Medin. According to the classical view, mental categories are defined sets of necessary and sufficient properties. Entities either have these features or not, and therefore either do or do not belong to a given category.

According to probabilistic views, mental categories are created with reference to a set of properties, without the criteria of necessity and sufficiency. Category members vary in the number and pervasiveness of their features, leading to a graded category structure. The defining features for a category in memory are either contained in a memory representation of the prototypical member (real or not) or are derived from an average of all of the separate exemplars of the category.

The third class of theories is knowledge based. In many ways, this is similar to schema theories. Here, the organization of concepts into a mental category is based on knowledge of how the various members function in the world. In other words, entities are organized into categories in the sense that they are used in similar ways to explain things about the world. This is in contrast to the other theories which regard the presence or absence of various properties as the basis for categorization. For example, the category 'things to take out of the house in a fire' would be made of things that are combustible, easily transportable, and difficult or impossible to replace. This would include such diverse things as family members, money, photos, and pets, which do not share features that would cause them to be classified in memory together a priori except that they conform to a common goal. Further details are discussed elsewhere in this encyclopedia.

Episodic memory

Episodic memory, at the highest level of Tulving's monohierarchy, is like semantic memory in that the information is easily articulated. However, episodic memory differs from semantic memory in that the subject matter is concerned with events from a person's life rather than general world knowledge. Thus, episodic memories are localized in time and place. For example, general knowledge of traffic law is in the domain of semantic memory, whereas knowledge of a particular incident of getting a speeding ticket is in the domain of episodic memory. Episodic memories, unlike procedural and semantic memories, are more influenced by the passage of time. That is, they exhibit the classic negatively accelerating forgetting curve outlined by Hermann Ebbinghaus at the end of the nineteenth century. Three specific aspects of episodic memory – mental models, autobiographical knowledge, and emotional experience – are worth special attention. Further discussion on this is dealt elsewhere in this encyclopedia.

Whereas schemas and categories refer to general knowledge, mental models represent specific events. An early conception of mental models was made by Philip Johnson-Laird. Mental models simulate the functional relations of elements in a situation. This often involves general knowledge, possibly from schemas. For example, the statement 'the bike tire is flat' may simulate the construction of a mental model based on a spatially organized schema concerning the physical state of

an object that is a part of a bike. Alternatively, the model of a friend's story about the circumstances surrounding her wedding day might be constructed on the basis of several different schemas or scripts, each of which is applied to a different sequence of events in the narrative.

Mental models are stored and retrieved relatively independently of one another. For example, a set of related information (e.g., knowing about a group of people and the locations they are in) that refers to different situations is stored in several mental models in memory and produces interference during retrieval. This is because the related mental models interfere with one another during retrieval. However, if everything can be stored in a single integrated representation, there is no interference at retrieval. So, mental models help aggregate information in memory into single representations of unique situations.

Much of the information one receives in the world directly involves oneself as an active participant in the ongoing events. This self-knowledge, or autobiographical memory, composes a large share of the episodic information that people accumulate. Autobiographical knowledge is distributed throughout episodic memory, although it may include semantic information as well, such as knowledge of what schools one has attended. Representations of this knowledge may initially be formed at different times and stored independently of one another. Later, these separate representations are retrieved and integrated into a single autobiographical memory that describes the sequence of events that occurred over a period of days, weeks, or even years. Thus, autobiographical memories often have a constructive quality. This interpretive and constructive has systematic effects on the memories for the event. For example, these memories tend to be remembered as closer in time to major events in a person's life, such as the start of a semester, losing a job, or the birth of a child. Once formed, these representations are 'theories' about oneself and one's behavior in the events in question. More details on this topic are dealt elsewhere in this encyclopedia.

Emotion can have a powerful influence on memory. For example, memories can be primed or made more available if they refer to events that evoked the same emotion as a person's current state (called mood congruent learning). Sad people find it easier to recall sad memories and happy people find it easier to recall happy memories. In addition, memory is generally improved for events that are emotional. Emotionally neutral events are not as well remembered as emotionally intense events. For example, if someone sees a traumatic event, the person is likely to remember the specific details about it well. However, this applies to the more central parts of the event. People are not as good at remembering unrelated, or peripheral, information that was also present. Possible causes of the memory benefit could be related to how emotion is processed neurologically. Activity, especially in the amygdala, serves to enhance basic memory processes, providing better memory for emotionally salient details.

Relations among memory systems

Although episodic and semantic memories are described as different systems here, it is clear that they influence one another in everyday use. For example, semantic representations

may be formed on the basis of episodic ones and vice versa. A person who is asked directions to a restaurant might respond on the basis of an episodic memory of how that person drove there the previous day, or on the basis of more general knowledge that is not temporally localized and is not based on personal experience at all. In some instances, semantic memories may simply be episodic representations (e.g., mental models) in which situation-specific features denoting the time and place of occurrences (and of oneself as the experiencing agent) have somehow been forgotten. Consequently, the distinction between episodic and semantic memory is not as clear as Tulving's monohierarchical system might suggest.

Reminding

One intriguing aspect of memory is that when people think of one thing, they are often reminded of something similar. This reminding is often of either information that the person may know or earlier experiences that are in some way similar to the current situation. The use of free association to bring otherwise inaccessible memories into consciousness is based on the idea that what is currently being thought about can remind a person of related pieces of knowledge that are more remotely associated with it.

Spreading Activation and Priming

A popular way of describing the reminding process is spreading activation. This idea assumes that memory is a network of concepts connected through a complex of associative links. When information in the network is used in some way, those concepts that are used are energized or activated. This activation spreads along the associative pathways from each of the activated concepts to other concepts, and when this activation build up exceeds some threshold, they are activated as well.

This activation process occurs for both general and event-specific knowledge. For example, if you were in a conversation and someone brings up the topic of fire trucks, your concepts for fire trucks would become activated in long-term memory. The activation would also spread to related concepts, such as red, emergency, and Dalmatians. This activation could also spread to event-specific knowledge, such as the last time you saw a speeding fire truck, you were in your neighbor's Plymouth and the engine died in the middle of a busy intersection.

Spreading activation is largely automatic, without deliberate intention. However, it can be controlled to some extent. When related information is irrelevant, or the activation has spread for some time with no benefit to the current goals, it can be dampened, and resources can be directed elsewhere. This helps people pursue their current goals, and keep them from constantly rattling through an endless series of irrelevant associative meanderings.

The effects of spreading activation have been investigated in many experiments. In a typical study, people are asked to decide whether each of several letter strings are words or non-words. People can identify 'nurse' more quickly after seeing the word 'doctor' than after seeing the word 'bread.' Encountering

the word 'doctor' and accessing its meaning in memory caused activation to spread to the concepts related to it, including 'nurse,' thus making 'nurse' easier to identify. In other words, 'nurse' was primed by the word 'doctor.'

Explicit and Implicit Memory

Another important memory distinction is between explicit and implicit memory. Explicit memory involves conscious remembering. Recognition and recall tasks, in which a person deliberately tries to remember something, are examples of tasks that rely heavily on explicit memory. In contrast, implicit memory involves unconscious remembering. Typical tests of implicit memory test the unconscious influence of previously encountered information on an ostensibly unrelated task. For example, people might read a list of words, one of which is 'memoirs.' Later, they do a task that does not involve conscious recollection, such as a word stem completion task in which they complete a word stem such as MEM with the first word that comes to mind. People are more likely to complete the stems with words that they had seen earlier than are people who were not exposed to the original list.

Explicit and implicit memories respond to different influences. For example, explicit memory is affected more by conceptually driven strategies, imposed by a person, that help to organize the information. Conversely, implicit memory is more affected by data-driven strategies that rely on the physical properties of a stimulus, such as color or font. Some theories argue that explicit and implicit memories are distinct systems with different representations and processes. Proponents of these theories point to studies in which the two processes are put in competition. For example, suppose some people in a word-stem completion task are asked to try to complete the stems with words that they saw earlier, whereas others are asked to complete the stems with words they did not see. The differential rate of completing the stems with earlier seen items provides indices of the use of explicit and implicit memory. These indices vary with the tasks used and the conditions in which they are done.

Evidence from Amnesia

A great deal of knowledge about how memory works has come from studies of anterograde amnesics. These people have suffered some brain injury, typically due to head trauma, surgical mishaps, or chronic alcohol abuse. They have difficulty remembering new information they received after the time of their injury. (Some of the more severe cases need to be reintroduced to their doctors if they leave the room for a few minutes because they have no memory of them.) Although amnesics are unable to recollect some types of information, they retain other types quite well. For example, severe amnesics with deficits in semantic and episodic memories have largely intact procedural memories. Amnesics, who knew how to play the piano before their injury, could be taught to play a new song. When asked if they know how to play the song they would report no memory of it, yet they would be able to play it successfully if coaxed into

trying. Amnesics also show deficits in explicit memory tasks, such as recognition and recall, which require active remembering, but have similar memories to normal people for implicit memory tasks, such as word-stem completion. More information on this is dealt elsewhere in this encyclopedia.

Permanence of Memories

People encounter a great deal of information in their lifetime. They see lots of things, meet many people, read many things, and have lots of experiences. What happens to all of this information? Is all of it remembered forever? Or is it the case that once information has been lost from memory it is lost forever, and will never again be recovered and play a role in influencing behavior?

One view is that everything that is ever encountered is stored in long-term memory and remains there permanently in some form or another. These memories either can be retrieved into consciousness and/or exert an unconscious influence on behaviors and ideas throughout the lifespan. A well-known source of evidence for the permanence of memory comes from the work of the neurosurgeon Wilder Penfield. During the 1950s, he performed operations that involved cutting away part of a patient's brain in the treatment of some ailment, like epilepsy. Before actually removing part of the cortex, Penfield stimulated various areas with a mild electrical charge to determine the functions of various areas so as not to remove any vital functions. Sometimes the patient reported vivid experiences. One patient reported "Yes, sir, I think I heard a mother calling her little boy somewhere" when receiving electrical stimulation in a specific area. These experiences, because of their mundane nature, led Penfield to suggest that the electrical stimulations caused a re-emergence of previously forgotten memories from the past and seemed to suggest that everything a person had ever experienced was stored in memory, and that all that is needed is a means to get it out; which in this case, was electrical stimulation of the cortex.

However, despite this convincing argument, this is not the complete explanation. First, only about 25% of Penfield's patients actually reported some experience, and only 3–7% of these reports were sufficiently clear to suggest that the patients were actually re-experiencing a previous life event. While cortical electrical stimulation may have brought back memories, it may also have just suggested experiences. No evidence was ever collected that suggested that the reported experiences actually happened to the patients.

Other positions have been put forward in support of some version of permanent memory storage. One is Harry Bahrick's *permastore* idea. According to this view, when information is first stored in memory, there is some forgetting over time. However, at some point (usually about 3 years later), the amount of forgetting ceases and what is left over stays in a stable state over long periods of time. The information that remains is said to be in a *permastore*, or permanent storage. In one study, Bahrick studied memory for college Spanish. For the first 3 years after college, there is a drop in the amount of information remembered. However, memory remained relatively constant for the next 40 years or so.

Forgetting in a Permanent Memory System

If memories are permanent, then how could forgetting occur? Two of the more prominent reasons are the lack of sufficient retrieval cues and retrieval interference.

Retrieval cues

Although information may be stored in memory, it may be destined for some dark and dusty corner of the mind that is inaccessible. One reason for this inability is that a person does not have the proper retrieval cues. Retrieval cues are the set of properties that allow for the appropriate selection and retrieval of the memory. If these cues are not available, the memory cannot be retrieved. A common metaphor that is used to describe this is that of a library. A book may be stored in the library shelves, and if it can be gotten, all of the information in it would be available. However, if its entry in the card catalog is missing, it becomes very difficult to retrieve, and might even be said not to exist in the library at all.

One of the factors that can influence the ability to remember is the amount of processing it received at encoding. Basically, the more time and effort that a person expends processing new information through elaboration or association with previously known information, the more likely it will be remembered later. This is called the level of processing hypothesis. According to this idea, information that is processed at a deeper level is remembered better because there are more cues that can be used to retrieve it. For example, if a person were to scan a newspaper article for certain letters, it is unlikely that much would be remembered. Whereas, if a person were to read the article in detail, thinking of related stories that have been reported earlier, or to other related topics, much of the information in the article would be remembered.

A related topic is the generation effect. Basically, information that was generated by people is remembered better than information that is merely presented. This occurs because all of the processing involved in the generation of the information is somehow associated with it in memory, thus allowing for a richer set of retrieval cues to access the information. While the information generation can greatly enhance memory, emerging research reveals something even more effective. Taking an evolutionary point of view, it has been found that people who try to relate knowledge to situations involved in a person's own survival, memory for that information is greatly improved. Moreover, this improvement is particularly strong if people imagine they are trying to survive in a grassland setting (as compared to, say, a city).

An extreme example of depth of processing is what are called 'flashbulb' memories. Flashbulb memories occur in situations of extreme surprise, shock, or other events that have a strong emotional impact. Common examples of flashbulb memories are highly detailed memories of what a person was doing, who the person was with, what the person was wearing, etc., when some surprising and important news was heard, such as the assassination of President Kennedy, or the September 11 terrorist attacks. It is as though a picture of the situation had been taken, hence the name flashbulb memory. The high degree of detail encoded in them would make them highly accessible because there would be many cues to retrieve them. However,

there are other explanations for flashbulb memories, such as the idea that these are events that are retrieved over and over again. This constant usage of information, a process called overlearning, allows them to be easily retrieved. There is also some evidence that the information in flashbulb memories may be incomplete and inaccurate, but through rehearsing and talking about it people have great confidence about their memories' veracity.

In a more mundane vein, more accurate information retrieval has been shown to occur by providing the same sorts of contextual cues that were available when the information was first learned. This effect is called encoding specificity. Contextual factors that can influence memory can be just about anything, including the person's mood (as noted earlier), the room that the information was learned in, the person from whom the information was originally learned from, and so on. The effects of encoding specificity can be seen in daily life. How often have you thought of doing something when you were in one room of your home, and walked into another room to act on it and then you could not remember why you went in there. So, you return to the room in which you started and, all of a sudden, you remember why you went to the other room in the first place. This remembering presumably occurs because the room in which the original idea occurred provides a sufficient number of retrieval cues to access the information.

Retrieval interference

Another reason for forgetting things that are actually stored in memory is retrieval interference. When a large number of pieces of information about an object are acquired at different points in time, they are stored independently of one another. In some cases, the more recent information appears to block or 'bury' the earlier information, making it more difficult to recall. This is *retroactive interference*. In other cases, the earlier information makes it difficult to remember subsequent information. This is *proactive interference*. Both types of interference are more pronounced when the memories contain content information that is similar and possibly conflicting. Then, the stronger memories are typically recalled instead of the weaker ones. Thus, the weaker memories appear to have been forgotten despite the fact they still exist in memory. For example, when people move, it may be difficult after a period of time to remember some of the streets in the town they lived in previously. This is because the names of the streets in the new town interfere with the retrieval of the street names in the old town.

Evidence for the Transience of Memory

The arguments for permanent memories can be quite convincing. However, there is good reason to consider the possibility that, while some information may be retained throughout a person's lifetime, due to frequent use or strong encoding, most information is removed from long-term memory after a period of disuse. Two sources of evidence for the nonpermanence of memory considered here are reconstructive processing and misleading postevent information.

Reconstructive Processing

Reconstructive processing refers to situations where people have forgotten various details of an original set of information and substituted other pieces of information. Much of the research on schema and script usage has shown that these gaps in memory are filled in with information that is consistent with the original source of information in terms of the gist of the originally presented facts, but nevertheless, is inaccurate. Even though gaps in one's knowledge have been filled in with unoriginal information, people express high confidence that the reported information was actually presented.

However, although the schema-enhanced report did contain some reconstructed inaccuracies, the original information was retained. In such a case, the general world knowledge was used as a crutch to avoid an extensive and effortful memory search. Some memory research has shown that if people are encouraged to adopt a perspective that is different from the one originally adopted during encoding, their ability to recall the original information accurately improves. At first, this seems to run counter to the encoding specificity effects described earlier. However, in this case, people are able to access the information in memory. Rather than expending all the effort needed to retrieve that information, they choose to reconstruct the more detailed aspects of the memory by assuming various defaults for the type of situation that is being remembered. In the case of encoding specificity, the nature of the information is unavailable to the person, not the details.

Misleading Postevent Information

Other evidence that the information in memory is not permanent comes from research on misleading postevent information. In studies investigating this topic, people may watch a series of events, such as a scenario of a car accident, in a slide-show or videotape. After seeing the situation, people are presented with a description that provides misleading information. In the case of the car accident, for example, people might be asked whether one of the cars stopped before the yield sign, when in fact the sign in the scenario was a stop sign. Later, people are likely to report that the features of the postevent information were actually part of the original event. This could occur because the more recent information contains features that were never observed, but were added to the original representation after it had been formed. Or, it could occur because the more recently described features actually replaced the original features in the memory, thus modifying it forever. This second possibility suggests that information in memory will be discarded if it is superseded by other relevant and more recent information.

The question of how postevent information can affect memory is especially important outside the laboratory, for example, in legal cases involving eyewitness testimony. One problem is that over time, the information in the memory of an event may decay, be difficult to retrieve, be interfered with, and perhaps be reconstructed. The additional possibility that the information a person may encounter subsequent to an event can actually change the eyewitness's memory has enormous legal ramifications. Eyewitness testimony is often thought of as one of the most valuable sources of evidence.

However, the fragility of the content of memory questions this assumption, as demonstrated by the fact that leading statements or questions by other people could cause the eyewitness to incorporate additional and extraneous information into their memory representation, thus corrupting their memory of the event. Further discussion on this topic is found elsewhere in this encyclopedia.

False Memories

It is important to remember that memories are not infallible. Through the processes of reconstruction, misleading information, and assumptions that we make based on schemas, major changes can happen to memories. Various changes and inaccurate remembering have been studied under the category of false memories, that is, memories for things that did not happen. Such inaccuracies range from misattributing a source, believing an event has happened more recently than it actually did, and believing in an event that never actually happened, such as being abducted by a UFO, or being abused as a child. Moreover, even just imagining and reporting a made-up event will lead to the creation of false memories of that event actually happening.

Summary

Human memory is a complex system. Information entering it is subject to different types of processing depending on whether it is in short-term or long-term storage. The question of how long information that is successfully stored in long-term memory will remain there is uncertain: it could remain throughout one's lifetime, or fade away permanently if it does not get used. Information is stored in different ways in memory depending on the type of information it is (whether it is knowledge of skilled action, general world knowledge, or knowledge of one's own life events). Information stored in memory has different effects on current processing goals depending on whether it was explicitly retrieved or whether it has an influence on behavior through some implicit, unconscious process.

See also: Alzheimer's Disease; Amnesia and the Brain; Autobiographical Remembering and the Self; Episodic Memory; Eyewitness Identification; Memory, Neural Substrates; Semantic Memory.

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Memory, Neural Substrates

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Glossary

Agnosia A condition in which familiar stimuli cannot be recognized, despite normal perception; agnosia for faces is known as prosopagnosia.

Amnesia Memory impairment, especially an inability to acquire new information (*anterograde amnesia*) or recall previously learned knowledge (*retrograde amnesia*).

Hippocampus A neuroanatomical structure in the mesial temporal lobe that is critical to memory.

Long-term memory Information that can be retrieved for long periods of time (days, years, decades) after initial learning; huge capacity.

Memory Knowledge stored in the brain, and the processes used to acquire and retrieve that knowledge.

Modality Any of the distinct types of sensations, such as visual, auditory, somatosensory.

Retrieval Remembering information through recall or recognition.

Temporal lobes Lobes of the brain located laterally and inferiorly, which contain many structures important for memory; on the left there is specialization for verbal information; on the right, there is specialization for nonverbal and visuospatial information.

Working memory A transient type of memory, lasting a few minutes and having limited capacity (about 7 'chunks' of information).

Introduction

Virtually all human behavior involves some aspect of memory. For example, we need memory for language, planning, decision-making, and problem-solving. Memory is important for every facet of our lives – for remembering important events and people, the facts and knowledge accumulated across the lifespan, learning new motor skills (e.g., riding a bike), as well as more mundane purposes, such as where we left our keys. Memory is not one single function of the brain with a single area dedicated to its processing; rather, virtually all areas of the brain have some role in the various aspects of memory. However, there are certain key neural regions that are especially critical to memory, and that is the focus of this article. The hippocampal complex, buried in the middle part of the temporal lobes, is critical to *acquiring new information*. Other areas of the temporal lobe are involved in *retrieving conceptual information*. Other structures such as the basal ganglia and the cerebellum are important for the *acquisition of new motor skills*. The amygdala is critical to *emotional memory*. Each of these areas is involved in a different facet of memory, and each has a prodigious capacity to acquire new information and memories.

This article aims to review the neural structures involved in memory, with a focus on adult humans. While studies of nonhuman animals have made an enormous contribution to our understanding of memory and its neural substrates, a review of such studies is outside the scope of this article. It is also important to note that the focus here is on the neural systems involved in memory, rather than the molecular or cellular mechanisms involved in memory. Therefore, the emphasis in this article is on the neural systems of the adult human brain that subserve memory.

Terms and Paradigms

Definitions and Terms

Memory is the process by which information is acquired, stored, and retrieved in the brain moment by moment. This process is believed to involve three steps: acquisition, consolidation, and storage. Acquisition is the process by which information is first brought into the brain and into a first stage memory 'buffer,' via sensory organs and primary sensory cortices. For example, when you meet a new person, the knowledge of her face is acquired by bringing the visual pattern of the face into your eyes and primary visual cortex in the occipital lobes. The second stage, consolidation, is the process by which information is rehearsed and a robust representation is created in the brain. Finally, storage is the process by which a relatively permanent 'record' or 'memory trace' is created. These records are *dynamic* so that they can be continually changed, updated, and modified over time and based on new experiences. Returning to the example of learning a new face, the visual pattern of the face would be consolidated and stored, and associations would form between the face and other important facts about the face (e.g., the name of the person, the context in which you met, how you feel about the person).

After memories have been created and stored, they must be retrieved at later times. The process of retrieval involves reactivating types of information that can form a mental image (e.g., retrieving a mental image of your house). Another form of retrieval involves reactivation of knowledge into a form that can be translated to motor output (e.g., speech, movement, autonomic activity). These different types of memory are independent concepts both theoretically and neurally. The former type, or information such as facts and events that can be brought into consciousness to form a mental image, is known as

declarative memory, while information that cannot be deliberately brought into consciousness is known as *nondeclarative memory* and typically refers to motor skills and habits. In other words, declarative memory can be ‘declared,’ in the sense that the information can be brought into the ‘mind’s eye’ and mentally inspected, whereas nondeclarative memory cannot.

There are several mechanisms of retrieval of declarative information: (1) *Recall* is the process by which information is deliberately evoked in the brain. For example, you can bring into consciousness and recall the food you ate this morning for breakfast. (2) *Recognition* is the process that occurs when one encounters material that has been previously learned, and realizes (or recognizes) that it has been previously learned. For example, when you run into a group of people, one of whom you have met earlier, you can recognize the face of person you have met earlier because it ‘matches’ the face you have learned previously. For nondeclarative memory, retrieval involves skills or habits that are not brought into consciousness, but instead, the information is retrieved through motor output. For example, the information needed for balancing and riding a bicycle cannot be expressed in words or images, but instead, is expressed through motor output.

Paradigms

The investigation of the neural substrates of memory has used many different methods and paradigms. The lesion method, or the study of the (impaired) functions of patients with focal brain damage, has been paramount to the study of memory. Exploration of the neural systems involved in memory was brought to the forefront of the field of neuroscience after a patient known as H.M. was described in 1957. After undergoing surgery to resect the medial temporal lobes bilaterally to control seizures, H.M. developed an inability to learn new declarative information about facts and events. Despite having a profound memory disturbance, patients with medial temporal lobe damage such as H.M. have otherwise relatively preserved cognitive functions – they have normal language, basic intellectual abilities, perception, and attention. Descriptions of patients with brain damage, such as H.M. and others, have elucidated many of the brain areas involved in memory, their specific functions, and the relationships between different types of memory.

The lesion method is a longstanding tradition in neuroscience and has brought about many important findings in the domain of memory. Recently, studies using functional neuroimaging techniques have corroborated and expanded on lesion studies. The two main forms of functional neuroimaging are functional magnetic resonance imaging (fMRI) and positron emission tomography (PET). These techniques are able to indirectly monitor the neural activity of healthy adults as they are performing a cognitive task. PET measures regional blood flow to areas of the brain by using radioactive tracers, while fMRI measures changes in oxygenation in the brain. Both techniques rely on the concept that increased neuronal activity in a brain region results in changes in blood flow and oxygenation in that region. Therefore, by measuring changes in blood flow and oxygenation, inferences can be made about the brain areas that are activated during a cognitive task. These methods have provided many insights regarding the neural substrates of memory, especially certain types, such as working memory.

Multiple Memory Systems in the Brain

As discussed earlier, there are multiple memory systems in the brain that are involved in different aspects of memory. Many of these systems are highly interconnected and work together to perform their various functions; however, they also function relatively independently, which can be best observed when brain damage to one system occurs.

Temporal Lobe Structures

The medial temporal lobes contain numerous structures critical to multiple aspects of memory. These structures include the hippocampus, amygdala, entorhinal and perirhinal cortices, and the parahippocampal gyrus. Specifically, the hippocampal complex, a term that encompasses the hippocampus, entorhinal and perirhinal cortices, and parahippocampal gyrus, is necessary for the acquisition of new declarative information. Other areas of the temporal lobe, including the anterior, inferior, and lateral aspects of the temporal lobes, are involved in the retrieval of knowledge from long-term memory (Figure 1).

Hippocampus and related structures

Anatomy

Anatomically, the hippocampal complex is highly interconnected with nearly all regions of the brain, including association cortices from all sensory areas as well as polymodal

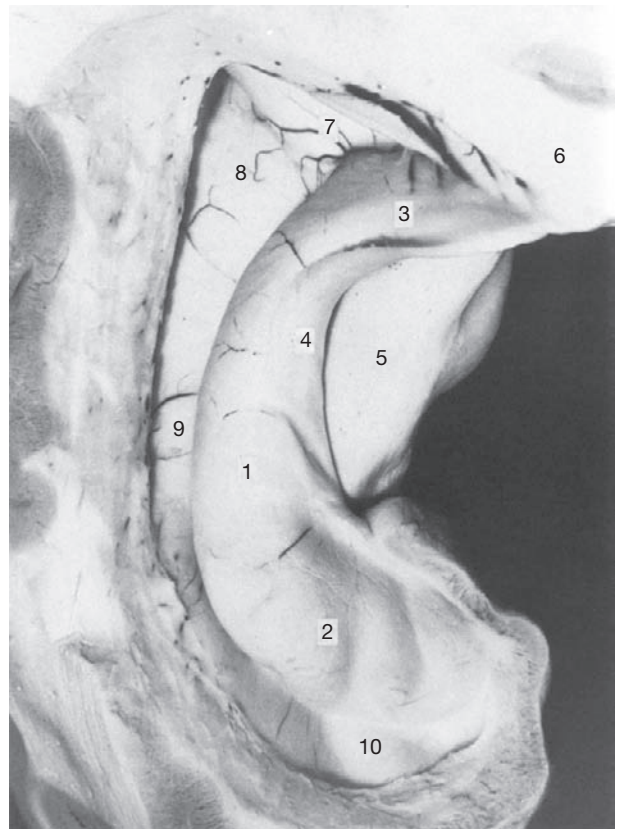


Figure 1 The hippocampus (Nos. 1–3) and related structures (Nos. 4–10). Adapted from Naidich TP, Duvernoy HM, Delman BN, Sorensen AG, Kollias SS, Haacke EM (2008) Duvernoy's Atlas of the Human Brain Stem and Cerebellum, New York: Springer.

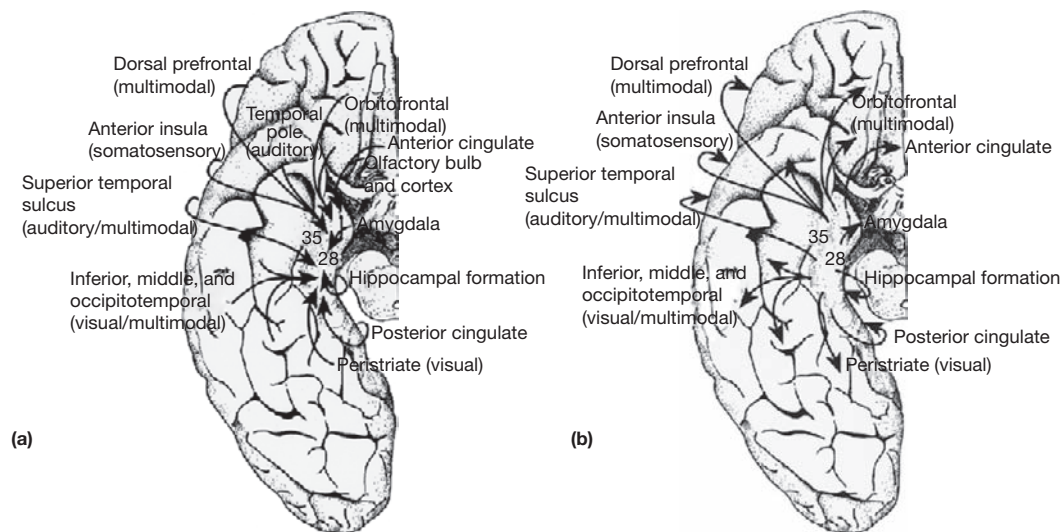


Figure 2 The neuroanatomical connectivity between the hippocampal complex memory system and various areas of the cerebral cortex. The Figure depicts ventral views of the human brain and the likely connections of the entorhinal (area 28) and perirhinal (area 35) cortices derived from nonhuman primate neuroanatomical research. This system has extensive bidirectional connectivity with unimodal sensory association areas (e.g., olfactory, auditory, visual) and polymodal association areas of the brain (e.g., prefrontal cortex, superior temporal, occipitotemporal regions). The hippocampal complex also receives input from limbic areas of the brain, including the amygdala, temporal pole, and cingulate cortex. The widespread connectivity of the hippocampal system allows it to interact with a multitude of neural systems to integrate and consolidate information.

association areas (where numerous types of sensory information are integrated) in the parietal and frontal lobes. Due to this structural arrangement, the hippocampal complex receives and influences information from virtually every area of the brain. Therefore, the hippocampal complex is ideally situated anatomically to subserve memory by creating associations that bind and integrate all modalities of information (e.g., visual, auditory, somatosensory). For example, this would allow for the association of a visual stimulus (e.g., a person’s face) with an auditory stimulus (e.g., the person’s voice) for a cohesive representation of an item or event (Figure 2 and Table 1).

Involvement in anterograde memory

The function of the hippocampal complex has been primarily elucidated through the study of patients with focal damage to this area. Patients with damage to the hippocampal complex have memory impairments specifically in the ability to learn new information, or *anterograde memory*. However, *retrograde memory*, or information learned prior to their brain injury remains intact for the most part. Thus, the hippocampal complex is critical to the acquisition of new information, but not as important for the retrieval of previously learned information. The hippocampal complex seems to play a time-sensitive, temporary role in memory, such that it is critical to the formation and short-term maintenance of memories, but long-term permanent memories are maintained and stored elsewhere. Non-mesial areas of the temporal lobe and higher order sensory association cortices are believed to be important for the storage and retrieval of long-term retrograde memories.

Involvement in declarative memory

Patients with hippocampal damage have impairments in creating new declarative memories, or memory for facts and events that can be explicitly recalled, or ‘declared.’ Declarative memory includes semantic memory, or memory for facts and information not associated with a specific event (e.g., knowing Paris

Table 1 Subdivisions of memory

Type	Characteristics
Long-term	Permanent; unlimited capacity
Working	Transient (~1 min); limited capacity (7 ± 2 chunks of information)
Declarative	Information that can be brought into consciousness; ‘declared’
Nondeclarative	Performance-based; motor output; habits; automatic tendencies
Retrograde	Previous learning; material acquired prior to onset of brain injury
Anterograde	New learning; material acquired after onset of brain injury
Verbal	Words, names, verbally coded facts; word-based material
Nonverbal	Faces, geographic routes, complex melodies; spatially based material
Unique	Information belonging to class of one; proper names
Nonunique	Information from classes larger than one; animals, fruits, tools
Retrospective	Memory for the past; what happened before
Prospective	Memory for the future; what will happen

is the capital of France), as well as memory for specific events associated with a time and place, known as episodic memory (e.g., your wedding day). Despite being unable to learn new declarative information, patients with hippocampal damage are still able to learn new skills and habits, suggesting that this type of memory is not dependent on the hippocampal complex. Memory for skills and habits, such as learning how to ride a bike or ski, is known as nondeclarative, or procedural memory. Other neural structures such as the basal ganglia and cerebellum are involved in nondeclarative memory and will be discussed in more detail later.

Lateralization

Bilateral hippocampal damage causes a global deficit in acquiring new declarative information of all modalities (e.g., visual, auditory) and of all types of material (e.g., verbal, nonverbal). However, there is lateralization of function in the hippocampal complex, which can be revealed when unilateral hippocampal damage occurs. This organization parallels the overall arrangement of the brain, such that for most individuals, the left hemisphere is specialized for verbal functions while the right hemisphere is specialized for spatial, emotional, and other nonverbal abilities. Thus, damage to the left hippocampal complex will impair acquisition of information related to verbal content, while damage to the right hippocampal complex will impair acquisition of nonverbal information such as faces and spatial locations. Normally, both the right and left hippocampi function in concert as we acquire new information. For example, when we meet a new person, we acquire both the knowledge of their face (nonverbal), as well as their name (verbal), and these pieces of information are bound together and can be retrieved upon prompting. However, after unilateral damage to the hippocampal complex, an individual may be impaired at learning new names and verbal facts, while still able to learn new faces and spatial arrangements.

Independence from working memory

Overall, the hippocampal complex has a very specific role in memory, such that it is critical to declarative, anterograde memory. Observations of patients with hippocampal damage have allowed for another distinction to be made between types of memory, as they are able to retain information for short periods of time, up to about a minute or so. For example, they are able to retain numbers (e.g., a telephone number) or spatial arrangements in their minds for short spans of time. This type of memory is called working memory and has a limited capacity (7 ± 2 'chunks' of information) and is time-sensitive. Patients with hippocampal damage are able to retain such information for about a minute; however, after this time, or if the patient is distracted, the information will be lost. Other structures such as the dorsolateral prefrontal cortex are believed to be involved in working memory (discussed in more detail later).

Future episodic memory

Humans have a remarkable ability to mentally 'time-travel.' That is, we are able to revisit our past experiences through our memories, as well as imagine future experiences and situations (e.g., your wedding day, the birth of your children, a major job promotion). Recent research has suggested that the same structures that are involved in creating memories for past experiences may also be involved in imagining and simulating future experiences. For example, patients with bilateral hippocampal damage are impaired at creating novel scenarios, such that their descriptions are fragmented and lack richness of content. This has been taken to suggest that the hippocampus may be involved in binding together the various aspects of a scenario, even imagined or future scenarios. The creation of this type of scenario requires drawing upon past experiences to guide one's representation of what might happen in the future. The hippocampus may be involved in flexibly recombining

past autobiographical information for use in novel future contexts. Functional neuroimaging studies have corroborated the idea that the hippocampus is involved in both creating memories for the past and creating and imagining the future. Other areas of the brain, including the ventromedial prefrontal cortex, are believed to be important for future thinking as well.

Updating and integrating information over time

Research has also shown that the hippocampus is important for integrating multiple pieces of information over time. Patients with bilateral hippocampal damage have impairments in updating and integrating the relationships between items and pieces of information across time in order to build a representation of a person or situation over time. For example, patients are unable to form and update associations between choices made (e.g., selecting from a certain deck of cards) and outcomes received (e.g., reward/punishment) across time, and are left to rely only on the information available at hand in that moment. Similarly, patients with hippocampal damage are unable to integrate information over time to properly build a cohesive representation of another person's moral character, and again tend to overvalue the most recent information learned when creating judgments of others. Therefore, patients with hippocampal damage often do not make advantageous decisions and appropriate judgments (e.g., about the moral character of others; or about which response is most likely to be rewarded), when multiple pieces of information must be integrated.

*Nonmesial temporal lobe**Anatomy*

Nonmesial temporal lobe structures include the lateral, inferior, and anterior regions of the temporal lobe, including the temporal pole (Brodmann area 38), inferotemporal cortex (Brodmann areas 20 and 21), and an area of transition between the posterior temporal lobe and inferior occipital lobe (Brodmann area 37; see [Figures 3 and 4](#)). These areas are involved in different aspects of memory than the medial temporal lobes; however, their functions have not been worked out in as much detail.

Retrograde memory

Earlier it was noted that patients with focal damage to the hippocampal complex typically do not have extensive impairments in retrieving previously learned information, or retrograde memory, suggesting that the medial temporal lobes are not a storage site for permanent memories. The nonmesial areas of the temporal lobe are important for retrograde memory and damage to these areas causes impairment in the ability to retrieve previously learned information. For example, Boswell, a patient whose brain damage included bilateral nonmesial temporal lobe structures, has very little capacity to retrieve any information about his past. Other than a few facts about his hometown, his parents, and his former occupation, he is unable to retrieve any other important information about his life, including about his spouse, children, or other places he has lived. However, it is rare to find focal brain damage that causes complete retrograde memory impairments, suggesting that there are other systems involved in retrograde memory. For example, higher sensory association areas have been implicated (discussed later).

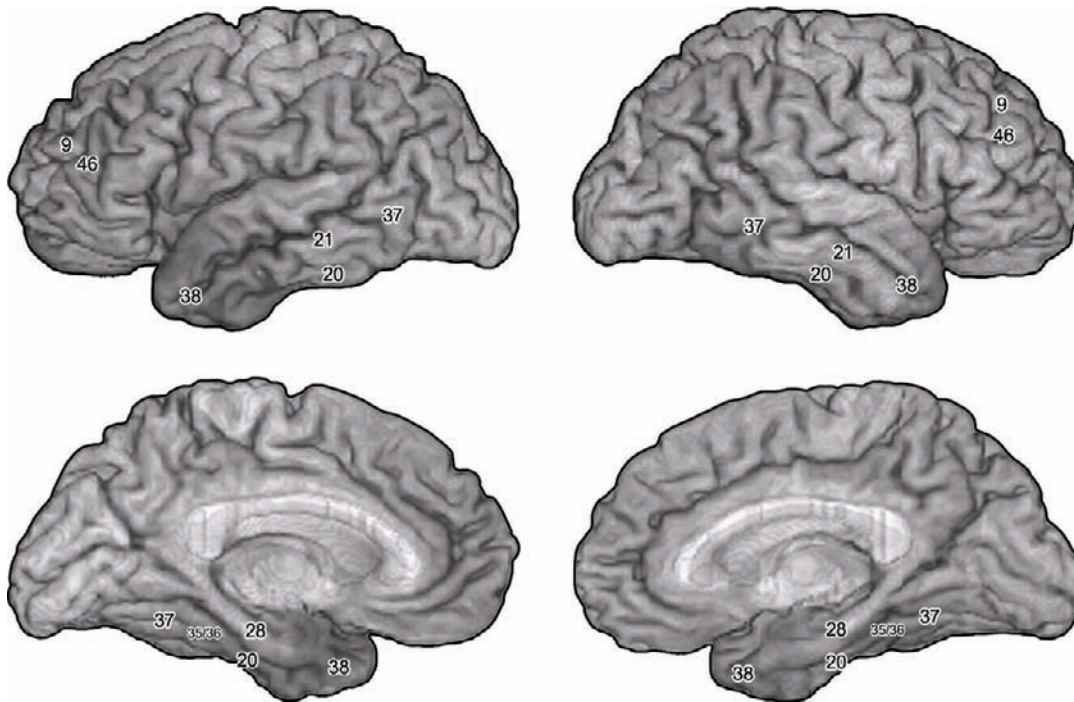


Figure 3 The lateral (upper) and mesial (lower) aspects of the left (left side of figure) and right (right side of figure) cerebral hemispheres. The Brodmann areas associated with regions of the temporal lobe (38, 20/21, 37, 35/36, 28) and dorsolateral prefrontal cortex of the frontal lobe (46, 9) important for memory are marked.

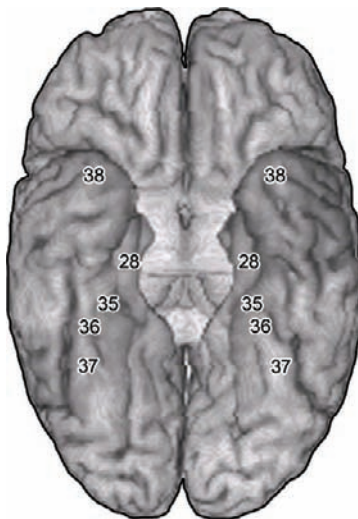


Figure 4 The inferior aspect of the cerebral hemispheres (the left hemisphere is on the right side and vice versa). Area 28 corresponds to the parahippocampal gyrus, and the hippocampus itself is buried deep within this region.

Lateralization

Similar to the medial temporal lobes, and the rest of the brain in general, there is lateralization of information processing in the nonmesial areas of temporal lobe. The left side seems to be important for the retrieval of verbal and lexical information, including retrieval of nouns (names) for unique and non-unique items. The right side seems to be important for the retrieval of nonverbal information such as faces and spatial

information. However, there is some overlap in the types of information processed by the left and the right hemispheres. For example, face processing involves both the right and left occipitotemporal regions, but the roles of each side are different. The right side uses a more holistic, gestalt-based method of analysis, while the left side tends to use a more feature-based, sequential method of analysis. Therefore, profound impairments in the recognition of faces, or prosopagnosia, typically occur only after bilateral occipitotemporal damage.

Unique and nonunique knowledge

The organization within the nonmesial areas of the temporal lobe is such that there is an increasing level of specificity or 'uniqueness' in the type of information processed from the posterior-to-anterior axis of the cortex. Specifically, the posterior aspects, including Brodmann areas 20/21, 36, and 37, are associated with information acquired, stored, and retrieved at the nonunique level. For example, names of entities such as tools or animals are retrieved at the nonunique level (e.g., hammer, wrench, squirrel), but not usually at a more specific unique level (for identifying a single individual squirrel, for example). However, certain proper nouns, such as names of people or unique landmarks, must be retrieved at a more specific unique level (e.g., the White House; Michael Jordan). This type of unique knowledge retrieval is dependent on more anterior aspects of the temporal lobe, including the temporal pole, or Brodmann area 38.

Amygdala

The amygdala is a structure seated just in front of the hippocampus in the medial temporal lobes. The amygdala is broadly

involved in emotion processing and plays a key role in the acquisition and expression of emotional memories. The amygdala consists of a collection of nuclei that receive input from all sensory areas of the brain and has connections to the hypothalamus and autonomic system for controlling the body's emotional response, as well as connections to higher order processing areas such as the prefrontal cortex and the hippocampus. The amygdala interacts with the hippocampal complex to enhance declarative memory for emotionally arousing stimuli. For example, in a list-learning task, healthy adults will show enhanced memory for emotional words (e.g., 'victim') versus neutral words (e.g., 'stamp'), as well as enhanced memory for emotional parts of a story compared to the neutral parts. However, studies with a patient with a bilateral damage to the amygdala (but not hippocampus) have shown that amygdala damage reduces this enhancement of memory for emotional stimuli (i.e., the patient recalls emotional stimuli no better than neutral stimuli). Importantly, unlike patients with hippocampal damage, bilateral amygdala damage does not affect memory for the neutral stimuli, but only reduces the enhancement of emotional memory.

The amygdala and the hippocampus have distinct but complementary roles in the creation of an emotional memory. The amygdala is able to strongly and persistently influence our emotional state; however, it must function in concert with the hippocampus in order to provide context for the emotional memory. For example, patients with bilateral hippocampal damage, with intact amygdala, can be influenced and aroused emotionally by emotional stimuli, long after they are able to consciously recall the stimuli that induced this mood. After seeing an emotional film clip that induces sadness, for example, a patient may continue to feel sad even long after they can recall what caused them to feel that way. Conversely, a patient with bilateral amygdala damage, with an intact hippocampus, is able to remember the details of the film but does not retain the enduring feeling of the emotion. This suggests that the amygdala is required for the emotion associated with memory, and the hippocampus for the context, but both are required for integrating emotion and context.

Higher Order Sensory Association Areas

Each primary sensory modality (e.g., visual, auditory, somatosensory) has an area of association cortex surrounding the primary processing areas. Sensory association cortices are critical to perceiving and processing higher order information related to the various sensory modalities. Interestingly, these same areas that are important for the perception of information are also important for the memory and recall of this information. For example, sensory association cortices are important for perceiving the various aspects of the object, the color, texture, shape, sound, etc. The ability to recall these various aspects of an object is also dependent on sensory association cortices. In fact, the different sensory aspects of an item are stored separately, such that brain damage can cause selective impairments in retrieving one modality of knowledge about an object (e.g., visual knowledge) while sparing other modalities of knowledge (e.g., auditory knowledge). A selective deficit in recognizing and retrieving information, typically regarding a single sensory modality, is known as *agnosia*. For example,

patients with damage to visual association cortices can often have visual agnosia, where they are impaired at retrieving and recognizing the information about an object such as an elephant from the visual modality when seeing a picture, but can recognize and name the elephant through hearing the sound an elephant makes.

This organization has been well studied in the visual modality. It has been shown that the neural units involved in the perception of color and form are also involved in their recall. Similar organization is believed to occur in auditory association cortex, where the neural units involved in the various auditory patterns, pitches, melodies, acoustic word-forms, are involved in both the perception and recall of auditory information. Somatosensory association cortices have neural units involved in both the perception and recall of information concerning tactile information such as weight, texture, and shape.

Frontal Lobe Structures

The frontal lobes are the most anterior part of the brain and are associated with higher order cognitive abilities such as planning and decision-making. However, certain aspects of the frontal lobes are involved in memory as well.

Basal forebrain

The basal forebrain (not technically a 'frontal lobe' structure, but in the vicinity) is a bilateral set of nuclei that includes structures such as the septum, diagonal band nuclei, and substantia innominata. This area contains neurons that innervate many areas of the brain, including the hippocampal complex and areas of the cerebral cortex, using the neurotransmitter acetylcholine. The delivery of acetylcholine and other neurotransmitters, such as dopamine and norepinephrine, by the basal forebrain to hippocampus and other areas is critical to memory function. Therefore, when damage to the basal forebrain occurs, a memory deficit results. This deficit is believed to occur because of the disruption of neurotransmitter delivery to medial temporal lobe structures; however, the memory impairment caused by basal forebrain damage is notably different from the memory impairment resulting from damage directly to the hippocampal complex.

The basal forebrain is believed to be involved in binding the different modal components of a particular memory together. Different parts of a memory must be bound together and integrated to form a cohesive representation. For example, a patient with basal forebrain damage is able to acquire and store new declarative information, such as the name of a person and their face, but these two pieces of information are not properly integrated and cannot be retrieved correctly at the same time. Importantly, this binding deficit can occur in both anterograde and retrograde memories. Patients with basal forebrain damage can learn new information from one modality, but have trouble integrating relationships between modalities. The binding impairment can also affect knowledge of temporal relationships between information and events, resulting in impairments in remembering the order in which events occurred. Similarly, retrograde memories can be retrieved but the information is not bound properly and tends to contain inaccurate information. For example, a patient recalling facts

about an occupation from 10 years ago may link facts together incorrectly by saying, "I used to work on an assembly line (correct) putting metal rings on the legs of frozen turkeys (correct), at the Hawkeye Packing Plant (incorrect) in the southwest part of town (incorrect)."

Dorsolateral prefrontal cortex

As mentioned earlier, the dorsolateral prefrontal cortex (including Brodmann areas 46, 9) is involved in working memory (see Figure 3). Working memory is the ability to hold a limited amount of information in mind for a short period of time. For example, working memory is necessary for holding a phone number 'in mind,' or keeping track of geographical locations as someone gives you multistep directions to a location across town. This type of memory is critical to bridging temporal gaps so that the information can be 'worked' with or mentally manipulated for a short period of time. This ability to hold representations in mind is critical to other complex cognitive functions, such as decision-making, planning, and problem-solving. Other areas of the brain, such as the parietal lobes, which are highly interconnected with the dorsolateral prefrontal cortex, have also been found to play a role in working memory.

Studies of nonhuman animals and functional neuroimaging have played an important role in discovering the role of the dorsolateral prefrontal cortex in working memory. Single-cell recordings from monkeys in this region have found neurons that fire more during the delay between stimuli presentation and recall, suggesting that they are involved in keeping the information 'online.' Functional neuroimaging studies suggest that similar to other areas of the brain, there is lateralization of function in the dorsolateral prefrontal cortex, such that the right side is important for spatial working memory, and left side is important for verbal working memory. However, the details of this organization are still under debate and much is yet to be discovered about the neural substrates of working memory.

The dorsolateral prefrontal cortex has also been implicated in memory for the frequency of an event (how often something happens) and recency of the event (how long ago it took place). For example, answering the question 'When was the last time you talked to your mother on the phone?' would be a recency judgment, while 'How many times do you talk to your mother on the phone every week?' would be a frequency judgment. Both of these types of judgments are forms of memory that are dependent on the dorsolateral prefrontal cortex.

Basal Ganglia and Cerebellum

The basal ganglia are a set of gray matter nuclei, including the caudate, putamen, globus pallidus, and subthalamic nuclei, buried deep within the cerebral hemispheres. The basal ganglia are primarily involved in motor control and refining and executing motor movements. This structure is also involved in non-declarative or procedural forms of memory; especially those that are dependent on motor movements. The basal ganglia are important for learning and retrieval of motor skills (e.g., riding a bicycle, skiing). Another structure involved in nondeclarative memory and motor coordination is the cerebellum, a structure located posterior to the brainstem at the base of the brain.

Diseases such as Parkinson's disease and Huntington's disease cause damage to the basal ganglia, and patients afflicted

with these diseases are impaired at the ability to learn new motor skills. Importantly, patients with damage to the basal ganglia retain the ability to learn new declarative information, because of their intact medial temporal lobe function. Similarly, patients with damage to the hippocampal complex are able to learn new motor skills, although they cannot remember any other declarative information about learning these skills (e.g., where or when they learned the information). This suggests that the hippocampal system for declarative memory and the basal ganglia system for procedural memory are independent systems.

The basal ganglia, especially the caudate and putamen, are also believed to be involved in nonmotor skill learning, such as habit learning. This involves the tendency to respond the same way to repeated stimuli or situations. For example, we often take the same route home everyday, or automatically reach for the seatbelt after entering the car. These are habits and response tendencies that are engaged fairly automatically without much conscious thought.

Thalamus

The thalamus is composed of a set of nuclei located in the brainstem. While the primary functions of the thalamus are not specifically for memory, it does play an important role in memory. The areas most important for memory are the dorsomedial and anterior nuclei of the thalamus, the mammillary bodies, and their associated tracts: the mammillothalamic tract, connecting the anterior nucleus of the thalamus and the medial temporal lobes, and the ventromygdalofugal pathway, which connects the dorsomedial nucleus and the amygdala. Damage to these areas of the thalamus can also cause memory impairments because of damage to their connectivity to the medial temporal lobes. In general, the role of the thalamus in memory is not well understood. The type of amnesia associated with damage to the thalamus is similar to hippocampal amnesia, in that it typically affects learning of new declarative memories; however, thalamic lesions can also affect retrograde memories. Wernicke-Korsakoff syndrome, which is typically caused by severe, prolonged alcoholism, causes damage to the thalamus and mammillary bodies and has severe effects on memory. Anterior aspects of the thalamus are important for remembering the temporal sequence of events (i.e., knowing the order in which events occurred). Finally, similar to many of the other brain regions discussed in this article, there is some laterality of information processing in the thalamus. The thalamic nuclei on the left side seem to be specialized for verbal information, while the right side is more involved in nonverbal, spatial information.

Conclusion

The human brain has an incredible capacity to learn and store a vast amount of information, including names, faces, events, facts, and skills, and to recall this information accurately and flexibly in a variety of contexts. The importance of memory for everyday life can hardly be overestimated. Memory is involved in virtually all behaviors and cognitive functions,

including language, social interaction, decision-making, and future thinking. The importance of memory and its associated neural structures can be seen through the devastation that occurs when these areas are diseased or damaged, such as Alzheimer's disease, in which case cell death begins primarily in the hippocampus and medial temporal lobes.

The neural systems that support memory encompass numerous structures in the brain. Many of these structures are not solely dedicated to memory processing, yet each area makes a critical contribution to memory function. The detailed study of patients with focal brain damage and more recent studies using functional imaging techniques have allowed distinctions to be made between different types of memory and have broadened our knowledge of the neural structures involved in memory. It is through the use of these methods that scientific explorations will continue to discover new facets of human memory.

See also: Alzheimer's Disease; Episodic Memory; Hippocampal Formation; Memory; Neurotechnologies; Semantic Memory.

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Mental Imagery

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Glossary

Dorsal stream Functional pathway in the primate visual brain that is specialized for processing spatial attributes.

Functional magnetic resonance imaging (fMRI) A noninvasive technique used to measure regional cerebral blood flow. Unlike PET, it does not involve radiation exposure.

Multivoxel pattern analyses Analyses of functional magnetic resonance imaging data that focus on subtle differences in the spatial pattern of activation across many voxels.

Occipital A posterior portion of the cortex involved in early processing of visual information.

Positron emission tomography (PET) A noninvasive technique employed to measure regional cerebral blood flow by using a radioactive tracer.

Transcranial magnetic stimulation (TMS) A noninvasive technique used to temporarily disrupt neural processing at a cortical site by using a strong magnetic field.

Ventral stream Functional pathway in the primate visual brain that is specialized for object processing.

Voxel Volume element.

Introduction

Our sensory systems enable us to register information about the world and to perceive objects and events in the external environment. However, perceiving such entities is possible only because our brains construct sophisticated and flexible internal representations of such entities that even modern computer systems are unable to mimic. These internal representations can be activated not only by signals generated by external stimuli, during perception, but also internally, during mental imagery. Although mental imagery can occur in all sensory modalities, this article focuses on the visual modality because it is the one that has attracted the most research. When asked a question such as ‘what shape is a cat’s ears?,’ one typically visualizes an image of a cat and zooms in on regions in the image that encompass the animal’s ears to determine their shape. Mental imagery relies on the reactivation and inspection of internal representations in the absence of external stimuli. Using the language of cognitive science, visual mental imagery relies on the reactivation of representations in long-term memory to construct representations that can be further manipulated in working memory. It is important to keep in mind that visual mental imagery is more than the simple reactivation of internal representations of stimuli and events that have been experienced: in many cases, visual mental images can be parsed and recombined, enabling the extraction of novel information. The following simple exercise can provide a good example of the constructive power of visual mental imagery. Imagine the capital letters ‘j’ and ‘d’ and rotate the letter ‘d’ counterclockwise by 90° and place it on top of the ‘j.’ Most people can immediately recognize the resulting object, even though they had never used the letters ‘j’ and ‘d’ for this purpose (the resulting object is a stylized umbrella). The constructive aspects of visual mental imagery are the main reasons why it is key in many important domains, including mathematics and engineering.

Brief History

The importance of mental imagery, and especially visual mental imagery, in human cognition has been recognized for a long time, at least since the Greek philosophers. For example, Aristotle believed that it is not possible to think without mental images and that images play a key role in desire and motivation by representing a goal object. The last 40 years have seen a rapid increase in the number of studies on visual mental imagery and in the amount of knowledge available about the processes, both cognitive and neural, that underlie visual mental imagery. It is important to remember that, despite the impressive amount of research on the topic in the last few decades, virtually no research had been conducted on visual mental imagery between the 1920s and the 1950s. Indeed, during these decades, the dominating behaviorist perspective had declared the study of imagery unscientific, seen as an essentially vague and private process without external measurable correlates. After the behaviorist period, with the emergence of the new theoretical framework of cognitive psychology, the 1970s witnessed a resurgence of interest in studying internal representations and processes and in experimental investigations of visual mental imagery. Among the seminal studies on the topic were those on the relationship between visual mental imagery and memory by Paivio and on the transformation of visual mental images by Shepard and collaborators. These and other studies convincingly showed that phenomena such as visual mental imagery, and more in general questions about internal representations, could be addressed scientifically. Much work has gone into the determination of the structure and format of the internal representations underlying visual mental images, generating a lively debate. Researchers on one side of the debate (depictive theorists such as Kosslyn) put forward the hypothesis that visual mental images are analog representations and function to depict objects and scenes, that is, they represent the shape and spatial relationships explicitly by means of their internal structure: distances among points in

the image map onto distances among the corresponding points in the stimuli they represent. In contrast, researches on the other side of the debate (nondepictive theorists such as Phylyshin) postulated that visual mental images were some sort of propositional representations, not different from the general-purpose mental representations underlying other thought processes. In this view, the fact that visual mental images appear to have pictorial features introspectively is irrelevant from the perspective of information processing, pretty much like the power light on a computer is irrelevant for the operations carried out by the computer.

Using Cognitive Neuroscience to Study Visual Mental Imagery

The 'imagery debate' became very intense in the late 1970s and early 1980s. During those years, it became increasingly clear that issues about the format of internal representations, and of visual mental images in particular, could not be resolved conclusively, even using the novel empirical methods of cognitive psychology. This point was summarized in a key paper by Anderson which demonstrated that behavioral results from several visual imagery studies were compatible with both depictive and propositional accounts of visual imagery, by just tweaking processing assumptions in the accounts. In his paper, Anderson showed that given a theory defined by a group of assumptions about depictive representations and processes operating on them, one could always design a second theory that could mimic the first theory on the basis of a different group of assumptions. This proof showed that the results of behavioral experiments could not unequivocally implicate the existence of specific representation-process pairs: the characteristics of these representation-process pairs could only be uncovered conclusively by using additional, nonbehavioral types of evidence, such as neuroscientific evidence. Thus, it became clear that neural evidence is critical for constraining and understanding theories of visual mental images and, more generally, of internal representations.

The pattern of results from several behavioral studies has demonstrated robust parallels between visual mental imagery and visual perception, providing a rationale for the use of neuroscientific data: if visual mental imagery and visual perception rely on the same processes, then the neural structures supporting vision should also support visual mental imagery. This kind of logic enabled the use of neurophysiological knowledge about the visual system of nonhuman animals to guide the generation of new hypotheses about how visual mental imagery works. Indeed, until recently, most of the knowledge about the neurophysiological basis of the human visual system came from studies in nonhuman primates, assuming homology among different species. Progress in technologies for noninvasive neuroimaging and brain stimulation has enabled cognitive neuroscientists to investigate the neural basis of vision in humans and to test this homology assumption directly. Experimental results using brain imaging and stimulation techniques such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI), and transcranial magnetic stimulation (TMS) have complemented data obtained from brain-damaged patients and confirmed that

the organization of the visual system in humans and nonhuman primates is very similar, especially in early visual areas. These same techniques have enabled the noninvasive study of visual mental imagery in humans.

The following sections provide a concise review of a subset of the cognitive neuroscience literature on visual mental imagery, focusing on one research topic that has received considerable attention.

Shared Neural Systems Between Visual Mental Imagery and Visual Perception

A key question is whether the neural processes engaged during visual mental imagery and perception are the same, as suggested by the cognitive psychology studies mentioned earlier. A handful of brain imaging studies, such as that by Ganis and collaborators, have quantified the overlap between neural structures recruited by visual mental imagery and perception across the entire brain, suggesting an overall overlap of over 90%. However, most neuroimaging studies on the topic have focused on the more circumscribed question of whether certain brain regions are engaged in common by visual mental imagery and visual perception. A subset of these studies is reviewed in the following section.

Role of Early Visual Cortex in Visual Mental Imagery

Several brain imaging studies have focused on the specific question of whether early visual cortex is activated during visual mental imagery. This is because early visual cortex plays a special role in visual processing, as outlined below.

Visual mental imagery and the organization of the primate visual system

The primate visual system is organized in a hierarchical manner, with the early visual cortex (visual areas V1 and V2, in the occipital lobe, also referred to as areas 17 and 18, respectively) at the bottom of the hierarchy. Area V1 receives information from the retina via subcortical nuclei (mainly the lateral geniculate nucleus) and feeds it to the rest of the visual hierarchy. The visual hierarchy itself is loosely divided into parallel processing streams, specialized for different kinds of information. The ventral stream, which runs inferiorly along the temporal lobe, is involved in shape and object processing, whereas the dorsal stream, which runs superiorly along the parietal lobe, is important for spatial cognition and action.

One key feature of early visual cortex is that it is organized topographically (or retinotopically) so that points that are close to each other in visual space are represented at nearby cortical locations, with a few exceptions. Points in this orderly representation are defined by their coordinates on two axes, referred to as polar angle and eccentricity. Polar angle is the angle between a horizontal line and the line that connects a point to the center of the visual field, whereas 'eccentricity' is the distance of a point from the center of the visual field. This topographic representation becomes weaker as one moves up the visual hierarchy, as neurons respond to larger parts of the visual fields and to more complex features of the stimuli.

V1 neurons, for instance, respond optimally to small oriented bars displayed at very specific locations in the visual field, whereas neurons in the inferotemporal cortex, much higher in the visual hierarchy, respond better to complex combinations of features (e.g., color, shape, texture, etc.) appearing nearly anywhere in the visual field. This organization suggests that the topographic representation in early visual cortex is better suited to make the spatial layout of a stimulus explicit, whereas the distributed representations used in the inferotemporal cortex are better suited at capturing and coding similarities between more complex features of classes of objects.

Another key feature of the primate visual system is that information does not flow only in a feed-forward manner, from lower to higher levels in the hierarchy. Typically, areas that receive information from a lower level area also send information to that area by means of feedback connections. Although the precise characteristics of these feedback projections are slightly different from those of the feed-forward projections, this means that areas that are high in the visual hierarchy can influence neurons in early visual areas.

These organizational features of the primate visual system have inspired neuroscience-based depictive theories of visual mental imagery such as those by Kosslyn and collaborators. At the core of these theories is the idea that visual object memories are stored in higher level visual areas (such as the inferotemporal cortex) and that the neural code used by these areas cannot represent the precise spatial layout of objects explicitly because they are not organized topographically. It is only in early visual areas, where distance in space is represented by distance on the cortex by virtue of their retinotopic organization, that the spatial layout of objects can be represented explicitly. Thus, according to depictive theories, the key process of many types of visual mental imagery is the reactivation of topographic representations in early visual cortex by means of signals from areas higher in the hierarchy. Finding evidence that early visual cortex is engaged during visual mental imagery would therefore provide support for depictive theories, which is why much research has focused on this issue.

Neuroimaging findings showing activation of early visual cortex during mental imagery

Early studies used PET to show that visual area V1 is recruited during visual mental imagery with a pattern that is consistent with the topographic organization of this area. In one study, Kosslyn and collaborators exploited the systematic representation of eccentricity in V1. They monitored cerebral blood flow (an indirect measure of neural activity in the brain) while subjects visualized letters at either a very small or at a very large size. Subjects were asked to maintain the image for several seconds and then to judge the geometric properties of the letter (e.g., whether it had any curved lines). The logic was that if visual mental imagery uses retinotopic representations in area V1, then small visual mental images should engage parts of area V1 that represent less eccentric regions of the visual field, located in increasingly posterior regions of the occipital lobe. The results were consistent with this prediction and showed stronger activation in the posterior parts of V1 when subjects visualized the letters at the small size than at the larger size. In another study, Kosslyn and collaborators used a similar rationale. During the PET session, subjects visualized objects

they had studied beforehand within boxes of different size. To ensure that subjects were actually carrying out visual mental imagery, they were asked to perform various visual judgments on the images, such as whether the right side of the studied pictures was higher than the left side. The results, again, were consistent with the predictions and with the systematic organization of eccentricity in early visual cortex.

These results were replicated and extended in subsequent studies using fMRI, a technique with a better spatial resolution than PET. Some of these studies focused on the polar organization of the early visual cortex and aimed at showing that the pattern of activation elicited during visual mental imagery is consistent with this organization. In one study by Klein and colleagues, subjects were asked to visualize narrow horizontal or vertical bow-tie shapes and the pattern of brain activation in early visual cortex was compared with that found when the same subjects actually perceived these bow-tie shapes. The results were generally consistent with the prediction that the same polar angle representation is used in perception and imagery. However, the pattern was not found in every subject, suggesting that individual differences play an important role. The polar angle representation was exploited by another study by Slotnick and collaborators that attempted to adapt retinotopic mapping methods to the investigation of visual mental imagery. In this study, the visual stimuli were thin rotating bow-tie shapes which, during the perception condition, would systematically cover the polar angle dimension. During the visual mental imagery condition, the stimuli were two thin arcs delineating the outer edges of the bow-tie shapes and subjects visualized the rest of the bow-ties. To make the tasks as similar as possible, subjects pressed a button each time a tiny red square was flashed inside the bow-tie region, which was only visualized in the visual mental imagery condition. The study also used a control attention condition. Results showed some retinotopic activation in area V1 that was not seen during the attention condition, but only in a subset of subjects. Furthermore, most retinotopic activation during visual mental imagery was in common with that observed during visual perception, suggesting that visuospatial attention processes may be an important component of visual mental imagery.

Thirion and collaborators extended these results by employing a complementary approach, referred to as 'inverse retinotopy.' With this approach, given a pattern of activation in early visual cortex, it is possible to compute the visual stimulus that would be more likely to have generated such a pattern. This approach relies on inverting the known mapping between a visual stimulus and its cortical representation. In the study, subjects either saw or visualized simple patterns and the key question was whether it would be possible to infer what pattern was being perceived or visualized on the basis of the neural signals from early visual cortex. Results showed that it was possible to determine consistently what pattern subjects were perceiving with high accuracy and in single trials, using information from areas V1 and V2. However, accuracy was much lower during visual mental imagery, and it was possible to determine which pattern subjects were visualizing only in a subset of subjects.

Overall, these neuroimaging studies generally support the claim that visual mental images of objects sometimes activate retinotopically organized areas in V1 and V2. However, the

signals observed during imagery are much weaker and variable than those found during visual perception.

It is important to note that some neuroimaging studies have failed to find activation in early visual cortex during visual mental imagery, raising the question of what factors may be responsible for these differences. This type of question can be best addressed by conducting a meta-analysis on the many studies on the topic. The most exhaustive meta-analysis carried out to date to address this question was conducted by Kosslyn and collaborators. This meta-analysis included data from 59 neuroimaging studies and the results showed that the tasks that typically lead to activation in early visual cortex during visual mental imagery involved the use of high-resolution imagery to evaluate details of mental images (as opposed to global aspects) and shape judgments (relative to spatial judgments). These two key task attributes make sense in light of the visual system organization discussed earlier. On the one hand, reconstructing the high-resolution details of visual mental images may require reactivating representations available only in the topography of early visual cortex. On the other hand, spatial judgments, unlike shape ones, may rely on representations stored in the dorsal stream that are already suited for tasks involving spatial attributes.

Virtual lesion and patient findings on the role of early visual cortex in visual mental imagery

One key question is whether the topographic organization in early visual cortex has a functional role in visual mental imagery, or even in visual perception. This question cannot be fully addressed by neuroimaging alone because the data it provides is correlational. A key objection to depictive theories of visual mental imagery is that the topographic organization of early visual cortex is functionally irrelevant. To use a technological analogy, the overall shape and type of packaging of an integrated circuit is not functionally related to the types of computations it can carry out. One way of addressing this question is to find evidence that the topographic organization of early visual cortex is needed for visual processing and for visual mental imagery. This type of evidence can be obtained from two sources: virtual lesion and patient studies, discussed in the following section.

By using techniques such as TMS, it is possible to produce transient disruption of neural processing in specific brain regions. It is well known that TMS pulses delivered to early visual cortex result in phosphenes (faint flashes) or, at higher intensities, in transient scotomas (blind regions in the visual field). Critically, the perceived location of these phosphenes and scotomas in the visual field is systematically related to the locus of the stimulation: with few exceptions, nearby stimulation sites result in phosphenes or scotomas in nearby locations in the visual field represented by the stimulated cortex. This is strong evidence that the topographic organization of early visual cortex is causally related to visual processing. Probably, the strongest evidence that early visual cortex is necessary for both high-resolution visual mental imagery of shapes and for perception is the one provided in a high-profile study by Kosslyn and collaborators. In this study, subjects first memorized a 2×2 array of stripes. The stripes in each cell of the array varied along multiple dimensions (e.g., width and length). During testing, subjects answered questions about these

dimensions. For example, they would be asked whether the stripes in cell 1 were wider than those in cell 4. In the perception condition, subjects saw the stimuli, whereas in the visual mental imagery condition, they visualized them with their eyes closed. In the experimental condition, subjects carried out the tasks after low-frequency TMS of early visual cortex for 10 min. In contrast, sham TMS was used during the control condition with the same task. Low-frequency TMS reduces cortical excitability, making it more difficult for neurons to fire. Therefore, the prediction was that this kind of stimulation would slow down both visual imagery and perception. The results supported this prediction: TMS slowed down not only response times during the visual perception task, but also visual mental imagery, providing strong evidence that early visual cortex is necessary for both.

The more extreme types of lesions are those produced by brain damage. The rationale here is similar to that for virtual lesions: if early visual cortex is necessary for visual mental imagery, a key prediction made by depictive theories, then its damage should result in impaired visual mental imagery. Although this logic may seem straightforward, in practice, the inference from brain damage to processes is complicated by several factors. First, it can be difficult to be sure that cerebral tissue is functioning normally. Second, the location of brain damage cannot be controlled experimentally, and so it is possible that damage to one area systematically affects nearby areas that may not be functionally related to the damaged area. Third, brain plasticity often leads to brain reorganization over time, complicating the interpretation of results. Fourth, in part due to some constraints in clinical settings, visual mental imagery has not been assessed thoroughly in many published studies (e.g., only paper and pencil tests were administered). A number of studies have reported disruption of visual mental imagery as a result of occipital cortex damage. Hemianopic patients are particularly useful for testing the prediction that early visual cortex is necessary for visual mental imagery. These patients are blind in parts of one visual hemifield because of damage to the visual cortex in one cerebral hemisphere, and so one can administer a visual mental imagery task in the impaired hemifield and compare performances when the same task is administered to the intact hemifield. An excellent example of such a strategy is a study conducted by Butter and collaborators in which hemianopic patients and control subjects were asked to perform a mental scanning task, an objective evaluation of visual mental imagery. All subjects were first shown four dots on a sheet of paper. Next, they were shown a second sheet containing a black arrow in the center. The task consisted in using visual mental imagery to decide whether the arrow pointed to a position previously occupied by one of the dots. The main finding was that patients with left occipital lobe damage (right hemifield problems, due to the contralateral organization of the human visual system) were more impaired in the task for dots falling in the right than in the left hemifield. The opposite pattern was found for patients with right occipital lobe damage. Control subjects made few errors and showed no effect of hemifield. Furthermore, control tasks ensured that all subjects were able to perceive the dots and the arrow. These results are consistent with those of an earlier single-patient study by Farah and colleagues. The patient examined in this study had the occipital lobe in one hemisphere removed,

resulting in a reduction of the horizontal extent of visual images by half, after surgery. As the vertical extent of the visual images was unchanged, the finding suggests that the loss of half of the horizontal meridian may have caused the horizontal 'shrinking' of the extent of visual images.

The patient literature also has some cases that, *prima facie*, seem to be inconsistent with the claims made by neuroscience-based depictive theories. In some of these cases, pervasive damage to area V1 that results in blindness appears not to disrupt visual mental imagery abilities. One such patient was described by Chatterjee and Southwood. Despite becoming cortically blind after a stroke that damaged her early visual cortex bilaterally, this patient was able to carry out many visual imagery tasks, including answering questions about the shape of capital letters and common animals. Interestingly, she also anecdotally reported using visual mental images in school classes she attended after becoming cortically blind. This is not the only such case in the literature, although generally, the tests of visual mental imagery have been rather minimal. However, so far, there have not been conclusive cases showing that complete destruction of early visual cortex leaves high-resolution visual imagery of shapes intact. First, the vast majority of studies did not measure response times, making it difficult to determine whether there was at least a decrease in processing speed, which could suggest the use of compensatory strategies not based on visual imagery. One such strategy could be to rely on motor representations instead of visual ones, for example, to answer questions about the shape of letters or objects. Second, in many cases, it is hard to verify that there are no spared V1 or V2 portions that could still support visual mental imagery. Given that visual mental imagery typically engages much smaller portions of early visual cortex than visual perception, the damage may have to specifically include all these portions to produce impairments in visual mental imagery. Third, many visual mental imagery tasks may be carried out using higher level visual cortex because they do not involve generating the types of high-resolution images supported by V1 and V2, as already mentioned and as discussed in more detail in the next section.

One final point worth mentioning is that some of these cortically blind patients report having vivid visual mental images. These introspective reports are not necessarily problematic for neurally inspired depictive theories of imagery because the introspective feeling of having a vivid mental image may not depend on early visual cortex and it may not correlate with actually being able to use these visual mental images. Only rigorous testing could tell whether patients reporting vivid images of this type can actually extract information from these images. A situation analogous to this is the introspective feeling most of us have of being able to perceive every detail of the visual world despite the fact that objective tests reveal that we only encode a few visual details.

Higher Level Visual Areas in the Ventral Stream and Visual Mental Imagery

As described earlier, higher level visual areas in the ventral stream receive information from retinotopically organized early visual cortex and process object attributes such as shape, texture, and color. Object representations in these areas are

distributed, as shown by Haxby and collaborators in humans, but they also show some degree of segregation. For example, Kanwisher and colleagues have shown that patches of cortex in the lateral fusiform gyrus are more responsive to pictures of faces than to pictures of other object categories, whereas cortical patches in parahippocampal cortex respond more strongly to pictures of buildings than other objects. To some extent, this general organization has also been observed for visual mental images of objects, as summarized below.

Neuroimaging findings

The pattern of spatial segregation of object representations in the ventral stream has been used to test the similarity between the representations engaged by visual mental imagery and visual perception. The general logic of most neuroimaging studies has been to determine whether brain regions engaged in visual processing of certain objects are also engaged when visualizing the same objects. The findings of numerous studies have supported the notion that visual mental imagery engages a subset of the same brain regions engaged by visual perception. For example, a seminal study by O'Craven and colleagues reported that visual mental imagery of faces engages a portion (about 17%) of the brain volume in the ventrotemporal cortex that is engaged when somebody actually perceives a face. A similar pattern was found in the perception and visual mental imagery of buildings. Importantly, and consistent with observations in early visual cortex, the activation found during visual mental imagery was weaker than that observed during visual perception of the same stimuli, possibly reflecting the more diffuse organization of feedback connections. These results were later confirmed by similar studies, such as those by Ishai and colleagues.

More recent studies have used variants of multivoxel pattern analyses to examine this issue in more detail. The rationale of multivoxel pattern analyses in this context is that, even if visual perception and visual imagery activate a region in common, there could still be systematic differences in the spatial pattern of activation within this common region that could be indicative of differences in the recruited neural populations. A recent study by Stokes and collaborators used this strategy and examined the similarity of the spatial patterns of activation elicited by visualizing and perceiving two letters in the lateral occipital cortex. Results indicated that in some ventral stream regions, such as the left anterior lateral occipital cortex, subtle differences in the spatial pattern of activation elicited by seeing different letters were similar to those elicited when visualizing such letters. Thus, it was possible to discriminate above chance between the visualized letters by using a classifier trained on the data from the perceived letters. Another study by Reddy and colleagues extended these findings by using four object categories (face, food, tools, and buildings). Results showed above chance discrimination among object categories by using activation in the ventral-temporal cortex both in the visual perception and imagery conditions. Furthermore, a classifier trained on the perception data was able to classify the visual imagery data above chance (in fact, as well as could be done by using a classifier trained on a different visual imagery subset). This indicates that the representations used by visual imagery and perception in higher level visual cortex are quite similar. Furthermore, classification rates on visual mental imagery data

were at chance when using information from early visual cortex. This is not entirely surprising, in light of the section on early visual cortex, because the task did not require inspecting high-resolution shape information and only involved deciding if the previous stimulus had the same color as the current one (and the few stimuli used in the task, e.g., 'apple' and 'banana,' were very different in color).

Single neuron findings

Multivoxel spatial analyses still look at the scale of single voxels, which is much larger than the scale of single neurons. Therefore, it is still possible that nonoverlapping neural populations of neurons could be recruited within the same voxels by visual categorization and visual mental imagery. The only technique that enables us to examine single neuron activity in humans is that of the invasive intracranial recordings in patients with epilepsy. One study by Fried and collaborators that compared visual perception and imagery directly examined the activity of single neurons in the medial-temporal lobe. In the study, subjects studied picture pairs and then imaged them, cued by one of the two auditory tones. The main result was that the vast majority of neurons that were recruited by both visual perception and imagery had similar stimulus selectivity. A follow-up study recorded single neuron data in the medial-temporal cortex when subjects watched video clips and when they visualized them later on. Most neurons responded to a small subset of the clips watched by the subjects and, critically, the pattern of selectivity was similar during visual mental imagery of the same clips. These findings are rather sparse, but they suggest that the similarity between the processes engaged by visual perception and visual mental imagery may hold down to the single neuron level.

Patient findings

The neuroimaging data just described and showing that visual perception and mental imagery of objects engage similar neural populations in the ventral stream suggest that damage to some of these neural populations should result in parallel deficits. Consistent with this prediction, the literature has reported cases in which brain damage results in domain-specific deficits in both visual perception and mental imagery. For instance, some patients with deficits in face recognition also exhibit problems in visualizing faces. Indeed, 14 of the 28 cases with object agnosia described in an early review by Farah showed parallel visual perception and visual imagery deficits. For most of the remaining cases, imagery was either not tested or not tested rigorously. These parallel deficits can be explained by assuming damage to ventral stream regions that store long-term memories needed both during object categorization and imagery. However, the picture is complicated by the fact that there are also cases in which impairments in object categorization are not accompanied by corresponding problems with visual imagery, for instance, a case described by Servos and collaborators. One potential explanation for these cases relies on the observation mentioned earlier that visual perception typically recruits larger volumes of cortical tissue than visual imagery in the ventral stream. Some of the nonoverlapping regions recruited by visual perception are likely to be the key for processes such as figure ground segregation that are

necessary for perception but not visual mental imagery. Thus, damage to these nonoverlapping regions could lead to dissociations in which a patient is impaired at object categorization but still able to perform visual imagery. There are also a few cases with the opposite pattern of impaired visual imagery and spared perception, possibly reflecting damage to frontal and parietal regions that may be providing feedback inputs necessary for visual mental imagery.

Summary and Conclusion

Our understanding of visual mental imagery has made enormous progress because of three concurrent developments over the last several decades. First, theories of visual mental imagery could build upon knowledge about the neural basis of perceptual and motor systems. Second, progress in behavioral and neuroscientific methods enabled the field to avoid relying entirely on introspection when studying visual mental imagery. These novel methods showed that imagery can be studied objectively, like any other entity in science: like many particles in theoretical physics that cannot be seen directly visual mental images have consequences that can be objectively assessed. Third, the birth and growth of computer science provided a new set of conceptual tools. These constructs enabled researchers to begin characterizing imagery, mental processes, and representations rigorously. The theories that relied on such conceptual tools were sufficiently well defined that they could be mapped to the brain and lead to testable predictions.

Despite such progress, our understanding of visual mental imagery is still in the early stages and there are many unanswered questions. Some of the explanations put forward to account for potential contradictions in the literature will need to be addressed empirically in a direct manner, ideally by using hypotheses generated by neurally inspired computational theories. Given the great progress made in the last two decades, we are optimistic that future work using the tools of cognitive neuroscience and cognitive science will resolve many of the currently open issues in the field.

See also: Attention; Creative and Imaginative Thinking; Memory; Neuroexecutive Function; Neurotechnologies; Spatial Perception; Visual Perception.

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Military Psychology

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Glossary

Human factors engineering Also known as applied experimental psychology or engineering psychology, human factors engineering is the systematic study of the role of human capabilities and limitations and their influence on the performance of engineered systems, such as high performance aircraft or military command and control centers.

Naturalistic decision making The ability of experts to make rapid and accurate decisions by employing intuitive and often unconscious cognitive processing.

Posttraumatic growth The experience of personal growth following a traumatic experience; increases in courage, capacity for love, or other positive traits following a potentially life or well-being threatening experience.

Posttraumatic stress disorder A maladaptive response to a highly stressful event or sustained period of stress exposure, characterized by reliving the event, impaired social behavior, and exaggerated autonomic nervous system reactivity.

Psychological resilience Ability to recover from stress and adversity, to remain strong when things are tough; buoyancy.

Situational awareness The ability of a person to perceive key elements of a complex situation, understand what these elements mean, and make accurate projections about what is likely to occur in the near future. Thought to be a critical component of tactical decision making.

History

The psychologist Herman Ebbinghaus once remarked “psychology has a long past, but only a short history.” Although Ebbinghaus did not have military psychology in mind when he said this, he well could have. Even a casual reading of ancient texts such as Homer’s *Iliad* and the *Odyssey* or Sun Tzu’s *The Art of War* reflects the critical importance of understanding human nature in planning, executing, and recovering from war. Psychology emerged as a formal discipline distinct from philosophy and biology in the late nineteenth century. By the twentieth century, military psychology emerged as a formal subdiscipline. Based on suggestions from noted psychologists including E. G. Boring, Ernest Hilgard, and Carl Rogers, the American Psychological Association (APA) reorganized in 1945 and included the Division of Military Psychology (Division 19) among its first group of formal subdivisions. In 2003, Division 19 changed its name to the ‘Society for Military Psychology’ to reflect its growing international composition. Today, the membership of Division 19 represents a cross-section of both the profession and science of psychology, counting among its ranks clinical, experimental, industrial–organizational, social, and engineering psychologists. Moreover, uniformed and civilian psychologists serve the military in virtually all nations. In short, military psychologists are united by their object of focus – the military – and not by traditional lines of disciplinary nuance, and the discipline of military psychology is international in scope.

War has historically driven advances in science. Noted military historian Robert H. Scales argues that every major war since 1900 has been associated with dramatic development in different scientific disciplines. World War I was critically influenced by chemistry. Physics dominated World War II. The Cold War was associated with rapid developments in information technology. The Global War on Terror may

ultimately rely on psychology and related behavioral and social sciences, insofar as ‘winning hearts and minds’ relies more fundamentally on knowledge and understanding of human behavior and culture, compared to traditional wars that were dependent on the successful application of kinetic energy to achieve victory.

Taking a closer look at the role of psychology in warfare, one can trace the field of psychological testing directly to World War I. Previous wars did not require much from soldiers in terms of aptitude or special skills. In contrast, weapons employed in World War I were increasingly sophisticated and required soldiers to be able to read and write in order to learn how to operate weapons systems and other equipment. For example, aircraft were first deployed in battle in World War I, and military trainers quickly learned that aviators required high intelligence in order to successfully fly and navigate the airplane and to operate weapons systems while doing so. This gave the impetus to develop, in the United States, rapid and efficient ways of classifying soldiers, and it led to the Army Alpha Examination. Over 2 millions soldiers were screened with this test before the close of the war.

World War II saw the continued development of increasingly sophisticated aptitude tests. The General Classification Test (GCT) was based on a subset of four of Thurstone’s primary mental abilities and was used to place recruits into four general classifications related to aptitude to learn. By 1960, the GCT had evolved into the Armed Forces Vocational Aptitude Battery (ASVAB), which is still in use. Besides psychological testing, World War II is credited with giving rise to applied experimental psychology, especially what has come to be known as human factors engineering or engineering psychology. In World War II, aviation, in particular, began to test the limits of human performance. Aircraft were faster, maneuvered more quickly, had increasingly sophisticated weapons and communications systems onboard, and the complexity of the cockpit

increased exponentially. Psychologists were needed to aid engineers in designing aviation and other complex military systems in such a way as to maximize the user's ability to optimally operate the system.

One can also look to war and its influence on clinical psychology. Concepts of battle fatigue, combat stress, and posttraumatic stress disorder (PTSD) grew directly from observations of the effects of combat stress on soldier adaptation. Formally labeled as a psychopathology by the American Psychiatric Association following the Vietnam War, PTSD continues to receive considerable attention amidst the conflicts of the twenty-first century. Research into the causes of PTSD and other combat-related stress reactions has significantly increased psychology's understanding of stress in general, and informed modern methods of treatment including both pharmacological and psychological based therapies.

The conflux of large numbers of people united in a common mission, highly stressful operating conditions, and increasingly complicated technological systems continue to have a major influence on the general science and profession of psychology. However, military psychology in its present form cannot be understood or appreciated without consideration of both its past and its history.

Industrial–Organizational Psychology

The US military selects hundreds of thousands of enlisted members and officers for service each year. Military members serve in hundreds of occupational specialties and conduct a variety of missions around the globe. With its daunting human resource management needs, the military relies heavily on industrial–organizational (I–O) psychology for efficient and effective recruitment, selection, training, performance assessment, and organizational development.

Since World War I, I–O psychologists have advanced cognitive ability testing to meet professional, practical, ethical, and legal standards and considerations. The ASVAB is administered to all applicants for enlistment. The ASVAB comprises ten subtests (work knowledge, paragraph comprehension, arithmetic reasoning, mathematics knowledge, general science, electronics information, auto information, shop information, mechanical comprehension, and assembling objects) with various reliable and valid combinations used for determining enlistment eligibility and job assignment. In addition to a paper-and-pencil version, a computerized adaptive testing (CAT) version is also available.

Because the overwhelming majority of military members are enlisted personnel (rather than officers) who enter service as labor force novices, there is a well placed emphasis on enlistment screening using cognitive ability measures. However, testing and selection efforts are extended to special applications such as more 'select' populations of officers and for subgroups of military personnel assigned to critical roles (e.g., special operations forces, pilots, recruiters, etc.). In addition to general cognitive ability measures, spatial, psychomotor, and perceptual aptitudes are tapped as are personality or temperament, interests, and attitudes.

Of course, in addition to developing reliable and valid predictors, I–O psychology has also tackled the criterion

domain. Based on job analysis, performance measures including hands-on tests, rating scales, and paper-and-pencil job-knowledge tests have developed and revised through the years. By understanding the so-called criterion space, I–O psychology has furthered the appropriate matching of predictors and criteria. For example, cognitive aptitudes are excellent predictors of general and core technical proficiency, whereas non-cognitive measures (e.g., temperament and biodata) predict performance dimensions involving effort, discipline, and leadership.

Between selection and performance comes training. The US military has been heralded as the world's largest training and education institution. From basic military skills indoctrination and inculcating technical skills, through high fidelity simulation, training is a comprehensive and critical enterprise for the military. Based on task analysis and sound learning principles and techniques, psychologists have contributed to training effectiveness and skill mastery. Training progressed from classroom lecture to computer-aided instruction, then on to computer-based training and intelligent tutors, and beyond. The military has been a pioneer in distance learning and realistic training. In addition to training technical skills such as marksmanship and equipment operation and repair, military personnel are trained in such soft skills as leadership and decision making; and they are trained to operate as a crew or team. Military training research and application not just encompasses content and delivery platform but aims to enhance motivation to learn because of its relationship to knowledge acquisition and training transfer and hence training effectiveness or outcomes.

The above discussion has highlighted the *Industrial* or 'I' side of I–O psychology with its overlap with experimental psychology and psychometrics. However, the *Organizational* or 'O' side of I–O psychology is also important to the military. The attitudes of youth and their influencers toward the military provide invaluable information for military recruitment efforts. Job satisfaction and other work related attitudes, motivation, individual performance, and retention are affected by organizational and leadership dimensions. The 'O' side of I–O psychology has its origins within social psychology, which is discussed as it pertains to the military within the section below.

Social Psychology

Military members are organized into teams and units of varying size; therefore, social structure is vital to the military context. Thus, group identification and processes such as socialization, unit cohesion, morale, and esprit de corps are important to military effectiveness. Effective leadership, in turn, is critical to group processes and functioning. Since World War II and the four-volume *American Soldier* series, social psychology has proven its value to understanding and shaping the military.

Upon entry into the military, members begin forming a group identity. In addition to customs and rituals, newcomers learn and are encouraged to adopt the core values of their particular service. The US Army espouses seven such values – loyalty, duty, respect, selfless service, honesty, integrity, and personal courage – that intentionally form the acronym

'LDRSHIP.' Social psychology considers such elusive constructs as climate, culture, cohesion, and commitment and relates them to work attitudes and performance. For example, organizational commitment, which comprises affective, continuance, and normative components (or wanting to, needing to, and moral obligations to be part of the organization) are linked to employee behaviors such as performance and retention. Further, commitment can be influenced by organizational support and leadership processes.

Morale, the emotional bond that holds the group together and is a function of cohesion and esprit de corps has been recognized as critical for combat effectiveness since World War II. More recently, to inspire cohesion across military functional branches, a warrior ethos has been identified and championed to unite members across occupational divides.

The principles of social psychology have also been invoked to smooth misunderstandings and tensions among diverse personnel subgroups based upon minority status, gender, and sexual orientation. Harassment and discrimination are not common but are quite disruptive to military readiness. Social psychology has been at the forefront of race relations and gender integration in the military. Today and in the future, the military does and will struggle with the inclusion and acceptance of members from diverse race, ethnic, gender, religious, cultural, and sexual orientation backgrounds.

In addition to military structure, function, and culture, military families represent another social construction that is critical to military effectiveness. Traditionally, the military comprised predominately single men who served for short terms. Today, however, military members have families and are expected to make the military a career. Family issues and the challenges of separation and mobility are important considerations for morale and retention. Spouse employment and children's transitions and disruption are issues that affect morale, retention, and effectiveness. Since the advent of the All Volunteer Force in 1973, there exists a social contract between members and the military. Quality of service and quality of life are critical for recruiting, performance, and retention, as well as overall military readiness and well-being.

Applied Experimental Psychology

Advances in the technology and practice of war continue to tax human capabilities. High performance aircraft, modern ground vehicles, and highly complicated command and control systems challenge the operator's ability to react in time to threats, withstand g-forces, and process volumes of critical information quickly enough to enable accurate and timely decision making. Basic experimental psychology, with its emphasis on carefully controlled experiments in artificial laboratory environments, proved inadequate to inform engineers and developers on how to design systems that people could safely and effectively operate. These considerations were instrumental in the rise of applied experimental psychology during and in the years immediately following World War II. Also known as human factors engineering, ergonomics, and engineering psychology, this area of study includes topics of sensation and perception, cognition, decision making, design of displays and controls, biomechanics and physiology, stress

and workload, automation and human-computer interaction, selection and training, and social factors. More importantly, it focuses on how these factors interact with engineered systems (aircraft, vehicles, weapons, etc.) to maximize soldier performance.

Cognition and Decision Making

Applied cognition is a major area of interest within military applied experimental psychology. Modern weapons and communication platforms are exceedingly sophisticated and can provide masses of data to the operator. In turn, the operator must perceive and understand this information in order to make timely and effective decisions. The construct of situational awareness (SA) represents a major area of research and development in understanding battlefield cognition. The most widely accepted SA model was developed by Mica Endsley. This model maintains that there are three levels of SA and each builds toward an individual's ability to make timely and accurate decisions in a challenging setting. Level I SA is perception, or the ability to accurately sense key elements of a given situation. For example, an infantry soldier may enter a village and notice debris in an unusual place. Level II SA refers to comprehension, or the ability to infer meaning from what is perceived. The infantry soldier may infer that debris could be set up to slow vehicles or force them to take another route. The highest level of SA, Level III, involves making accurate predictions about what may happen in the near future. In the case of the infantry soldier, he may infer that an ambush is likely to occur if vehicles are diverted from their planned route and into a route where the enemy has prepared an assault. The three levels of SA are viewed as necessary components of consistently effective decision making. Considerable research exists linking SA to improved decision making in a variety of military situations, for both individuals and teams.

Another area of cognition of importance to the military is the role of intuition in tactical decision making. Many times, military personnel involved in tactical situations such as fire-fights do not have sufficient time to invoke deliberate, controlled processing in reacting to the situation. This is also true in other domains, such as fire and police service, where operators are apt to lose control of the situation, that is, let the fire get out of control or let the criminal escape if they stop to critically evaluate all potential options for action. The concept of naturalistic decision making (NDM) has emerged to explain how people come to make effective decisions in such circumstances. According to this model, with time and exposure to many different tactical scenarios (in training and on the job), people develop a complex and diverse set of scripts that may be rapidly invoked when encountering similar situations. Thus, an expert infantry soldier may respond to an attack on his convoy by pattern matching a script to the nuances of the present attack. This can occur rapidly and without apparent tapping of conscious decision making processes. After such an action, soldiers may report that they 'acted on instinct' and may have difficulty articulating why they responded as they did in that particular situation. According to the NDM approach, therefore, decision making based on the automatic processes can be quite effective. Interestingly, the NDM approach conflicts with a separate body of literature of heuristics and

cognitive biases, which suggest that such intuitive responses are often in error. However, the two approaches may be more complementary than not.

Sensation and Perception

Applied experimental military psychologists investigate how vision, audition, touch, and the vestibular system respond under the conditions encountered by military personnel, including sleep deprivation, extreme heat or cold, high altitude, strong g-forces, and other stressful environments. For example, how many hours may a soldier go without sleep before vigilance is adversely impacted? Or how do g-forces affect visual perception? Sound localization and speech perception are of vital concern to the military. Recently, military psychologists have begun investigating ways of using the sense of touch to communicate in conditions where vision and audition are severely limited. Signal detection theory is a key construct in this area of military psychology. This approach, which focuses on the ability of an operator to correctly detect a target stimulus under distracting conditions, has wide applicability across a host of practical situations. Will the operator of a radar system correctly identify a target as friend or foe, and will the operator then make the correct decision to engage or not? Both intrapersonal and technological factors that improve the ability to make correct decisions are vital to the success of modern military operations.

Controls and Displays

Broadly speaking, human factors engineering investigates the role of the human operator in a larger system. The complexity of modern military systems requires them to be congruent with human capabilities and constraints. Controls and displays must be easy to read and operate. A modern military tactical operations center may contain dozens of computers and displays, collectively making available thousands of bits of information to the commander and his or her staff. Information must be filtered so that only the most critical and time-sensitive pieces of information are presented to the commander. Controls should be optimally positioned and adhere to well-established principles of ergonomic design. In short, military workspace must be designed with the human operator in mind. A weapons system that is too complex or unresponsive to work is of little value on the modern battlefield.

Stress and Workload

The military operates under conditions unthinkable to civilians. Task and environmental stressors combine with the potential of loss of life or serious bodily injury to play a major role in human performance under the challenging conditions of combat. Infantry soldiers may carry well over 100 pounds of equipment into battle. They may perform in nearly continuous operations for several days at a time with little or no sleep. Military psychologists study psychological and physiological reactions to such stress in order to develop training programs and operational procedures to allow the soldier to maximize performance under the most trying circumstances. Toward this end, they study the effects of fatigue and sleep

deprivation, work overload and under load, life stress, and environmental and a host of other stressors on soldier performance.

Human-Computer Interaction and Automation

Many complex military tasks are now executed by computers. Naval aviators do not assume control of their aircraft, for example, until it has departed from the deck of the aircraft carrier. Semiautonomous and even fully autonomous weapons systems are under development. What are the effects of decreasing the human's role in operating such systems? A growing body of research on factors that affect how humans interact with automated systems exists. Topics include the reliability of the automation, trust and mistrust, workload, and training. Does the operator of a remotely controlled aerial vehicle, stationed half way around the world from the theater of operations, derive the same degree of pride and satisfaction in performing missions that a traditional fighter pilot would? How does one train differently for operating such systems versus operating traditionally piloted aircraft? Work must be optimally distributed between the automated system and the human. Too much responsibility for the automated system and the human may disengage. Too much responsibility for the human, and their performance may degrade.

Summary

Soldiers do not fight in the laboratory. Traditional, laboratory-based experimental psychology yields findings high in internal validity but low in external validity. Military psychologists must carefully weigh the tradeoff between the two, but they are ultimately more concerned with how experimental manipulations play out in the real world. For this reason, military psychologists tend to be at the cutting edge of methods and procedures relevant to understanding human behavior in its natural context.

Clinical/Counseling Psychology

Given the psychological demands of military life and missions, mental health professionals are essential personnel. Across the world, thousands of psychologists in uniform prepare, support, and care for military members and their families through the stresses and strains of combat, peacekeeping, and humanitarian operations. Licensed clinical and counseling psychologists serve within the military mental health system as commissioned officers in all branches of military service. They are called on to assist service members and their families with regard to life skills such as anger management, conflict resolution, coping with loss and grief, substance abuse, parenting, parent/child communication, relationship issues, and marriage enrichment. Such counseling support is not unique to the military; however, the military lifestyle is associated with unique demands. Military mental health professionals are familiar with the military lifestyle and are prepared to support soldiers, sailors, marines, and airmen through deployment, combat, reintegration, relocation, and separation. They serve in military hospitals and clinics in the United States and

overseas as well as aboard aircraft carriers, in special operations units, and in combat theaters.

In addition to routine mental health screening prior to service entry, military personnel are screened prior to deployment and upon return so as to identify those 'at risk' for further evaluation. Although the severely mentally ill (e.g., those with a diagnosis of psychosis or other debilitating psychiatric condition) are ineligible for service, deployment can take its toll on mental health on even well-adjusted people. Sleep disturbances, depression, suicidal and homicidal ideation, and PTSD are among the problems that require detection, if not prevention, monitoring, and treatment. And, with better body armor and other protective equipment, many more soldiers survive wounds that would have killed those fighting in earlier wars. This creates additional challenges for clinicians who specialize in neuropsychology, and cognitive and physical rehabilitation.

Given the challenges and stress associated with military service, proactive mental health training is common practice. Such psychoeducation serves to mitigate problems and promotes good mental health. Resilience and stress inoculation training help prepare military members for the psychological demands of combat and aim to sustain the well-being of deployed service members. Military members receive training in relaxation, deep breathing, progressive muscle relaxation, and guided imagery. Service members are trained to identify their own signs of stress as well as stress among their peers and subordinates. Training is also aimed at reducing the perceived stigma of mental health disorders and treatment. Routine mental health screening and individual and group based training and early intervention are the key for the high risk military population, with access to weapons, who tend not to seek or follow through with care.

Typically, clinical and counseling psychologists work within the military's medical community and offer such therapeutic services as behavioral therapy, psychotherapy, and even medication. However, clinical psychologists also more directly support commanders who lead combat and other operations including survival, evasion, resistance, and escape (SERE) and psychological operations (PsyOps). Clinical psychologists are also providing interrogation and detention support with special attention to human dignity and rights. The umbrella term for this mission-oriented subdiscipline is 'operational psychology.'

Military psychologists in clinical and operational roles face unique ethical challenges. As military officers and licensed psychologists, clinicians have dual responsibilities – to the unit and to the soldier-patient – that occasionally conflict. Among the issues that clinicians grapple with is whether to return a service member with a mental health problem to combat. Furthermore, maintaining clear and professional boundaries and ensuring confidentiality and informed consent are more challenging in the military than in civilian life. Likewise, the widely publicized abuses of Iraqi prisoners of war at Abu Ghraib question the ethical limits of the role of military psychologists in interrogations.

Given the stressors from combat, peacekeeping operations, high operational tempo, and the home front, a focus on mental health is imperative. Clinical and counseling psychology offer an invaluable discipline to address the diagnosis, treatment, research, training, and operational support needs of the

military across the spectrum of missions and environments to enhance mental fitness in deployment and garrison environments alike.

Recent Developments

Just as the two World Wars of the twentieth century fueled the development of psychology both as a profession and as a science, the Global War on Terror continues to energize contemporary developments in the discipline. This should come as no surprise, for, as discussed earlier, war pushes people to their limits. And as the nature of warfare evolves, so does the psychological science that supports the understanding of soldier adaptation and performance.

For example, social psychologists are developing a science of mortality salience that seeks to understand the impact that the realization of one's own mortality has on a variety of outcomes. Because soldiers routinely operate in settings where death and severe injury – including their own – is likely, then knowing how this awareness affects behavior is critical. Many interesting findings have emerged from this line of research. Activating an awareness of one's own mortality through experimental manipulations is associated with several outcomes. When this awareness is induced, for example, people may become more willing to engage in life-threatening behaviors. While this would likely be dysfunctional in civilian society, on the battlefield, this could encourage soldiers to engage the enemy. Other studies show that increased mortality salience may, in some persons, increase their motivation to volunteer for military service. Religious people may become more intensely so under the threat of death. People with good self-regulation skills respond with fewer death-related thoughts following mortality salience activation. There even is evidence that following mortality salience activation, people may experience short increases in physical strength.

Military psychologists are also now developing methods and procedures to systematically study leadership in situations where lives are on the line. Thomas Kolditz defines *in extremis* leadership as "giving purpose, motivation, and direction when there is eminent physical danger, and where followers believe that leader behavior will influence their physical well-being or survival." Findings suggest that effective *in extremis* leaders do not react to danger with normal distress reactions. Studies of special weapons and tactics teams, mountain climbing guides, leaders of jungle expeditions, parachute teams, and combat leaders suggest they share seven characteristics: inherent motivation for the task or mission, a learning orientation, a sense of shared risk, a common lifestyle with followers, competence, the ability to develop trust from their followers, and loyalty to the organization. Knowing how to select, train, and develop effective *in extremis* leaders may pay dividends not only in mission performance but also in the improvement of the adaptability of their followers.

The widely reported increases in maladaptive reactions to combat exposure such as PTSD and suicide are driving innovations in screening, treatment, and prevention of these disorders. Mental health research, consulting, and practice are being conducted in real time and in vivo, and broad support is being offered throughout the deployment cycle. The advances in

routine screening and training, and also peer, leader, and organizational support are working to reduce the stigma of seeking mental health care and continuing the same.

At the same time, the challenges of combat has increased interest among psychologists in understanding what factors and processes allow some – in fact most – soldiers to actually grow from their experience. The emerging field of positive psychology provides a theoretical framework to examine this phenomenon. Positive psychology focuses on positive states, positive traits, positive institutions, and positive social relations. It is interested in what allows people to flourish, even in the face of substantial challenges. For example, the concept of posttraumatic growth (PTG) refers to positive consequences of having survived a traumatic event. Recent research suggests that PTG is a more common sequel to combat trauma than PTSD, yet, surprisingly, it garners just a fraction of the attention. Other research suggests that personal character strengths such as courage, persistence, teamwork, honesty, self-regulation, and the capacity to love are linked to successful performance and adaptation among soldiers.

Based on positive psychology principles, the US Army is adopting a program called Comprehensive Soldier Fitness (CSF). Under the CSF program, a diagnostic metric was developed to assess soldier resilience in five domains – physical, emotional, social, family, and spiritual. Moreover, a variety of evidence-based interventions are being developed to provide soldiers with the tools needed to improve themselves if they are weak in a given area. Just as a soldier may seek help from a strength coach to improve performance in pushups or sit-ups, these interventions allow soldiers to build resilience in other domains. For example, the Penn Resiliency Program, a 12-lesson program originally designed to improve emotional resilience in children, has been adapted for use among soldiers. Outcome studies suggest the intervention has effects that last up to 2 years. A major desired outcome of the CSF is to encourage soldiers to utilize psychological services with a view of strengthening resilience or fitness, versus to ‘treat’ pathology. This approach could have significant implications in healthcare beyond the military, if successful.

Cultural psychology and related disciplines are also seeing innovations as a result of the Global War on Terror. In addition to war fighting, military members are increasingly asked to engage in other missions (e.g., nation building, security and stability operations) that require cultural expertise and political savvy. Such missions require social, emotional, and cultural competencies – or relationship skills that traditionally have not been the core areas of concentration in military education, training, or development. As language and cultural education and training are stepped up, civilian social scientists, including psychologists, are lending their expertise to military efforts at home and alongside deployed combat teams. For example, the Human Terrain System embeds teams of social scientists with brigades in Iraq and Afghanistan to coach the military commanders and units on patrol with regard to interaction, negotiation, and communication.

Advances in digital technology and related technical disciplines are also reflected in state-of-the-art military psychology. Breakthroughs in nanotechnology will soon lead to chameleon-like camouflage for both uniforms and systems. This development is motivating new research into the human visual

system as well as technologies that may be designed to defeat such camouflage. Microcomputers can now be mounted on individual soldiers, giving them far better command and control information than is commonly available in vehicles or housed in tactical operations centers just a few years ago. Today, a soldier on the battlefield can communicate instantly across echelons within the theater of operations, as well as around the world. This raises a plethora of questions about how soldiers, their superiors, and political leaders can handle such real-time and high-volume information.

These developments have social implications. For many years, it was accepted as a fact that soldiers who could directly hear or touch each other would fight more bravely and persevere better in combat than those who were socially isolated. Hence, soldiers were grouped into battle buddies, fire teams, squads, platoons, etc. This social organization was necessary to channel information in a hierarchical organization, but also ensured that soldiers maintained close proximity with each other. But the digitally equipped modern platoon (30–35 soldiers) has the communications ability and firepower to occupy the territory that an infantry battalion (500–600 soldiers) did in World War II. Now, soldiers communicate by radio or digital texting. Work is underway to better understand how this may affect morale. Moreover, the hierarchical system of command and control that evolved through the millennia may be obsolete with the advent of these technologies.

Conclusion

To tell someone that you are a military psychologist conveys little about what specialty of psychology you ascribe to. Clinical, social, industrial-organizational, and experimental psychologists all contribute to the field of military psychology. Indeed, the development of psychology as a general discipline was and continues to be closely linked to the special demands brought on by the evolution of warfare. Just as the race to place humans on the moon led to a plethora of scientific and technical discoveries with applications across society, warfare might necessitate paradigm shifts in how psychologists conceive of human nature. Perhaps it is a sobering comment on the human species, but without warfare, many innovations in science – including psychology – would never have occurred.

See also: [Human Factors/Ergonomics; Posttraumatic Stress Disorder.](#)

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The Mind–Body Problem

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Glossary

Behaviorism The notion that behavior can be completely described and understood solely in terms of objectively observable phenomena, without any need to consider internal, subjective experiences.

Dualism The notion that two irreducibly distinct domains of discourse and analysis, the physical and the mental, are needed to completely describe reality.

Explanatory gap The difficulty in making a coherent connection between external, objective phenomena and internal, subjective experience.

Identity theory The notion that mental phenomena are in some way identical to physical states of brain physiology.

Mentalism The notion that only mental experience is irreducibly real and all else (including the physical world) is derivable in some way from mental experience.

Panpsychism The notion that some kind of subjectivity, mentality, or consciousness permeates the universe and is an intrinsic property of all phenomena.

Physicalism The notion that only physical phenomena are irreducibly real and mental phenomena must be accounted for entirely in terms of the physically described properties of matter, energy, etc.

Physical An aspect of reality describable in terms of mathematical properties ascribed to coordinates in space–time: mass, energy, trajectories, forces, field strengths, etc.

What Is the Problem?

All that we know comes to us by way of our mental experience – our thoughts, feelings, and perceptions. We will call this collection of internal, subjective mental experiences ‘mind.’ The term ‘consciousness’ is also used in this context. By consciousness we here mean the capacity to be aware – aware of mental processes such as thoughts, feelings, perceptions (visual, auditory, olfactory, gustatory, tactile), mental images, and one’s sense of self. To have consciousness (by this definition) is to have some kind of awareness of what it is like to ‘be’ a particular person, or an animal, or an organism, or (who is to say at this point?) a thing. We can consider these characterizations of mind and consciousness to be working definitions for the purposes of engaging in scientific dialogue.

Much discussion can go into defining the words ‘mind’ and ‘consciousness,’ and misunderstandings sometimes occur because people are using the words in different ways. By the definition used here, one would be conscious during wakefulness, lose consciousness upon falling asleep, and regain consciousness upon waking. The recall of dreams would indicate the presence of some level of awareness or consciousness. Lucid dreaming occurs when there is a kind of full awareness while dreaming, even though the person is asleep. General anesthesia, as used for surgery, would produce loss of consciousness. Coma would presumably be associated with the absence of consciousness. In all these conditions, there are variations in the level or the quality of awareness.

One also hears about unconscious mental processes. By this we mean processes that take place out of awareness, but that have the capacity to enter awareness under suitable conditions. Otherwise, by our definition, such processes would not be mental, but would be physiological processes that could never have a subjective quality. Thus, there may be mental processes happening during sleep that are generally unconscious; dreams would often fit into this category. When a

dream is remembered upon awakening, or when lucid dreaming takes place, there is consciousness of the dream. Clearly, our operational definitions of mind and consciousness are very closely related, since to be part of ‘mind’ by this definition, there must be either awareness or the possibility of awareness. As a result, one often finds the two terms used interchangeably. This may be fine most of the time, except that confusion can arise in discussing unconscious mental processes, such as non-lucid, nonremembered dreams, and repressed memories. The key feature in all these phenomena is that consciousness and mental processes are irreducibly subjective, first-person experiences.

It is sometimes said that studying the mind is beyond the scope and methods of science, that subjective phenomena are not suitable for scientific study. Is this so? The origin of the word ‘science’ is knowledge, to know. It has come to mean the collection and organization of knowledge about the world (nature, the universe) that leads to some sort of ‘explanatory understanding.’ The method of science is fundamentally to collect data through observation and experiment. This is guided by the formulation of questions and hypotheses, and further deepened by theoretical frameworks of ‘explanation’ and ‘understanding’ that endeavor to connect observations together in ever richer networks. Based on these established criteria for science and the scientific method, there is no reason why the investigation of mental experience cannot fall under this rubric. As will be discussed later in this article, this may be facilitated by methods for carefully observing subjective phenomena.

A vast amount of empirical data, accumulated especially over the last two centuries, suggests that our mental processes (our mind) and our awareness (our consciousness) are intimately related to the material substance of our body and in particular of our brain. The great pioneer of the contemporary science of mind, William James (1842–1910), stated it clearly in his 1890 book *The Principles of Psychology*:

If the nervous communication be cut off between the brain and other parts, the experiences of those other parts are non-existent for the mind. The eye is blind, the ear deaf, the hand insensible and motionless. And conversely, if the brain be injured, consciousness is abolished or altered, even although every other organ in the body be ready to play its normal part.

Thus, damage to the brain is associated with specific changes in mental functioning. In addition, certain chemical substances (psychoactive drugs such as stimulants, sedatives, psychedelics, and so forth) that enter the brain are associated with specific effects on mental processes. And the neural activity of the brain – as measured by imaging technologies such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET) – is correlated in specific ways with perceptions, emotions, and other mental processes.

That there is an intimate relationship between mind and body is unquestioned. However, just how this relationship is manifest – how it is that the physical processes taking place among the ions, molecules, and cells of the brain and body are related to the subjective experiences of the mind – is a deep mystery. This is the so-called mind–body problem and some say it constitutes the greatest question in contemporary science.

The Mind–Body Problem in the Context of Western Science

To better understand why it is sometimes said that the study of the mind is outside the scope of science, it is instructive to look at the historical trajectory of modern science, at least as it developed in Europe, beginning around the time of Copernicus. The publication of *On the Revolutions of the Heavenly Spheres* by Nicolaus Copernicus (1473–1543) in 1543, the astronomical observations of Johannes Kepler (1571–1630), the observations and writing of Galileo (1564–1642), culminating in the publication of his *Dialogue Concerning the Two Chief World Systems* in 1632, and, finally, the development by Isaac Newton (1643–1727) of a comprehensive description of motion that applied equally to celestial and terrestrial phenomena, published in his *Mathematical Principles of Natural Philosophy* in 1687 provided a powerful framework of organization for a multitude of observations. Concepts of space, time, matter, and energy were central to this description and, together with mathematical equations describing dynamical interactions, a system of stunning explanatory power was in place. In the nineteenth century, James Clerk Maxwell (1831–1879), building upon the work of Michael Faraday (1791–1867) and André-Marie Ampère (1775–1836), developed an elegant mathematical description of electricity and magnetism in terms of electromagnetic fields, further expanding the explanatory and predictive power of physical science. And, at the beginning of the twentieth century, Albert Einstein (1879–1955) again expanded the explanatory framework by formulating the special and general theories of relativity and describing matter, energy, and gravitation with awesome beauty and predictive power. This mathematical framework of physical science, as developed from Galileo to Einstein, is often referred to as ‘classical physics.’

It was found in the early years of the twentieth century that classical physics failed when its dynamical equations were applied to describing the behavior of atoms. To deal with the observed properties of photons, electrons, atoms, and molecules, it was necessary to develop an entirely new physical theory with new physical concepts and new dynamical equations: quantum mechanics. A large number of physicists at the beginning of the twentieth century made substantial contributions to this truly revolutionary undertaking: Max Planck, Albert Einstein, Niels Bohr, Louis de Broglie, Werner Heisenberg, Erwin Schrödinger, Wolfgang Pauli, Max Born, and Paul Dirac among them. Nearly a hundred years later, quantum mechanics continues to provide a profoundly successful description of the measurable properties of matter. Like classical physics, quantum physics is built upon an elegant mathematical framework. Indeed, the search for aesthetically elegant mathematical formalism has been a driving force in the development of physical theories of nature, from Newton to Maxwell to Einstein to quantum mechanics to contemporary attempts to extend physical theory into new domains via multidimensional string theories.

Quantum mechanics also profoundly changed the ontological status of physical theory. In classical physics, the objects of analysis and the properties of physical systems are conceived as having an existence independent of observation. The properties of matter and energy are inherent qualities of the universe that can be fathomed by our observations, but are not in any way dependent upon observations. In quantum physics, interaction is crucial to defining the properties of a system, and the interaction we humans have as observers plays a new and critical role that was unanticipated in classical physics. Because of its possible relevance to the mind–body problem, we will return to a discussion of quantum physics later in this article.

Concepts from the physical sciences (here, physics and chemistry) provide the foundation for the biological sciences. Living organisms are understood as particular configurations of molecular components, having specific properties of stability, information storage, energy generation, and replication. From atomic and molecular chemistry to biological macromolecules to cell physiology to organisms, the framework of physical science as pioneered by Newton provides an elegant organizational explanatory structure. To this is added the conceptual framework for understanding the diversity of living organisms, as articulated by Charles Darwin (1809–1882) in *On the Origin of Species* in 1859. Today, it is understood how Darwin’s ideas operate even at the level of the molecular components of living cells. Extending the framework of the physical and biological sciences to nervous systems, the human brain, and human behavior, the field of neuroscience now presents as a system of great explanatory potential.

All of this is about observation and description of what is understood as an objective external physical reality. We humans, together with our brains, are understood as having evolved within this physical reality. Mind, mental experience, consciousness, and subjectivity are left out. It is accepted that somehow, at this point in our evolutionary history, we have developed a capacity that allows us to be privy to observing and deeply analyzing our own place in the world. However, this conscious mental experience seems not to be explicable in

any coherent way in terms of physical processes. This disconnection between subjective, mental experience and the observations and explanatory scenarios of physical science has been around at least since the time of Galileo.

Early on, René Descartes (1596–1650) struggled with this disconnect and came to the conclusion that mental experience and the physical world may not be explicable one in terms of the other, or unifiable in any way, and that two irreducibly distinct domains of reality would be necessary. Descartes called the two domains *res cogitans* and *res extensa* and speculated that they would interact with one another within the human body, for example. This reasonable stab at making sense of subjectivity has been termed dualism, referring to the dual domains of the mental and the physical. Indeed, classical physics, as developed following Descartes by Newton and others, is built on this foundation, focusing on the physical and, from the very beginning, excluding the mental. It is a kind of external, outsider perspective on nature, one that has sometimes been called a ‘god’s-eye’ view of the universe or a ‘view from nowhere.’

Such an exclusion of the mental from the scope of the explanatory framework of science could be seen as unsatisfactory, for why should we not ask that our science provide a unified understanding of our entire world, one that includes both objective physical reality and subjective mental phenomena? How to accomplish this is a central aspect of the mind–body problem. It may be that because mentality has been excluded from our physical science from the beginning, attempting to make sense of subjectivity within this framework has seemed difficult. Indeed, this explanatory gap between the mental and the physical has been called the ‘hard problem’ of consciousness research.

Attempts to Bridge the Gap

Cartesian dualism is one approach to bridging the explanatory gap by defining the gap to be primary and insurmountable, thus positing two separate domains of reality. Dualism sets a metaphysical frame within which the phenomena of our observations are organized. Another framework is to attempt to reduce physical phenomena to mental experience in some way. This has been termed mentalism or idealism. Here, only mental experience is irreducibly real and matter must be explained in terms of mind. Within Western philosophy, one of the foremost exponents of this perspective was George Berkeley (1685–1753), who wrote that ‘esse is percipi’ (to exist is to be perceived), arguing that it is perception that is irreducibly real, and objective physical reality is some kind of an abstraction from this. Certainly there are components of truth here, since it is the case, as stated at the beginning of this chapter, that everything we are able to know does come to us by way of our mind and consciousness. Thus, in a fundamental way, all there is for us is mental experience, and one might imagine a science of mind based upon a deep analysis of mental experience. The philosophical tradition of phenomenology, as developed in the twentieth century by Edmund Husserl, Martin Heidegger, Maurice Merleau-Ponty, and others, stresses the importance of first-person experience in addressing the nature of the mind.

Contemporary Western science, however, takes as its underlying metaphysical framework that of physicalism, sometimes called physical materialism. In physicalism, only the physical is irreducibly real and mental phenomena, including consciousness, must ultimately be understood completely in terms of physical processes. Here, by physical, we mean describable in terms of mathematical properties ascribed to coordinates in space and time: mass, energy, trajectories, forces, field strengths, and the like. Physical phenomena are what are described by the dynamic equations of classical and quantum physics.

There exist various approaches to describing the mind within physicalism, each of which has been articulated and critiqued extensively by numerous philosophers over the years. There is ‘behaviorism,’ which posits that whatever mental experience is, it can be completely represented by observable behaviors, making any reference to mentality unnecessary. Behaviorism dominated the experimental study of human psychology, at least in the United States, for a good part of the twentieth century. There is ‘identity theory’ and there is ‘functionalism,’ which hold that mental states are somehow identical to physical states of brain physiology or functional activity. There are various notions of ‘emergent properties,’ sometimes described by terms such as ‘higher-order interpretation’ and ‘supervenience.’ However, in none of these cases have scenarios been articulated that even begin to describe how it is that subjective mental experiences are identical to or emerge from physical properties of the brain. It is simply assumed that this will come in time, with more and more research into the structure and function of the brain. Philosopher Karl Popper (1902–1994) has referred to this notion as ‘promissory materialism.’

Confidence in the physicalist approach derives from the awesome success of physics, chemistry, and molecular biology in explaining so much of the world. The successes of this approach are indeed stunning, contributing to the achievement of great technological sophistication: jet airplanes, lasers, MRIs, rocket ships, computers, genetically engineered organisms, atomic bombs, and cell phones, to name a few examples. A significant number of contemporary scientists comment that we may be close to grasping the whole shebang, from the origin of the universe to the evolution and operation of the human brain and mind. That there is still little clue as to exactly how to understand mentality within this framework is no deterrent for its advocates, for such a string of past successes can only presage every kind of future success in this area. This has led to a kind of dogmatic belief (rather than a working hypothesis) within contemporary neuroscience that whatever the mind is, it is necessarily a function of physical processes in the brain and nothing more. Sometimes the words ‘brain’ and ‘mind’ are used almost interchangeably and some neuroscientists are prone to referring to the ‘measurement of mental processes’ with various brain-imaging technologies, rather than making the more accurate reference to the measurement of ‘neural correlates’ of mental processes.

Physicist John Wheeler (1911–2008) and others have speculated that the concept of information is at the core of our conception of reality, a notion Wheeler calls ‘it from bit.’ Taking off from this, philosopher David Chalmers has discussed the idea that whatever the psychophysical laws

connecting mind and brain might be, the concept of information is key, and that somehow the physical and mental may be conceived as objective and subjective perspectives on information. Connecting a particular measure of information to nervous system physiology, neuroscientist Giulio Tononi has proposed that awareness is related to what he calls ‘integrated information.’ This latter phenomenon finds its physical expression in the complexity of interactions between neurons, and in the human brain includes active communication between widespread areas of the cerebral cortex. In this conception, loss of consciousness or awareness during sleep, general anesthesia, or coma would be related to a loss of integrated connection between cortical neurons. Simpler nervous systems would also be associated with less integrated information, corresponding to a simpler capacity for conscious awareness. Although this provides an attractive neurobiological framework in which to understand different levels of awareness, it still says nothing about how subjectivity comes about. We are still faced with the question of how to bridge the explanatory gap.

That little or no progress has been made on resolving the explanatory gap from a physicalist approach has been a factor in conceptualizing the mind–body connection as an aspect of a larger domain of synthesis. This idea has been articulated in one form or another by a number of folks over the last several centuries. Among the approaches that share something akin to this are neutral monism, dual-aspect theories, panpsychism, panexperientialism, and others. Philosophers have dissected and analyzed these various views and discussed their similarities and differences. What they share is some sort of pre-eminent existence of domains of mentality and of physicality (akin to dualism), but now, and very importantly, conceptualized as parts of a larger synthesis. Alfred North Whitehead (1861–1947), for example, has taken this perspective to a high level of development, in which reality is described as being constructed by processes termed ‘actual occasions’ that possess both physical and mental aspects. As interesting as these metaphysical frameworks are, thus far none have been widely appreciated as offering enough to grasp on to, something that gives an experimentally testable picture of the underlying ‘*unus mundus*,’ to use the alchemical term meaning ‘one world.’

The lack of ideas about how to make sense of mentality in terms of brain processes has even led some to declare that the mind–body problem is fundamentally unsolvable, in that the capacity to discern this connection, to span the gap, may be beyond our intellectual capacity. It has been said that it might be like attempting to teach a dog about quantum physics; a dog simply lacks the cognitive apparatus to grasp the necessary concepts. And so it perhaps is for humans and the explanatory gap. Perhaps so; but really, is it possible to make such claims with any degree of confidence? What would have been the predictions of physicists a century or two ago about many things we take for granted today? It sometimes seems to be the case that philosophers, scientists, and other scholars of today believe that our historical moment is especially privileged and that we somehow have gotten a handle on the way things are that is almost as good as it can get. While it is the case that our current scientific story does work very well for many things, such an egocentric view seems quite shortsighted!

Among the other important issues related to the mind–body connection is the problem of what kind of causal efficacy mental states have. We have the experience that our will is free, that our subjective thoughts and feelings can and do have effects on our actions in a very direct way. Naturally, the nature of the connection between mind and body is central to addressing this issue in a meaningful way. Many contemporary scientists, if they bother to think about the question of free will at all, consider that our experience of free will must be illusory. Such beliefs have important implications in issues of ethics and criminal justice, for example.

Toward a Revolution in the Mind Sciences

The history of science has been punctuated with revolutionary shifts of paradigm or explanatory framework. Such a shift occurred in the period extending from Copernicus to Newton. Before and after this period, the scientific understanding of the universe was very different. Another revolutionary shift occurred with Einstein and the relativity theory. After Einstein, space and time were no longer considered absolute and invariant frameworks in which the physical processes of the universe took place, but were interconnected and malleable, could warp and bend, and have beginnings and endings. A third revolution in physics occurred with the introduction of quantum mechanics, after which matter, at least at the atomic level, is no longer represented as moving along well-defined trajectories, but in terms of potentialities. Measurement, probing, or other interaction seems to be required to impart a kind of definiteness to what is otherwise described as a distribution of probabilities or potentialities.

In biology, Darwin initiated a revolution when, after spending decades carefully observing biological phenomena, he provided a grand conceptual framework for understanding diversity among living organisms in terms of variation and natural selection. The Darwinian revolution took on additional momentum in the twentieth century when, with a growing knowledge of biochemistry, the quest for understanding the molecular basis of life took center stage. Of particular interest was the great mystery of heredity, how the information needed to construct a living cell was stored and transmitted from one generation to the next. In a lecture delivered in 1932, Niels Bohr (1885–1962), one of the physicists who founded quantum mechanics, speculated that perhaps the laws of physics and chemistry, as then currently understood, might be inadequate for describing the fundamental nature of living organisms. However, Bohr saw this not as a reason for pessimism, but rather its opposite; for just as the analysis of matter at the atomic level had precipitated the discovery of the new physical laws of quantum mechanics, so perhaps the pursuit of the molecular basis of life would entail the discovery of new laws of nature. What could be more exciting than that?

Bohr’s lecture was inspirational to Max Delbrück (1906–1981), a young physicist who heard it at the time, and went on to become one of the pioneers of the yet-to-be-founded scientific field of molecular biology. Delbrück was one of the first to consider that genetic information in organisms was somehow stored in large molecules, and went on to develop experimental techniques to investigate the molecular basis of heredity,

using bacteria and viruses. The ideas of Bohr and Delbrück were further elaborated in a widely read little book, *What is Life?*, published in 1944 by another one of the founding physicists of quantum mechanics, Erwin Schrödinger (1887–1961). Especially by way of Schrödinger’s book, the idea that new laws of nature might be discovered in the quest to understand the molecular basis of life was inspirational to a number of scientists in the early days of molecular biology.

The scientific revolution begun by Darwin achieved culminating moments with the molecular description of deoxyribonucleic acid (DNA) in 1953, the description of the genetic code within the following decade, and more recently, the sequencing of the human genome and the genomes of an increasing number of other organisms. At least thus far, Bohr’s speculation that new laws of nature might be discovered in the quest to understand life has not panned out. Increasingly sophisticated descriptions of the molecular basis of heredity, and other biochemical and biophysical processes underlying life at the cellular and molecular level, have been developed without needing to invoke any new laws of nature. Indeed, contemporary molecular biology has seen a series of triumphs in the application of a reductionist physicalist framework, leading to a richer understanding of the nature of life. Still, within this framework, some great mysteries remain, perhaps the most notable of which are the emergence of life from nonliving matter and the mind–body problem.

As stated earlier, the history of science has been punctuated with revolutionary shifts of paradigm or explanatory framework. If any place is now poised for such a shift, it may be the science of the mind. Contemporary science has reached an impasse in tackling the explanatory gap and some philosophers and scientists interested in the mind–body problem are open to an expansion of our scientific framework for there to be substantial progress toward a richer understanding of the mind–body connection. Perhaps the new laws of physics about which Bohr, Delbrück, and Schrödinger speculated will be found in connection with attempts to more deeply understand the nature of the mind. In any case, our scientific understanding of the nature of reality has always been an evolving enterprise and who is to say what the next phase will involve. William James, writing in 1892 about the scientists who would one day more fully illuminate the mind–brain connection, said that “the best way in which we can facilitate their advent is to understand how great is the darkness in which we grope, and never to forget that the natural-science assumptions with which we started are provisional and revisable things.”

At the time when James wrote this, classical physics was still strong, but was, unbeknownst to him, on the verge of going down for the count as the premier explanatory framework for understanding nature. Within a few years (although after James had died) quantum mechanics displaced classical physics as the fundamental description of nature. And quantum physics may indeed contain the seeds of an expanded framework of physical theory that provides a place for mentality or consciousness in a way that classical physics may never be able.

How might this be so? Thus far in the biological sciences, while quantum mechanics is assumed to be necessary to explain the stability of atoms and molecules, quantum-mechanical effects have not (yet?) been appreciated as playing any central role in our conceptual understanding and

description of living systems. For example, when describing the signaling between nerve cells taking place at synapses, neurotransmitter molecules, receptor proteins, reuptake transporters, and so forth are described as if they were solid objects of matter that could in some sense be visualized as microscopic billiard balls knocked around by the forces of electrostatic interaction and thermal diffusion.

However, quantum mechanics posits that measurements are necessary to turn the characteristics of a system from potentialities into well-defined properties. Some physicists argue that some sort of additional framework, beyond what is described by the equations of quantum mechanics, is necessary to specify the measurement. Bohr referred to this as the ‘free choice of experimental arrangement’ and it may be a place to at least begin a discussion of how mentality is connected with the rest of the physical universe. An important implication is that mentality need not be identical to, be derivable from, or somehow emerge from the physically described properties of matter, as it is in the various approaches of physicalism. Instead, mentality may interact with the physical system in some way to fully define its properties. It is a concept that may fit within an expanded dual-aspect-like framework. However, thus far it has been difficult to specify what might be the next steps in describing such a framework, since quantum physics itself says nothing about the structure of the mental domain, if that is what it is. The implications of this so-called quantum-mechanical measurement problem are hotly debated among physicists who are interested in what quantum physics has to say about the nature of reality and our ability, through experiment, to acquire knowledge about reality.

Toward an Empirical Science of the Subjective

Something not generally discussed in the context of philosophical or neurobiological discussions of the mind–body problem is the idea that in order to move forward, we may need to develop methods to more deeply investigate the mind on its own terms. William James articulated this in his classic 1890 text *The Principles of Psychology*, wherein he laid out a threefold approach to the study of the mind: (1) behavior, (2) neural correlates of behavior, and (3) direct study of mental phenomena themselves, stating that “introspective observation is what we have to rely on first and foremost and always.”

Just as progress in astronomy and cosmology has depended strongly upon the implementation of ever more powerful telescopes of various kinds, and progress in cellular and molecular biology has employed ever more powerful microscopes and microscopic probes of various kinds, it seems reasonable that greater progress in the science of the mind will benefit from more refined methods of observation of mental phenomena. Some argue that because we are all intimately familiar with the mind, refined observation of mental experience is second nature to everyone. After all, are we not experiencing thoughts, feelings, and perceptions all the time? Nonetheless, introspectively carrying out careful observation of mental processes is a difficult business at best and requires years of practice, just as learning how to make other kinds of scientific observations requires extensive training. We can each of us look at the sky at night, be aware of the phases of the moon and the movement

of the planets, be awed by the countless number of stars, but this does not qualify us to make the kind of refined observations that have led to our current cosmological understanding of the universe.

Refined introspective observation and analysis benefits from stable and highly focused attention, something that does not come easily to most people. Our attention is generally moving about quite actively from one thing to another. Contemplative practitioners associated with various religious and spiritual traditions have for millennia been developing refined introspective methodologies, to better observe and understand mental experience. It was in part this potential of sharing ideas about the nature of the mind and how it could be investigated that motivated the Dalai Lama of Tibetan Buddhism to first propose, in the 1980s, that cognitive scientists and Buddhist contemplatives engage in a dialogue that might be of benefit to both traditions. These dialogues rapidly broadened to include neuroscientists and physicists and have become annual events, leading to the generation of new experimental research at the interface of contemplative practice, psychology, and neuroscience. However, the task of bringing the highly refined methods of mind observation into the domain of contemporary cognitive science is much more difficult, due to the rigors of the training involved.

Conclusion

We assume that the mind and consciousness have developed according to principles of biological evolution: that whatever mental experience may be, it has evolved in intimate concert with brain and body physiology and is an essential part of how our body engages with the physical world. It certainly could be the case that a capacity for conscious awareness might give us (and other creatures that possess such awareness) an enhanced ability to analyze and integrate information and that such an ability would facilitate survival and reproduction in a complex environment. Since brain processes are intimately connected with mentality, it makes eminent sense to continue to advance the study of brain function at the molecular, cellular, and systems levels as one program of investigation of the mind–body connection. This includes continued development of experiments to elucidate neural correlates of mental experiences. Perhaps it will be that a far more complete understanding of mind will come solely from an analysis of the already known and yet-to-be discovered molecular, cellular, and systems properties of the brain and the body. Perhaps a physicalist metaphysics will provide a framework sufficient to adequately address the mind–body connection. Perhaps even, as some have argued, the Cartesian linguistic distinction of ‘mind’ and ‘matter’ sets up a disconnect that predisposes us to certain limitations in the way we conceptualize the mind–body problem. Are the explanatory gap and the seemingly special and irreducible nature of first-person subjective experience somehow artifacts of this distinction?

However, it also makes sense to be attuned to phenomena that do not readily fit within the explanatory structure of brain function as currently understood, for such phenomena may point the direction to an expanded framework for

understanding the mind–body connection. These would include, but are not limited to, some aspects of near-death experiences, especially reports of out-of-body experiences and of clear awareness during periods of sensory deprivation and minimal brain activity; mystical, transpersonal, or transcendental experiences, some spontaneous, some facilitated by shamanic processes such as the ingestion of certain powerful plant or chemical preparations; experiences suggesting some kind of survival of mental information after the death of the body; other phenomena grouped broadly under the heading of anomalous (telepathic communication, remote viewing, and precognition, for example). Some of these phenomena are very difficult at best to study under laboratory conditions. Moreover, there is widespread belief in Western science that many of these phenomena simply cannot be real and it is fashionable to dismiss them as mere pseudoscience. Such attitudes are in part tied to an apparent lack of theoretical explanation within current physical theory. Additionally, many who are dismissive are remarkably unfamiliar with the evidence that does exist concerning some of these phenomena. As many of these phenomena are widely reported across cultures and across millennia, it may be that an expanded science of the mind will be unable to continue to ignore them. Ultimately, one hopes that the self-correcting nature of the scientific enterprise will foster the development of frameworks to encompass whatever is empirically justified.

We began with an operational definition of the mind as the collection of our mental experiences and of consciousness as our capacity to be aware of these mental experiences. As pointed out earlier, these operational definitions of mind and consciousness are very closely related, since to be part of the ‘mind’ by this definition, there must either be awareness or at least the possibility of awareness. It is possible that empirically we will be brought to a place where more nuanced definitions of mind and consciousness are needed, perhaps incorporating transpersonal and transcendental aspects. Biological evolution has had several billion years to refine the processes of life, and it is likely that the extent of connectivity and interaction within the web of life is much more complex than we presently imagine. This may include aspects of the mind–matter relationship that are as far or farther beyond our present scientific description as contemporary theories of mathematical physics would have been to Newton. Moving toward the next level of insight concerning the mind–body connection may entail honoring how little we presently know and openness to radically new perspectives.

See also: [Drugs, the Brain, and Behavior](#); [Electroencephalography](#); [Empirical Challenges to Conventional Mind–Brain Theory](#); [Free Will](#); [Meditation: The Science and the Art](#); [Near-Death Experiences](#).

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Relevant Websites

- <http://www.consc.net> – David Chalmers' comprehensive bibliography of resources on philosophy of mind.
- <http://www.mindandlife.org> – Mind and Life Institute (dialogues between scientists and the Dalai Lama).
- <http://www.sbinstitute.com> – Santa Barbara Institute for Consciousness Studies.
- <http://plato.stanford.edu> – Stanford Encyclopedia of Philosophy (many articles on philosophy of mind).

The Mirror Mechanism

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Glossary

Affordances Affordances is a term introduced by James J. Gibson indicating that the observation of an object determines an immediate and automatic selection of those of its properties that allow one to interact with it. The affordances are not the visual aspects of the object, but the *pragmatic opportunities* that the object offers to the observer.

Canonical neurons Canonical neurons are a specific class of neurons of the monkey ventral premotor cortex that discharge during motor act execution and in response to the presentation of 3D objects. Typically they show congruence between the motor act, the code (e.g., precision grip), and the physical properties of the observed object (e.g., small object).

Mirror neurons Mirror neurons are a distinct class of neurons found in the monkey premotor cortex and IPL that discharge both when the monkey execute a given motor act or observes the same motor act performed by another individual.

Motor act Unlike the term movement that describes a displacement of body parts, motor act indicates movement with a goal.

Motor cortex Motor cortex is defined as that part of the frontal lobe that lacks the layer containing granular cells. Its electrical stimulation, at low threshold, elicits discrete movements of contralateral body parts.

Potential motor act Potential motor act is defined as the activity of a motor neuron triggered by sensory stimuli and not accompanied by an overt motor response.

Voluntary movement Voluntary movements are manifestations of a centrally generated intention to act. The way in which intention is generated is irrelevant for the notion of voluntary movement. It may result from bodily needs such as hunger or thirst, or from higher order deliberations based on one's own beliefs and desires. What accounts for voluntary movements is that the individual has a goal and that this goal determines movements leading to its achievement. Unlike for reflexes, in voluntary behavior, stimuli do not determine a motor response, they only *set the occasion* for it. According to their needs, animals may or may not respond to the same stimulus.

Introduction

In the early 1990s, Giacomo Rizzolatti and his coworkers Luciano Fadiga, Leonardo Fogassi, and Vittorio Gallese discovered a distinct class of neurons in the monkey premotor cortex that discharge both when the monkey performs a goal-directed motor act and when it observes a similar motor act done by another individual. These neurons were called 'mirror neurons.' There is now evidence that the mirror neurons of the monkey's premotor cortex represent a particular case of a more general mechanism, the 'mirror mechanism,' that is present also in other species of animals, including humans. The mirror mechanism operates as follows: it transforms the visual representation of an observed motor act into a representation of that motor act in a motor format. Because the observing individuals know the outcome of their motor representations, the mirror mechanism provides them with a *direct* knowledge of what the others do.

The functional role of the mirror mechanism is not unique but changes according to where it is located in the brain. At present, there is evidence that it plays a role in the recognition of songs in birds, in understanding motor acts in monkeys and in recognition of motor acts, intention, emotions, and phonemes in humans.

The Mirror Mechanism in Monkeys

Anatomical and Functional Organization of the Parieto-Frontal Areas

The encephalon of primates, and humans in particular, is characterized by the enormous increase of the cerebral cortex. A large part of this increase is due to the development of the 'association areas' and, among them, of the posterior parietal lobe. The classical view of the functional role of the association area and of the posterior parietal lobe, in particular, was that they 'put together' information coming from different sensory modalities. Perception would be the consequence of this 'putting together.'

A series of studies carried out by Vernon Mountcastle and Juhani Hyvarinen in the 1970s radically modified this view. These authors recorded single-neuron activity from the inferior parietal lobule (IPL) in awake macaque monkeys and assessed their responses to sensory stimuli and during motor behavior. The results showed that many parietal neurons respond to sensory stimuli and often to stimuli from different modalities (e.g., visual and somatic stimuli). However, a large number of neurons discharged in association with motor acts performed by the monkeys. A recent analysis of the organization of IPL has shown that the IPL is organized according to a motor

scheme. Neurons located rostrally (areas PF) discharge in relation to mouth actions; neurons located centrally (PFG and PG) fire mostly in association to hand and arm movements; finally those located caudally are related to eye movements. The sensory, unimodal and polymodal, responses are linked to the body parts that are motorically represented in a given area. Thus, the basic organization of IPL is not sensory, but motor, with the sensory and association responses inserted in a motor scaffold.

Congruent with this new view of IPL organization are anatomical data showing that there is no such a thing as a large multipurpose association area, but that cytoarchitectonically different parietal areas (Figure 1) have specific connections with premotor areas and form, together with these areas, a series of circuits coding different types of motor behaviors. Here we will discuss the functional properties of three of

these circuits, AIP/PFG-F5, VIP-F4, and LIP-FEF (frontal eye field), all endowed with the mirror mechanism.

AIP-PFG-F5: The Hand Grasping and Manipulating Circuit

The functional properties of this circuit have been investigated by Sakata and Rizzolatti and their coworkers. Sakata and his colleagues recorded the neural activity from area AIP in monkeys trained to grasp different objects requiring specific types of grip. They found that there were neurons responding to the mere vision of the objects, others discharging during the motor acts directed toward objects, and, others that became active both during the mere vision of an object and during an action on it (visuomotor AIP neurons).

Rizzolatti and his coworkers recorded the activity of neurons from area F5. They found that virtually all neurons of this area discharged in association with hand motor acts (e.g., grasping, holding, manipulating). Many F5 neurons also discharged when the monkey observed an object. These visual responses were present not only if the monkey subsequently grasped the observed object, but also when it had to release a lever following object presentation. This finding indicates that the discharge was not related to grasping preparation. As in area AIP, the majority of these visuomotor neurons (also called 'canonical' F5 neurons) were selectively activated by the presentation of objects of a certain size, shape, and orientation. The visual specificity was congruent with the motor specificity.

What can be the explanation of the behavior of AIP visuomotor and F5 canonical neurons? The explanation is that every time a three-dimensional (3D) visual stimulus is presented, these AIP and F5 neurons transform their visual affordances (action possibilities) into 'potential motor acts,' that is into a possible motor act. This potential motor act may be executed or not. Thus, potential motor acts give individuals the freedom to choose whether to respond to a stimulus or to hold it in memory. Their discharge does not represent a command to act.

F5 and AIP Mirror Neurons

While the observation of a 3D object is sufficient to trigger AIP visuomotor and F5 canonical neurons, the observation of a *motor act* (i.e., a goal-directed movement) is necessary to trigger *mirror neurons* (Figure 2). These neurons are located in the premotor cortex (area F5) and in two areas of IPL (AIP and PFG). However, because most studies of the basic properties of mirror neurons have been carried out on F5 neurons, we will deal mostly with these neurons.

Like all neurons in F5, mirror neurons discharge during the execution of specific motor acts such as grasping, tearing, or holding. In addition, they fire when the monkey observes another individual (human or monkey) performing the same motor act. They do not discharge in response to mere object presentation.

What is the function of mirror neurons? Why are they activated during the observations of actions done by others? To address this issue, one must solve first a preliminary problem: what do the parieto-frontal mirror neurons encode when they discharge during voluntary movements?

Before doing this, one has to have clear in mind that what is recorded in extracellular single-neuron studies is the neuron

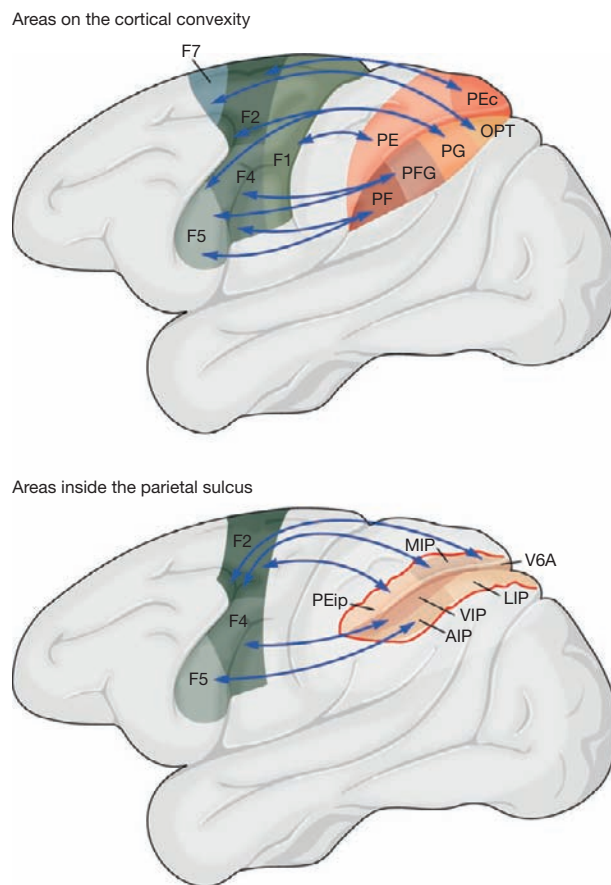


Figure 1 A lateral view of the monkey brain showing some parieto-frontal circuits. The main cytoarchitectonic feature of the frontal motor cortex is the absence of granules (agranular frontal cortex). This cortex is formed by the primary motor cortex (F1 or M1) and by various premotor areas. Some (areas F2, F4, F5, and F7) are located on the lateral cortical surface. Two (F3 and F6, not shown in the figure) are located on the medial cortical surface. F means frontal. The parietal areas located on the cortical convexity (upper panel) are indicated according to the terminology of von Economo (PF, PG, PFG; P means parietal). The areas located inside the intraparietal sulcus can be seen by opening this sulcus (lower panel). AIP, anterior intraparietal area; LIP, lateral intraparietal area; MIP, medial intraparietal area; PEip, intraparietal PE; VIP, ventral intraparietal area; V6A, an extrastriate visual area.

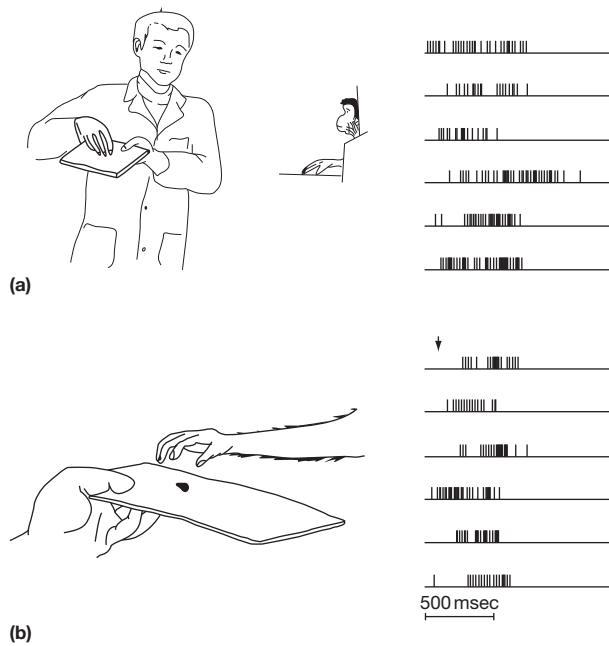


Figure 2 F5 mirror neuron. Upper panel: neuron's responses during the observation of grasping movements done by the experimenter; Lower panel: responses of the same neuron during monkey grasping movements.

output. This is (obviously) true both for action execution and action observation. Thus, a way to assess which information is carried out by a mirror neuron when activated during action observation is to establish what this neuron encodes during agent's own motor act execution.

There is evidence that most motor neurons of F5 encode *motor acts* (see definition above) rather than *movements*, that is, body parts displacements without a specific goal (e.g., finger flexion). Crucial evidence in this sense has been recently provided by Umiltà et al. These authors recorded single neuron in monkeys trained to grasp objects using two different types of pliers: 'normal pliers,' which require hand closing to grasp an object, and 'reverse pliers,' which, in contrast, require hand opening for the same purpose. The results showed that F5 neurons discharge, in both conditions, during the same phase of grasping regardless of whether, in order to achieve the goal, the hand has to be opened or closed (Figure 3).

It is clear from this experiment that the mirror neurons of F5 code the *goal* of the observed motor act. They give an immediate knowledge to the observer on what the agent is doing.

The functional properties of IPL motor neurons seem to be similar to those of F5 neurons: the goal of the executed motor acts is the parameter that IPL neurons that fire during the execution of motor acts encode.

Recently, a single-neuron study investigated the effect of the spatial relations between agent and observer, comparing the responses of F5 mirror neuron to motor acts performed within the reach of the monkey (peripersonal space) or outside its reach (extrapersonal space). The results showed that many F5 mirror neurons are differentially modulated by the spatial location of the observed motor acts. Some neurons are selective for actions executed in the monkey's peripersonal space, whereas others prefer extrapersonal space stimuli. These

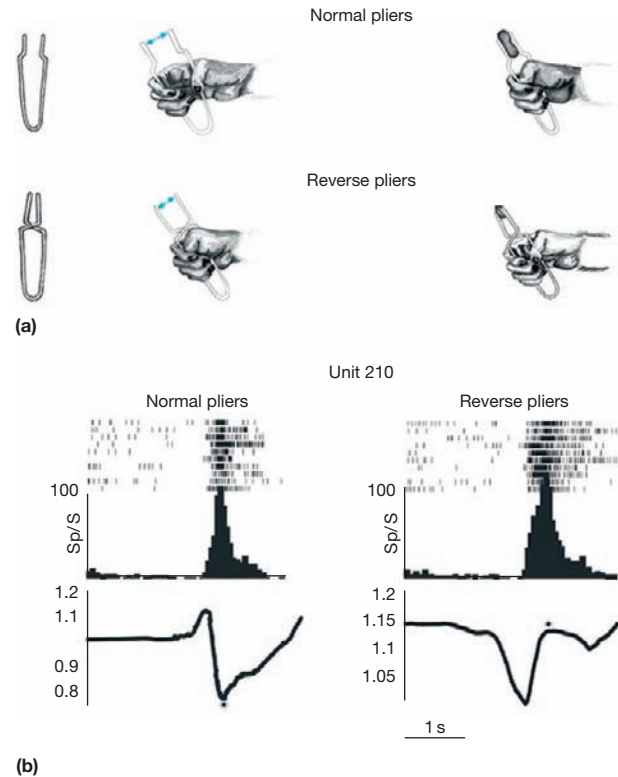


Figure 3 F5 neurons code the goal of a motor act. Upper part: schematic illustration of the used experimental paradigm. (a) normal pliers and (b) reverse pliers. Lower part: activity of a neuron recorded in area F5. Rasters and histograms illustrate the neuron's discharge recorded during grasping with normal pliers (left) and reverse pliers (right). Both rasters and histograms are aligned with the end of the grasping closure phase (asterisks). The traces below each histogram indicate the instantaneous hand position recorded with the potentiometer and expressed as function of the distance between the pliers handles. Trace down indicates that the hand closes and the distance between handles decreases, while trace up indicates that hand opens and the distance between handles increases.

findings indicate that mirror neurons may encode the goal of others' motor acts in the observers' centered spatial framework, thus providing the observer with critical information for organizing their own future behavior in cooperation and/or competition with the observed individuals.

Motor Goals and Motor Intentions in PFG/AIP-F5 Circuit

The properties of parieto-frontal mirror neurons described up to now indicate that their activity reflects what is going on 'now' and 'here.' However, there is evidence that parietal and frontal mirror neurons are involved in encoding not only the observed motor acts but also the entire action of which the observed motor act is a part. Fogassi and colleagues trained monkeys to grasp objects with two different motor intentions: to place them into a container or to bring them to their mouth. After training, IPL grasping motor neurons were studied in the two conditions. The results showed that more than 60% of grasping neurons discharged with an intensity that varied according to the action in which the motor act was embedded ('action-constrained' motor neurons). This finding implies that

IPL is constituted of chains of neurons in which each neuron encodes a given motor act and is linked to other neurons that are selective for subsequent motor acts. Together these neurons form a motor chain that encodes a given action (e.g., grasping-for-eating).

A striking result of this study was that many of 'action-constrained' motor neurons have mirror properties. When tested in the two conditions described above, the majority of them were differently activated when the observed motor act belonged to one action or another ('action-constrained *mirror* neurons'). This finding indicates that IPL mirror neurons not only describe what the observed individual is doing (e.g., grasping), but also, thanks to IPL chained organization, allow the observer to predict *why* the individual is doing it. In other words, they allow the observer to recognize the agent's motor intention.

VIP-F4: The Hand Reaching Circuit

Area VIP is located in the fundus of the intraparietal sulcus. It receives visual projections from components of the dorsal visual stream. There are two main categories of neurons in VIP: purely visual neurons and polymodal (somatosensory and visual neurons). Polymodal neurons have somatosensory and visual receptive fields that lie in register. A visual receptive field in front of the face, for example, is associated with a tactile receptive field on the face. Recordings demonstrate that many neurons in VIP are encoded in body part-centered coordinates.

Area VIP neurons appear to encode the first step in the construction of peripersonal space. The area in which this process becomes fully expressed is area F4. Neurons in area VIP have been recently discovered by Ishida and colleagues. These authors recorded from VIP neurons that respond to stimuli presented in the peripersonal space. They assessed then the distance at which the neurons ceased to respond. At this point the experimenter entered into the extrapersonal space and moved a stimulus around his face. The results showed that these neurons started to fire again. A good correspondence was found between the location of tactile and visual receptive field on the monkey face and that of the experimenter.

Motor responses were not studied by Ishida and colleagues. One has to keep in mind, however, that area VIP is strictly connected with area F4, where also peripersonal space is encoded and whose neurons discharge during reaching movements. It is very likely therefore that neuronal responses in VIP although elicited by visual stimuli are, at least in most cases, not visual responses in the strict sense, but potential motor acts directed toward specific space sectors or specific body parts.

The demonstration of mirror neurons in VIP is of great interest because it shows that neurons endowed with the mirror mechanism may encode body-directed, and not only object-directed, motor acts (F5 mirror neurons), thus opening fascinating possibilities for understanding how individuals encode the body of others.

LIP-FEF: The Circuit of Eye Movement

The two main areas that control the saccadic eye movements are area LIP and the FEF. Area LIP is located in the posterior

part of the lateral bank of the intraparietal sulcus. It receives a direct input from many extrastriate visual areas and from the temporal lobe. It is richly connected with the FEF. Electrical stimulation of LIP evokes saccadic eye movements. The threshold for evoking saccade is, however, higher than that of FEF or the superior colliculus. This finding indicates that LIP, although involved in processes leading to saccade generation, is more distant from eye movement generating centers than the last two structures.

Single-neuron recording showed that nearly all LIP neurons respond to the presentation of visual stimuli. Their receptive fields are typically large and coded in retinal coordinates. Some LIP neurons discharge stronger to complex visual stimuli than to unstructured light stimuli. Many LIP neurons discharge before saccadic eye movements. Pure movement-related neurons are rare. The majority of LIP neurons with saccade-related activity discharge also at the presentation of visual stimuli.

FEF is a cortical visuomotor center involved in the genesis of saccadic eye movements. Electrical stimulation of FEF even at low intensity produces contralateral saccades.

The electrophysiological properties of FEF have been extensively studied. These studies showed that, schematically, FEF neurons can be subdivided into three major classes: neurons that respond to visual stimuli, neurons that have movement-related activity (movement neurons), and neurons that have both visual and movement-related activity.

Visual neurons respond vigorously to stationary light stimuli. Their receptive fields are large, varying from a few degrees to an entire quadrant of the visual field. Movement neurons fire during ocular saccades. Most of them discharge before movement initiation. Visuo-movement neurons have both visual and movement-related activity. They discharge to visual stimuli in the absence of saccades, but they fire also during purposive eye movements made in darkness. There is a continuum of visuo-movement cells, from neurons in which visual activity predominates to neurons in which movement activity predominates. Association of visual stimulus and eye movements produce the strongest discharge.

LIP Mirror Neurons

There is some evidence that there is a population of neurons in LIP that are endowed with a mirror mechanism. Shepherd and colleagues found that there are LIP neurons that discharge both when the monkey looked in the neuron-preferred direction and when it saw another monkey looking in the same direction. Interestingly, they also found another set of LIP neurons that discharged when the recorded monkey looked toward a certain direction but whose discharge was, in contrast, suppressed when the observed monkey looked in the same direction. The authors suggested that LIP mirror neurons contribute to the sharing of observed attention and might play role in imitative behavior.

The Mirror Mechanism in Humans

There is a large amount of evidence that several human cortical areas possess the mirror mechanism. This evidence comes from studies using noninvasive techniques (PET, fMRI, TMS, EEG,

MEG) and, more recently, also from single-neuron recordings. The mirror mechanism is present in the areas of the parieto-frontal circuits, in the insula, cingulate cortex, the hippocampus, and supplementary motor cortex.

By using single-subject fMRI analyses, evidence has been recently provided that there are also other cortical areas (e.g., SI, SII) that become active during action observation and action execution. It might be, however, that these activations outside of mirror circuits reflect additional mechanisms (e.g., internal models) that are triggered by the mirror mechanism. These activations, not properly due to the mirror mechanism, would enrich the information about other individuals' behavior that the mirror mechanism provides.

Human Parieto-Frontal Circuits with Mirror Properties

The human mirror parieto-frontal circuit mostly studied is the one coding grasping motor acts. This circuit is formed by two main nodes: the IPL including the cortex located inside the intraparietal sulcus and the inferior sector of the precentral gyrus plus the posterior part of the inferior frontal gyrus (Figure 4). It is likely that there is another parieto-cortical circuit formed by the superior parietal lobule and the dorsal premotor cortex. It has been suggested that this dorsal circuit contains the mirror mechanism for the observation–execution of reaching movements.

What does the grasping mirror circuit code? In accord with early findings, a series of more recent fMRI studies provided strong evidence that the human mirror parieto-frontal circuit encodes the goal of observed motor acts. Gazzola and colleagues instructed volunteers to observe video clips in which either a human or a robot arm grasped objects. In spite of differences in shape and kinematics between the human and robot arms, the parieto-frontal mirror circuit was activated in both conditions. These results were extended by Peeters and

colleagues who investigated the cortical activations in response to the observation of motor acts performed by a human hand, a robot hand, or using different tools. They found bilateral activation of a network formed by intraparietal and ventral premotor cortex regardless of the acting effector. Most interestingly, the observation of tool actions produced a specific activation of a rostral sector of the left anterior supramarginal gyrus, suggesting that this sector specifically evolved in *homo sapiens* for tool use.

Further evidence for goal encoding by the parieto-frontal mirror circuit was obtained in an fMRI experiment in which two aplasic individuals, born without arms and hands, and control volunteers were asked to watch video-clips showing hand actions. All participants also performed actions with their feet, mouth and, in the case of control volunteers, hands. The results showed that the parieto-frontal mirror circuit of aplasic individuals that was active during foot and mouth movements was also recruited by the observation of hand motor acts that they have never executed but whose motor goals they could achieve using their feet or mouth.

An important issue is how we understand actions that are not present in our motor repertoire. An fMRI study addressed this issue. Two types of actions performed by humans, monkeys, and dogs were shown to volunteers. They were biting and oral communicative actions (speech reading, lip smacking, barking). The results showed that the observation of biting, regardless of whether performed by a man, a monkey or a dog, determined the same activation foci in the IPL, in the pars opercularis of the IFG, and the adjacent precentral gyrus. The left rostral parietal focus and the left premotor focus were virtually identical for all three species, while the right side foci were stronger during the observation of actions made by a human being than by an individual of another species. Different results were obtained with communicative actions. Speech reading activated the left pars opercularis of IFG;

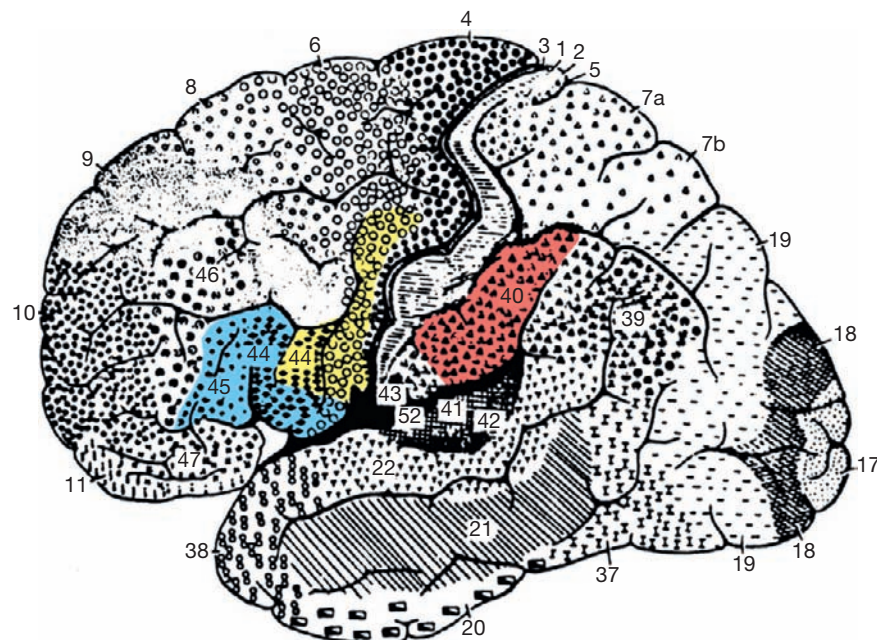


Figure 4 Later view of human brain. The figure shows the areas (in color) that form the human parieto-frontal grasping mirror circuit.

observation of lip smacking, a monkey communicative gesture, activated a small focus in the pars opercularis of IFG; observation of barking did not produce any frontal lobe activation.

These results indicated that actions made by other individuals could be recognized through different mechanisms. Actions belonging to the motor repertoire of the observers are mapped on their motor system. Actions that do not belong to this repertoire are recognized essentially on visual basis. It is likely that these two different ways of recognizing actions have two different psychological counterparts. In the first case, the motor activation translates the visual representation into a 'personal knowledge' (see Merleau-Ponty), while this is lacking in the second case.

Mirror Mechanism for Encoding Movements

Unlike monkeys, humans are endowed with the mirror mechanism also for movements that are not goal-directed. Evidence for this was originally obtained with TMS experiments. Various studies showed that the observation of others' movements, even when devoid of a goal, results in an activation of the muscles involved in the execution of those movements. Further support for the existence of this movement-related mirror mechanism comes from EEG and MEG studies showing that the observation of movements without a goal desynchronizes the cortical rhythms recorded from motor areas.

Recently it has been shown that coding the goal of an observed motor act or the movements that form it depends on the content of the observed behavior. Cattaneo and colleagues recorded motor-evoked potentials (MEPs) to TMS from the right *opponens pollicis* (OP) muscle in participants that were observing an experimenter either opening and closing normal and reverse pliers or using them to grasp objects (see Section on 'F5 and AIP Mirror Neurons'). The observation of tool movements (i.e., opening and closing without grasping anything) activated a cortical representation of the hand movements involved in the observed motor behavior. In contrast, the observation of the tool-grasping action activated a cortical representation of the observed motor goal, irrespective of the individual movements and the order of movements required to achieve it. This duality of coding is probably one of the major factors that allows human beings to learn by imitation.

Imitation

Although the term imitation has several definitions, there are two main senses in which it is most commonly used. The first defines imitation as the capacity of an individual to replicate an observed motor act; the second defines imitation as the capacity to acquire, by observation, a new motor behavior and to repeat it using the same movements employed by the teacher. In both cases, imitation requires the capacity to transform sensory information into a motor copy of it.

There is clear evidence that the mirror mechanism is involved in imitation in the first sense, that is, to replicate immediately an observed motor act. In an fMRI experiment, volunteers were tested in two main conditions: 'observation' and 'observation-execution.' In the 'observation' condition, participants were shown a moving finger, a cross on a stationary finger, or a cross on empty background. The instruction was to observe the

stimuli. In the 'observation-execution' condition, the same stimuli were presented, but, this time, the instruction was to lift the finger, as fast as possible, in response to them. The crucial contrast was between the trials in which the volunteers made the movement in response to an observed action ('imitation') and the trials in which the movement was triggered by the cross (a nonimitative behavior). The results showed that the activation of the mirror mechanism and in particular of that located in the posterior part of IFG was stronger during 'imitation.'

More complex appears to be the mechanism involved in imitations learning. In this case, imitation, as suggested by Byrne, appears to result from the interaction of two distinct processes: (a) segmentations of the action to be imitated into its individual elements and their transformation into the corresponding potential movements of the observer and (b) organization of these potential movements into a temporal and spatial pattern that replicates that shown by the demonstrator. A study of Buccino and colleagues on learning to play chords on guitar showed that the first step of imitation learning is achieved through the mirror mechanism, while the second one is mostly due to the activity of the prefrontal lobe and in particular of area 46 that memorizes and recombines the motor elements in the new pattern.

Intention Understanding

As discussed in the previous sections, the sight of motor acts done by others produces, in the observer, the activation of cortical motor areas involved in the organization of the observed motor acts. This activation is at the basis of understanding 'what' the observed individual is doing. There is now evidence that, besides understanding motor acts, mirror mechanism is also involved in understanding 'why' a motor act has been performed, that is, the *intention* behind the observed motor acts.

Convincing evidence in this sense has been provided by an fMRI study by Iacoboni et al. In this study, there were three conditions. In the first one (called 'context'), the volunteers saw some objects (a tea-pot, a mug, a plate with some food on it) arranged as if a person was ready to drink the tea or arranged as if a person had just finished to have his breakfast; in the second condition (called 'action'), the volunteers were shown a hand that grasped a mug without any context; in the third (called 'intention'), the volunteers saw the same hand action within the two before and after breakfast contexts. The context and the different grip shapes suggested the intention of the agent, that is, grasping the cup for drinking or grasping it for cleaning the table.

The results showed that in both action and intention conditions there was an activation of the mirror parieto-frontal circuit. Crucial was the comparison between intention and action conditions. This comparison showed that the understanding of the intention of the doer determined a marked increase in activity of the right frontal node of the parieto-frontal mirror grasping circuit.

In line with these findings are the results of a more recent fMRI study based on the repetition suppression paradigm. This study confirmed the involvement of the frontal node in motor intention understanding and, in addition, also showed that the parietal nodes activity underlies this capacity.

Taken together, these data clearly show that the intentions behind the actions of others can be recognized by the mirror mechanism. They do not imply, of course, that intention of others cannot be understood using other more cognitive ways (see Frith and Frith), but they suggest that the mirror mechanism (see monkeys data) is most likely the most basic neural mechanism for intention understanding from which other aspects of understanding others evolved.

Recognizing Emotions

Up to now we discussed the neural mechanisms that enable individuals to understand actions without an obvious emotional content. In social life, however, it is equally important to recognize the emotions of other people. As discussed for 'cold' action, it is reasonable to admit that emotions can be understood in two ways: one based on sensory information provided by others' emotional behaviors and successive mentalizing; the other on a direct mapping of the observed behavior on the motor structures that, when active, produce, the observed emotion in the observer.

These two ways of recognizing emotions are experientially radically different. With the first, the observer understands the emotions expressed by others, but does not experience them. He deduces them. A certain facial or body pattern means fear, another happiness. Different is the case for the direct matching mechanism. In this case, the recognition occurs because the observed emotion triggers the experience of the same emotion in the observing person. It is a 'first-person' recognition.

What is the evidence for this type of action understanding? There are two sets of data that indicate the existence of this mechanism. Wicker and colleagues carried out an fMRI study aimed to find out whether the same cortical sites that show activation during the experience of disgust, also show activation during the observation of faces expressing it. In this study, volunteers were subjected to an fMRI experiment consisting of two sessions. In the first session, the participants were exposed to unpleasant and pleasant odors; in the second session, they watched a video showing the facial expression of people sniffing an unpleasant, a pleasant, or a neutral odor.

Among other structures, the exposure to smells determined activations in the insula and the anterior cingulate. The most important result, however, was the finding that the same foci that were activated within the insula and the anterior cingulate by the exposure to disgusting odorants were also activated by the observation of facial expression of disgust. The anatomical colocalization of the active foci strongly suggests that the insula contains neural populations that becomes active both when individuals experience disgust and when they see it in others.

Similar results were obtained also for pain. Singer and coworkers conducted an fMRI experiment in which the participants were either subjected to a mildly painful electric shock applied by electrodes located on their hand or asked to watch while the same electrodes were fastened to the hand of a loved one. The results showed that the same sites of the anterior insula and of the cingulate cortex became active in both conditions, thus showing that both direct pain experience and its evocation are mediated by a mirror mechanism similar to that found for disgust.

Language

There is disagreement on whether the human speech has its evolutionary roots in gestures or animal calls. Yet, nobody denies that speech is something more than a mere collection of curious sounds. This was clearly demonstrated by Liberman, who showed that one could not build an efficient communication system by simply using tone combinations. According to Liberman, the unique property of speech is its capacity to elicit the motor representation of the heard sound in the listener.

There is evidence that this capacity has a precise neural correlate. In a TMS experiment, the left hemisphere speech motor centers were stimulated and MEPs were recorded from the tongue muscles in volunteers instructed to listen carefully to acoustically presented verbal and nonverbal material. The stimuli were words and bitonal sounds. In the middle of words, there was either a double 'f' or a double 'r'. 'f' is a consonant that, when pronounced, requires virtually no tongue movements, whereas 'r' is a consonant that, in contrast, requires, marked tongue muscle involvement to be pronounced. The results showed that listening to words containing the double 'r' produced a significant increase of MEPs amplitude recorded from tongue muscles compared to listening to bitonal sounds and words containing the double 'f'.

Similar results were obtained using the same technique and recording MEPs from a lip muscle and a hand muscle in four conditions: listening to continuous prose, viewing speech-related lip movements, listening to nonverbal sounds, and viewing eye and brow movements. Compared to viewing eye and brow movements, listening to and viewing speech enhanced the amplitude of MEPs recorded from the lip muscles. All of these effects were seen only in response to stimulation of the left hemisphere.

Taken together, these data indicate that in humans, in addition to the mirror mechanism transforming observed movements into potential movements, there is a further system transforming heard phonemes in the corresponding motor representation of the same phoneme. There is no doubt that this mechanism plays a fundamental role in language learning.

Mirror Mechanism and Autism

Over the last few years, electrophysiological and brain imaging experiments showed that individuals with autistic spectrum disorders (ASD) have an impairment of the mirror mechanism, suggesting that the social isolation typical of patients with ASD may result from this deficit. There are two versions of this theory. The early version suggests that the deficit concerns the mirror neurons as such (single mirror neuron hypothesis). As a consequence, the observation of motor acts of others does not activate the mirror mechanism in individuals with ASD in a way comparable to that of neurotypical (NT) individuals. Because of this impairment, individuals with ASD present deficits in understanding action, intention, and emotion of others. The type and severity of the deficit depend on the location of the impaired mirror mechanism.

A more recent version of the relation between ASD and mirror mechanism (mirror neuron chain hypothesis) is based on the discovery in the parietal and premotor cortex of the monkey of neural chains mediating specific actions. As described

above, these neural chains are formed by specific sets of neurons ('action-constrained neurons') that code motor acts forming a specific action. Parietal and frontal motor chains become also active when an individual observes a motor act done by others, provided that the observed motor act is part of a specific action (e.g., grasping-for-eating, but not grasping-for-moving). In virtue of this mechanism, the observer may understand the intention of the acting individual from the very beginning of the observed action (first motor act) and hence understands his/her motor intention.

Recently, the existence of this chained organization has been demonstrated also in humans. Cattaneo et al. tested NT and ASD children during the execution and observation of actions. They found that, during the execution of a given action in NT children, there was activation of the muscles involved in the final motor act of an action as soon as the action started. Similarly, during the observation of an action done by another individual, there was activation of the muscles that the observer would have used if executing that action. In contrast, children with ASD, although able to execute the tasks, failed to express their motor intention in advance to the final motor act. Most interestingly, the observation of actions done by the others did not 'enter' in their motor system, the muscle involved in final motor act being not activated. The authors proposed that the basic deficit in ASD resides in a connectivity impairment that prevents the organization of intentional motor chains. This impairment is responsible of abnormal motor action organizations as well as understanding of others' intention.

Additional evidence in favor of a deficit of the chain-based mirror mechanism in ASD is provided by a recent study in which the authors tested the capacity of NT and ASD children to report the goal of the observed motor act, that is, *what* the actor was doing and the intention underlying it, that is, *why* the actor was doing it. The results showed that children with ASD are able to recognize individual motor acts with the same error rates as TD children, but they fail to understand the intention behind them when contextual information is absent.

A General Overview

In conclusion, the mirror mechanism is a general mechanism that transforms the visual representation of an observed motor behavior in an analogous representation in a motor format. The specific role of the mirror mechanism depends on the functional properties of the neural circuit in which it is located. The mirror mechanism located in the parieto-frontal circuits on the lateral brain convexity transforms the sensory representation of motor acts into a motor representation of the same acts. Its function is to give the observer a direct understanding of the seen motor behavior. The mirror mechanism located in the insula and rostral cingulate transforms an emotion observed in others into a visceromotor pattern analogous to that present when an individual feels that emotion elicited by natural stimuli. It gives the observer a direct feeling of others' experience.

The mirror mechanism plays also a role in imitation, in imitation learning, and in translating the speech sound into the motor pattern responsible for the emission of the same

speech sound. Preliminary evidence suggests that the mirror mechanism might also be involved in the understanding of the meaning of verbal material.

Although this list of the functions mediated by the mirror mechanism may seem to be rather long, actually it is only preliminary. Considering the generality of the mirror mechanism, it is very plausible that future research will demonstrate its presence in other species besides birds, monkeys, and humans and its involvement in other functions besides those discussed here.

See also: Autism and Pervasive Developmental Disorders; Electroconvulsive Therapy and Transcranial Magnetic Stimulation; Intention; Motor Control.

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The Conceptual Foundations of Gene Theory

For thousands of years, at least since the beginnings of agrarian culture, human beings have recognized that the traits of offspring resemble, in a predictable manner, those of their parents and that this relationship holds true for both animal and plant species. It is in this agrarian past that modern genetics has its origins. Mendel's discovery that this parent-offspring predictability followed reliable statistical laws is one of the landmark discoveries in modern science. Yet, the rule-like regularity with which phenotypic traits get passed from one generation to the next has also led to one of the greatest debates in the history of science – the nature-nurture debate. The crux of the dilemma stems from the fact that while patterns of inheritance are reliably observed and can, with statistical estimations extending from Mendel's initial calculations, be predicted with some degree of accuracy, the process or mechanism through which this statistical regularity occurs has remained a mystery.

The genesis of contemporary gene theory is found in early scientific attempts to resolve the unknown process, which generated these statistical regularities between parent and offspring traits. Contemporary gene theory was born out of an era when the Newtonian mechanical universe was the dominant paradigm of science (or natural philosophy, to which science was then referred). This worldview held that the universe and all of its subsidiary features, such as plant and animal life, functioned via the mechanical interactions of discrete and independent objects, be they atoms, molecules, or as in the present case, genes; causes were considered to be singular (i.e., there was one and only one actual cause for an event) and deterministic. Further, the explanation for most complex events was thought to be found through a process of reducing the objects involved down to their most fundamental and atomistic dimensions and then delineating the deterministic transactions among those atomistic components. Within this philosophical backdrop, contemporary gene theory derived its key principles:

1. Genes must be discrete causal agents 'located' in the germ cells. This principle is derived entirely from the Newtonian assumptions of linear, singular, and deterministic causes. Indeed, it was a completely assumed *a priori* 'given.' The only empirical observations related to this principle were the basic, observable aspects of sexual reproduction.
2. Genes behaved statistically 'as if' they contained independent and unique causal information, which additively combine to form the adult organism, although there were no formal tests of this assumption. The logic being that if our atomistic and additive conceptualization is true, then the statistical properties of the organism would follow certain parameters; the statistical properties do follow these parameters; therefore, our conceptualization of the gene is true. Philosophers of science refer to this logical fallacy as 'affirming the consequent.'

3. Because traits are predictable from the statistical estimations of Mendel and then later Fisher, both of whom did not include terms representing either development or environmental variation, it was further asserted that the causal information contained in genes was effectively isolated and independent of external influence (either biological or ecological).

These key principles, variations of which are referred to as the central dogma of molecular biology, soon became codified into the methodological operations of quantitative genetics. At its inception, and indeed, until only very recently, the gene, seemingly so concrete and definitive a structure, was nothing more than a hypothetical construct in a statistical equation. Even with the discovery of the unique and highly functional structure of deoxynucleic acid (DNA) by Watson and Crick, a little more empirical light was shown on the subject than simply having a molecule with the kinds of properties through which the hypothetical gene might work. It has only been in the last decade or so that molecular biology has developed the methodological tools for inducing segments of DNA to synthesize proteins and thereby identify a 'biological gene' as opposed to a 'statistical gene' or what Moss refers to as a D-gene (for DNA) rather than a P-gene (for phenotype inferred). It is worth noting that molecular biology has, within just a few short years of reliably observing the action of genes, abandoned the central dogma of genetics as untenable. In fact, work in stem cell biology takes contextual influences on gene synthesis to be foundational.

Traditional Quantitative Behavioral Genetics

One of the key, and perhaps most damaging, outcomes of the historical development of the gene concept is that not only did the assumptive base underlying the central dogma become codified into the methodology of the discipline, but also this once hypothetical construct became reified in the statistical equations of quantitative geneticists and subsequently divorced from empirical observation. As evidence for this, we note that there is not a single published study using a 'genetically informed design' in which a biological assessment of any kind has been undertaken. There are no actual genes to be found in the methods section of quantitative behavior genetics studies. Because of this empirical divorce, quantitative behavior geneticists have persisted in their Newtonian belief of the hypothetical gene, even when their molecular biology counterparts have abandoned the idea.

As a result, quantitative behavioral genetic studies explicitly measure neither sources of environmental variance (shared or unique) nor genetic variance. Indeed, it is only the dependent variable that is actually explicitly measured. It is true that the zygosity of each twin pair is measured as an indirect measure of the sequential structure of DNA, but this is not the same

as genetic variance. The use of zygosity as a surrogate index of genetic variance is only valid if one adopts a preformationist concept of a genotype. It is assumed that there is a limited phenotypic range about the prescribed genotypic potential through which environmental factors can influence the ultimate phenotypic outcomes.

This preformationist conceptualization is inherent in the fundamental equations of quantitative behavior genetics. It is explicitly assumed that phenotypic variance is an additive function of genetic, common environmental, and unique environmental factors. Algebraically, this is represented as

$$P = h^2 + c^2 + e^2$$

where P is the observed variance in some phenotypic trait, h^2 the proportion of variance due to genetic factors, c^2 the proportion of variance due to common environmental influences, and e^2 is the proportion of variance due to unique environmental experiences. Given that the DNA sequences in monozygotic twins are identical, it is assumed that monozygotic twins should have identical genotypes and in the absence of environmental influences they should have identical phenotypes. As the genomes of dizygotic twins have on average only half of their DNA sequences in common, sans environmental influences, they should on average share about 50% of their phenotype. Using this preformationist logic, the proportion of genetic influence can be inferred from the discrepancy of phenotypic correlations between monozygotic and dizygotic twin pairs:

$$h^2 = 2(r_{mz} - r_{dz})$$

Environmental influences common to both twins in a twin pair, such as having the same parents, are estimated then as the difference between the monozygotic correlation and the proportion of that correlation that is due to putative genetic factors.

$$c^2 = r_{mz} - h^2$$

Finally, environmental factors that are unique to each member of a twin pair is simply the residual term.

$$e^2 = 1 - h^2 - c^2$$

It is clear from this set of equations that genetic variability is inferred from the relative degree of phenotypic similarity in monozygotic and dizygotic twins. This is not the same thing as observed genetic variability.

Moss makes this important distinction by referring to genetic variance inferred from phenotypic similarity as P- genes and observed genetic variance as D-genes. The critical point is that P-genes are not informative about DNA and that D-genes are largely not informative with respect to phenotypes. In fact, basic cellular biology texts make this point "...the relationship between genotype and phenotype is very obscure.structural similarity between proteins does not necessarily imply [DNA] sequence similarity".

As such, when the authors of this article state that genetic factors account for the majority of increased variance in perceived adolescents, they do not really mean genetic factors, what they really mean is that the discrepancy between the monozygotic correlations and dizygotic correlations has

increased. This is an interesting finding and could potentially lead to important insights into developmental processes, but the limited attribution of this finding to statistical genetic effects restricts further analysis. If structural sequences in the genome were isomorphic to genetic function and more importantly to protein function, then the inferred genetic variability assumed by behavioral genetic models might be more instrumental. However, genes, rather than being static structural entities, are dynamic processes. What is important is not solely their nucleotide structure, but also their linear spatial location in the genome, their spatial location in the intranuclear environment, their individual temporal patterns of expression, and the patterns of expression and inhibition across the entire genome. Moreover, gene expression is far from a straightforward process. It is highly dependent upon complex genetic regulatory networks as well as extracellular factors. Gottlieb identified no less than 16 empirical studies demonstrating behavioral/environmental factors affecting gene/protein expression. Moreover, a single gene is capable of synthesizing more than a single protein, which has severe consequences for relating genes to phenotypic outcomes as compared to the assumption that there is a one-to-one relationship between genes and proteins. Thus, knowledge of the gene sequence itself, without the developmental conditions differentiating when a given protein might be synthesized, provides little information about how gene sequences relate to proteins, let alone complex behaviors such as perceptions of adolescent-parent relationship quality.

Given this more dynamic, integrative systems understanding of gene expression, the conceptualization of the structural genotype as a set of special instructions guiding development then is in direct conflict with empirical findings. Structural sequences of DNA have no independent developmental information. It is only in the context of developmental transactions of gene-gene and gene-environment (broadly defined) regulatory networks that the genome takes on any developmental salience. This completely undermines the utility of inferring genotypic variation from the relative phenotypic correlations of monozygotic and dizygotic twins. When the authors of this article refer to proportions of variance due to genetic factors, they are really reporting variance due to both genotypic and epigenotypic variance. The latter term coined by Waddington to describe the "...organizers and organizing relations to which a piece of tissue will be subject to during development..." (cited by Van Speybroek, 2002, p. 69).

Indeed, in studies of some of the strongest behavioral candidates based on heritability estimates, such as schizophrenia and major depression, we find that actual genetic variability is not significantly associated with behavioral variability with effect sizes of <1% of covariance. Another purported benefit is to use behavioral genetic models to identify genetic predispositions or risks for developing various disorders. However, since there is such a disparate relationship between genetic mechanisms and observed phenotypes, this use of behavior genetic findings also has to be taken with caution. In a recent review of data regarding adult chronic disorders such as hypertension and diabetes mellitus, which are generally thought to be reflective of genetic predispositions, Gluckman and Hanson found that they are more highly related to prenatal environmental experiences than to statistically estimated genetic

susceptibility. So, the empirical literature seems to suggest, much as developmental biologists, experimental embryologists, and developmental psychobiologists have suspected, that the presence of a high heritability estimate provides little information about the relationship between actual genes and behavior.

A Developmental Systems Perspective on the Role of Genes in Development

Developmental psychobiology, which has close historical ties with both comparative psychology and experimental embryology, was also impacted by the methodological limitation surrounding a pivotal construct that no one had ever empirically measured. Chiefly, in the absence of an empirical gene, the field could only indirectly infer an alternative view of the role of genes in development. Because of the experimental tradition of developmental psychobiology, the arguments that ran counter to the central dogma of genetics, such as those made by Gottlieb, were derived from a much stronger logical position. A large portion of this entire body of empirical literature comprises studies which provide counterfactual evidence to the central tenets of behavioral genetics.

One of the strongest of these arguments against the central dogma of genetics is drawn from experimental findings supporting the norm-of-reaction concept. The norm-of-reaction concept is a relatively old concept in the field of embryology, which states that phenotypic variability is restricted in a population because the developmental ecology of a population is relatively homogeneous (i.e., normalized) and that under conditions of increased ecological variability, there would be an associated increase in phenotypic variability. This is in stark contrast to the reaction range concept, which posits genetic limits on phenotypic variability with a limited range of variance due to environmental conditions. A central idea is that there is substantial phenotypic plasticity latent in the genome and that it is the developmental ecology that serves as the limiting or normalizing source of phenotypic variance rather than the genome.

There are several classic empirical examples of this effect, notable is the difference in wing morphology in several species of *Drosophila*. As was the case for the *Drosophila*, differential temperature during embryonic development is a key extragenetic mechanism for affecting phenotypic outcomes. Temperature has been shown to directly impact not only broad morphological outcomes Kaplan & Phillips, but also molar developmental processes, including heterochronic differences in development, as well as intracellular processes such as rates of diffusion, enzyme-induced protein activity, and gene expression. Early experimental work on the pluripotency of cell lines also provided counterfactual evidence to the central dogma.

Yet, the field was largely in the position of arguing what genes could not logically do rather than what they in fact did; a much less appealing case. This developmental-oriented theoretical perspective differed from the standard central dogma perspective on a number of levels. On a substantive level, based on empirical observations, genes are considered to be participatory components of a much broader biopsychosocial system. Genes were likely important factors in the

development of phenotypic traits; remember there had not been any empirical investigation of a biological gene, but they could not serve as the reductive prime cause. As such, it was inferred that the gene could have no independent causal influence and rather worked through causal interactions among variables in an integrated hierarchy. Further, phenotypic development has been shown to be highly probabilistic rather than deterministic, a result of the continual dynamic transactions across the development of biological, psychological, and ecological variables.

The Impasse Between Genocentric and Developmental Systems Perspectives

On a much deeper level, the theoretical perspective of Gottlieb and his predecessors stood in stark contrast to the Newtonian worldview. Theirs was a perspective in which causes were multiply determined and where multiple causal events could lead to the same outcome; a perspective in which the idea of a deterministic cause was untenable; where hierarchical systems, like organisms, were determined by the dynamic patterns of relationships among their parts rather than by the additive attributes of their constituent parts. The argument between developmentally oriented theorists and the central dogma-oriented perspectives of many behavior geneticists was played out without either side having empirical knowledge of an actual biological gene. So, both sides based much of their conceptualization on indirect inferences. And, while the counterfactual experimental evidence of developmental psychobiologists was particularly condemning for the central dogma perspective, which was on much weaker logical footing, there was no methodological framework for laying out the developmental- and systems-oriented postulates of developmental psychobiology. As such, concepts such as emergence, integrative levels, probabilistic epigenesis, and horizontal and vertical coactions were relegated by opponents to being little more than descriptive heuristics.

Contemporary Molecular Behavioral Genetics

It is almost common knowledge among biologists and philosophers of biology...that the classical molecular gene concept is not sufficient any longer in the face of the complex interactive processes being reported by molecular biology.

(Neuman-Held, 2001, p. 69).

Neuman-Held and others also point out that since the end of the twentieth century, the very notion of just what a gene is has changed. It is no longer sufficient to speak of 'the' gene; the term has come to mean different things to different people. The term gene is now understood to be shorthand for several different kinds of units. It may be that 'gene' is not so much an identifiable *thing* as it is a *process* involved in binding DNA to other factors which act together in polypeptide production. At its inception, and indeed, until only very recently, the gene, seemingly so concrete and definitive a structure, was nothing more than a hypothetical construct in a statistical equation. Even with the discovery of the unique and highly functional

structure of deoxynucleic acid (DNA) by Watson and Crick, a little more empirical light was shown on the subject than simply having a molecule with the kinds of properties through which the hypothetical gene might work.

However, it is now understood that there is no explanation in attributing a trait, behavioral or structural, to genetics in light of what converging current research from several disciplines indicates. Many behavioral scientists, behavior geneticists, and evolutionary psychologists seem to be unaware of these recent developments in our understanding of genetics as Gottlieb and others have pointed out. It turns out that there is no information in the genome to be triggered or nurtured by the environment, though this is the current consensus in the behavioral and much of the biological sciences. This has been consistently and reliably demonstrated empirically in data from a large number of studies which give us a new picture of the role of genes in development in general. "For instance, genes are not informational in the way supposed, nor do they initiate or direct ontogeny, there is no such thing as a genetic programme, and there is no straightforward 'unfolding' relation from genotype to phenotype."

It is now known that genes do little more than code for the many different proteins that go into making up living things; the proteins are themselves incorporated into the ever-changing molecular and cellular structure and physiology that is an individual organism. Genes participate in turning reactions on or off, they function as catalysts. Similarly, they really operate by participating in the timing of important chemical events. When the default schedule is followed, certain interactions inevitably occur. "There is no need for genes to encode and control those interactions directly. Instead, they follow from the laws of physics, geometry, topology – laws of great generality."

In this context, it is useful to recall the distinction between the genotype and the phenotype. The genotype is the actual genetic code, the genetic blueprint that influences every cell of our bodies. As all cells trace their beginnings to a single daughter cell, the genotypes of each cell must be identical. The result of how those genes express themselves is the phenotype, but there is no direct relation here. It is not the case that the genotype codes for the phenotype. While all cells have the same genotype, some become bone cells, some blood cells, some skin cells. Human beings possess some 256 different types of cells. These different cells arise as a result of epigenetic forces acting upon the genes to cause them to express themselves in different ways (e.g., "Cellular differentiation is a classic example where epigenetic phenomena have a critical role"). Genes express themselves in the context of a field of internal and external forces which impinge upon them. It is known that in addition to a cell's own internal chemistry, genes can be switched on and off by signals from other cells and from other aspects of the environment, including positional information, referred to earlier in this article. "The path linking genes or molecules to the expression of behavior is long and complex... There are innumerable ways genes can influence development, physiology, and the nervous system to affect behavior. Further, the genome has a dynamic relation with behavior, and each influences the other through complex regulatory mechanisms." The relation between genetics and behavioral phenotypes is extremely indirect. Thus, two strains

of inbred mice, C57BL10J and A/J, differ substantially in their aggressive behaviors, not a result of their inheriting aggressive or nonaggressive genes, but rather the result of their sensitivity to stimulation, a biological factor that is indeed an inherited trait, much as myopia is in human beings. The title of a review of T. C. Schneirla's writings reflected this: 'A long way from genes to behavior'.

The field of molecular biology has learned a great deal about the functioning of genes in the past few decades, exploding a number of ideas we now see to be myths. These include the notion that single genes affect single traits – eye color for example. While some single gene/single traits are known to exist, the common mode is for genes to act in concert with others. What a gene does, then, is very much influenced by which other genes are being turned on or off at any particular time during development. In other words, genes do their work along with other genes, rather than individually. The developmental process, then, is not a predetermined one, but, rather, a probabilistic one. Put another way, "Since it has become evident that genes interact with their environment at all levels, including the molecular, there is virtually no interesting aspect of development that is strictly 'genetic,' at least in the sense that it is exclusively a product of information contained within the genes."

Genes and Development

A common question, whether implicitly or explicitly posed, in theoretical papers regarding genetics, evolution, and development, asks what the role of biology is in shaping development. Such questions take the form of hypotheses regarding the relation between a given allele and trajectories of behavioral outcomes such as adolescent smoking or the heritability of attachment or the findings of fMRI studies correlating age-related declines in spatial abilities with changes in regional neural metabolism during a spatial memory task. In the case of evolution, if the research questions posed are even reasonably empirically testable, they tend to be framed in the form of the constraints that evolution places on behavioral development. Alternatively, evolutionary perspectives simply articulate putative adaptive explanations for developmental phenomena. In all of these situations, there is an underlying assertion that development is subsidiary to evolutionary trajectories and biological factors. In other words, ontogeny is a function of phylogeny and behavioral development is shaped by the organism's biology. From this perspective, biology is the fundamental and guiding force that drives individual differences in developmental trajectories of behavior.

However, a relational holistic position takes a dramatically different perspective on the relations between biology, evolution, and psychological development. From this perspective, development is an active system of processes superordinate to biology and evolution. Thus, it is not that the gene or evolution explains development, but that the developmental system explains the functioning of both the gene and the evolution. From this perspective, it is the developmental system that integrates biological functions into coordinated patterns which support behavior. It is the process of development that shapes biological organization and provides a temporal context

for biology–behavior–ecology interrelations. So, the question really is how does development shape biology and the relation of genes and neurons with behavioral outcomes in a given environmental context?

In endorsing this relational holistic position, we believe that the focus of study in psychology should be on the pattern of interrelations between biological structure, psychological states, and ecological contexts. A clear characterization of development, be it biological or behavioral, is that organisms are initially comprised of relatively undifferentiated biological and behavioral features which over time become increasingly differentiated and reintegrated into a coherent biological and behavioral system. It is the probabilistic epigenetic and self-organizing principles of development within a dynamic ecological context that shape the process of differentiation and integration which characterize a given individual's genetic, neurological, and behavioral attributes, rather than the other way around.

As early as 1929, Woodger made a very important distinction between the study of development in the form of embryogenesis and the study of genetics. The study of development has, as its focus, the patterns of biological and behavioral differentiation within a single organism over time. This notion of development is echoed in the recent work of Nesselroade and colleagues (e.g., see also Nesselroade & Molenaar, this volume) emphasizing the importance of methods for the study of intraindividual variability. However, the study of genetics has, as its focus, the pattern of differences in attributes between organisms at a given point in time. In relating the two sciences, Woodger stated that even at the turn of the twentieth century, the source of individual differences in patterns of differentiation were sought both in the nucleus and in the cytoplasm of the germ cells, yet these attempts were unsuccessful. But despite the consistent lack of empirical support for the genesis of developmental differentiation in the physical attributes of the germ cells, it is an assumption that has yet to yield. However, what has consistently been demonstrated empirically from experimental embryology at the turn of the twentieth century to contemporary molecular genetic studies is that the physical attributes of the cell, including protein formation and structure, are a direct result of developmental transactions of the biological aspects of an organism and the environmental context of that organism. As Woodger put it

The cells of a given developing embryo are internally related to one another in the sense that the rate and plane of division, at least, of a given cell, depend upon its relations to the neighbouring cells, and hence on its position in the whole. . . . At a certain period of development the cells of an embryo undergo intracellular elaboration depending partly on their mutual relations, and partly on their intrinsic properties so that the latter may be the same in all cells, [and] which of them are realized in a given cell will depend upon its relations to the whole, which will of course differ from place to place. (p. 384)

And so it would seem that nearly 90 years of empirical findings suggest that rather than searching for the source of intraindividual differentiation in interindividual differences, we should perhaps be looking for the source of interindividual differences in the patterns of intraindividual differentiation. The sequencing of the human genome has not yielded the

scientific fruit for behavioral science that many leading behavioral geneticists envisioned, as we discussed earlier. Rather, there has been a realization among cell biologists that genes do not carry biological or developmental information, and that they have the capacity to differentially respond to environmental and developmental signals originating at multiple levels of biosocial organization. As a result, there has been a resurgence of interest in epigenesis as a developmental process and of epigenetics as a mechanism through which genes and contexts transact through development.

While the concept of epigenesis originated in biology, with respect to behavioral development, the usefulness of *probabilistic* epigenesis was recognized and promoted throughout the twentieth century by psychologists such as Zing-Yang, Gilbert Gottlieb, Susan Oyama, and T. C. Schneirla, though Schneirla never specifically employed the term epigenesis in his writings. Probabilistic epigenesis has gained support from an exciting set of developments in contemporary science subsumed under the rubric of 'dynamic systems theory and relational developmental systems theory' in which complex developmental processes are understood as composed of interrelations among many active system components of the whole developmental system. The implication of this position is that in a dynamic and changing environment, rather than genes specifying a particular developmental outcome, be it structural or behavioral, *every outcome is an emergent result of the transaction between genes and their cellular, organismic, ecological, and temporal contexts*. This view of epigenesis is epitomized by recent discoveries in biology that even identical genomes in extremely similar environments do not always follow the same developmental pathways. Ko and colleagues studying enzyme activity in bacteria found that despite identical genomes and extremely uniform culture conditions, individual cells developed different levels of enzyme activity and grew into colonies of different sizes. Ko's studies showed that cell state in bacteria is determined not only by genotype and environment. Rather, "Changes of state can occur spontaneously, without any defined internal or external cause. By definition, these changes are epigenetic phenomena: dynamic processes that arise from the complex interplay of all the factors involved in cellular activities, including the genes" (Solé and Goodwin, 2000, p. 63).

In an impressive review of developmental processes shaping biological phenotypes, Rudel and Sommer have identified ten basic developmental principles that can adequately describe biological development. What is perhaps most intriguing about these principles is how few of them are genocentric. In fact, nearly all of them involve either epigenetic factors or epistatic genetic regulation.

Molecular Behavioral Genetics

Over the last decade, there has been substantial advancement in behavioral genetics as a result of being able to incorporate genes and their functions into traditional behavioral outcome studies. Three assessment techniques in particular have been quite valuable. The first quantitative trait loci (QTL) is a method for producing genetic maps of nucleotide sequences and comparing differences in a parent sample to those of an offspring sample

and correlating those differences to phenotypic outcomes. This technique is primarily aimed at identifying chromosomal regions in which heterogeneous allele distributions are associated with phenotypic variance. QTL provides a starting point for later molecular genetic analyses to link mechanisms of genetic expression to endophenotypes (neural mediators of behavioral outcomes). For example, QTL analyses have pointed to several candidate genes that appear to be associated with key socioemotional and behavioral outcomes. Foremost among these include the DRD4 gene and 5-HTT genes. The DRD4 gene is the dopamine D4 receptor gene and has been associated with a wide array of behaviors, including ADHD, externalizing behavior, and dimensions of temperament, including activity level and impulsivity. The 5-HTT gene is one of a series of serotonin transporter promoter genes that have been associated with more internalizing disorders as well as temperamental negative affect and anxiety. That these two genes have been associated with this broad array of behavioral outcomes is not surprising, given the well-known roles of dopamine and serotonin in molecular neuroscience and psychopharmacology, giving credence to the initial relationships demonstrated via QTL analyses.

However, a second key methodological technique, single nucleotide polymorphism (SNP), has demonstrated a more complex relationship between genetic variation such as those seen with DRD4 and 5-HTTLPR. SNPs are a more targeted analytic approach in which variance in the allele of a specific gene is correlated with variance in behavioral outcomes. The DRD4 gene, for example, has a 48 base pair variable number tandem repeat (VNTR) in exon 3. These repeats range in number from 2 to 11 and there is significant variance across individuals in the number of repeats. The DRD4-7r is a 7 repeat allele and seems to be less responsive to dopamine molecules (xxx) and seems to be associated with the array of behavioral outcomes described previously. Interestingly, but not surprising to many developmental psychobiologists, the association with behavioral outcomes is highly context-dependent. Caspi et al first described the strong influence of behavioral context on gene-behavior relationships in their landmark study showing that a variant of the 5-HTT gene was associated with adult depression, but only in the context of elevated life stressors. Similarly, we see this pattern of gene X environment interaction or as more recently referred to as gene X environment interplay.

The role that genes play in behavioral development across the life span is a perennial source of enthusiasm and controversy in psychology. Driven by the remarkable progress in molecular genetics research over the last decade, this discourse has reached yet another watershed for developmental science. Indeed, the focus of debate has moved away from the traditional nature-nurture controversy to a broad acceptance of gene-environment interactions or interplay. As such, the manner in which genes and environments mutually effect each other and how their interplay conjointly influences behavioral trajectories is the overarching question driving contemporary gene-environment research. For instance, there is a growing recognition that genes do not necessarily code for any specific phenotypic outcome, but rather play an interdependent role in the potentialities of a phenotypic dimension. Recent research trends incorporate the growing recognition that genetic effects

need to be considered at an appropriate level of analysis and that they are participatory components of a dynamic, integrated biopsychosocial system. There is also a growing recognition that structural features (i.e., nucleotide sequences) are of less consequence than the functional synthesis of proteins. No more profound finding has emerged from the plethora of molecular genetic research than the dissolution of the dogma of a one-to-one relationship between a given nucleotide sequence and the resulting protein. The same gene can synthesize different proteins, depending on the spatial and temporal context of the synthesis process. This has led to much greater recognition of the probabilistic epigenetic approach to gene functioning, as well as the adoption of a norm-of-reaction (as opposed to the more traditional reaction range) concept in relating genotype to phenotype. Finally, with the ability to measure genetic effects directly, there has been a marked increase in our understanding of the consequences of ecological effects on the functional genome. This has moved gene-behavior research toward a more dynamic and transactional model of gene-environment interplay.

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Moral Development

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Glossary

Autonomy The capacity to govern oneself according to one's own reasoning.

Disequilibrium The first part of stage transition in which the equilibrium or balance achieved at a particular stage is disturbed by a cognitive conflict.

Heteronomy The subordination of the self to an external authority, law, or source of influence.

Intentionality The child's ability to take into account intentions and motives in making judgments of praise and blame.

Longitudinal study A method that assesses the same individuals over time.

Perspective or role-taking stages Stage that describe the ability of children to take the view of others and to coordinate different viewpoints.

Structural wholeness The assumption that a cognitive developmental stage is characterized by an organized pattern of reasoning that underlies particular content considerations of moral choices and values.

Transformational model A model of stage development in which the lower stages are integrated by the higher stages.

A Historical Overview

Introduction

How humans develop from impulse-governed infants to morally responsible adults has been a question of perennial concern and debate since the time of ancient Greece. Socrates, for example, believed that one's morality developed through rational inquiry into the nature of the good. He, therefore, challenged the youth to question the morality of the status quo, a practice that led to his being sentenced to death. Aristotle, on the other hand, emphasized the role of habituation in forming virtue. In his view, individuals learn how to be moral much the way apprentices learn their craft.

In the first half of the twentieth century, the discussion of moral development took a more radical turn as psychoanalytic and behavioral psychologists called into question the very notions of universal morality, character, and virtue. The most significant of all research at this time was Hartshorne and May's landmark study of deception, self-control, and service. They indicated that moral behavior does not depend on an individual's character or virtue but is a function of influences operating in the situation. Following Hartshorne and May, the psychological study of morality, as it has traditionally been understood, practically ceased, until the cognitive developmental approach of Piaget and Kohlberg took hold in the 1960s and 1970s. That approach dominated the field of psychology well into the 1990s. At the turn of the century, evolutionary psychology, neuroscience, and cultural anthropology have challenged the foundations of the cognitive developmental approach. On the other hand, Turiel's domain theory and Blasi's investigations into the moral dimensions of the self have refined and enlarged the scope of the cognitive developmental approach.

Psychoanalytic Theory

Psychoanalytic theorists take their definition of what is moral from the norms and values of the existing culture. They describe the operation of becoming moral as the internalization of those cultural norms and values in the superego through a process of

parental identification, which according to Freud, culminates in the resolution of the Oedipal conflict at age 5 or 6. In their research, they typically look for correlations between early childhood parenting and behavior, and between the arousal of guilt and behavior. This paradigm presents the essence of moral functioning as following one's conscience in order to avoid guilt. Given the irrational nature of the superego, psychoanalytic theorists are concerned not only that cultural standards are upheld but also that the superego does not become excessively punitive.

Social Learning Theory

Social learning theorists tend to equate morality with societal norms and more broadly with other-oriented or altruistic actions. Like the psychoanalytic theorists, they maintain that individuals become moral through the internalization of those societal norms. In place of processes of parental identification, however, social learning theorists, such as Bandura, attempt to demonstrate that norms are acquired not only through external rewards and punishments but through observational learning and intrinsic reinforcement. Children are, in this view, initially motivated to satisfy their own needs and desires. They are then shaped or socialized by environmental mechanisms to find satisfaction in socially approved and other-oriented actions. The test of a person's morality is thus whether she or he will adhere to a social norm or perform an altruistic action without the expectation of a reward or punishment.

Cognitive Developmental Theory

Cognitive developmentalists reject the assumption shared by psychoanalytic and social learning theorists that morality can be equated with culturally relative standards. Taking an explicitly philosophic stance, they maintain that morality is a process of adjudicating conflicting claims on the basis of universally recognized principles of justice and benevolence. Cognitive developmentalists see moral development as occurring through a sequence of stages in which individuals reason about moral

problems in progressively more adequate ways. In contrast to psychoanalytic and social learning theorists, who view the child as being passively formed by environmental forces, cognitive developmentalists picture the child (and later the adolescent and adult) as developing a personal moral perspective through interacting with the environment.

Piaget's Theory

The Moral Judgment of the Child

The study of moral development as we know it today drew its initial inspiration from Jean Piaget's seminal study, *The Moral Judgment of the Child*; it is the fifth of a series of books that Piaget published at the beginning of a highly productive career. Developmentalists either have focused directly upon these studies to elaborate, refine, and confirm their conclusions or, like Kohlberg, have used Piaget's ideas and methods as a springboard for their own theories. *The Moral Judgment of the Child* is subdivided into three empirical parts and a fourth theoretical part in which Piaget contrasts his views on moral development and education with those of other theorists, most notably, the great French sociologist Emile Durkheim.

Heteronomy and Autonomy

In the first part of *The Moral Judgment of the Child*, Piaget examines the ways in which children from the ages of 3–12 understand and apply the rules of marbles and hopscotch, the most popular children's games in French-speaking Switzerland. Piaget believed that by studying children at play, he could penetrate into their own moral world, a world that they were attempting to understand and control on their own terms. Feigning that he had forgotten the rules of the game, he asked the children to teach him and let him play with them. He then proceeded to ask the children about the various shots in the game and how to determine the winner. All the while, he played the game as seriously as he could, letting the children beat him to sustain their sense of superiority but making an occasional good shot to avoid being dismissed as incompetent. Having determined children's 'practice of the rules,' Piaget proceeded to inquire into their consciousness of the origins of rules by asking such simple questions as Can you make up a new rule. Would it be all right to play like that with your pals. Have people always played as they do today.

Piaget found that young children (usually under the ages of 8) typically believed that adults made the rules and the rules could not be changed. On the other hand, older children (usually over the age of 9) readily believed that they with their peers were authorized to make and change rules. Piaget theorized that children's belief in the creation of rules by adult authorities reflected a quasi-mystical, heteronomous respect for the rules, while older children's belief in their own power to make rules reflected a secular, autonomous respect. As is most evident in the final section of his book, Piaget's perspective was deeply influenced by Durkheim, whose views on the sociology of religion and moral education were highly influential at that time. According to Durkheim, respect for rules could be generated only if the rules were regarded as emanating from a power superior to the individual. Durkheim's historical studies led him to postulate

that religion and morality were originally undifferentiated and that all rules were regarded as sacred because of their divine origin. With societal evolution, rules became secularized, but, retained their power to elicit respect because of their transcendent, societal origin. In Durkheim's view, rules elicited respect only if they were seen as issuing from a superior, quasidivine being. Individuals, therefore, had to look beyond themselves to the collective being of society as the authority behind the rules.

Piaget's entire book may be regarded as an effort to respond to Durkheim by showing that children develop an alternative, autonomous morality through cooperative peer relationships. Unfortunately, his preoccupation with Durkheim's view seems to have foreclosed his exploration of other types of moral reasoning, types later uncovered in Kohlberg's research. What Piaget's analysis loses in breadth, it gains, however, in depth by juxtaposing moral heteronomy with moral autonomy.

Egocentrism

Piaget found that children at the heteronomous stage flagrantly but unwittingly broke the very rules that they regarded as sacred and immutable. Piaget explained this paradox as a function of childhood egocentrism. This term should not be confused with egoism or selfishness; it simply connotes children's inability to distinguish their subjective perspective from the perspective of others. As Piaget and others have noted, egocentrism is a salient characteristic of children's speech and play. For example, when telling stories or making requests, young children typically fail to take the needs of their listeners into account. They seem to assume that their listeners know what they are talking about. Similarly, when young children play with one another, they tend to parallel play or play as individuals in the company of others.

Although young children tend to behave in egocentric ways, there is considerable debate over whether their egocentrism should be regarded as a stage of cognitive immaturity. Some research indicates that very young children are capable of altering their speech and actions to meet the needs of others, and Piaget himself had noted that even adults can be egocentric in expressing their opinions. There are other studies, however, that have reconceptualized the egocentrism construct to consist of a stage of perspective or role taking in turn influences concepts of the self, friendship, groups, and morality.

Overlooked in this debate, as Youniss has noted, is the relational dimension of the egocentrism construct. Piaget consistently maintained that the unequal relationship that children have with adults fosters egocentrism by encouraging children to submit to the adult authority. On the other hand, the equal relationship that exists among peers encourages children to consider their perspective in making reasonable decisions through mutual agreement. Piaget's relational perspective on moral development leads to the radical conclusion, elaborated in a provocative study by Youniss, that peers, not parents, play the decisive role in promoting moral development.

Intentionality

In the next section of the book, Piaget examined children's modes of moral evaluations with a focus on the origin of children's awareness of intentionality. The best known of his

queries asks who was the naughtiest, a child who knocked over 15 cups accidentally or a child who broke 1 cup in an act of disobedience. Piaget found that children below 8 or 9 years old typically based their judgments of culpability on the extent of material damage. The older children, however, recognized the moral relevance of the intentions of the actors. Conceding that objective responsibility may largely be a function of the way in which parents respond to children's clumsiness, Piaget observed that his own young children made spontaneous judgments of objective responsibility, even though he and his wife were careful not to punish or blame their children for unintentional damage. Furthermore, Piaget found that when considering cases of stealing and lying, younger children tended to make judgments of objective responsibility that their parents would be very unlikely to make. For example, the younger children regarded lying as saying something untrue, whether or not the misstatement was made intentionally. The mere violation of moral rule was a sufficient determinant of guilt. As in his discussion of egocentrism, Piaget attributed young children's failure to differentiate moral from physical laws (moral realism) and intentions from consequences partly to their immature thinking and partly to authoritarian child rearing practices.

The Two Moralities of Childhood

In the third section of the book, Piaget studied children's conception of punishment and distributive justice. Although his data indicated that development generally proceeds from heteronomy to autonomy, the many exceptions to this pattern suggested that heteronomy and autonomy are not sequential stages but two irreducible types built on different relational foundations. For example, Piaget found that young children see expiatory punishment as fair only in the adult-child relationship, whereas, in the child-child relationship, children at all ages favor what Piaget called punishment by reciprocity, that is punishment aimed solely to make the transgressor aware of the undesirable consequences of his or her misdeed.

Post-Piagetian researchers, as indicated, have tended to view sociomoral development in a more cognitive and less relational framework than Piaget. Although this may have led many researchers to underestimate the effects of constraint and cooperation on sociomoral problem-solving, it also led to important breakthroughs in the study of such topics as perspective-taking and intentionality. Furthermore, in the case of moral development, the cognitive developmental focus has led away from the two morality hypothesis to a unitary process of stage development.

Kohlberg's Theory

The Moral Domain

When asked to give his views on moral development and education, Lawrence Kohlberg was fond of citing Socrates' response to a similar request at the beginning of Plato's *Meno*: "You must think I am very fortunate to know how virtue is acquired. The fact is, far from knowing whether it can be taught, I have no idea what virtue really is." Kohlberg, like Socrates, did not believe that one could address questions of moral psychology and

education without first attempting to define in a philosophically justifiable way the nature of morality. Yet in the mid-1950s, when Kohlberg began his dissertation research on moral development, social scientists paid little if any attention to the philosophical presuppositions of their work.

Kohlberg was particularly distressed by the claim prevalent in social learning research and psychoanalytic theory that moral development reduces to the internalization of the rules and practices of one's society. Having become involved in the Hagganah's effort to smuggle European Jewish refugees into Israel following the Holocaust, Kohlberg was committed to an understanding of morality that transcends the status quo and provides a rational basis for responsible social criticism. He also questioned the assumption that morality can be reduced to culturally relative norms and values. Such an assumption, based on observed cultural differences, blurs an important distinction between morality and custom or social convention. Moral norms and values, such as prohibitions against causing physical injury, concern the rights and welfare of individuals in any societal arrangement. Customs or conventions (e.g., table manners), on the other hand, concern socially imposed rules that provide a certain order and decorum but are not recognized as obligatory in the same sense as moral norms.

In addition to differentiating morality from custom, Kohlberg also distinguished morality from personal and religious values or the right from the good. Underlying the distinction between the right and the good is a recognition that what is right or moral is obligatory, whereas what is good is left to individual choice, as long as it is in harmony with what is right. Kohlberg used this distinction to argue that moral education could be undertaken in public schools without violating the separation between church and state or without indoctrinating personal values.

Following up on Kohlberg's philosophical attempt to delineate the moral sphere, Turiel and his colleagues have proposed that morality, convention, and personal values comprise three conceptual domains, each with its own developmental trajectory. Their research indicates that even very young children are capable of distinguishing moral violations from violations within the other domains. Such findings confirm the wisdom of Kohlberg's effort to base his research on a carefully defined conceptualization of morality, even as they call into question whether he consistently distinguished the moral from the conventional in some of his stage descriptions.

The Moral Judgment Interview

Kohlberg's definition of morality as justice, his emphasis on studying the development of moral reasoning, and his aim of charting moral development throughout the life span led him to construct a semiclinical moral judgment interview. His original interview posed ten hypothetical moral dilemmas drawn, not from familiar episodes in the world of children (as were Piaget's) but from challenging problems in the world of adults. Kohlberg regarded the Heinz dilemma (slightly abbreviated here) as his best:

In Europe, a woman was near death from a special kind of cancer. There was a drug that could save her but the druggist was charging twice as much as the sick woman's husband, Heinz, could raise.

Heinz pleaded with the druggist, but the druggist said, "No, I discovered the drug and I'm going to make money from it." Heinz has exhausted all other alternatives, should he steal the drug?

The Heinz dilemma puts subjects in the uncomfortable position of having to decide between his wife's claim to life and the druggist's legally sanctioned claim to property. The point of the interview is not to identify subjects' action choices but to examine the ways in which they justify their choices; therefore, interviewers are instructed to ask subjects to present, elaborate, and clarify their arguments.

Levels and Stages

Kohlberg's current theory describes a sequence of six stages grouped into three levels: the preconventional level (stages 1 and 2), the conventional level (stages 3 and 4), and the postconventional level (stages 5 and 6). As the labels indicate, the levels are determined by the perspective taken on the moral expectations (rules, roles, norms, and values) of the conventional social order. The word 'conventional' connotes simply what is commonly accepted and should not be confused with Turiel's use to mean a non-moral custom. At the preconventional level, conventional expectations are seen as external to the self. The obligation to follow such expectations comes not from their intrinsic worth or their place within the social fabric but from the mere fact that they are commanded or that noncompliance is punished. At the conventional level, conventional expectations are internalized. Conventional expectations are respected because individuals value their membership in society and want to be regarded as upstanding members of their communities. At the postconventional level, conventional expectations are subordinated to general, foundational principles. Conventional expectations are critically appraised according to such principles from a prior to society perspective, that is from the perspective of a moral agent aware of basic rights and values that all societies should recognize.

Like the levels, the structural core of the stages depends upon what Kohlberg calls the sociomoral perspective of the subject. At stage 1, individuals are, to use Piaget's term, egocentric: they fail to differentiate their perspective from others, particularly those in authority who are valued for their superior size and power. As a consequence, those at stage 1 believe that rules are to be obeyed for their own sake or for the avoidance of punishment, which is seen as inevitable. For example, children at this stage often state that Heinz should not steal the drug simply because stealing is wrong or because his theft will be punished. At stage 2, individuals are aware that individuals have concrete wants and desires and that such wants and needs can come into conflict. It is right to pursue one's interests as long as others are not prevented from pursuing theirs. Individuals at this stage sometimes justify Heinz's stealing simply by appealing to his wife's need or to the presumption that anyone in Heinz's situation would not want their wife to die or would automatically do what was necessary. They will likewise justify Heinz's not stealing by noting that the risk of punishment may not be worth it. Conflicts of interest are to be settled by making deals. For example, Heinz should steal the drug for his wife in return for what she has done for him or because he may need a favor from her sometime.

At stage 3, individuals take a third-person perspective and view themselves and others not only as individuals, but also as members of relationships or small groups. They seek to uphold shared expectations for good behavior and value sympathetic and prosocial motives. For example, subjects will argue that Heinz should steal the drug because he loves her or because he is her husband. On the other hand, they will also argue that Heinz should not steal because stealing is selfish or takes advantage of the druggist who works hard. At stage 4, individuals assert that the social system and respecting of laws and legal processes are necessary for maintaining social order. Just as they see the need for consistency in society, they also see the need for developing individual character and respecting the dictates of conscience. At this stage, individuals sometimes maintain that Heinz should not take the law into his own hands by stealing. They will, however, also maintain that stealing may be justified in response to an idealized natural law that is higher than the human law.

At stage 5, individuals take a prior-to-society perspective and judge the moral worth of rules and values insofar as such rules and values are consistent with more fundamental considerations such as liberty, the general welfare or utility, human rights, and contractual obligations. They typically argue that Heinz should steal the drug because the right to life is more basic than the right to property. At stage 6, individuals take a procedural or dialogical perspective on decision-making. What is right is what would be freely chosen by all interested parties who take one another's point of view into account and who respect others as equal and autonomous persons. Those at this stage make explicit appeals either to a procedure for adjudicating claims or to universal, regulative principles of justice.

The empirical status of stage six is uncertain. Although stage 6 continues to be listed in the table of stages, the current scoring manual provides only criterion judgments through stage 5 because no stage 6 examples were found in the longitudinal sample. The current formulation of stage 6 is embedded with the contractarian tradition in moral philosophy extending from Rousseau and Kant to Rawls and Habermas. Such a formulation and the fact that the few examples of stage 6 cited by Kohlberg come from individuals with philosophic training suggest that stage 6 may not be a psychological stage but a philosophical position.

Reliability and Validity

At the very heart of cognitive development theory are the assumptions of invariant stage sequence and structural wholeness. The test of invariant sequence is whether individuals develop through the stages in ascending order without skips or reversals. The test of structural wholeness is whether individuals respond to different kinds of moral dilemmas by using the same or adjacent stage reasoning. These assumptions have guided efforts over the years since Kohlberg's dissertation to refine the stage description and methods for scoring the interviews. The early definitions and procedures for scoring were based on moral content, that is, the moral concerns and values typically associated with a particular stage. For example, a simple statement of concern for law and order was scored as stage 4. At the 10th year of Kohlberg's longitudinal study, problems of regression and stage heterogeneity across the

different dilemmas called the cognitive developmental assumptions of Kohlberg's theory into question. Case analysis indicated that regressions were occurring because content, like the law and order concern, was being coded as stage 4 regardless of its meaning in the larger context of the interview. Kohlberg thus revised both his stage definitions and his scoring method to focus on structure rather than on content. Because the structural scoring method required far greater interpretive judgment than the earlier method, interrater reliability suffered for a time, prompting critics to challenge the empirical foundation of the theory.

In response, Colby, Kohlberg, and their colleagues developed the present Standard Issue Scoring Manual, which supplements the structural scoring process by providing over 700 prototypes (criterion judgments) of common responses to nine dilemmas. Stage scores are assigned by matching arguments in the interview to these criterion judgments. This new method achieves high interrater reliability (from 88% to 100% agreement within a third of a stage) by eliminating much of the subjectivity in the structural coding method, while, nevertheless, providing guidance for distinguishing content from structure.

The case for the validity of the measure is based on how well longitudinal data support the major theoretical assumptions of invariant sequence and structural wholeness. Three major studies, of US males, of Turkish males from rural and urban areas, and of male and female adolescents from an Israeli kibbutz, were used to determine the validity of the construct. All of the studies show that development proceeds through an invariant sequence. There were no instances of stage skipping or stage reversal within the limits of measurement error (determined through test-retest instability). All of the studies also indicate that development proceeds as a structured whole. Individuals generally respond to different dilemmas using one or two adjacent stages (e.g., at stages 2 and 3). Cases in which three stages are used are infrequent (<10%). The data thus support Kohlberg's major theoretical claims as well as the adequacy of the methodology.

Cross-Cultural Validity

Longitudinal studies in Turkey and Israel and cross-sectional studies in over 25 Western and non-Western countries, which include populations from both urban and traditional folk societies, generally support the universality of the moral stages. Although content differences were found and stage development in folk societies rarely got above stage 3, the interview responses were generally codable with the new manual and the pattern of the sequential stage development and structural wholeness was similar to that of the US longitudinal sample.

New Directions

The Defining Issues Test

The Defining Issues Test (DIT) was developed by Rest as an alternative to the moral judgment interviewing and scoring procedures for individuals at or above a 12-year-old reading level. It presents participants with stage prototypic responses to six moral dilemmas and asks them to rate and then rank

their preferences. Although the DIT has been widely and successfully used as a proxy for the clinical moral judgment method (it correlates moderately well with the Kohlberg measure), it is an important measure in its own right. The DIT measures individuals' comprehension of and preference for moral arguments. Finding considerable rating and ranking heterogeneity in the DIT and charging that Kohlberg's scoring procedures have tended to smooth over significant stage irregularities, Rest and his colleagues have proposed that a moral schema model of development may be more adequate than Piaget and Kohlberg's transformational or displacement stage model. Support for the schema model comes not only from DIT research but also from studies indicating considerable stage heterogeneity when comparisons are made between standard and nonstandard moral dilemmas and between hypothetical and real-life dilemmas. Furthermore, most post-Piagetian psychologists, influenced by cognitive psychology, prefer a more differentiated and incremental approach to development. The evidence favoring the holistic, transformational model comes from production tasks, like the moral judgment interview, which is designed to assess the moral reasoning competence and to facilitate the interpretation of discrete ideas into a more comprehensive framework.

Early Childhood Development

Kohlberg's longitudinal sample begins with 10-year-olds because the original intent of his research was to build upon Piaget's work. The nature of his moral dilemmas would have precluded his starting much earlier because they were specifically designed to describe how individuals develop the capacity to resolve moral problems in the adult world. Yet, such dilemmas emphasize the limitations of children's thinking (as is evident in the punishment and obedience description of stage 1). Returning to Piaget's method of presenting children with familiar problems, Damon demonstrated that the sociomoral conceptions of young children (ages 4–9) in the areas of distributive justice, friendship, and authority develop through surprisingly varied and sophisticated developmental levels. For example, in describing the development of children's resolutions of distributive justice problems, Damon described a six-level sequence in which children based their judgments on the following sequence of considerations: their own desires, strict equality, merit, equity, and combinations of merit and equity that best serve the common good.

More recent work by Kochanska suggests that the precursors of conscience develop in toddlerhood when children demonstrate a capacity for understanding rules and a willingness to comply with them. Conscience develops in the preschool years and later as children monitor others' thoughts and feelings in relation to their own and develop the emotions of shame and guilt.

Gender and Development

Gilligan has since the mid-1970s charged that Kohlberg's stage theory is biased against women because it describes the justice and rights orientation favored by males, while it neglects the care and responsibility orientation favored by females. She attributed the one-sided orientation of Kohlberg's

approach to his embeddedness in the Western male philosophical and psychological traditions, his all-male sample, and his use of hypothetical moral dilemmas, which were better suited to males, who preferred abstractions, than to females who preferred context. Originally, support for Gilligan's critique came from several studies showing women's moral judgment scores were, on the average, lower than those of men. Yet, reanalyses of those studies indicated that once adjustments were made for education and occupation, differences between men and women disappeared. Gilligan has, nevertheless, persisted in her claim that an alternative theory is needed to describe women's moral voice. She maintains that Kohlberg has overlooked the dynamics of relatedness and interdependence, dynamics that require a radically new approach to moral psychology.

In spite of the popularity of Gilligan's criticism, there is little evidence to support the view that men and women follow radically divergent development paths. On the other hand, Gilligan's analyses suggest that men and women may have somewhat different moral concerns and sensitivities.

Culture and Morality

Drawing on anthropological research, Shweder argues that although individuals across cultures share similar moral concepts, individuals adopt culturally diverse ways of thinking and valuing. Shweder believes that Kohlberg and Turiel's approaches to moral development fail to articulate distinct ethical systems, which characterize different cultures. Shweder identifies three different ethics: autonomy, community and divinity, which have their own views of the person and their own kind of moral reasoning.

Moral Judgment and Moral Action

In an effort to organize the literature on moral action and to integrate relevant research in areas other than cognitive moral development, Rest has proposed that the internal processes leading to moral action be divided into four sequential components or phases: (1) interpreting the moral situation, (2) formulating the moral ideal, (3) choosing a course of action in the light of one's moral and nonmoral values, and (4) executing one's choice.

The process of moral action begins with a perception that one is in a situation that is likely to require a moral response. Feminist ethicists have pointed out that key to this perception is what Weil and Murdoch have called attentiveness and what Noddings has called engrossment, a sensitive openness to and focused awareness of the needs, thoughts, and feelings of others. Their analyses as well as the studies of Eisenberg and Hoffman among others point to the critical role that empathy plays in motivating individuals to become involved and in providing information about the source of the other's distress and how it may be alleviated.

The second phase involves the reasoning and decision-making process that result in a moral judgment or in the determination of a moral ideal. The cognitive developmental approach has dominated the research in this area; yet, it has only identified deep structures of moral reasoning. Such structures do not directly predict behavior or action choices, yet, the

stages of moral judgment have been shown to be related to delinquency, altruism, resistance to the temptation to cheat, the clinical performance of medical interns, participation in the Berkeley Free Speech Sit-in, and a willingness to disobey in the Milgram experiment. In most studies, the higher one's moral stage was, the greater the likelihood that one would perform the putatively moral action.

In the third phase, individuals ascertain the extent to which they feel personally responsible for acting on their moral choices at the second phase. For example, many of those who participated in the Milgram experiment admitted that it was wrong to administer painful shocks, but nevertheless, believed that they did not have a responsibility to quit the experiment because they were following the instructions of the psychologist in authority. Blasi's research indicates that as individuals develop, they experience themselves as more autonomous, that is, as more personally responsible for their values, decisions, and actions. Judgments of responsibility, while related to cognitive moral development, appear rooted in the processes of identity and personality development. Colby and Damon found that moral exemplars could be characterized less by a high stage of moral reasoning than by the centrality of moral commitments to their sense of identity.

In the fourth phase, moral aims become moral deeds. Many personality variables play a role at this phase. For example, research by Krebs and Kohlberg indicated that stage 4 subjects with high ego strength were better able to resist the temptation to cheat than stage 4 subjects with low ego strength. Research by Haan showed that defenses and coping and self-assertion strategies play an important role in the way in which individuals interact in game-simulated moral situations. Recent studies by Oser and Weil suggest that moral action in the political realm requires specific organizational competencies.

Promoting Moral Development

Cognitive developmentalists generally explain stage change as the result of the disequilibrium brought about by experiences that are not readily assimilated within a person's existing cognitive structure. Such experiences are thought to lead to cognitive conflict, which in turn leads to the construction of a new stage. Experimental and educational research suggest that experiences fostering moral development provide at least one of the following conditions: (1) exposure to a higher stage of reasoning, (2) exposure to a conflicting opinion (at the same stage as one's own), and (3) perspective taking.

Relatively little attention has been paid to the role of families in promoting moral development. This is partly due to the research showing that moral development is not confined to early childhood as Freudians among others had posited but continues into adulthood. The lack of attention to the family may have also been influenced by Piaget's belief that the parent-child relationship tends to foster a heteronomous morality. There is a growing body of research, however, that indicates that the parenting style and the nature of family discussions play a significant role in stimulating moral development. Baumrind, for example, has found that the most effective parenting is neither authoritarian nor permissive, but authoritative. Authoritative parenting combines a high level of parent and child communication with control and

realistic demands. Focusing on family discussions, Power has identified that the patterns most conducive to moral development blend cognitive challenges with affective support.

Considerable research has been conducted on educational applications of moral development theory. The most widely used approach based on cognitive developmental theory is the discussion of moral dilemmas. Hundreds of studies have found that moral discussions led by a teacher-facilitator employing Socratic questioning techniques promote modest (about a third stage) but significant stage change.

Kohlberg, Higgins, and Power have developed a more radical moral educational strategy, the just community approach, which builds on Piaget's view that moral autonomy is fostered under conditions of equality and reciprocity. Just communities consist of a relatively small group (from 30 to 90) who take a core of courses together and who make and enforce their rules with their teachers in a direct participatory democracy. Research in the United States and Europe (e.g., by Oser) indicates that the just community approach not only promotes the development of moral reasoning but also nurtures the students' sense of responsibility and agency.

Key to the 'just community' approach is an emphasis on building a positive moral culture. This culture has been described in terms of the extent to which norms and values expressive of a relatively high stage of fairness and group solidarity are shared and upheld by members of the program. A positive moral culture appears to provide both a motivating and a disequilibrating context for moral development. Students are attracted to a democratic group that they perceive as genuinely caring. At the same time, students are challenged by membership in a group with high expectations for responsible behavior.

The EQUIP program for juvenile and adult offenders, which Gibbs and Potter devised, also emphasizes the importance of building a positive moral culture. The key to EQUIP is identifying and addressing cognitive distortions that trap individuals in immature ways of thinking and behaving.

Conclusion

The study of moral development emerged in the early 1960s as the seminal cognitive developmental studies of Jean Piaget

and Lawrence Kohlberg and captured the attention of developmental and social psychologists. The initial phase of cognitive developmental research focused on the description of stages of reasoning from childhood through adulthood. The current phase of research seeks to understand the relationship between moral reasoning and moral behavior by exploring dimensions of the self as well as the social environment.

See also: Altruism and Helping Behavior; Empathy; Judgment; Socioemotional Development.

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Moral Emotions

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Glossary

Compassion It is an emotional state in which the emotional capacities of empathy and sympathy are linked to an active desire to alleviate another's suffering.

Empathy It is an affective and cognitive response that stems from the apprehension of another's emotional state. The affective response is similar to what the other person is feeling. The cognitive response is the intellectual identification with the feelings of another.

Guilt feelings These are painful feelings of regret that are aroused when the actor causes or believes to have caused a transgression and accepts responsibility for violating internalized norms.

Happy victimizer It is a phenomenon in which young children expect a moral perpetrator to be happy, even though they understand the validity of the moral rule.

Moral emotions These are self-evaluative and other-oriented emotions, evoked by the individual's

understanding and evaluation of the self or by an affective response to the emotional state of the other.

Moral judgments These are making decisions and evaluations that are moral (i.e., based on internal principles).

Pride These are positive emotions that are generated when the self resists moral temptations and acts in accordance with obligations and responsibilities and/or if one is responsible for a moral action.

Respect It is a positive emotion of esteem for a person in his or her quality as a human being.

Shame It is a negative feeling that is evoked by the experienced wrongness of the aspects of one's being.

Sympathy It is a feeling of concern for the other stemming from the apprehension of another's emotional state, but it is not the same feeling as the other person may experience.

For centuries, psychologists and philosophers have debated on how to frame the role of moral emotions in human morality. Recently, this question has experienced a renaissance. Although the issue is far from resolved, there is a consensus that moral emotions and ordinary moral concepts are linked. For example, moral emotions, such as compassion or guilt feelings, are recognized as influencing a person's understanding of the prescriptive nature of the norms of fairness and caring. Therefore, developmental researchers have called for an integrative approach to the study of moral emotions and moral cognitions, as well as their emergence in human moral development.

Although moral judgments are assumed to be at the core of morality, it is also claimed that moral emotions help children and adolescents anticipate the outcomes of sociomoral events and adjust their moral action tendencies accordingly. Thus, moral emotions can serve as motives for morally relevant action. Moral emotions such as sympathy represent a genuine orientation toward the other's welfare; conjointly with moral cognition, they are important to the early development of moral action tendencies. Obviously, the relationship between moral emotions and moral action is complex. Thus, feelings of guilt do not necessarily prevent the violation of moral rules. Rather, their presence following a moral violation indicates moral awareness. This awareness of personal responsibility has been interpreted as an indicator of the beginnings of the moral self.

The aim of this article is to review selected current theory and research on central moral emotions such as guilt and shame in childhood and adolescence. We focus on the framework of the happy victimizer research paradigm, because most of the recent developmental research on moral emotions has

been conducted within this framework. Furthermore, we discuss relations between moral emotions and social behavior. Additionally, we describe educational approaches to enhance the development of moral emotions.

Defining Moral Emotions

Moral emotions are considered to be a key element of human moral experience. Typically, they are linked to the interests of society or other people. Developmental researchers have defined moral emotions as self-conscious or self-evaluative emotions, because they are evoked by the individual's understanding and evaluation of the self. Moral emotions may play an important (influential) role in why individuals adhere or fail to adhere to their own moral standards. Psychological theories on morality have described emotions such as guilt, shame, and compassion and also positively charged emotions such as pride as a quintessential part of children's emerging morality, because these emotions genuinely express the moral orientation of internalized norm orientation. Tangney et al., distinguished between self-conscious moral emotions (guilt, shame, embarrassment, and moral pride) and other-focused moral emotions (righteous anger, contempt, disgust, elevation, and gratitude).

Guilt has been defined as a painful feeling of regret over wrongdoing. Thus, guilt feelings indicate the self's awareness that he or she has acted in a morally wrong way and takes responsibility for his or her actions. They create desires to punish the self or to recompense. Shame has been defined as negative feeling evoked by the experienced wrongness of the

aspects of one's being. In contrast to guilt, ashamed people focus on devaluing and degrading aspects of the entire self, and it is often associated with the desire to undo the aspects of the self and/or self-destructive behavior. Embarrassment has been defined as a less intense form of shame. Compassion is defined as cosuffering. It describes an emotional state in which the emotional capacities of empathy and sympathy are linked to an active desire to alleviate another's suffering. It is viewed as the key component in what manifests in the social context as altruism, because compassion is seen to motivate care-taking behavior.

Positive moral emotions such as pride have been relatively neglected in research on moral emotions. Mascolo and Fischer define pride as an emotion generated by appraisals that one is responsible for a moral outcome. Moreover, researchers discussed other-oriented empathy as a morally relevant emotional process with both affective and cognitive components. Although empathy/sympathy is considered an important moral emotion, it is not being discussed in this article since it is being discussed elsewhere in this Encyclopedia. Finally, several researchers have considered respect as a moral emotion. Respect has been defined as a positive feeling of esteem for a person in his or her quality as a human being.

The idea that emotions are self-conscious and include evaluations shows that moral emotions are complex. Emotions such as guilt or sympathy are based on an understanding of the other person's circumstances and/or one's own internalized moral standards and constitute the basic motive in situations calling for moral actions. Thus, several researchers have argued that moral emotions are inevitably intertwined with cognitive moral processes. A strict distinction between cognition and emotions seems therefore not necessary in the concept of moral emotions.

Theoretical Model of Moral Emotions

Moral emotions such as guilt feelings indicate that the self feels committed to a norm. Thus, researchers have interpreted the existence of moral emotions as an early precursor and antecedent of the development of the moral self. Developmental research has supported the argument that moral emotions such as guilt feelings are the primary motive in situations calling for moral actions. They motivate reparative behavior, such as apologies, and they restrict immoral, aggressive behavior. However, if moral emotions are not anticipated, it is likely that cognitive moral complexity will be used strategically to achieve personal goals. Thus, understanding emotions in the context of moral conflict is important if we are to understand how young people resolve the conflicts that occur inevitably in everyday life.

An understanding of complex moral emotions, such as guilt feelings or shame, is assumed to emerge around the age of 6–8 years. The understanding of guilt feelings requires complex cognitive abilities, namely, the integration of the understanding of a moral rule's validity with the understanding that other's evaluation of the self depends on the self's own actions. Developmental studies support the conclusion that emotions in the context of moral conflict are a salient feature of children's experience of rule violations and that they help children

to increasingly differentiate their moral judgments from other social judgments. From a motivational perspective, moral emotions such as guilt, shame, or embarrassment indicate that the self feels committed to a norm. Thus, researchers have argued that moral emotions provide an early foundation for the development of the moral self.

In an effort to address more completely the development of moral emotions, Malti and Keller devised an integrative theoretical model that connects research on the development of moral emotions with the moral self. According to this model, the development of moral emotions and the emerging moral self entails sociomoral knowledge about persons, interactions, and norms. Cognitively, the self increasingly comes to understand the world of others by participating in social interactions. Affectively, the moral self is characterized by an empathic sharing of the consequences of its actions on others. Based on this idea, Malti and Keller have proposed that moral emotions develop sequentially: when children first learn to *distinguish* between the perspectives of the self and others, the self becomes aware that moral transgressions have negative consequences for others. However, the self does not take these consequences into account, thus leading to the happy victimizer phenomenon. The happy victimizer phenomenon describes the fact that young children attribute positive feelings to a moral transgressor in order to achieve a personal goal, although they understand the rule to be valid. In the second step, when children learn to *coordinate* the two perspectives, they realize that transgressions not only have negative effects on others but also give rise to the moral emotion of guilt, shame, or embarrassment (the unhappy victimizer). As a third step, a generalized third-person perspective is developed. This perspective helps to establish a self-evaluative system that determines how one ought to treat others to establish and maintain relationships built on trust. Feelings of guilt or shame emerge when the person violates this trust (unhappy moralist). This moral self has positive moral feelings, such as pride, provided it acts in accordance with its obligations (happy moralist). This perspective typically develops in adolescence.

This sequential developmental model assumes both normative developmental trends and individual differences in moral emotions. For example, although many children shift from positive to negative emotion attributions during middle childhood, it has also become clear that the attribution of positive feelings remains well into adolescence.

Moral Emotions Research

The sequential developmental model provides a conceptual framework for developmental research on moral emotions. A central approach to the study of moral emotions has been to study the emotions that children and adolescents expect will follow from various (im)moral acts. Thus, research on moral emotions has frequently employed in the happy victimizer paradigm to investigate the attribution of emotions to hypothetical victimizers following rule violations. Children and adolescents are typically presented with scenarios in which a protagonist violates a moral rule (e.g., pushing somebody off a swing or stealing sweets) in order to achieve a personal goal and asked to attribute emotions to the protagonist or

self-as-protagonist. Such emotion attributions generally have a strong cognitive component, because they require a basic understanding of the conflict, specifically the protagonist's situation and actions and the related consequences for the self and others. The LOGIC study in Germany was one of the first attempts to use this paradigm to obtain information on the development of moral emotion in children and adolescents. It revealed a gap in children's cognitions and moral emotion attributions, the latter lagging behind the former. Around 7 years of age, children seem to show a change in emotion attributions to transgressors by switching from a 'happy victimizer' or positive attribution to an 'unhappy victimizer' or the attribution of negative or guilt feelings. The observed decrease in the happy victimizer phenomenon signals an important developmental transition in children's moral emotion attributions. This transition involves the child's understanding that immoral conduct makes a transgressor feel sad, guilty, or remorseful. The previous developmental literature on moral emotions, as a whole, likewise shows that feelings such as guilt emerge in middle childhood. However, sympathy appears very early in life.

Despite impressive empirical evidence for the happy victimizer phenomenon and developmental change, studies in the happy victimizer tradition have revealed some inconsistencies. For example, Keller, Lourenço, Malti, and Saalbach have shown that moral (i.e., negative) emotion attributions also depend on perspective: Children attributed negative emotions more frequently and earlier to the self-as-victimizer than to a hypothetical other victimizer. Additionally, studies with adolescents indicated that individual differences in self-attributed emotions continue to exist. Thus, the empirical picture is not being resolved completely.

Furthermore, moral emotions as assessed in happy victimizer research mostly relied on children's and adolescents' verbal reports so far, whereas a few studies used nonverbal methods to elicit shame or guilt feelings. Most of these few studies have been conducted with early childhood samples. For example, Kochanska, Gross, Lin, and Nichols observed reactions to mishaps in 33- and 45-month-old children to assess guilt feelings. In general, however, very few studies have used observational measures to assess spontaneously occurring emotions in moral conflict situations, particularly in middle childhood or adolescence (for an exception, see Arsenio and Killen, 1996). Thus, we do not know to what extent, if any, spontaneous emotions differ from self-reported emotions in the context of moral conflict. Some difference is likely, however, because self-reported emotions are more likely than spontaneous emotions to be intertwined with cognitive processes and reflections.

Researchers have offered different explanations for the happy victimizer phenomenon. For example, some researchers have interpreted the phenomenon as resulting from a lack of social-cognitive competence. Various social-cognitive prerequisites for the development of moral emotion attributions have been considered in research, such as an interpretive theory of mind or an understanding of mixed emotions. In contrast, other researchers have explained the happy victimizer phenomenon in terms of a motivational moral deficit. Accordingly, young children do not necessarily lack the social-cognitive prerequisites to act morally, but rather are not motivated to act upon moral rules. More empirical research is needed, particularly on the

relation between moral emotions and social-cognitive development, to rule out one or the other explanation of the phenomenon.

The majority of research on the development of moral emotions has focused on guilt, shame, and empathy/sympathy. Within the framework of the happy victimizer paradigm, guilt and shame are seen as an important indicator of moral development, because they point out a person's internalized knowledge about a moral norm. In contrast, very few studies have investigated positively valenced moral emotions such as pride. Among the few, Tracy, Robins, and Lagatutta found that children can recognize praise by age 4 years and that pride recognition improves from age 3 to 7 years. Krettenauer and Johnston investigated if positively valenced emotions such as pride and negatively valenced emotions such as guilt differentially relate to adolescent's moral choices in prosocial and antisocial situational contexts. The authors found that positively valenced emotions were more closely related to moral choice in prosocial contexts (helping, donating), whereas negatively valenced emotions such as guilt were more important for antisocial contexts (stealing, cheating). Given the importance of both negatively and positively valenced moral emotions in the development of human morality, future studies that systematically investigate developmental differences and similarities among these different types of self-evaluative emotions are warranted.

Taken together, it has become clear that research in the happy victimizer tradition has provided valuable information on how children anticipate negatively charged emotions in interpersonal-moral conflict situations. This research has almost exclusively focused on hypothetical moral conflict situations. But what role do moral emotions play in real-life contexts of transgression? Although moral emotions are not specifically addressed in the literature on narrative development, a recent line of research has begun to investigate how young people make meaning of their own emotional and social experiences in real-life situations involving moral conflicts. Because narratives represent contextualized social interactions, it is likely that moral emotions are different for narratives of real-life situations than for hypothetical scenarios. Moreover, real-life situations are more complex than hypothetical situations because, in addition to the moral considerations, perpetrators must justify their own transgressions by referring to their own goals.

In a recent study by Gutzwiller-Helfenfinger et al., children's narratives describing their interpersonal conflicts, including emotional aspects of their own moral transgressions, were explored. The findings indicated that the emotions constructed in the course of these real-life narratives differ from the emotions generated in the context of hypothetical transgressions. In the narratives, all self-evaluative emotions mentioned spontaneously were negative. In contrast, emotions attributed in the interview part covered a broader spectrum, including happiness and positive self-evaluative emotions.

In summary, the emphasis placed on moral emotions in the study of morality has been highlighted in recent theoretical and empirical developmental work, and promising first steps toward systematic empirical analysis have been taken. So far, most published studies have focused primarily on a particular negatively valenced moral emotion such as guilt feeling. Future research needs to investigate more systematically the

development of other moral emotions (e.g., shame, pride), as each of these emotions may follow a distinct developmental trajectory. It also still remains unclear what the varying relations among different types of moral emotions are. For example, are empathy and guilt related over the course of development, or do they develop independently from each other? Longitudinal studies may be particularly well suited to address this and related questions in future research. Psychological research is also needed in order to elaborate how different assessments of moral emotions (e.g., self reports vs. observation) may influence this developmental process, and how contextual features (e.g., hypothetical vs. real-life moral conflict situations; culture) interact with the normative developmental trajectories of various moral emotions. Finally, future research is needed to better understand the various relations between moral emotions with moral cognition and social-cognitive development.

Moral Emotions and Social Behavior

The idea that emotions in the moral domain are linked to morally relevant behavior seems to be uncontroversial in the developmental literature. Emotions signal those aspects of the social interaction that are worth acting upon. Thus, scholars have pointed to the need to investigate the neglected role of moral emotions in the genesis of interindividual behavioral differences. The question how moral emotions impact children's and adolescents' social behavior is of great significance for developmental and clinical psychologists, because it may help us gain further insight into the moral deficiencies as well as the strengths of aggressive and prosocial young people. Several studies have elucidated the role of moral emotions in causing (mal)adaptive behavior. These studies are reviewed selectively in the next section.

Moral Emotions and Aggressive Behavior

Developmental research has investigated the relation between moral emotions and aggressive behavior in the happy victimizer experimental paradigm. Some studies have documented a negative relation between aggression and the attribution of positive emotions to a moral transgressor. In contrast, other studies have revealed no such association. One of the reasons for this lack of consistency might have been that children do not spontaneously identify with the hypothetical victimizer. As outlined earlier, Keller and colleagues showed that children's emotion attributions to themselves in the role of the hypothetical victimizer are perceived as personally more obligatory. There is empirical evidence that self-attributed moral emotions are negatively relevant to immoral, aggressive behavior in adolescence and in childhood.

In a recent meta-analysis of 45 studies with 7,762 participants, Malti and Krettenauer analyzed the overt impact of moral emotions as assessed in the happy victimizer paradigm on aggressive behavior. This study documented a robust significant association between moral emotion attributions and aggressive behaviors. Moderation of these effect sizes by the type of moral emotion attribution indicated that self-attributed moral emotions showed larger effects than emotions attributed

to hypothetical characters when predicting aggressive behavior. Taken together, these findings underscore the value of considering emotional processes in explaining immoral, aggressive action tendencies. The findings have mostly relied on cross-sectional, correlational evidence so far. Thus, future studies with longitudinal and experimental designs are needed to validate and extend this productive line of research.

Moral Emotions and Prosocial Behavior

Developmental researchers consider the experience of self-evaluative emotions (in particular guilt) as an important indicator of a person's readiness to comply with rules. The experience of self-evaluative emotions indicates that a moral norm has been internalized and thus has the potential to predict morally relevant, prosocial behavior. In accord with this theoretical notion, developmental studies have supported a positive relationship in children between different measures of sympathy (i.e., behavioral or physiological reactions, and self- and other-reports) and prosocial behavior. Despite the ample empirical evidence for a positive relation between sympathy and prosocial behavior, a meta-analysis by Eisenberg and Miller revealed that the relation is rather modest in strength. Researchers have therefore argued that a further analysis of the moderators of prosocial behavior is needed. Among these factors are other moral emotions besides empathy.

Research on moral emotions other than empathy and prosocial, adaptive behavior has been surprisingly rare, even though the role of two of the moral emotions (empathy and guilt) in prosocial behavior has been acknowledged. Gummerum, Keller, Rust, and Hanoch showed that preschool children with high levels of guilt feelings also shared more attractive stickers in a prosocial dilemma situation. Malti et al., found that guilt feelings were related to prosocial behavior in 6-year-old children. In a study with adolescents, Krettenauer and Johnston did not find evidence for a relation between moral emotions (particularly guilt) and self-reported prosocial behavior. Further studies are needed to continue this promising research avenue.

Educating Moral Emotions

To date, there are no evaluated educational approaches that systematically promote various moral emotions in young people. Yet, there are numerous educational approaches that focus on the development of empathy in children and adolescents. These programs are most commonly listed under social and emotional learning programs (SEL), moral and character education programs, or Positive Youth Development programs. The underlying assumption of SEL programs is that empathy is a protective factor that promotes young people's psychosocial adjustment, and helps them overcome risk factors for maladjustment, particularly aggression and immoral behaviors. Similarly, character education and Positive Youth Development programs aim to promote empathy and caring in young people, since they are considered key assets to adaptation and social responsibility. Studies demonstrate that empathy can be taught effectively through school-based programs. Today, there are numerous evidence-based programs providing

systematic classroom instruction that enhances children's and adolescents' ability to be empathic, take the perspectives of others, and behave prosocially.

Most of these programs focus on the cognitive component of empathy (i.e., perspective-taking skills). Thus, many programs share the methods typically utilized by programs that aim to promote moral reasoning and cognitive moral skills, such as group discussions about moral issues. In the future, it will be important to also give children the opportunity to develop the affective components of moral development by experiencing self and other's multifaceted feelings in everyday moral situations. Researchers have argued that emotional experiences in real-life situations can be meaningfully used as a basis for children's moral learning. It is therefore important to raise educators' awareness of real-life moral conflict situations as a resource for moral education. In line with Oser's conception of learning from moral mistakes, educators can help inculcate children's sociomoral sensitivity by discussing specific conflict situations and the emotions they invoked in the child – as victim, perpetrator, bystander, and/or observer.

Another family of programs specifically addresses the problem of bullying and aggression. These school approaches aim not only to establish rules for tackling specific instances of bullying, but also to promote empathy (see also the Roots of Empathy program).

The developmental studies center provides a list of research-based social and emotional learning programs for children and adolescents. The mission of the nonprofit CASEL (collaborative for academic, social, and emotional learning) organization (www.casel.org) is to promote the establishment of evidence-based social and emotional learning (SEL) programs as an essential part of education. One of the many well-known prevention programs is second step, a violence prevention program that integrates academics with social and emotional learning. Adolescents learn social skills such as empathy, emotion management, and cooperation. The effectiveness of SEL programs has been documented by evaluation studies. Strengths of effects vary as a function of program type, program characteristics, and participant characteristics. Improvement has been shown in empathy and prosocial behavior.

Summary and Future Directions

Moral emotions are a central dimension of human morality and of key importance for (im)moral action tendencies. In this article, we selectively reviewed literature on some key issues in the moral emotions area that have emerged in both developmental research and applications. Moral emotions are an umbrella term, and its definitions have been correspondingly broad. A commonly shared feature of these definitions is that these emotions are described as self-conscious or self-evaluative emotions, because they are evoked by the individual's evaluation of the self. Feelings of guilt and shame have been considered key indicators of affective moral development. Likewise, positively valenced self-evaluative emotions such as pride have been described as morally significant. Additionally, other-oriented emotions such as empathy/sympathy have been considered moral emotions. A theoretical model of moral emotions was presented and it describes how emotions

attributed to protagonists in interpersonal-moral conflicts develop. Research on moral emotions in the corresponding happy victimizer research tradition was selectively reviewed. This research has described how various moral emotions such as guilt develop in childhood and adolescence. Most of this research has focused on emotions attributed in the context of hypothetical transgressions. More recent research has begun to investigate emotions in the context of real-life moral conflict. As moral emotions are considered to play an influential part why individuals adhere or fail to adhere to their own moral standards, research on the link between moral emotions and pro- and antisocial behavior was described. This research has been predominantly focused on cross-sectional relations and selected moral emotions such as empathy and guilt. Longitudinal studies on various moral emotions and pro- and antisocial behavior is needed next. Additionally, it was shown that theorists have begun to analyze the relationship between moral emotions and social-cognitive development. However, not much research on this relation has been conducted so far. Future research on the relationship between various moral emotions and dimensions of social-cognitive development, such as an interpretive theory of mind or an understanding of second-order beliefs, is therefore needed. Finally, a number of educational approaches have addressed the promotion of moral emotions in children and adolescents. These programs, which are frequently classified under social and emotional learning, are often school-based and focus on the promotion of a particular moral emotion, mostly empathy/sympathy. Promising advances have been made in integrating research and practice. Future efforts at integrating research and educational practices in the area of child and adolescent moral emotions are needed.

See also: [Empathy](#).

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Relevant Websites

- <http://www.devstu.org> – Developmental Studies Center.
- http://prevention.psu.edu/projects/PEACE_Area2.html – Pennsylvania State University.
- <http://www.rootsofempathy.org/> – Roots of Empathy program home page.

Motivation

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Glossary

Achievement motive A capacity to derive pleasure from mastering challenging tasks.

Affiliation motive A capacity to derive pleasure from having close, harmonious relationships with others.

Extrinsic motivation Externally regulated, controlled form of goal pursuit.

Incentive Affectively charged stimulus that elicits goal-directed, motivated action.

Intrinsic motivation Internally, autonomously regulated goal pursuit.

Mastery goal A goal that aims at improving one's competence or performance level relative to one's previous performance.

Motivation Affectively charged state that energizes and directs action aimed at the attainment of a reward (or avoidance of a punishment).

Motivational congruence State of alignment between a person's implicit motives on the one hand and explicit goals and values on the other.

Motive A stable disposition to seek a particular type of reward and experience its attainment as pleasurable. Stable personality disposition to experience particular types of incentives as pleasurable.

Performance goal A goal that aims at demonstrating one's competence relative to others or a social norm.

Power motive A capacity to derive pleasure from having physical, social, or emotional impact on others.

Self-determination The autonomous setting and pursuit of a goal.

Introduction

The term *motivation* characterizes an affectively charged state that energizes and directs action aimed at the attainment of a reward or avoidance of a punishment. For instance, a food-deprived bear experiences hunger (*affectively charged state*) and therefore orients its attention and behavior toward cues in its environment that signal the availability of food (*directing function* of motivation). The hungrier it is, the more vigorously, quickly, and frequently it will go after berries, honey, and prey (*energizing function* of motivation). Here, the reward is food, and obtaining sufficient amounts of it will satisfy the bear's hunger and thus end this particular motivational episode.

In this case, the affectively charged state at the core of the motivational state was due to deprivation – the bear had not eaten for a long time and the body's nutrient levels had to be replenished. Still, the bear had to be sensitive to suitable cues in the environment that signaled the availability of food – so-called incentives – and ignore many other cues. This highlights an important principle in motivation science: goal-directed behavior is a joint product of the individual's internal need (hunger in this case) and situational incentives (food-related cues) that allow the expression of this need. This also means that individuals with a stronger need become more motivated by the same incentive cue than individuals with a weaker need. Thus, individual differences in transient as well as enduring motivational needs are important for motivation. Conversely, some incentives are more 'incendiary' and luring than others, with the former eliciting more motivation than the latter in individuals with similar motivational needs. In extreme cases, high incentive value can even beat motivational need, as when people ignore signs of satiety after a full meal

and cannot resist the lure of an ice cream box or a bag of potato chips.

The fact that the bear ceases its search for food after it has gorged itself on berries and honey, that it has actually stopped being motivated to seek food, highlights another important principle of motivation: it is dynamic. A specific episode of motivated behavior is set in motion by the interplay of an internal need and the presence of suitable external incentive cues and persists until the individual reaches the desired reward. Motivation for pursuing the reward then stops and the individual is free to engage in other motivational pursuits. For instance, a person who was hungry and in single-minded pursuit of food will be free to think of and do other things once the craving for food has been stilled by eating a full meal.

Motivation also guides learning of reward-predictive signs and behaviors that are instrumental for obtaining a reward. For instance, the bear from the above example may learn to associate a certain patch of the woods or a particular smell therein with the taste of mushrooms and berries, because both can be found on a specific type of soil with its characteristic look and scent and both signal that food can be found with high likelihood here. And it may learn to carefully pluck the berries from the bush with its snout without getting pinched by the thorns. The more motivated the bear is, the quicker it will learn both the food-predictive signs and effective food-gathering behavior.

While the above examples only involved motivational needs and processes that all higher species share (such as hunger and feeding, and also dominance, affiliation, sexual reproduction, etc.), there is an important distinction between animals and humans: only the latter can set and pursue abstract goals, goals that are rooted in a person's culture, that can be verbally communicated to and coordinated with other

humans, and that have the capacity to override and suppress more biologically based forms of motivation. For instance, people can set and pursue diet and fitness goals that make them forsake food and leisure time that their bodies may crave but that provide them with a sense of meaning and purpose, sometimes even at the expense of hedonic pleasure. There is thus a fundamental difference between verbally mediated, conscious forms of motivation, represented by the goals people set and pursue in their daily lives, at home and at work, and the types of motivation humans share with other animals and that do not necessarily require language or consciousness for their proper enactment (e.g., eating, drinking, social closeness, dominance, sex). Both types of motivation can effectively guide behavior, but for different reasons: biologically based motivation, because it ensures the attainment of pleasurable, rewarding, and ultimately survival-enhancing goal states; and culturally based goal pursuits, because they enhance social coordination and provide human lives with a sense of meaning.

Motivational dispositions and processes are most frequently studied from the perspective of biopsychology, social psychology, and personality psychology. Biopsychology, using animals as research subjects, allows the experimental manipulation of brain areas assumed to be involved in motivation across mammalian species and studies the effects of these manipulations on behavioral markers of motivation. Social psychology studies the effect of situational factors on human motivation, as assessed through questionnaires, cognitive processes, and behavioral observation, and is interested in drawing conclusions about general features of motivating stimuli and contexts as they apply to all people. Personality psychologists are interested in individual differences that make people respond differently to the same types of incentives. Individual differences in motivational dispositions and processes are most frequently assessed through questionnaire measures, although indirect measures (such as content coding of verbal material) and cognitive-process measures are also employed. Affective and social neuroscience, an emerging new field that cuts across the three previously mentioned research approaches and that uses brain imaging methods in combination with behavioral and questionnaire data in human subject populations, rapidly provides new approaches and opportunities for studying motivational dispositions and processes.

Approach and Avoidance Motivation

A fundamental distinction in the psychology of motivation is the one between approach motivation (aimed at the attainment of rewards) and avoidance motivation (aimed at the avoidance of frustrations and punishments). The latter can be subdivided into active avoidance, characterized by active execution of instrumental behavior aimed at moving away from a punishment (such as running away from a predator if it is still some distance away), and passive avoidance, characterized by the behavioral inhibition of behavior in order to avoid a punishment (such as being very still when a predator passes by in the vicinity).

Based on the distinction between approach and avoidance motivation, Jeffrey Gray developed reinforcement sensitivity theory, a biopsychological model that incorporates three basic systems presumed to underlie any motivated behavior.

(1) A behavioral approach system (BAS) that energizes behavior aimed at the active attainment of learned and natural rewards as well as attainment of stimuli indicating safety or nonpunishment. The BAS is essential not only for active approach motivation, but also for active avoidance motivation, because it facilitates behavior aimed at reaching rewarding safety. It is associated with the brain's mesolimbic dopamine system, a key structure for motivated behavior. (2) The fight-freeze-flight system (FFFS) generates behavior aimed at the avoidance of imminent learned and natural punishers as well as experiences of intense frustration. This system is associated with the periaqueductal gray, the medial hippocampus and the amygdala and is essential for escape and defensive aggression. (3) The behavioral inhibition system (BIS) gets involved when an individual's approach and avoidance goals are simultaneously activated, that is, when both the BAS and the FFFS are equally engaged. Once BIS gets activated, premature action tendencies elicited by either the BAS or the FFFS are inhibited and the individual is instead put into an enhanced cognitive-processing state that allows him to collect more information to resolve the current approach-avoidance conflict in one direction or the other. This might, for example, be the case in situations in which an animal tries to reach available food in an area where a potential predator is present. The septohippocampal system represents the neuroanatomical basis of the BIS. Behaviorally oriented animal studies provide ample support for the validity of Gray's model, as do neuroimaging and behavioral studies with normal and clinical human populations.

Another theory about the neurobiological basis of approach and avoidance motivation was suggested by Richard Davidson. Research on victims of strokes and other accidents that scar the brain's tissues links differences in the location of a stroke to differences in subsequently experienced symptoms of depression. Specifically, strokes in the left but not the right frontal cortex are responsible for diminished positive affect. Looking at normal, healthy individuals, Davidson found that the induction of positive mood was associated with increased left frontal cortex activity while the induction of negative mood was connected to higher right frontal activity. Moreover, he also found that differences in left versus right frontal activity relate not only to transient emotional states but also to enduring differences in personality traits. People with habitual higher left frontal cortex activation under resting conditions characterize themselves as more extraverted, outgoing, and emotionally positive, while people with higher right frontal cortex activation describe themselves as more prone to anxiety, mood swings, and negative emotionality. Davidson therefore concluded that positive affect, either as a state or as a trait, is associated with left frontal activation and negative affect with right frontal activation. However, the frontal cortex is not itself the seat of affective states or dispositions; rather, it exerts inhibitory control over subcortical affect generators such as the amygdala, and research has shown that this is the reason why differences in frontal cortex activation are associated with differences in positive and negative affect.

The relationship between cortical asymmetries and motivation was further elaborated by Eddie Harmon-Jones who contended that higher left frontal activity is not necessarily related to more positive affect per se but rather to increased approach motivation. He found that negative emotional states, such as

anger, can also be associated with elevated left frontal cortex activity. More specifically, trait and state anger as well as behavioral aggression, although all representing negative affect, are associated with greater left than right prefrontal activation. Harmon-Jones argues that anger is an approach-related affective state that occurs if the way to a cherished goal or reward is blocked and the obstacle can be removed. He therefore argues that it is more accurate to link left frontal activity to approach motivation and right frontal activity to avoidance motivation than to positive or negative affect *per se*.

Other neurobiological models of motivation also assume the existence of separate systems for approach and avoidance motivation, but postulate additional systems that can help make behavior flexible beyond reflex-like responding to rewards and punishers. There is evidence for the existence of an additional impulse-control system that can restrain the impulsive, stimulus-driven effects of approach and avoidance motivational systems on behavior and bring behavior under the guidance of analytical thinking, the setting of deliberate plans and goals, and verbal self-instructions or instructions from others. The impulse-control system enables humans to delay gratification of motivational needs for extended periods of time (e.g., being able to sit through a lecture despite feeling hungry) and appears to be associated with the neurotransmitter serotonin.

More recent theories of motivation emphasize the interaction between motivational states and cognitive processes. For instance, Julius Kuhl's personality systems interaction (PSI) theory links functional properties of positive and negative affect to four cognitive processing systems. According to PSI, positive affect activates an intuitive behavior control system that is specialized in executing automatic, well-established behavioral programs and is functionally similar to Gray's BAS. If intuitive behavior runs into trouble and is no longer adaptive, positive affect is reduced. This in turn switches off the intuitive behavior control system and instead activates a cognitive system dedicated to analytical thinking and the careful crafting of behavioral plans and strategies. Negative affect, on the other hand, facilitates object recognition in the service of a thorough analysis of unexpected events and situations, a function that is similar to Gray's BIS. When the environment matches one's expectations, on the other hand, negative affect is decreased, which in turn switches off object recognition and activates a system called extension memory, a broad network of knowledge about the world and the self. Thus, in PSI, high or low positive or negative affect is functionally related to distinct cognitive processes and motivational states.

Despite obvious differences in all these theoretical accounts to approach and avoidance motivation, with some being more concerned with the neuroanatomical basis, others with hemispheric differences or the role of affect and cognition, there is extensive empirical evidence for each model and it seems possible that they may 1 day be integrated into a comprehensive theory of the generation and regulation of approach and avoidance motivation.

Implicit Motives

Whereas approach and avoidance motivation characterize general behavioral trends toward rewards and away from

punishers, motives define the specific types of incentives individuals strive for. A motive is a capacity to experience a specific type of incentive as pleasurable. Motives drive, orient, and select behavior that aims at obtaining motive-specific incentives and satisfying the motivational need. For instance, a person with a strong food motive has a particularly well-developed capacity to relish the taste of food. When this person's food motive is aroused (i.e., if she feels hungry), she will act in such a way as to find a food source, prepare, and eat the food, thereby satiating her appetite. Motives are implicit in the sense that they are rooted in specialized brain systems developed over evolutionary time spans, operate outside of a person's conscious awareness and therefore have to be assessed indirectly, such as by content coding of verbal material. Such indirect motive measures predict a large array of motivational phenomena, ranging from physiological and neural responses to incentive stimuli, to economic success and political action, but frequently fail to overlap with people's explicit declarations of their motivational needs and goals.

Three motives have received particular attention from researchers over the past 60 years: these are the need for achievement (*n Achievement*), a capacity to derive pleasure from the autonomous mastery of challenging tasks; the need for affiliation (*n Affiliation*), a capacity to derive satisfaction from establishing, maintaining, and restoring positive relationships with others; and the need for power (*n Power*), a capacity to enjoy domination and having an impact on others or the world at large.

Individuals high in *n Achievement* strive to do something better for their own sake, simply for the intrinsic satisfaction of doing something better. The incentive to do better is strongest when the task at hand is of moderate difficulty. If a task is too simple there is little challenge in doing it better. On the other hand, if a task is extremely difficult and therefore has a very low probability of being completed, then the likelihood of failure is very high and this makes it almost impossible to do better. Moderately difficult tasks therefore provide achievement-motivated individuals with the best opportunity of improving a skill or competency. In the workplace, individuals high in *n Achievement* frequently try to improve their personal performance and meet or exceed standards of excellence. This can have positive results, such as when employees surpass self-imposed standards, accomplish something new and make long-term plans for their career. For managers, however, a high level of *n Achievement* can lead to negative side-effects such as micromanaging, offering little positive feedback to subordinates, expressing impatience with poor performers, and a higher focus on goals than people.

Individuals with a high *n Affiliation* learn social relationships more quickly, engage more often in dialogue with others, and maintain their connections with other people via letter writing, telephone calls, personal visits, etc. Organizational leaders with a strong affiliation motive experience a need to maintain close, friendly relationships with others. As a result, such leaders avoid confrontation, look for ways to create harmony, avoid giving negative feedback, with a general focus on people rather than on performance. While an aspiration to be liked and accepted might not conform well to the demands of most managerial positions, this characteristic is indispensable for success in positions in which a person is responsible for integrating employees.

The way in which the implicit power motive manifests itself varies widely across people, socioeconomic classes, professions, cultures, regions, and, in some circumstances, gender. With few exceptions, most societies are ambivalent about individuals' desire to dominate others. For this reason, individuals with a high *n* Power must find socially acceptable outlets for satisfying this need by, for example, participating in highly competitive or high-risk sports, choosing influential occupations, collecting prestigious possessions, and seeking recognition in small groups. In leadership contexts, *n* Power is differentiated into socialized and personalized power. A manager with a high need for personalized power seeks to be strong and influence others by being coercive, even ruthless, wanting to control or manipulate others, and focusing on reputation maintenance rather than management of subordinates. Leaders with a high need for socialized power strive to help people feel strong and more capable. In other words, this type of leader strives for power in order to empower others. This individual's leadership behavior is characterized by coaching and teaching, being supportive to subordinates, involving others in the decision-making process, with an overall focus on the group instead of on the self.

Explicit Motivation: The Self-Concept, Goals, and Values

In contrast to implicit motives, which influence motivation and behavior nonconsciously, individuals' explicit, language-based self-concept, values, and goals afford conscious modes of behavioral regulation. The self-concept represents an individual's mental image or perception of 'the self,' encompassing the temporally stable self-knowledge of this particular individual (e.g., one's personality attributes, knowledge of one's skills and abilities, one's occupation and hobbies, and awareness of one's physical attributes), including her or his attitudes, affective preferences, values, goals, and life story. In other words, the self-concept is viewed as a system of affective-cognitive structures providing coherence for the individual's self-relevant experiences. It refers to the sum total of an individual's beliefs about his or her own personal attributes. It is made up of self-schemas, that is, knowledge structures that guide the processing of self-relevant information and determine how people interpret new information and organize past experiences in their memories. A person's self-concept is complex, dynamic, and may change over time.

It is important to note that the self-concept is not restricted to the present. Conceptions of the self in the future are called 'possible selves.' They represent individuals' perceptions of what they might realistically become, what they would very much like to become ('ideal self'), and what they are afraid of becoming ('feared self'). In other words, an individual's repertoire of possible selves can be viewed as the cognitive-affective manifestation of enduring goals, aspirations, fears, and threats. Possible selves are cognitive links between the present and the future, specifying how individuals may change from what they are now to what they will become. That is, if a current self-concept is challenged or supported, it is often the nature of the activated possible selves that determines how the individual feels and what course the subsequent action will take. Possible selves thus function as incentives for future behavior and allow

comparisons of present and desired future states, providing a frame of reference for the assessment and evaluation of current goal attainment.

Personal goals have been defined as personally meaningful concerns, projects, or strivings people pursue and try to attain in their everyday lives. Similar to motives, goals are relevant to the regulation of behavior. However, unlike implicit motives, they are verbally represented, conscious, and measurable by self-report. Personal goals are subjectively meaningful representations of anticipated end-states delineating what a person wants to achieve, maintain, or avoid in his or her current life situation. Individuals actively derive personal goals from their self-concepts and then plan and engage in activities directed toward goal attainment. The process of goal setting and planning focuses on intention and acquisition of knowledge, and helps to organize resources. The implementation of goals depends on how much a person is committed to a given goal, particularly when the going gets tough. Research shows that people who are not strongly committed to a goal may actually miss opportunities to enact the goal and, when faced with challenges and setbacks on the way toward the goal, may abandon it altogether. In contrast, individuals who feel firmly committed to a goal are better at utilizing opportunities to realize it (a case of chance meeting the prepared mind) and, when they encounter difficulties, will step up their efforts to attain the goal or seek alternative ways to realize it. Successful pursuit and implementation of personal goals in turn provides individuals with a sense of meaning in life, with greater life satisfaction, and with emotional well-being, although the latter effect depends on the fit between a goal and the person's implicit motives (see next section).

Only rarely are goals represented mentally in a purely abstract, verbal format. Most goals entail imagining a 'possible self' realizing the goal. A crucial element of any goal is the mental image of approaching and attaining it. Goals are particularly effective regulators of behavior when the person can conjure up representations of the self achieving them (e.g., imagine your 'self' graduating, buying a car, trying hard to get a job, etc.). In other words, a goal will have a stronger impact on behavior to the extent that an individual can personalize it by building a bridge of self-representations between one's current state and one's desired or hoped-for state.

Central, overarching human goals are often referred to as values. Although there does not exist a common definition for the term, most scholars agree upon the following five aspects regarding values: a value is a subjective belief that pertains to desirable end states (goals) or behaviors, that transcends specific situations, that guides the selection or evaluation of behavior, people, and events, and that is ordered by importance relative to other values to form a system of value priorities.

Similar to 'possible selves' and goals, values are defined as desirable end states. They serve as guiding principles for the lives of individuals (personal values) and social groups or society as a whole (social values). Implicit in this definition of values are the following: that they serve the interests of some social entity; that they can motivate action, giving it direction and emotional intensity; that they function as standards for judging and justifying action; and that they are acquired through unique learning experiences of individuals

or groups. Other goal-related constructs such as 'personal strivings' and 'life tasks' may be seen as expressions of values in specific life domains.

The content of a distinct value is heavily determined by the motivational goal this value expresses (e.g., the value 'helpfulness' represents the goal to preserve and enhance the welfare of others). Values represent, in the form of conscious goals, responses to three universal requirements with which all individuals and societies in all cultures must cope: needs of individuals as biological organisms, requisites of coordinated social interaction, and requirements for the smooth functioning and survival of groups. From these three universal requirements, a number of motivationally distinct types of values can be derived: power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity, and security. For example, the value 'conformity' stems from the desire for smooth interaction and group survival. This value expresses the goal to restrain impulses and inhibit actions that might hurt others.

Taken together, the self-concept, personal goals, and enduring values provide humans with conscious, explicit routes for regulating their goal-directed behavior in harmony with the demands and affordances of the sociocultural context they live in and with ways to experience their pursuit of incentives as meaningful and rewarding.

Interactions Between Implicit and Explicit Levels of Motivation

The simultaneous existence of an implicit and an explicit level of motivation, represented by individuals' implicit motives on the one hand and their explicit views of themselves, their values and their goals on the other, raises the question of how these two levels interact with each other to shape thought, feeling, and behavior. Hundreds of studies conducted over several decades have consistently shown that measures of implicit and explicit motivation within a given domain have little statistical overlap with each other. This means that, for instance, a person with a strong implicit achievement motive can have explicit goals and values that do not emphasize achievement and, vice versa, that a person with low implicit achievement motivation can strongly endorse explicit achievement values and be firmly committed to a host of achievement goals. In both cases, implicit and explicit levels of motivation are incongruent with each other, and such motivational incongruence can give rise to problems. Motivationally incongruent people experience less satisfaction with life and less emotional well-being. They are also more prone to develop symptoms of psychosomatic illness. In contrast, people who endorse values or pursue goals that are congruent with their implicit motives (e.g., a person high in implicit achievement motivation who pursues many achievement goals in her daily life) report overall better life satisfaction, emotional well-being, and fewer psychosomatic symptoms.

Because motivational congruence and incongruence can have profound effects on well-being, researchers have started to look for factors that can help people achieve higher congruence between their implicit motives and their explicit values and goals. Dispositional factors that are associated with

high motivational congruence include a strong sense of self-determination, being tuned to one's bodily sensations, the ability to quickly overcome negative affective states, and being able to verbalize one's perceptions quickly. But people can also increase their motivational congruence strategically by vividly imagining a potential goal before committing to it, because imagination helps translate the verbal content of the goal into the nonverbal format in which implicit motives process information.

Learning and Performance Goals

Research on achievement motivation in classroom settings and educational contexts has focused on the difference between performance goals and mastery goals: while performance goals describe the desire to appear competent compared to others, mastery goals emphasize the acquirement of competence through successful mastery of tasks. Carol Dweck and others have provided extensive evidence that performance goals can be hurtful for all but the most accomplished learners, because having to prove one's ability to others makes one vulnerable to the negative social consequences of failure, and fear of failure in turn undermines one's performance. Mastery goals, in contrast, promote learning and motivation, because one's current performance is not compared to others' performance, but only to one's own performance, and success and failure are only diagnostic of whether one has succeeded in improving one's skill level, not one's standing in a social hierarchy.

Andrew Elliot has argued that learning and performance goals can be further differentiated by considering a person's motivational orientations, that is, whether someone is primarily concerned with *approaching* a desirable outcome or whether someone is driven by the objective of *avoiding* aversive outcomes. The interplay between learning and performance goals on the one hand and approach and avoidance on the other has led Elliot to first propose a trichotomous achievement goal framework in which the performance goal construct was divided into performance-approach and performance-avoidance goals. The former describes the striving toward the goal to perform better than others, that is, to pursue a normative approach goal, and is associated not only with more persistent, absorbed, and efficient goal striving, but also with greater test anxiety and unwillingness to cooperate with others. Performance-avoidance goals are about not wanting to perform worse than others and are associated almost exclusively with negative outcomes such as distracted and disorganized learning, anxiety, and impaired performance.

In a later version of the theory, Elliot also divided mastery goals into approach and avoidance goals, with mastery-approach goals reflecting the desire to master a task and mastery-avoidance goals representing the desire to avoid making a mistake or performing worse than previously. Mastery-avoidance goals are grounded in fear of failure and low self-determination, that is, a low desire for autonomy and choice. An analysis of parenting styles showed that parents of mastery-avoidant children tended to give a lot of negative feedback concerning the child as a person (e.g., 'you are not a good person') as opposed to a specific behavior (e.g., 'you did

not put a lot of effort into completing this task') and to create a family climate characterized by worrying. Consequently, the pursuit of mastery-avoidance goals is predictive of disorganized studying and worry-proneness among children. Interestingly, parental socialization practices appear to be unrelated to the development of mastery-approach goals, perhaps because an active approach toward mastering one's environment is inherent in human nature and therefore does not need to be reinforced externally. Performance-approach goals were linked to parents' conditional approval of children (e.g., 'you have to do well in school to make me happy') and positive feedback by fathers that focused on their children's overall personality rather than just on the positive outcome of the task. This type of person-focused feedback by parents also facilitates children's adoption of harmful performance-avoidance goals.

To summarize, research in classroom and learning contexts shows that people benefit from mastery goals, particularly when they are approach-oriented, because they allow to focus on gradual improvement of one's skills, and suffer when they pursue performance goals, particularly when they are avoidance-oriented, because they induce harmful social comparisons.

Self-Determination Theory and Basic Needs

When people believe that a particular behavior will reliably lead to the desired consequences and they also feel capable of performing that behavior, they will experience intentionality and a sense of personal causation. To account for the diverse effects goals have on affect, cognition, and behavior, Ed Deci and Richard Ryan argued that intentional behavior is regulated along a continuum from autonomous (self-determined) to controlled by intrapersonal or interpersonal forces. They also distinguish between intention and choice: while choice refers to autonomously initiated intentional behaviors that reflect intrinsic motivation, intentional behavior can also be at the other end of the spectrum and be executed for reasons extrinsic to the person, thus reflecting extrinsic motivation (e.g., when a soldier executes an order given by a higher ranking officer). The autonomous and controlled ends of the self-determination continuum also differ in the sense of a person's inner endorsement of his or her actions. For example, an anorectic person refusing to eat is not showing autonomous intentional behavior as the intention contains a strong element of compulsion. When controlled intentions motivate behavior, people feel they are 'pawns' to the desired outcomes.

According to self-determination theory, all humans are propelled by three basic needs, namely the needs for competence, autonomy, and relatedness. These needs are seen as essential for psychological growth, self-esteem, integrity, and wellness. Intrinsic motivation is facilitated to the extent that a person's needs for autonomy and competence are supported; their suppression leads to extrinsically motivated forms of behavior. For example, imposing deadlines for the completion of an interesting task is being perceived as controlling and will therefore decrease intrinsic motivation, as is receiving certain types of rewards. Also, self-awareness, that is, seeing oneself through the eyes of others, or ego involvement (e.g., when the task is evaluative of a person's abilities) will lead to controlled regulation of behavior, which is associated with low persistence and

task enjoyment. In contrast, having the opportunity to choose between different tasks or being supported in one's autonomy by teachers and parents will lead to an increase in intrinsic motivation and thus to high persistence, task enjoyment, and qualitatively superior outcomes.

Although extrinsic reasons for action often undermine intrinsic motivation, extrinsically motivated behaviors can become autonomous via internalization. People can introject external reasons; that is, they can 'swallow' the reasons without really digesting them. But they can also accept them and identify with them if they think they are reasonable and valuable, or, in the best case, they can actively integrate them with their own sense of self. Thus, extrinsic reasons for behavior are not always at odds with autonomous regulation, provided that a person can internalize in some way the external reasons for behavior. Research shows that internalization of external values and regulations is effective in social contexts that support autonomy.

Since its formulation, self-determination theory has been successfully applied to various contexts, including sports, politics, and psychotherapy. However, it has also drawn some criticism because it fails to account for the fact that extrinsic rewards can also boost creativity, motivation, and performance in the laboratory and many domains of life.

Conclusion

Motivation is a unifying term for a diverse group of phenomena and constructs that are all related to goal-directed behavioral regulation. A fundamental rift exists between implicit motivation that automatically directs behavior toward incentives and away from disincentives without requiring conscious awareness and explicit motivation, a uniquely human form of self-regulation that is rooted in a person's ability to verbalize her or his sense of self, to adhere to culturally transmitted values, and to set and pursue personally meaningful goals. Another fundamental distinction is the direction of motivation: whether it fuels approach to rewards or avoidance of aversive stimuli. This distinction is valid both at the levels of implicit and explicit motivation and is manifested, for instance, in the types of mastery and performance goals people pursue in academic contexts. Finally, behavior can be motivated extrinsically, such as when pressure is exerted on a person to perform a certain task, or intrinsically, such as when a person feels strongly motivated to perform a task. A thorough understanding of motivational phenomena thus requires a multidimensional approach to their assessment and conceptualization.

See also: Hope and Optimism; Positive Psychology; Self-Esteem; Self-Fulfilling Prophecy; Work Efficiency and Motivation.

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Motor Control

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Glossary

Central pattern generator Network of neurons responsible for generating properly timed rhythmic output.

Closed-loop control Mode of control consisting of a reference mechanism (standard of correctness) against which feedback from the ongoing or completed response is compared to generate error.

Coordinative structures Group of muscles constrained to act as a functional unit, also called synergy.

Degrees of freedom The least number of independent coordinates needed to describe the positions of the elements of a system.

Dynamics Branch of sciences that deals with changes in systems, expressing their existing and evolving states.

Feedback Information from sensory receptors that monitor the state of the body and the external environment.

Feedforward Information used prior to executing a particular act, with the main advantage that the human movement system is prepared in advance of the movement and tuned to processing response-produced information.

Motor programs Central representation of movement containing abstract movement commands.

Open-loop control Mode of control that does not make use of error information but, instead, prepares instructions for actions in advance, without modifications on the basis of feedback.

Synchronization Phenomenon that refers to the (mutual) attraction of limb movements or body parts, often resulting in phase and frequency synchronization.

Motor control is a relatively young discipline of scientific inquiry that attempts to describe and explain how movement is accomplished with special reference to concomitant postural adjustments. It focuses on the organization and control of the motor apparatus. Moreover, it seeks to understand how sensory processes converge with action. Different sources of sensory information have to be integrated to generate purposeful movements. This field of study has theoretical as well as practical relevance. Movement is at the heart of everyday life and the inability to move severely limits our capability to interact with the environment. Therefore, a better understanding of skilled performance in daily activities, sports settings, artistic contexts, and the workplace is desirable. This body of knowledge can be applied to the organization of practice or therapeutic intervention with the ultimate goal to improve performance or restore movement disabilities resulting from accidents, stroke, neurodegenerative diseases, etc.

The study of motor control has a pronounced interdisciplinary flavor. It is an interface between the neurosciences, biophysics, engineering, kinesiology, and the behavioral sciences. The neuroscientific perspective unravels how the brain and spinal cord bring about movement. With the development of imaging techniques, the brain structures involved in human motor control and their functional role have become apparent (see [Figure 1](#)). The biophysical/engineering and kinesiological perspective seek to understand the physical principles to which the human body in action, consisting of limb segments with pendular characteristics and springlike muscles, obeys. More recently, computational approaches have received increasing attention (see section 'Representations for Actions'). The behavioral perspective attempts to describe and explain observable movement behavior and the various manipulations that affect it, leading to inferences about the design of the control system. Increasingly, these perspectives are merging into a unified approach for understanding human movement behavior.

How Does Movement Take Place?

Movements such as reaching, grasping, and typing are so embedded in everyday life that one hardly thinks about how these actions are accomplished. We only learn to appreciate how complex this process really is when confronted with the consequences of pathology. Control of movement is an interplay with the various forces of nature. On the one hand, movers exploit these forces to produce skillful actions (e.g., ground-reaction forces, elastic forces, interaction torques), generated through the spring-like properties of muscles attached to segments that are connected to each other. On the other hand, living beings continuously fight against gravitational forces for their survival. Limbs have similarities to levers, designed to overcome these forces. Standing up against the laws of gravity, which takes several months in the newborn, is a primary accomplishment with survival value. As one grows older, it also becomes a limiting factor. Control of posture deteriorates in older individuals, sometimes resulting in falls.

Motor control research attempts to describe and explain movement as a complex combination of external and internal forces. On the one hand, mutual interactions between the mover and the (external) environment are a central focus of study. Action often leads to changes in the environment, and changes in the environment bring about modifications in action. On the other hand, because the human body consists of a kinematic chain of interconnected body parts, various interactions exist among the respective segments. Even within a limb, interactions among the joints can be identified which are governed by various types of torque.

For voluntary movement to take place, three elements are minimally required: muscles, a signaling system that makes muscles contract, and a system of sensors that provides information about the state of movement. Many centers in the brain are activated before, during, and after movement execution.

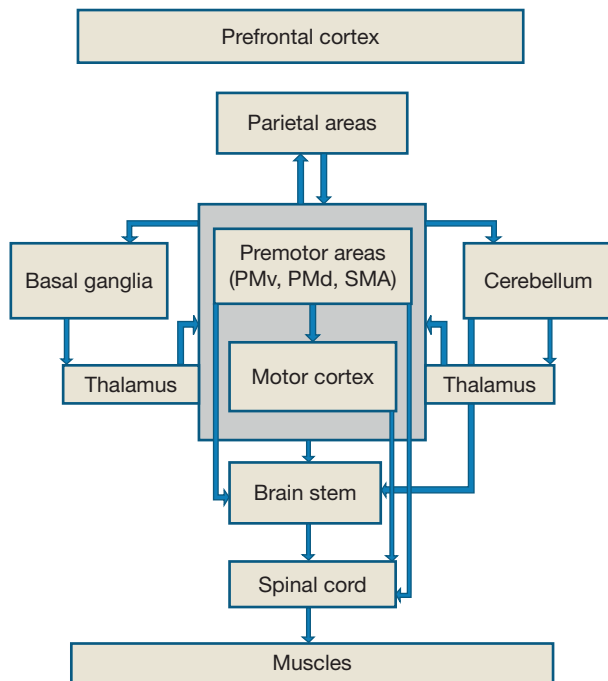


Figure 1 Rudimentary sketch of brain areas involved in motor control.

Among them are various subcortical and cortical structures working together to control the final outputs from the brain to the spinal cord (see [Figure 1](#)). An important question refers to how the information is encoded by these high-level systems, which are apparently far removed from the detailed peripheral events in the muscles. It appears that coding of movement represents a continuum ranging from abstract/goal-directed to specific. The parietal cortex is a critical neural site for abstract encoding whereas the (pre)motor areas are important for more specific movement-related encoding (see [Figure 1](#)). E. Evarts, who pioneered the recording of activity of single cells in the brain of awake animals, provided a major impetus to understanding the role of the motor cortex. He argued that activity of the nerve cells in the motor cortex was primarily related to the amount and pattern of muscular contraction rather than to the displacement that was produced by the contraction. Evarts also hinted at the tuning of the cortical cells to movement direction and this feature has been investigated intensively in subsequent years by Georgopoulos and colleagues. They proposed that cells have a directional preference even though they are only 'broadly tuned' to movement direction. Movement in a specific direction is then represented as a weighted sum of the directions signaled by a population of cells in the motor cortex (the population coding hypothesis). The motor cortex is an important brain structure because it resides close to the final motor output. What happens next? Neural information from higher levels is relayed to motor neurons whose cell bodies are located in the spinal cord and whose axons terminate on the muscle fiber membrane. At this site, neural events are translated into mechanical energy by generating a contractile force in the muscles. The properties of these muscles constrain the calculations of the central nervous system: the combination of muscle lengths and tensions are interdependent with the velocity of muscle shortening or lengthening.

Before information converges to provide input into the motor cortex, many brain areas play a role in providing information about the properties of objects to interact with as well as the trajectory that needs to be planned in view of the spatial requirements. In this context, the discovery of mirror neurons in the beginning of the 1990s has constituted a breakthrough. Rizzolatti and coworkers from Parma discovered neurons in the premotor cortex (and later also in the inferior parietal cortex) that not only fired when a monkey reached out for food but also when he observed another monkey or human performing a similar action. Apparently, the monkey mirrored the intentions of the observed other onto his own action repertoire. This provides a neurophysiological basis for action imitation and understanding that is of considerable importance for human development and (imitation) learning. Current research is primarily directed at unraveling the brain regions involved in the human mirror neuron system and at exploring its role in the broader context of social interactions.

[Figure 1](#) shows a schematic overview of the principal brain areas involved in movement control. This flow chart may leave the impression of a strict hierarchy in which a strict distinction is made between cognitive, perceptual, and motor areas. However, Cisek and Kalaska recently challenged this hierarchical perspective, suggesting that these different modules are closely interconnected. Neural processing is thought to be continuous rather than organized in distinct serial stages.

General Control Modes

A key issue that has dominated thinking in motor behavior since its inception concerns the locus of movement control. Competing ideas on this matter have formed one of the most persistent controversies throughout the history of motor control. On the one hand, the peripheral viewpoint argues that movement is controlled via some combination of feedback from the muscles and joints and the vestibular, auditory, and visual systems. The central perspective, on the other hand, assumes that commands are structured in advance and that feedback is not essential to produce patterned movement. These perspectives can be exemplified by two distinct modes of control, known as closed- and open-loop systems. These form extremes on a continuum.

Closed-Loop Systems

Closed-loop systems (like home-heating techniques), usually consist of three parts. A central feature is the reference mechanism, which represents the goal of the system or something to be achieved (e.g., the thermostat setting). Information from the environment is gathered to determine the value that the system seeks to regulate (actual temperature in the house), and this information is relayed to the reference, termed feedback, thereby closing the loop. Comparisons between a desired and actual state give rise to error detection. The executive level, informed about errors, takes action to reduce the error toward zero (e.g., the heater is turned on). Granted that slowly graded responses may be controlled in a closed-loop fashion, one is prompted to ask how very fast (ballistic) movements are produced.

Open-Loop Systems

In contrast to closed-loop control, strictly open-loop systems do not contain the feedback cycle and are not directed at nullifying error. Commands are structured in advance and are executed without regard to the effects they have on the environment. The major advantage of such a system is that it can act quickly, as it does not have to process incoming information. Its drawback is that it cannot adjust to changing environmental circumstances unless one steps away from strictly open-loop control.

Representations for Actions

In the past decade, the conventional open–closed control debate has waned and attempts have emerged to combine these control modes into a more comprehensive framework. On the one hand (and similar to centralists), the so-called motor systems perspective, backed by the information-processing approach, assumes that movements are centrally represented. Movement commands, specified in rather general or abstract terms, are responsible for output organization. This perspective does not strictly adhere to open-loop control as feedback is argued to play a role, depending on the type of task involved. Experimental observations showing invariant temporal relations between the muscle contractions underlying movement, despite variations in overall speed, are argued to be consonant with this viewpoint.

Conversely, the dynamical approach sets out a different strategy by minimal reliance on representations or central prescriptions for explaining order and regulation manifest in motor behavior. Instead, it is argued that order in action emerges as an *a posteriori* fact, or as a necessary consequence of the way the system is designed to function. The key question becomes what can be explained in movement organization ‘for free’ (i.e., through universal biophysical laws) before burdening the central nervous system with computational and control problems. This approach is characterized by an emphasis on processes of self-organization, a feature inherent to complex biological and physical systems. The interplay of forces and mutual influences among the components of a system, tending toward equilibrium, is largely held responsible for order in movement. Dynamics refers here to a more recent approach at the interface between mathematics and the sciences that is concerned with a description of changes in systems, their existing and evolving states. This perspective is committed to applying a rather universal language for describing systems in which multiple components become collectively organized. It recognizes rhythmic movement as a cornerstone for a theory of coordination.

Computational motor control approaches have lately become more prominent and they provide new insights into the previously mentioned open- and closed-loop control modes. Central in this notion is the idea of ‘optimal control’ implying that (1) minimization of costs and (2) maximization of rewards, drive the performer. Based on experience, the nervous system is involved in the formation of an internal model of the human body in interaction with the environment by relating motor commands to their outcomes. A key component of the optimization problem is the processing of feedback from

the sensory receptors. In addition, another source of information is ‘internal’ because it arises from these internal models that monitor the motor output and predict their sensory consequences. The latter feedback loop is faster than the former one (based on sensory input), allowing very rapid adjustments. Thus, three problems need to be resolved: (1) the sensory consequences of our motor commands need to be accurately predicted (system identification), (2) these predictions need to be combined with actual sensory feedback to form a belief about the state of our body and the external environment (state estimation), (3) based on these beliefs, the gains of the sensorimotor feedback loops have to be adjusted to maximize performance (optimal control). How a performer finally moves is based on expected rewards and the cost he/she accepts to pay.

Although opposite schools of thought have initiated lively debates on major control issues in the past decades, this clash of doctrines has created the opportunity to appreciate the benefits of various modes of control which can be explored by the mover in response to the huge variety of existing task dimensions and environmental constraints. This paves the road for conceiving hybrid models of human motor behavior. Next, evidence for central and peripheral contributions to motor control will be discussed. This description goes beyond the formerly made sharp distinction between closed- and open-loop systems.

Central and Sensory/Perceptual Elements in Motor Control

Central Contributions to Motor Control

This perspective suggests that central commands are mainly responsible for organization of movement. To strengthen this argument, various sorts of evidence have been collected to demonstrate that patterned movement can occur in the absence of peripheral feedback. Under conditions of feedback deprivation through deafferentation (severing the sensory nerves that carry information into the nervous system), monkeys have been shown to walk and climb, mice to display grooming patterns, and birds to sing even though portions of the song are eliminated by denervating one side of the vocal apparatus, etc. This has led some to argue that movement is mainly controlled via centrally stored movement commands, often called programs.

A motor program can be defined as a central representation of movement or skill. It has been a cornerstone of motor control theories that are inspired by the information-processing framework. Although the program is generally considered to be represented centrally, where exactly it resides remains obscure and medical imaging has not been able to resolve this matter. Task features may be an important factor in this respect. For example, in the case of learned movements, looking for a program in a well-defined location within the central nervous system might not be fruitful, as it may consist of several nodes that are widely distributed in the nervous system involving many interconnected brain areas. On the other hand, programs for certain inborn rhythmic behaviors, such as locomotion, swimming, and scratching, have a more circumscribed location, taking the form of a network of

neurons (called a neural oscillator or central pattern generator (CPG)), responsible for generating properly timed rhythmic output. Timing of these repetitive movements is then regulated by intrinsic properties of the central nervous system. For example, the CPG for locomotion in certain animals is located in the spinal cord. CPGs drive the spinal motoneurons (innervating muscles) by rhythmically raising and lowering their membrane potentials, causing them to fire in bursts. The excitability of the CPGs is governed by locomotor centers in the midbrain and brain stem.

Although CPGs are mainly invoked for the generation of inborn interlimb cyclical actions, they may be critically involved in, or form the basis of, learned movements. S. Grillner, a pioneer in CPGs, has proposed that these are made up of networks of smaller unit generators that may be of use in learning new motor acts that are far removed from locomotion. Think, for example, about the leg action in the breast-stroke: Leg propulsion is accomplished by extending the hip and knees while dorsally flexing the ankle to maximize grip on the water. This is a difficult matter for the beginning swimmer because there is a natural tendency to flex and extend all joints simultaneously. It is reminiscent of the tight cooperation among joints that is already evident in the kicking movements of the newborn in supine position. With practice, the ankle joint is dorsally flexed while extending the other joints, referring to a recoordination of parts of the locomotor synergy.

Whereas CPGs were previously assumed to consist of a well-defined assemblage of neurons, functionally distinguishable from others, recent work with invertebrates suggests that they may not be immutable functional entities. Instead, neurons from different circuits can be reconfigured into a new circuit that enables a different function. This selective dismantling of preexisting networks, and the building of new ones, provides us with important clues for a better understanding of the mysterious but enormous flexibility in motor coordination that can be found across the animal world. Additional research is required to demonstrate similar phenomena in the vertebrate nervous system where the neural networks are inherently more complex.

Sensory/Perceptual Contributions to Motor Control

Even though the nervous system is capable of issuing stored motor commands without reference to peripheral feedback, this does not imply that feedback is unimportant for goal-directed motor performance and learning. As mentioned previously, some have argued that birdsong is represented centrally. However, when birds are reared from an early nestling stage without experience of their own species-specific song, the learned contributions to development of the normal song template become evident. These observations point to the important role of auditory experience in species-specific song development. Similarly, even though CPG networks can produce patterns of interlimb coordination in the absence of afferent information, it is equally the case that afference plays a critically important role in normal locomotion for grading the component movements to specific environmental contingencies, such as unexpected obstacles or irregular surfaces.

Research on deafferented humans clarifies the role of sensory information in human motor control. Two patients,

showing severe loss of somatosensory modalities following episodes of sensory polyneuropathy, have been investigated intensively by scientists in the United Kingdom (Marsden et al., 1984) and in Quebec (Teasdale et al., 1993). Although these patients can perform many skillful activities with the help of visual information, they experience difficulties in producing fine manual skills, such as feeding, writing, and fastening buttons. Moreover, their recovery from unexpected perturbations during movement production, takes longer than in control subjects. Interlimb and intralimb (intersegmental) coordination is disturbed as well. These observations point to the important role of sensory afferents in motor control. Thus, whereas the peripheral and central viewpoints are incompatible at their polar extremes, their reconciliation is no longer a matter of doubt. The question can now be rephrased as to 'how central commands and sensory information cooperate to produce skilled action.'

Several sources of sensory information play a determining role in movement regulation: proprio- and exteroception. Proprioceptors provide information about body position in space, joint angles, and the length and tension of muscles. It is information about our own (proprio) movements. Exteroceptors inform us about the spatial coordinates of surrounding objects and the environment. When contacting surfaces and objects, tactile information is also of critical importance to drive our actions. This allows us to hold a glass of water without letting it slip from our hand. A reciprocal relationship exists between sensory information and movement. Sensory information allows movement to proceed correctly as it tells the mover about the state of the body and environment; conversely, movement allows us to sense and perceive. For example, when holding a pen between your fingers for some time, you will experience a loss of sensation of the pen, and its presence fades from consciousness until you move your fingers again, informing you that the pen is still there. In addition to the important role of sensory information in movement, it is also critically involved in the maintenance of posture.

Sensory information and postural control

A variety of receptors contribute to the maintenance of posture. The vestibular apparatus in the inner ear contains receptors sensitive to deviations from the vertical and, more general, to the orientation of the body in space. In addition, receptors in the muscles (e.g., muscle spindles, golgi tendon organs) and joints (e.g., Ruffini endings, Pacinian corpuscles) provide information about muscle stretch, degree of muscle tension, and angle positions. Great effort has been spent in studying these ingenious receptor devices; nevertheless, their modes of operation are still a matter of debate. The muscle spindle is particularly interesting for movement control and has, perhaps, been studied most extensively. It signals changes in muscle length as well as rate of length changes. Sometimes these changes occur abruptly, giving rise to an immediate response.

For example, when standing upright in a driving bus that suddenly stops, one tends to fall forward, resulting in a stretch of muscles in the lower leg (e.g., gastrocnemius, soleus). This results in contraction of these muscles to maintain equilibrium. This response is initially mediated by the stretch reflex, which originates in the muscle spindle and causes muscles to increase tension (although not sufficient) soon after detection

of muscle lengthening. It is an example of a fast closed-loop control mode. Another negative-feedback servomechanism originates in the golgi tendon organ, which senses force rather than muscle elongation, resulting in the reduction of force. Postural control is not only an end but also a means to an end in that it participates in almost any action. When lifting the arm, leg muscles will be activated before onset of arm movement to secure body equilibrium during this focal act. Thus, posture can be regarded as a background upon which a picture of voluntary movement is 'engraved.'

In addition to these muscle-specific sensory devices, vision is a very dominant receptor system in the control of posture and movement. Close your eyes when balancing on one leg, and you will realize that visual information is important for postural equilibrium. Vision also provides information about the position and movements of objects in the environment, leading to decisions for action. But, it is a far richer source of information in that it also tells us about our own movements in relation to the environment (also called exproprioception, as distinguished from extero- and proprioception). When the observer moves in the environment or when an object moves with respect to the observer, changes in the optical array occur, called optical flow. Thus, visual environmental information (e.g., texture, gradients, surface of objects) flows past us as we move around. For example, the rate at which trees and houses become larger and pass by as we drive a car down a road, tells us about our speed and the time at which upcoming objects will be contacted (time-to-contact). Sometimes vision can be so powerful that it overrules the proprioceptive information. As such, the human system is not only capable of integrating different sources of sensory information but also of giving different weights to these sources based on their reliability at a certain time.

Formal evidence for the powerful effects of vision in motor control has been provided by Lee and Aronson in a 'moving room' experiment. Subjects stood on a stationary floor surrounded by walls that could be moved back or forward together. When moving the wall a few centimeters toward or away from the subject, a loss of balance occurred. Apparently, moving the wall changed the optical array that was used as a source of information for postural control. The changes in the visual array were inappropriately interpreted as a loss of balance and produced a compensatory response, that is, moving the wall toward the subject induced the illusion of falling forward. The subject compensated with a backward movement, resulting in a disruption of posture.

Sensory/perceptual information and movement

Role of sensory information before movement

Information about the environment is gathered before actions are planned and executed. When throwing a ball, information is obtained about the location of the target to be hit and the position of the limbs and body. When enough time is available, such information processing may occur at a conscious level. In other cases, as in suddenly avoiding obstacles, decisions for action need to be made so fast that time-consuming processing stages are omitted. For example, information derived from optical flow patterns enables the identification of important external temporal events (the time-to-contact objects), which can be used to control motor activity in

humans and animals. This time-to-contact information is argued to derive directly from the rate at which retinal images of an object change in reference to their image size. It allows precise timing of actions without much conscious processing. This is supposedly the way humans accurately strike the takeoff board and initiate the long-jump when running up the trackway. With the latter examples, the distinction between use of information prior to and during action has become blurred.

Role of sensory information during movement

Ongoing movements can also be adjusted on the basis of incoming information that is fed back to a reference, as long as these movements proceed slowly enough. Examples of such control in human motor behavior are found in continuous tracking tasks such as driving an automobile, flying a small airplane, etc. While driving an automobile, for instance, a major goal is to keep the vehicle on the right track without approaching the road borders too closely. This environmental information is used to guide steering behavior through a series of corrections. The motor system is directed at nullifying error in these tracking tasks. Because the brain is a predictive organ, error detection and correction are implemented very quickly.

Role of sensory information after movement completion

Sensory information can also be processed after movement has taken place, particularly when movements are performed rapidly. After completion of a golf swing, the information produced by this response (response-produced feedback information; e.g., the way the ball was hit, the sound produced at contact) is compared to some reference of correctness, providing information about the degree of success obtained. Any discrepancy between the actual (what is) and expected (what should be) states leads to error detection and decisions for error correction that can be of use for the following trial. When the moving proceeds slow enough, such comparisons can also take place during movement production and may lead to corrections that occur very rapidly, particularly when well-developed internal models of sensory information are available.

This comparator function is hypothesized to reside predominantly in the cerebellum because central motor commands, as well as somatosensory, vestibular, and visual reports from the periphery, converge in this structure. One hypothesis concerning the mode of operation of this comparison process contends that signals are sent to certain neural centers, ahead of the response, to ready the human movement system for upcoming motor commands and for the receipt of feedback information. This advance information is also called corollary discharge (a related term is efference copy), and represents an example of feedforward control. In contrast to feedback, feedforward control refers to sending information ahead of time to prepare for upcoming sensory information or for planned motor commands. Prediction has the advantage that incoming information undergoes facilitated processing. Evidence for this viewpoint comes from experiments showing different sensory experiences in the case of passive or active movement production. As indicated previously, feedforward control is a cornerstone of computational models of motor control.

Movement Constraints: Computational Simplification

Degrees of Freedom and Control of Movement

Considering all movements that can in principle be generated at one joint through various muscle combinations and reflecting on the numerous ways to combine the movements of many joints, our ability to control all these muscles for the purpose of goal-directed behavior is rather remarkable. Indeed, an enormously rich configuration of neuromuscular assemblages is theoretically conceivable in the human motor apparatus. This was coined the 'degrees-of-freedom problem (df)' by the Russian physiologist Bernstein. Roughly defined, df refers to the number of independent states or variables that must be controlled at the same time. The df problem can be conceptualized at various levels of the movement apparatus (e.g., muscles, joints, motor units, neurons). How the control and coordination of several limb segments acting together are accomplished, has become of major interest.

There are various ways to address the df. For example, one can maximally exploit the biomechanical properties of the motor apparatus such as the length-tension characteristics of muscles or the external forces that act on movement (e.g., gravity). Another (related) way is to conceive of 'efficiency' or 'cost' as a dominant criterion for shaping action. For example, it has been proposed that the minimization of torque or mean squared jerk (the first time derivative of acceleration) is a primary efficiency constraint. Third, movement organization can be simplified by invoking larger units of behavior, such as preexisting synergies or reflex patterns, as discussed next.

In attempting to perform more than one motor task concurrently, limitations emerge that constrain our capability to perform different limb movements at the same time. Think, for example, about patting the head while rubbing the stomach simultaneously. A tendency for one movement to impose its pattern of activity on the other or a mutual synchronization of both action patterns becomes evident. Such constraints are common experience and are not limited to motoric dual-task performance. The study of these limitations is a long-standing issue in experimental psychology. I will limit the discussion to the particular case of discrete and continuous motor task coordination.

In a study on bimanual aiming tasks (pointing to different locations in space), Kelso and coworkers (1979) showed that the laws governing unimanual performance do not necessarily apply to multilimb action. In order to better appreciate their findings, it is necessary to first elaborate on one of the most fundamental laws in motor behavior. When aiming with the arm at a certain target, more time is needed when the distance to be covered increases, or, when the target becomes smaller. This can be put in a formal mathematical relationship, known as Fitts' law: $MT = a + b[\log_2(2A/W)]$, where MT is movement time, a and b are empirical constants, A is amplitude of the movement, and W is target width. A combination of the latter two variables provides an indication of task difficulty. If the index of difficulty is increased, the movement will be performed at lower speed. Hence, there is a speed accuracy trade-off. This is a powerful law in that it generally holds for a variety of aiming tasks, irrespective of whether one aims for a glass with the hand, types a keystroke with the finger, or positions the foot on the accelerator.

Given the strength of this lawful relationship for single effector performance, Kelso and collaborators wondered what would happen when making a short pointing movement to a wide target with one hand together with a long movement to a small target with the other hand. In the case of individualized control of the limbs, Fitts' law would predict both movements to be completed in different overall times because of their differential degree of difficulty. The findings, however, proved otherwise: the slow movement was sped up and the fast movement was slowed down, resulting in a rescaling of the movements toward a common underlying temporal structure. This was interpreted as evidence for a coordinative structure, that is, interlimb control by means of a group of muscles constrained to act as a functional unit. These findings do not invalidate Fitts' law which was only conceived for unilimb motions. The point is, however, that the laws governing multilimb actions are not necessarily linear extrapolations of those applicable to unilimb action. In other words, the whole is more than or is different from the sum of its parts. Please note that such constraints refer to the default state of the movement system. Practice allows these constraints to be overcome and musicians are a nice example of differentiated manual performance.

Interlimb interactions equally appear in discrete and cyclical movement production. The latter often display features of oscillators. The theoretical and experimental basis for this work was laid down by Von Holst some 50 years ago during his investigations of the coordination of fin movements in anesthetized fish species. Two important principles of coordination were discovered, which have relevance for many species (including humans). First, each fin pattern tended to maintain its own frequency or speed of natural oscillation, referred to as the maintenance tendency (*Beharrungstendenz*). Such intrinsic frequencies are interdependent with the lengths and masses of the segments to be moved, that is, smaller segments (such as the human arm) are likely to display higher frequencies than larger segments (such as the leg). Second, Von Holst observed a tendency for one fin movement to impose its frequency on another, or for both fin movements to mutually affect each other. This (mutual) attraction was called the 'magnet effect' (*Magnet effect*), often leading to a 1:1 temporal relationship between fins. These principles demonstrate that coordination arises as a result of the interplay between competitive and cooperative tendencies. Moreover, they exemplify how various modes of coordination are accomplished by lower centers through the combination of a few elementary principles. This reduces computational complexity through minimization of the degrees of freedom.

When humans perform cyclical limb movements simultaneously, similar phenomena can be observed. Although this does not necessarily imply that the basic modes of operation are the same in both types of species, it is noteworthy from an evolutionary perspective that some general principles of coordination arise within the animal world. When making horizontal finger or elbow movements in both upper limbs simultaneously, a strong tendency emerges to synchronize the output patterns in a temporally compatible fashion (1:1 frequency ratio), similar to the magnet effect. Both arms are either flexed or extended simultaneously (in-phase), or one arm extends whereas the other is being flexed (antiphase) (see [Figure 2\(a\)](#)). In-phase coordination is associated with the

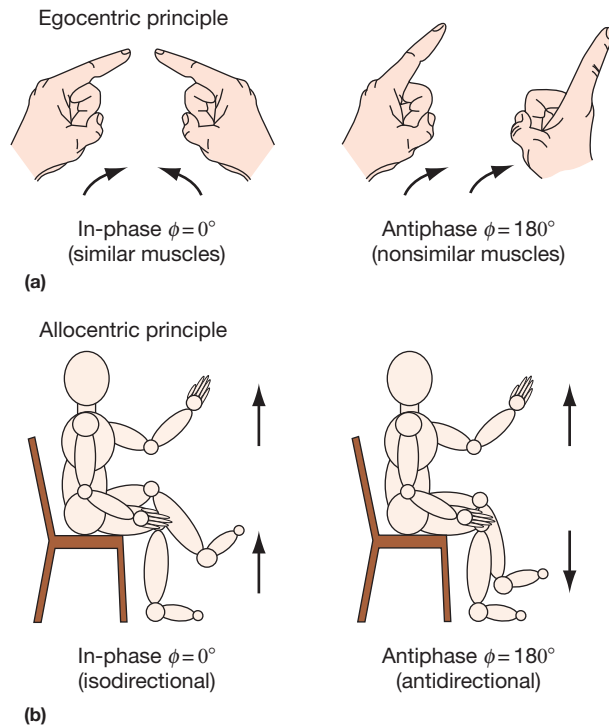


Figure 2 Basic coordination constraints: the egocentric, and allocentric principles. (a) The egocentric principle refers to a preference for mirror symmetrical movements, which involves activating homologous muscle groups simultaneously. (b) The allocentric principle refers to a preference for moving the limbs or limb segments in the same direction in extrinsic space. Φ = relative phase. Reproduced from Swinnen SP (2002) Intermanual coordination: From behavioural principles to neural-network interactions. *Nature Reviews Neuroscience* 3: 350–361, with permission from Nature Reviews Neuroscience.

simultaneous activation of homologous muscle groups whereas antiphase coordination requires the simultaneous activation of nonhomologous muscle groups. This refers to the egocentric constraint. Phase refers to the point of advancement of the signal within a cycle, ranging from 0° to 360° . By subtracting the phase angles of both limbs, one obtains the phase difference or relative phase which provides a signature of the mode of interlimb coordination. Applied to the previous examples, in-phase refers to 0° and antiphase to 180° relative phase. Alternative coordination modes, such as moving the limbs 90° out-of-phase with a 1:1 frequency ratio or producing a pattern with a 3:2 frequency ratio, are more difficult to accomplish and often require substantial learning to attain comparable degrees of stability.

With respect to coordination of nonhomologous limbs or segments (e.g., ipsilateral hand and foot), the most preferred and stable pattern is characterized by moving both limbs in the same direction in extrinsic space, that is, both limbs are moving up and down simultaneously (isodirectional, $\Phi = 0^\circ$) (see Figure 2(b)). Conversely, movements in different directions, that is, one limb moves up whereas the other moves down (antidirectional, $\Phi = 180^\circ$), are perceived as being more difficult to sustain, particularly at higher movement frequencies. This is referred to as the allocentric constraint, denoting a general preference for performing movements in the same direction in

extrinsic space, irrespective of the muscle combinations. The compelling impact of this constraint can be experienced when making cyclical clockwise circular motions with your right leg from a seated position and suddenly drawing the number '6' with your right arm. The anticlockwise motion during drawing '6' results in a sudden shift from clockwise to anticlockwise motion in the lower leg, resulting in isodirectionality.

This directional constraint is also evident during coordination of the homologous limbs, even though it is subordinate to the egocentric constraint. More specifically, coordination patterns of the upper limbs that involve simultaneous activation of the same muscle groups and isodirectional movements in extrinsic space are more accurate and stable than any alternative patterns. Preferred neuromuscular and perceptual aspects could underlie these basic coordination constraints. In this respect, an interesting parallel can be drawn with visual perception, in which mirror image symmetry on the one hand and perceptual grouping of isodirectional stimuli on the other hand are more salient than alternative symmetry or grouping principles. The type of coordination pattern that performers will ultimately produce is task-specific and context-dependent. Recent medical imaging studies have shown that the perceived differential difficulty between the aforementioned bilateral or ipsilateral coordination modes is also associated with differential brain activity, that is, the more difficult mode requires a greater recruitment of neural resources in cortical (temporoparietal and premotor areas, see Figure 1) and subcortical structures (cerebellum, basal ganglia, thalamus) than the easier mode.

Overall, the previously mentioned observations point to a fundamental tendency for frequency and phase synchronization that is evident during the production of various coordination patterns. Stability during in-phase and antiphase coordination is easily obtained and does not require much practice in adults, that is, both are intrinsically stable coordination modes. Advocates of the dynamical systems perspective refer to these modes as 'behavioral attractors.' The important behavioral implication is that alternative coordination patterns tend to converge to or are biased by these attractors, thereby inducing errors in performance.

Thus, we have identified synchronization as a fundamental organizational property governing interlimb coordination and resulting in the exploitation of a restricted range of preferred interlimb relationships. It is now easier to appreciate the nature of errors or the interference that subjects experience when attempting more difficult or incompatible coordination patterns, such as in musical performance. In summary, research on interlimb movements points to the necessity for investigating coordination as a distinct type of control problem with its own lawful modes of operation. In a more general way, global behavior of biological systems cannot always be understood by investigating its elemental units, because interactions among the units are responsible for emergent properties at the macroscopic level that cannot be directly deduced from knowledge of the individual components.

Significant Units of Motor Control

Research on coordination has prompted an animated discussion about the significant units of movement to be controlled

by the human motor system. The viewpoint has gained acceptance that cooperating groups of muscles, constrained to act as a functional unit, are preferably recruited. These are also referred to as muscle collectives, coordinative structures, or synergies, as discussed earlier. This mode of control has a number of advantages. First, it provides an economical solution to the aforementioned df problem in that a limited set of preferred modes of movement organization become apparent. Second, computational complexity is reduced, as these muscle synergies constitute not only the external language of movement but also the internal language of the central nervous system. Although the synergy perspective provides a fruitful and economical way to theorize about the organization of action, it should not be taken to imply that individual muscles, or even motor units, cannot be controlled individually, or that a release from the constraints imposed by these coordinative structures would be impossible. This latter issue will be discussed later.

What evidence has been advanced to support the control of muscle groups by the central nervous system? The strong tendency to synchronize patterns of motor output in the limbs has already been reported. Another line of evidence is provided by the appearance of complete or fractionated reflex patterns in voluntary movement. For example, the tonic neck reflex, which arises in neck proprioceptors, gives rise to body and limb movements through a series of internally triggered reactions. The asymmetric tonic neck reflex, induced by turning the head sideward, is characterized by extension of the limbs on the side of face orientation and flexion on the other side. The symmetric neck reflex causes the upper limbs to flex and the lower limbs to extend when bending the head forward (ventriflextion) whereas the reversed pattern occurs when bending the head backward (dorsiflextion). As head movements also activate the inner ear receptors, these patterns often operate together with labyrinthine reflexes. Reflex patterns can be elicited rather easily in newborns or children with cerebral dysfunctions, but more careful observation reveals that they are also evident in the skillful performances of athletes. For example, attention to head position often induces major improvements in somersaults because it triggers the correct limb or trunk responses. These empirical observations are corroborated by experimental work that has shown actions in accordance with the tonic neck reflexes to confer additional strength. Thus, inherited reflex patterns appear to be part of the behavioral repertoire and become integrated with voluntary movement. This viewpoint is not incompatible with a programming notion of movement control. Central commands may help orchestrate the possible role of these muscle synergies in movement and may incorporate fractions of it into the overall plan of action.

Acquiring New Patterns of Coordination

In the previous section, synchronization was emphasized as a key organizational feature in movement coordination. However, this may also constitute an obstacle whenever differing or incompatible limb movements have to be performed together, such as in playing two different rhythms on the piano. Tapping rhythms with the fingers is not difficult when fingers move in synchrony (1:1), or when tapping in one finger is an integer

multiple of the tapping rate in the other (2:1, 3:1). But, when the timing relationships are less compatible (3:2, 5:3), achieving the same degree of consistency in tapping rate is much more difficult. Degree of temporal incompatibility between the movements marks task difficulty.

Luckily, the human motor control system can overcome or eliminate natural or preferred response tendencies to generate new task-specific forms of coordination. Therefore, it is as important for a theory of coordination to identify the restricted range of interlimb interactions as to provide insights into the way patterns of activity can be differentiated within a highly interconnected neural system, that is, to de- and recompose coordination patterns. The latter is not only a matter of selecting the appropriate action patterns, but also of inhibiting or repressing unwanted or excessive motor activity. Shaping new forms of coordination requires a release from the constraints imposed by intrinsic muscle synergies to meet the general principle of minimal expenditure of energy.

Recoordination of action patterns sets in at an early age. In the newborn, reaching toward a visual target is initially accomplished by a tight coordination of elbow, wrist, and finger extension. This coordinative pattern evolves into a more differentiated organization of the joint movements in which the fingers can be flexed in anticipation of grasping an object while the arm extends; this is an example of intralimb coordination. Sometimes, the overruling of constraints is easily accomplished. At other times, it requires considerable practice as expert athletes, dancers, musicians, etc. testify. Intention and the deployment of attentional strategies are helpful to stabilize otherwise unstable patterns of coordination. Moreover, the use of conceptualisation strategies, instructional means to promote task integration, and/or visual transformation procedures, has been gaining increasing attention of late. Thus, the manner in which actions are conceptualized and represented affects the amount of interference observed. Complex tasks that are seemingly difficult to perform can become easy when familiar events or symbols are called upon. These cognitive strategies serve as binding rules to generate meaningful gestalts. For example, it is generally difficult to produce a 90° out-of-phase finger tapping pattern but learners may catch the trick when referring to a sound made by a galloping horse. Experimental evidence supporting the role of conceptualization processes has been obtained by Franz and coworkers during the simultaneous production of semicircles with both hands. When you perform these geometrical forms in front of you in the air from left to right and back, such that the overall pattern gives rise to a full circle, performance is easy (Figure 3(a), left part). When the semicircles start and end far apart but approach each other in the middle (like a 90° rotated X symbol), performance is much more difficult (Figure 3(a), right part). Both tasks are similar in their relative phasing but differ in familiarity of the symbols that are brought to mind to conceptualize both limbs' subtasks into a meaningful 'gestalt.' Whereas the latter example refers to relatively spontaneous behavior, conceptualization strategies can also be imposed. Binding rules are also critical when performing complex polyrhythms (e.g., a 3:2 or 5:3 frequency ratio). Polyrhythms can be performed successfully when the subtasks become integrated into a common temporal structure in which the taps of the slower limbs are integrated into those of the faster limb. Perhaps the advantage of such

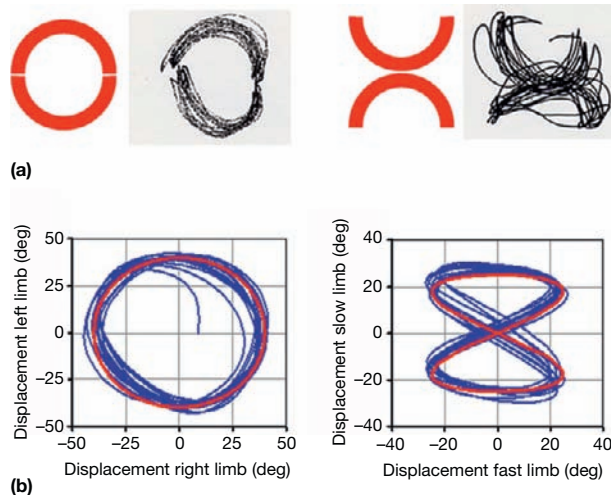


Figure 3 Examples of conceptualization processes or visual transformations that promote task integration. (a) Participants are required to draw semicircles in front of them with both arms. They move in the air from left to right or vice versa. One task (left) requires starting and ending both fingers together in space whereas there is maximal separation in the middle of the trajectory. The other task (right) starts and ends with both fingers separated but the trajectories meet in the middle. When the resulting global pattern is represented by a circle (left), performance is more successful than when a less familiar pattern is generated (right), in spite of the similar relative phasing patterns in two-dimensional space for both tasks. The template is shown in red and actual performance in black. (c) Difficult relative-phasing patterns can be produced and acquired more easily when performers receive real-time augmented feedback displaying their displacements in an integrated fashion. Participants perform cyclical forearm movements in the horizontal plane while the Lissajous figures are represented on a screen in front of them. The left arm motion is presented in the ordinate and the right motion in the abscissa. Examples of patterns with a 1:1 (left) and 2:1 (right) frequency ratio in which one limb lags 90° with respect to the other. Mathematically generated ideal templates are shown in red, actual performance across a 15-s trial is indicated in blue. Reproduced from Swinnen SP and Wenderoth N (2004) Two hands, one brain: Cognitive neuroscience of bimanual skill. *Trends in Cognitive Sciences* 8(1): 18–25.

binding rules is that attention is no longer divided across the subtasks but is focused on the gestalt.

Instructional aids can also be employed to reduce coordinative complexity by provision of a simplified visual representation of the task.

For example, coordination between the limbs can be displayed more directly by a single integrated signal instead of two separate signals representing each limb. When plotting the displacement signals of each limb online during performance in an orthogonal fashion (i.e., a Lissajous figure), difficult coordination patterns become 'graspable' (Figure 3(b)). This type of augmented feedback provides direct information about the nature and quality of coordination and has been used successfully in the context of learning new bimanual coordination patterns.

In summary, the human motor system is plastic and adaptive to overrule coordination constraints. Abstract binding or visual transformation rules can help to overcome these

constraints by enslaving the sensorimotor networks. This is consistent with a hierarchy in control with higher level abstract and lower level muscle- or effector-specific codes.

Motor Control Flexibility and Goal Accomplishment

Writing a computer program that is sufficiently generic for the analysis of various data sets is more elaborate than for one particular data set. Creating an adaptive program or any other device to meet general-purpose requirements is indeed a thorny problem. Flexibility and adaptability are interesting properties of the human motor control system, favoring goal-appropriate behavior through various means. For example, when brushing your teeth, you can move your arm or your head or you can explore various ways to combine them. This is often referred to in the literature as motor equivalence.

Response equivalence is not unique to humans but can also be found in lower mammals as shown in conditioning studies. For example, a sheep is initially trained to lift his left foot off a grid floor at the sound of a tone that signals an impending electrical shock. When the sheep is subsequently forced to lie down with its head on the grid floor, it will now lift its head and shoulders from the floor when the tone sounds. Apparently, the animal has not learned a stereotype response but a goal-directed action, that is, it does whatever is needed to avoid the shock.

At least two types or levels of movement flexibility have received attention. One type concerns adjustments to environmental circumstances through a rescaling of certain movement variables without affecting the basic structure of movement. A second type of adjustment is more invasive and occurs very fast. The former one may be more preplanned through evaluation of initial conditions, whereas the latter may appear rather suddenly during movement, or whenever attainment of action intentions is in danger.

Goal Accomplishment Through Adjustable Parameter Specification

A favorite example to demonstrate that movement can be performed under a variety of circumstances without affecting its basic structure is that of handwriting. Handwriting skill is also a classic case for advocates of programmed control. If you do not believe that movements can run off in a clocklike (programmed) manner once initiated, try this: Write the words 'motor control' at normal speed but try to omit the horizontal bar in the letters 't.' Although you intend to do so before movement initiation, modifying this particular aspect is difficult unless you slow down considerably. It leaves the impression that this action happens beyond voluntary control. But granted these strokes seem to be almost rigidly strung together into one unit, what evidence is there in favor of motor output flexibility? Suppose that you write the word 'skill' under different circumstances and with different overall sizes and speeds. The basic question is whether each variation constitutes a different movement or another version of the same movement structure. Current evidence tends to support the second case. Figure 4 shows the vertical acceleration patterns generated for writing the word skill on a digitizing board positioned

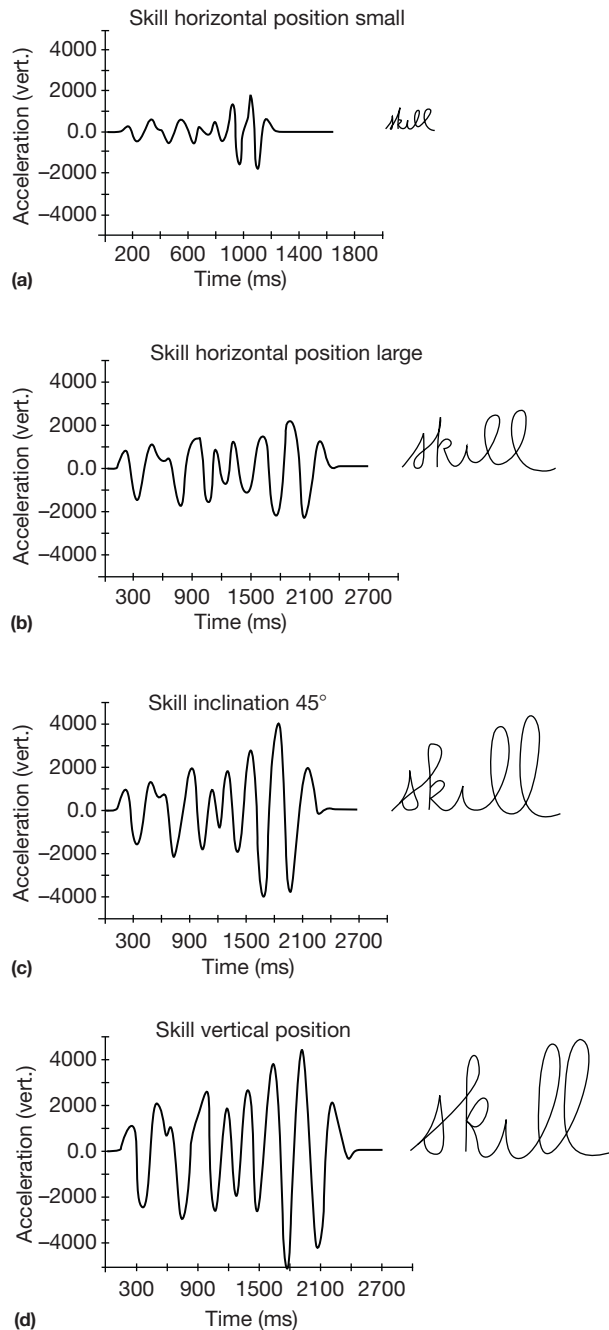


Figure 4 Vertical acceleration patterns produced for writing the word 'skill' on a digitizer positioned horizontally, with 45° inclination, and vertically. On the Y-axis are shown the acceleration patterns. Note that the time basis in graph (a) is different from those in graphs (b–d). Both upper traces differ from each other in letter size, as shown on the right. Letter sizes in (c–d) are also different from (a) although total duration is similar. Reproduced from Swinnen SP (1994) In: Ramachandran VS (ed.) *Encyclopedia of Human Behavior*, vol. 3, pp. 229–243. New York, NY: Academic Press.

horizontally (small and large size), with 45° inclination, and vertically (as in writing on the blackboard), respectively.

As shown in the figure, the word skill is written in different overall sizes: the word presented in graph (a) is two to five

times smaller as the words in graphs (b)–(d) (see Figure 4). The total duration for the smallest word is half that needed for writing the larger words. Leaving aside these parameter differences, similarities among these variations are apparent. They reflect existing task constraints as well as the individual's particular writing style. Thus, although the absolute values of peak accelerations and decelerations differ among these written words, the general form of these acceleration patterns is very similar even though this word has never been written before under these varying conditions. However, the forms are not exactly the same and this is due to the unique way movement commands unfold on every attempt in view of contextual requirements. It reminds us that each movement is unique and is never made in exactly the same way as before.

The consistencies or invariances across variations are noteworthy when realizing that the particular set of muscles used is unique for each example (due to shifts in writing posture, differential gravity effects, writing size, etc.). Consequently, the same program is run off using entirely different muscle groups and with variations in overall size and timing. Whatever is represented in this motor program must be coded in rather abstract terms. Accordingly, a one-to-one relationship between the program and movement does not exist; rather, programs govern all movements that belong to the same class. Schmidt therefore uses the term 'generalized motor programs.' Recent medical imaging studies support the idea that some brain activations are effector-dependent (such as those in the primary sensorimotor cortex) whereas others are effector-independent (such as in the left parietal and premotor cortex). The separation of invariant features and adjustable parameters represents an economical account to human movement production in that movement can be tailored to particular environmental demands without compromising on its basic features.

Goal Accomplishment Through Response Reorganization: Evidence for Motor Equivalence

In contrast with the previous example, the preservation of the movement goal in the face of disturbances can also result in a more invasive reorganization of control. When environmental circumstances impede ongoing movement, the intended goal can often be accomplished by means of short latency but set-dependent responses. Short latency refers to the rapid character of these responses; set-dependence refers to their dependence on the performer's intention. Speech control research has illustrated motor equivalence although it has also been observed in fine precision grip movements and target-directed arm movements. There is mounting evidence that rapid reorganization of movements involved in speech is possible to achieve articulatory goals. For example, when upward movement of the mandible is impeded in the process of saying something that requires a labial occlusion (as in p or b), the upper lip increases its downward movement within 50–60 ms to achieve the articulatory goal. It is a case of feedforward control. These movements are unique in that they differ from voluntary responses that have much longer latencies. But they are also distinct from reflexes in that they are more adaptive in meeting the subject's goal and intentions. These short-latency responses indicate that higher level parts of the control system are

relatively unconcerned with the specific contribution of sub-systems as long as the intended goal is met.

All together, these observations indicate that what is represented as a result of learning is not muscle specific but consists of a rather abstract formulation of movement goals. By specifying general action goals or intentions at the highest levels and leaving the movement details to be fitted later in the process of organization at lower levels, the central nervous system is capable of producing the same effect over and over again, but never in exactly the same way. This is motor equivalence.

Summary

Recent concerns for the df problem on the one hand and for motor equivalence and output variability on the other hand illustrate that organizational and purposive issues in movement form basic tenets in motor control theories. This will eventually lead to a better understanding of the ingenious mechanisms that characterize the human motor control system and will promote the development of appropriate learning settings to improve skilful behavior and to help restore movement disabilities.

The field of motor control has increasingly attracted the attention from a large umbrella of widely different subfields of science. It generates research at an accelerating pace and is marked with interesting discoveries that will ultimately result in the establishment of a solid body of knowledge on the functioning of the central nervous system and the great diversity of actions it generates. However, it is also a challenging area to work in for the practicing scientist in that information from various areas of research has to be brought together.

See also: The Brain; The Mirror Mechanism; Spatial Orientation; Touch; Visual Perception.

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Near-Death Experiences

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Glossary

Autoscopy The experience of seeing a hallucinatory image of one's body in external space.

Cardiac arrest A sudden, complete cessation of the heartbeat and cardiac function, causing blood to stop circulating through the body.

Deathbed vision A vision or other experience that a dying person may have in the minutes, hours, or days before his or her death.

Ego boundary The normal psychological delineation of the self from everything that is not the self.

Extrasensory perception (ESP) The acquisition of information about an external event or object in some way other than through any of the known sensory channels.

Hallucination A subjective perception that appears to be real but is generated by the mind rather than by any corresponding external stimulus.

Mind/brain problem The philosophical problem of the interrelationship between the mind and the brain.

Neurotransmitter A chemical that transmits neural signals across a synapse between a neuron and another cell.

Out-of-body experience (OBE) An experience in which one's center of consciousness seems to be in a spatial location outside one's physical body.

Rapid eye movement (REM) Sleep a sleep stage in which dreaming occurs, characterized by rapid eye movements and a waking-like EEG.

Introduction

Near-death experiences (NDEs) are profound and sometimes life-changing experiences reported by people who have been physiologically close to death, as in cardiac arrest or other life-threatening conditions, or psychologically close to death, as in accidents or illnesses in which they feared they would die. The characteristic transcendence of ego boundaries, including a sense of separation from the physical body and experience of cosmic unity, leads many near-death experiencers (NDErs) to interpret the event in spiritual or mystical terms.

Experiences of altered consciousness on the threshold of death can be found in the folklore and writings of most cultures and have been described sporadically in the Western medical literature since the nineteenth century. The phenomenon was first described as a discrete syndrome in 1892 by Albert von St. Gallen Heim, a Swiss geology professor who was motivated to collect accounts after he himself had a profound experience while falling from a mountain in the Alps. However, the term *near-death experience* and its acronym *NDE* were not coined until 1975. Extensive research since then suggests that NDEs are reported by 12–18% of cardiac arrest survivors (between 1600 and 2400 Americans each year).

Early research into NDEs was predominantly retrospective, raising the question of the reliability of the experiencer's memories. However, studies comparing NDE accounts from the same experiencers on successive occasions varying from days apart to 20 years apart have found no indication of embellishment or other distortion over time; and more recent research has placed greater emphasis on prospective studies.

Phenomenology of NDEs

Raymond Moody, who coined the term *near-death experience*, used it to refer to an ineffable experience on the threshold of

death that may include feelings of peace and cessation of pain; a sense of being out of one's physical body and watching events from an out-of-body perspective; a sense of movement through a dark tunnel or void to another realm; seeing an unusually bright light that may be experienced as a 'being of light'; a panoramic life review; meeting other nonphysical beings, including deceased acquaintances; a border or point of no return; and a return to the physical body, followed by profound changes in attitudes and values and elimination of the fear of death.

The most common features of NDEs can be grouped into four components. Cognitive features reflect changes in thought processes, including distortions in the sense of time, acceleration of thought, a life review or panoramic memory, and a sense of revelation or sudden understanding. Affective features reflect changes in emotional state, including a sense of peace and well-being, joy, a sense of cosmic unity, and an encounter with a brilliant light that seems to radiate unconditional love. Paranormal features include purported psychic phenomena, such as extraordinarily vivid physical senses, extrasensory perception, precognitive visions, and a sense of being out of the physical body. Transcendental features include apparent otherworldly phenomena, such as travel to a mystical or unearthly realm or dimension, an encounter with a mystical being or presence, visions of deceased or religious figures, and a border beyond which one cannot return to earthly life.

NDEs are reported both by individuals who had been pronounced clinically dead but then resuscitated, and by individuals who, in the course of accidents or illnesses, merely feared that they were near death. Some individuals who actually do die are able to describe 'deathbed visions' in their final moments, or speak and act in ways that suggest they are having visions, which bear some similarities to NDEs. Although all elements of the NDE can be reported by individuals who merely believe themselves to be near death, an encounter with a brilliant light, enhanced cognitive function, and positive

emotions are more common among individuals whose closeness to death has been corroborated by medical records.

Many of the experiential features of NDEs are typical of those of mystical experiences occurring in other settings: a sense of cosmic unity or oneness, transcendence of time and space, deeply positive mood, sense of sacredness, noetic quality or intuitive illumination, paradoxicality, ineffability, transiency, and persistent positive aftereffects. However, typical NDEs differ from classical mystical experiences in three respects: the accent on individual identity, such as in the life review and encounters with deceased relatives; the relative clarity of events; and the lower frequency of the experience of union, which is a defining characteristic of mystical experience.

Aftereffects of NDEs

NDEs can permanently and dramatically alter an individual's attitudes, beliefs, and values. Aftereffects most often reported from long-term follow-up studies, including interviews with significant others, include increases in spirituality, compassion and concern for others, altruistic behavior, appreciation of life, sense of connection to others, belief in postmortem existence, sense of purpose, and confidence and flexibility in coping with life's vicissitudes; and decreases in fear of death, interest in materialism, personal status, and competitiveness. Although decreased fear of death usually increases suicidal risk, NDEs paradoxically express stronger opposition to suicide than comparison samples, primarily on the basis of increased transcendental beliefs and sense of meaning and purpose in life.

This transformative aspect of NDEs has not been reported in connection with the various fragmentary experiences that are sometimes compared to NDEs, such as the 'dreamlets' induced by hypoxia or other abnormalities of blood-gas concentrations, or experiences reported by patients receiving temporal lobe stimulation. Moreover, the transformative features associated with NDEs differ from those associated with the experience of coming close to death but not having an NDE. For example, although most individuals who come close to death express greater appreciation for life, those who did not have NDEs often become more fearful of death and less flexible in coping with stressors.

Psychological Models of NDEs

How can these phenomena best be understood? Psychological speculations have attributed NDEs to defense mechanisms, depersonalization, wishful thinking, retroactive confabulation, and expectation, although these psychological models are not supported by empirical evidence, and some have been rebutted by what evidence we have. One such explanation suggests that NDEs are products of the imagination, constructed from personal and cultural expectations to lessen the threat of death. However, individuals often report experiences that conflict with their specific religious and personal expectations of death. Specific knowledge individuals had about NDEs previously does not influence the details of their own experiences: people who have not known about NDEs describe the same kinds of experiences as do people who are familiar with them,

and experiences that were reported before 1975, when the term NDE was coined, do not differ from those that occurred after that date. Furthermore, children too young to have received substantial cultural and religious conditioning about death report the same kinds of NDEs as do adults; some cases have been reported to have occurred before the child could have acquired significant language skills.

Although there are some cross-cultural variations in the content of NDEs, these may reflect simply the experiencers' difficulty processing and expressing an experience that is largely ineffable. At this point it is unclear whether cultural beliefs influence the actual experience itself, or merely its recall and retelling, or the investigators' collection of the accounts. There seems, in short, to be an underlying core experience that is inevitably cast in the images, concepts, and symbols culturally available to the individual.

Since religion addresses fundamental human concerns such as death and dying, one might speculate that religious orientation or religiosity might influence NDEs. One view of the NDE is that it represents essentially a religiously inspired illusion. However, several studies in the United States and in other cultures have failed to find associations between religion or religiosity and subsequent NDEs, although they have found that an individual's belief system influenced the *interpretation* of the experience.

Another psychological model attributes NDEs, with their dark tunnel, a bright light, and transition to another realm, to memories of birth. However, newborns lack the visual, spatial, or mental capacities to register memories of birth experiences. Furthermore, many NDEs do not contain the features of a tunnel or a light, and many other common features of NDEs are not accounted for by this model. Finally, claims of out-of-body experiences (OBEs) and of passing through a tunnel to another realm are equally common among persons born by normal vaginal delivery and those born by Caesarean section, whose birth would not include any 'tunnel' analogy.

Researchers have identified very few personal traits or variables that can predict who will have an NDE or what kind of NDE a person may have. NDEs are indistinguishable from other survivors of close brushes with death in terms of age, gender, race, intelligence, neuroticism, extroversion, trait and state anxiety, history of mental illness, or relevant Rorschach measures. However, some studies have suggested that NDEs tend to be good hypnotic subjects, remember their dreams more often, and are adept at using mental imagery, and tend to acknowledge significantly more childhood trauma and resultant dissociative tendencies than others. It is not clear whether these distinguishing personal traits are the results of having had an NDE or whether people who already have those characteristics are more prone to have NDEs when they come close to death.

Comparison of NDEs to Psychopathological Conditions

As noted above, retrospective studies of NDEs have shown them as a group to be psychologically healthy individuals, who do not differ from comparison groups in measures of mental health. The percent of psychiatric patients reporting NDEs is comparable to that found in the general population, suggesting that mental illness itself bears no association with NDEs.

Psychiatric patients who have been close to death report more psychological distress than those who had not; however, among those patients who had come close to death, those who reported NDEs report less psychological distress than those who did not. Thus, NDEs seemed to have a protective effect against, rather than to cause, psychological distress. Despite this evidence of mental health among NDErs, NDEs and their aftereffects have been compared by some authors to several psychopathological conditions.

Depersonalization involves feelings of detachment, strangeness, and unreality, which some have compared to the perceptions in NDEs. However, in depersonalization, the feeling of one's own reality is lost, whereas NDEs are described as being vividly real; depersonalization is usually unpleasant, in contrast to most NDEs; and depersonalization involves an emotional detachment from the body but not a perception of actually leaving the body. Depersonalization does not include the hyperalertness and mystical consciousness seen in NDEs, and it differs from NDEs in its age and gender distribution.

NDEs have been compared with *dissociation*, the separation of thoughts, feelings, or experiences from the normal stream of consciousness and memory. Symptoms of dissociation are more common among NDErs than among individuals who have come close to death without NDEs, but they are still within the range of the normal population and much lower than in clinical dissociative disorders. The dissociative symptom profile of NDErs is suggestive of a normal psychophysiological response to stress, a shifting of attention from the physical environment to an altered state of consciousness, rather than a pathological type of dissociation or a manifestation of dissociative disorder.

Related to dissociation is *absorption*, the ability to screen out the external world and focus attention either on selected sensory experiences or on internal imagery, and *fantasy proneness*, characterized by frequent and vivid fantasies, hallucinations, intensely vivid sensory experiences, and eidetic imagery. Empirical data regarding absorption and fantasy proneness among NDErs have been equivocal. A relationship between fantasy proneness and NDEs might suggest that NDEs are fantasies, or it might instead reflect an ability to enter more readily into altered states in which the ordinary relationship of consciousness to brain activity and the external environment has changed.

Among the psychological and biological responses to trauma is *posttraumatic stress disorder (PTSD)*, which involves a biphasic pattern of reliving the trauma through intrusive memories, alternating with avoidance of reminders and numbing. NDEs can in some cases lead to PTSD-like symptoms of intrusive recollections of the event, recurrent dreams of the event, diminished interest in previously important activities, estrangement from others, and a sense of foreshortened future. The incidence of PTSD-like symptoms among NDErs is higher than that among survivors of close brushes with death without NDEs, although it is within the normal range and far below that seen in clinical PTSD. The NDErs' profile of moderate elevation of intrusive (though not distressing) thoughts, images, feelings, and dreams, but no elevation of avoidant psychic numbing, behavioral inhibition, or counterphobic activities, is typical of a normal response to stress rather than of PTSD.

NDEs have sometimes been compared to *autoscopy*, seen in a variety of brain lesions. However, in NDEs the observing self or point of perception is experienced as outside the physical

body, and the subject sees his or her own inactive physical body; in autoscopy, the observing self remains inside the body and sees an apparitional 'double.'

NDEs also are superficially similar to psychoactive substance-induced hallucinations, but are generally more complex than the mental imagery induced by drugs, are more often endowed with personal meaning, and usually occur in the absence of psychoactive substances. Although schizotypal personality disorder can include cognitive and perceptual distortions, it requires a pervasive pattern of interpersonal deficits that is not seen in NDEs. NDEs can be differentiated from brief psychotic disorders by their acute onset following a stressful precipitant, and by the experiencers' good premorbid functioning and positive exploratory attitude toward the experience.

Physiological Models of NDEs

There have been numerous attempts to explain NDEs in terms of conventional biochemical or neurobiological mechanisms, based on known or hypothesized changes in the neurochemistry of the brain brought on by the conditions accompanying a close brush with death and leading to abnormal neuroelectric activity in critical brain areas, usually the temporal lobes. However, as researchers have learned more about the variations and complexities of the conditions under which NDEs can occur, there has been a noticeable move away from attempting to find a single common mechanism underlying all NDEs and toward a multifactorial interpretation. It should be noted that these hypothetical neurobiological mechanisms, for which there is little if any empirical evidence, may suggest brain pathways through which NDEs are expressed or interpreted, but do not necessarily imply causal mechanisms.

Hallucinations

Because NDErs report events that others around them cannot see or experience, some have regarded NDEs as elaborate hallucinations produced either by medications given to dying patients or by metabolic disturbances or brain malfunctions as a person approaches death. However, many NDEs are recounted by individuals who had no known metabolic or organic malfunctions that might have caused hallucinations. And although some drugs may occasionally induce experiences that bear superficial similarities to NDEs, comparative studies have shown that patients who receive medications in fact report *fewer* NDEs than do patients who receive no medication. Such findings suggest either that drug-induced delirium, rather than causing NDEs, in fact inhibits them from occurring or that delirious patients tend not to recall their experiences upon recovery.

As for metabolic causes of hallucinations, organic brain malfunctions generally produce clouded thinking, irritability, fear, belligerence, and idiosyncratic visions, quite unlike the exceptionally clear thinking, peacefulness, calmness, and predictable content that typify the NDE. Visions in patients with delirium are generally of living persons, whereas those of patients with a clear sensorium as they approached death are almost invariably of deceased persons. Patients who were febrile or anoxic when near death report fewer NDEs and less elaborate experiences than do patients who were not.

Altered Blood Gases

One physiological model attributes NDEs to decreased oxygen (*hypoxia*) or to a complete lack of oxygen (*anoxia*), which is often the final common pathway to death. However, NDEs also occur without anoxia or hypoxia, as in nonlife-threatening illnesses and near-accidents. Furthermore, the experiential phenomena associated with hypoxia are only superficially similar to NDEs. 'Dreamlets' occurring during the brief periods of hypoxia-induced unconsciousness induced by rapid acceleration in fighter pilots, for example, share with NDEs tunnel vision and bright lights, floating sensations, pleasurable sensations, brief fragmented visual images, and (rarely) a sense of leaving the body. In contrast to NDEs, these 'dreamlets' include visions of living people but never dead people, and no life review or panoramic memory. NDEs do not include typical hypoxic symptoms, such as myoclonic convulsions, retrograde amnesia for events prior to unconsciousness, automatic movements, memory effects, tingling in extremities and around the mouth, confusion and disorientation upon awakening, and periawakening paralysis. Hypoxia or anoxia generally produces idiosyncratic, frightening hallucinations, and leads to agitation and belligerence, quite unlike the peaceful NDE with consistent, universal features. Furthermore, the few published studies of blood gases in people near death have shown that those who have NDEs do not have lower oxygen levels than those who do not.

Another possible model suggests that elevated carbon dioxide levels (*hypercarbia*) may contribute to NDEs. However, the NDE-like features that have been reported in hypercarbia, such as a sense of leaving the body, bright light, dark void, memory revival, and sense of peace, are rare and isolated. Furthermore, there have been reports of NDE in patients in whom carbon dioxide levels were not elevated. Finally, if anoxia and hypercarbia played an important role in NDEs, NDEs should be much more common than they are in patients with cardiac arrest.

Neurotransmitters

NDEs have been speculatively attributed to a number of neurotransmitters in the brain, most frequently endorphins or other endogenous opioids released under stress, although other models have implicated serotonin, adrenaline, vasopressin, glutamate, and dimethyltryptamine. At this point, such models are speculative and none has been tested.

However, endorphins produce pain relief and a sense of well-being that persists for hours, whereas the peace and cessation of pain in the NDE are brief, often only a few seconds. Furthermore, the release of endorphins fails to account for many other important components of NDEs, such as the OBE, seeing deceased persons, a life review, and the transformative effects.

A more intriguing model has been proposed based on a putative neurotransmitter that in fact is not known to exist. Ketamine, an anesthetic agent that selectively occupies *N*-methyl-D-aspartate (NMDA) receptors, can at subanesthetic doses produce feelings of being out of the body, and can produce other experiences that resemble NDEs, such as travel through a dark tunnel into light, believing that one has died, or communing with God. It is plausible that a ketamine-like endogenous neuroprotective agent – which has been

hypothesized but not yet found to exist – may be released in conditions of stress, acting on NMDA receptors.

However, unlike the vast majority of NDEs, ketamine experiences are usually frightening and involve bizarre imagery, and patients usually express the wish *not* to repeat the experience. Most ketamine users also recognize the illusory character of their experience, whereas NDEs are almost always convinced of the reality of the experience. Many important features of NDEs, such as seeing deceased people or a life review, have not been reported with ketamine. Furthermore, ketamine typically exerts its effects in an otherwise more or less normal brain, while many NDEs occur under conditions in which brain function is severely compromised.

REM Intrusion

In one recent study, an association was suggested between NDEs and 'rapid eye movement (REM) intrusion,' the intrusion into waking consciousness of thought processes typical of REM or dream sleep. NDEs and REM intrusion share common elements of seeing light and feeling alert to the surroundings while the body seems passive. However, the interpretation of this association is questionable, as the post hoc estimation of 'REM intrusion' was perfunctory and possibly biased, and comparison groups were quite dissimilar. In fact, NDEs report the same amount of 'REM intrusion' as does the general population, whereas the comparison group in that study reported about one fourth the 'REM intrusion' of the general population. Data arguing against the contribution of REM intrusion to NDEs include many features, such as fear, that are typical of 'REM intrusion' but rare in NDEs; the frequent occurrence of NDEs under general anesthesia and other drugs that inhibit REM; and the transformational aftereffects of NDEs.

Neuroanatomical Models of NDEs

NDEs have also been speculatively linked to a number of anatomic locations in the brain, most often the right temporal lobe, although various neuroscientists have also suggested involvement of attention-control areas in the frontal lobes and elsewhere, the somatosensory body maps in the parietal lobes, the thalamus, the hypothalamus, the amygdala, the hippocampus, and Reissner's fiber in the central canal of the spinal cord. The brain region most often implicated in NDEs has been the *temporal lobes*, based on purported similarity of NDEs to temporal lobe seizure phenomena. However, NDE-like phenomena are almost never seen in temporal lobe seizures, and electrical stimulation of the temporal lobes may elicit fragmented bits of music, isolated and repetitive familiar scenes, hallucinated voices, fear or other negative emotions, or bizarre, dream-like imagery, in addition to a wide range of somatic sensations that are never reported in NDEs. Initial reports of NDE-like phenomena induced by transcranial magnetic stimulation of the temporal lobes turned out to be quite unlike NDEs in their detail, and even those could not be replicated and have now been attributed to suggestion.

OBEs, in which a person's consciousness is experienced as separated from the physical body, are a frequent feature of NDEs, being reported by between 50 and 80% of experiencers. Abnormal activation of areas of the temporal lobes may

produce alterations in body perceptions, and recent neuroimaging studies have linked OBEs to the temporal–parietal junction (TPJ). However, in those studies, the TPJ was only a region of statistical ‘mean overlap’ of individual lesions that were actually distributed much more widely, and in many subjects the seizures were in different brain regions that did not involve the TPJ or could not be localized at all.

Even if the TPJ were involved in the production of at least some OBEs, that part of the cortex would probably not be producing them. Both seizure activity and direct electrical stimulation of a brain region typically disrupt whatever patterns of neuroelectric activity would otherwise be going on there; thus, it could explain the failure of the normal integration, but not the production of an integrated altered state such as an OBE. Moreover, the vast majority of patients with temporal lobe seizures do *not* experience OBEs. Thus localized abnormal activity in the brain is not only not *necessary*, but also not in general *sufficient* to produce an OBE.

Even if OBEs were associated with a certain region of the brain, that would not account for complex perception or thought processes at a time when the abnormalities in brain functioning would ordinarily abolish consciousness. To equate OBEs with pathological ‘body illusions’ ignores the complexity of their physiological, psychological, and phenomenological aspects.

Multifactorial Explanations

Despite the questionable foundations for assertions that NDEs are similar to experiences associated with abnormal temporal lobe activity, anoxia, hypercarbia, ketamine, or endorphins, several multifactorial theories, based on these foundations, combine these putative causes at will to account for whatever constellation of features is observed in any given NDE. Even if supporting data were found for some of these physiological models for NDEs, correlating a brain state with an experience does not necessarily imply that brain states cause the experience; the brain state may alternatively allow access to or simply reflect the experience, an interpretation favored by some researchers who have investigated neurophysiological models of NDEs.

NDEs in Anesthesia and Cardiac Arrest

The most important problem with current psychophysiological theories of NDEs is that mental clarity, vivid sensory imagery, a clear memory of the experience, and a conviction that the experience seemed more real than ordinary consciousness are the norm for NDEs, even when they occur in conditions of drastically altered cerebral physiology under which current neuroscientific models of the mind deem such phenomena impossible. In short, our current physiological models do not explain the enhancement of mental functioning at a time when the brain is grossly impaired, as it is under conditions such as general anesthesia and cardiac arrest.

NDEs that occurred under *general anesthesia* typically include such features as OBEs that involved watching medical personnel working on their body, an unusually bright or vivid light, meeting deceased persons, and thoughts, memories, and sensations that were clearer than usual. Unconsciousness

during anesthesia is associated with a distinct EEG frequency shift, spatial distribution, and decoupling of rhythms across the brain; this consistent pattern of brain electrical activity confirms the disabling of awareness under anesthesia according to our current neurophysiological understanding. Likewise, blood flow, glucose metabolism, and other indicators of cerebral activity under general anesthesia show that, although sensory pathways remain relatively unimpaired, they no can longer ignite the cooperative network interactions generally believed necessary for conscious experience.

Reports of NDEs in *cardiac arrest*, like those that occur with general anesthesia, typically include vivid or even enhanced sensation, thinking, and memory formation, despite cerebral functioning shutting down within seconds. In cardiac arrest, there is instantaneous cessation of blood flow, and oxygen uptake in the brain plunges swiftly to zero. EEG signs of cerebral ischemia are detectable within 6–10 s, and progress to flat-line EEGs within 10–20 s, reflecting the absence of any cortical activity. Cardiac arrest leads rapidly to the three major clinical signs of death – absence of cardiac output, absence of respiration, and absence of brainstem reflexes. Nevertheless, many NDEs have been reported in conjunction with well-documented cardiac arrest. In fact, the incidence of NDEs in cardiac arrest is ten times greater than that in other serious cardiac incidents.

Of course, even with a flat-lined EEG there still could be undetected brain activity in *subcortical* brain regions, as the EEG detects only activity common to large populations of neurons in the cerebral cortex. However, the type of brain activity that is thought necessary for conscious experience is detectable by EEG, and it is indisputably abolished both by anesthesia and by cardiac arrest. In cardiac arrest, even neuronal action potentials, the ultimate physical basis for coordination of neural activity between widely separated brain regions, are rapidly abolished. Moreover, cells in the hippocampus, essential for memory formation, are especially vulnerable to the effects of anoxia, making it implausible that NDEs in cardiac arrest can be accounted for by a hypothetical residual capacity of the brain to process and store complex information under those conditions.

It has been suggested that some NDE features may occur not during the actual episodes of brain shutdown, but just before or after, when the brain is still more or less functional. However, unconsciousness produced by cardiac arrest characteristically leaves patients amnesic for events immediately preceding and following these episodes, in contrast to the extreme mental clarity associated with NDEs. In addition, the confusional experiences occurring as a person is losing or regaining consciousness do not have the life-transforming impact so characteristic of NDEs. Moreover, a substantial number of NDEs contain time ‘anchors’ in the form of verifiable reports of events occurring during the period of brain shutdown itself, such as circumstances occurring in conjunction with resuscitation procedures in the hospital while the patient was comatose.

Implications of NDEs for the Mind–Brain Problem

Although NDEs can occur in a wide variety of conditions in which the person is clearly *not* near death, many such experiences clearly *do* occur when the brain is severely impaired.

Thus, NDEs raise questions about the common assumption in neuroscience that consciousness is the product of brain processes, or that mind is merely the subjective concomitant of neurological events.

The idea that mind and brain are not identical is not inherently unscientific. Although it contradicts the assumption of many psychologists and neuroscientists that brain produces mind, or indeed is the mind, the direction that physics has taken in the last century justifies ample caution when it comes to making assumptions about the scope and the fundamental character of consciousness and its relationship to the physical world.

The evidence from enhanced mental function, accurate out-of-body perception, and some visions of the deceased during NDEs fundamentally conflicts with the conventional belief that brain processes produce consciousness, and supports the alternative view that brain activity normally serves as a kind of filter, selecting material that is allowed to emerge into waking consciousness. On this latter view, the relaxation of the filter under certain poorly understood circumstances may lead to drastic alterations of the normal mind/brain relation and an associated enhancement of consciousness.

Enhanced Thought Processes

Perhaps the most important of these features, because it is so commonly reported in NDEs, is the occurrence of normal thought processes, and even enhanced mental activity, at times when the mind/brain identity model would expect such activity to be severely diminished, if not impossible. NDEers often describe their mental processes during the NDE as remarkably clear and lucid and their sensory experiences as unusually vivid, surpassing those of their normal waking state, as if the mind had been freed from the distractions and limitations of the physical brain. Indeed this mental clarity, vivid sensory imagery, a clear memory of the experience, and a conviction that the experience seemed more real than ordinary consciousness are the norm in NDEs, even when they occur under conditions of drastically altered cerebral physiology. Moreover, the closer people are to death physiologically, the more likely they are to report such enhanced mental functioning. People who have NDEs during cardiac arrest almost invariably retain vivid memories of their experience that change little with the passage of time, despite the fact that memory under such conditions is ordinarily seriously impaired. In contrast, most patients with temporal lobe epilepsy have no memory afterward for what happened during a seizure.

Another example of enhanced mental functioning during an NDE is a rapid revival of memories, often called a 'life review.' In contrast to the isolated and often just single brief memories evoked during cortical stimulation of the temporal lobes, memories revived during an NDE are frequently described as being an almost instantaneous 'panoramic' review of the person's entire life.

Out-of-Body Experiences

About half of all NDEers report having viewed their bodies from a different point in space, and many are able to describe accurately what was going on in the vicinity of their physical

body, such as resuscitation attempts, while they were ostensibly unconscious. Many such reports of accurate perception during NDEs are not simply vague or general statements but contain very specific details unlikely to have occurred by chance.

Additionally, some experiencers report that, while out of the body, they became aware of events occurring beyond the reach of their ordinary senses even if they had been conscious. Some of these accurate perceptions included unexpected or unlikely details. There are also well-documented examples of blind individuals, including those blind from birth, who experienced during their NDEs accurate quasi-visual perceptions of objects and events. Many of these apparent out-of-body perceptions had been reported to someone else *before* being verified by independent researchers.

It has been suggested that some of these apparent out-of-body perceptions may be retrospective imaginative reconstructions attributable to a persisting ability to hear, even when unconscious. However, claims that adequately anesthetized patients retain significant capacity to be aware of their environment, let alone to hear and understand, have not been substantiated. There is no convincing evidence for adequately anesthetized patients having any explicit, or conscious, memory of events during the surgery – other than patients who have reported such memories in connection with an NDE. It is implausible that memories of complex sensory experiences occurring during general anesthesia could have been acquired by the impaired brain itself during the period of unconsciousness.

Partial awakening during surgical procedures does occur in less than 1% of general surgical procedures, usually attributable to insufficient anesthesia, but these awakenings are altogether different from NDEs, and generally extremely unpleasant, frightening, and painful. The partial-awakening experiences are typically brief and fragmentary, and primarily auditory or tactile, and not visual; for example, the patient may report hearing noises or snippets of speech, or briefly feeling sensations associated with intubation or with specific surgical procedures. Explanations of NDEs involving sensory awareness during anesthesia are even less credible when, as commonly happens, the sensory channels involved in the reported experience have been deliberately blocked, such as when visual experiences are reported by patients whose eyes were taped shut during the surgical procedure.

It is conceivable that some accurate apparent OBE perceptions may be retrospective imaginative reconstructions attributable to expectations about what was likely to have occurred. However, studies in the United States and in the United Kingdom specifically examining that possibility show that patients who reported leaving their bodies during cardiac arrests described their resuscitations accurately, including idiosyncratic and unexpected details, whereas cardiac arrest survivors who had not reported leaving the body made numerous errors in regard to equipment and procedures when asked to describe their resuscitation.

Although some of the reports of accurate perceptions of events at a distance from the body depend on the experiencer's testimony alone, many cases have been corroborated by independent witnesses. A recent review by Jan Holden of 93 reports of potentially verifiable out-of-body perceptions during NDEs found that 92% were completely accurate, 6% contained some

error, and only 1% were completely erroneous. Even among those cases corroborated to the investigator by an independent informant, 88% were completely accurate, 10% contained some error, and 3% were completely erroneous. The cumulative weight of these cases is inconsistent with the conception that purported out-of-body perceptions are nothing more than hallucinations.

Encounters with the Deceased

Many NDErs report that, during the time they seemed to be dying, they met deceased relatives and friends. Some of these visions may be due to hallucinations or to expectations of or wishes for reunions with deceased loved ones. However, although NDErs often perceive deceased people with whom they were emotionally close, consistent with the expectation theory, in one-third of the cases the deceased person was either someone with whom the experiencer had a distant or even poor relationship or someone whom the experiencer had never met.

Moreover, some experiencers on their deathbeds see, and often express surprise at seeing, a recently deceased person of whose death neither they nor anyone around them had any knowledge, excluding the possibility that the vision was a hallucination related to the experiencer's expectations. In some cases, the person seen died at the time of, or immediately before, the vision, allowing no possibility for the experiencer to have learned of the death. Reports of these cases, in which the dying individual sees someone recently deceased but thought to be still living, are scattered throughout the literature; but there are enough of them to warrant giving them serious attention.

Furthermore, in some cases the deceased person seen was someone whom the experiencer had not even known. Recently published examples of this type of case include a man who reported encountering his biological mother, whose photograph he had never seen because his father had remarried after her death when he was an infant; a child who reported encountering a brother she was unaware of, who had died before her birth; and a man who encountered a stranger whom he later recognized as his biological father from a photograph he had not previously seen, whom his mother had never married, and whom he had never known.

Summary

Although NDEs have been reported for centuries, they have become more prevalent as modern technology has allowed us to bring people back from the brink of death and indeed to blur the boundary between life and death. These technological medical advances have increased the number of reported NDEs, which are important to behavioral scientists for three reasons. First, NDEs precipitate pervasive and durable changes in beliefs, attitudes, and values. Second, they may be confused with psychopathological states, yet have profoundly different effects requiring different therapeutic approaches. Third, clarification of their mechanisms may enhance our understanding of consciousness and its relation to brain function.

The extensive research on NDEs over the past three decades has focused primarily on their epidemiology, their

psychophysiological correlates, and their effects on the lives of experiencers. Aftereffects most often reported include increases in spirituality, compassion, and concern for others, altruistic behavior, appreciation of life, sense of connection to others, belief in postmortem existence, sense of purpose, and confidence and flexibility in coping with life's vicissitudes; and decreases in fear of death, interest in materialism, personal status, and competitiveness. Studies of NDErs have shown most of them to be psychologically healthy individuals, who do not differ from comparison groups in measures of mental health. NDEs share some features in common with dissociation, depersonalization, PTSD, and hallucinations, but also differ from those conditions in significant ways.

Despite the research focus on mundane aspects of NDEs, the main reason that these experiences generate interest among the general public is that they seem to provide evidence that consciousness can function independent of the human body. NDEs commonly include a number of features challenging the conventional assumption that consciousness is solely the product of brain processes, or that mind is merely the subjective concomitant of neurological events. These features include enhanced cognitive function in the presence of demonstrable brain dysfunction, accurate perceptions from a visual perspective out of the physical body, and apparent encounters with deceased spirits. Although some of these visions of the deceased may be attributed to expectation and wishful thinking, that explanation cannot account for cases in which the deceased person seen was not known or expected to be dead.

The theoretical challenge of NDEs lies in asking how complex consciousness, including thinking, sensory perception, and memory, can occur under conditions in which current physiological models of mind deem it impossible. This dilemma is most apparent in NDEs that occur under conditions of general anesthesia and/or cardiac arrest. Scientific discussions of the mind-brain problem, to be responsible intellectually, must take these data into account.

See also: Altruism and Helping Behavior; Attitude Change; Empirical Challenges to Conventional Mind-Brain Theory; Moral Emotions.

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Negotiation

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Glossary

Best alternative to negotiated agreement (BATNA) The outcome if there is no agreement in negotiation, a useful reference for evaluating the merits of offers and possible outcomes.

Concession-making Reducing one's demands or offers, that is, changing one's proposal so that it provides less benefit to oneself.

Contending Attempting to persuade the other negotiator to make a concession, or an attempt to resist a similar effort by the other negotiator.

Integrative potential The degree to which a mutually beneficial agreement exists.

Issue A topic under consideration in negotiation that requires a joint decision by negotiators. An issue entails two or more options, which are called 'alternatives.' A negotiation over a single issue is referred to as 'distributive'; a negotiation over more than one issue that entails different priorities across the issues is referred to as 'integrative.'

Limit The offer level at which a negotiator refuses to concede beyond, also known as reservation value; sometimes limit is the BATNA, which is often identical with the status quo, that is, the situation that would have obtained if negotiation had never taken place.

Offer A proposal on an issue or a set of issues for an agreement, for a possible settlement, also known as demand.

Problem-solving Trying to locate and adopt options for settlement that satisfy both parties' goals or aspirations.

Strategy A plan of action that specifies broad objectives and the general approach that should be taken to achieve them. Some strategies must be translated into more specific *tactics*, for example, a problem-solving strategy is reflected in the tactic *provide truthful information*.

Win-win agreement The outcome of a negotiation that satisfies the major aspirations of all parties involved, also known as an integrative agreement.

The General Negotiation Paradigm

The behavioral approach to the analysis of negotiation seeks to develop and test predictive theory about the impact of environmental conditions on negotiator behavior and the impact of these conditions and behaviors on negotiation outcomes. Most branches of the social sciences have contributed to and have influenced the study of negotiation. For example, economists and game theorists have developed important mathematical models of rational behavior in negotiation. The behavioral analysis of negotiation has also been influenced by books and manuals, written by practicing experts, that provide advice to negotiators. The results of many behavioral studies of negotiation have practical implications as well as mathematical underpinnings.

Most behavioral studies of negotiation reflect a general paradigm or model of thought, which is shown schematically in [Figure 1](#). Conditions that prevail at the time of negotiation, for example, characteristics of the social context, are assumed to have an impact on psychological states, such as motives, cognitions, and emotions (path A in [Figure 1](#)); recent research in the neuroscience of negotiation has used fMRI imaging to observe these processes. Psychological states, in turn, have either a direct impact on negotiation outcomes (path B) or an impact that is mediated by negotiator strategies and tactics (paths C and D), which includes the things that negotiators might say to one another (e.g., 'This is my last offer, take it or leave it').

Issues, Offers, and Outcomes of Negotiation

Issues and Offers

The topics that negotiators discuss can usually be divided into one or more issues that require a decision. Each issue entails two or more options or alternatives that are often expressed in offers, which are proposals that negotiators place 'on the table.' Take for example the buying and selling of a car: the main issue is how much to pay for the car. The alternatives being considered include prices between \$9000 and \$11 000. A second issue is whether a package of accessories is installed in the car. The alternatives for this issue are installation versus non-installation. An offer might be 'I'll give you 9k for the car.'

Divergence of interest between two negotiators can be precisely defined in terms of a 'joint utility space,' which is shown in [Figure 2](#). The points in this space define the alternatives available for possible agreements for a set of issues. The solid points define alternatives currently under consideration. The hollow points define alternatives that can be devised if the negotiators show some creative thinking. The axes of [Figure 2](#) define the utility (subjective value) to each negotiator of the alternatives shown.

[Figure 2](#) represents the car buying example mentioned previously. Options 1–5 are prices between \$9000 and \$11 000. These options are arranged so that higher prices have greater utility to the dealer and less utility to the customer. In other words, the parties differ in their utility ordering for at least some of the options under consideration, which is divergence of interest.

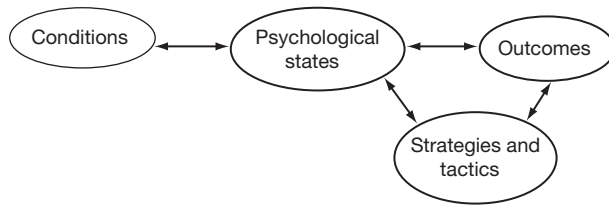


Figure 1 Causal sequence in the general negotiation paradigm that dominates behavioral research on negotiation.

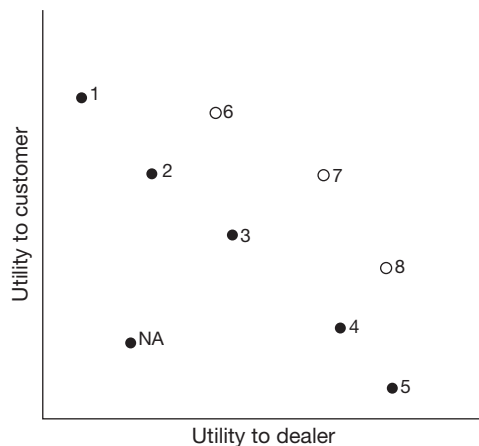


Figure 2 Joint utility space in car buying example. The following options are shown: NA = no agreement; 1 = \$9000; 2 = \$9500; 3 = \$10 000; 4 = \$10 500; 5 = \$11 000; 6 = \$10 000 plus options package (o.p.); 7 = \$10 500 plus o.p.; 8 = \$11 000 plus o.p.

Options 6, 7, and 8 are mutually beneficial options. For these alternatives, the dealer will throw in accessories that cost less than they are worth to the customer. They are shown as hollow points because they do not yet exist, that is, that parties have not thought of them at the start of the negotiation. There is a divergence of interest among these three options as well. However, options 6, 7, and 8 have an advantage: they are better for both parties than some of the options that do not include the accessory package. These are mutually beneficial options. Thus, the negotiation illustrated in [Figure 2](#) has *integrative potential*. Integrative potential refers to the existence of possible options that can integrate the interests of the two negotiators and thus provide greater mutual benefit.

Outcomes

There are four basic kinds of outcomes that can end negotiation:

1. Victory for one negotiator (a win-lose agreement), for example, in [Figure 2](#), agreement on option 1 or 5.
2. A compromise, defined as an agreement on some middle ground on an obvious dimension that connects the parties' initial offers. For example, an agreement on options 2, 3, or 4 in [Figure 2](#).
3. A win-win agreement (also called an 'integrative agreement'), where the parties achieve higher joint benefit (collective utility) than they could with a compromise.

For example, in [Figure 2](#), an agreement on one of the mutually beneficial options 6, 7, or 8. Win-win agreements can have a number of advantages over compromises: they are more likely to be complied with and are more beneficial to the relationship between the parties. A win-win agreement is 'efficient' (sometimes called 'Pareto optimal') in the sense that when the parties achieve the maximum joint gain possible, neither party can do better in an alternative agreement unless the other does worse.

4. Failure to reach an agreement, which is shown by the point marked 'NA' (no agreement) in [Figure 2](#). Either party can drop out of negotiation and thus produce a failure to reach an agreement, which is unlike the other options that require joint approval. Often, the value of nonagreement is the utility of what has been labeled the 'best alternative to a negotiated agreement' (BATNA). For example, a car buyer would have a BATNA of \$10 000 if he or she knew that the same car could be bought from another dealer at that price. BATNA is usually identical with the status quo, that is, the situation that would have occurred if negotiation had never taken place. In [Figure 2](#), no agreement is shown as a poor outcome for both parties. But this is not always the case: one negotiator may be advantaged by the status quo, making no agreement the same thing as victory for that negotiator (e.g., NA could be at point 1 or point 5 in [Figure 2](#)).

Most negotiations take place in mixed-motive settings, which evoke both competitive and cooperative motives in the parties involved. The competitive motive arises because the players have opposing preferences (i.e., a divergence of interest) for some pairs of options. Thus, in the car buying example shown in [Figure 2](#), the buyer prefers option 1 over option 2 and option 6 over option 8, while the seller has the opposite preferences. The cooperative motive arises because the players have similar preferences for other pairs of options. Thus, both of them prefer option 7 (one of the win-win options) to option 3 (the equal outcome compromise), and options 2, 3, and 4 to no agreement (NA).

The mixed-motive nature of negotiation can create a dilemma for negotiators. The competitive motive encourages negotiators to be contentious and to try to push the other party into making concessions that could mean a more favorable outcome. But the cooperative motive encourages negotiators to engage in problem-solving, which might lead to better outcomes. The dilemma stems from the possibility that one's cooperative gestures might not be reciprocated but instead may be exploited by a contentious opponent.

Research Tasks

Behavioral research on negotiation has been conducted in both laboratory and field settings. Field research often involves case studies of actual instances and questionnaire surveys where professional negotiators are the respondents. Laboratory studies usually entail undergraduate volunteers who are asked to negotiate with one another, a confederate, or a computer program. In laboratory studies, communication is sometimes face to face, sometimes via voice only as with phone, and sometimes via other devices or services such as smartphone,

e-mail, sms, and sns. The tasks used in laboratory experiments usually involve stripped-down simulations of real-life negotiation. Two kinds of tasks are most common. The first involves negotiation about a single issue, for example, the price of a hypothetically used car. The second involves negotiation about two or more issues, such as the price of a car and the accessories to be mounted on it. The latter type of task provides the opportunity to study the development of the 'logrolling' type of win-win agreement.

Strategies and Tactics

It is possible to distinguish five broad strategies that can be used in negotiation. A strategy is a plan of action for negotiation that specifies broad objectives and the general approach that negotiators should take to achieve them. Some of these strategies must be translated into more specific tactics in order to be used, and there is evidence that the ordering of strategies in negotiation is important. The strategies include:

1. Concession-making (yielding) – reducing one's goals, demands, or offers – in other words, changing one's proposal so that it provides less benefit to oneself.
2. Contending – trying to persuade the other party to concede or trying to resist similar efforts by the other party.
3. Problem-solving – trying to locate and adopt options that satisfy both parties' goals.
4. Inaction – doing nothing or as little as possible, for example, putting off meetings, talking around the issues, etc.
5. Withdrawal – dropping out of the negotiation.

Concession-Making

There are three basic, interrelated findings about the effects of concession-making on the outcome of negotiation. One finding is that if an agreement is reached, a firm negotiator will often achieve a larger outcome. A firm negotiator has high goals, makes large initial demands, and resists concession-making. For example, the car seller in [Figure 1](#) starts with option 5 and only extremely reluctantly makes a concession to option 4.

A second finding is that negotiator firmness lengthens negotiation and makes an agreement less likely. The more negotiators demand at first, and the slower they make concessions, the harder it will be for them to reach an agreement. This unsurprising finding is true in most cases. However, there is a strange reversal when one negotiator is at the low (very soft) end of this dimension. If one negotiator makes a really low initial demand or makes very fast concessions, an agreement is less likely and takes longer to reach than if that negotiator had been a little more ambitious. This is because very fast concessions signal extreme weakness to the other negotiator, leading the other negotiator to expect more and thus stop making concessions. This makes an agreement less likely.

A third finding is derived from the first two. Given that an agreement has value to a negotiator, there will be an inverted U-shaped relationship between negotiator firmness and negotiation outcome. Negotiators who demand too little may reach an agreement but they will achieve very low profits. Negotiators who demand too much will fail to reach an

agreement and thereby do poorly. Thus, the most successful negotiators, the ones who will maximize their outcomes in the long run, will be those who are moderately firm and who make moderate demands and moderate concessions.

Contending

There are many tactics that can be used to implement contending, including threats, positional commitments, and persuasive arguments.

Threats

Threats are effective to the extent that the penalty threatened has credibility. Credibility refers to the perceived likelihood that a threat will be carried out. Threat credibility goes up when threats have been regularly carried out in the past. It goes down when fulfilling the threat is costly to the threatener as well as the target. Credible threats can reduce the attractiveness of the no agreement option for the target of the threat. Credible threats can be successful at eliciting concessions. Sometimes they are the only way to get the other party to negotiate at all. However, threats have their down side: they tend to generate resentment and resistance, and they tend to be reciprocated, which can produce counterthreats and destructive conflict spirals.

Positional commitments

Positional commitments (also called 'irrevocable commitments') are often combined with a threat to break off negotiation if the other party does not accept an offer. They are only effective if failure to reach an agreement is costly to the target. As with threats, positional commitments must be credible to be effective. They are not very credible if it is clear that their user will be badly hurt by no agreement. One way to demonstrate credibility is to show that one has a credible alternative to a negotiated agreement (a favorable BATNA). But positional commitments can be hazardous: they can lock the negotiator into a position that is unworkable because it is completely unacceptable to the other negotiator – it exceeds the other's limit or minimally acceptable level of benefit. Negotiators can get around this hazard by hedging the commitment, indicating that it is not completely firm. Although this can endanger credibility, it allows a graceful retreat from the commitment if it is unworkable. Another approach is to delay making positional commitments until later in negotiation. There is evidence that experienced negotiators, in comparison to novices, will tend to delay positional commitments to the end of negotiation.

Persuasive arguments

Social psychologists have long been interested in the effectiveness of persuasive arguments. In negotiation, persuasive arguments have the objective of convincing the target that one's proposal is in the target's best interests.

What effect do contentious tactics have on negotiation? Unequal use of contentious tactics can lead to an agreement that favors the heavier user. But such victories can be short-sighted when the negotiation situation has integrative potential. This is because contentious tactics often lead to low joint benefit and, when limits are high, to failure to reach an

agreement. Users of contentious tactics tend to focus on particular demands, which makes them unlikely to seek or discover new options. Contending creates a rigidity of thought that is incompatible with creativity. Contentious tactics are especially problematical when they are reciprocated by the other negotiator, when threats elicit counterthreats. Many studies have shown that reciprocated contentiousness is associated with failure to reach an agreement in negotiation and poor long-run relations between negotiators.

However, despite their defects, contentious tactics can be useful as precursors to, or in conjunction with, problem-solving. They can lead a reluctant adversary to the negotiation table and they can reduce a tough negotiator's goals to a realistic level that may then allow the discovery of an agreement. They may persuade an adversary that contentious tactics will not succeed, which might encourage them to shift to problem-solving.

Problem-Solving

There are very many problem-solving tactics, including the provision of information about one's own priorities among the issues. Some problem-solving tactics involve joint problem-solving, in which the two parties work together to try to find a mutually acceptable alternative. Others involve individual problem-solving, which has one or both negotiators acting on their own.

Problem-solving can lead to win-win agreements if there is integrative potential and the parties adopt ambitious but realistic goals. Win-win agreements can be reached in several different ways. Some win-win agreements are constructed by increasing the available resources so that both sides can get what they want, which is called expanding the pie. A second way to construct win-win agreements is for the negotiators, or a third party, to analyze the concerns that underlie the positions in the negotiation and then seek a way to reconcile these concerns. Alternatives that reconcile both negotiators' underlying concerns are called bridging solutions. Often, bridging solutions are novel, as in the case of two people who were fighting over ownership of an orange. The problem was completely solved when it was discovered that one wanted the orange only for its pulp to make juice and the other wanted only the peel for use in making a cake. Sometimes only one negotiator's underlying concerns need to be examined, because that negotiator will accept the other's demands if these concerns are handled. Alternatives that resolve one negotiators' underlying concerns are called cost cutting solutions.

A third way to construct win-win agreements is for negotiators to exchange concessions on different issues, with each negotiator yielding on issues that are of low priority to oneself and high priority to the other party. Such concession exchanges are sometimes called 'trade-offs' or 'logrolling,' after the old American tradition of helping neighbors roll logs into a pile for burning. Many laboratory studies of negotiation use multiple-issue tasks that provide the opportunity for trade-offs among the issues.

Sometimes negotiators are willing to speak directly about goals, priorities, and concerns, which is called information exchange. Information exchange is a crucial element of joint problem-solving – a process in which the negotiators view their

separate interests as a common problem and ponder possible alternatives for solving it. Both laboratory and field studies have confirmed that information exchange and joint problem-solving are useful ways to achieve win-win agreements.

It can be argued that joint problem-solving is the best approach in negotiation, since it can attenuate the rigidities and delays that are inevitable when negotiators develop their proposals before coming to the negotiation table. Unfortunately, information exchange and joint problem-solving require a high level of trust in the other party, which is often lacking in negotiation. Without trust, negotiators tend to fear that the other party will misuse any information provided.

Inaction and Withdrawal

Both inaction and withdrawal are different from the other strategies in that they do not push negotiation toward agreement. Withdrawal means breaking off the negotiation. Inaction can take a number of forms such as not showing up for meetings or talking around the issues during negotiation. Inaction is sometimes a way station in negotiation, prior to adoption of some other strategy. But if inaction goes on and on, it is essentially withdrawal. Negotiators who are advantaged by the status quo tend to opt for inaction.

Stages of Negotiation Strategies

Changes over time in negotiation strategy reflect an explicit design, for example, as seen in the famous 'good-cop/bad-cop' sequence, which is a shift from contending to problem-solving (and often exercised by a two-person team). It is effective, in part, by creating the impression that problem-solving cannot be exploited and therefore should be reciprocated.

Studies in political science suggest that a period of 'hurting stalemate' (contending by all parties) often gives way to problem-solving when the parties realize they are going nowhere. Several studies suggest that such a shift is associated with the parties adopting win-win agreements, and that these 'turning points' are more often positive than negative.

Psychological Antecedents of Negotiation Strategy

The psychological antecedents of negotiation strategy and outcome can be roughly divided into two broad categories of processes: motivational and cognitive. These processes can influence the negotiator's choice of strategy or they can have a direct impact on the outcome of negotiation (see [Figure 1](#)).

Motivational Antecedents

The most comprehensive account of negotiator motives is the dual concern model. It asserts that negotiation strategies result from the conjunction of two independent motives: self-concern and other-concern. Self-concern and other-concern are regarded as independent dimensions. The model is shown in [Figure 3](#).

The dual concern model predicts negotiator preferences among the strategies described earlier from combinations of high and low self- and other-concern. It makes the following

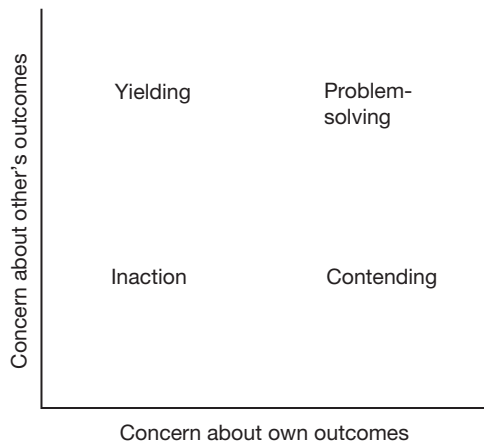


Figure 3 The dual concern model showing strategies of negotiation as a function of two motives: concern for own outcomes and concern for other's outcomes.

four predictions: (1) high self-concern coupled with low other-concern encourages contending, (2) high other-concern and low self-concern encourage concession-making, (3) high self-concern and high other-concern encourage problem-solving, and (4) low self-concern and low other-concern encourage inaction. Of course, the negotiator's choice of strategy has many other antecedents in addition to the two concerns specified by the dual concern model. But the model is one basis for making predictions about the negotiator's strategic preference.

The dual concern model can be viewed as a theory of personality, that is, of individual differences in conflict style. Conflict style is the way a person most commonly handles conflict situations. There is a psychometric tradition of research on the dual concern model that involves scaling of the methods individuals use for dealing with conflict. Taken together, the data suggest that conflict style is a function of the strength of two nearly independent personality variables, concern about own interests and concern about other people's interests, which are the two dimensions of the dual concern model.

The dual concern model is also a theory about the impact of changing conditions on strategic choice in negotiation. Some of these conditions affect concern about one's own interests, while others affect concern about the interests of the party with whom one is negotiating. Combinations of these conditions can predict the strategy that will be chosen in a given circumstance.

Self-concern in negotiation is a general reluctance to making concessions. This reluctance is often determined by the height and rigidity of limits and goals, and the strength of needs and principles that are linked to limits and goals. Higher limits tend to produce larger initial demands and greater resistance to concession-making. Principles in negotiation, that is, convictions about what is proper or fair, are another source of goals and limits. This is because people aspire to, and are unwilling to concede beyond, benefits to which they feel entitled.

Other-concern is often enhanced by positive feelings toward and a perception of common group identity with the other negotiator. However, in negotiation, other-concern more often arises from instrumental considerations. Such considerations

arise when people expect to be dependent on the other party in the future and wish to make a good impression now.

One way of looking at the dual concern model is that high other-concern leads to two different forms of cooperation, depending on the strength of self-concern: problem-solving and concession-making. When self-concern is strong, other-concern encourages problem-solving. This implies that negotiators are likely to do their most creative thinking about the issues under circumstances that force them to try to reconcile both parties' interests. An example of such circumstances is when they are caught between a desire to please powerful constituents and a need to get along with the other negotiator in the future. But when self-concern is weak, high other-concern produces concession-making. With no strong concern about their own outcomes, subjects develop weak goals which they easily abandon in the face of a strong desire to please the other negotiator. Hence, they do not work at satisfying both parties' interests. This suggests that concern about other people's interests – whether due to altruism or instrumental considerations – is usually quite desirable, but that it will lead to suboptimal results unless it is coupled with a healthy respect for one's own interests as well.

The dual concern model predicts a negotiator's preferred strategy. But if this strategy seems infeasible, he or she will shift to another strategy. Thus, high self-concern will lead to a preference for contending. But if contending seems infeasible, negotiators are likely to shift to problem-solving as the next best approach to achieving their goals. Some conditions will influence the perceived feasibility of a given strategy. For example, time pressure encourages both concession-making and increased use of contentious tactics. This is because the basic effect of time pressure is to reduce the feasibility of inaction and thus to heighten the urgency of taking action to move toward agreement. Concession-making is one form such action can take, contending is another; hence, time pressure can produce both reactions. For problem-solving to seem feasible, it is necessary for there to be perceived integrative potential, that is, some basis for believing that one can find a win-win solution.

Cognitive Antecedents

The analysis of cognitive mechanisms in negotiation extends theory and research in social cognition, information processing in cognitive psychology, and decision theory, to negotiation. The root of the problem of suboptimal outcomes in negotiation is that negotiators have limited attention, limited capacity to store and retrieve information from memory, and limited capacity to process information.

As a result of cognitive limitations, negotiators consciously or unconsciously rely on heuristics and schemas. Heuristics are mental shortcuts and simplifying strategies that people use to help to manage information. Schemata are cognitive structures that contain information about aspects of a particular situation or a general class of situations. Schemata are thought to develop from prior observations of the phenomena to which they are relevant, and they lead people to construe situations in specific ways. Schemata tend to guide information processing, directing attention and memory, and thus cause some events to be noticed and remembered while others are ignored or forgotten.

A litany of cognitive effects and processes has been identified in negotiation. They include the fixed-pie assumption, reactive devaluation, overconfidence, availability, representativeness, framing, and anchoring.

The fixed-pie assumption

An example of a schema that is often found in negotiation is the assumption that the two parties' interests are directly opposed, that is 'your win is my loss.' This fixed-pie (also called zero-sum or win-lose) assumption, which is tantamount to low-perceived integrative potential, makes problem-solving seem infeasible and hence encourages contentious behavior. For example, in multiple issue negotiation, the fixed-pie assumption implies that the other has the same priorities on the issues as the self. This is a faulty judgment that can block the discovery of a win-win solution.

Reactive devaluation

Proposals and offers suggested by the opposing negotiator tend to be devalued in negotiation, simply on the basis of the knowledge that the adversary has offered them. In one study, some negotiators rated the value of an opposing negotiator's concession before it was actually made and others rated the concession after it was offered. The results indicated that negotiators denigrated and misconstrued concessions offered by the opposing negotiator. Apparently, negotiators reason that whatever is good for the other must be bad for the self. Other work indicates that reactive devaluation is caused by the fixed-pie assumption.

Overconfidence

Another cognitive source of suboptimal agreement in negotiation stems from the beliefs that negotiators have about their likelihood of success. Negotiators sometimes believe that the opposing negotiator will make greater concessions than they will. Also, sometimes, negotiators believe that the consequences of nonagreement are more favorable than they actually are.

Availability and representativeness

Availability is the negotiator's use of the ease of recall of information as a cue for judgments about frequency or likelihood of occurrence, which in some circumstances can produce biased judgment. Information that is more available in memory, more salient, or more concrete and vivid may play a greater role in judgment than it should. Availability can lead negotiators to rely too much on salient information and therefore produce biased negotiator judgment. For example, negotiator behavior can be unduly affected by the salience of costs associated with failing to reach an agreement.

Representative thinking can also bias judgment. This involves making judgments solely on the basis of the most obvious features of the object being judged and ignoring more subtle features that would permit a more balanced judgment. The object being judged may be the opposing negotiator, or it may include features of the negotiation context or issues.

Availability and representativeness may underlie the tendency for negotiators to rely too much on historical analogies. If an historical incident is highly memorable, or seems representative of a current situation, it may exert greater influence in the current decision than may be warranted. This may lead

negotiators to miss other, possibly better, alternative outcomes, or other approaches to the negotiation. For example, in 1938 in Munich, negotiations between Neville Chamberlain and Adolf Hitler produced an agreement that resulted in British appeasement and unchecked Nazi aggression, with calamitous consequences. More than 50 years later, the statement, "If this aggression goes unchecked it will be another Munich," is sometimes used to justify the choice of struggle over negotiation. In this case, an historical negotiation is seen as representative of a current situation, when the current situation may in fact be quite different.

Framing

Issues and offers in negotiation are often judged in the light of a reference point, for example, the status quo. If construed as a loss, negotiators are less likely to make concessions and reach an agreement than if construed as a gain, an effect that is associated with negotiator aspirations. There is additional evidence that a loss frame is more likely to migrate across the negotiation table and be adopted by the other negotiator than a gain frame.

Anchoring

Anchoring occurs when judgments and behavior assimilate to salient reference points. There is evidence that a negotiator's first offer is likely to become an anchor, leading the other negotiator to adapt to it. But if other parts of the negotiation are salient, such as the BATNA, or the negotiator's aspirations, the anchoring effect of the first offer is eliminated.

Emotion Antecedents

Emotion also has been shown to impact negotiation behavior and outcome, with regard to mood states as well as via the impact of emotion expression, that is, knowing the other parties' emotion.

Mood states

Mood states, such as positive affect – pleasant feelings that are typically induced by commonplace events such as reading a cartoon, hearing a joke, or getting a small gift or piece of candy – can have important effects in negotiation. For example, professional mediators have been known to tell humorous stories prior to and during negotiation in an effort to improve cooperation between negotiators. Positive affect diminishes hostile and contentious behavior and makes problem-solving behaviors more likely. Positive affect also enhances concession-making.

In addition to these effects, positive affect enhances cognitive functioning, including the capacity for creative problem-solving. The result is that positive affect can enhance the likelihood of adopting win-win agreements. In one study, the subjects with positive affect were no more likely than the control subjects to exchange information during negotiation, but they were more likely to discover that the negotiators had complementary priorities among the issues and, hence, to discover win-win agreements. This was a sign of improved cognitive functioning. In contrast, negative mood and emotion can increase contending and interfere with the development of win-win agreements.

Emotion expression

Expressing anger in negotiation can lead the other to expect less, and thus accept less in negotiation; but expressing anger is also associated with lesser problem-solving and the discovery of integrative agreements. And there is evidence that angry negotiators are avoided in future dealings. The former effect appears to be a result of assumptions about the other party's limit, with an angry other being seen as more stubborn on the issues, so greater concessions are needed if an agreement is to be reached. The opposite results when the other is seen as happy in the negotiation. There is evidence that these effects are especially likely when negotiators have time to process information about the negotiation, or are motivated to have a deeper understanding of the negotiation.

Social Antecedents of Negotiation Strategy

Other antecedent conditions that affect negotiation (see Figure 1) are social context variables, which include social norms, the nature of the relationship between the negotiators, group processes, and culture.

Social Norms

Norms are shared beliefs about how people should behave. They are very often important in negotiation. They can affect the positions taken, the arguments and concessions made, and the agreements reached. Fairness principles are also particularly important, with the general finding that negotiators tend to be more concerned about fairness to self than fairness to the other negotiator.

Among the most important norms are principles of fairness (also called 'distributive justice' norms), which govern distribution of resources. There are three broad classes of fairness principles: the equality rule, which specifies that everybody benefits or contributes equally; the equity rule, which specifies that benefit should be proportional to contribution (e.g., that pay should be proportional to the work done); and the needs rule, which specifies that benefit should be proportional to need (e.g., that sick people should be taken care of). Each of these classes embraces a number of more specific rules, for example, the principle that both sides in a negotiation should make equal concessions as they move toward an agreement. This reflects the reciprocity norm which is an adaptation of the broader equality norm.

Norms often curtail social conflict: (1) They sometimes prevent conflict altogether, for example, the principle of equal dues makes it unnecessary to debate the issue of whether some members should pay more than others. (2) Norms often regulate the way conflict is conducted, for example, talking directly first before taking the dispute to a third party. (3) Norms can help resolve a dispute by providing a solution once conflict arises, for example, a dispute in which two friends are both trying to pay the entire restaurant bill may be solved by splitting the bill evenly.

Though norms often curtail conflict, they sometimes exacerbate it instead. This happens when they require one to challenge another person, for example, to fight injustice or defend

one's rights. This also happens when two or more parties disagree about which norms are applicable to their situation or how to interpret a norm that is clearly applicable.

In negotiation, agreement is more likely and is reached more rapidly when a single fairness principle can be applied compared to when no principle can be applied. There are two reasons for this. One is that both sides are likely to view fair outcomes as correct and hence not quibble about them. The other is that both sides are likely to think that such outcomes are inevitable, because the other side cannot be expected to accept less than a fair outcome.

Even when there is a principle that clearly applies to the issues under consideration, agreement is not always reached. One reason for this is that the parties may disagree about how to interpret this principle or the nature of the evidence that pertains to it. For example, the principle of equal concessions is vulnerable to a partisan bias such that each party views the other's concessions as smaller than his or her own.

Relationships Between Negotiators

Preexisting relationships between the negotiating parties, especially aspects of power and trust, can have a great influence on how negotiation progresses.

Power in negotiation is usually viewed as the control of resources which, if used, will affect the other party's future welfare. One can reward the other or punish the other, and thus have a positive or negative effect. When viewed as an element of the relationship between two parties, there are two dimensions of power: relative power and absolute power. Relative power is the extent to which one party is more powerful than the other; for example, most supervisors have more power than their subordinates. Absolute (also called 'total') power is the extent to which the parties have power over each other. Several studies have shown that, in the case of unequal power to punish the other negotiator, the party with greater power made fewer concessions than the one with less power. This accounts, at least in part, for the better outcome usually achieved by the party with greater power.

The opposite of power is dependency. If A has power over B, B is dependent on A. This is often reflected in negotiation in terms of BATNA, with the party that has the better alternative to agreement less dependent and thus more powerful. Powerful negotiators tend to make the first offer and tend to achieve more favorable outcomes. In one study of negotiation in romantic couples, it was found that the party who was more in love achieved lower outcomes. This may have been because that party was the more emotionally dependent of the two. His or her partner had more power because of having less need for the relationship.

A mild discrepancy in power can put the negotiators at cross-purposes, producing what is sometimes called a 'power struggle.' High-power negotiators apparently expect to achieve more than their opponents, but low-power negotiators were unwilling to accept this lower status and fought for equal treatment. The high-power negotiators put up a return fight, creating an escalation that often wrecked the negotiation. Such a struggle did not occur when there was a large discrepancy in power, presumably because the low-power negotiators realized that struggle was hopeless.

Several studies have looked at the impact of absolute power, finding that fewer threats were made and more agreements were reached when the two parties had high punitive power rather than moderate or low power.

Trust is the expectation that the other party will cooperate in the future. It is an aspect of the relationship between parties in that it deals with how the parties perceive each other. Trust has been shown to have many antecedents. Trust can be a personality variable – a general faith in humanity that is measured by a self-report inventory. Or it can be produced by environmental conditions, for example, when the other has cooperated with oneself, especially recently, or if the other is known to have cooperated with other people in the past. Several studies suggest that trust encourages the exchange of information about values and priorities and makes it easier to reach an agreement.

Group Processes

Negotiators often represent other people, who can be called their ‘constituents.’ When negotiators are a representative, they are motivated to make a positive impression on their constituents and avoid making a negative one. In one study, negotiators representing a simulated helping agency were more likely to use an allocation rule they thought would please their constituent than a rule that would provide the most effective help to these constituents. If they believe that their constituent wants them to be contentious, negotiators will tend to make high demands and few concessions. But they will tend to make concessions if they believe their constituent favors cooperation and agreement.

Representatives are especially eager to please their constituents when they are accountable to these constituents. Accountability is the extent to which negotiators can be rewarded or punished by their constituents for their performance. It is produced by giving the constituents power over negotiators’ outcomes or by making it clear that the constituents will receive information about the outcome of the negotiation. Accountability has usually been found to slow concession-making and enhance contending, making it harder to reach an agreement.

Representatives are also especially eager to please their constituents when they feel insecure about their standing in the group. Negotiators are insecure when they have a low status in their organization or when they feel distrusted by their constituents. Representatives who have a higher status in their group are not so tied to their constituent’s views and thus are freer to make concessions than those with a lower status. These findings suggest a paradox: even though distrusted group representatives aspire to improve their relationship with their group, they often undermine their group’s interests by failing to reach an agreement with others outside the group. Constituent surveillance of the negotiation also tends to reinforce perceived constituent preferences.

In some cases, representatives can be more rational than their constituents, having a better understanding of the other party’s priorities and hence being more realistic about success. Also, negotiation through representatives provides an opportunity for the use of tactical stratagems, such as the ‘black-hat/white-hat’ routine. In this routine, the representative adopts a cooperative stance, while one of his or her constituents

shows a tough stance. For example, the representative might say, “I’d like to give you this really good price on the car; but I can only do so if my manager approves it, and she’s pretty tough about these matters.” Such a strategy has been shown to be effective in eliciting concessions.

Sometimes negotiation is conducted by a negotiation committee or by teams, small groups of individuals whose responsibility is to negotiate on behalf of a larger group or organization. Team negotiation does seem to produce better outcomes compared to outcomes achieved by individuals. Negotiation teams are better at problem-solving and discovering win–win agreements than are individual negotiators.

Group boundaries can also have a large influence on negotiation. Negotiators who deal with a member of their own group make more concessions and are more likely to adopt a problem-solving strategy than those who negotiate with a member of another group. Also, negotiations within a group are characterized by greater trust and greater concern that both parties should attain a good outcome.

Moreover, several studies suggest that within-group processes can have important carryover effects on between-group negotiation. In one study, groups whose members engaged in a cooperative or competitive negotiation within their group adopted the same approach to a subsequent negotiation with an out-group. Within-group cooperation made between-group cooperation more likely, and within-group conflict diminished the likelihood of between-group cooperation. This has implications for third parties in an intergroup conflict. If they want to facilitate between-group cooperation, they should foster within-group cooperation prior to between-group negotiation.

There is evidence that group identity can impact negotiation. Indeed, when property is an issue in negotiation, the more that group identity is associated with the property, the greater it is valued. And such property is especially highly valued if at the same time the opposing side also professes a group identity association to that property.

Culture

Most behavioral research on negotiation has been conducted on Western participants, with an assumption that effects generalize broadly across cultures. But there is now considerable evidence that cultures differ in how negotiation is conducted. For example, there is evidence that Japanese people show greater concern for preserving an opponent’s face and maintaining relationships in negotiation, which reflects the cultural variable, collectivism. One study found that Chinese people (collectivists), in contrast to Americans, were more likely to prefer consensual procedures (negotiation and mediation) to resolve a conflict than third-party procedures such as arbitration. Western society reflects individualism, a cultural variable that emphasizes attainment of individual outcomes as opposed to group outcomes. Consistent with this, there is evidence that accountability to constituents encourages individualists to adopt a contentious approach to negotiation, whereas it encourages collectivists to adopt a problem-solving approach. Individualism and collectivism are instances of many cultural variables, and a good deal of recent research effort focuses on identifying and delineating the effects of other culture variables on negotiation.

Expanding the General Negotiation Paradigm

Current research on negotiation is largely devoted to expanding the field of vision beyond the general paradigm. An important advance in the field concerns a broader consideration of the nature and types of outcomes of negotiation, for example, whether the subjective aspects of outcome are as important, perhaps even more important, than the objective aspects. Subjective aspects are about feelings: feelings about instrumental outcomes such as the amount of money achieved in the agreement, feelings about one's self such as perceived competency, feelings about the process such as whether the negotiation was constructive, and feelings about the relationship such as whether the negotiation preserved it. Moreover, there is increasing attention being paid to the possibility that many of the integrative bargaining effects uncovered to date pertain largely to 'logrolling' negotiations, where there are multiple issues and the possibility of trade-offs. But there are other types of win-win agreements and a large question is about the extent to which findings obtained about logrolling generalize to these other types.

The 'agreement circumplex' model, shown in Figure 4, reflects a larger set of negotiation outcome types, of which logrolling is just one. The others are bridging, cost cutting, compensation, compromise, superordinate, modify, and expand, all defined on the basis of whether they deal with achieving the parties' underlying interests, or the parties' positions, and whether they entail changing the negotiator's preferences or

changing an aspect of the environment of issues to fit the negotiator's preferences.

Considerable research attention is now being paid to how to overcome cognitive biases, and this has focused on tactical solutions, as well as the identification of moderating conditions. There is evidence that motives can overcome cognitive biases; for example, a loss frame combined with a cooperative motivation can enhance the likelihood of discovery of win-win agreements. Also, there is evidence that motives to enhance intellectual functioning in negotiation can have the same effect by reducing the use of reliance on cognitive heuristics.

Another approach to overcoming cognitive bias effects is via negotiator training and the use of negotiator support systems. Studies suggest that training programs can enhance the likelihood that negotiators will later uncover win-win agreements, especially if the training involves learning by analogy, where the training cases embody general principles that can be extracted and applied at a later point. Negotiation support systems, entailing computer support, can help negotiators handle large amounts of information, and there are numerous success stories, for example, the negotiations around the United Nations Convention on the Law of the Sea.

There are recent trends that indicate that future research in negotiation will focus on the technological aspects of negotiation, and how different technologies (e.g., e-mail, sms, sns) can transform negotiation in communities and organizations. These are but a few of the areas of inquiry that will advance theory and research in the psychological analysis of negotiation.

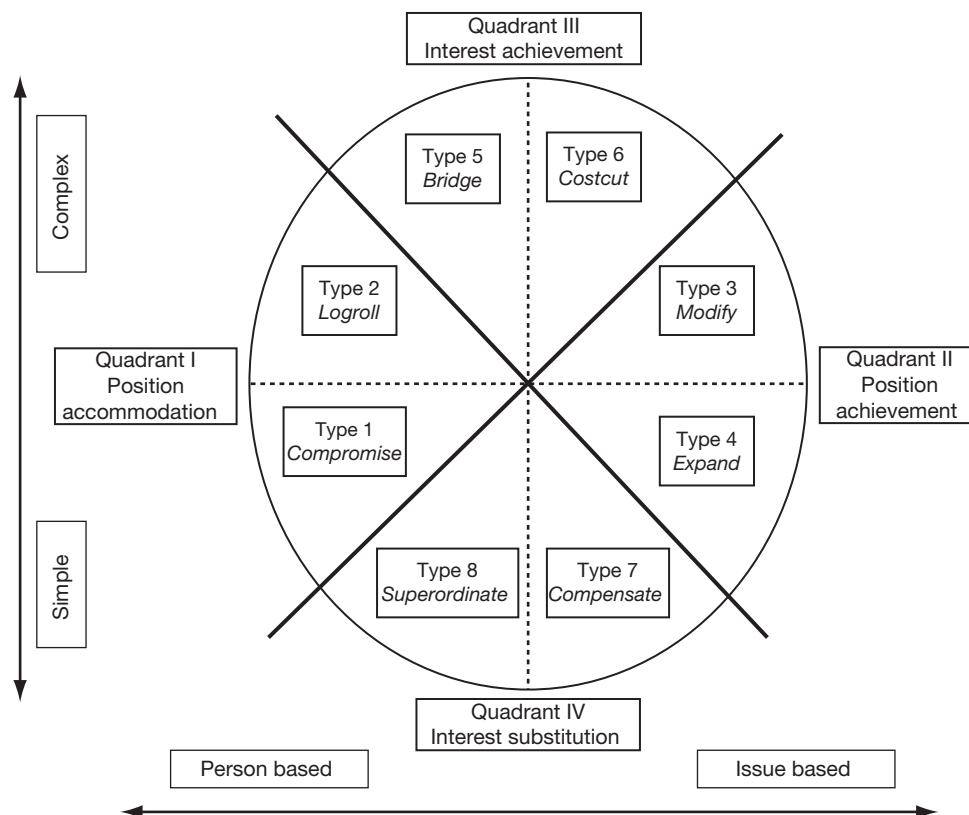


Figure 4 The agreement circumplex.

See also: Aggression; Altruism and Helping Behavior; Anger; The Clinical and Cognitive Psychology of Conflict; Creative and Imaginative Thinking; Decision Making (Individuals); Equity Theory; Group Dynamics; Tickling.

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Neuroesthetics: The Body in Esthetic Experience

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Glossary

Esthetic appraisal The subjective evaluation of an object based on an introspective identification of the emotional responses to the object. It is not the expression of high-order cognitive considerations and mechanisms, but rather of association processes between the perceptual object and the beholder's emotional memories. It answers the question: 'Do you like it?'

Esthetic attitude The implicit mindset enabling to appreciate the esthetic content of the contemplated object by focusing attention to its esthetic qualities. It leads to esthetic experience.

Esthetic experience The response to perceptual objects consisting of the embodied simulation of the actions, emotions, and sensations that the content of the object evokes in the beholder. Such experience is not necessarily confined to the appreciation of artworks, although this is grounded on it.

Esthetic judgment The explicit esthetic rating of an object according to culturally and socially determined esthetic canons. It represents the most cognitive aspect of the relation established with artworks. It answers to the question: 'Is it beautiful?'

Introduction

In the last few decades, cognitive neuroscience has extended its field of investigation to the domain of art, focusing in particular on music and visual arts. For the sake of concision, in the present contribution we will exclusively deal with the neuroscientific investigation of esthetic experience in visual arts. The term currently employed to define this approach is neuroesthetics.

The term neuroesthetics was coined by Semir Zeki referring to the study of the neural bases of beauty perception in art. Zeki's approach to art is closely related to the definition he provides for the functioning of the visual brain, namely a search for the constancies (unchanging properties) of objects, situations and so forth, with the aim of obtaining true knowledge about the world. In this process, the brain (as the artist) needs to discard inessential information from the visual world in order to represent the real character of an object in an enduring manner. For instance, when defining color constancy, the brain needs to discard information regarding the exact composition of the wavelength reflected by objects' surfaces; with dimension, inessential information is the precise visual distance; whereas, with form, it would be the exact viewing angle. It is in this selection process that the brain is able to retain and categorize never-changing information about a world that, on the other hand, is in continuous transformation.

In brief, according to Zeki "the overall function of art is an extension of the function of the brain: the seeking of knowledge in an ever-changing world." It is for their ability of capturing the essential elements of the world that artists, according to Zeki, can be defined as 'natural scientists' able to elicit an esthetic response in the creative brain of the observer.

Another noteworthy construal of esthetic experience viewed from a neuroscientific perspective is that of the neurologist V.S. Ramachandran. Ramachandran's approach to neuroesthetics is concerned with the unfolding of 'universal rules' that govern beauty perception in art. The description of these 'universals' relates to the way in which visual perceptual rules can account for art processing in an observer and, most importantly,

to their underpinning brain mechanisms. In particular, Ramachandran's theory rests on the interaction between cognition and physical pleasure, which is claimed to be rooted in the human biological makeup. Indian representations of women's body, for example, often reflect attention to primordial elements that recall the idea of procreation, such as pronounced hips and breasts. This concept is accounted for by the 'universal' of *emphasis*.

As with Zeki's approach, Ramachandran's description of artistic experience ultimately results in the pleasure gathered from the unfolding of perceptual elements that capture conceptual cores. For example, *grouping*, a perceptual process that allows the brain to extract a figure from the background, may be an enjoyable process. Pleasure would be the ultimate stage of an evolutionary driven motivational process, whereby individuals' survival depends on the necessity to discover alerting events in the environment, such as predators. In this way, attention is drawn toward important features. According to this perspective, perceptual grouping comes about as reinforcement to early vision at every stage of visual processing. The resolution of visual ambiguity would then result in a pleasant 'aha' experience accompanying the perceptual experience we make of the world. Artists' skill would then hinge upon their ability to evoke these biological perceptual processes in the observer, who is urged upon a creative and pleasurable reconstruction of the observed artistic object.

The study of the brain as it responds to art implies the existence of neural mechanisms entailed in art appreciation that are common to all individuals. The elements that are able to elicit these neural processes, that is, the 'access keys,' though, may be various and variable. In fact, they are under the influence of cultural and experiential constraints that define fluctuating trends over time and across individuals, even within the same cultural frame. When we visit a museum or an art gallery, we do not simply perceive images, but we contemplate objects whose presence in that specific physical space is justified and determined by their status of artworks. Our fruition of art is certainly cognitively mediated because the peculiar quality of our esthetic experience is influenced by our culture,

by the environment in which we were educated, by the esthetic canons informing our time, by our level of expertise and familiarity with the artworks we contemplate.

Both Zeki and Ramachandran's approaches to neuroesthetics resolve this variability problem with the ability of the visual brain to process essential information from the world that remains immutable and that can most naturally find a biological access to the observers' creative mind. Yet, the complexity of the relation that builds between an artwork and the observer compels us to reason beyond the mere, though vital, perceptual – and mostly visual, as accounted for by Zeki and Ramachandran – ability of the brain to capture essential perceptual elements from the environment. In esthetic experience, there are components that, in our view, cannot be disregarded as they constitute the most direct 'access keys' to the observers' comprehension of the artwork; that is, the embodied motor and emotional components of esthetic experience.

Our idea is that through the involvement of sensory-motor processing, the esthetic experience of art allows the beholder to feel the artwork in an embodied manner. More specifically, our hypothesis follows from the proposal by Freedberg and Gallese that the esthetic experience of artworks consists of activating embodied simulation of actions, emotions, and corporeal sensations, and that these mechanisms are universal. Observing the world is a more complex enterprise than the mere activation of the visual brain, as it implies a multimodal notion of vision that encompasses the activation of somatosensory and emotion-related components, within the more general frame of the intrinsic pragmatic nature of every intentional relation with the external world.

Our proposal challenges more standard accounts of esthetic experience privileging the primacy of cognition in our responses to art. In particular, our hypothesis, echoing historical views (see below), stresses the empathic nature of the relationship automatically established between artworks and beholders and capitalizes upon the discovery of the mirror neurons mechanism.

The present article is composed of four sections. In section 'An Historical Perspective: *Einfühlung* and Esthetic Experience,' we will concisely review aspects of the historical contribution of the notion of *Einfühlung* (empathy) to esthetic experience and show why we believe that such tradition of thought in esthetics is still highly relevant, if discussed on the basis of recent neuroscientific evidence. In section 'Neuroesthetics: Explicit Appraisal and Reward,' we will chart the available empirical evidence in neuroesthetics in relation with the cognitive aspects of esthetic experience, particularly focusing on the dimensions of reward and of the explicit appraisal of the esthetic value of artworks. In section 'Neuroesthetics: Embodied Approaches,' we will address the putative role of mirror mechanisms in esthetic experience, dealing first with actions and then with emotions.

An Historical Perspective: *Einfühlung* and Esthetic Experience

Invoking a role for the body in esthetic experience while contemplating visual artworks is an old idea. The notion of empathy (*Einfühlung*) was originally introduced in esthetics by the German philosopher Robert Vischer in 1873, thus well before

its use in psychology. By *Einfühlung*, literally 'feeling-in,' Vischer meant the physical responses generated by the observation of forms within paintings. He described how particular forms aroused particular responsive feelings, depending on the conformity of forms to the design and function of the muscles of the body, from those of the eyes to our limbs and to our bodily posture as a whole. Vischer clearly distinguished a passive notion of vision – seeing – from an active one – looking at. According to Vischer, it is the act of looking that best characterizes our esthetic experience when perceiving images, in general, and artworks, in particular.

This account of art perception implies an empathic involvement, which, in turn, encompasses a series of bodily reactions of the beholder. Particular observed forms would evoke specific emotional reactions on the basis of the conformity of the former with the design and functionality of the body of the beholder. According to Vischer, symbolic forms acquire their meaningful nature first and foremost because of their intrinsic anthropomorphic content. Symbols are something different from the indirect manifestation of concepts. It is through the nonconscious projection of her/his body image that the beholder is able to establish a relation with the artwork.

Developing Vischer's ideas, August Wölfflin (1886) speculated on the ways in which observation of specific architectural forms engage the beholder's bodily responses. Very shortly afterwards, Theodor Lipps wrote at length about the relationship between space and geometry on the one hand, and esthetic enjoyment on the other (1897, 1903).

The work of Vischer also exerted a very powerful influence over two other German scholars whose contributions are highly relevant for our present proposal: Adolf von Hildebrand and Aby Warburg. The German sculptor Hildebrand in 1893 published a book entitled *The Problem of Form in Figurative Art*. In this book, Hildebrand proposed that our perception of the spatial characters of images is the result of a constructive sensory-motor process. According to Hildebrand, space does not constitute an a priori experience, as suggested by Kant, but its product. The reality of artistic images resides in their effectuality, conceived both as the end result of the artist's actions producing them and of the effects artistic images produce on the beholder. According to the same constructivist logic, the esthetic value of artworks would reside in their potentiality to establish a link between the intentional creative acts of the artist and their reconstruction on the side of the beholder. In this way, creation and artistic fruition are directly related. To understand an artistic image, according to Hildebrand, means to implicitly grasp its creative process. A further interesting aspect of Hildebrand's proposal concerns his notion of the fundamental motor nature of experience. It is through movement that the available elements in space can be connected, that objects can be carved out of their background and perceived, that representations and meaning can be formed and articulated. Ultimately, according to Hildebrand, sensible experience is possible and images acquire their meaning just because of the acting body.

Hildebrand exerted a strong influence on another famous German scholar, Aby Warburg. Warburg conceived art history as a tool to shed light on the psychology of human expressive power. His famous notion of 'pathemic form' (*Pathosformel*) of expression implies that a variety of bodily postures, gestures,

and actions can be constantly detected in art history, from Classic art to the Renaissance period, just because they embody in exemplar fashion the esthetic act of empathy as one of the main creative sources of artistic style. According to Warburg, a theory of artistic style must be conceived as a 'pragmatic science of expression' (pragmatische Ausdruckskunde).

Warburg, when describing the classic marble group known as the Laocoon, identified transition as a fundamental element to turn a static image in movement charged with pathos. Several years later, the Russian movie director Ejzenstejn, when commenting on the same Laocoon sculpture, wrote that the lived expression of human sufferance portrayed in this masterwork of classic art is accomplished by means of the illusion of movement. Such movement illusion is obtained by condensing in one image different aspects of expressive bodily movements that could not possibly being visible at the same time.

Phenomenologists such as Maurice Merleau-Ponty further highlighted the relationship between embodiment and esthetic experience. Merleau-Ponty suggested the relevance for art appreciation of felt bodily imitation of what is seen in the artwork. Consistent with the role of *Einfühlung*, Merleau-Ponty also emphasized the importance of the artist's implied actions for the esthetic experience of the beholder, exemplifying it by referring to the paintings of Cézanne. He famously stated that we cannot possibly imagine how a mind could paint.

In conclusion, these scholars and many others believed that the feeling of physical involvement with a painting, sculpture, or architectural form, provokes a sense of imitating the motion or action seen or implied in the work, and also enhances our emotional responses to such work. Thus, it constitutes a fundamental ingredient of our esthetic experience of artworks.

The last sections of this article show how contemporary neuroscientific research can revitalize and shed new light on the role of empathy in art appreciation.

Neuroesthetics: Explicit Appraisal and Reward

The empirical investigation of the basic neural mechanisms underpinning our responses to art and the ensuing esthetic experience are complex issues. There is great heterogeneity across results from investigations trying to clarify the neural correlates associated with esthetic experience of visual art.

The esthetic experience of visual artworks begins with the visual analysis of the stimulus, which then undergoes further processing. This progression may lead to an esthetic experience likely based on biological and embodied mechanisms that can be modulated by factors such as the context, individuals' interest in the artwork, prior knowledge, and familiarity. Thus, one possibility for the heterogeneous results of studies on neuroesthetics is that they may reflect the output of different esthetic processing levels. Even more fundamental is the distinction between the cognitive processes that produce rewarding experiences in the beholder and the emotions directly associated with esthetics. This distinction highlights the concepts of esthetic judgment and esthetic pleasure, which can be related to the cognitive and emotional aspects of esthetics, respectively.

In experimental tasks, the need to explicitly verify participants' subjective judgments leads to self-evaluation and

decision-making processes. These processes imply the involvement of high-order cognitive processes in which the effects of cultural and individual traits may play a crucial role in defining the esthetic experience. These evaluations may interfere with the ultimate goal of neuroesthetics to unfold the basic neural mechanisms involved in esthetic experience shared by all individuals. Thus, the data obtained may only be partially representative of the actual neural underpinnings under investigation or, in some cases, even misleading.

It is important to distinguish between processes underlining esthetic pleasure and those underpinning esthetic judgment. These two processing levels of esthetic experience are tightly bound, yet not interchangeable. Whereas esthetic pleasure is more concerned with an automatic emotional response to artworks, esthetic judgment requires the contribution of explicit cognitive appraisal, holistically grouping the individual's values, knowledge and personal taste, all factors that are influenced by cultural and experiential dynamics. Though separable, these two aspects are strongly related and continuously affect each other during the building up of the esthetic experience.

The study of neuroesthetics has mostly dealt with esthetic judgment, in that participants are typically asked to explicitly judge a visual stimulus either as beautiful or ugly. One of the first attempts to define the neural underpinnings of the esthetic experience of beauty was designed by the founder of neuroesthetics, Semir Zeki. Kawabata and Zeki used fMRI to investigate the neural correlates of beauty perception during the observation of different categories of painting (landscapes, portraits, still life and abstracts) that participants judged beautiful, neutral, or ugly. The brain imaging results revealed different brain activations for judged-beautiful stimuli versus both neutral and ugly images in medial orbitofrontal cortex (OFC). Additionally, comparison between judged-beautiful and judged-neutral images elicited activation in the anterior cingulate gyrus and the left parietal cortex. While showing that functional specialization lies at the basis of esthetic judgments, because during an esthetic experience different categories of stimuli elicit activation of brain areas specifically devoted to their visual analysis (e.g., the fusiform gyrus for portraits), Kawabata and Zeki also discussed OFC differential activation by the observation of beautiful, neutral, and ugly stimuli as an effect of reward.

This latter observation deserves a consideration. Activation of OFC, and particularly of its medial sector, has often been associated to the perception of rewarding stimuli. Reward-related processing may be reasonably expected in esthetic experience as being spontaneously evoked to reinforce behavior that produces positive experiences. This architecture has biological foundations since hedonic sensations associated with rewarding mechanisms are at the basis of the motivation that drives the consolidation of behavior.

These processes have to be distinguished from the basic emotions and sensations that hallmark esthetic experience in the first place, which are of a different nature and that are processed at other neural levels (see below). The activation of limbic structures such as OFC or the cingulate gyrus, found active by Kawabata and Zeki, underpins the involvement of rewarding processes that represent a component of esthetic experiences, though at a more cognitive level of processing.

Further neuroscientific evidence showing that rewarding processes are involved with esthetic experience comes from a

study of Vartanian and Goel. This event-related fMRI study investigated esthetic preference for representational versus abstract paintings in three versions: originals, altered, filtered. Participants explicitly appraised the presented images by entering their response during stimulus presentation and indicating their preference on a rating scale. Behavioral results showed that preference was accorded to representational more than to abstract paintings. In both categories, original paintings elicited higher preference. In terms of brain activations, a decreased activation was observed in the right caudate nucleus extending to putamen in response to decreasing preference for paintings (in depressed patients, low activity in caudate nucleus correlates with decreasing ability to experience pleasure and reward – anhedonia), while activity in left cingulate sulcus, bilateral occipital gyri, bilateral fusiform gyri, and bilateral cerebellum increased in response to increasing preference for paintings. Because the involvement of the striatum in processing emotionally salient and reward-based stimuli is well established, these results suggest, according to the authors, that the decrease in activation in right caudate nucleus in response to decreasing preference may be a specific example of its general pattern of reduced activation in response to less rewarding stimuli. Additionally, increased activation in the primary and extrastriate visual cortices is in line with their role in processing pictures and faces varying in emotional valence.

This evidence suggests that the reward mechanisms are involved in the course of esthetic experience. The pattern of activations observed in OFC (Kawabata and Zeki's) and in the right caudate nucleus (Vartanian and Goel) indicate that both brain structures respond with decreased activation, with respect to baseline, to esthetic stimuli. Decreased activation, in both instances, is more pronounced for stimuli judged of poorer esthetic value.

Neuroesthetics: Embodied Approaches

The Motor Component of Esthetic Experience

The biological mechanism upon which embodied theories of esthetic experience rest is the mirror neurons mechanism. Mirror neurons are motor neurons originally discovered in the ventral premotor cortex of macaque monkeys (area F5) that discharge when the monkey executes goal-related hand motor acts such as grasping objects, and also when observing other individuals (monkeys or humans) executing similar acts. Neurons with similar properties were later discovered in a sector of the posterior parietal cortex reciprocally connected with area F5. Mirror neurons provide the neurophysiological basis for primates to recognize different actions made by other individuals: the same neural motor pattern characterizing a given motor act when actively executed is also evoked in the observer when witnessing the motor behavior of others.

This matching mechanism has also been shown in humans, both indirectly by means of brain imaging techniques and, more recently, at the single neuron level. Furthermore, empirical evidence suggests that the same neural structures that are involved in the subjective experience of emotions and sensations are also active when we see others express the same emotions and sensations. A whole range of different 'mirror

matching mechanisms' is present in the human brain. These mirroring mechanisms have been interpreted as constituting a basic functional mechanism in social cognition, defined by Gallese as embodied simulation.

Since the activation of the mirror mechanism for action is typically induced by the observation of ongoing actions, its relevance for the esthetic experience while contemplating static artworks could be negligible. However, even the observation of static images of actions lead to action simulation in the brain of the observer, through the activation of the same brain regions normally activated by execution of the observed actions.

The significance of mirror neurons in understanding esthetic responses to art has not been fully assessed. Freedberg and Gallese recently proposed that a fundamental element of esthetic response to works of art consists of the activation of embodied mechanisms encompassing the simulation of actions, emotions, and corporeal sensations. As we have shown above, historically, theorists of art have commented on a variety of forms of felt bodily engagement with works of art, but the mechanisms by which this happens have remained unspecified or entirely speculative. Mirroring mechanisms and embodied simulation can empirically ground the fundamental role of empathy in esthetic experience. Freedberg and Gallese's theory of empathic responses to works of art is not purely introspective, intuitive or metaphysical, but has a precise and definable material basis in the brain/body system.

This theory is articulated in two complementary aspects. (1) The relationship between embodied simulation-driven empathic feelings in the observer and the content of artworks, in terms of the actions, intentions, objects, emotions, and sensations portrayed in a given painting or sculpture. This aspect can be viewed as the 'what' of esthetic embodied experience. (2) The relationship between embodied simulation-driven empathic feelings in the observer and the quality of the artwork in terms of the visible traces of the artist's creative gestures, such as brush work, chisel marks, and signs of the movement of the hand more generally. We can refer to this component as the 'how' of esthetic experience (see also next section).

The sensory-motor or 'cold' component of the mirror mechanism includes the activation of parietal and premotor areas, which have been often found active in neuroesthetic studies. The recent work by Di Dio and colleagues provides suggestive evidence compatible with this hypothesis. In this investigation, the observation of Classical and Renaissance sculptures elicited activation of the ventral premotor cortex and of the posterior parietal cortex, suggesting motor resonance congruent with the implied movements portrayed in the sculptures. The observation of sculptural representations of the human body, although depicted in a bidimensional image viewed under an unnatural context like that of an MRI scanner evokes motor resonance congruent with the implied movements portrayed in the sculptures and underpinning an embodied comprehension of the observed object. In other words, we do not only see an artwork with our eyes – and our visual system, but also experience it with our body as the repository of our potentialities for action.

The involvement of parietal and premotor areas in esthetic experience was also observed in the fMRI study of Jacobsen and colleagues. In this study, participants were required to make an esthetic appraisal of abstract geometrical shapes, whose

symmetry and level of complexity had been manipulated. Brain imaging results indicated that, in both the comparisons of symmetry judgment and esthetic judgment tasks versus the control condition (observation of an arrow), activations were enhanced in areas subserving visuomotor processes, including the intraparietal sulcus and the ventral premotor cortex.

Additional evidence in this respect comes from a study by Cela-Conde and colleagues, in which gender-related similarities and differences in the neural correlates of beauty were investigated. The experimental stimuli consisted of a set of images of either artistic paintings or natural objects, divided into five groups: abstract art; classic art; impressionist art; postimpressionist art; photographs of landscapes, artifacts, urban scenes, and true-life depictions. Through magnetoencephalography (MEG), which allows studying the various temporal stages of brain stimulus processing, enhanced activation for 'judged-beautiful versus judged-ugly' stimuli in several parietal foci was shown, bilaterally for women and mainly in the right hemisphere for men, with a latency of 300 ms after stimulus offset.

In humans, as in monkeys, the posterior parietal cortex is involved in the organization and recognition of action. Physiological and anatomical studies on macaque monkeys suggest that the posterior parietal cortex is part of the motor system. It has been shown that posterior parietal areas map different motor acts (such as grasping) on the basis of the goal of the action (such as eating) of which they are a component. This functional organization, shared by posterior parietal and ventral premotor areas, likely underpins high-order cognitive functions, such as understanding others' basic motor intentions through an embodied simulation mechanism. These functions have been observed in the inferior parietal lobule (IPL) where visual information of ventral and dorsal stream is integrated with motor information, to build a pragmatic description of the observed object.

Most studies in neuroesthetics show activation of parietal and, in some cases, premotor areas. This evidence supports the idea that esthetic experience is strongly characterized by visuo-spatial coding as well as, importantly, by motor mapping. The exact role of the motor component, though, can be better understood when considering this aspect of esthetic experience as the automatic access to emotional levels of stimulus processing. This aspect of esthetic experience is the focus of next section.

Emotion in Action

Emotions and sensations represent the esthetic quality that characterizes the success of the relationship established between the observer and the artwork. This concept can be readily understood when thinking of explicit visual representations of human emotional states, with which the observer can automatically relate through the mirror neurons mechanism. In this stance, embodied simulation mechanisms are in place, likely mediating the empathic feeling arising in the observer toward the representational content of the artwork.

A representative example of the idea of bodily empathy experienced by art viewers is given by I Prigioni (the Prisoners), a series of unfinished sculptures by Michelangelo. Through the observation of these sculptures, viewers are led to experience the struggle of the prisoners to free themselves from the

stone. The effect of the struggle is expressed through the effective and forceful representation of the muscles carved from the stone. In this example, one can appreciate the relevance of embodied simulation in art, whereby the mere visual description of the artwork develops into an esthetic experience in which the bodily sensation felt by the viewer is in consonance with the artist's intention to ultimately convey a specific emotional state. The expressed or implied movement within the representational content of a work of art becomes the vehicle through which viewers can find an automatic access to those emotions and sensations that underpin the esthetic experience.

On what grounds, though, can we describe the human tendency of ascribing feelings and emotions to inanimate objects, independently of their abstract or concrete nature? Philosophical accounts of emotion in esthetics suggest that emotion ascription to nonsentient objects is due to imagination processes that either associate or impute states of mind to the object as representative of the emotion state of the artist or of the character depicted in the artwork.

These accounts differ considerably from our conception of an emotional embodied esthetic experience. For example, what is there in the representation of a landscape displaying the violence of the blowing wind if not the marks left behind by the artist's violent brush strokes? The observers' eyes catch not only information about the shape, direction and texture of the strokes, but most importantly – by means of embodied simulation – breach into the actual motor expression of the artist when creating the artwork.

Observers are likely able to appreciate the violent nature of the artwork because those brush strokes feature the movements they resonate with by means of the mirror mechanism. In this example, the artwork becomes the mediator of the motor and emotional resonance that establishes between the artist and the observer. The sensory-motor component of stimulus processing represents the most direct and automatic level of processing, which allows the beholder to feel the artwork in an embodied manner.

The marks on the painting/sculpture are the visible traces of goal-directed movements, hence capable of activating the relevant motor areas in the observers' brain, as suggested by the mirror neuron research. While at present there are no published experiments specifically targeting this issue, there is empirical evidence indirectly suggesting that this could be the case. Studies by Longcamp and colleagues show that motor simulation is induced in the observer's brain also when observing the static graphic consequence produced by the action, such as a letter or a graphic stroke. This shows that our brain can reconstruct actions 'a posteriori' by merely observing the static graphic outcome of the agent's past action. We posit this reconstruction process during observation to be the expression of the embodied simulation mechanism, relying on the activation of the same motor centers required to produce the observed graphic sign. We predict that similar results could be obtained using as stimuli artworks characterized by peculiar gestural signs of the artist, as in the case Fontana's or Pollock's works.

The relationship between esthetic experience and emotion was recently revealed by the abovementioned fMRI study by Di Dio and colleagues. Analyses of the imaging data showed that esthetic experience of artworks is marked by an emotional

component that is processed at different anatomical levels. The areas involved in the emotional portrayal of esthetic stimuli were the insula and the amygdala.

In this experiment, Classical and Renaissance sculptures were presented in two versions: originals and proportion-modified. The distinctive feature of this study was to allow participants to observe the images without expressing any explicit judgment. In the attempt to induce the required implicit 'esthetic attitude,' participants were instructed to examine the images as if they were in a museum (as much as they could in a scanner). Explicit esthetic and proportion evaluations were required only in subsequent conditions. Imaging results showed that the observation of original sculptures, relative to the modified ones, produced activation of lateral and medial cortical areas (lateral occipital gyrus, precuneus, and prefrontal areas) and, importantly, of the right anterior insula. Activation of the insula was particularly strong during simple observation condition, in which observers, hence their brain, responded most spontaneously to the presented images.

The contrast of canonical versus proportion-modified images in the study of Di Dio and colleagues highlighted the brain areas that preferentially code for esthetic stimuli, so defined by their intrinsic physical properties. In particular, insular activation may be involved with a matching mechanism relating the artwork or some of its attributes with some descriptive processing levels in the beholder's brain. We can define this kind of esthetic experience an 'objective' one: it emerges from the processing of sensory-motor input and, crucially, from the feeling of pleasure, mediated by the activation of the insula.

Though, esthetic experiences are only partially built on objective measures. In order to separate the objective esthetic value from subjective esthetic evaluation, a further analysis was carried out, contrasting brain responses to liked versus disliked images as judged by each participant during the explicit esthetic judgment condition in which they were asked how much they liked the displayed stimuli. Here, preferred stimuli selectively activated the right amygdala, a brain structure mapping the emotional salience of stimuli for the observer. These results support the idea that the more 'subjective' aspect of esthetic experience is mediated by association processes with the observer's own emotional experiences.

Overall, these results suggest an overt neural link between esthetics and emotion, showing that core emotion centers like the insula and the amygdala mediate esthetic preference, at least at basic levels of processing.

Of particular interest for the emotional and sensory comprehension of an artwork is insular activation and, more specifically, its anterior portion. Anterior insula is often found active in studies investigating social empathy or emotional mirror resonance. The anterior sector of the insula has an agranular/disgranular structure and is characterized by its extensive connections with prefrontal and premotor areas as well as with limbic structures and with centers involved in autonomic functions. Functionally, the anterior insula is thought to mediate feelings and the behavioral dispositional attitudes associated to specific emotional states. It is plausible to assume that insular activation during esthetic experience mediates the specific esthetic quality defining artworks and the feelings associated

with them by bridging evoked motor resonance with the associated emotional state.

A study by Cupchik and colleagues supports this idea. In this study, participants viewed various categories of representational paintings (portraits, nudes, still-life, and landscapes) that were classified as 'hard-edge' (containing well-defined forms) and as 'soft-edge' (containing ill-defined forms). The underlying rationale for this classification was based on the hypothesis that 'soft-edge' paintings should facilitate esthetic experience by stimulating active image construction. Both 'hard'- and 'soft'-edge paintings were presented in two conditions: one that required the participants to observe the images in an objective and detached manner to gather information about the content of the stimulus (pragmatic condition), and one that required the participants to observe the paintings in a subjective and engaged manner, appreciating the feelings evoked by the stimuli (esthetic attitude condition).

Observation of representational paintings under the esthetic attitude condition versus baseline condition (viewing of non-representational paintings accompanied by no explicit task-related instructions) elicited bilateral activation of the insula, suggesting that this area is crucially implicated in the emotion feeling specifically associated with esthetic experience.

Like in the paper by Di Dio and colleagues, in this study too insula activation was particularly enhanced in conditions in which no explicit judgment of the stimulus was required, but where participants were induced to appreciate the artworks by explicit instruction given prior to scanning. Under these conditions, observers viewed the artworks with an implicit 'esthetic attitude.' In an experimental setting, explicit judgments are usually required to induce specific task-related states of mind that, however, may mask basic neural processes. In fact, self-evaluation and decision-making processes may diminish spontaneous hedonic responses associated with stimulus processing. Intention guides attention, and this is possibly the reason why participants' intention and 'attitude' play a crucial role in the classification of a visual experience as an esthetic one.

Conclusions

More than being a discipline, neuroesthetics is a specific field of neuroscientific investigation that has just begun to identify the functional relationship between the brain/body system and esthetic experience. One crucial problem concerns the specific quality of esthetic experience related to artworks. To which extent the same perceptual content – the beauty of a sunset – evokes the same esthetic experience when observed in nature or in a painting by Turner? Does the a priori definition of an image as an artwork affect the esthetic experience of the perceived object qua artwork? And does it entail the activation of specific brain mechanisms? These are only some among many excruciating questions neuroscience can perhaps help to answer.

The term esthetic experience connotes a multilayered state in which several dimensions can be distinguished. The current available evidence suggests that specific attention must be paid to the distinction between mere observation, esthetic attitude, esthetic appraisal, and esthetic judgment. These different ways

of relating to an object are apparently underpinned by different brain mechanisms. It is possible that what really counts in esthetic experience is not the quality defined a priori of an object as artwork, but the way we decide to relate to it. Such decision can dramatically modulate the quality of an esthetic experience. A variety of contextual and culturally determined factors affect this decision.

The contemporary way of appreciating artworks is historically and culturally determined. However, while believing that esthetic experience is multilayered, we still posit it to be grounded on a core component without which it cannot be fully understood. We posit that this component can be found in the variety of embodied resonance mechanisms we concisely reviewed in the present article.

Art is the ripe fruit of the way in which human beings at a given point of their cultural evolution were able to relate with the external world. The material world was no more exclusively considered as a domain to exploit for the utilitarian satisfaction of biological needs. Material objects lost their unique status of tools to become symbols, public epiphanies able to make visible something absent, something that apparently is only present in the mind of the artist and of the beholder. Human beings, thanks to the expression of their artistic creativity, acquired the possibility to give shape to material objects, conferring them a meaning they intrinsically lack. Such meaning is the outcome of the artist's action of laying colors on a canvas or turning a marble block into a David or a Proserpina's Rape. Today cognitive neuroscience has the tools to shed new light – from its own peculiar and reductionist perspective – on the esthetic quality of human nature and its natural creative inclination. This new research field has the potentiality to help us understand how and why artworks are probably the most fundamental expression of our human nature.

From a certain point of view, art is more powerful than science. With much less expensive tools and with greater power for synthesis, artistic intuitions show us who we are, probably in a much more exhaustive way with respect to the objectifying approach of the natural sciences. Being humans square with the ability to ask ourselves who we are. Since the beginning of mankind, artistic creativity has expressed such ability in its

purest and highest form. It is therefore perhaps understandable why many scholars in the field of the humanities are afraid that a neuroscientific approach to esthetics may hinder, if not even destroy, the magic and wonder normally accompanying our appreciation of art.

We believe that such fears are unjustified. We think that the empirically based approach to art and esthetic experience provided by neuroesthetics can in principle enable a further valorization of the most distinctive feature of human creativity.

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Glossary

Brain fingerprinting A technique which may be able to detect whether a person recognizes a picture, word, or phrase. Brain fingerprinting uses EEG readings in an attempt to identify changes in brain activity when a subject is presented with familiar information. These EEG readings are then compared to the subject's verbal report regarding what he knows.

Compatibilism The view that human action can be understood to be free even if it is fully determined by a physical-causal chain of prior events, if the act is linked in a particular way to a person's desires or psychological states.

Dualism The view that humans have two components: the physical self and a nonphysical mind or soul.

Electroencephalography (EEG) The recording of the electrical activity along the scalp produced by the firing of neurons within the brain. These electrical voltages, often called brain waves, vary as a function of time and type of brain activity (e.g., the EEG of a person in a coma will look different from the EEG of a normal, awake adult).

Libertarianism The view that free will exists only where an act is uncaused by prior physical effects, but is not random or uncaused. This position usually entails the idea that an immaterial self or soul is the causal agent in human action.

Magnetic resonance imaging (MRI) An imaging technique used to visualize detailed internal structure and function of the body. MRIs use a powerful magnetic field to align the nuclear magnetization of atoms in the body. Radio frequency (RF) fields are then used to produce a signal that can construct an image of the internal structure of the body. Functional MRIs (fMRIs) measure signal changes in the brain due to changing neural activity by detecting increases and decreases in blood flow.

Neuroethics The body of work exploring the ethical, legal, and social implications of neuroscience.

Neuroimaging Technologies such as computed tomography (CT), anatomical and functional magnetic resonance imaging (aMRI and fMRI), and positron emission tomography (PET), which can display the structural and functional neurobiological bases of our cognitive capacities and psychological states.

Physicalism The view that humans are made of only one component, the physical stuff (and thus there is no immaterial soul or immaterial mental state).

Position emission tomography (PET) An imaging technique that produces an image of the functional structure of the body. The technique uses a tracer that is introduced into the subject's body and its presence is then detected and reconstructed into a three-dimensional image.

The term 'neuroethics' was coined in 2003 by political journalist and New York Times columnist William Safire. At a conference convened by Safire and the Dana Foundation, of which Safire was the Chairman, Safire defined neuroethics as 'the field of philosophy that discusses the rights and wrongs of the treatment of, or enhancement of, the human brain.' He then charged 150 neuroscientists, bioethics scholars, policy-makers, and journalists with the task of exploring the ethical, legal, and social implications of neuroscience.

Safire's definition has since been expanded to include not only the ethical implications of neuroscientific research – the ethics of neuroscience – but also the neuroscience of ethics. According to Adina Roskies, the neuroscience of ethics is concerned with a neuroscientific understanding of the brain processes that underpin moral judgment and behavior. The ethics of neuroscience, on the other hand, includes the potential impact that advances in neuroscience may have on social, moral, and philosophical ideas and institutions, as well as the ethical principles that should guide brain research, treatment of brain disease, and cognitive enhancement.

This article discusses these different aspects of neuroethics, with a special focus on how neuroscience might impact our sense of self and personal responsibility, a concern that cuts across these categories. For example, it discusses whether the advancing knowledge of brain states or processes undermines

common notions of free will and responsibility. It also examines whether certain treatments of brain abnormality are ethical (is it acceptable to irreversibly 'cure' pedophilia or obsessive/compulsive disorder?), a discussion that falls squarely under the category of the ethics of neuroscience. Finally, it discusses whether the neuroscience of ethics can provide insight into who should be deemed criminally responsible via a neuroscientific analysis of intentional action.

Neuroscience: The Self, Free Will, and Responsibility

Neuroscience is a scientific discipline, which aims at understanding how human behavior and capacities are related to brain structure and systems. Neuroscience includes neurophysiology, neuropsychology, and neuroanatomy, and utilizes techniques such as electroencephalography (EEG) as well as brain imaging technologies such as computed tomography (CT), anatomical and functional magnetic resonance imaging (aMRI and fMRI), and positron emission tomography (PET). These technologies can explain the structural and functional neurobiological bases of our cognitive capacities and psychological states and processes, such as decision-making, desires, memories, and emotions.

Other disciplines that treat human beings as objects of scientific inquiry include anatomy, biology, and chemistry.

However, neuroscience focuses upon the operations of the nervous system, which is the locale of capacities closely associated with personality, character, and the self. Thus, neuroscientific findings are thought to have deep philosophical implications with regard to who we are (and possibly, what we are).

So, who are we according to neuroscience? Neuroscience describes the brain as a causal machine. This means the brain goes from state to state as a function of prior, or antecedent, conditions: if the antecedent conditions were different, the result would be different; if the antecedent conditions were the same, the result would be the same. For example, at the beginning of some of these functional state changes is a perceptual (or sensory) input and at the end of some series of changes is a behavioral output (action).

Somewhere in between the input (perception of the environment) and output (action), thoughts, preferences, memories, and decisions seem to reside. Neuroscience provides us with new means to examine how these mental states and processes are instantiated in the brain by allowing scientists to observe the brain undergoing processes in response to stimuli via fMRI machines. Data from an fMRI scanner shows what sites in a subject's brain are active (indicated by an increase of the blood flow signal) during mental activity, such as the experience of particular conscious mental states. Additionally, aMRI and PET scans allow scientists to view the structure of the brain, thereby facilitating the identification of abnormalities in the brain tissue. It may then be postulated that such abnormalities impact brain function in particular ways.

Neuroscience is thus thought by some to comment upon three age-old philosophical problems: First, what is the nature of the human mind? Second, how is the brain related to human action? And third, for which acts may a person be held responsible?

Neuroscience and the Mind

Long before neuroscience informed our ideas of how the brain operates, many philosophers and scientists were already convinced that the position of dualism – that humans are made out of two types of stuff, a physical part and a nonphysical mind or soul – was false. Many feel that there is little evidence in support of an immaterial mind, especially if one thinks this immaterial mind has causal effects. Neuroscience adds to the already substantial body of evidence to the fact that brain states and processes either enable or constitute our psychological states and processes, including thoughts, memories, and even higher mental functions such as consciousness and reasoning.

The tools of neuroscience thus provide further evidence that the brain constitutes the mind, and may even eventually describe which parts of the brain constitute which mental states or processes. However, neuroscience does not necessarily rule out the possibility of a nonphysical aspect of the mind. Some think that conscious states, such as pain or love, are just what it feels like to undergo certain neural processes. Frank Jackson, however, has argued that the conscious feel of a mental state, such as the perception of the color red, could be an immaterial 'add-on' to a physical brain state. Jackson notes, however, that in this case it is most likely that such immaterial states, which he calls 'qualia,' are epiphenomenal: that is, they

have no physical-causal effects. This means that it would be the neural instantiation of the state of pain or thirst that causes behavioral effects, not the immaterial conscious feel.

Although neuroscience may not definitively rule out immaterial qualia, it does seem to indicate that the cognitive capacities we consider most representative of the 'self,' such as decision-making capacities and modulation of emotions, can be functionally identified as discrete states or processes within the brain. fMRI studies have allowed us to isolate and locate important cognitive capacities within the brain by identifying stored representations (memories) as functionally dissociated from the processes that operate upon them (decision-making). Neuroscience indicates that the frontal lobes do not contain many of our mental representations or memories, and that they instead reside in the posterior cortical regions, in the temporal and parietal lobes. (An exception may be motor representations and some representations involved in procedural or working memory.) The prefrontal lobes primarily contain the thought processes, often called executive processes by neuroscientists, which monitor and manipulate representations.

As we shall see, neuroscience's increasing ability to provide a structural and functional description of the brain has far-reaching implications. First, it could allow us to designate a portion of the brain as particularly important – because it functions in a way crucial to decision-making, for example – and in need of protection against manipulation or even enhancement (see below). Second, neuroscience may be able to not only identify brain abnormalities, but also explain why certain disorders of the brain are experienced as particularly harmful. Third, neuroscience could provide us with a better understanding of which decisions and acts persons should be held responsible for, via the analysis of the function of that part of the brain that is most closely associated with the self and decision-making.

Free Will

Philosophers have long questioned whether the everyday concept of free will – the libertarian version of free will where a free act is uncaused by prior physical effects, but is not random – is true. However, because neuroscience advances the idea that the brain is a causal machine, it has provided further evidence that this traditional libertarian theory of free will is false. Neuroscience appears to support what scientifically minded philosophers had long surmised: that there are no explanatory gaps in our brain processes wherein the causal chain is broken and libertarian free will steps in to cause action. Neuroscientific evidence, like a biological understanding of the conditions under which a neuron fires (or fails to fire), indicates that one need not appeal to an immaterial self or 'soul' to explain human behavior.

In particular, the work of Libet caused many people outside the field of philosophy to think that neuroscience meant human free will is an illusion. Libet conducted experiments in which he had subjects make voluntary hand movements while he measured their brain activity using event-related potentials. Subjects were told to report the position of a black dot when they made the conscious decision to move their hands. Then this moment was compared to the time when the subject's brain appeared to change in relation to the desire to move the hand.

Libet discovered that the brain appeared to initiate the sequence resulting in the hand movement before the subject was consciously aware that he or she had made a decision to move: about 300 ms elapsed between the beginning of brain activity and the decision. Thus, it seems our brains know we are going to make a decision, and perhaps maybe even what the decision is, before we do. (The 'we' here is the conscious agent.)

Libet noted, however, that there are about 100 ms left after the initiation of the act for the conscious mind to either endorse or veto the decision. Therefore he argued that free will was not entirely an illusion, claiming that it consists of this veto power that consciousness may have over a decision.

Regardless of how one interprets Libet's results, neuroscience does not force one to abandon the concept of free will. Many philosophers now accept the position of *compatibilism* – that human action can be understood to be free even if it is fully determined by a physical-causal chain of prior events. Walter Stace, for example, argues that free acts are "those whose immediate causes are psychological states in the agent," regardless of whether those states are physically instantiated and part of a larger causal chain. That is, it may be that your desire to get a drink was initiated by some physical state equal to thirst and that your decision to get up and open your refrigerator was causally determined by this physical state. But because these states are 'yours' the action should be considered free. By contrast, unfree acts are acts whose immediate cause is some state of affairs external to the agent, such as one holding a gun to your head.

Who Is Responsible?

Quite a few scholars have raised the alarm in the criminal courts regarding the use of neuroscience precisely because they feel that criminal responsibility requires libertarian free will. But as indicated above, even if neuroscience provides a new sort of explanation of the causes of behavior, this explanation does not necessarily constitute an excuse. The current criminal justice system can hold persons responsible even if human actions have full physical explanations: that is, even if a desire to kill is neuronally instantiated and has a complete causal history, the criminal justice system is designed to attribute responsibility when that desire leads to criminal harm.

Criminal responsibility requires that action be immediately caused in a certain way. If a harmful act is connected to the actor's desires or goals, and if the actor holds certain beliefs about the harm that could result from the act, then he or she is criminally responsible. Thus, to be guilty of murder under the US Model Penal Code, for example, one must have a *mens rea* (or a mental state) that includes: (1) the desire to perform an act that results in the death of another; and (2) performance of the act with the desire to kill, knowledge one will kill, or with such reckless indifference that there is a chance that one may kill.

It is possible (although unlikely, at least given the current state of the science) that neuroscience may provide a complete physical-causal description of the mental states required for criminal responsibility – the desire to kill and the understanding that the act will result in a death. But even if this were to happen, it need not affect the categories of culpability (such as

murder, rape, and theft) themselves. The breadth of category is a policy decision determined by legislatures and judges. Neuroscientific knowledge can thus be understood as a tool to help us better categorize defendants as guilty or not guilty on the basis of the existing categories of culpability and defense.

However, there is some chance that neuroscience will make us alter or abandon the categories we use to attribute criminal guilt. Some have suggested that the vast majority of offenders on death row suffer from severe prefrontal lobe damage. What if it turned out that the vast majority of murderers had severely compromised executive function, such that, using the delicate tools of neuroscience, we determined they could not either control or understand their violent acts in the way that those without compromised brain function can? In other words, what if they did not have normal desires or did not understand the nature or consequences of their acts in a 'normal' way? Would punishment still be justified?

In the United States, criminal punishment tends to be justified on the basis of one or several of the 'principles of punishment' such as deterrence, incapacitation, or retribution. Neither retribution nor deterrence would seem to justify severe punishment of persons with brain function compromised in a way relevant to criminal responsibility (e.g., with regard to intentional or rational action). Such persons would not deserve retribution if they truly did not understand the nature of the act they were performing or were unable to stop themselves from performing it. Similarly, an understanding of the act as criminal and the ability to stop oneself from performing the act is crucial to the effectiveness of deterrence.

However, just as we incapacitate those deemed legally insane or 'guilty but mentally ill' despite the fact that they are ineligible for punishment, we might also decide to incapacitate violent offenders who lack the capacity to understand or abstain from criminal acts. Thus in this case, neuroscience might alter our theoretical handling of offenders with abnormal brain processes, but our actual treatment of the offenders – incapacitating them – may not change.

Brain Research, Treatment, and Enhancement

In addition to its implications for the traditional philosophical concepts of mind, will, and responsibility, there are other ethical concerns raised by advances in neuroscientific research. These ethical concerns include issues of privacy and the way in which the 'self' might be altered or enhanced via neuroscience.

Privacy

Take, for example, the use of neuroscience as a 'lie detector.' The first lie detector consisted of a polygraph test. A polygraph is an instrument that measures and records physiological indices such as blood pressure, respiration, pulse, and skin conductivity while the subject is asked and answers questions. Although many dispute the accuracy of polygraph tests, some argue that lying produces a physiological response that can be differentiated from true answers.

A recently developed lie-detector technique, however, uses neuroscience. 'Brain fingerprinting' devices use EEG readings in an attempt to identify changes in brain activity when a

subject is presented with familiar information. An EEG records the electrical activity along the surface of the scalp produced by the firing of neurons within the brain. These electrical voltages, often called brain waves, vary as a function of time and type of brain activity (e.g., the EEG of a person in a coma will look different to the EEG of a normal, awake adult). In brain fingerprinting, changes in EEG readings are compared to the subject's verbal report regarding what he knows. The device is thus thought to be able to determine whether a criminal suspect is familiar with some aspect of a crime, and hence whether the suspect is telling the truth concerning his/her involvement. Such a device could also be used by potential employers, or even insurance companies, to determine if a job candidate or person seeking insurance is being honest about his/her past work experience, or any preexisting conditions.

Because brain fingerprinting detects brain activity directly, it is thought by some to be a more accurate lie detector than the polygraph. This is because it does not entail detection of emotional responses, which can be consciously manipulated by some subjects. However, there is controversy over whether brain fingerprinting provides consistently accurate results. In addition, brain fingerprinting can only indicate whether a subject is familiar with certain information; the technique cannot indicate how the subject gained this information (e.g., via being present at the crime scene, or reading about the crime in the newspaper).

There are other ways that neuroscience may provide access to previously private mental states. Newly developed quantum dot technology is being used to gather information on the brain at the level of the neuron. Nanosized functional quantum dots can help build data-capture devices that are easy for neuroscientists to use. Many feel that nanotechnology in conjunction with neuroscience will eventually allow for targeted interactions between neurons, the cells responsible for signal transmission in the brain. Ultimately, it seems clear that nanotechnology will allow us to visualize and track functional responses in neurons and this means we will be provided information about a person's thoughts remotely.

Several ethical issues are raised by the possibility of the use of brain fingerprinting devices or functional quantum dots. Normally, an employer or a police officer must rely upon information voluntarily offered: regardless of what one thinks, the information actually spoken is what counts, and most persons have control over the words they choose to speak. Insofar as neuroscience allows others direct access to one's consciousness or mental states, it would appear to entail a serious violation of privacy. And in the cases mentioned above, the consequences of the violation are severe: one might not get a job or qualify for health insurance, or in the case of criminal law, one could lose his or her liberty or life.

Enhancement

The possibility of brain enhancement via neuroscience brings forth other ethical worries. Pharmacological enhancement of brain function is already widely practiced via drugs such as selective serotonin reuptake inhibitors (SSRIs, prescribed for mood enhancement), Ritalin (for improved attention and concentration), and Aricept (for improved memory). Although originally conceived to make up for deficits in cognitive ability

due to disorders such as depression and attention deficit hyperactivity disorder, such drugs are now often used by those with highly functioning, and even 'normal' cognition, like those diagnosed of being vulnerable to depression (but without any current depressive symptoms).

Enhancement may also be achieved by brain implants. Brain implants have been used to lessen the effects of several common disorders, such as Parkinson's and chronic pain. For example, in the case of Parkinson's, a technique called deep brain stimulation (DBS) uses a brain implant to deliver electrical impulses to a region at the center of the brain that controls and coordinates movement. DBS has also been used in an attempt to stimulate various parts of the brain which appear dysfunctional in those who suffer from major depression and Tourette's syndrome. In the future, it is possible that DBS could be used to enhance the cognitive function of those without psychological disorders.

Scientists are currently making progress using both carbon nanotubes and conventional silicone implants in the brain. Ultimately, such implants may be used to manipulate thought, possibly via transmission or implantation of thoughts. One possible use of this technology could be to help soldiers to fight better under combat situations, or to aid athletes in performing their sport.

One ethical concern regarding brain enhancement is the idea that for humans to fully enjoy or appreciate life, they must experience both joy and pain. Overuse of SSRIs or other brain enhancing drugs might thus blunt a person's ability to enjoy the full range of human experience. Another worry is about the way in which enhancement will be distributed. It is likely that the wealthy and privileged will have more access to such enhancements, thus creating an even wider gap between socioeconomic classes. For example, a drug that assists in memory may mean that those who can afford the drug may have an advantage in the job market, and athletes with neuroenhancements will be able to out-compete those without enhancement.

Yet another concern regarding neurological enhancement is that it is done in accordance with a normative idea of the optimal human being or life. However, there is much disagreement about the 'good life' for human beings, and even capacities we might all agree are beneficial with regard to specific tasks could turn out to have negative outcomes overall. For example, there is some evidence that the average human level of forgetfulness actually helps us attend to the things that are important, instead of being distracted by unnecessary details. There is certainly no evidence that having better mental capacities will make human beings happier.

There is also the possibility of the use of neuroenhancement or manipulation in the criminal justice system. For example, a handful of US states have chemical castration laws, which means that at least some subset of their criminal offenders either must or may submit to chemical castration as a part of their sentence. Depro-Provera is the drug most often used for chemical castration. The chemical used is an analogue of the female hormone progesterone, which reduces the normal level of testosterone in a male, thus reducing sex drive, and often diminishing seminal ejaculator fluid to zero.

Depro-Provera has to be continually administered, which requires non-incapacitated offenders to submit themselves to

weekly shots. One might imagine neurological castration as a replacement to this drug regimen. Neurological castration might directly inhibit activity in certain parts of the brain (e.g., within the hypothalamus), by blocking connectivity between areas of the brain (e.g., between representations of children and sexual arousal). One might imagine that a nanotechnological approach to castration may be more successful, and have far fewer side effects, than current methods.

Neurological castration could just be the beginning of neurological sentencing techniques. If it becomes possible to neurologically inhibit strong violent responses to stimuli, the state might offer offenders the option to submit to this operation in exchange for a shortened or commuted sentence. Granted, at the moment this possibility is more fiction than science. However, given the success in drug interventions on aggressive behavior – for example, with tranquilizers and some antidepressants – it is possible that neuroscience could discover a more targeted means of delivering the same result.

Neuroscience could thus potentially allow us to reimagine the principle of rehabilitation by providing a means to directly change behavior. One might even wonder whether we could eventually come up with what some might call an ‘artificial conscience.’ Until recently, persons who violate the law have been allowed to remain the sort of person they have been (even if that person was a pedophile), although the space within which they have been allowed to be that person is limited to a prison. And after offenders served their time, they were released to continue to pursue their individual desires. However, neuroscience instead might allow us to permanently change a person’s character, such that he or she no longer commits criminal acts.

Any neuroscientific manipulation or enhancement that changes a person’s loci of decision-making represents nothing less than changing their identity. Most philosophers believe that one’s psychological states – beliefs, desires, memories, and emotions – are a crucial component of one’s identity. Our psychological states are the ‘source’ of our behavior: we act in a certain way because we desire and believe certain things. If neuroscience changes what we want, what we know, or what we believe, it changes who we are.

With regard to criminal offenders, involuntary manipulation of psychological states via neuroscience would be a severe violation of human agency in that it would infringe upon the ability of a human being to choose, and be responsible for, his own acts. However, use of technology in this way raises serious ethical concerns even if offenders participated in such programs voluntarily. Would we really be giving offenders a choice with regard to neuro- or nanotechnological alteration if they must choose between 30 years in prison and freedom after a ‘simple’ operation? There are real worries that such an option would be no option at all.

A Neuroscientific Understanding of Moral Judgment and Action

Traditionally, philosophers such as Immanuel Kant argued that higher level reasoning was crucial to moral judgment and action. However, it has become increasingly clear that moral judgments are not the sole product of reason or introspection, isolated from emotion. Indeed, it turns out that emotional

input is crucial to moral action and the judgments we make regarding whether others’ actions are right or wrong.

Neuroscientific research attempting to isolate the regions involved in moral reasoning and behavior supports this conclusion. Neuroimaging indicates that there is no particular ‘moral center’ of the brain. Widely distributed brain areas have been found to be activated during moral reasoning tasks, including those regions associated with higher cognitive functions and those involved in emotional responses. There appears to be a complex interplay between reasoning and emotions in the formulation of a moral decision, indicating that there may not be an easy distinction between thinking and feeling when it comes to morality.

It is somewhat difficult to parse apart findings indicating the brain regions associated with moral judgments from those regions associated with behavior that we might judge immoral or ‘bad.’ This is because being able to determine that a situation requires moral judgment, and treating a decision as a moral decision, may be important for moral behavior. If one does not see one’s decision to steal a neighbor’s TV, or not to give money to the Red Cross, as a moral judgment with ethical implications, then it seems one is less likely to make a decision that others will approve.

Moral Judgments

Studies have found significant neurological differences between subjects making judgments on personal moral dilemmas, and those contemplating impersonal moral dilemmas and non-moral dilemmas. Moral dilemmas involving a personal component – where one is asked to consider whether they would personally perform some moral or immoral act – seem to activate the orbital, ventromedial and dorsolateral prefrontal cortex (PFC), the medial frontal gyrus, and possibly the posterior cingulate cortex, amygdala, and inferior parietal lobe. These regions are associated with the integration of emotions, mental imagery, and memories into decision-making, representation of rewards and punishments, and control of risky or inappropriate behavior. In addition, the medial frontal gyrus, anterior and posterior cingulate cortex, and temporal areas (such as the superior temporal sulcus and temporal pole) are associated with the theory of mind, the ability of human beings to attribute mental states to others as a means to understand and predict their behavior.

Antonio Damasio and colleagues have found that patients with a damaged posterior ventromedial cortex have impaired ability to make moral judgments. However, their impairment was primarily emotional; they appeared to have an inability to generate and effectively use what Damasio calls ‘somatic markers’: neural representations of body states that give potential bodily actions (sometimes unconscious) an emotional feel, making them more or less appealing. If you ask subjects without ventromedial damage to imagine running over another person in their car, they tend to have a negative emotional response in association with the mental image. Although subjects with ventromedial damage could imagine performing the act and its consequences, and knew that society would judge such an act as wrong or criminal, they failed to have a normal emotional response to the mental image.

It seems the more personal a moral dilemma, the stronger one’s potential emotional response. Greene and Haidt scanned

subjects using an fMRI while they responded to a series of personal and impersonal moral dilemmas, as well as nonmoral dilemmas. They determined that a moral violation is personal if it is clear that the subject is hurting some particular person, whereas it is impersonal if it did not require the subject directly harm someone else. A classic philosophical thought experiment, for example, asks whether the subject would pull a switch to move a trolley car from one track, where five people are likely to be hit by the trolley and killed, to a second track, where only one person is going to be hit and killed. This is an impersonal moral dilemma because it does not require that the subject's act directly causes harm, but only deflect harm from one party to another. On the other hand, when a subject is asked to push a fat man onto the tracks to derail the trolley to keep the five persons from being killed, the dilemma becomes personal because it requires direct harm to be caused by the subject to a person who would otherwise be safe.

Greene and Haidt found that responding to personal moral dilemmas, as compared with impersonal and nonmoral dilemmas, produced increased activity in the medial frontal gyrus, posterior cingulate gyrus, and the angular gyrus. These areas are associated with social and emotional processing. Impersonal and nonmoral dilemmas, on the other hand, produced increased activity in areas associated with the working memory, such as the dorsolateral prefrontal areas. These findings again indicate the importance of emotional input in moral decision-making: subjects faced with a moral dilemma tended to be quick to moral condemnation but slow to approval of personal violations, apparently due to the salience of negative emotions, whereas approvals and disapprovals took equally long when subjects were faced with impersonal and nonmoral dilemmas.

In sum, neuroscience indicates that many different capacities are important to moral reasoning and judgment, including normal decision-making and theory of mind capacities; however, the importance of emotional input may be particularly important to moral judgments (as opposed to many other types of judgments).

Moral (or Immoral) Behavior

As indicated above, there is significant overlap between the brain regions associated with moral judgment and the regions associated with immoral or antisocial behavior. Regions common to both include the ventral and medial PFC, the amygdala, and the angular gyrus/superior temporal gyrus. One difference, however, is that persons who tend toward antisocial behavior show hippocampal and anterior cingulate impairment, whereas moral judgment studies fail to indicate such activation consistently in moral reasoning tasks. However, psychopaths also show frontotemporal-limbic gray matter reductions (DeOlivera-Souza et al., 2008) and reduction in connections between the amygdala and OFC (Craig et al., 2009).

Adrian Raine and colleagues have argued that some of the neurological impairments found in antisocial individuals disrupt moral-emotional decision-making, which in turn acts as a factor predisposing such individuals to antisocial behavior. Some antisocial personalities, and psychopaths, appear to show normal or excellent moral reasoning ability, but appear to fail to apply the outcome of such reasoning processes because of a lack of emotional input.

As an example, some argue that the ventromedial frontal cortex (VM cortex) mediates between the neural systems for arousal and emotion, and is therefore important to moral behavior. Patients with VM cortex damage tend not to show deficiency in moral reasoning; that is, in their ability to identify potential moral conflicts and potential solutions to such conflicts. However, at least some VM patients *feel* differently about the identified solutions than those without VM damage. Going back to the trolley thought experiment, both VM patients and persons without VM damage realize that killing one fat man will save five others lying in wait on the other trolley track. However, persons without VM damage tend to judge that it is wrong to kill him. Persons with VM damage, however, are more likely to judge that pushing the fat man onto the tracks is the right thing to do.

Not surprisingly, the difference between the two judgments seems to be emotional: as indicated above, many think psychopaths act immorally partially owing to a lack of normal affect. Thus, persons with VM damage may be more likely to engage in antisocial or immoral behavior, precisely because they do not feel badly about such an action. In conclusion, many argue that it is predominately the failure to *feel* what is moral, rather than knowing what is moral, that leads many to antisocial or immoral action.

Neuroscientific Evidence and the Criminal Law

From the perspective of the criminal justice system, it is difficult to understand what the conclusion that many antisocial persons lack emotional insight should mean. To the extent that neuroscience has thus far been used by the criminal law, it has been introduced to help the court determine whether a defendant had either minimal capacity to form the intent to commit a crime, or if the defendant was capable of forming the highest level of intent (e.g., the intent to kill in the first degree or 'purposely,' for which the defendant might qualify for capital punishment). In this way, neuroscience has been understood to be a rough tool for commenting upon the basic decision-making capacities necessary to understand the nature and quality of one's actions in a normal way.

For example, in 2003, Burns and Swerdlow reported the case of a 40-year-old schoolteacher, in an otherwise normal state of health, who developed an increasing interest in pornography, including child pornography. The patient also began soliciting prostitution at 'massage parlors,' which he had not previously done. Magnetic resonance imaging revealed a large tumor in his right orbitofrontal lobe. The patient's symptoms disappeared after the tumor was removed. The tumor in the frontal lobes had impacted several important higher cognitive functions (executive processes), including inhibition (denial of immediate gratification), the moderation of emotional responses, and consideration of the potential future consequences of actions. Burns and Swerdlow hypothesized that the tumor had not given the patient new goals or desires, but had rather impacted the patient's ability to conform his behavior to societal norms and laws.

The patient was arrested for sexual assault of his stepdaughter. If the case had gone to trial, it would seem that identification of the man's tumor would seem to be extremely helpful to an accurate understanding and categorization of his behavior. Indeed, it would appear to be unjust to deny a judge or jury a

chance to consider the neuroscientific evidence of the presence of a tumor in the man's orbitofrontal lobes as evidence of diminished legal capacity.

However, this specific use of neuroscientific evidence in criminal law is quite different from imagining the implications of finding that some high percentage of antisocial behavior is linked to brain abnormalities. In the above case, the tumor in the brain of the patient described by Burns and Swerdlow led him to behavior that was abnormal by his standards (and disappeared after the tumor was removed), indicating that it is only appropriate to attribute lesser responsibility to the patient for an act that is actually linked to the tumor. However, as stated above, if all murderers have certain common brain abnormalities, does that mean we have a better indicator of the sort of person we feel is dangerous and want to punish, or does it mean such persons are less culpable? This question does not appear to have an empirical answer and seems to fall instead within the realm of public policy.

See also: Electroconvulsive Therapy and Transcranial Magnetic Stimulation; Free Will; Moral Development; Neuroesthetics: The Body in Esthetic Experience; Neurotheology.

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- http://neuroethics.ubc.ca/National_Core_for_Neuroethics/Home.html – The National Core for Neuroethics at the University of British Columbia.
- <http://www.neuroethicssociety.org/> – The Neuroethics Society.

Neuroexecutive Function

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Glossary

Automatic processes Behavioral patterns that are invariant, do not require decision, and typically occur when the consequences of actions are known in advance.

Behavioral assessment of the dysexecutive syndrome (BADS) A battery of clinical neuropsychological tests utilized to diagnose patients' deficits in organizing and planning nonroutine behaviors.

Biased competition Signals from a higher-order brain system to a lower-order brain system that selectively enhance or suppress some among a set of competing stimulus or action representations, based on the current context or task requirements.

Cognitive estimation A neuropsychological test whereby the participant is asked to estimate some quantity whose value is not common knowledge but can be logically derived from other quantities that are common knowledge.

Contention scheduling system The neural system for choosing among a repertoire of automatic behaviors.

Controlled processes Behavioral patterns that require decision, and that typically occur when the consequences of actions are not known in advance.

Dysexecutive syndrome A pattern of mental deficits that tends to include distractibility, inability to deal with nonroutine situations, and difficulty in organizing and planning actions.

Prefrontal inhibition Signals from the prefrontal cortex to subcortical systems that serve to override a prevailing response when the context calls for a different response.

Stroop test A neuropsychological test whereby words for colors are presented in ink of either the same or a different color as the one the word represents. The participant is asked to state the ink color rather than read the word.

Supervisory attentional system The neural system for detecting contexts that require nonroutine behaviors and for deciding on appropriate actions for those contexts.

Tower of London A neuropsychological test of planning and monitoring functions, whereby the participant is asked to move from one configuration of balls on poles to another configuration in at most a prespecified number of moves.

Trail Making Test A neuropsychological test whereby the participant is asked to draw connections between circles in a prespecified sequence without lifting his or her pencil.

What Is Brain Executive Function?

There are many formulations of executive function by different neuroscientists, experimental psychologists, and clinical neuropsychologists, all pointing to similar themes. Broadly speaking, executive function denotes those cognitive processes required to manage or direct behavior in nonroutine situations. A sampling of essentially equivalent definitions follows:

The executive system is a theorized cognitive system in psychology that controls and manages other cognitive processes. It is also referred to as the executive function, executive functions, supervisory attentional system, or cognitive control. (Wikipedia).

In our daily life, we often rely on executive, or cognitive, control processes, which can be defined in general terms as the means by which our brain optimizes the flexible use of limited cognitive resources to currently prioritized tasks. Such control may become necessary when automatic or previously learned behaviours can no longer achieve a goal – for example, when we need to override habitual responses, inhibit distracting stimuli, solve new problems or shift between different tasks. (Mansouri et al., 2009: 141).

Executive functioning is the term used to encompass a range of cognitive skills including problem solving, planning and organization, self-monitoring, initiation, error correction and behavioural regulation. (Evans, 2008: 193).

The cognitive psychologist Alan Baddeley and his colleagues developed a theory of working memory in which the 'central executive' controls two 'slave systems': the phonological loop and visuospatial sketchpad. The Baddeley theory led some scientists to define executive function to include the

cognitive functions discussed in the last three definitions but to exclude the behavioral regulation Evans mentioned. However, that reformulation separates emotional from cognitive aspects of behavioral control, which seems unwarranted because of the strong mutual influences in the brain between emotion and cognition. Therefore, this article defines executive function in the more commonly used manner that includes behavioral regulation as well as cognitive control.

Since the early 1970s, executive function in the brain has been widely associated with the prefrontal cortex, the far forward (association) part of the frontal lobes. There are many reasons the prefrontal cortex has received special attention in analyses of executive function. First, there have long been data from both human patient studies and monkey lesion studies showing that prefrontal damage leads to disorganized behavior, deficiencies in planning, and reduced ability to keep a goal in mind without external cues. This set of observations generated a variety of clinical tests of executive function that are often given to prefrontal patients. Second, the prefrontal cortex is the slowest part of the mammalian brain to develop, both in the evolution of species and in the life of individuals. This developmental consideration supports the notion that the prefrontal cortex is the most 'advanced' part of the brain, the area that allows primates (humans especially) to engage in more complex cognition and social organization than other species.

Recent advances in cognitive neuroscience have deepened our knowledge of the role of the prefrontal cortex in executive functioning. Yet as this knowledge has developed, the notion

of a unitary executive in one brain location has gradually been replaced by the concept of an *executive system*. Our current knowledge of the executive system includes differentiated and interacting roles not only for prefrontal subregions such as dorsolateral, orbital, ventral, and anterior cingulate, but also for nonprefrontal regions that have extensive bidirectional connections with the prefrontal cortex. Executive functions commonly engage the basal ganglia, amygdala, hypothalamus, and parietal cortex, for example.

History of the Executive Concept

The concept of neuroexecutive function developed in the 1960s and 1970s to explain behavior that is not repeatable in fixed patterns but adapted to current contexts, situations, and goals. It is a fusion of concepts from experimental psychology and from neuroscience.

Experimental psychology in the 1960s was starting to emerge from the dominance of behaviorism and to embrace the study of complex cognitions and internal mental states. One of the ideas that emerged was that perceptual responses are not automatic reactions to particular stimuli but heavily influenced by previously developed categorizations. For example, the pioneering psychologist Donald Broadbent modeled selective attention using the idea that two separate processes influence selection: one process coming from the physical inputs themselves and the other from internal codes that activate categories.

Broadbent did not, however, clearly develop the origins and functional organizations of the two selective processes. A further clarification of his idea was the distinction the psychologists Walter Schneider and Richard Shiffrin introduced in the 1970s between *automatic* and *controlled* processes. Controlled processes require the participant's active decision and are utilized when the consequences of specific actions are not known for sure. Automatic processes do not require active decision and are utilized when the consequences of actions are invariant. Often, learning changes a process from controlled to automatic, as when one learns to drive a car or speak a language.

Around the same time, neuroscience was embracing the plasticity of neural connections, which had been discovered in the pioneering work of several investigators starting with Nobel laureate Eric Kandel in the mid-1960s. The growth of interest in plasticity generated a search for the neural correlates of controlled (presumably more plastic) versus automatic (less plastic) processes.

In the mid-1980s, the neuropsychologist Tim Shallice posited two interacting neural systems for generating automatic and controlled cognitive processes. Shallice called the generator of automatic processes the *contention scheduling system* (CSS) and the generator of controlled processes the *supervisory attentional system* (SAS). His joint book chapter with Donald Norman enumerated the following types of situations that require SAS involvement:

1. Those that involve planning or decision making.
2. Those that involve error correction or troubleshooting.
3. Situations where responses are not well learned or contain novel sequences of actions.

4. Dangerous or technically difficult situations.
5. Situations which require the overcoming of a strong habitual response or resisting temptation. (Norman and Shallice, 1986; paraphrased by Wikipedia).

Concurrently, interest was developing during the 1970s and 1980s in the specific functions of brain regions that are several synapses removed from primary sensory or motor pathways and are involved in regulating attention, cognition, and behavior. In particular, there was an emerging interest in functions of the prefrontal cortex, which had previously been treated as 'silent cortex' because it is not required for the most elementary or routine movements. In fact, the prefrontal cortex had been regarded as unimportant enough that prefrontal lobotomies were accepted as a means to control mood and anxiety disorders. Yet the famous century-old case of Phineas Gage, who changed from sober to impulsive after a railroad accident injured that part of his brain, should have clued neuroscientists and clinicians to the importance of the prefrontal cortex for organizing behavior, that is, for what we now call executive function. Indeed, by the 1970s, many clinical neuroscientists had found evidence that prefrontal lesions could lead to many types of executive deficits, including distractibility; disorganization; inappropriate behavioral control, which could manifest as either impulsiveness or overdeliberateness; and paradoxically, both perseveration in formerly rewarding behavior and excessive attraction to novelty.

Hence Shallice's laboratory looked for correspondence between their SAS and prefrontal cortex. They enumerated some evidence that patients with damage to the prefrontal cortex (especially its dorsolateral portion), more than those with damage to other areas of cortex, had trouble engaging the SAS and were therefore under the control of automatic contention scheduling. Shallice's laboratory developed several types of cognitive tasks in which patients with prefrontal lesions were deficient. One of these tasks was the Tower of London (TOL), a simplified version of the much older Tower of Hanoi. The TOL involves moving three colored balls sitting on poles from one configuration to another in a certain pre-specified number of moves. For many TOL problems, the optimal long-term strategy differs from the strategy that produces apparent short-term gains. Prefrontal patients, being deficient in planning, tended to use solutions that appeared advantageous in the short term but did not reach the right configuration in the right number of moves. Another type of task involving the prefrontal cortex was *cognitive estimation*, whereby the participant was asked to estimate some quantity that was not common knowledge but could be deduced from some other quantity that was more widely known. An example of a quantity to be estimated was the average length of an adult male's legs, which could be estimated as approximately half of the widely known average adult male's height. Shallice and his colleagues found that prefrontal patients could retrieve widely known quantities from memory but had trouble making deductions from known to unknown quantities.

The conception of prefrontal executive functions developed from human patient studies was further reinforced by results from monkey single-neuron studies. In particular, the neuroscientist Joaquin Fuster and his colleagues found that in the course of cognitive tasks such as delayed matching to sample

(whereby the monkey was reinforced for approaching an object identical to one it had previously seen), neurons in the monkey prefrontal cortex became selectively responsive to various aspects of the task (e.g., the stimulus, the delay, and the responses). Results such as these led Fuster to develop his theory that the overarching function of prefrontal cortex was linking events across time, which is an important component of controlled cognitive processes.

Further clarification of the executive roles of prefrontal cortex awaited the development of noninvasive human brain imaging. The current explosive growth in functional magnetic resonance imaging (fMRI) studies of executive function began in about the mid-1990s. Results of fMRI studies enabled neuroscientists to incorporate insights of pioneering investigators such as Brenda Milner, Walle Nauta, Karl Pribram, Tim Shallice, and Joaquin Fuster into theories that include specified functions for prefrontal subregions (e.g., orbital, ventral, dorsolateral, and cingulate).

Top-Down Cognitive Control

The neuroscientists Earl Miller and Jonathan Cohen described the overarching function of prefrontal cortex as *top-down cognitive control* of other brain systems. This notion is a concise neural instantiation of the supervisory system's influence on the contention scheduling system. Numerous fMRI studies have found that when tasks require conscious attention they tend to activate prefrontal regions, whereas after the tasks are learned and have become automatic the primary activation shifts to further posterior regions such as posterior parietal cortex or premotor cortex.

Cognitive control is sometimes discussed under the rubric of *prefrontal inhibition*. The idea of prefrontal inhibition captures the insight that control is necessary when the task requires suppressing an automatic or habitual response. A commonly discussed example is the Stroop test: a word for one color is presented in ink of another color and the participant has to consciously name the color of the ink when his or her automatic response is to read the word. Yet top-down control is not exclusively inhibitory: it also involves enhancing selective attention to task-relevant items, and sometimes includes disinhibition of a previously inhibited response. The prefrontal cortex seems to selectively enhance or inhibit subsets of a set of competing action representations at other brain levels including the posterior parietal cortex. That mixture of selective enhancement and inhibition has been observed elsewhere in the brain, such as in the influence of higher-order on lower-order visual cortex, and has been termed *biased competition*.

Within the prefrontal cortex a consensus has emerged on the roles of specific prefrontal subregions. In particular, there are widely accepted conceptions of the dissociable executive functions for the three large regions of orbitofrontal cortex (OFC), anterior cingulate cortex (ACC), and dorsolateral prefrontal cortex (DLPFC).

The executive role of the OFC and nearby prefrontal areas involves monitoring the emotional values of stimuli and utilizing emotional information to guide behavior. OFC damage has been observed to lead to poor decision making and inappropriate social behavior in many patients including the

nineteenth-century patient Phineas Gage. These clinical observations, combined with some animal lesion studies, indicate that the OFC forms and sustains mental linkages between specific sensory events in the environment and positive or negative affective states. This region creates those linkages via interactions both with neural activity patterns in the sensory cortex that reflect past sensory events and with other neural activity patterns in the amygdala and hypothalamus that reflect emotional states. Long-term storage of affective valences is likely to take place at connections between the OFC and amygdala.

For the part of prefrontal cortex devoted to visceral and emotional monitoring, neuroscientists often designate a larger area called the ventromedial prefrontal cortex (VMPFC). VMPFC includes the medial portion of the OFC (Brodmann areas (BAs) 14 and the medial portions of areas 11 and 13) and parts of areas 25, 32, and 10 in the medial prefrontal cortex. Many scientists have identified the VMPFC's basic function as holding in working memory the positive or negative emotional properties of objects or potential actions during the implementation of behaviors.

The executive role of DLPFC involves selectively sustaining task-relevant working memory representations. DLPFC is involved with information processing at a higher level of abstraction than the OFC. For example, in monkeys, while OFC lesions impair learning of changes in reward value within a stimulus dimension (i.e., reversal learning), DLPFC lesions impair learning of changes in which dimension is relevant. Evidence from human fMRI studies indicates that DLPFC is involved in choosing correct actions based on task-appropriate rules, particularly in tasks that require overriding a prevailing response.

Within the DLPFC and adjoining areas, there is a hierarchy whereby anterior regions encode more abstract rules and posterior regions encode more concrete rules. In an fMRI study by Kalina Christoff and Kamyar Keramian, participants were given tasks that required rule-guided behavior at three levels of abstraction. Their targets consisted of circles that were half black and half white. For the concrete rule the target had a black side oriented in a specific direction (right, left, up, down); for the first-order abstraction it was a pair of those circles whose orientation was the same or different; for the second-order abstraction it was two pairs of circles whose orientations were either 'related' (both the same orientation or both different) or 'unrelated' (one the same and one different). The use of concrete rules for attention activated posterior areas of cortex, whereas first-order abstraction activated the DLPFC (BAs 9 and 46) and ventrolateral prefrontal cortex (areas 12 and 47). As the rules moved toward second-order abstraction there was more activation further anterior, in the rostral prefrontal cortex (area 10).

The ACC (parts of BAs 24, 25, and 32) is involved in detection either of potential response error or of conflict between signals promoting competing responses. The ACC tends to be activated when a subject must select or switch among different interpretations or aspects of a stimulus. Also, in fMRI studies of the Stroop color-naming task, the ACC is consistently more active when the two rules conflict (i.e., a word for one color is written in ink of another color) than when the two rules agree. In an fMRI study of judgment by

Wim DeNeys and his colleagues, participants were asked to estimate the probability of a person in a group being in one of two professional categories (engineer or lawyer), based both on the numbers of people in the group (base rates) and a personality description stereotypical of one of the professions. DeNeys et al. found that ACC activation was greatest in the incongruent case, such as the combination of a lawyer stereotype with a group that was more than 99% engineers.

The ACC is closely connected with the limbic system, hypothalamus, and hippocampus, and is sometimes classified as limbic cortex. These connections allow it to play a strong role in the emotional regulation aspects of executive function. Some investigators divide the ACC into a 'cognitive' component (dorsal ACC) and an 'emotional' component (ventral and rostral ACC). Yet more recent investigators emphasize the deep interconnections and mutual influences between emotion and cognition, making it hard to separate different brain regions responsible for each.

Recent Neuroimaging Studies

A 2006 book chapter by Todd Braver and Hannes Ruge reviews much of the recent work in functional neuroimaging of executive function. These authors identify seven different categories of executive functions, all interrelated but each emphasized in different tasks. These seven categories are (1) strategic control of memory; (2) stimulus-response interference; (3) response inhibition; (4) underdetermined responding; (5) performance monitoring; (6) task management; and (7) higher cognition.

These authors summarize recent fMRI findings about areas activated by those categories of tasks as follows:

Task conditions involving the preparatory cuing of attention or the use of attentional control to resolve interference tend to activate posterior and inferior regions of lateral prefrontal cortex (PFC).

Task conditions requiring the temporary suppression of ongoing responses tend to activate right inferior PFC regions.

Task conditions requiring rapid shifting of attention to different dimensions or reconfiguration of task sets reliably engage the superior parietal cortex.

Task conditions involving the free selection of potential response alternatives engage superior medial frontal areas near the supplementary motor area (SMA).

Task conditions involving the processing of internal or external feedback related to the outcome of generated actions reliably engage the ACC and nearby medial frontal areas.

Task conditions that require the tracking of changing stimulus-response contingencies elicit activation in the OFC.

Complex cognitive activities (such as planning, analogy verification, and controlled episodic retrieval) that involve the evaluation or integration of abstract dimensions maintained in working memory tend to engage the anteriormost regions of PFC (BA 10).

(Braver and Ruge, 2006: 330).

Figure 1 shows the locations of some of the key regions for specific executive functions.

Clinical Disorders of Executive Functions

An early clinical investigator described some characteristic effects of prefrontal dysfunction as "disturbed attention, increased distractibility, a difficulty in grasping the whole of a complicated state of affairs ... well able to work along routine lines ... cannot learn to master new types of task in new situations ..." (Rylander, 1939: 20). Alan Baddeley coined the term *dysexecutive syndrome* (DES) for that pattern of

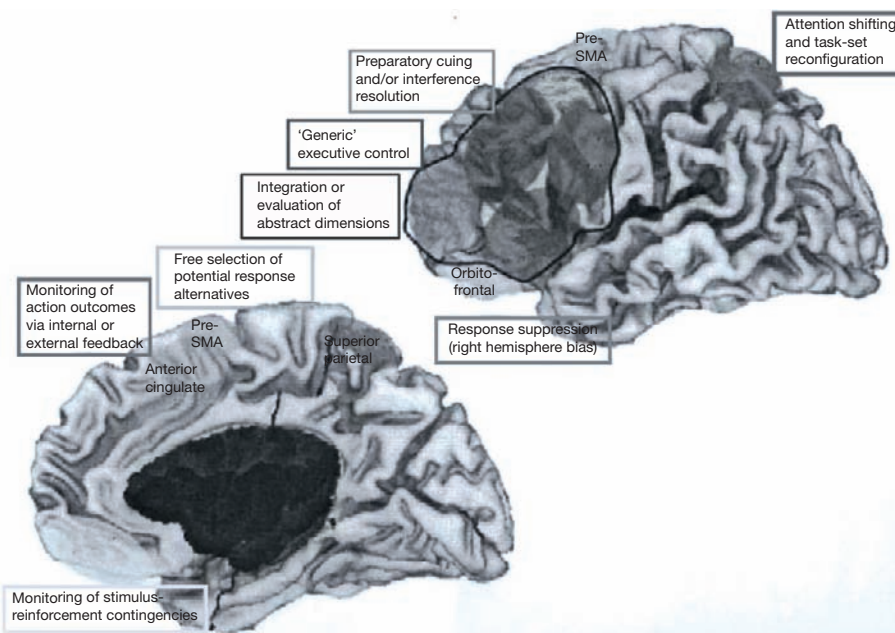


Figure 1 Locations in the brain of regions that typically are activated by selected executive operations. Adapted from Braver TS and Ruge H (2006) Functional neuroimaging of executive function. In: Cabeza R and Kingstone A (eds.) *Handbook of Functional Neuroimaging of Cognition*, 2nd edn., pp. 307–348. Cambridge, MA: MIT Press, with permission from MIT Press.

deficits, noting that it involves malfunctioning of the SAS Shallice and Norman described.

From the mid-1980s through the 1990s, Baddeley, Shallice, and their associates gradually developed a variety of tests for the DES as it applied to daily life situations. This development culminated in a series of tests called the BADS (Behavioural Assessment of the Dysexecutive Syndrome). The BADS includes the following:

Rule Shift Cards Test: In the first part of the test, participants are asked to say 'Yes' to a card of one color and 'No' to a card of another color. In the second part they are given a different rule, namely, to say 'Yes' if the card is the same color as the previous one and 'No' if it is a different color from the previous one.

Action Program Test: Participants are asked to solve the mechanical problem of getting a small piece of cork out of the bottom of a thin tube. There is a beaker of water available, and the solution requires moving water from the beaker into the tube.

Key Search Test: Participants are presented with a piece of paper with a small square in the center and a small black dot below the square. They are asked to imagine that the square is a field in which they have lost their keys. Then they are asked to draw a line from the black dot into the square to show where they would search to be sure they had found their keys.

Temporal Judgement Test: This part is similar to Shallice's cognitive estimation test, but the questions specifically involve time estimation. Examples could have answers that involve either a small amount of time (e.g., How long does it take to blow up a party balloon?) or a large amount of time (e.g., How long is the life of a typical dog?).

Zoo Map Test: Participants are given a map of a zoo and asked to imagine how they would visit a series of designated locations within the zoo. Some rules are attached that limit the variations on the order in which they can visit those locations. In one part of this test, visiting the designated locations in the order in which they are given in the instructions leads to errors, thereby testing the participant's initiative and planning ability.

Modified Six Elements Test: Participants are instructed to do three tasks of different types (dictation, arithmetic, and picture naming), and each task is divided into two parts. They are required to attempt at least something from each of the six task parts within a 10-min interval, but not allowed to do two parts of the same task in order.

The BADS is only one of several measures utilized by clinical neuropsychologists to assess executive functions. It has supplemented but not supplanted other tests that have been in use for longer, such as the Wisconsin Card Sorting Test, TOL, Verbal Fluency Test, and Trail Making Test. The BADS and TOL deal primarily with the planning, task management, and monitoring parts of executive functioning (categories (5) through (7) in the schema of Braver and Ruge). So does the Trail Making Test, which requires the participant to connect a sequence of numbered circles on different parts of a page in ascending numerical order without lifting his or her pencil from the page. Yet some of those tests also engage other categories of executive function. For example, the Rule Shift

Cards Test requires the processing of a change in stimulus-response contingencies (category (2) of Braver and Ruge), albeit at a fairly abstract level. (The neuroscientists Rasika Dias, Trevor Robbins, and Angela Roberts note a distinction between DLPFC and OFC function, in that orbitally lesioned monkeys have difficulties in learning changes in the reward value of specific stimuli, whereas dorsolaterally lesioned monkeys have difficulties in learning changes in the relevant stimulus dimension. Dias et al. call this distinction "dissociation ... between affective and attentional shifts." However, learning is affectively motivated in both cases, so I believe it is more useful to call the distinction between those two regions dissociation between less and more abstract shifts.) So does the much older Wisconsin Card Sorting Test (Milner, 1964), whereby participants first learn to classify a particular type of card using one criterion (e.g., color of the designs on the card) and then are required to shift, without warning, to using a different criterion (e.g., shape or number of the designs on the card). Underdetermined responding (category (4)) is often tested by means of the Verbal Fluency Test, whereby the participant is required to generate as many words as possible beginning with a certain letter or as many words as possible that fit a particular category such as animals or household objects. Response inhibition (category (3)) is often tested using the Stroop Test or the Iowa Gambling Task (IGT), whereby participants must choose between four virtual decks of cards that yield probabilistic gains or losses, and the two decks that yield the highest initial payoffs are not the decks that are most advantageous in the long run.

Emotionally derived impulsiveness can easily interfere with performance on 'cognitive' tasks such as TOL, and improper memory monitoring can easily interfere with performance on 'emotional' tasks such as the IGT. All these executive subfunctions reinforce one another, which makes it hard to parcel executive tasks neatly by what subfunctions they engage.

Just as there is no one test that always captures deficits in executive function, there is no one treatment that works for all patients presenting with executive deficits, most of whom sustained damage to one or more prefrontal regions as adults from an accident, stroke, or removal of a tumor. A variety of treatments for executive disorders are reviewed in the 2009 book edited by Oddy and Worthington. Some treatments involve cognitive aids, such as repeatable organizing techniques that the patients can learn to have a better handle on the steps they need to take in nonroutine situations. Other treatments are pharmacological, particularly involving drugs that increase available dopamine in the prefrontal cortex and thereby facilitate attention and learning. However, there is appreciable danger that dopamine agonists can lead to undesirable side effects such as inappropriate, aggressive, and even psychotic behaviors.

Summary

Executive functions include a large number of skills that are somewhat dissociable from other forms of intelligence. That is, high scores on traditional IQ tests do not necessarily translate into an ability to plan and organize behavioral sequences, monitor one's behavior, and react appropriately to changing reinforcement contingencies.

The various executive functions engage different parts of the prefrontal cortex and related regions and are difficult to disentangle from one another. Further technical advances in the near future, both theoretical and experimental, can advance our understanding of behaviorally and cognitively relevant interactions between all these brain regions.

On the theoretical level, there has been rapid progress in the last decade in biologically realistic neural network modeling. For example, Stephen Grossberg and Lance Pearson developed the LIST PARSE model which “joins together a cognitive working memory, a motor working memory, a motor trajectory generator, and a volitional controller that coordinates variable-rate recall of both novel and previously learned sequences as they are read-out into sequential action from a cognitive plan” (Grossberg and Pearson, 2008: 686). Executive function might be simulated by combining LIST PARSE or a similar model with some other model that replicates decision processes and reinforcement learning.

On the experimental level, fMRI techniques have begun to move beyond simple measures of brain region activations to mapping of neural patterns and functional interactions. Future advances in this type of recording are needed to make the implications of imaging measurements less ambiguous and more reflective of actual brain processes in the behaving individual. Another technique increasingly likely to be used to map functional interactions in humans is transcranial magnetic stimulation, which temporarily inactivates a small selected area of the brain.

The systemic understanding generated by these technical advances should in turn suggest hypotheses for what forms of intervention will help with what types of patients with executive disorders. Also, our understanding should suggest hypotheses for what sorts of human activities and interactions optimize executive functioning in nonbrain-damaged individuals, with implications for many fields including education, psychotherapy, and organizational management.

See also: Decision Making (Individuals); Intention; Judgment; Memory, Neural Substrates; Planning; Reasoning.

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Neuroimaging of Dementia

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Glossary

Alzheimer's disease A disease that causes memory loss and as it progresses affects also other cognitive aspects, such as language and the ability to navigate unfamiliar surroundings. There is excess deposition of amyloid in the brain and damage of the structure of brain cells, leading to their progressive loss.

Amyloid A protein that is derived from the amyloid precursor protein and is the primary component of plaques characteristic of Alzheimer's disease.

Dementia A condition of deteriorated mentality that is characterized by marked decline from the individual's former intellectual level, enough to interfere with professional or social activities.

Diffuse Lewy-body disease A progressive disorder characterized by impairment of cognitive abilities, similar to Alzheimer's disease, but in addition the person has slowing of movements, and stiffness in the muscles, similar to people with Parkinson's disease.

Frontotemporal dementias A group of diseases causing dementia through the loss of brain cells. The location of cell loss in the brain typically differs from Alzheimer's disease and for this reason, rather than starting with memory loss,

they tend to start with bizarre behavior, apathy, language disorders or hand clumsiness.

Magnetic resonance imaging A noninvasive diagnostic technique that produces computerized images of internal body tissues and is based on nuclear magnetic resonance of atoms within the body induced by the application of radio waves. It is also called MRI.

Positron emission tomography A technique that yields an in vivo, cross sectional image of the distribution of a compound in the tissue object of study, the brain in the case of this article. The image is obtained by determining by means of a computerized process the distribution of gamma radiation given off in the collision of electrons in cells with positrons emitted by radionuclides incorporated into the substance object of study. It is abbreviated as PET.

Single-photon emission computed tomography A medical imaging technique that is used especially for mapping brain function and that is similar to positron emission tomography in using the photons emitted by the agency of a radioactive tracer to create an image but that differs in being able to detect only a single photon for each nuclear disintegration. Often known as SPECT.

Introduction

At the time of writing of this article, three panels of the US National Institute of Aging are completing a set of new guidelines for the diagnosis of diseases leading to dementia. Novelties include the use of neuroimaging tools as biomarkers of disease and the attempt to diagnose these disorders before cognitive impairment occurs, at what could be called the pre-symptomatic stage. A practice guideline on the management of dementia states: "Neuroimaging is now the most important ancillary investigation in the work-up of dementia to aid in differential diagnosis and management decisions." Few areas in medicine are evolving as quickly as the ability to image the human brain. Indeed, the rapid development of neuroimaging tools in the past few years has provided the physician with a panoply of imaging modalities, each with a somewhat complex technology and with specific applications. A learning need exists to update the knowledge of neurologists and other physicians on the current role of imaging in the management of dementia, which is one of the most prevalent neurological disorders. Currently, around 24 million people in the world have dementia, with the number being projected to double every 20 years. Moreover, therapeutic intervention is likely to be most effective in the preclinical stages of the dementing process, or at least in the early stages of cognitive impairment, when the halting of progressive neuronal loss seems most feasible. At these early stages of the process, neuroimaging

provides key information to determine whether the patient has a degenerative dementing disease and which type it is, particularly when neuroimaging is combined with genetics.

When facing a patient with a dementing process, a major concern is to rule out the unusual situation of a nondegenerative disorder, such as a brain tumor, presenting with the clinical picture of dementia. However, as the prognosis and management of the various neurodegenerative dementias begins to differ, there is an interest in diagnosing the type of degenerative dementia as well. As most disorders causing dementia do not have a curative treatment at present, physicians are most eager to know about ongoing research that may lead to more effective treatments of these devastating disorders. Therefore, this article is divided into three main sections:

1. Neuroimaging to diagnose nondegenerative dementia.
2. Neuroimaging to distinguish the various degenerative dementing processes.
3. Use of neuroimaging in dementia research and in the evaluation of new therapies.

Neuroimaging to Diagnose Dementia Caused by Nondegenerative Disorders

Potentially reversible neurological or psychiatric conditions leading to cognitive impairment may be diagnosed with the help of neuroimaging (Figure 1). For this reason, the 1994

American Academy of Neurology (AAN) guideline on the management of dementia, which did not require the use of imaging to diagnose a degenerative dementia in a patient with progressive memory loss and no motor or sensory findings or epilepsy, was changed to require structural imaging (computed tomography (CT) or magnetic resonance imaging (MRI)) in the 2001 guideline. The report of patients with a clinical picture of progressive memory loss caused by tumors or subdural hematomas (Figure 2) contributed to this change. Unless a tumor infiltrates the cortex, for instance in the case of very rare lymphomas or metastases from malignant melanoma, a CT without contrast is enough to rule out potentially reversible structural brain lesions. The European guidelines for the work-up of dementia suggest that, if possible, an MRI be performed to increase specificity, given that MRI provides additional information on the vascular causes of dementia, and to distinguish the various degenerative dementias.

Symptomatic hydrocephalus in an older person presents with gait impairment and urinary incontinence, which generally are more prominent than cognitive impairment. When present, cognitive impairment is characterized by psychomotor slowing and impaired executive function and memory, but with preserved naming. Cortical sulci may be large and ballooned in symptomatic hydrocephalus (Figure 3). This finding should not be confused with the sulcal dilatation observed in hydrocephalus 'ex vacuo,' caused by atrophy of the brain.

The role of vascular disease as a cause of dementia continues to need further definition. Small vessel infarction, of the subcortical type, seems more likely to contribute to dementia than large cortical infarctions. The effect of vascular and degenerative changes is cumulative. When vascular disease is the primary cause of dementia, multiple infarctions are generally present on CT or MRI (Figure 4), particularly involving the thalamic nuclei bilaterally. By contrast, the extent of white matter involvement on T2-weighted images does not correlate with cognitive impairment in many studies, but it does in some. Medial temporal atrophy, a feature of Alzheimer's disease (AD), also correlates with cognitive impairment in

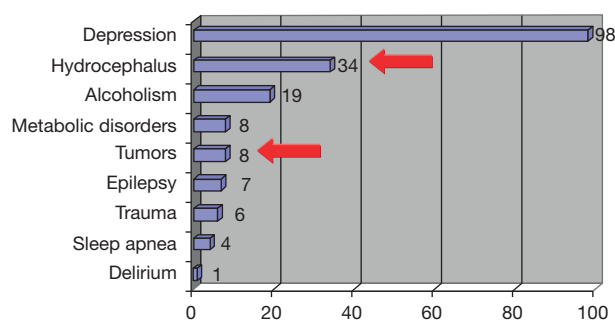


Figure 1 Potentially reversible primary etiologies for cognitive impairment in 1000 patients referred to a memory disorders clinic. A potentially reversible primary etiology for cognitive symptoms was identified in 19% and a potentially reversible concomitant condition in 23% of all patients. As this was a referral sample, it may not represent the proportion of these disorders among the population with dementia at large. Note that vascular dementia is not included here. Red arrows indicate the main etiologies ruled out by structural brain imaging. Depression or mania can be suspected in a patient with a normal metabolic brain study.

vascular dementia. Cognitive impairment is a prominent feature of cerebral amyloid angiopathy (CAA), which presents with white matter hyperintensity on T2 MRI and cortical microhemorrhages, best seen on gradient-echo MRI sequences (Figure 5). Amyloid deposition in CAA can now be imaged with ^{11}C PiB PET (Pittsburgh Compound B positron emission tomography) (Figure 6). In rare cases, CAA can be worsened by regional inflammation, susceptible to immunosuppressive treatment (Figure 7). Involvement of the white matter of the frontal and temporal poles on MRI may help differentiate cerebral autosomal-dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL) from sporadic subcortical arteriosclerotic encephalopathy (Figure 8).

Prion diseases may present as a rather rapidly progressive dementing process, often accompanied by clinical manifestations of basal ganglia or cerebellar involvement. Imaging is very helpful and tends to be abnormal before the onset of any characteristic electroencephalography (EEG) pattern. Bilateral caudate or thalamic areas of high signal intensity on diffusion-weighted or fluid-attenuated inversion recovery (FLAIR) MRI are characteristic (Figure 9). The cortical ribbon is often affected, particularly in the parietal regions of the frontal lobes. The same regions have reduced metabolism on 2-deoxy-2-fluoro-D-glucose (FDG) PET.

Most cognitive impairment from depression or mania can be readily diagnosed from the clinical findings and response to therapy. However, in some older patients, making these diagnoses may not be straightforward. In a patient with impairment in various areas of cognition, likely to be attributable to an attentional deficit with a normal structural imaging study, a negative PET or single-photon emission computed tomography (SPECT) study may help decrease the probability of a neurodegenerative disorder. A normal ^{18}F FDG-PET study lowers the probability of the patient presenting a neurodegenerative disorder in the following few years to about 10%. The 67% probability of a pathologically confirmed diagnosis of AD with a clinical diagnosis of possible AD was lowered to 52% with a negative SPECT. The findings characteristic of neurodegenerative dementia on PET and SPECT will be reviewed below. A negative ^{11}C PiB PET will decrease the probability of AD and dementia with Lewy bodies (DLB), but not of a frontotemporal dementia (FTD).

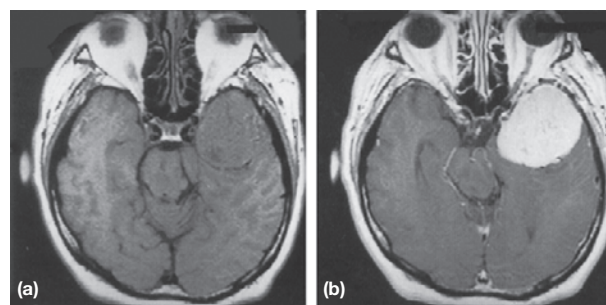


Figure 2 Dementia with meningioma. (a) T1-weighted and (b) gadolinium-enhanced T1-weighted MRI of the brain of a 65-year-old woman, showing a large, contrast-enhancing mass lesion in the left lobe that compresses the left hippocampus and displaces the midbrain.

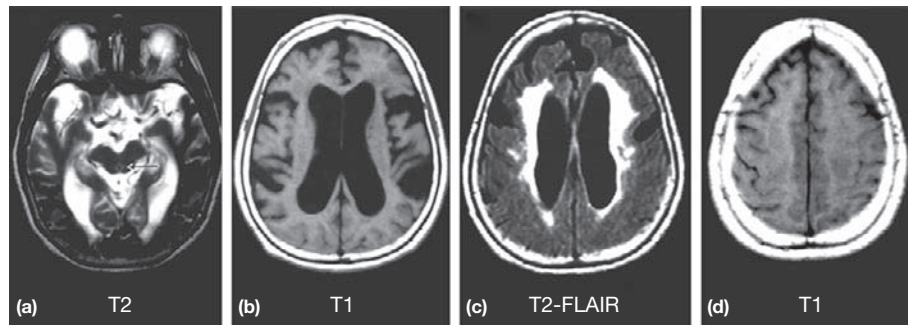


Figure 3 Hydrocephalus. (a–d) Axial sections of the MRI from a 71-year-old woman with progressive gait and cognitive impairment, as well as urinary incontinence (Case 1). Notice the low signal in the Sylvian aqueduct, due to a flow void from a vigorous CSF flow in this structure (A, arrow). Although the basal cisterns (a) and the interhemispheric and sylvian fissures (b–c) are dilated, the sulci in the high convexity (d) are compressed. Transependymal reabsorption of CSF, suggested by the homogeneous high signal in the periventricular white matter (c), need not occur in all cases of symptomatic hydrocephalus.

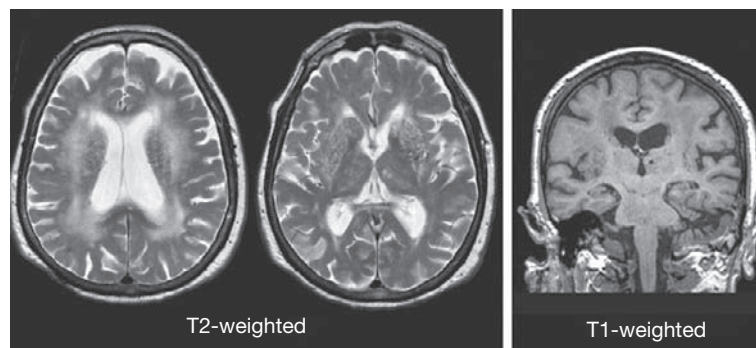


Figure 4 Vascular dementia. Shown are axial T2-weighted and coronal T1-weighted images from an 80-year-old woman with impairment of cognition and gait. Note the thalamic infarctions and the large areas of altered signal (increased on T2 and decreased on T1) in the centrum semiovale.

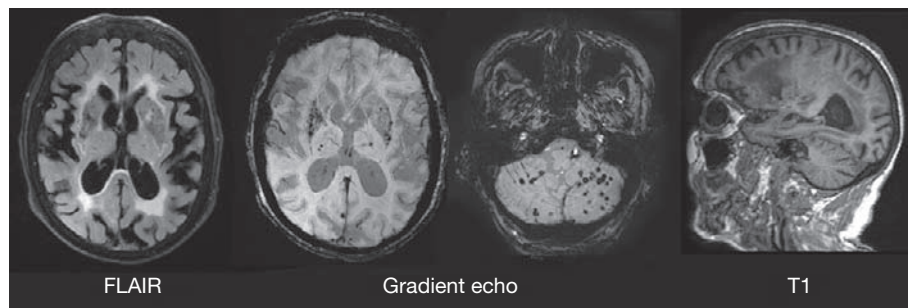


Figure 5 Cerebral amyloid angiopathy (CAA). Shown are MR images from a 72-year-old woman with dementia and CAA. The white matter contains many abnormal areas, which appear hyperintense on the transverse FLAIR image and hypointense on the sagittal T1-weighted image. Multiple lacunar infarcts are present in the lenticular nuclei and few in the thalami. Microbleeds, best seen on the gradient echo images, dot the lenticular nuclei, thalami, and the cerebellum. Scattered microbleeds can also be seen in the cortex or subcortical white matter.

Neuroimaging to Distinguish the Various Degenerative Dementing Processes

In this section, I review the most characteristic imaging findings in the most frequent types of neurodegenerative dementia. Many of the disorders that we now consider diseases, such as Alzheimer's, may turn out to be caused by a variety of genetic and environmental conditions. As an example, the genetic heterogeneity of the FTDs has become apparent in the past

few years. Thus, the classification I follow is mostly syndromic, based on the clinical presentation and some associated imaging or neuropathological changes.

From an imaging/neuropathology perspective, the advent of compounds such as PiB to image amyloid deposition in the brain (**Figure 10**) allows us to separate dementias with amyloid deposition (AD, DLB) from dementias without amyloid deposition (frontotemporal and other dementias) (**Table 1**).

Alzheimer's Disease

Structural Imaging (MRI and CT)

Most cases of AD start with mesial temporal atrophy, which can be appreciated by a dilation of the temporal horn of the lateral ventricle on CT or by atrophy of the entorhinal and hippocampal cortex on MRI (Figure 11). The same is true of mild cognitive impairment (MCI) leading to AD. Scheltens has developed a visual rating scale to gauge medial temporal atrophy (Table 2). The sensitivity and specificity of this scale for the detection of mild to moderate AD compared with controls has been estimated as 85% and 88%, respectively. In practical terms, if the probability of AD were 60% before taking temporal atrophy into account (in line with the sensitivity values for

the National Institute of Neurological and Communication Disorders and Stroke-Alzheimer Disease and Related Disorders Association (MINCDS-ADRDA) criteria), the presence of temporal atrophy raises the probability to 91% and its absence lowers the probability to 20%. Automated methods are more precise and facilitate longitudinal follow-up. The accuracy of the software that classifies clinically appropriate cases has been compared favorably with that of trained readers. Cortical atrophy predicts worsening from MCI to AD.

As the disease progresses, atrophy extends from the limbic cortex to the neocortex, particularly in regions posterior to the rolandic sulcus. Medial temporal atrophy is not specific to AD, and happens in FTD and vascular dementia as well. Greater bilateral symmetry and predominantly posterior atrophy tend to suggest AD over FTD. In some patients, early atrophy of areas in the parietal, occipital, or posterior temporal lobe can be prominent, giving rise to presentations such as Balint's syndrome (Figure 12). In such cases, regional atrophy may be determined by automated methods, such as voxel-based morphometry now available in some clinical units. By facilitating the comparison of two or more studies, automated methods greatly simplify the determination of the annual rate of volume change in temporal cortex, which distinguishes AD from controls with greater sensitivity and specificity than one-time measurements. Whereas the volume loss in normal aging is less than 1%, rates as high as 4% occur in early AD.

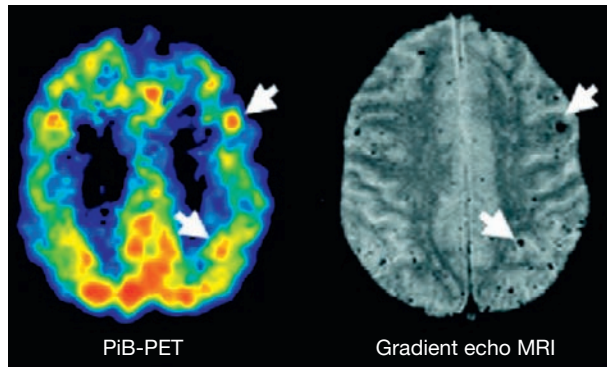


Figure 6 Amyloid deposition in CAA. Shown are transverse supraventricular Pittsburgh Compound B (PiB)-PET and coregistered gradient-echo MRI images from a patient with cerebral amyloid angiopathy. Microbleeds, seen as dark dots on MRI, at times appear close to foci of amyloid deposition on PiB-PET (arrows).

Regional Cerebral Metabolism Studied with PET

Regional cerebral metabolism studies with PET have used ^{18}F -FDG as a metabolic marker. The most typical pattern found in early AD is decreased metabolism bilaterally in the parietotemporal association cortex and posterior cingulate gyrus (Figures 13 and 14), as well as the medial temporal

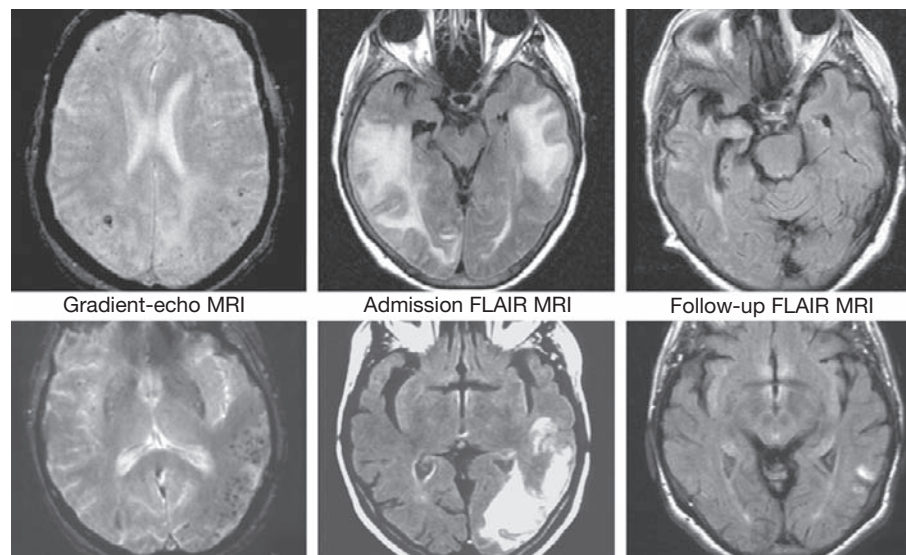


Figure 7 Amyloid-angiopathy-related inflammation. Magnetic resonance imaging (MRI) appearance in patients with cerebral amyloid angiopathy (CAA)-related inflammation, managed with immunosuppressive treatment. The gradient echo images from patients 1 and 2 show multiple small hypointense lesions characteristic of CAA-related microhemorrhages. The fluid-attenuated inversion recovery (FLAIR) images performed at presentation and after follow-up intervals of 2 months (Patient 1) or 22 months (Patient 2) demonstrate confluent regions of white matter hyperintensity that largely resolve at follow-up.

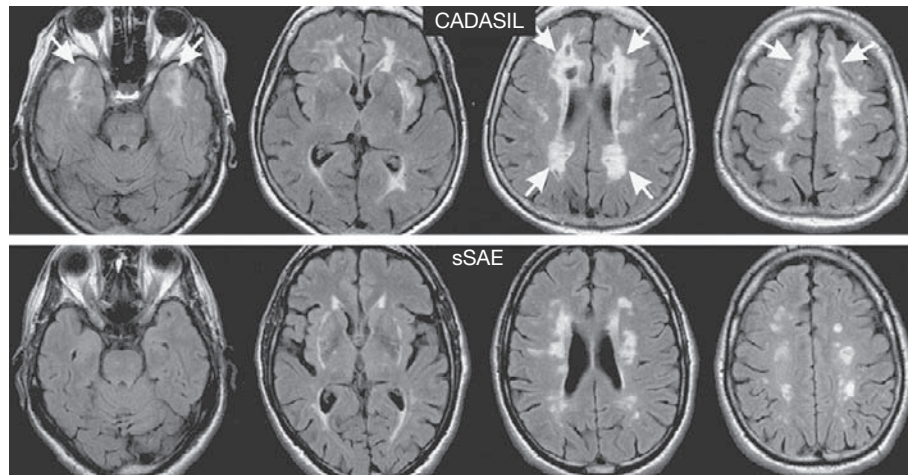


Figure 8 CADASIL. Images obtained in representative patients with biopsy-proved cerebral autosomal-dominant arteriopathy with subcortical infarcts and leukoencephalopathy (CADASIL, top row) and sporadic subcortical arteriosclerotic encephalopathy (sSAE, bottom row) display the differentially involved temporopolar and superior frontal white matter. Note the marked symmetry of lesions and the extension of lesions into the superficial white matter in CADASIL (arrows).

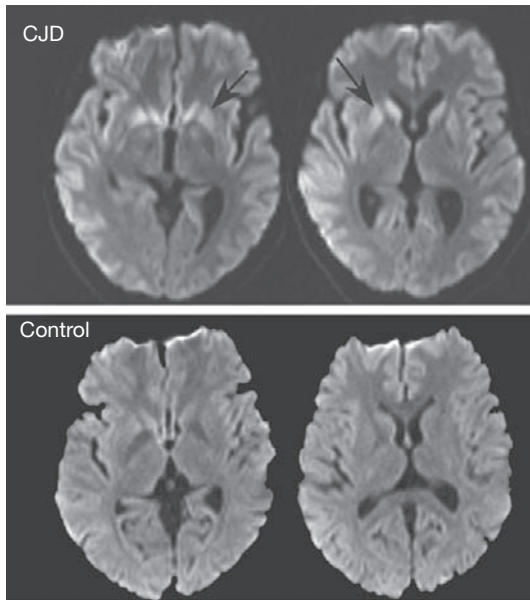


Figure 9 Creutzfeldt-Jakob disease. Images shown (FLAIR MRI) are from a 39-year-old woman who developed chorea, followed by anxiety and progressive cognitive and motor impairment, leading to inability to walk and marked dysarthria and dementia by the time this imaging study was obtained, that is, 5 months after symptom onset. Note the high intensity of the caudate and of the anterior portion of the lenticular nuclei (arrows). For comparison purposes, the lower image row was obtained with a similar technique, but from a control individual.

region. As the disease progresses, the frontal association cortex becomes involved, while the paracentral cortex (primary motor-sensory areas) remains preserved. The specificity and sensitivity of these findings continue to be debated. In studies with neuropathological confirmation, the sensitivity (84–95%) has been higher than the specificity (71–74%), which in a normal study is seldom associated with AD. FDG-PET improves diagnostic accuracy over the clinical evaluation in separating histologically

proven AD from FTD. This clinical application of FDG-PET has been approved by the Centers for Medicare & Medicaid Services (CMS, USA) since 2004. Among persons with MCI, the most likely to progress to AD have metabolic findings similar to AD. FDG-PET may predict better than structural MRI or SPECT the worsening from MCI to AD.

Regional cerebral perfusion studied with SPECT

The most commonly used tracers for studying cerebral perfusion with SPECT are ^{99m}Tc HMPAO (hexamethyl propylamine oxime, CeretecTM), a lipid-soluble macrocyclic amine, and ^{99m}Tc ECD (ethyl cysteinate dimer, NeuroliteTM). The pattern of decreased regional perfusion in parietotemporal cortex, hippocampus, anterior and posterior cingulum, and dorsomedial and anterior nucleus of the thalamus had a sensitivity of 86% and a specificity of 80% for AD compared to normal controls. In a group of 70 patients with dementia and 14 controls, all with autopsy, SPECT was most useful when the clinical diagnosis was of possible AD, with a probability of a diagnosis of AD of 67% without SPECT, of 84% with a positive SPECT, and of 52% with a negative SPECT. Although perfusion SPECT is less expensive and more readily available than FDG-PET, the consensus is that PET is slightly more sensitive and specific than SPECT for the diagnosis of mild AD, but it is clearly better for the differential diagnosis of vascular dementia.

Amyloid Imaging

Until very recently, brain amyloid could be imaged only with ^{11}C PiB, helping to separate the dementias with marked amyloid deposition from the rest. Now, at least two similar compounds are labeled with ^{18}F , a much more versatile isotope, which will greatly facilitate the clinical application of this technique. In some initial studies, PiB positivity is a strong predictor of worsening to AD in individuals with MCI. It has also been found to predict dementia in cognitively normal individuals and to correlate with a higher genetic risk for AD.

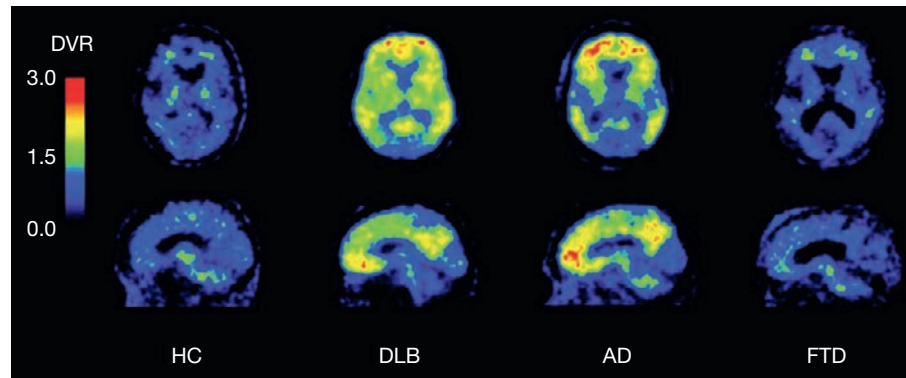


Figure 10 In vivo imaging of β -amyloid ($A\beta$) burden in aging and dementia. Representative distribution volume ratio (DVR) PET transaxial images (top) and sagittal images (bottom) of a 73-year-old healthy control (HC) subject (Mini-Mental State Examination (MMSE) = 30), a 78-year-old patient with dementia with Lewy bodies (DLB) (MMSE = 19), an 82-year-old patient with Alzheimer's disease (AD; MMSE = 22), and an 80-year-old patient with frontotemporal dementia (FTD; MMSE = 25). DVR PET images show clear differences when comparing HC or FTD subjects with DLB or AD patients, with nonspecific Pittsburgh Compound B (PiB) binding in white matter in the HC and FTD subjects compared to PiB binding in the frontal, temporal, and posterior cingulate/precuneus cortex of the AD and DLB patients.

Table 1 Amyloid deposition in the dementias

<i>Dementias with amyloid deposition</i>	<i>Dementias without amyloid deposition</i>
AD	Frontotemporal dementias
Lewy-body dementia	Corticobasal degeneration
Some prion disorders	Progressive supranuclear palsy
Amyloid angiopathy	Vascular dementia without amyloid angiopathy

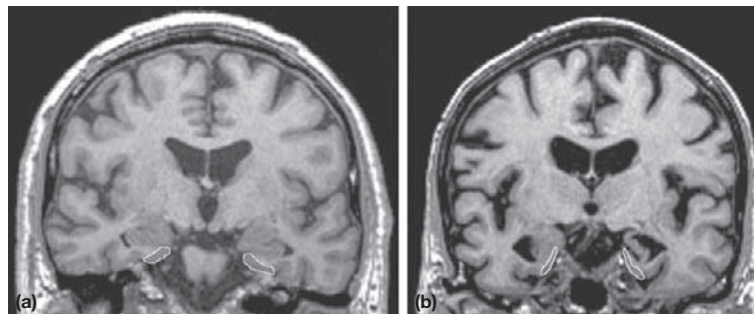


Figure 11 Temporal atrophy with AD. Coronal MRI at the level of the mammillary bodies. The entorhinal cortex has been outlined in a normal control (a) and a person with mild cognitive impairment of the amnesic type (b).

Table 2 Scheltens' scale for the visual assessment of medial-temporal-lobe atrophy

<i>Score</i>	<i>Width of choroid fissure</i>	<i>Width of temporal horn</i>	<i>Height of hippocampus</i>
0	Normal	Normal	Normal
1	↑	Normal	Normal
2	↑↑	↑	↓↓
3	↑↑↑	↑↑	↓↓
4	↑↑↑	↑↑↑	↓↓↓

↑, increased; ↓, decreased.

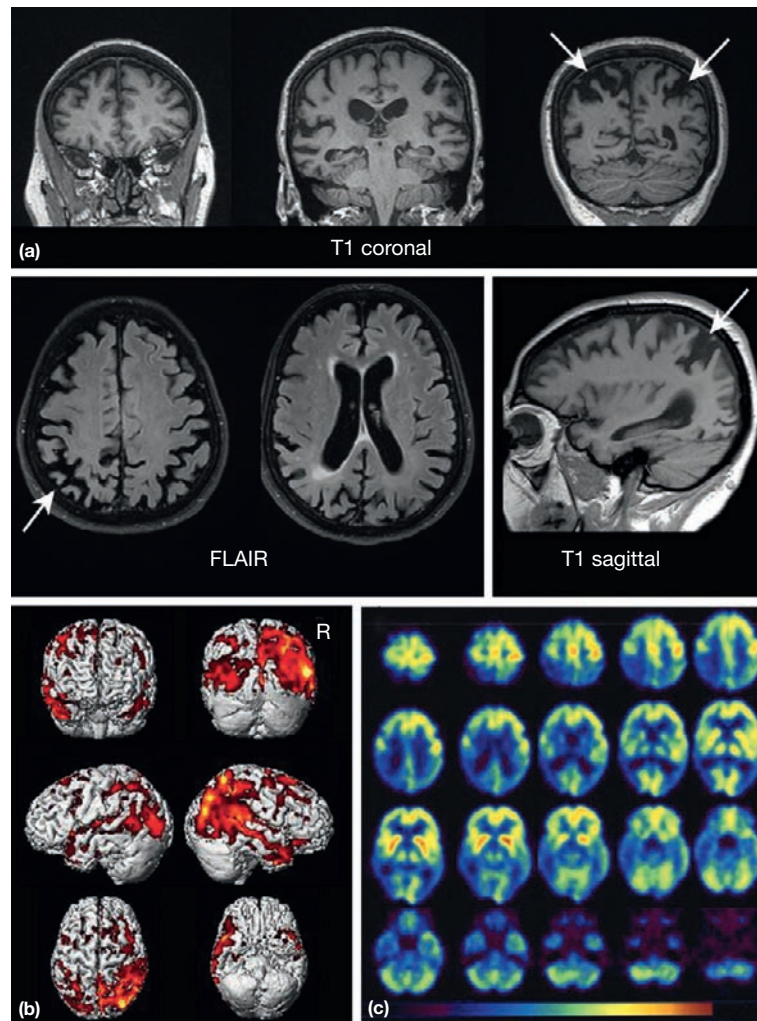


Figure 12 Balint's syndrome with AD. Shown are the (a) conventional MRI, (b) volumetric MRI on a rendered image, and (c) PET studies from a 61-year-old woman with a 3-year history of progressive reading difficulties, aphasia, and dressing apraxia. On examination, she had Balint's syndrome, with simultanagnosia, apraxia of eye movements, optic ataxia, and 'tunnel vision.' Note in (a) the marked atrophy in the lateral parietal lobe, with dilation of the intraparietal sulcus (arrows). There is also hippocampal atrophy, albeit less prominent. In (b) voxels with significant atrophy (compared with SPM to 48 controls, $p < 0.05$ uncorrected; $k > 20$) are displayed in red. Note that in (b) the right side of the brain is displayed on the right side of the image, opposite to the radiological convention on the conventional MRI (a) and PET (c). Areas of decreased metabolism on PET (c) most closely match the clinical picture.

Lewy-body dementia

There are very few neuropathologically confirmed imaging studies of Lewy-body dementia (LBD). More occipital atrophy in LBD than in AD has been reported by a group with a good diagnostic record. In agreement is the finding of decreased metabolism in occipital association cortex. As PiB binds with much greater affinity to β -amyloid than to α -synuclein, positive PiB studies in LBD probably reflect amyloid binding.

Frontotemporal dementias, corticobasal degeneration

Clinically, neuropathologically, and genetically, FTD comprises a heterogeneous group of disorders. It can present with a frontal-lobe syndrome, characterized by impulsivity and

disinhibition, or as a progressive aphasia, either semantic (Figure 15) or nonfluent (Figure 16). Atrophy on MRI or decreased metabolism on FDG-PET tends to be regional and corresponds well to the area preferentially affected by the pathology. Except for rare cases with motor neuron involvement, these disorders tend to affect the association cortex rather than the primary motor or sensory cortices (Figures 17 and 18). The clinical, imaging, and neuropathological findings are summarized in Table 3. The most common clinical variety, FTD, is also the most neuropathologically and genetically heterogeneous, as is the more recently characterized hippocampal sclerosis dementia. Frontotemporal abnormalities on FDG-PET/SPECT may antedate the atrophy that eventually becomes obvious on MRI (Figure 16). For this reason, PET has been approved for FTD diagnosis by the CMS. Amyloid imaging is negative in the FTDs.

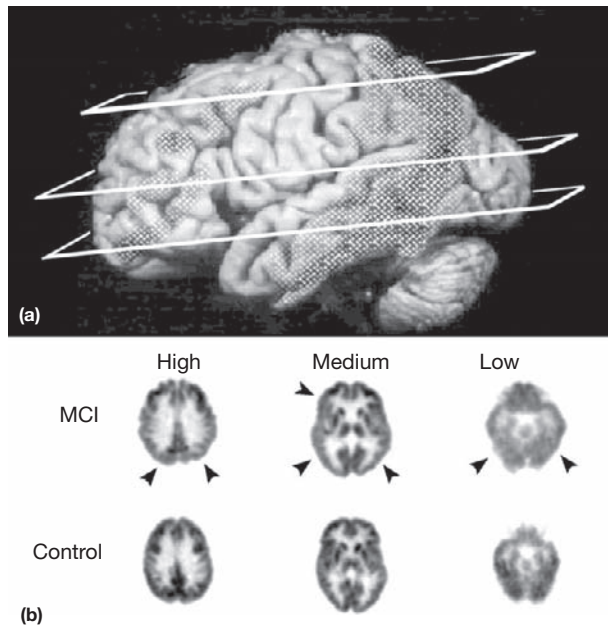


Figure 13 PET in AD. (a) Regional density of amyloid plaques and neurofibrillary tangles in a sample of patients with Alzheimer's disease. The density is represented on the lateral aspect of the left cerebral hemisphere and is greatest in the temporoparietal association cortex. (b) PET with fluorodeoxyglucose of a 71-year-old individual with mild cognitive impairment (MCI) and a healthy control. The person with MCI had isolated memory impairment. Selection of axial sections (3 of the 15 comprising the full study) at the levels indicated in (a). Sections identified high, medium, and low. Note the hypometabolism (see arrows) in the region with the greatest density of amyloid plaques and neurofibrillary tangles. The medial temporal region of both hemispheres, visible in the lowest section, has the lowest metabolism in the MCI case. This region has not been marked in the corresponding section, in order not to obscure the surrounding structures.

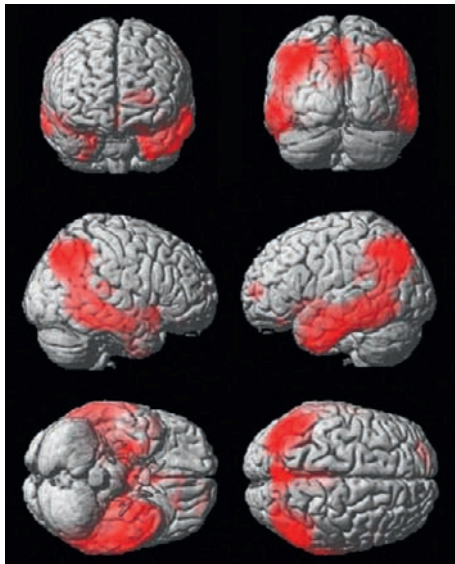


Figure 14 PET in AD: group findings. Projected on a rendered MRI and shown in red are areas with low metabolism in a group of 28 patients with mild AD, compared to 28 normal controls.

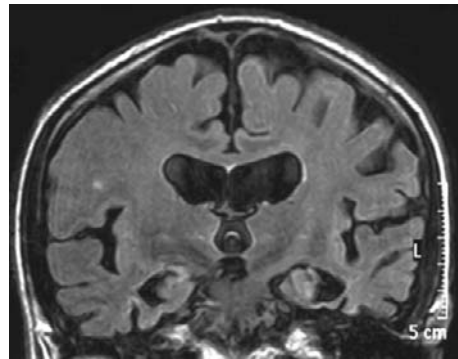


Figure 15 Semantic dementia. Shown is a coronal FLAIR image from a 72-year-old man with progressive anomia. Although the patient's spontaneous language was almost normal, he could not name by confrontation objects as common as a table. Note the marked atrophy in the anterior portion of the temporal lobes, more pronounced on the left.

In corticobasal degeneration (CBD), FDG-PET shows decreased metabolism in the affected hemisphere, ipsilateral lenticular nucleus, and ipsilateral thalamus (Figure 19).

Use of Neuroimaging for Dementia Research and in the Evaluation of New Therapies

An important application of longitudinal yearly or bi-yearly MRI studies is to determine atrophy rate as a surrogate marker of disease progression in patients with MCI or AD, thus facilitating the evaluation of new therapies. For instance, in a study of a new muscarinic agonist with a sample size of 192 patients and a follow-up of 1 year, disease progression was better gauged in 99% of the patients with measurements of hippocampal atrophy than with cognitive or behavioral testing ($p < 0.001$). Using neuroimaging markers would allow a marked reduction of the sample size. In this study, the estimated number of subjects required per arm to detect a 50% reduction in the rate of decline over 1 year were as follows: AD Assessment Scale–cognitive subscale, 320; Mini-Mental Status Examination, 241; hippocampal volume, 21; and temporal horn volume, 54. Longitudinal studies of the yearly decline in glucose metabolism could also be used to monitor the rate of decline in therapeutic trials. Using maximal glucose metabolism reductions in the left frontal cortex, Alexander et al. estimated that as few as 36 patients per group would be needed to detect a 33% treatment response with one-tailed significance of $p \leq 0.005$ and 80% power in a 1-year, double-blind, placebo-controlled treatment study. The practicality of using MRI or PET in collaborative controlled trials is being evaluated since 2005 in the Alzheimer's Disease Neuroimaging Initiative (ADNI), a project cofinanced by the National Institutes of Health (NIH) and pharmaceutical companies.

Neuroimaging is being used for the presymptomatic diagnosis of the onset of the dementing process in families with familial dementia. Diffusion tensor imaging is not the only modality that can be used for this purpose; even more striking results are available from longitudinal measurements of the medial temporal lobe or from studies of brain

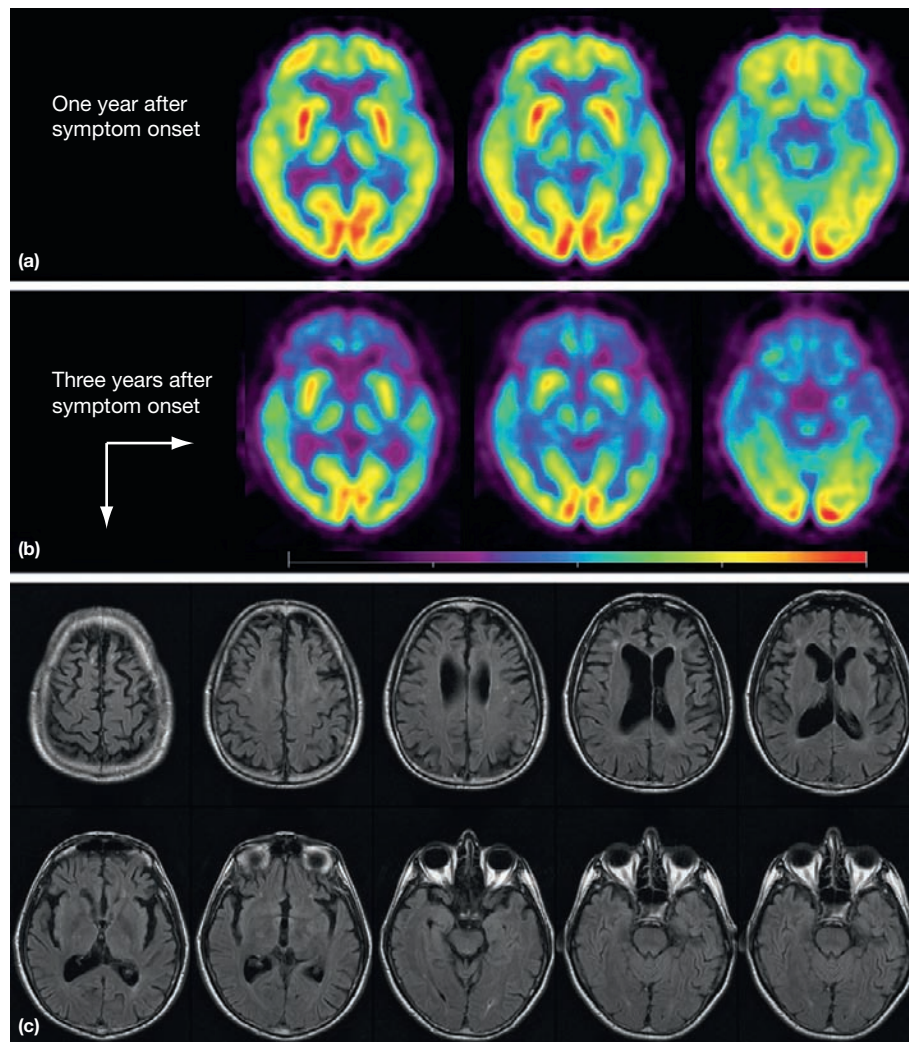


Figure 16 Frontotemporal dementia. Shown are FDG-PET (a, b) and FLAIR MRI (c) studies from a 51-year-old man with progressive speech apraxia and impaired planning, to the point of mutism and complete dependency for activities of daily living when studies (b) and (c) were obtained, taken on the same day. Metabolism was already decreased on the initial PET study, particularly on the frontal opercula and temporal tips, but it is much more obvious on the follow-up study, showing extensive frontotemporal hypometabolism. Note that the frontotemporal abnormality is much more obvious on the PET study (a, b) than on the MRI study (c), which shows frontal atrophy.

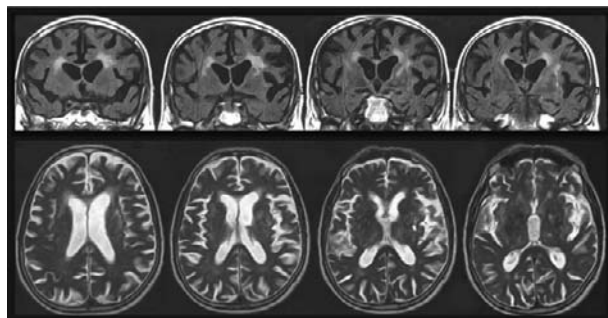


Figure 17 Coronal FLAIR (top row) and axial T2-weighted (bottom row) MRI images showing mild to moderate leukoaraiosis of the frontal periventricular white matter and lacunar infarctions in the left putamen, globus pallidus, pulvinar, and internal and extreme capsules. They are from an 80-year-old right-handed man with a stuttering course leading to progressive nonfluent aphasia.

metabolism. These findings suggest that the combination of genetic and neuroimaging information can be of great value to study disease-modifying or preventing therapies at very early stages of the process, when neuronal loss is still limited.

Similar to patients with AD, some cognitively normal individuals have brain amyloid deposits detected with PiB, while their cerebrospinal fluid (CSF) amyloid- β 42 is decreased. This finding suggests that AD may be related to impaired clearance of β -amyloid from the brain. Inflammation that is present in AD could be simply reactive to tissue damage or play a role, either positive or negative, in the disease process. The brain inflammatory cells, activated microglia, can be imaged with the PET agent (R)-PK11195. PET can also be used to image the regional density of a host of molecules that may be relevant to understand better the mechanisms of the dementias, such as acetylcholine esterase in AD.

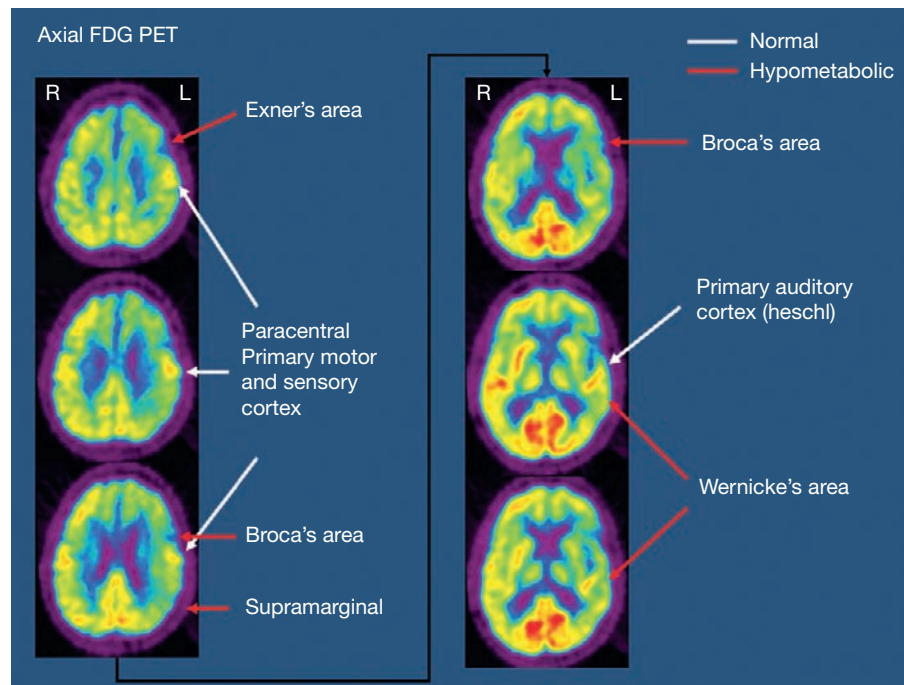


Figure 18 Functional study with PET of the same patient whose MRI is shown in [Figure 17](#). Axial FDG-PET showing hypometabolism in the perisylvian association cortex of the frontal, parietal, and temporal lobes of the left hemisphere. The primary auditory and motor-sensory cortices are spared. Selective sparing of the primary cortices is indicative of a neurodegenerative disorder, rather than ischemic disease, as possibly suggested by the MRI findings in [Figure 17](#).

Table 3 Nonamyloid dementias

<i>Dementia type</i>	<i>Clinical findings</i>	<i>Atrophy (MRI)</i> ↓ <i>Metabolism (PET)</i> ↓ <i>Perfusion (SPECT)</i>	<i>Motor neuron disease (%)</i>	<i>Ubiquitinated bodies (TDP-43) (%)</i>	<i>Tau (%)</i>	<i>Known genetics</i>
Behavioral variant frontotemporal dementia (bvFTD)	Behavioral and personality changes and executive dysfunction	Bilateral frontotemporal atrophy, hypometabolism, and hypoperfusion	20	50	50	Progranulin (PGRN) and microtubule associated protein tau (MAPT)
Frontotemporal dementia with motor neuron disease (FTD-MND)	Similar to bvFTD	Frontal > temporal lobe atrophy, hypometabolism, and hypoperfusion	100	100	0	Possible Chromosome 9
Semantic dementia (SD)	Anomic aphasia, loss of comprehension, surface dyslexia	Bilateral (L>R) anterior temporal, atrophy hypometabolism and hypoperfusion	<5	80	20	None determined
Progressive nonfluent aphasia (PNFA)	Nonfluent speech with agrammatism	Left perisylvian association cortex atrophy, hypometabolism, and hypoperfusion	<5	20	80	PGRN and MAPT
Corticobasal syndrome (CBS)	Apraxia, rigidity	Asymmetric frontoparietal, lenticular, and thalamic atrophy, hypometabolism, and hypoperfusion	<5	5	95	MAPT H1 haplotype and PGRN (four families)
Progressive supranuclear palsy syndrome (PSPS)	Vertical supranuclear palsy, apathy, symmetric parkinsonism	Midbrain atrophy, mild frontal lobe atrophy, hypometabolism, and hypoperfusion	<1	1	99	MAPT H1 haplotype

Courtesy of Dr. Keith Josephs.

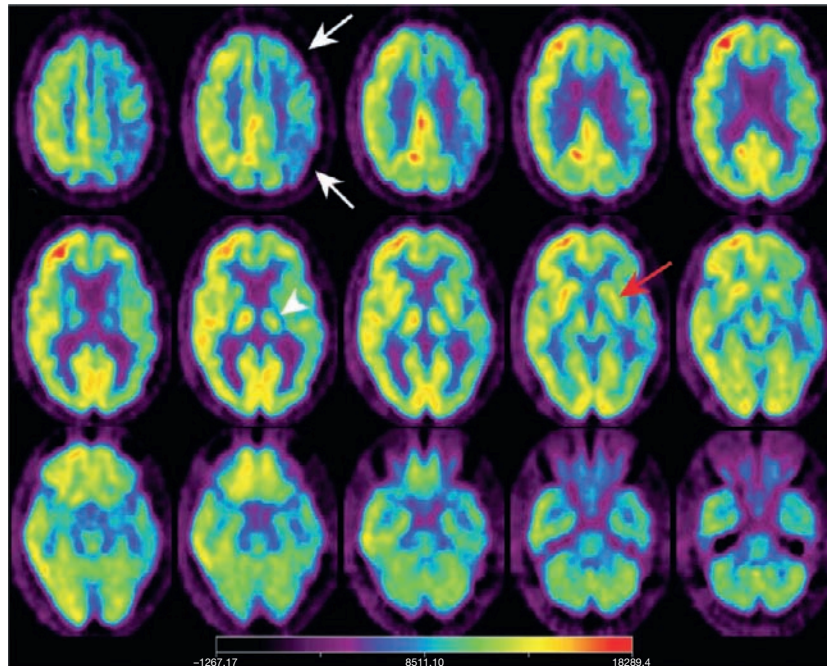


Figure 19 Corticobasal degeneration. Shown are axial sections of an FDG-PET study from a 47-year-old man with progressive agraphia and apraxia, as well as right-sided parkinsonism. Metabolism in the association cortex of the frontal and parietal lobe is decreased (white arrows), as well as in the ipsilateral thalamus (arrowhead) and lenticular nucleus (red arrow).

See also: Alzheimer's Disease; The Brain; Neurotechnologies.

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Neurotechnologies

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Glossary

Functional magnetic resonance imaging (fMRI) A neuroimaging technique employing magnetic fields in which, most commonly, the difference in the magnetization state of hydrogen atoms in oxygenated and deoxygenated hemoglobin is used to image the changes in local blood flow accompanying changes in neural activity.

Hemodynamic response function (HRF) A quantitative description of the compensatory blood flow generated by neural activity in the brain, and an indirect measure of neural activity employed by fMRI and frequently by PET.

Magnetoencephalography (MEG) A neuroimaging technique that reconstructs an image of brain activity with excellent temporal resolution based on the detection of magnetic fields generated by electrical activity in the brain.

Positron emission tomography (PET) A radionuclide-based neuroimaging technique in which positrons emitted by intravenously administered radiolabeled tracers give rise to coincident γ -rays used to reconstruct an image.

Single-photon emission computed tomography (SPECT) A radionuclide-based neuroimaging technique in which γ -rays emitted by intravenously administered radiolabeled tracers are used to reconstruct an image.

Introduction

Cognitive neuroscience is a discipline that attempts to determine the neural mechanisms underlying cognitive processes. Specifically, cognitive neuroscientists test hypotheses about brain–behavior relationships that can be organized along two conceptual domains: *functional specialization* – the idea that functional modules exist within the brain, that is, areas of the cerebral cortex that are specialized for a specific cognitive process – and *functional integration* – the idea that a cognitive process can be an emergent property of interactions among a network of brain regions, and thus that a brain region can play a different role across many functions.

Early investigations of brain–behavior relationships consisted of careful observation of individuals with neurological injury resulting in focal brain damage. The idea of functional specialization evolved from hypotheses that damage to a particular brain region was responsible for a given behavioral syndrome characterized by a precise neurological examination. For instance, the association of nonfluent aphasia with right-sided limb weakness implicated the left hemisphere as the site of language abilities. Moreover, upon the death of a patient with a neurological disorder, clinicopathological correlations provided information confirming the site of damage that caused a specific neurobehavioral syndrome. For example, in 1861, Paul Broca's observations of nonfluent aphasia in the setting of a damaged left inferior frontal gyrus cemented the belief that this brain region was critical for speech output. The introduction of structural brain imaging more than 100 years after Broca's observations, first with computerized tomography and later with magnetic resonance imaging (MRI), paved the way for more precise anatomical localization in the living patient of the cognitive deficits that develop after brain injury. The superb spatial resolution of structural neuroimaging has reduced the reliance on the infrequently obtained autopsy for making brain–behavior correlations.

Functional neuroimaging methodologies, broadly defined as techniques that measure brain activity, have expanded our ability to study the neural bases of cognitive processes. As technology has advanced, a number of these techniques have arisen, including single-photon emission computed tomography (SPECT), positron emission tomography (PET), functional MRI (fMRI), and magnetoencephalography (MEG). Using these techniques, researchers can measure regional brain activity in healthy subjects while they perform cognitive tasks, and thereby link localized brain activity with specific behaviors. For example, functional neuroimaging studies have demonstrated that the left inferior frontal gyrus is consistently activated during the performance of speech-production tasks in healthy individuals. Such findings from functional neuroimaging complement findings derived from observations of patients with focal brain damage. To provide the reader with the necessary background for understanding functional neuroimaging data, this chapter focuses on the principles underlying each of these techniques, and their relative strengths and weaknesses. Particular attention will be paid to fMRI, as it is perhaps the most widely employed neuroimaging method. The chapter concludes with some of the novel ways in which these techniques are being combined to harness their complementary strengths to answer questions in cognitive neuroscience.

Single-Photon Emission Computed Tomography

One of the earliest methods used for functional imaging, SPECT relies on the use of radionuclide-labeled agents. The radionuclide emits photons, primarily in the γ range, that are detected by a collimator and then used to generate a three-dimensional reconstruction of the distribution of the radionuclide within the brain. In a typical study, a subject receives an intravenous injection of the radiolabeled tracer. Depending on the nature of the tracer, a number of minutes are allowed to

pass prior to imaging, allowing the agent to distribute throughout the body. Images are then obtained and analyzed.

The first important choice when using SPECT, and one of the primary advantages of this technique, involves the nature of the radioligand. The two commonly used radioisotopes – ^{99m}Tc and ^{123}I – can be incorporated into larger molecules that are relevant to the neuroscientific process of interest (in a fashion similar to PET, and unlike fMRI and MEG). Tracers in clinical use, for example, include ^{99m}Tc -hexamethylpropylene amine oxine (HMPAO) and ^{123}I -Ioflupane. The former agent provides a measure of cerebral perfusion. When infused, this lipophilic agent rapidly crosses the blood–brain barrier in proportion to cerebral blood flow. Once inside cells, it undergoes a reaction that renders it hydrophilic, preventing it from leaving the cell and generating a marker for cerebral areas with greater blood flow. In contrast, the latter agent – a cocaine analog – binds to dopamine reuptake transporters. As such, it provides a marker for the dopamine system, and has been used clinically to investigate, for example, whether subjects with parkinsonism have reduced uptake of the tracer in the basal ganglia. An important note concerns the nature of these markers: they allow the researcher/clinician to obtain a single snapshot of activity, rather than ongoing assessments of activity. At times, this snapshot can be an advantage – clinically, one may be able to capture blood flow during a seizure, then image hours later – or a disadvantage, when a measure of ongoing activity at different points during a process is desired.

Once the radionuclide is absorbed and distributed, the γ -ray signals it generates must be detected. The resolution of the γ -rays is limited by at least two factors: physical factors, such as absorption or scatter of the emitted photons by other structures/tissues within the body; and instrumentation factors, including the detection efficiency and spatial resolution of the collimator. These factors limit the overall spatial resolution of the sample. In SPECT scanners in everyday use, this limit is on the order of 1 cm, though specialized collimators in use with small animal studies can reduce the spatial resolution to ~ 5 mm. Because the measure of incident photons is not spatially independent, the SPECT signal cannot be quantified in absolute terms.

In total, SPECT imaging has a number of advantages over PET, with which it is most often compared. The cost of SPECT equipment is considerably cheaper, the radionuclides have longer half-lives and do not require a nearby cyclotron for synthesis, and the radiation levels are lower. Its disadvantages with respect to PET, however, have led SPECT to serve primarily as a clinical imaging technique. These disadvantages are discussed in the next section.

Positron Emission Tomography

Like SPECT, PET is a technique that relies upon the detection of signals generated by radionuclides. In this case, the radioactive substance emits positrons that collide with, and are annihilated by, nearby electrons. The resulting collision generates two high-energy photons that travel in exactly opposite directions. PET imaging relies on the idea of coincidence

detections: that is, that the coincident identification of two γ -rays traveling in opposite directions permits the localization of the source in space.

Commonly used radionuclides include ^{18}F , ^{15}O , ^{11}C , and ^{13}N . Due to its longer half-life (~ 110 min), ^{18}F may be most commonly used. As with SPECT, these radionuclides can be incorporated into molecules that are associated with the neuroscientific process of interest – for example, ^{18}F -fluorodeoxyglucose to study energy metabolism, ^{15}O - H_2O to monitor cerebral blood flow, and ^{18}F -DOPA to study dopamine receptor occupancy. The tracer of choice is injected into the subject intravenously, and images are obtained, often as subjects perform a task of interest but possibly also as subjects lie quietly in the scanner (depending on the nature of the tracer).

Relative to SPECT, PET has a number of advantages. A primary advantage is the increase in spatial resolution. Unlike SPECT, which relies upon detection of γ -rays, PET's use of coincidence detection significantly increases the specificity of the signal. Typical spatial resolution is on the order of 5 mm. Moreover, the ubiquity of the radionuclides allows almost any molecule to serve as a tracer, unlike SPECT tracers that are based primarily on the use of ^{99m}Tc , which can be difficult to incorporate into small molecules. Finally, the variety of half-lives allows for studies that provide images at different time points during an experiment. The half-life of ^{15}O , for example, is ~ 2 min, permitting frequent imaging (although requiring multiple tracer injections).

An important implication of the ability to image subjects repeatedly has to do with task design. Because multiple images can be acquired, PET permitted the development of so-called 'block designs,' in which variations of a task, or contrasting cognitive processes, can be repeated within the same subject in the same session. For example, Roskies and colleagues compared a 'synonym' task, in which subjects judged the meaning of two words, with a 'rhyming' task, in which subjects implicitly evaluated the sounds of two words, to identify brain regions that were differentially activated by semantic and phonological language tasks. This capability represented a significant advance over SPECT, which was subsequently trumped by the development of event-related designs in fMRI (see section on fMRI). In current usage, PET has now largely been supplanted by fMRI, for reasons discussed later. However, its capacity to obtain information about specific neurotransmitter systems continues to make it a unique and valuable methodology.

The Physiological Basis for Neuroimaging Signals

As has been evident in the discussion of both SPECT and PET (and will become important for fMRI), these methods are based on indirect measurements of neural activity, either hemodynamic or metabolic. (Studies of receptor occupancy can be considered somewhat separately in this case, as they do not purport to measure neural activity. On the other hand, MEG, which measures magnetic fields generated by neuronal activity, is in this sense a more direct measure.) Hemodynamic and metabolic measurements rely on the tight coupling between neural activity and other physiological changes. In the case of metabolic changes – as measured, for example, by

the uptake of labeled fluorodeoxyglucose – this coupling is quite direct: as the neural activity in a brain region increases, the metabolic activity in neurons and astrocytes increases, leading to greater glucose demands and greater tracer uptake.

In the case of hemodynamic signals, the local increase in metabolic demands leads to an increase in blood flow and a corresponding rise in the oxygenated:deoxygenated hemoglobin ratio. These increases peak at ~6 s after onset, then decline to levels that frequently dip below the previous baseline before returning to prestimulus levels ~10–15 s after onset. This response is typically described concisely by a hemodynamic response function (HRF), the precise shape of which can vary by brain region. Although neuronal spiking is a prominent feature of neuronal activity, it is thought that the basis for the HRF lies in the postsynaptic activity of large collections of neurons and associated astrocytes. Importantly (as discussed in the relevant sections of this article), the nature of the hemodynamic response places constraints on the ultimate spatial and temporal resolution of the detected signal.

Functional Magnetic Resonance Imaging

fMRI has now become the predominant functional neuroimaging method for studying the neural basis of cognitive processes in humans. At its foundation, MRI of any kind (functional or structural) relies upon the magnet of the scanner to generate a large magnetic field (commonly 1.5 or 3.0 T) that differentially aligns the spins of hydrogen atoms. When this large magnetic field is briefly perturbed and then returned to baseline, different hydrogen atoms will dephase and return to alignment with the large magnetic field at different rates, determined by their local chemical environments. For example, a hydrogen atom that is part of a water molecule will ‘relax’ at a different rate than one that is part of a long carbon chain in the lipid of a fat cell. This differential signal is exploited by structural MRI to distinguish different tissues in the brain (and body).

In fMRI, the difference between the local environments of the hydrogen atoms in oxygenated and deoxygenated hemoglobin serves as the basis of the functional signal. Because of the aforementioned tight coupling between neural activity and blood flow, brain regions that show greater activity also show greater blood flow with a larger concentration of oxygenated hemoglobin. This indirect neural signal – the so-called BOLD (blood-oxygen-level-dependent) signal – can be detected in fMRI and exploited to determine which brain regions are active.

fMRI as a Cognitive Neuroscience Tool

Compared to its predecessor, PET scanning, fMRI offers many advantages. For example, MRI scanners are much more widely available, and imaging costs are less since MRI does not require a cyclotron to produce radioisotopes. MRI is also a noninvasive procedure since there is no requirement for injection of a radioisotope into the bloodstream. Moreover, given the half-life of available radioisotopes, PET scanning is unable to provide comparable temporal resolution to that of fMRI, which can provide images of behavioral events occurring on the order of seconds rather than the summation of many behavioral events over tens of seconds. PET scanning is also

unacceptable for studies of children, for example, due to the radiation exposure.

In selected circumstances, PET can provide an advantage over fMRI for studying certain questions concerning the neural basis of cognition. PET scanning may remain desirable or necessary when studying certain populations of individuals. For example, amnesic patients suffering from cerebral anoxia often have implanted cardiac pacemakers, precluding them from having MRI scans because of the adverse effect of the magnetic field on the pacemaker. A particular advantage of PET scanning in the study of cognition that can nicely complement fMRI studies is its ability to assess neurochemical (neurotransmitter and neuromodulator) systems. Radioactively labeled ligands may be used to directly measure density and distribution of particular receptors and even receptor subtypes, as well as the distribution of presynaptic terminals or enzymes involved in the production or breakdown of particular neurochemicals.

The MRI scanner, compared to a behavioral testing room, is less than ideal for performing most cognitive neuroscience experiments. Subjects perform experiments in an acoustically noisy environment in the somewhat awkward supine position, often requiring them to visualize the presentation of stimuli through a mirror. Moreover, many individuals develop some degree of claustrophobia due to the small bore of the MRI scanner and find it difficult to remain completely motionless for the long duration of time that is required for most experiments (typically 60–90 min). These constraints of the MRI scanner make it especially difficult to scan children or certain patient populations (e.g., Parkinson’s disease patients), resulting in fewer fMRI studies involving children than those involving adults, and involving neurological patients in general. However, mock scanners with motion devices have been built in many imaging centers to acclimate children (and patients) to the scanner environment before they participate in fMRI studies. This approach has increased the number of fMRI studies of children, which are providing tremendous insight into the mechanisms underlying the developing brain.

All sensory systems have been investigated with fMRI including the visual, auditory, somatosensory, olfactory, and gustatory systems. Each system requires different technologies for successful presentation of relevant stimuli within an MRI environment. The most common means of presenting visual stimuli is via a liquid crystal display (LCD) projector system, with the sophistication of the system depending on the quality of image resolution required for the experiment. For auditory stimuli, several options exist, including piezoelectric or electrostatic headphones. However, the biggest challenge remains the acoustic noise produced by the pulsing of the fMRI gradient coils. For example, during echoplanar imaging within a 4 T magnet using a high-performance head gradient set, sound levels can reach 130 dB. As a reference point, Food and Drug Administration (FDA) safety regulations require no greater than an average of 105 dB for 1 h. One of the biggest technical challenges within an MRI scanner has been the ability to present olfactory stimuli. However, sophisticated MR-compatible olfactometers have been designed and utilized successfully. Such methods use a nasal mask in which the change from odorant to no-odorant conditions occurs within a few milliseconds.

Acquiring ancillary electrophysiological data such as electromyographic recordings to measure muscle contraction or electrodermal responses to measure autonomic activity enhances many cognitive neuroscience experiments. Devices that are MR compatible for these types of measurements, as well as for other physiological measures such as heart rate, electrocardiography, oxygen saturation, and respiratory rate have been developed. The recording of eye movements is becoming commonplace in MRI scanners, predominantly via the use of infrared video camera equipped with long-range optics. Video images of the pupil–corneal reflection can be sampled at 60/120/240 Hz allowing for the accurate ($<1^\circ$) localization of gaze within 50 horizontal and 40 vertical degrees of visual angle. Although most behavioral tasks used in cognitive neuroscience experiments rely on collecting manual responses, the ability to reliably collect verbal responses without introducing significant motion artifacts has been demonstrated by several laboratories.

Electroencephalography (EEG) recordings have also been successfully performed during MRI scanning (see later sections as well). However, the recording of event-related potentials (ERP), a signal that is much smaller in amplitude than the signal in EEG, can be more difficult in a magnetic field due to artifacts induced by gradient pulsing and head movement from cardiac pulsation. New monitoring devices and algorithms to remove artifacts have been developed, allowing for reliable measurements of ERPs during MRI scanning. In summary, most initial challenges facing cognitive experiments within the MRI environment have been overcome, creating an environment that is comparable to standard psychophysical testing labs outside of a scanner. Although individual laboratories have achieved most of these advancements, MRI scanners originally designed for clinical use by manufacturers are now being designed with consideration of many of these research-related issues.

Temporal resolution

Two types of temporal resolution need to be considered for cognitive neuroscience experiments. First, what is the briefest neural event that can be detected as an fMRI signal? Second, how close together can two neural events occur and be resolved as separable fMRI signals?

The time scale on which neural changes occur is quite rapid. For example, neural activity in the lateral intraparietal area of monkeys increases within 100 ms of the visual presentation of a saccade target. In contrast, as noted above, the BOLD signal gradually reaches its peak magnitude within 4–6 s after an experimentally induced brief (<1 s) change in neural activity, and then decays back to baseline after several more seconds. Thus, neural dynamics and neurally evoked hemodynamics, as measured with fMRI, are on quite different time scales.

The sluggishness of the hemodynamic response limits the temporal resolution of the BOLD signal to hundreds of milliseconds to seconds, in contrast with the millisecond temporal resolution of EEG or MEG recordings of neural activity. However, brief changes in neural activity can be detected with reasonable statistical power using fMRI. For example, appreciable BOLD signal can be observed in sensorimotor cortex in association with single finger movements and in visual cortex during very briefly presented (34 ms) visual stimuli. In contrast, the temporal resolution of fMRI limits the detection of

sequential changes in neural activity that occur rapidly with respect to the hemodynamic response – that is, the ability to resolve the changes in the BOLD signal associated with two neural events often requires the separation of those events by a relatively long period of time compared with the width of the hemodynamic response. This limitation results from the fact that two neural events closely spaced in time will produce a hemodynamic response that reflects signal accumulation from both neural events, rendering estimates of the contribution of each individual neural event difficult. In general, evoked BOLD responses to discrete neural events separated by at least 4 s appear to be within the range of resolution. However, provided that the stimuli are presented randomly, studies have shown significant differential functional responses between two events (e.g., flashing visual stimuli) spaced as closely as 500 ms apart. In some tasks, the order of individual trial events cannot be randomized. For example, in certain types of working memory tasks, the presentation of the information to be remembered during the delay period, and the period when the subject must recall the information are individual trial events whose order cannot be randomized. In these types of tasks, short time scales (<4 s) cannot be temporally resolved. These temporal resolution issues in fMRI have been extensively considered regarding their impact on experimental design.

Spatial resolution

It is yet to be determined how precisely the measured BOLD signal, which arises from the vasculature, reflects adjacent neural activity. Thus, the ultimate spatial resolution of BOLD fMRI is unknown. fMRI studies in both monkey and man at high field (4–4.7 T) have demonstrated that BOLD signal can be obtained with high spatial resolution – $\sim 0.75 \times 0.75 \text{ mm}^2$ in-plane resolution. In monkeys, with novel approaches involving a small, tissue-compatible, intraosteally implanted radiofrequency coil, ultra high spatial resolution of $125 \times 125 \text{ mm}^2$ has been obtained. Using this method, Logothetis and colleagues demonstrated cortical lamina-specific activation in a task that compared responses to moving stimuli with those elicited by flickering stimuli. This contrast elicited BOLD signal mostly in the granular layers of the striate cortex of the monkey, which are known to have a high concentration of directionally selective cells. Advances in such methods would allow for imaging of hundreds of neurons per voxel as opposed to hundreds of thousands of neurons per voxel, which is more typical for a human cognitive neuroscience fMRI experiment.

Virtually all fMRI studies model the large BOLD signal increase resulting from the local low-deoxyhemoglobin state to detect brain changes correlating with a behavioral task. However, optical imaging studies have demonstrated that preceding this large positive response is an initial negative response reflecting a localized increase in oxygen consumption that causes a high-deoxyhemoglobin state. This early hemodynamic response is called the ‘initial dip’ and is more tightly coupled to the actual site of neural activity evoking the BOLD signal as compared to the later positive portion of the BOLD response. For example, Kim and colleagues, scanning cats in a high-field scanner, demonstrated that the early negative BOLD response (e.g., initial dip) produced activation maps that were consistent with orientation columns within visual cortex. This finding is quite remarkable, given that the average spacing between

two adjacent orientation columns in cortex is ~ 1 mm. In contrast, the activation maps produced by the delayed positive BOLD response appeared more diffuse and cortical columnar organization could not be identified. Thus, empirical evidence suggests that deriving activation maps by correlating behavioral responses with the initial dip may markedly improve spatial resolution. Several groups have detected the columnar architecture (in this case ocular dominance columns) by modeling the positive BOLD response in humans scanning at 4 T.

Another unique method for improving spatial resolution, called functional magnetic resonance-adaptation (fMR-A), could provide a means for identifying and assessing the functional attributes of sharply defined neuronal populations within a given region of the brain. Even if the spatial resolution of fMRI evolves to the point of being able to resolve a population of a few hundred neurons within a voxel, it is still likely that this small population will contain neurons with very different functional properties that will be averaged together. The adaptation method is based on several basic principles. First, repeated presentation of the same type of stimuli (i.e., a picture of one object) causes neurons to adapt to those stimuli (i.e., neuronal firing is reduced). Second, if these neurons are then exposed to a different type of stimulus (i.e., a picture of another object) or a change in some property of the stimulus (i.e., the same object in a different orientation), recovery from adaptation can be assessed (i.e., whether or not the BOLD signal returns to its original state). If the signal remains adapted, it implies that the neurons are invariant to the attribute that was changed, while if the signal recovers from the adapted state, it would imply that the neurons are sensitive to that attribute. For example, Grill-Spector and colleagues demonstrated that an area of lateral occipital cortex thought to be important for object recognition was less sensitive to changes in object size and position as compared to changes in illumination and viewpoint. Thus, with this method it is possible to investigate the functional properties of neuronal populations with a level of spatial resolution that is beyond that obtained from conventional fMRI data analysis methods.

Considering all the neuroscientific methods available today for studying human brain-behavior relationships, fMRI provides an excellent balance of temporal and spatial resolution. Improvements on both fronts will clearly add to the increasing popularity of this method.

Magnetoencephalography

Unlike the previous three methods, MEG relies on a much more direct measure of neuronal activity. In response to a stimulus, neural activity – specifically, electrical activity – changes within the brain as ion channels open and close. These electrical currents generate an associated magnetic field, oriented according to a right-hand rule in which the magnetic field is perpendicular to the direction of current. In the brain, the source of this magnetic field is thought to be the postsynaptic currents that arise in the dendrites and flow to the cell body. Unlike electrical currents, magnetic fields are not distorted by intervening tissues; thus, unlike EEG, in which the signal recorded by scalp electrodes is compromised by the

intervening brain, skull, and scalp, magnetic fields arrive outside the brain relatively unaltered.

This lack of distortion is a significant boon to analyses. On the other hand, magnetic fields are compromised by intrinsic and technical issues that render them more difficult to record. One factor is their exceedingly small size. Relative to the earth's magnetic field, other magnetic field generators within the body (e.g., the heart), and other magnetic fields produced by ubiquitous electrical currents operating lab equipment, for example, those generated by the brain are many orders of magnitude smaller. Therefore, the MEG recordings must be done in magnetically shielded rooms. Additionally, they require special sensors for detection: so-called SQUIDS, or superconducting quantum interference devices. Current MEG set-ups commonly include SQUIDS numbering over 100. Because these devices require liquid helium to operate, they are of necessity a distance of 2 cm or more from the scalp, a factor that further decreases signal because these magnetic fields decrease in magnitude with the square of the distance. Despite these hurdles, MEG can obtain very good spatial resolution (on the order of 1 cm or less) and excellent temporal resolution (on the order of 1 ms).

To overcome measurement noise, one approach is to repeat tasks studied using MEG numerous times to obtain an event-related magnetic field, or ERF. As with EEG signals, a range of frequencies is obtained, and bands ranging from α (~ 10 Hz) to γ (> 30 Hz) can be used to search for links to cognitive tasks. These ERFs are then used to estimate the sources of the electrical field (the electrical dipoles) that generated them. Rather than attempting to predict magnetic fields based on the underlying electrical currents (a so-called 'forward problem'), the experimenter attempts to reconstruct the underlying currents from their outputs. This 'inverse problem' has an infinite number of solutions that can be consistent with the observed magnetic field, so the location of the cortical surface, as determined by MRI, and other nontrivial constraints – such as the number of dipoles – are often employed to define a solution. A larger number of dipoles or an incorrectly estimated number of dipoles can potentially change the solution. The use of the ERF also favors the identification of dipoles that are both time- and phase-locked to the stimulus.

Newer reconstruction techniques include 'beamformer' approaches. In this case, the previously defined brain space is spatially filtered to reflect the relative contributions of different areas to the signal. Based on the covariance in the data, the relative contribution of each of the SQUID sensors is defined for each voxel in brain space. The activity in different areas in the brain can then be determined by applying the weights to the ongoing MEG signal. In this way, regions that are time-locked, but not necessarily phase-locked, to the stimulus can be identified, and whole-brain maps produced. These statistical parametric maps can be analyzed in much the same way as previously discussed for fMRI data. Further improving and standardizing these methods remains an active area of research. In particular, techniques that take advantage of statistical knowledge about the likely number of magnetic sources and temporal relationships between them may further improve resolution.

Practically, the excellent spatial and temporal resolution of MEG is also tempered by a factor having to do with the

arrangement of cortical neurons and the cortical surface. Signals from structures that consist of parallel current generators – such as pyramidal neurons in layer five of the neocortex – are detected with significantly greater fidelity than those generated by other arrangements of neurons, such as those in subcortical structures (in addition to the distance-related reduction in signal strength from these structures). Even within cortex, because of the right-hand rule, regions that are parallel to the surface of the skull (e.g., cortex that can be found in the walls of sulci) are much better detected, because their magnetic fields emerge from the head oriented radially. Improving the detection of magnetic field signals from these other regions also remains an ongoing area of research.

With respect to the other neuroimaging methods, MEG has a number of advantages. First and foremost is a temporal resolution on the order of milliseconds, which is at least two orders of magnitude greater than that for fMRI. Its spatial resolution of ~ 1 cm approximates that of PET, approaches that of fMRI, and may continue to improve as MEG analysis techniques are refined. Disadvantages specific to this technique include some difficulty imaging subcortical structures and limitations in identifying dipoles that are present in the crowns of gyri.

Combination Methods

With the availability of all of these methods, attempts are being made to combine them with other imaging modalities in the same subjects, often simultaneously, to improve spatial resolution, data reconstruction, and other technical factors. Initial work, for example, has combined these functional methods with structural imaging in order to better constrain and localize acquired signals. SPECT-CT and PET-CT take advantage of the anatomical information in the CT scan to co-register functional data across multiple scan sessions. Similarly, as mentioned previously, fMRI analyses rely on anatomical MRI images obtained in the same scanning session to localize fMRI data in the brain; and MEG takes advantage of anatomical MRI images to constrain source localization.

More recently, a particularly exciting area of methods development has focused on the integration of multiple forms of functional neuroimaging. As mentioned, fMRI, for example, has been combined with EEG to obtain timing information at a resolution not possible in whole-brain fMRI images. Additionally, recent papers have described the development of combined high-field fMRI – PET scanners for animal studies. Because the photomultiplier devices used in PET scanners are very sensitive to magnetic fields, the new systems have either developed optical means for moving the signal outside the magnetic field, or photomultipliers based on MRI-compatible equipment. Such systems open the possibility of visualizing, for example, the location of neurotransmitter systems along with functional activity based on blood flow. Finally, not only

structural MRI, but also fMRI, images are being used to constrain MEG sources, in a way that strengthens both localization and timing of functional signals.

Conclusions

The neuroimaging techniques discussed in this chapter for studying brain–behavior relationships represent extremely valuable tools that have emerged over a relatively recent period of time. Readily available, minimally invasive, and with generally excellent temporal and spatial resolution, they provide complementary mechanisms for investigating brain function. New approaches to experimental design and data analysis, especially for fMRI and MEG, are appearing in the literature at a rapid rate, leading to numerous options for testing hypotheses on brain–behavior relationships. Combined with information from other methods (such as studies of patients with focal lesions, healthy individuals with transcranial magnetic stimulation, pharmacological interventions, and ERP), data from studies based on these techniques can provide new insights regarding the organization of the cerebral cortex and other brain structures, as well as the neural mechanisms underlying cognition. Moreover, the clinical applications of these techniques are sure to increase as their neuroscientific applications and technological improvements continue.

See also: [Brain and Behavior Relationships; Electroconvulsive Therapy and Transcranial Magnetic Stimulation; Electroencephalography.](#)

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Neurotheology

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Glossary

Cognitive neuroscience The field of study that links cognitive processes to brain function.

Frontal lobes Most forward part of the brain involved in attention focusing and emotional processing.

Functional brain imaging Refers to techniques such as functional magnetic resonance imaging, positron emission tomography, and single photon emission computed tomography that measure change in brain function.

Hypothalamus A small central brain structure with many important functions such as regulating basic body functions, hormones, and the immune system.

Limbic system A group of structures such as the hippocampus and amygdala in the inner part of the temporal lobes and involved in emotional responses.

Neurotheology The field of study that links religion and theology to neuroscience and psychology.

Neurotransmitters Molecules that the brain uses to support mental functioning.

Parietal lobe Located along the back-top part of the brain and involved in spatial and body orientation.

Thalamus A central brain structure that subserves many functions, particularly as a main sensory relay.

Introduction

Neurotheology is an emerging field of study that seeks to integrate in some manner cognitive neuroscience with religion and theology. Its development as a field is attested to by significant interest in both the academic and lay population. Neurotheology is multidisciplinary in nature and includes the fields of theology, religious studies, religious experience, philosophy, cognitive science, neuroscience, psychology, and anthropology. Each of these fields may contribute to neurotheology, and conversely, neurotheology may ultimately contribute in return to each of these fields. Ultimately, neurotheology must be considered a multidisciplinary study that requires substantial integration of divergent fields.

'Neurotheology' has garnered substantial attention in the academic and lay communities in recent years. As would be expected, there have been many positive and negative responses to purported neurotheological studies. Early Buddhist and Hindu texts frequently make reference to the functioning of the mind and spiritual pursuits. Many philosophers from Plato to Kant also attempted to address how human thought might relate to the spiritual or divine nature within us. In the 1800s Phrenologists attempted to better delineate the areas of the brain associated with a variety of psychological and spiritual processes, but did not have available the current abilities of today's cognitive neuroscientist to measure changes in brain function associated with different neurocognitive processes. The field of neurotheology may have found its origins in the line of research and scholarship that began in 1975 when Eugene d'Aquili and Charles Laughlin published 'The Biopsychological Determinants of Religious Ritual Behavior.' Their thesis was that all religious phenomenology arose from neuropsychology, but in a way much more complex than simple materialistic reductionism. The first 10 years of this scholarly movement were very difficult indeed. The attempt to integrate neuropsychology and theology was extremely controversial in the mid-1970s and often dismissed as an attempt to integrate incommensurables. The early scholars painted neurotheology

with broad strokes in part due to the limitations in brain research at the time. More recent scholars have contributed in different ways with some providing empirical data via state-of-the-art functional brain imaging studies, and others providing the theoretical or theological foundation.

Individuals engaged in neurotheology can help develop theoretical models of the neurophysiological mechanisms of brain activity during religious and spiritual practices such as meditation, prayer, or ritual. This analysis also includes the spiritual or religious experiences associated with such practices as well as those that arise spontaneously such as near-death experiences. The overall purpose of this area of neurotheology is to generate a substantial theoretical base from which to explore the other aspects of religious and spiritual phenomena. Models will typically build upon both the known neuropsychological and neuroscientific literature in order to determine exactly how various brain structures function both individually and as an integrated whole. Models will typically include not only general brain function, but changes in a variety of neurotransmitter and hormonal systems. An analysis of various types of neuropsychiatric disorders such as schizophrenia or temporal lobe epilepsy as they relate to religious and spiritual phenomena must also be considered as a way of helping to understand various aspects of religious experience. It is also important to consider whether religious or spiritual phenomena associated with known pathological conditions are in fact the same as religious or spiritual phenomena that are not associated with any pathology.

The brain structures that have already been shown to be involved in religious practices such as meditation or prayer include the frontal lobes (involved in attention focusing and emotional processing), the limbic system (part of the temporal lobes and involved in emotional responses), the parietal lobe (involved in spatial and body orientation), the thalamus (a main sensory relay), and the hypothalamus (regulating basic body functions, hormones, and the immune system). However, most analyses involved more specific details as to the brain processes associated with various religious and spiritual phenomena.

Defining Neurotheology

Clearly, one of the initial problems with neurotheology as a field is the use of 'neurotheology' as a term. Too often, the term 'neurotheology' has been used inaccurately or inappropriately. Many times, it appears to refer to a study or idea that incorporates neither neuroscience nor theology. Strictly speaking, neurotheology refers to the field of scholarship linking the neurosciences and theology. Neuroscience would thus refer to the empirical study of the central nervous system or brain and theology would refer to the critical and rational analysis of a particular religious belief system, specifically one pertaining to God. Of course, both the terms 'neuroscience' and 'theology' have evolved over time. Neuroscience used to imply the study of nerve cells and their function without a clear regard for behavioral and cognitive correlates. Neuroscience today tends to extend over many different fields including cognitive neuroscience, neurology, psychiatry and psychology, and sociology. The tools have also become much more advanced, including a variety of brain imaging capabilities, for exploring the relationship between the brain and various cognitive, emotional, and behavioral processes.

Theology has also changed over time. In a very strict sense, theology is the study of a *theos* or God. Thus, the word 'theology' should be reserved for theistic religions only, and even more specifically, from those arising out of the Judeo-Christian tradition. However, with the development of comparative theology in the early part of the last century, it became apparent that the nonpersonal Eastern religions possessed many of the formal characteristics of the classic Western religions. It became academically fashionable to use the term 'theology' for the formal study of any belief system centered on an Ultimate or Absolute, whether personal or nonpersonal, whether understood as God or as an ultimate state. It is now acceptable to speak of a theology of Buddhism, of Hinduism, and even of Shamanism.

Within each religious tradition, the word 'theology' can be used in two senses – natural theology and theology proper. Natural theology is not really theology at all, but rather a branch of philosophy. It attempts to prove, or at least prove probable, the existence in reality of the 'hypothesis – God, or of the hypothesis – Absolute' by reason alone, without any appeal to Divine Revelation (in the West) or to fairly rare esoteric experiences (in the East). Theology proper represents intellectual deductions from a foundational story or myth (i.e., the primary myth upon which the religion is based) as well as 'reasonable' extrapolations upon such a myth. Such extrapolations may also involve the employment of analogical reasoning and symbolic logic that does not necessarily neatly fit within a logical reasoning pattern. Eventually, theology becomes a process of reflecting upon the way individuals of a particular religion should live out their faith. The beginning point of theology proper, at least in the West and in primitive societies, is a belief in the transcendent truth of the foundational doctrine either at the literal surface level or at a deeper symbolic level. Depending on how it is applied, neurotheology may be of use in both natural theology and theology proper. Neurotheology may also inform scholars regarding the process of theology proper to help better elucidate how and why human beings come to specific beliefs and understandings about religion and God.

For neurotheology to be a viable field, it most likely should not be limited to only neuroscience and theology. In reconsidering the term 'neurotheology' then, it seems appropriate to allow for expanded uses of the 'neuro' component and the 'theology' component. It would seem appropriate for neurotheology to refer to the totality of religion and religious experience as well as theology. This ability to consider, in a broad scope, all of the components of religion from a neuroscientific perspective would provide neurotheology with an abundant diversity of issues and topics that can ultimately be linked under one heading. On the other hand, if the target of study encompasses so many aspects of religion and spirituality, the field might become so broad that it loses its ability to say something unique about religious and spiritual phenomena. If neurotheology becomes too broad, then, it might become very difficult to distinguish brain correlates of religious and spiritual phenomena from a variety of cognitive, affective, and experiential processes. The neurosciences also may be considered broadly to include not only what goes on within the human brain per se, but within the human body as a whole. Furthermore, since mental processes are intimately linked to the brain, the 'neuro' component of neurotheology should be considered to include psychiatry, psychology, endocrinology as well as other macro- and microperspectives of the neurosciences. One might even consider variations on the theme of neurotheology to include other hybrid terms such as 'neuro-spirituality,' 'psychotheology,' or 'biotheology.' For now, however, the word, 'neurotheology' appears to be the term that has received the most use and acknowledgment in both the academic and popular domains.

An important point about neurotheology as a field and term is that neurotheology should be considered a 'two-way street' with information flowing both from the neurosciences to the theological perspective as well as from the theological perspective to the neurosciences. In other words, neurotheology should not be considered the 'neuroscientific study of religious or theological concepts,' since this would greatly limit what neurotheology might be able to offer. Theology and religion must also be able to freely inform scholars about neuroscience and how to interpret human activities from a psychological, social, and spiritual perspective. By enabling a free exchange of ideas, data, and information, neurotheology can achieve a very high level of sophistication.

Brain Functions and Theological Argument

We now turn briefly to an analysis of theology and theological constructs from a neurotheological perspective. Since we have already described theology as a complex rational deduction from a foundational doctrine, we must consider how this rational deduction arises. Rather than selecting specific theological concepts and describing them from a neurotheological perspective, we examine a variety of overarching brain functions to determine how theological concepts, in general, might be derived. It should be stressed that the brain functions described below relate to broad categories of functions which may have many subfunctions. Future neurotheological scholarship will need to better evaluate the specifics of different brain processes to determine if and how they relate to religious and theological concepts.

The Holistic Function

The brain has the ability to perceive holistic concepts such that we perceive and understand wholeness in things rather than particular details. Thus, we understand the family as a wholeness of related individuals, and from a religious or spiritual perspective, we might understand a concept of absolute oneness as pertaining to the universe or God. This function would seem to be of fundamental importance for theology since it enables an account of God's otherwise noncommunicable attributes such as omnipresence, omniscience, and ability to bind and maintain the entire universe. Thus, any serious consideration of the implications of the functioning of the holistic processes in the brain necessitates, at least, considering the expansion of any foundational myth to apply to all of reality, including other people, other cultures, other animals, and even other planets and galaxies. In fact, as human knowledge of the extent of the universe has evolved, the notion of God has evolved to incorporate the expanding sense of the totality of the universe. The holistic functions of the brain pushes us to contemplate that whatever new reaches of the universe astronomers can find, God must be there. No matter how small and unpredictable a subatomic particle might be, God must be there, too.

That the holistic functions must be taken into account when evaluating foundational doctrines is never more apparent than in the Christian concept of the Trinity consisting of the Father, Son, and Holy Spirit. Christian thought has generated great effort to maintain the notion of the trinity in the face of the holistic need of God's being an absolute unity. Thus, the three components of the trinity are traditionally understood to be discrete as regard to *persons* (rational subjectivities), but all are said to possess the same, single, and absolutely undifferentiated divine nature. Attempts at explaining this seeming contradiction have included each person eternally and perfectly proceeding from the others as well as each person being eternally and perfectly immanent in the others. But there is always that perfectly undifferentiated divine nature which prevents the trinity from deflating into tritheism. The holistic function has, in some sense, forced the issue and made the situation far more complex (in terms of human understanding) than perhaps it would have been without this function.

The Reductionist Function

The antithesis of the holistic function is the reductionist function which enables us to break things down into their component parts. We observe the brain processes that underlie this global function prominently in fields of science such as when an attempt is made to break all matter down to its subatomic constituents. This function also occurs in philosophical traditions dependent on extreme logical rationalism. Of course, this sense of underlying reality quickly develops into the theological/philosophical concept that the whole comprises, and only comprises, the sum of the parts. When applied to the foundational myths of the monotheistic religions, the result is the notion that God actually comprises the totality of all of the parts of the universe. This is akin to the concept of pantheism in which God is considered to be the universe. Clearly, it seems that the reductionist function would not lead to the notion of a transcendent God. However, reductionism is important in

theology as a way of establishing specific elements of a religion and how they relate to individual behaviors and practices. From the neurotheological perspective, reductionism is also important in helping to determine whether religious and spiritual phenomena can eventually be reduced only to biological processes.

The Quantitative Function

In the most general sense, the quantitative processes of the brain helps to produce mathematics and a variety of comparisons of objects in the world. Similar to the reductionist function, the quantitative function clearly both underlies and supports much of science and the scientific method. Science essentially is based upon a mathematical description of the universe. In terms of philosophical and theological implications, the quantitative function appears to have heavily influenced the ideas of philosophers such as Pythagoras and Baruch Spinoza who often used mathematical concepts such as geometry to help explain the nature of God and the universe. Further, religions throughout history have placed strong emphasis on a certain magic inherent in numbers and mathematics. Numbers abound in the bible and lend their significance in terms of time, people, and places. Various numerologies in the folk practices of Christianity and Islam as well as the gematriot in Judaism all bear witness to the powerful force of the quantitative function to impress the mind with the 'mysticism' of numbers.

The Binary Function

The binary processes of the brain enable us to set apart two opposing concepts. This ability is critical for theology since the opposites that can be set apart include those of good and evil, justice and injustice, and man and God among many more. Many of these polarities are encountered throughout religious texts of all religions. Much of the purpose of religions and their myths is to solve the psychological and existential problems created by these opposites. Theology, then, must evaluate the myth structures and determine where the opposites are and how well the problems presented by these opposites are solved by the myth structure. In particular, this concept, similar to the Hegelian triadic concept of thesis, antithesis, and synthesis, is crucial to the development of theology, because it is ultimately the foundational and soteriological myth, and specifically the power of God, that brings together the problematic opposites.

The Causal Function

The ability of the brain to perceive causality is also crucial to theology. When the causal processes of the brain are applied to all of reality, it forces the question of what is the ultimate cause of all things. This eventually leads to the classic notion of St. Thomas Aquinas's Uncaused First Cause as an argument for God's existence. For monotheistic religions, the foundational doctrines posit that God is the cause of all things. However, this very question of how something can be uncaused is a most perplexing problem for human thought. In fact, theologians, philosophers, and scientists have tangled with causality as integral to understanding the universe and God. Aristotelian philosophy postulated four aspects of causality – efficient

causality, material causality, formal causality, and final causality. These notions of causality led to the understanding of a metaphysic that would later be integrated into traditional Christian theology. The question of causality thus became applied to God to determine how, in fact, God could cause the universe.

However, the problem of causality in the world leads to many other related theological issues. Foremost is the notion of free will. The notion of free will relies heavily on causality, but is also a substantial problem arising in current cognitive neurosciences. Free will is of particular interest to Christian theology, but clearly is important in other religions. Free will is a necessary part of Christianity's foundational myth particularly with regard to the notion of sin, and in particular, original sin. Free will must be maintained in order for someone to be responsible for committing a sin. If everything is predetermined, then a sinful act cannot be ascribed to the person committing that act since they had no choice. If the person freely chooses to commit a sin, then they can be held accountable for that sin. Free will is also the *sine qua non* of ethics. In order for ethics to be viable, free will has to exist. Thus, the notion of causality in relationship to free will becomes an important issue within theology.

Eastern traditions have a slightly different perspective in terms of causality. The Buddhist and Hindu ideologies suggest that causality manifests within the Karma of living beings and that it is critical to escape causality in order to eliminate suffering. The individual ego and material reality are seen more or less as an illusion, with ultimate reality being the true reality in which causality is removed. These traditions suggest that once the experience of ultimate reality is attained and the usual causal relationships are removed, there is a natural flow of right behavior which derives from it and that this type of behavior is what comprises ethics.

Abstract Thought

Abstract thought is tied into the brain structures that underlie language and the conceptualization of categories of things. In some senses, this process derives the essential characteristics of whatever types of objects the brain is working on and presents us with a sense of 'thingness' or 'being' since it generates the basic components of any object and reifies that object as a particular thing. The 'conceptual thingness' of the totality of reality is akin to the Greek concept of Being either in the Platonic or Aristotelian sense. It is the formal and organizing element indwelling matter and giving matter meaning. Thus, the brain's abstract thought processes can yield a profound sense that reality is fundamentally Pure Being. From this profound sense soon arises philosophical/theological concepts such as Plato's *The Good*, Aristotle's *Hylomorphism*, or Aquinas' *Being*, or Paul Tillich's *Ground of Being*, as a description of God. This 'ground substance of being' could be attributed to God. Theology must then be forced to explain how God can be the ground substance of all being while performing other roles stipulated in the foundational doctrines. Certainly issues as to whether God constantly supports existence or simply wound up the clock and lets things work out on their own lies at the heart of important theological controversies. However, it seems that the notion of God as the ultimate being

and supporting all of existence would be a natural consequence as well as constrained by the abstract thinking supported by the brain.

Emotional Values

One of the most important functions of the brain is not cognitive, but emotional. The ability to impart emotional values upon whatever is presented within our experience has a profound influence on our ability to perceive and understand the world. If there is a positive emotional interpretation of all things, then the result is that the entire universe appears to be an overwhelmingly beautiful, blissful, and loving place. When applied to mystical states, the experience may be perceived in a personal manner such that the individual has become one with God or some form of a divine being. When applied to the concepts of theology, God is the primary driver for this overwhelmingly positive affect that pervades the universe. However, this immediately presents important theological problems since the pain and suffering that exists in the world must somehow be explained in light of the overwhelming love of God.

If the universe or God is perceived as emotionally neutral, then all is considered to be impersonal and distant. In terms of mystical experiences, this neutral emotion is likely to be associated with Void Consciousness or Nirvana in which there is an empty, impersonal consciousness that lies at the foundation of the universe. When the neutral emotion is applied to theological or philosophical concepts, it may underlie the notions elaborated upon in existentialism. Existentialism is based on the fact that all we can do is exist and 'feel' our way through. Other than our emotional sense, we can get at no other understanding of that reality. From a theological perspective, the conclusions drawn from the neutral interpretation suggest that God is impersonal or perhaps that there is no God at all and everything simply is without purpose or even meaning. This existential approach is antithetical to most theistic religions; however, theology must contend with the possibility of an existential universe.

It is also conceivable that the universe is perceived with negative emotions. The result is that the entire universe would be viewed as intrinsically evil and horrible. There are very few examples of absolute negative emotions in the mystical literature. The negative emotions applied to theology may help us understand the notion of Hell in which all of existence becomes horrible and terrifying. In Judeo-Christian theology, though, it becomes difficult to explain how such a negative existence can be maintained alongside the generally positive image of God.

Willfulness and Orienting Functions

There remain two other parts of the brain, the functioning of which may relate to theological concepts. These are related to the areas of the brain that support willful or purposeful behavior and the areas that support our ability to orient our self within the world. The willful processes that appear to arise in large part from the frontal lobes might enable us to comprehend a sense that everything is derived from intention or will. The notion that the entire universe is derived from will also leads to several theological implications. Certainly, the will of

God has a prominent place in Western traditions. God used His will to create the universe and to carry out all divine actions. Thus, it could be argued that will is the driving force of the universe; however in religion, it is God's will. That human beings have a part of the universal will also leads to an analysis of free will.

The orienting function of the brain as related to the external universe and God leads to several more theological concepts. The brain continuously attempts to orient our selves with respect to space and time in the world around us. In terms of time, we might experience the sense of eternity or timelessness, which is often considered to be a characteristic of God. Similarly, God can be thought of as being spaceless or infinite even though God can be manifested also in the space that exists within material reality. Thus, the orienting processes of the brain can be useful in understanding certain theological concepts related to time and space.

Reflections on Major Topics of Neuroscience

There are a number of neuroscience topics that directly influence and are influenced by neurotheological research. One of the major issues that neurotheology faces is the problem with the ability to determine the subjective state of the subject. This is also a more universal issue in the context of cognitive neuroscience. After all, one can never know precisely what a research subject is thinking at the precise moment of imaging. If you have a subject solving a mathematical task, one does not know if the person's mind wandered during the task. You might be able to determine if they did the test correctly or incorrectly, but that in and of itself cannot determine why they were right or wrong. The issue of the subjective state of the individual is particularly problematic in neurotheology. When considering spiritual states, the ability to measure such states empirically while not disturbing such states is almost impossible. Hence, it is important to ascertain as much as possible what the person thinks they are experiencing. Neurotheology research can help better refine subjective measurements. Spiritual and religious states are perhaps the best described of all states, and thus, can be an important proving ground for advancing research in the measurement of subjective states.

The problem of consciousness and its ability to arise in the brain is of primary concern in the neurosciences. Consciousness of anything, and particularly self-reflexive consciousness in human beings, is something that has not been adequately elucidated on the basis of current empirical research. Spiritual and religious states often involve altered states of consciousness. And in many circumstances, these states are purposefully manipulated. Those individuals who are most capable of altering their consciousness and enabling that consciousness to affect other parts of their body, might be particularly useful in furthering our understanding of human consciousness.

Another area in which neurotheology could provide important information is in understanding the link between spirituality and health. A growing number of studies have shown positive, and sometimes negative, effects on various components of mental and physical health. Such effects include an improvement in depression and anxiety, enhanced immune system, and reduced overall mortality associated with

individuals who are more religious. On the other hand, research has also shown that those individuals engaged in religious struggle or who have a negative view of God or religion, can experience increased stress, anxiety, and health problems. Research into the brain's responses to positive and negative influences of religion might be of great value in furthering our understanding of the relationship between spirituality and health.

Finally, one of the most important goals of cognitive neuroscience is to better understand how human beings think about and interact with our environment. In particular, this relates to our perception and response to the external reality that the brain continuously presents to our consciousness. Neurotheology is in the unique position to be able to explore epistemological questions that arise from neuroscience. Integrating religious and scientific perspectives might provide the foundation upon which scholars in a variety of disciplines can address some of the greatest questions human beings face.

Reflections on Major Topics of Theology

Of course, neurotheology can also provide new perspectives on theological questions. Theological questions regarding the nature of God, God's existence and relationship to the universe, the nature of spiritual revelation, the soul's existence, and how human beings can be saved through religion all may be approached from a neurotheological perspective. Neurotheology can encourage research to explore the neuropsychological aspects of these issues and help to determine which functions of the brain directly relate to these questions.

Theology attempts to make logical arguments that address these and other issues related to God and God's relationship to the world. A number of 'arguments' have been offered throughout history which include the Cosmological Argument – that since the world exists and since the world cannot come from nowhere, there must be an original or first cause which is God; the Teleological Argument – which suggests that there is a purpose and intelligent design in the universe which must arise from God; the Moral Argument which states that God is what must have provided human beings with their sense of morality; and the Ontological Argument – which states that that if we could conceive of a Perfect God who does not exist, then we could conceive of something greater than God. Since this is impossible, God must exist. What is interesting about each of these arguments, and the many other arguments put forth to prove, or at least support, God's existence, is that they each depend on various functions of the human brain. Thus, the rationale that these arguments provide are highly dependent upon the brain functions that conceive of them.

Is it possible that neurotheology could play a role in the discussion regarding the existence of God? If it can be shown that the human brain definitely creates the concept of God and its elaboration through religion, then neurotheology could provide critical information as to how this might happen. If on the other hand, such a determination can never be made, this will have important implications for assessing the overall intersection between religion and science. A neurotheological perspective would also have to take into consideration the possibility of religion being a cultural construct and must

include other factors such as philosophy, nationalism, racism, myth, and ritual. However, neurotheology must also constantly remind scholars of the limitations imposed on human beings in discerning reality. For example, a brain scan that demonstrates changes in certain structures when a nun experiences being in God's presence could suggest that the brain changes created the experience or that the brain was responding to the actual experience. The scan itself should not be construed as proving the existence or nonexistence of God in this context. Neurotheology should continue to encourage research of brain function during religious experience and seek to determine if a study design might be possible that could more specifically address the proof of God question. The methodological challenges of such a study are clearly very substantial, but it is important to stress the need for careful planning and interpretation of results.

If God does exist, then neurotheology continues to provide information about how human beings relate to God, but there is also the possibility that such studies might determine which ways of relating are 'better' than others. This is a potentially dangerous proposition since the implication is that various religious groups could utilize such information to proselytize, criticize, oppress, or attack other groups. It would seem unlikely that any neurophysiological study could provide the kind of evidence that would support which beliefs are more accurate, but results from such studies might help individuals determine what works best for them. There is probably too much variability in normal human function to clearly differentiate the effectiveness and accuracy of certain beliefs or practices. Nonetheless, neurotheology has the potential to be thrust into the middle of many different kinds of conflicts and anyone seeking to be a scholar in this field should maintain a very cautious position regarding results and interpretations of such studies.

Another interesting aspect of theological concepts is the determination of the attributes of God. God's attributes are sometimes divided into those that cannot be shared with human beings (incommunicable), and those that can be shared (communicable attributes). There is a clear distinction between what the human brain can and cannot perceive. Incommunicable attributes are those related to God being considered: omnipotent, eternal, infinite, omniscient, and omnipresent. Communicable attributes are related to those things that human beings can potentially perceive such as: mercy, justice, wrath, and love. Neurotheological methods could be utilized to better evaluate the human perception of different attributes of God to help assess which are able, or more easily able, to be processed by the brain. One might design a study to help better understand how the brain deals with concepts such as infinity or eternity. God's immanence in the world may also be an appropriate question for neurotheology in the context of how God might be immanent within the human brain. By tracing the effects of religion and spirituality and the brain, one might question whether this informs the discussion regarding how God might affect the brain, such as an interaction actually exists. After all, the ability of God to be immanent within the human brain would seem to be crucial for understanding the relationship between God and human beings.

The nature of good and evil, particularly in relation to God, has great importance for theology since it helps to establish a

sense of morals and also relates to sin and free will. A number of recent brain imaging studies have explored the nature of moral processing in the brain. Questions related to the cognitive and emotional elements of morality can be studied. Of course, one of the pressing concerns most individuals have is why apparently bad things happen to apparently good people. One might question their faith if they feel that in spite of doing everything they are supposed to do, bad things continue to happen to them. The individual might feel that their religious beliefs are not helping and ultimately reject them. In the Bible, the story of Job plays a pivotal place in considering this issue. Theology itself strives to address such questions, but the eventual answer is that these issues are not always understood by the mind of human beings. Human beings can have a basic moral understanding of how to act in the world, but are limited in their ability to determine what is ultimately right and wrong. Research into the brain has also provided an interesting framework from which to consider the topics of sin and free will. Research suggests that almost any person can be driven to immoral behavior when placed within a certain environment. In other words, the human brain is easily manipulated into doing very bad things. Brain research has also explored interesting aspects related to free will as studies have attempted to determine exactly when decisions are made regarding choices and behaviors. Such research may eventually point to the mechanism by which we do have free will – or it might prove that we do not.

Spiritual revelation in the context of neurotheology is akin to the ability of the human brain to receive God. The concept of Revelation thus raises the issue of how do human beings come to have any understanding that God exists and that God wants us to do certain things? Revelation is more religiously, rather than neurologically, oriented. However, there is much that can be considered from a neuropsychological perspective. For example, how are human beings limited in what can be revealed and how is revelation actually experienced? If human beings can only have access to communicable aspects of God, then there are specific limitations that are placed on the ability to perceive and understand God.

Along similar lines, the ability of a human being to be saved is another important theological issue upon which neurotheology might provide an interesting perspective. One such perspective might be the following: salvation should pertain to both the spiritual and material nature of who we are. It might be argued that salvation requires the brain, at least to some degree, in order to help the individual understand what salvation requires and what thoughts, beliefs, and behaviors are associated with salvation. While salvation refers specifically to the soul, a neurotheological interpretation could be commensurate with psychiatry and neurology which continually seek out ways of improving mental life. However, a deeper understanding of the brain's ability to change and to seek religious and spiritual goals might provide highly useful understanding of the concept of salvation.

It should also be clearly stated that whatever limitations the human brain places on our ability to conceive or receive God, this has no impact on whatever is the true nature of reality. Regardless of whether we can perceive causality, abstract concepts, time, or space, has no bearing on the actual nature of the universe and whether or not God exists. Furthermore, one has

to be very careful interpreting neurotheology as being able to comment on whether or not God does exist and whether the brain creates God or God creates the brain. This is an extremely complex question that is often approached with substantial biases from both believers and nonbelievers. The perspective that is most appropriate from a neurotheological perspective is to carefully evaluate all ways of understanding God, including an absence of God, in order to best determine what the brain can know about reality.

However, the very notion that theology pertains more to the human understanding of God is commensurate with the goals of neurotheology. Neurotheology necessarily must explore how the brain can think, feel, and perceive the concept, (or the actual reality) of God. More specific theological analysis can be developed depending on the focus of a particular course. What is important in terms of neurotheology is to observe how the various developments in theology pertain to human perceptions, feelings, cognitions, and behaviors. Any time the focus turns to one of these aspects of theology, a neuropsychological perspective can be added that deepens the understanding of these concepts.

Conclusions

As an emerging field of study, neurotheology has the potential to offer a great deal to our understanding of the human mind, consciousness, scientific discovery, spiritual experience, and theological discourse. However, neurotheological scholarship must tread carefully upon these topics and try to develop clear, yet novel methods of inquiry. All results of neurotheological scholarship must be viewed and interpreted

cautiously. However, if neurotheology is ultimately successful in its goals and principles, it has the potential to revolutionize our understanding of the universe and our place within it.

See also: [The Brain](#); [Meditation](#); [The Science and the Art](#); [Moral Development](#); [Psychology and Religion](#).

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Nonverbal Communication

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Glossary

Nonverbal communication It refers to the sending and/or receiving of information and influence through

the physical environment, appearance, and nonverbal behavior.

Nonverbal communication is a pervasive influence in our interactions and relationships with others. It is important to appreciate that nonverbal communication is not limited to face-to-face encounters. Any communications medium that carries visual and vocal information is a vehicle for nonverbal communication. Thus, the images on television, films, the Internet, and even in photographs are examples of nonverbal communication. In addition, the audio channels of mediated communication provide vocal cues, including pitch, volume, intonation, and pauses that are elements of the nonverbal system of communication. Although linguistic, or verbal, communication is a powerful means of transmitting a wide range of information, nonverbal communication usually has a greater impact on our social contacts with others.

Introduction

As social animals, our survival and general welfare are dependent on communicating with others. Nonverbal communication is a powerful and efficient means of managing these necessary interactions. The popular referent for nonverbal communication is 'body language,' but this is an unfortunate and misleading term. There are two simple reasons for this. Nonverbal communication involves more than the body and it is not a language. The first point will be covered in more detail later in the section on the components of nonverbal communication. Let us look briefly at the second point. Body language is commonly used in describing the mood and motivation of individuals. When a team is losing badly and its prospects look bleak, sportscasters proclaim that 'you can see it in their body language.' The body language of politicians and other public figures is often scrutinized closely. Although appearance and nonverbal behavior can reflect feelings and attitudes, this is not 'body language.'

To clarify, let us take a brief look at language. There is a consistent vocabulary with language. In contrast, what does a particular smile mean? It might indicate that someone is pleased to see you. The same smile could simply mean that someone wants to be friendly or, perhaps it is a sign of appeasement. The meaning of a particular nonverbal behavior, unlike language, is conditional. That is, it is dependent on the social and behavioral context in which it is issued.

There is, however, more to language than just semantics. With language, there is also a syntax determining how words and phrases are combined in usage. There is no syntax for nonverbal communication. American Sign Language (ASL) is an example

of a language that is not spoken. ASL does have a vocabulary, with signs carrying specific meaning, as well as a syntax. Even though ASL engages signing, it functions like a verbal language, and shares the identical neural basis in the brain. ASL and verbal language are primarily controlled by areas in the left hemisphere of the brain. In contrast, most of the sending and receiving of nonverbal signals is controlled by areas in the right hemisphere of the brain. Speech and sign language are similar in function, but different from nonverbal signals such as gaze, facial expression, interpersonal distance, and touch. Thus, nonverbal communication is not body language.

Characteristics of Nonverbal Communication

The distinctiveness of nonverbal communication is particularly clear when compared to verbal communication. A first and basic characteristic of nonverbal communication is that the nonverbal channel is always 'on' in social settings. That is, as long as there is some visual, auditory, tactile, or olfactory information, the nonverbal channel is open. Even when there is no movement, the physical appearance of the interactants still registers and affects the judgments of others. In contrast, verbal communication is intermittent and typically involves partners taking turns. Even amidst animated conversation, the verbal channel is sometimes closed as people pause or reflect about others' comments. Of course, just because the nonverbal channel is always open does not mean that we process everything from our social environments. Attention is selective, and we preferentially notice events that affect us and our welfare.

A second characteristic of nonverbal communication is that the sending and receiving of nonverbal signals may occur simultaneously. In fact, this is critical in coordinating our behavior with those around us. This happens both in conversational exchanges and in situations where individuals are simply sharing a common presence, with no intention of mutual interaction. For example, in choosing a seat in a waiting room or standing in line at the grocery store, we make subtle adjustments to others in the setting.

A third characteristic of nonverbal communication is that most nonverbal messages are sent and received automatically and outside of awareness. In contrast, verbal communication usually requires some attention in both speaking and listening. Of course, we can apply effort in thinking about how to manage our own behavior (sending side) and how to make sense of a partner's behavior (receiving side), but this is usually unnecessary. That this kind of concentration is optional reveals a

fourth characteristic of nonverbal communication – it is cognitively efficient. As a result, the routine give-and-take of nonverbal communication drains little from our cognitive batteries, even when the verbal stream has become tiresome.

Components and Patterns

The nonverbal system of communication includes components that are both static and dynamic. That is, some elements are relatively unchanging over the course of an interaction, although others are highly variable. To speak of the ‘elements’ of nonverbal communication may be misleading, however, because how each element functions is tied fundamentally to the other elements in play. In other words, nonverbal communication typically occurs as a coordinated pattern of elements, not simply an additive package. A smile may mean one thing if the smiler is holding a gift, and another if he is wielding a knife. Thus, this section focuses first on the primary component elements of nonverbal communication, and then turns to the patterns that bear the intent and the impact.

Static Features

Every face-to-face interaction occurs in a particular context. The *design and arrangement* of settings are basic factors affecting our communication with others. Something as simple as placing chairs farther from, rather than closer to, one another means that people will probably make eye contact more and speak up when they interact. In the Western business world, powerful individuals in an organizational hierarchy typically have large, well-furnished offices with scenic views. In contrast, lower level employees may simply share a large bullpen area or be pigeon-holed in partitioned cubicles. The particular furnishings and arrangement of executive offices also reinforce the power and status of the people in the top echelon of an organization. Large desks with visitor chairs directly opposite the executive’s chair keep the subordinates at a greater distance than is common in casual interactions outside of the business setting.

The design and arrangement of furniture are also important in our homes. For example, important visitors might be directed to a well-furnished living room rather than to the den or the kitchen. The latter choices may be more common for good friends or family members. In addition, the physical contents of personal territories generate expectancies that facilitate interactions between occupants and visitors. The allocation of time may also be important in setting the context of interaction. In some countries, showing up on time for a meeting implies interest and reliability; in other countries, it implies desperation. Time as a resource is also manipulated by the physical setting. Furniture in fast-food restaurants is engineered to be uncomfortable enough that patrons will finish their meals promptly and interact minimally; cushier furniture in fancier restaurants sets the stage for slower meals and extended interactions. The availability of alcoholic beverages both widens the domain of possible interactions, and signals that the wider domain is tolerated. As a result, even before an interaction begins, the setting imposes physical constraints and social norms on communication.

Next, *appearance characteristics* provide important information affecting impressions and communication. Although

we often hear ‘don’t judge a book by its cover,’ automatic judgments of others are inevitable and often useful. For example, physical appearance provides information about sex, race, and age. Clothing style can also tell us something about a person’s social class, ethnicity, religion, and even occupation. We are also sensitive to appearance because it indicates whether others are similar to or different from us. Although appearance characteristics are imperfect indicators of what others are really like, the automatic judgments they precipitate are useful and relatively accurate. Nevertheless, appearance can also be strategically modified to create desired impressions. Some modifications may be as simple as changing clothing or grooming to increase attractiveness or perceived dominance. Politicians and actors often pay considerable sums of money for ‘makeovers’ that change their covers but not what they hold inside. Other interventions, such as exercise, weight loss regimens, and plastic surgery require a greater investment of time and/or money, but they also indicate how important appearance can be.

Dynamic Behaviors

Although the fixed features of the setting and interactants establish the context for interaction, the dynamic behaviors are the fluid components in the give-and-take of nonverbal communication. Perhaps the most basic elements are *distance and orientation*. Even though the fixed features of design and arrangement of settings affect how individuals space themselves, distance and orientation are still flexible, especially in standing interactions. Distance and orientation are important because they contribute to the overall involvement level in interactions and affect the other dynamic behaviors. For example, as partners are farther apart in interactions, they tend to take a more directly facing orientation, increase gaze, and speak more loudly. In contrast, at closer distances, for example at 0.5 m, partners are typically less directly oriented toward one another, gaze and speech loudness decrease, and touch is possible. Thus, various component behaviors operate as a system, with some behaviors compensating for changes in other behaviors.

Next, *gaze* is fundamentally important, because most of our information about others comes through the visual channel. Gaze also facilitates turn-taking in conversations and provides feedback in face-to-face interactions. In addition, gaze changes can modify the meaning and impact of a message. In general, holding gaze increases arousal in the recipient and increases the impact of a verbal message. The meaning of a particular look, however, depends on more than just the amount of gaze. That is, the impact of gaze is also a product of the facial expressions that frame the gaze and the accompanying posture. This is another example of how separate behaviors combine in shaping the meaning of nonverbal messages.

Facial expressions are particularly rich sources of information. In interactions, most of our visual attention is directed at others’ faces. We also manage our own facial expressions more than we do our other behavior. The research of Paul Ekman and his colleagues suggests that universal patterns in the sending and receiving of facial expression are the hardwired product of natural selection. Much of this research contends that facial expressions are primarily signals of emotions, including happiness, sadness, anger, fear, disgust, and surprise. A different approach, Fridlund’s behavioral ecology theory, proposes

that facial expressions are signs of intentions, not emotions. Thus, facial expressions signal what people are likely to do, not how they feel. For example, an 'angry' face is not actually a reflection of underlying anger, but a threat. A smile is not a sign of happiness, but an indication of wanting to cooperate and be friendly. Facial expressions also complement and qualify verbal comments. When there is inconsistency between the words and the expression, listeners might second-guess the intent or candor of the speaker.

Next, *posture and movement* also provide information about a person's feelings and intentions. An individual's posture can signal interest, respect, and openness toward a partner, or the opposite. For example, a closed and rigid posture is less inviting than a more open and relaxed one. Posture differences can also reflect contrasts in power and status. Usually, more powerful individuals are more relaxed and less vigilant about their social environment than are less powerful individuals. People also differ in how quickly they move and whether they are graceful or awkward, coordinated or clumsy.

Gestures are specific movements of the hands, arms, and even the head that merit distinction from the broader movements just described. Although gestures are usually closely linked to speech, they can also be initiated independent of speech. Nevertheless, the close relationship between gestures and speech suggests that many gestures are really part of the verbal system of communication. Different types of gestures may be distinguished on the basis of their functions. First, *emblems* are gestures that have a specific verbal translation and, like language, their meanings can vary across culture. For example, the 'OK' sign in the United States is an obscene gesture in some countries. Next, *illustrators* depict their linguistic referents. For example, a person might make a downward movement with her hand in referring to a book on the lowest shelf of a bookcase. Finally, *regulators* are pacing gestures that are timed to identify particular referents in a verbal list. Thus, a speaker may quickly raise and then lower a hand as he says 'the first point . . .' A similar gesture may be repeated as he continues talking about subsequent points. Regulators help speakers in presenting their messages fluently, and they benefit listeners' ability to store and recall the verbal messages later.

Next, *touch* is a basic component in nonverbal communication, in all kinds of relationships. Contrary to the teaching of early behaviorists like John B. Watson, tactile stimulation is critical to the physical and psychological health and welfare of infants and young children. The routine touch involved in feeding, changing, bathing, comforting, and playing with infants is an important source of stimulation, and it facilitates bonding between parents and children. Touch is important in other relationships in signaling affection, support, and comfort, but touch is also a component in intense hostile and aggressive encounters. The type and frequency of touch between individuals are also signals of the closeness of relationships. The norms regarding touch vary across culture, and sometimes inappropriate touch leads to very negative impressions. For example, butt-slapping in some cultures is harmless flirtation, while in others it is sexual harassment. Even in one culture, a punch to the shoulder can be a sign of solidarity, yet in another context it can be considered an assault.

Vocal behaviors are characteristics of speech that are distinct from its content or meaning. Changes in tone of voice and

emphasis can modify the meaning of comments, as in the case of sarcasm. More generally, pitch, loudness, emphasis, tempo, and pausing are all vocal (not verbal) characteristics that can indicate something about speakers and their feelings and motivations. The voice also affects first impressions, including judgments of attractiveness and dominance.

Finally, the importance of *olfactory cues* is evident in varying cultural rules about cleansing and grooming, and in the marketing of soaps, shampoos, deodorants, colognes, perfumes, and air fresheners. People spend billions of dollars every year on products to remove unpleasant odors and replace them with more desirable ones. Some natural scents, called pheromones, may not even register consciously, but still affect sexual attraction and even fear. This is another instance where nonverbal communication operates automatically and outside of awareness in affecting judgments and behavior.

Patterns of Behavior

Identifying the component cues and behaviors is only the first step in appreciating the complexity of the nonverbal system of communication. Because nonverbal communication operates in a holistic fashion, it is important to move beyond elemental components to overall patterns. We cannot possibly consider the countless permutations of subtle changes in the various components, and there is no formula for the weighted combinations of elements that determine particular meanings. Nevertheless, we can find some common themes across the various components that shape the meaning of integrated patterns of nonverbal communication. Two-pattern dimensions are particularly important.

The first dimension is *involvement* or immediacy. In general, increased involvement is indicated by a closer distance, touch, gaze, greater facial expressiveness, a more direct-facing orientation, forward lean, gesturing, and vocal expressiveness. Higher levels of involvement reflect greater interest in our partners. For example, friends are usually more comfortable with high levels of nonverbal involvement than are strangers. Nevertheless, high involvement may also occur in negative situations, such as escalating physical conflict between individuals who may be yelling at each other while only inches apart. In both situations, involvement is high, but there is no difficulty in distinguishing the positive from the negative encounters.

Involvement also provides a kind of metric for identifying the intimacy of relationships. Two people walking hand-in-hand and sharing a high level of gaze are more likely to be seen as a couple than are two others who happen to be walking next to one another. Maintaining a comfortable level of involvement is usually achieved automatically and outside of awareness. Nevertheless, a stranger's stare or looming approach can be very uncomfortable, and might result in compensation in the form of increasing distance, decreasing gaze, or even leaving the setting. At the other extreme, avoidance by a good friend who keeps a distance and makes minimal eye contact is also noticeable and uncomfortable. In such a case, one might try to restore involvement by moving closer and even initiating touch as a way to determine the reason for the avoidance.

Of course, involvement can be deliberately managed in order to influence a partner or even to create a particular

impression for others in the setting. We understand that the salesperson's solicitous behavior does not indicate how much he likes us, but rather how much he wants the sale. In contrast, two people who are trying to hide a romantic relationship might minimize their mutual involvement around others.

A second pattern dimension is *disposition*. Because we are social animals and interact with a wide variety of people, we have to make sense of their behavior quickly and they have to make sense of ours. In social settings, we have to signal our intentions and motivations to others and, at the same time, forecast what those around us are likely to do. Particularly important in these processes are the expressive reactions of our faces and bodies. Although facial expressions provide the most detailed information, they are complemented by other behaviors, including distance, gaze, posture, muscle tension, and speed of movement. For example, a friendly greeting is easily distinguished from a hostile threat. We are the products of those hominid ancestors who made such judgments quickly and accurately.

Determinants

Although specific instances of nonverbal communication may vary widely, great consistencies abound as well, as a function of biology, culture, gender, and personality. Much of social interaction is ritualized. For example, greetings, departures, flirtations, solicitations, and a variety of ceremonies transpire with little or no conscious control. In fact, they typically proceed more smoothly if people do not think about them or vary from the prescriptions. This section examines how the basic determinants constrain stable patterns of nonverbal communication.

Biology

From the time of our hominid ancestors, a few million years ago, our species has been shaped by natural selection. Our biological evolution has modified not only on our physical characteristics and physiologies, but also our nonverbal communications. Even the development of language could not replace the efficiency of nonverbal communication in managing the immediacy of our face-to-face interactions. To suggest that biology plays a role in nonverbal communication does not mean that we all react in an invariant, programmed fashion. To the contrary, natural selection breeds diversity as well as communality, and part of the human evolutionary heritage is our plasticity – including our ability to adapt quickly via cultural transmission.

First, because we are social beings, close attention to others is highly adaptive. The nonverbal reactions of others alert us not only to their intentions, but also to changes in the immediate environment. For example, we are wired to target those appearance cues and behavior that can signal threat on one hand or cooperation on the other. This information, in turn, facilitates an appropriate response to changing circumstances.

Next, appearance characteristics and nonverbal behavior are also critical in mate selection. Because both males and females have no direct information about a potential mate's reproductive value, they have to rely on appearance and behavioral cues that signal information about a partner's

characteristics. For example, males' typical preferences for younger, shapely females with symmetrical features, clear skin, and lively behavior correlate with both better health and greater fecundity. In turn, females' typical preference for somewhat taller, older, dominant-looking males with resources reflects her interest in securing a mate who can provide for the welfare and security of both her and her offspring.

Survival of our species also requires long-term, special care of young children. Beyond food and shelter, children need love, stimulation, and security for successful development. One critical signal prompting the appropriate, nurturing care is the baby-face appearance of infants and young children. That is, the large forehead, small rounded chin, and big eyes of infants are powerful stimuli that promote adult concern and care. This effect even generalizes to baby-faced adults who are judged as more innocent, helpless, and less responsible than are more mature-looking adults.

Culture

Our shared biology provides the foundation for basic communalities in nonverbal communication, but different physical and social environments increase variability in nonverbal communication across culture. Many of these differences in nonverbal communication reflect basic cultural dimensions. For example, the *individualism–collectivism* dimension is relevant for cultural differences in expressive behavior. Individualistic cultures, including the United States and most of Western Europe, tend to emphasize the distinctiveness of an individual and promote a focus on the self, personal achievement, and fulfillment. In contrast, collectivistic cultures, including many East Asian countries, tend to emphasize one's identity within a larger social group, and interdependence with that group. Thus, in a situation in which one person is walking ahead of a group, the individual is likely to be seen as a trailblazer by the Westerner, and a glory-hound by the East Asian. Because most people from individualistic cultures are predisposed to value assertiveness and independence, they are more likely to show negative expressions in social situations and are better at identifying them in others than are people from collectivistic cultures. A second dimension, *power distance*, reflects the degree to which power, prestige, and wealth are unequally distributed within a culture. Thus, high power-distance cultures, including Mexico, Colombia, Venezuela, and India, have a clearer hierarchy of power and influence, whereas low power-distance cultures, including Great Britain and Germany, are more egalitarian. In general, a lower power person is likely to show greater respect and control in interacting with a higher power partner in a high power-distance culture than in a low power-distance one. In terms of nonverbal communication, this might be evident in efforts to keep greater distances from high-power others and to minimize negative facial expressions.

The anthropologist Edward Hall proposed that cultures also differ in the degree to which communication is relatively explicit or implicit. Specifically, in *low-context* cultures, most information is transmitted in a relatively direct and explicit fashion through language. As a result, ambiguity in the meaning of messages is minimized. People mean what they say. In contrast, in *high-context* cultures, there is greater ambiguity in messages because there is an increased emphasis on both the

situational cues and the nonverbal behavior of individuals. Thus, in high-context cultures, nonverbal communication plays a larger role in understanding the meaning of interactions. In general, East Asian countries are typically on the high-context end of the continuum, whereas the United States and northern European countries are on the low-context end.

Although the broad contrasts on these dimensions provide some insight into cultural differences, some caution is warranted. Most cultures are not at the extremes of these dimensions, and within a particular society, people vary considerably. Not everyone possesses the cultural characteristic; members of any culture differ in the degree to which they identify with the culture. Differences can and do occur between younger and older generations, and between urban and rural dwellers. Finally, cultural norms are not immutable, especially in this age of global communication and the increased ease of international travel.

Gender

In general, women are more sensitive on the receiving side of nonverbal communication than are men. This may be the result of women simply noticing more or being better at actually forming judgments, or some combination of both. This female advantage in reading others may be the product of both natural selection, and social norms found in most cultures that emphasize women's sensitivity to and caring for others. On the sending side, women's nonverbal behavior is usually more easily read than that of men. Nevertheless, in many cultures it is less appropriate for women than for men to threaten or show anger explicitly.

Next, compared to men, women are usually more comfortable with higher levels of nonverbal involvement in interactions, especially in same-sex interactions. This might be seen in women's closer distances, greater gaze, and occasional touch with same-sex partners. Women also smile more frequently and receive more smiles than men, a sex difference that is probably facilitated by females' higher level of gaze. Smiles are primary signals for getting along with others, and women are generally more invested in their social contacts than men are. In addition, because these sex differences in smiling align with the expectation that women are more sociable than men, smiling may also reflect impression management. Of course, these patterns may be reversed if women are interacting with male strangers and greater reserve is appropriate.

Personality

This section discusses a few of the personality traits that predict distinctive patterns of nonverbal communication. One set of related traits – introversion, social anxiety, and affiliation – all reflect a broader *social approach–avoidance* dimension. That is, introverted, socially anxious, and low-affiliation individuals constitute the 'social avoidance' end of the continuum, whereas extroverted, nonanxious, high affiliation individuals constitute the 'social approach' end. On the sending side of nonverbal communication, social-avoidant individuals typically keep greater distances from others, make less eye contact in interactions, are less expressive, and talk less than social-approach individuals. On the receiving side of nonverbal communication, social-avoidant individuals are less sensitive to

others' nonverbal signals, and less accurate in social judgments than are social-approach individuals. The decreased judgment accuracy of social-avoidant individuals may follow directly from their decreased gaze, which restricts the amount of information they have available.

A second dimension, *field dependence–independence*, identifies contrasting perceptual, cognitive, and interpersonal styles. Field-dependent individuals are more influenced by broader visual and social contexts than are field-independent individuals. For example, on a perceptual task such as identifying an embedded hidden figure, field-dependent types do not perform well in identifying the figure. That is, they are more dependent on and affected by the surrounding visual context than are field-independent individuals. The same holds for social behavior, with field-dependent individuals being more dependent on, or connected to, other people. Thus, field-dependent individuals prefer closer distances and greater gaze in interactions than do those who are field-independent. The social connectedness of field-dependent individuals is also reflected in higher levels of behavioral mimicry in interactions.

The next dimension, *self-monitoring*, is characterized by the tendency for motivated self-presentation, sensitivity to changing situational norms, and the ability to modify one's behavior for different kinds of goals. That is, high self-monitors are more skillful at reading social situations and more flexible in managing their own behavior than are low self-monitors. High self-monitors are social chameleons who can adapt their behavior to fit the situation and influence others. In contrast, low self-monitors are less sensitive to the changing situational demands and less flexible in their behavioral styles. In general, successful politicians, actors, and salespeople are likely to be high self-monitors.

Sometimes, the extremes of personality veer toward frank psychopathology, with consequences for nonverbal communication. In the syndrome of paranoia (seen in disorders such as schizophrenia, mania, stimulant abuse, posttraumatic stress disorder, and in paranoid personality disorder), sufferers may be overly attuned to the nonverbal behavior of others. They may interpret any nonverbal behavior as signifying malicious intent. They may further interpret the behavior as intended toward them even when it is not, such as interpreting the smirk of a TV news commentator as a personal comment (this is known as a *delusion of reference*). At the other extreme lie the autistic spectrum disorders (ASD). Those with these disorders are often insufficiently attuned to the nonverbal behavior of others. In one variant of ASD known as Asperger's syndrome, individuals can be verbally quite articulate but nonverbally clueless. Such ASD examples point to some degree of 'encapsulation' of nonverbal perceptual skills from general verbal fluency.

Overview of Determinants

Biology, culture, gender, and personality are the primary determinants of stable patterns of nonverbal communication. The combination of these factors constitute the 'baggage' that we all bring to social settings, constraining variability in the sending and receiving sides of nonverbal communication. Nevertheless, we are affected also by the specific situation, our individual goals, and our interaction partners. Although these determinants predispose a person toward relatively predictable and even

stereotyped patterns of nonverbal communication, changing circumstances modify the patterns. Thus, the sending and receiving sides of nonverbal communication change across settings and circumstances, as nonverbal communication operates in the service of different functions.

Functions

Providing Information

In social settings, we continuously send and receive information. Appearance characteristics signal basic information regarding gender, race, age, and fitness. Clothing, hair style, grooming, tattoos, and jewelry are frequently indicators of socioeconomic status, group membership, and even personal interests. Behavior provides additional information about personality, attitudes, feelings, and even motives in the situation. It is useful to signal this information to others and to receive it from them. We are the products of those distant ancestors who were effective in their expressive behavior and in gauging the reactions of others.

Automatic judgments are inevitable and relatively accurate. We are not wired to assimilate information and simply suspend judgments until a careful, reasoned assessment occurs. Of course, sometimes rapid judgments are inaccurate and the appropriate corrections require additional reflection. If we are not sufficiently motivated to apply the effort to make the correction, or we are distracted and do not have the necessary cognitive resources, corrections are less likely.

The earlier biology discussion highlighted the importance of appearance characteristics in mate selection and care of offspring. More generally, appearance also informs us whether others are relatively similar to or different from us. Typically, we are more comfortable with others who are more similar to us, and we like them better than those who are different. Although appearance cues are imperfect indicators of what people are really like, they facilitate expectations and adaptive reactions to others.

Even the briefest encounters provide behavioral information about others. Thin slices of behavior, lasting only a few seconds, are sufficient for relatively accurate judgments. In as little as 5–10 s, perceivers make accurate judgments of relationships, status, and competition. In everyday settings, facial expressions, body tension, and speed of movement are critical behaviors that signal how others are likely to act. Finally, behavior can even be self-informing. That is, sometimes we ‘discover’ how we think or feel only after behaving. For example, when we meet someone new, we might realize that we are more engaged and expressive with this person than with others and conclude that we like her. Thus, in some situations, behavior happens first, and it affects how we think and feel later.

Regulating Interaction

Nonverbal communication plays a central role in the routine give-and-take between people in social settings. But interactions involve more than simply having conversations. Sociologist Erving Goffman used the term ‘focused interactions’ to identify instances where people were having conversations, but recognized that interaction often occurs without conversation. People can be interacting when they simply share a close presence with others and accommodate their behavior to them. For Goffman, these were ‘unfocused interactions’; they occurred without

words. Examples of unfocused interactions include standing in line at the grocery store, picking a seat in a half-filled waiting room, or passing by strangers in the mall.

In unfocused interactions, we negotiate our position and relationship with others entirely through our nonverbal behavior. For example, we might quickly glance at a stranger as we enter an elevator, but then avoid gaze for the rest of the ride. In this way, we recognize his presence but then grant him privacy. There are, of course, cultural differences in how unfocused interactions are managed. For example, in Japan, pedestrians approaching one another on the sidewalk are likely to show complete avoidance. In contrast, in the United States, pedestrians frequently glance at the approaching stranger and, occasionally, smile and nod.

In focused interactions, nonverbal communication facilitates the efficient give-and-take of verbal exchanges. Because the momentary goals of speakers and listeners are different, their patterns of nonverbal communication are also different. One of the basic contrasts is that speakers gesture but listeners do not. Speakers usually gaze less at listeners than do listeners at speakers. This is probably due to the greater cognitive demand involved in speaking than in listening. Thus, gaze avoidance may facilitate speakers’ retrieval of verbal content. In fact, speakers occasionally break gazing at the partner as they are searching for the appropriate word. Protracted gaze toward the listener by the speaker is used for emphasis, and prolonged gaze aversion by speakers can signal anxiety, subordination, or indifference. Nevertheless, speaker gaze is important in reading the reactions of the listener and is more likely at the end of a speaker’s turn. Listeners gaze relatively more at speakers because part of the verbal meaning lies in speakers’ expressive behavior. Listeners often respond to speakers’ comments with head nods that signal understanding or agreement. Sometimes, listener vocalizations, such as ‘yeh,’ ‘uh-huh,’ or ‘OK’ substitute for a head nod. These brief listener vocalizations are not attempts to initiate a speaking turn, but simply reinforce speakers’ comments. The absence of listener feedback can be unsettling to a speaker and result in hesitations or rephrasings by the speaker in order to produce the listener’s feedback.

Finally, nonverbal communication is critical in the process of taking turns in conversations. As speakers end a turn, the verbal cue of finishing a grammatical clause is complemented by several nonverbal and vocal behaviors. Among these changes are the following: (1) the cessation of gestures; (2) a change in vocal intonation, particularly a pitch drop on the last few words; (3) decreased loudness on the last few syllables; (4) a longer pause, that is, longer than the brief pauses in the middle of a turn; and (5) an increased probability of listener-directed gaze. Listeners who are about to take a turn typically show the following changes: (1) an audible inhalation; (2) a postural readjustment and start of a gesture; and (3) a louder vocalization, that is, compared to the reinforcing listener vocalizations, such as ‘yeh’ or ‘OK.’ Thus, our face-to-face contacts, in both unfocused and focused interactions, are primarily regulated by nonverbal communication.

Expressing Intimacy

Intimacy is an important element in most relationships. In general, as relationship intimacy increases, so does the typical

level of nonverbal involvement between partners. For example, good friends are more comfortable with high levels of nonverbal involvement than are mere acquaintances. This might take the form of a close approach, touch, gaze, and expressiveness, but not always. Situational constraints and norms may well limit the appropriate levels of involvement. Lovers behave differently in a business meeting than at a party. In addition, intimate relationships are sometimes characterized by the opposite of high involvement, specifically, ignoring one's partner. Thus, long-term partners may be quite comfortable, on occasion, to ignore one another; entire dinners can occur without a word between them.

It is common to assume that one person's feelings for, or commitment to, a partner determines behavior. This might be described as an inside-out link; greater underlying attachment (feelings and attitudes) precipitates increased nonverbal involvement (external behavior) with a partner. The rapport that is characteristic of people in intimate relationships is also reflected in increased behavioral coordination. This is evident in behavioral mimicry and synchrony in the timing of partners' movements, and, for example, in the ability to finish each other's sentences. Typically this happens automatically and outside of awareness.

The intimacy-behavior link is, however, a reciprocal one; either one can determine the other. In the case of first meetings, appearance affects impressions and initial liking, but the give-and-take of behavior can modify the first impressions. For example, a person might notice that she's gazing at her acquaintance and smiling more than usual. She might also lean forward and gesture expressively as she is talking. In turn, her acquaintance might respond in turn, with increased behavioral mimicry as a result. Thus, this pattern of reciprocated high nonverbal involvement and mimicry evolves over the course of an interaction, and the interactants 'discover' that they like each other.

Exercising Influence

Influence is present in all kinds of situations, including face-to-face interactions and various types of mediated communication. In general, exercising influence might be described as goal-oriented behavior initiated to change the behavior, attitudes, and feelings of others. Like many of our everyday activities, influence can operate automatically. Sometimes the goal-oriented behavior, and even the goals themselves, operate outside of awareness. There are several different categories of nonverbal influence. First, nonverbal communication is present in instances of *power and dominance*. In the business world, powerful people typically control larger territories, have greater privacy, and more expensive furnishings. These setting features are not only perquisites of powerful people, but also status cues that help regulate contact with others. In addition, powerful people usually have the prerogative of initiating either high involvement in the form of close approaches, high levels of gaze, and touch – or the opposite, in ignoring those with less power. In contrast, when low-status individuals interact with high-status partners, they have to be more careful in attending to the high-status partner and minimizing negative expressions. Finally, high-status individuals are typically more relaxed in interacting with low-status partners than are low-status individuals with high-status partners.

Second, nonverbal communication is important in providing *feedback and reinforcement*. A smile, pat-on-the-back, or a simple head nod can signal approval to a partner, even without a verbal comment. These may act as reinforcers that strengthen the preceding behavior and increase its frequency in the future. This may be particularly important in influencing the behavior of young children, because for them nonverbal signals may have greater impact than mere words. Third, nonverbal communication is important in *compliance and persuasion*. Extensive research shows that high involvement in the form of a close approach, increased gaze, and touch increases compliance on simple, low-level requests. This might happen with securing small donations or getting people to sign a petition. In such cases, the high involvement may increase stress on the target, and compliance is the easiest way to end an uncomfortable interaction. Changing attitudes, the essence of persuasion, is more complicated and requires an opportunity to reflect on the message and evaluate its merits. Because high involvement is stressful and distracting, it interferes with cognitive processing and is less effective than moderate involvement. Thus, different tactics are effective in gaining simple behavioral compliance versus longer term persuasion. Finally, nonverbal communication is critical in *deception*. Effective deception requires that liars manage their nonverbal behavior to be consistent with the verbal lie. Sometimes successful detection of deception is the result of targets noticing the inconsistency between the verbal statement and the accompanying nonverbal behavior. In some cases, these discrepancies are present in the facial expressions and gestures of liars, especially when the liars are themselves conflicted about lying and betray signs of conflict. Even when these discrepancies are evident, most people are only slightly better than chance at detecting lies. Furthermore, our perceived confidence in detecting lies is unrelated to actual accuracy in detection. This is another example of our having relatively little insight into our own judgments.

Managing Impressions

Nonverbal communication is also critical in impression management. People can change their appearance, clothing, and grooming, and most importantly, their behavior, in order to create particular images or identities. In some cases, people invest considerable time, energy, and resources to modify their appearance. This might include plastic surgery, weight loss programs, exercise, hair replacement, and other interventions, all designed to fashion a more desirable appearance. Behavioral changes are more common as people routinely enter settings with conscious or unconscious goals of creating particular impressions in others. For example, in a job interview, applicants are likely to be more expressive, attentive, and responsive to the interviewer on the sending side of nonverbal communication, than they would be in casual conversation. In addition, on the receiving side of nonverbal communication, applicants will attend closely to any nonverbal signs of approval or disapproval from the interviewer, and they will adjust their behavior accordingly. Similar self-presentation efforts might be initiated on first dates, interacting with one's supervisor, and meeting important people.

Managing impressions is particularly important in politics, and election outcomes are often affected by the appearance

and behavioral style of candidates. Actors and politicians are well known for hiring expensive media consultants to help them tailor and refashion their images. Defense attorneys in high-profile cases hire such consultants to 'make over' their clients to increase the odds of acquittal. Sometimes impression management requires an accomplice in creating a pair or couple identity. For example, at a family gathering, a feuding couple might try to sustain the image of a happy marriage by being attentive and affectionate, even though they can barely stand one another for the moment.

Summary

Nonverbal communication is pervasive in both face-to-face and mediated communication. Because much of nonverbal communication operates automatically and often outside of awareness, it provides an efficient means of regulating our social contacts with others. The determinants of biology, culture, gender, and personality shape stable patterns of nonverbal communication. Nevertheless, the flexibility and utility of nonverbal communication are evident in several distinct functions, including providing information, regulating interaction, expressing intimacy, exercising influence, and managing impressions. Thus, the complementary behavioral and social judgment tracks of nonverbal communication constitute an indispensable system for navigating our social worlds.

See also: Evolutionary Social Psychology; Extraversion–Introversion; Facial Expression of Emotion; Impression Formation; Interpersonal Perception and Communication; Love and Intimacy; The Mirror Mechanism.

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Obsessive–Compulsive Disorder

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Glossary

Classical conditioning Also known as Pavlovian or respondent conditioning; a type of learning in which a neutral stimulus is repeatedly paired with a stimulus that naturally elicits certain responses until the neutral stimulus acquires the ability to elicit the same responses.

Compulsion A ritualistic, stereotypic, or repetitive action generally performed to reduce anxiety associated with an obsession; a compulsion (or ritual) is generally perceived as excessive or irrational, although individuals find the behaviors difficult to resist.

Ego-dystonic Refers to thoughts or behaviors that are inconsistent or in conflict with how one views oneself; ego-dystonic thoughts are experienced as intrusive and unwanted.

Ego-syntonic Refers to thoughts or behaviors that are consistent with how one views oneself.

Negative reinforcement A form of operant conditioning; a process in which a behavioral response increases in frequency because of the avoidance, escape, or removal of an aversive stimulus from the environment.

Obsession A thought, image, or urge that is intrusive, unwanted, persistent, and uncontrollable; an obsession is generally perceived as irrational, excessive, and distressful.

Obsessive–compulsive disorder A syndrome in which obsessions and compulsions occur with significant frequency, duration (at least 1 h day^{−1}), or intensity to impair social, occupational, or family functioning or cause significant psychological distress.

Operant conditioning A type of learning that uses consequences to modify the occurrence and form of behavior.

Nature of Symptoms

Obsessive–Compulsive Disorder

Obsessive–compulsive disorder (OCD) is characterized by the presence of obsessions and/or compulsions. Obsessions are recurrent ideas, images, or impulses that are unwanted, intrusive, difficult to control, and experienced as ego-dystonic. Obsessions can present in a variety of forms, including images, urges, and fears. Obsessional images are vivid scenes that are often violent or sexual in nature (e.g., images of rape or molestation). Obsessional urges are strong impulses to carry out certain inappropriate behaviors (e.g., shouting obscenities at church). Obsessional fears are excessive worries about potential danger (e.g., fears of contamination or harm). Because of the intrusive and unwanted nature of obsessions, individuals often feel compelled to control them through a variety of strategies, including dismissing, suppressing, or neutralizing the obsessions through the use of compulsions.

Compulsions, or rituals as they are commonly called, are repetitive, stereotypic, and intentional behaviors and cognitions (i.e., thoughts, images) performed in response to an obsession to prevent or reduce emotional distress. Compulsions that involve cognitions are referred to as mental rituals. Both forms of compulsions are distinguished from other forms of repetitive behavior, such as addictions or impulse-control disorder, in that they are not performed to increase pleasure or gratification. Examples of compulsions include excessive washing or cleaning and repeated checking. Many individuals also perform mental rituals, such as counting or praying, to undo or neutralize intrusive thoughts.

The Diagnostic and Statistical Manual, Fourth Edition, Text Revised (DSM-IV-TR) emphasizes the functional link between obsessions and compulsions, whereby obsessions cause anxiety or distress, and compulsions are overt (i.e., outward behaviors) or covert (i.e., mental) actions that are performed to reduce the anxiety or distress. Although a limited number of people with OCD may have only obsessions or compulsions, over 90% of individuals with OCD experience both. In fact, when mental rituals are included, only 2% of individuals report experiencing ‘pure’ obsessions (i.e., obsessions without corresponding compulsions).

To meet diagnostic criteria, individuals must experience either obsessions or compulsions. These obsessions and/or compulsions must cause marked distress and interfere substantially with daily functioning. In addition, individuals must recognize that the obsessions or compulsions are excessive and unreasonable, although the level of insight experienced varies. Although not formally part of the diagnostic criteria, avoidance behaviors are also quite common. Individuals with OCD often avoid various situations or events so as not to trigger the obsessions and/or compulsions.

There is considerable variability in the expression of OCD symptoms. However, studies have found that certain obsessional themes and types of compulsions are more common than others. In terms of obsessions, fear of contamination is the most common. Doubting obsessions and sexual/aggressive obsessions are also common, followed by somatic concerns, need for symmetry, and religious/blasphemous obsessions. In addition, compulsions tend to correspond to certain obsessions. Some of the most common compulsions include

washing/cleaning and checking compulsions. Individuals also often report urges to ask or confess, urges to arrange things in a symmetrical or precise manner, and hoarding of objects. That certain obsessions and compulsions tend to be quite common in individuals with OCD suggests that certain subtypes or dimensions of OCD exist.

Many individuals with OCD experience fluctuations in level of insight, depending on the situation and level of anxiety, with higher anxiety leading to poorer insight in the moment. However, a small subset of individuals with OCD also exhibit low levels of insight that is not bound by the situation or anxiety level. In the DSM-IV, a subtype of OCD 'with poor insight' was included to describe these individuals who fail to recognize the senselessness of the OCD symptoms. Approximately 5% of individuals with OCD demonstrate poor insight, which is defined as holding fixed beliefs that obsessions and compulsions are reasonable. An additional 20–25% report strong but not fixed convictions.

OC-Related Disorders

A number of disorders, referred to as OC-related disorders, have similarities with OCD and are conceptualized as existing on a spectrum with OCD. These OC-related disorders include several neurological disorders characterized by repetitive behaviors, such as Tourette's syndrome and tic disorders; impulse-control disorders, such as trichotillomania and skin picking; and disorders associated with bodily preoccupation, such as body dysmorphic disorder and hypochondriasis. These disorders are similar to OCD in that they involve repetitive behaviors that generally function to reduce anxiety or tension.

In tic disorders, individuals perform vocal and motor tics in response to uncomfortable sensory phenomena, such as an itch, tickle, tingle, or pressure on their skin or within their body. These sensory phenomena, referred to as premonitory urges, may be localized to specific areas of the body, experienced as more generalized sensations, or experienced as a psychological feeling that something is not 'just right.' Performance of a tic temporarily relieves whatever tension the individual is experiencing as a result of the urge. Tics can be simple or complex in nature. More complex tics can resemble ritualistic behavior associated with OCD.

Trichotillomania and skin picking also involve maladaptive repetitive behaviors that are similar to compulsive behavior in OCD. In trichotillomania, individuals repeatedly pull hair from various regions of the body. Individuals experience internal tension, and this tension builds until the individual engages in hair pulling. After the behavior is performed, relief and gratification are experienced, similar to the anxiety reduction experienced by individuals with OCD when they perform a ritual. Most individuals engage in two types of pulling: automatic, which occurs outside one's awareness; and focused, which is intentional and purposeful. Similarly, individuals who engage in pathological skin picking do so to relieve internal discomfort. Skin picking often results in noticeable tissue damage and can lead to permanent disfigurement.

Body dysmorphic disorder (BDD) and hypochondriasis are associated with excessive bodily preoccupation. In BDD, individuals are preoccupied with imaginary defects in their appearance or an excessive concern with small physical imperfections.

Individuals with BDD often spend an inordinate amount of time obsessing about their appearance. In addition, they perform repetitive and time-consuming behaviors that are intended to decrease the anxiety they experience because of their imagined defect. These rituals include excessive grooming, camouflaging their perceived defect, checking their reflection, repetitive touching or measuring of parts of the body, and asking for reassurance. In hypochondriasis, individuals are preoccupied with the fear of having a serious physical illness, and they often engage in repetitive internal and bodily checking, as well as reassurance seeking. These rituals are intended to reduce the anxiety associated with their bodily preoccupation; however, they usually have the effect of increasing long-term anxiety.

Epidemiology

OCD is one of the most severe and chronic anxiety disorders. It has been ranked by the World Health Organization as one of the most debilitating psychological disorders. Although early epidemiological studies estimated the prevalence of OCD to be as low as 0.05%, more recent studies have reported higher prevalence rates. The Epidemiologic Catchment Area Study reported the 1-year prevalence rate as 1.6% and the lifetime prevalence rate as 2.5% (based on DSM-III criteria). Other epidemiological studies have reported the 1-year prevalence rate as ~1%, and the lifetime prevalence rate as between 1% and 3%.

Onset of OCD symptoms typically occurs in early adulthood, with 50–70% of individuals reporting onset of symptoms between ages 18–24, and a substantial number of individuals reporting subthreshold symptoms in childhood or adolescence. Approximately 15% of individuals report onset after 35 years. Often, development of OCD symptoms is gradual, although acute onset has been reported in some cases. OCD symptoms often wax and wane in response to stress, and a clear precipitant can be identified in ~60–70% of cases (e.g., pregnancy, childbirth, divorce, death of a loved one). However, about 10% of individuals report episodic and deteriorating courses.

OCD is diagnosed twice as often in boys as girls. However, adult men and women are affected equally. Although men and women do not differ in the rate of diagnosis, other differences have been found in terms of onset and expression of symptoms. Men tend to have an earlier age of onset (13–15 years) than women (20–24 years). In addition, men are more likely to report sexual or aggressive obsessions, and women are more likely to report contamination obsessions. Checking rituals are reported equally in men and women.

OCD has similar prevalence rates and age of onset across cultures. However, obsessional content varies, based on culture. For example, dirt and contamination obsessions are more prevalent in Indian culture than in American culture, and religious and sexual obsessions are more prevalent in cultures with strict religious moral codes.

Comorbidity

There is a high rate of comorbidity between OCD and other Axis I disorders. In fact, 50–65% of individuals with OCD have at least one current additional Axis I diagnosis, and 85% have

another Axis I diagnosis at some point in their lifetime. Depression is one of the most common comorbid diagnoses; 30–50% of individuals with OCD have an additional diagnosis of current major depressive episode or dysthymia, and 65–80% are diagnosed with depression in their lifetime. Onset of depressive symptoms tends to occur following onset of OCD symptoms, suggesting that the effects of OCD often lead to development of a secondary depressive disorder. Although in some cases depression precedes the onset of OCD symptoms, the progression of OCD to depression occurs three times more often than progression of depression to OCD. Comorbid depressive symptoms can exacerbate OCD symptoms.

OCD often occurs with other anxiety disorders as well. Approximately 50% of individuals with OCD have a comorbid anxiety disorder. When OCD co-occurs with other anxiety disorders, OCD tends to be the primary or most debilitating diagnosis. Individuals with OCD often have additional diagnoses of social phobia (35–41%) or specific phobia (17–21%). The relationship between OCD and other anxiety disorders, such as panic disorder and generalized anxiety disorder (GAD), is not as clear. Some studies have found that panic disorder has a moderately high comorbidity rate (29%) with OCD, but other studies report a lower comorbidity rate (12%). Similarly, studies have found comorbidity rates between OCD and GAD that range from 7% to 22%.

Individuals with OCD are also frequently diagnosed with OC-related disorders. Approximately 17% of individuals with primary OCD have comorbid Tourette's syndrome. It is much more common for individuals with primary Tourette's syndrome to have comorbid OCD; studies have reported comorbidity rates ranging from 28% to 63%. In addition, individuals with OCD and comorbid tics are more likely to have aggressive and sexual obsessions and intrusive images than individuals without comorbid tics. Less is known about comorbidity with impulse-control disorders, although studies have found higher rates of lifetime OCD in individuals with trichotillomania. In addition, 15–37% of individuals with primary OCD have comorbid BDD.

OCD also co-occurs with many personality disorders. In fact, 50–65% of individuals with primary OCD also meet the criteria for an Axis II disorder, and at least half of those individuals are diagnosed with more than one personality disorder. Between 5% and 30% of individuals with OCD are also diagnosed with either dependent personality disorder (PD), avoidant PD, histrionic PD, schizotypal PD, or obsessive–compulsive personality disorder (OCPD). Avoidant PD is often cited as the most common comorbid personality disorder (30%), followed by dependent PD (10–20%), histrionic PD (5–25%), schizotypal PD (15%), and OCPD (ranges vary widely from 2% to 55%, with the median being 6%).

Differential Diagnosis

OCD has many similarities with other disorders. Therefore, differential diagnosis is extremely important and can sometimes be challenging. Depressive ruminations can appear similar to obsessional thinking. Ruminative thinking and obsessional thinking are both very repetitive. However, depressive rumination involves pessimistic ideas about the self or others; whereas

obsessions are anxiety-provoking thoughts that are often related to danger. Ruminations are ego-syntonic, meaning that they are consistent with how the individual views himself or herself; whereas obsessions are ego-dystonic, meaning that they are inconsistent with how the individual views himself or herself. Finally, ruminations and obsessions differ in the level of effort expended to control the thoughts. Typically, individuals try to suppress obsessions but expend much less effort trying to control ruminations.

Worry thoughts, which are present in GAD and other anxiety disorders, are also sometimes confused with obsessions. Often, the obsessional style of thinking in GAD is similar to thought patterns in OCD. The difficulty in distinguishing worry from obsessions is even more apparent when outward behavioral compulsions (e.g., handwashing, checking locks) are not present, as when individuals have only mental compulsions or 'pure' obsessional OCD. Some differences between worry and obsessional thinking are related to the content of the thoughts and how the individual responds to the thoughts. Like depressive ruminations, worries are experienced as ego-syntonic, and obsessions are experienced as ego-dystonic. As a result, individuals typically try to strongly resist or suppress obsessions, but resist worry thoughts to a much lesser extent. In addition, worry thoughts are typically focused on more common and everyday concerns; whereas obsessions are more related to less likely situations and sometimes even have a magical quality to them. Worries are often focused on long-term consequences of actual situations, and obsessions are often focused on consequences of the thought itself.

Obsessive–compulsive personality disorder (OCPD), which is characterized by a rigid preoccupation with perfectionism, orderliness, rules, and mental and interpersonal control, shares some similar features with OCD. Certain features of OCPD are more often associated with OCD than with others. Perfectionism, for example, is significantly elevated in individuals with OCD. In addition, OCPD traits may be associated more with particular subtypes of OCD symptoms, such as doubting/checking. Although OCD and OCPD share some similar features, most individuals with OCD do not have comorbid OCPD. One important difference between OCD and OCPD is that obsessions in OCD are generally ego-dystonic, whereas obsessions in OCPD are generally ego-syntonic.

It is also important to differentiate between strongly held beliefs, or overvalued ideas, and delusions. Many individuals with OCD have overvalued ideas, which are less fixed than delusions. An example of an overvalued idea within the context of OCD may be an individual who strongly believes (s)he will become ill if (s)he comes into contact with a contaminated object. Overvalued ideas often cannot be differentiated from delusions based on the level of bizarreness, as OCD obsessions can be quite bizarre in nature. Rather, overvalued ideas are distinguished from delusions based on the level of fixity and the presence or absence of compulsions. A belief may be deemed a delusion if it is held with firm conviction and is not responsive to clear contradictory evidence. Overvalued ideas, on the other hand, are less fixed. Other features that suggest a delusion as opposed to an overvalued idea are failure to elicit distress or anxiety and the absence of compulsions. It is important to assess the level of insight, as poor insight can negatively affect treatment outcome.

Models of Development and Maintenance of OCD Symptoms

Several models have been used to describe the etiology, development, and maintenance of OCD symptoms, including biological, neuropsychological, behavioral, and cognitive models.

Biological and Neuropsychological

The role of genetic variables in the etiology of OCD has been examined using twin studies and family history. Twin studies have found that monozygotic twins of individuals with OCD show higher rates of OCD symptoms than do dizygotic twins. Further, first-degree relatives of individuals with OCD have OCD themselves at a rate 3–12 times higher than the general population. Although this suggests that genetics may play a role in the etiology of OCD, it is important to note that environmental factors likely play an important role as well.

Studies have found neuroanatomical abnormalities in the brain of individuals with OCD, including dysfunctional circuitry involving the orbitofrontal cortex, anterior cingulate, basal ganglia, and medial thalamus. These abnormalities lead to the proposal that the direct and indirect striatopallidal pathways of the basal ganglia may be involved in OCD. The direct pathway projects from the cortex to the striatum, then to the globus pallidus and the thalamus, and then back to the cortex. The function of the direct pathway is to facilitate routines. The indirect pathway projects from the cortex to the striatum, then through the globus pallidus to the subthalamic nucleus, before returning to the globus pallidus, thalamus, and the cortex. The role of the indirect pathway, which is a negative feedback loop, is to break up the routines driven by the direct pathway. OCD may be a result of an imbalance between these two pathways. In individuals with OCD, the direct pathway is thought to overfunction and contribute to obsessive thoughts; and the indirect pathway inadequately regulates the repetition of routines and accounts for compulsions.

Various neuropsychological differences have been identified in individuals with OCD. Individuals with OCD are more likely to be unable to inhibit and direct attention from distressing thoughts and images toward more pleasant or less-distressing mental experiences. In addition, there are deficits in executive functioning, specifically set shifting. There is also some evidence that individuals with OCD have deficits in nonverbal memory, as well as lower confidence in memory judgments.

Behavioral

The development and maintenance of OCD symptoms is influenced by environmental variables and learning principles. In terms of environmental variables, the onset of OCD often occurs following significant life events, such as marriage, childbirth, and death of a loved one. In addition, the course of the disorder typically waxes and wanes in response to various life stressors, such as career or job changes, relationship difficulties, and school-related problems.

The behavioral theory of OCD was based on Mowrer's two-stage theory of fear and avoidance. Mowrer's theory has been used to explain how symptoms are acquired and maintained

through classical and operant conditioning. Although empirical support for the acquisition phase is lacking, there is evidence that Mowrer's theory can explain the maintenance and growth of fear and avoidance behavior. Additionally, Mowrer's theory aids in the conceptualization of OCD symptoms and led to development of the primary evidence-based behavioral treatment for OCD, which is exposure and response prevention (ERP).

Mowrer's theory purports that learning occurs via two stages. In the first stage, obsessions develop through classical conditioning: a neutral stimulus is paired with a stimulus that naturally elicits discomfort or anxiety, and then the previously neutral stimulus takes on the function of eliciting discomfort or anxiety itself. Through this process, objects, thoughts, and images can take on the ability to elicit anxiety. In the second stage, performance of behaviors that reduce anxiety (i.e., compulsions or rituals) are developed and maintained through a process of negative reinforcement. Each time a compulsion is performed and successfully reduces the fear experienced by the individual, the likelihood that (s)he will perform that compulsion in the future in response to the obsession increases.

Cognitive

Several cognitive models have also been proposed. Salkovsk'i's Inflated Responsibility Model states that intrusive thoughts are experienced by everyone and only turn into obsessions because of distorted appraisals about personal responsibility for preventing harm. This model suggests that distorted appraisals provoke anxiety, and neutralizing rituals and subsequent thought suppression occurs as a means of reducing the anxiety. Rachman proposed a Misinterpretation of Significance Model, in which obsessions are the result of interpreting intrusive thoughts as personally significant and as signifying a threat. Clark's Cognitive Control Theory of Obsessions emphasizes the role of faulty beliefs about the importance of mental control: individuals misinterpret their obsessions and engage in faulty evaluation of their mental control efforts and perceived consequences of failure to control the obsession.

Finally, the Obsessive–Compulsive Cognitions Work-Group Model has identified six belief domains that may have etiologic importance and may be specific to OCD. These domains incorporate many of the earlier models: (1) inflated responsibility – the belief that one has the power to bring about or prevent negative events; (2) overimportance of thoughts – the idea that having a thought indicates that it is important; (3) overestimation of threat – believing that harm is more probable than is realistic; (4) importance of controlling thought – thinking that it is possible and desirable to exert complete control over one's thoughts; (5) intolerance of uncertainty – the belief that one must be certain and one cannot cope with uncertainty or unpredictable change; and (6) perfectionism – believing that there is a perfect solution to problems, that it is possible and necessary to complete tasks perfectly, and that minor mistakes are unacceptable and catastrophic.

Diathesis–Stress

Although many models have been proposed, no single model is able to fully explain why OCD develops. Therefore, the etiology of OCD may best be explained by complex

interactions between the various models (e.g., biological, behavioral, and cognitive). A diathesis-stress model of OCD suggests that certain individuals have a biological predisposition to develop OCD, and that onset of the disorder occurs only when specific environmental variables or learning patterns interact with these biological factors. This model is supported by evidence that individuals without OCD often experience obsessive-compulsive symptoms that differ only in frequency, intensity, and experienced distress. That many individuals experience obsessive-compulsive symptoms without developing OCD suggests that individuals with OCD may have a biological and/or psychological vulnerability to developing the disorder.

Treatment

Several treatment modalities are effective in treating OCD. Behavior therapy, specifically ERP and pharmacotherapy, have the largest evidence base. Cognitive therapy also has been shown in some studies to be effective; however, other studies have found cognitive therapy to be inferior to ERP and pharmacotherapy. Other treatment approaches that include a mindfulness component are also being explored, but their efficacy is not yet well established.

Exposure and Response Prevention

Early behavioral interventions for OCD included systematic desensitization, modeling, operant reinforcement, aversion relief, and relaxation therapy. These interventions produced mixed results. In 1966, Victor Meyer described a new behavioral intervention, ERP, which was based on Mowrer's two-factor theory of fear and avoidance. The basic approach of ERP is that individuals expose themselves to situations that trigger their feared obsessions, and they then tolerate any anxiety that is provoked by the exposure while refraining from the associated compulsion or ritual. At the beginning of treatment, individuals generate a fear hierarchy, which is a list of situations or objects that elicit obsessions, provoke anxiety, and which the person typically avoids. The individual then ranks the exposures based on level of distress. After the hierarchy is developed, the individual begins exposing himself or herself to these situations, starting with items that provoke a moderate anxiety level and then gradually moving to items that provoke higher anxiety levels. It is important that the individual remains in a situation without ritualizing until habituation is achieved (i.e., until the anxiety decreases significantly). Therapists often provide encouragement and support (not reassurance) and will sometimes model the exposure prior to asking the patient to complete the exposure.

ERP is the most effective intervention for OCD, with 60–85% of individuals who complete ERP showing significant symptom improvement. Of those who respond to the treatment, about 75% maintain their gains long term. Actually, a deliberate focus on relapse prevention has a significant effect on maintenance of treatment gains. Compared with pharmacotherapy, ERP is generally superior, particularly when maintenance of gains is considered. Those who receive ERP also demonstrate lower dropout and refusal rates compared with individuals who receive pharmacotherapy.

Despite these encouraging results, ERP is not an effective or desirable treatment for everyone. Approximately 25% of people refuse ERP, and another 3–12% will begin but not complete it. This leaves a large number of individuals who are not able to benefit from ERP. In addition, most outcome studies have included mostly individuals with cleaning and checking rituals as primary compulsions. Less is known about efficacy of ERP for individuals with other types of OCD symptoms, such as obsessional slowness, hoarding, symmetry/ordering rituals, or mental compulsions.

Several factors may have a negative effect on response to ERP. Individuals with mild-to-moderate comorbid depression, for example, may not experience gains as significant as those without comorbid depression, and severe depressive symptoms are associated with poor response to ERP and higher risk of relapse. Any comorbid personality disorder diagnosis also is predictive of poorer treatment outcome for both ERP and pharmacotherapy, especially diagnoses of schizotypal and borderline personality disorders. Overvalued ideation has also been shown to be a predictor of poor treatment outcome.

Pharmacotherapy

Antidepressants are also an effective treatment for OCD. Several double-blind, randomized, placebo-controlled studies have demonstrated the efficacy of these drugs in reducing OCD symptoms, including clomipramine (Anafranil), sertraline (Zoloft), fluoxetine (Prozac), fluvoxamine (Luvox), citalopram (Celexa), escitalopram (Lexapro), and paroxetine (Paxil). Of these, clomipramine is the only drug from the tricyclic family, whereas the others are selective serotonin reuptake inhibitors (SSRIs). Tricyclics were the first generation of antidepressants, and they work by increasing the amount of norepinephrine and serotonin in the brain. Although the tricyclic antidepressants are quite effective for many people, because they interfere with other neurotransmitter systems, they also have a number of side effects.

SSRIs work by slowing the reuptake of serotonin by the secreting neuron and allowing the dendrites of the receiving neuron to make contact with and use more of the secreted serotonin. Because SSRIs do not interfere with other neurotransmitter systems, they generally have fewer side effects and are better tolerated than tricyclics. Forty to sixty percent of individuals with OCD show significant improvement following treatment with SSRIs. However, serotonergic drugs are not more effective than ERP, and when medications are discontinued, relapse is common. Although serotonergic drugs do not increase the benefits of ERP, these treatments are commonly combined in clinical settings.

Cognitive Therapy

Cognitive therapy (CT) is often combined with, and is sometimes used instead of, ERP for OCD. CT focuses on changing maladaptive beliefs or interpretations of one's obsessions. For OCD, some common maladaptive beliefs include overestimating the probability of danger, viewing thoughts as overly important, and believing that having a thought is the same as performing an action (i.e., thought-action fusion). Therapists use Socratic questioning and other cognitive techniques to challenge these maladaptive beliefs.

Generally, CT combined with ERP (i.e., CBT) is an effective treatment for OCD. However, only a few studies have directly compared CT with ERP. These studies have produced mixed results, with one study suggesting that CT is superior to ERP, two studies suggesting that ERP is superior to CT, and at least one study finding no difference between the treatments. In addition, these studies are difficult to interpret because CT often includes behavioral experiments and ERP often includes cognitive techniques, thereby confounding the independent variables. Mode of treatment delivery may also confound results. Some studies employ group rather than individual therapy, which may affect treatment outcome, depending on the severity of symptoms; more severe OCD may respond better to individual as opposed to group therapy.

CT and ERP have different strengths, and individuals may respond differentially based on various factors. For example, severity of symptoms may affect response to CT versus ERP. One study showed a trend for mild-to-moderate patients to respond better to CT and more severe patients to respond better to ERP. Type of symptoms may also affect response to CT versus ERP. Symptoms such as hoarding and mental rituals may respond more to the addition of cognitive techniques. CT may result in lower refusal and dropout rates for certain individuals than ERP, although this pattern is not strongly supported in the literature.

Future Directions

Despite the effectiveness of ERP and pharmacotherapy, many individuals do not adequately benefit from these treatments. Therefore, other treatments continue to be explored. Several treatments are emerging that use a mindfulness-based approach to OCD. Mindfulness-based interventions may be particularly well suited to the treatment of OCD because of the fact that individuals with OCD tend to ascribe special meaning and significance to their obsessions, and mindfulness training fosters a nonjudgmental stance toward one's thoughts and feelings. Some treatment approaches that have been applied to OCD are acceptance and commitment therapy (ACT) and metacognitive therapy (MCT).

ACT posits that experiential avoidance, which is the tendency to avoid or control thoughts and emotions, is a key process of any psychological disorder. Rather than targeting the form, frequency, or situational sensitivity of thoughts and emotions, ACT therapists instruct individuals in various exercises, including mindfulness exercises. These exercises are designed to assist individuals in experiencing their obsessions as just thoughts and their anxiety as just an emotion, thereby reducing the need to ritualize. Like CT, ACT can be conducted with or without in-session exposure therapy. When exposures are conducted, the purpose is to help individuals develop willingness to experience thoughts and emotions in the service of moving toward their values, not to achieve habituation.

MCT is another approach that incorporates mindfulness. MCT is based on a theory of psychological dysfunction that suggests that all disorders are a result of a dysfunctional pattern of cognition – specifically, inflexible self-focused attention, perseverative thinking (i.e., worry and rumination), attentional strategies of threat monitoring, and coping strategies that fail to challenge and modify maladaptive beliefs. To

combat this dysfunctional thinking pattern, MCT therapists incorporate detached-mindfulness techniques. Detached mindfulness, which is considered to be incompatible with the dysfunctional thinking style that is characteristic in psychological disorders, consists of being conscious of one's thoughts, comprehending that thoughts are not facts, being able to refocus one's attention flexibly, having low conceptual processing of one's thoughts, and not having the goal of removing or avoiding threat.

The efficacy of these approaches is not yet well established, as no randomized controlled trials for ACT or MCT for OCD have been conducted. However, one multiple baseline study suggests that ACT may produce clinically significant reductions in compulsions. ACT may also be beneficial for other OC-related disorders, such as trichotillomania and skin picking. Evidence from experimental and case studies is also emerging that MCT may be an effective treatment for OCD. In many ways, these mindfulness-based approaches may not differ radically from more standard approaches. For example, the meta-cognitive approach to obsessions is also used in standard CBT for OCD; the detached-mindfulness techniques of MCT are similar to imaginal exposures used in ERP; and, even though habituation is emphasized, ERP promotes willingness to tolerate anxiety to pursue one's values. To sort out whether there are meaningful differences between these mindfulness-based approaches and standard CBT approaches, head-to-head comparisons of these treatments will need to be conducted.

Conclusions

Over the past 30–40 years, our knowledge of OCD and its treatment has advanced significantly. Comorbidity with other anxiety disorders, OC-related disorders, depression, and personality disorders has been investigated. In addition, factors that may affect treatment outcome have been examined, including negative factors such as the presence of overvalued ideation, severe depression, and personality disorders, and positive factors such as deliberate focus on relapse prevention. However, numerous questions remain, particularly regarding improving treatment outcomes. Future research will need to continue refining our ability to identify individuals most likely to benefit from available treatments, address how best to treat various forms or subtypes of OCD, and determine whether the addition of various cognitive and mindfulness-based techniques may improve treatment outcomes, and for whom.

See also: [Anxiety Disorders](#); [Body Dysmorphic Disorder: A Review](#); [Hypochondriasis or Health Anxiety](#); [Stress and Illness](#).

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Relevant Website

www.ocdfoundation.org – International OCD Foundation.

Obsessive–Compulsive Personality Disorder

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Glossary

Comorbid Two distinct disorders that exist within a person at the same time.

Obsessive–compulsive disorder An anxiety-based disorder that consists of obsessions (repetitive, unwanted intrusive thoughts) and compulsions (acts that need to be completed in a certain rigid fashion).

Psychoanalysis Developed by Sigmund Freud, psychoanalysis describes various theories relating to conscious and unconscious psychological processes.

Semistructured interview Administered by a clinician, the interview has a certain set of questions that are posed to the patient. Based on the response, the clinician uses clinical judgment to continue or discontinue the line of questioning.

Unstructured interview Administered by a clinician, this is an interview style in which questions can be changed or adapted. Unlike in structured interviews, there is no preset manner in which questions must be asked. The increased flexibility provided by this interview style brings some potential drawbacks such as a decreased ability for generalization and limited diagnostic capabilities.

The origins of obsessive–compulsive personality disorder (OCPD) can be traced back to Sigmund Freud in the early 1900s, who characterized individuals with this disorder as having “a neurosis connected with difficulties at the anal phase in psychosexual development.” Freud referred to this neurosis as the ‘anal character.’ According to classical analytic theory, the anal character arises out of conflicts over toilet training in the second to third year of a child’s life. Improper toilet training techniques coupled with high levels of tension between the child and the child’s caretakers can result in an anal fixation. This anal fixation or anal character is what we know today as OCPD. Although the field has moved away from this psychoanalytic explanation, the traits that characterize these individuals remain largely unchanged.

Diagnosis

According to the DSM-IV-TR, OCPD is described as a “pervasive pattern of preoccupation with orderliness, perfectionism, and mental and interpersonal control, at the expense of flexibility, openness, and efficiency.” These behaviors typically begin in early adulthood and present in a variety of contexts. In an effort to maintain control, individuals with OCPD become obsessed with rules, details, lists, order, organization, and schedules. Such individuals hold themselves and others to high, unrealistic standards, resulting in problems with relationships, friendships, and with their own personal sense of well-being. These individuals are oblivious to the fact that in their quest for perfection, they are sacrificing efficiency and, as a result, they are often unable to accomplish everyday responsibilities and meet deadlines. For example, an individual with OCPD might spend more time searching for a lost shopping list than spend a few moments to rewrite it.

People with OCPD are often excessively dedicated to work and the need to be productive, for reasons beyond obvious economic necessity. For this reason, they rarely participate in leisure activities and feel they do not have time to take vacations. When they do take a vacation, they are unable to relax.

They equate not working with wasting time and become so uncomfortable with this idea that they bring work to do while they are on vacation. Individuals with OCPD prefer activities that are structured, with clear rules to follow, such as sports. They are not, however, able to play sports ‘for fun.’ Sports and activities are approached very seriously and they strive for perfection. For example, a game of basketball is considered an opportunity to develop the perfect free throw rather than an enjoyable way to spend time with friends.

According to DSM-IV criteria, individuals with OCPD tend to be overconscientious, scrupulous, and inflexible about matters of morality, ethics, or values. They tend to be self-deprecating about personal mistakes. Rules and laws are followed rigidly and interpreted literally. They believe rules are not meant to be bent or broken under any circumstances. These behaviors should not be accounted for by cultural or religious identification.

Many people have collections of objects that are meaningful to them. People with OCPD, however, tend to be ‘pack rats’ and have trouble discarding worn-out or useless objects, even those without sentimental value. They will often engage in hoarding behavior and collect many different materials, such as old appliances and magazines, out of a fear of needing them, not because they enjoy the objects of their collection. They can also be very stingy or miserly with money and see it as something to be hoarded and conserved for potential emergencies.

Individuals with OCPD have great difficulty in delegating tasks to others. They believe that there is only one right way to do a task and that everyone should conform to their high expectations. They are typically controlling, bossy, and give detailed instructions on how to complete menial tasks (e.g., how to load the dishwasher, how to wash the car). They become upset and irritated if their directions are not followed exactly. It is unusual for OCPD to be the patient’s primary reason for seeking treatment as people with this disorder are generally oblivious to the impact of their behaviors on other people. Often, they will begin therapy to receive treatment for problems with anxiety, stress, or relationship issues. Diagnosis depends on careful observation and behavioral assessment,

especially since some features of OCPD may overlap with other personality disorders. It is necessary to assess the impact of these behaviors on daily functioning as these traits, in moderation, can be desirable and adaptive. It is also important to distinguish between obsessive-compulsive disorder (OCD) and OCPD. Although these disorders share certain behavioral features, there are notable differences, affirming that OCPD is not a prerequisite to the development of OCD. People with OCD have obsessions and compulsions; however, they are not typically relevant to real-life problems and cause significant distress to the individuals. Symptoms experienced as part of OCD are ego-dystonic, that is, they are inconsistent with the person's self-conception and personality and have variable intensity, duration, and morbidity. Individuals with OCPD are comfortable with their rules, procedures, and beliefs. Unlike in OCD, these behaviors are considered ego-syntonic or congruent with the person's self-concept and are therefore not subject to resistance. Additionally, the behaviors tend to be fixed, long-standing, and enduring. In reality, a person may be suffering from both OCD and OCPD, but the two disorders are not always comorbid. OCPD has been associated with conditions other than OCD, including ulcerative colitis, hypochondria, depressive disorders, anorexia nervosa, self-mutilation, and somatoform disorder, in addition to anxiety disorders.

Assessment

A diagnosis of OCPD is most typically made following the administration of either a semistructured or an unstructured diagnostic interview. There are five semistructured interviews used to diagnose the DSM-IV personality disorders, including OCPD: Diagnostic Interview for Personality Disorders (DIPD), International Personality Disorder Examination (IPDE), Personality Disorder Interview-IV (PDI-IV), Structured Clinical Interview for DSM-IV Axis I Personality Disorders (SCID-I), and Structured Interview for DSM-IV Personality Disorders. The questions asked in semistructured interviews are systematic and tend to provide a more comprehensive and reliable assessment than unstructured interviews. Semistructured interviews provide specific questions for the diagnostic criteria of OCPD and increase the ability to replicate the results across interviewers. Currently, results of structured assessments are not part of the diagnostic criteria for OCPD in the DSM-IV, though it has been proposed by the APA and National Institute of Mental Health DSM-V Nomenclature Work Group to be included in the DSM-V. Proponents of unstructured interviews prefer to use assessments such as Shedler-Western Assessment Procedure-200 (SWAP-200). The increased flexibility of this type of interview allows the therapist to obtain additional information about the individual's life history in order to put their symptoms in context. This measure has been shown to have excellent construct validity when used to assess personality disorders.

Etiology

Multiple researchers have tested the validity of Freud's theory regarding toilet training and the development of anal character traits. One study reported a significant positive relationship between anal eroticism and obsessional-compulsive traits,

but overall, there appears to only be meager, if any, support for this psychoanalytically based explanation. Currently, psychologists favor an explanation based on a combination of biological, psychological, and environmental factors. Although there is no evidence to currently support a solely biological basis for OCPD, there is empirical support for the following environmental factors: parental overcontrol, learned compulsive behavior, and emphasis on perfectionism. Children who reported higher levels of perfectionism and rigidity have higher rates of OCPD than children not reporting those traits. Individuals with OCPD tend to have been raised by authoritarian parents. These parents are characterized as being extremely strict and having high expectations for their children but show only minimal levels of emotional nurturance. As a result, children become used to striving for perfection in order to please their parents but do not form strong emotional bonds. To avoid the feelings of shame and guilt that result when these standards are not met, these individuals mimic their caregivers, develop an obsession with perfection, and become acutely focused on minute details to ensure their flawlessness. There are no data that upbringing alone is responsible for the development of OCPD. These environmental factors most likely interact with biological factors such as a shared genetic predisposition. In turn, these psychological and behavioral dispositions appear to be reinforced by family factors such as authoritarian parenting styles.

Epidemiology

Although estimates of prevalence rates vary, it is generally accepted that the prevalence of OCPD in community samples is about 1% and about 3–10% in clinical samples. According to a National Epidemiologic Survey published in 2004, 14.8% of adult Americans (or 30.8 million) had at least one personality disorder. Of these disorders, OCPD had the highest prevalence, with approximately 7.88% (or 16.4 million) having this diagnosis. Odds of developing OCPD were found to be the highest for young Caucasians with at least some college education ($OR = 1.18$) though the effect size for education was small. Caucasians have a higher prevalence rate of OCPD than both Hispanics ($OR = 0.71$) and Asians ($OR = 0.60$). Odds of having OCPD were lowest for respondents in the oldest age groups ($OR = 0.62$) and for those with less than a high school education ($OR = 0.77$). There were no differences in prevalence for gender, income, marital status, or region. It is necessary to be cautious when interpreting results of epidemiological studies as the prevalence rates provided have been shown to vary based on methodological issues such as when the assessment occurred, presence of axis I disorders, the source of information, and the instrument used. For example, personality disorders tend to be made less frequently with unstructured interviews than with semistructured interviews. In addition, incidence of OCPD is higher in epidemiological studies utilizing DSM-III criteria as the DSM-IV-TR has a higher amount of criteria required for diagnosis.

Treatment

Of all the personality disorders, OCPD is considered to be the most responsive to treatment. There are three primary approaches to the treatment of this disorder. Though the

approaches are different, the goal is to help the individuals develop more realistic expectations for themselves and others and to help them understand that decreasing rigidity can increase productivity. The first of these approaches, cognitive-behavioral therapy (CBT), tends to be the most accepted by people with OCPD as it is the most structured. CBT focuses on changing maladaptive beliefs that performance is either perfect or the person is a failure. Because people with OCPD have difficulty relating to and recognizing the feelings of others, empathy training and interpersonal skills are commonly included in CBT. A second approach is group therapy, although care must be taken to ensure a proper balance of personalities within the group. Due to the controlling nature and lack of empathy often found among people with OCPD, these individuals try and dominate the group and are often rejected by the other group members. The third most commonly used form of therapy is psychodynamic psychotherapy, which helps the individuals recognize and reconcile their insecurities resulting from problems with toilet training. Traditionally, psychodynamic psychotherapy is unstructured with the therapist assuming a more passive role than other forms of therapy. This can be problematic when dealing with people with OCPD since techniques such as free association can result in the individual ruminating about minute details. There has been very limited empirical research surrounding the efficacy of these different treatments for OCPD. Even less data exist regarding cross-cultural and gender issues in treatment. Therefore, most treatment efficacy data and recommendations come from generalizations drawn from clinical experiences or by looking at OCPD as part of a broader category of personality disorders. Research has, however, shown a significant decrease in OCPD symptoms when using long-term supportive–expressive psychodynamic therapy, although it may be more realistic and practical to utilize a more short-term and goal-directed form of therapy.

See also: Behavior Analysis; Big Five Model and Personality Disorders; Cognitive Behavior Therapy.

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Operant Conditioning

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Glossary

Aversive control Changing the probability of behavior through the use of punishment or negative reinforcement.

Conditioned reinforcer A stimulus that maintains behavior because it predicts the occurrence of a reinforcer.

Delay-reduction theory (DRT) A model for predicting choice, according to which the value of a conditioned reinforcer is greater the more improvement it signals in time to reinforcement.

Discriminative stimulus (S^D) An event or stimulus that precedes, and sets the occasion for, an operant behavior.

Extinction In operant conditioning: (1) when responding no longer produces reinforcement; (2) the decline in responding that occurs when responding no longer produces reinforcement.

Matching law Responding on two or more concurrent schedules of reinforcement is distributed in proportion to the amount of reinforcement available on each schedule.

Negative reinforcement A response is strengthened (becomes more likely) when it is followed by the removal, through avoidance or escape, of an aversive stimulus or situation.

Operant conditioning The increase or decrease of an operant (instrumental) behavior as a function of the consequences that follow it.

Punishment The likelihood of a behavior decreases when it is followed by an aversive stimulus or event or by the withdrawal of a positive stimulus or event.

Reinforcement An increase in the likelihood of a behavior when it is followed by a (usually positive) stimulus or event.

Reinforcement principle A higher frequency (more preferred) behavior can serve as a reinforcer for a lower frequency (less preferred) behavior; conversely, a lower frequency behavior can serve as a punisher for a higher frequency behavior.

Stimulus control The degree to which behaviors reinforced in the presence of particular stimuli are emitted in the presence of other stimuli.

Three-term contingency (S^D -R- S^R) A response (R) that is emitted and reinforced (S^R) in the presence of a discriminative stimulus (S^D) becomes more probable in the future in the presence of that, or a very similar, stimulus.

The American psychologist B.F. Skinner (1904–1990) suggested that much of an organism's observable behavior could be categorized into classes of actions that he termed operants, since these actions operated on (and changed) the environment in some specifiable way. Thus, the process by which an organism's interactions with its environment modified its future actions came to be known as operant conditioning or instrumental conditioning. The consequences responsible for this modification are known simply as reinforcement and punishment. Responses followed by reinforcement are more likely to recur; those followed by punishment are less likely to recur. The response–reinforcer relationship is central to operant conditioning and helps distinguish it from Pavlovian conditioning, as we discuss briefly below.

More is needed, however. Rarely does a professor lecture unless there is at least one student in the classroom. Rarely does a motorist drive through a red traffic signal. Another term is needed then in addition to response and reinforcement. This useful third term is the discriminative stimulus, a stimulus preceding or accompanying the operant response. In the examples given, the discriminative stimulus for lecturing is a classroom with students present and the discriminative stimulus for the motorist to drive is a green traffic signal. These stimuli are called discriminative stimuli because they signal which responses may lead to positive reinforcement and which may lead to the avoidance or reduction of punishment. In other words, they set the occasions on which responses may be reinforced.

Basic Concepts

The Three-Term Contingency

The three-term contingency refers to the relationship between these three central events: the discriminative stimulus, the response, and the reinforcer: a response that is emitted and reinforced in the presence of a discriminative stimulus becomes more probable in the future in the presence of the same or very similar discriminative stimulus. A different relationship between stimuli, responses, and reinforcers occurs in Pavlovian conditioning. Thus, we should briefly distinguish between these two fundamental conditioning processes.

Operant Versus Pavlovian Conditioning

Both operant and Pavlovian conditionings are powerful ways of modifying behavior. There is an important difference, however, in the kind of behavior they affect. Pavlovian conditioning (also called respondent conditioning or classical conditioning) deals with responses that follow, or are elicited by, a specific stimulus (the unconditioned stimulus or US). Examples include salivating to the taste of food and recoiling at the touch of fire. Operant behavior has the appearance of being voluntary, whereas there is no question of interpreting most respondent behaviors (e.g., an eye blink to a bright light or to an air puff directed at the eye) as voluntary. In Pavlovian conditioning, an originally neutral stimulus, such as the ringing of a bell, is paired with a US such as meat powder, for a hungry dog (which salivates

to the taste of meat powder, the UR or unconditioned response). After repeated pairings, the neutral stimulus (CS or conditioned stimulus) comes to elicit salivation, that is, the CS elicits what is now the CR, or conditioned response. In operant conditioning, by contrast, the critical relation is between the response and reinforcer: the latter makes the former subsequently more probable. The experimenter cannot arrange response–reinforcer pairings unless the organism makes the response.

Stimulus Control

If a response that has been conditioned in the presence of one stimulus is then emitted when new stimuli are presented, we say that stimulus generalization has occurred (the response has generalized to the new stimuli). If the response is not emitted when new stimuli are presented, discrimination has occurred (the new stimuli do not signal the same response–reinforcer relation as in the presence of the original stimulus). Thus, generalization and discrimination reflect differing degrees of stimulus control, or covariation of stimuli and responses. Generalization reflects relatively imprecise (or broad) stimulus control and discrimination reflects relatively precise (or narrow) stimulus control. Generalization and discrimination are matters of degree and may be represented by generalization gradients. Two examples of generalization gradients are shown in **Figure 1**. These gradients indicate the extent to which responses conditioned in the presence of one stimulus are emitted in the presence of (generalize to) other stimuli along the same sensory continuum. The gradient shown at the top of **Figure 1** depicts a scenario in which reinforcement has been delivered to an organism, such as a pigeon, for responding to a stimulus with a wavelength at 589 nm (yellow light). Following this training, the organism is exposed to an assortment of wavelengths across the visible spectrum with reinforcement typically no longer provided. The experimenter measures the

rate of responding (here responses per minute) as a function of wavelength. The figure describes the typical generalization gradient with a peak at the previously reinforced wavelength and with diminishing response rates as the wavelength becomes more distant from 589 nm. The fact that responding occurs at relatively high rates to wavelengths different from 589 nm is an example of generalization; the fact that the responding is less for wavelengths other than 589 nm is an example of discrimination. By contrast, the lower gradient in the figure represents the outcome if reinforcement training had not occurred: low rates of responding, undifferentiated with respect to wavelength.

Discrimination can be trained if responses to one stimulus (say a yellow light) are reinforced and responses to a second stimulus (say an orange light) are not. Discrimination training results in more precise stimulus control and is reflected in a steeper generalization gradient. A history of such experiences (differential training) accounts for the marvelous discriminatory power sometimes demonstrated by connoisseurs (e.g., wine tasting experts).

Acquisition and performance

We must take care to acknowledge that performance may not always reflect what has been learned (or acquired). The lower gradient in **Figure 1** might also be obtained if the organism being tested were colorblind. And such low, undifferentiated rates of responding might also be evident should the organism not be properly motivated, that is, deprived of the reinforcer (e.g., food may not motivate key pecking reinforced with food when the organism is already sated with respect to that food). This is the basis of the classic learning–performance distinction: The availability of an adequate reward for a deprived organism may be required to translate learning into performance.

The Nature of Reinforcement

Classical learning theory posited a fixed set of what were known as primary reinforcers, such as food, water, and sex. However, it was obvious that other reinforcers motivated most behavior. Thus, there occurred a proliferation of putative reinforcers such as exploration, affection, avoidance of discomfort, etc. A better way to treat reinforcement conceptually was provided by David Premack who called it the reinforcement principle; today, it is often called the Premack principle.

The Reinforcement Principle

Premack made the point that almost any activity may be reinforcing depending on its availability. He stressed that it was more useful to discuss reinforcers in terms of activities (e.g., eating) rather than the stimulus (e.g., an ear of corn). He showed that the same activity that serves as a reinforcer for some responses may be the reinforced response in other situations. For example, he showed experimentally that a thirsty rat will run more than usual when doing so produces access to water while a long-idle rat will drink more water than usual when doing so obtains access to a running wheel. An implication of this, confirmed in studies with humans and nonhumans, is that deprivation affects an activity's position in an

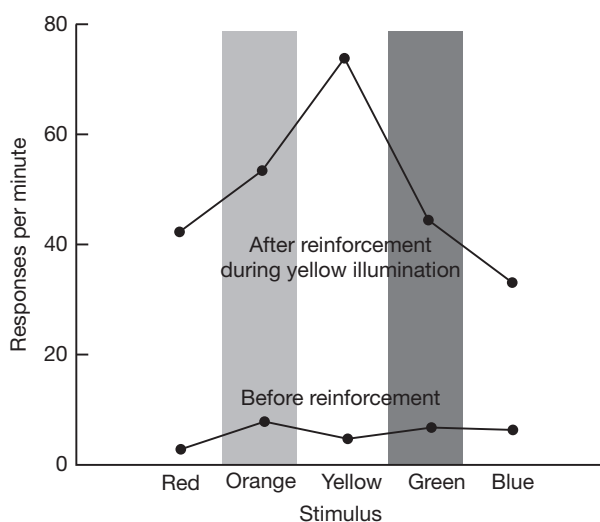


Figure 1 Generalization gradients before (bottom) and after differential reinforcement training. Adapted from Fantino E and Reynolds GS (1975) *Introduction to Contemporary Psychology*. San Francisco: W.H. Freeman & Co. Shadings indicate different colors. See text for details.

organism's reinforcement hierarchy. Every organism has a reinforcement hierarchy consisting of most preferred to least preferred activities. The hierarchy may be determined by observation and/or by preference tests. Given comparable deprivation conditions, the higher ranked activity is the one performed and chosen more often. The crux of Premack's theory and experimentation is that any activity on the hierarchy may reinforce any activity below it (i.e., the higher ranked activity made contingent upon the performance of the lower ranked activity will make the lower ranked activity more probable than it would be otherwise). Similarly, that same higher ranked activity will be reinforced (i.e., made more probable) when its performance leads to a still higher-ranked activity.

The Correlational View of Reinforcement

The second relativistic breakthrough involved the realization that correlation, not simple temporal contiguity, was the cornerstone of conditioning. This was shown to be true for both Pavlovian conditioning and operant conditioning. Events that bring the organism into the presence of higher rates of primary reinforcement, or closer in time to primary reinforcement, themselves serve as reinforcers. In order for the reinforcement effect (response strengthening) to occur reliably in the presence of a particular stimulus, responding during the occurrence of the stimulus should be correlated with a higher rate of reinforcement than that occurring in its absence. It is not enough to consider only the absolute temporal relation between the stimulus and the reinforcer. This correlational view will be elaborated when discussing the topics of choice and conditioned reinforcement.

Learning Phenomena

The acquisition of new behavior is sometimes acquired by deliberate shaping, a simple process in which successive approximations to the target behavior are reinforced. New behavior may also be learned by modeling or by imitation, and for organisms with language, with instructions. Once behavior is acquired, how is it maintained?

Schedules of Reinforcement

Just as reinforcement is instrumental in the acquisition of behavior, so it is in the maintenance of that behavior. Although in some situations appropriate reinforcers are provided each time the relevant response occurs (as when we receive today's *New York Times* and we give the newsboy \$2.00), most reinforcers do not occur on continuous schedules of reinforcement (CRF). Instead, they are obtained on schedules of partial or intermittent reinforcement. For example, only some of our phone calls are answered and we may drive past our destination several times seeking out a parking space. There are many intermittent schedules of reinforcement. We shall consider seven of the most common. Interval schedules are those in which reinforcement occurs for the first response after a certain amount of time has elapsed. In a fixed-interval (FI) schedule, that period of time is constant. Thus, in a FI 1-min schedule, the first response after 1 min has elapsed is

reinforced. In a variable-interval (VI) schedule, that period of time is variable so that in a VI 1-min schedule, reinforcement becomes available after intervals that average 1 min in duration. Ratio schedules are those in which the *n*th response is reinforced. Thus, a CRF schedule is effectively a fixed-ratio (FR) 1 schedule. While the ratio is always the same (or 'fixed') in any FR schedule, in variable-ratio (VR) schedules, the ratio varies from trial to trial (as the intervals do in a VI schedule) with an arithmetic mean equal to the value of the VR schedule. Fixed-time (FT) and variable-time (VT) schedules are analogous to FI and VI schedules except that no response is required for reinforcement – hence, these are response-independent schedules of reinforcement. Finally, extinction (EXT) is a schedule in which reinforcement does not occur. We consider the important role of EXT in the next section.

The basic schedules of reinforcement generate reliable and characteristic patterns of responding: very high constant rates on VR schedules, which make them popular with operators of slot machines and unpopular with labor leaders; a pause after a reinforced response on FR and FI schedules, with accelerated response rates on FI schedules as the interval elapses; and steady response rates on VI schedules which make them ideal for use as baselines in studies of independent variables, for example pharmacological agents. Although no responding is required on either FT or VT schedules, substantial amounts of responding typically occur – perhaps due to adventitious reinforcement – also known as superstitious responding.

While we can identify everyday examples of all of these schedules, behavior maintained on schedules of reinforcement is not always easy to recognize. Much of behavior is under the control of more complicated schedules that only recently have been studied intensively in the laboratory. The laboratory study of simple schedules nonetheless helps us to understand much human behavior and also helps us to understand behavior on more complex schedules. Reinforcement schedules have predictable, orderly, and sometimes profound effects on the organism's pattern and rate of responding.

Extinction

EXT would appear to be the simplest of schedules (along with CRF), but it has several important functions. First of all, of course, a behavior placed on EXT will soon cease to be emitted. This is true of behavior that had been reinforced on simple schedules of reinforcement in the laboratory as well as of problem behaviors such as temper tantrums that have occurred in the home or school. How quickly EXT is effective depends on the schedule that had previously maintained the behavior. Behavior after CRF extinguishes rapidly since the discrimination between the former reinforcement period and the new EXT period is easily formed. Thus, you are unlikely to place money in a previously reliable vending machine after it fails to produce a soft drink when you have inserted the requisite \$2.00. Most likely, one trial of EXT will be enough to send you in search of another machine. Similarly, if a parent has always reinforced tantrum behavior in his child (by giving in to the child's demands), it should be relatively easy to extinguish the tantrum behavior by placing it on EXT (by ignoring it). On the other hand, if the parent had only occasionally reinforced the tantrums (say on a lean VI schedule), the tantrums may take a very long time to extinguish: from the child's point

of view, it would be difficult to discriminate the former period of reinforcement (on the lean VI) and the present period of EXT. In general, EXT proceeds most rapidly after CRF, next most rapidly after the more predictable fixed schedules (FR and FI), and most slowly after more variable schedules (such as VI and VR).

EXT does not wipe the behavioral slate clean. First of all, after EXT appears to be complete (the behavior placed on EXT is no longer emitted), spontaneous recovery typically occurs. Thus, the next time a pigeon is placed in the apparatus in which it has undergone EXT, the previously reinforced behavior will emerge again, though for a relatively short time. Similarly, if you come across the vending machine a week after it had malfunctioned, you may well risk another \$2.00. Spontaneous recovery can also be understood in terms of discrimination: the situation when the pigeon is placed in the experimental chamber again resembles the times when responding has been reinforced as well as the one time when EXT was in effect. Second, when reinforcement is reestablished for a response that has been extinguished, it is reacquired almost instantaneously, revealing that EXT had not eradicated the original acquisition of the response. This fact is reminiscent of the learning-performance distinction we made earlier. The first reinforced response after EXT reactivates response strength.

EXT plays a critical role in discrimination training, as we discussed in our section on stimulus control. We elaborate on EXT's role in discrimination learning next when we turn our focus to attention.

Attention

Organisms attend more to stimuli differentially correlated with reinforcement. Thus, hungry pigeons orient toward a light that precedes food, and people attend to others who dispense reinforcers and punishers (e.g., parents, police officers, and professors). Just as differential reinforcement facilitates discrimination learning, so does it predispose organisms to attend to stimuli that are differentially correlated with reinforcement. For any given organism and situation, certain stimuli will be more readily attended to than others. Thus, cats attend much more readily to movement than to color, and humans to what is presented on a television screen than to the box of tissues sitting on top of it.

Attention has been studied with compound stimuli that consist of two or more component stimuli – for example, a vertical line on a green key or a horizontal line on a red key. Would pigeons presented with these two stimuli attend to the color or form? In one experiment, all four pigeons showed control by the color in the compound but not by the form. Thus, it appears that they attended to color and ignored form. But subsequently, the pigeons were given discrimination training in which the vertical line was uniquely correlated with reinforcement and the horizontal line was uniquely correlated with EXT. Unsurprisingly, the pigeons readily acquired this discrimination based on form. They were then reexposed to training and testing with the compound stimuli. While their choices had been predominantly controlled by color before the discrimination training with form, after this training they attended predominantly to form. These results demonstrate that reinforcement history affects attention.

The control of responding by a stimulus depends on its salience and on the history of reinforced (or extinguished) responses in its presence as well as on the sensory capacities and genetic predisposition of the attending organism. However, it also depends critically on the salience and reinforcement history of other stimuli simultaneously present. This generalization is supported not only by results from the compound stimulus experiment discussed above but also from experiments on overshadowing and blocking. Overshadowing is a phenomenon known since Pavlov's time: a more intense CS will overshadow a less intense CS, meaning that the CS will not be likely to elicit a CR. The same phenomenon occurs in operant conditioning. Overshadowing has been shown to be an attentional phenomenon that can be best understood in terms of stimulus (or sensory) properties. A more complex phenomenon of stimulus selection can be demonstrated with compound stimuli. In blocking, the prior correlation of a stimulus with reinforcement prevents (or blocks) the development of effective control by a second stimulus when the two stimuli are presented concurrently in compound. The phenomena of overshadowing and blocking have helped shape the contemporary view of attention and of stimulus control.

In summary, organisms are predisposed to attend to particular stimuli in their environment. Certain classes of stimuli may be more attention getting than others, either owing to the organism's sensory capacities or its prior experience with members of this stimulus class. The particular situation, or stimulus context, may help direct which stimuli are attended to. For example, if a student tries a new food (scallops) for lunch in his college cafeteria and then begins to feel ill, he is more likely to associate the illness with the scallops than with his luncheon companions or with the table at which he is sitting. The importance and ubiquity of such stimulus–consequence interactions have been widely demonstrated.

Conditioned Reinforcement

In Pavlovian conditioning, an originally neutral stimulus, becomes an effective CS by virtue of pairings with a US. A similar process occurs in operant conditioning in the sense that stimuli that reliably predict the occurrence of reinforcement themselves become conditioned reinforcers. Conditioned reinforcers are familiar to anyone who has seen animal acts at a zoo or marine park. The clickers that are used to train and maintain spectacular chains of behavior at these shows are conditioned reinforcers that reinforce behavior by virtue of their learned association with reinforcement. Conditioned reinforcers are also commonly used in dealing with children and adults with behavior problems. But in addition to their widespread applications, conditioned reinforcers have played a prominent role in clarifying what is the nature of reinforcement.

Theories of Conditioned Reinforcement

Establishing the necessary and sufficient conditions for establishing a stimulus as a conditioned reinforcer has been the lively source of theoretical and empirical disputes. The traditional view of conditioned reinforcement held that stimuli that were

contiguous with reinforcement became conditioned reinforcers. Thus, the pairing hypothesis of conditioned reinforcement stipulated that stimuli frequently paired with reinforcers themselves became (conditioned) reinforcers. However, research showed that pairing a stimulus with a reinforcer is neither a necessary nor a sufficient condition for establishing that stimulus as a conditioned reinforcer. It is not necessary because stimuli that are not in close temporal contiguity with reinforcement may nonetheless act as conditioned reinforcers. It is not sufficient because stimuli in close temporal contiguity with reinforcement do not necessarily function as conditioned reinforcers.

Two more contemporary theories of conditioned reinforcement are uncertainty-reduction theory (also known as the information hypothesis of conditioned reinforcement) and delay-reduction theory (DRT). We consider each in turn as well as an elegant body of experiments that distinguish between them.

Uncertainty-reduction theory states that the conditioned reinforcing strength of a stimulus is a function of how informative it is about the availability (or nonavailability) of reinforcement. In other words, the more the occurrence of a stimulus reduces uncertainty about the availability of reinforcement, the stronger a conditioned reinforcer that stimulus will be.

DRT states that the conditioned reinforcing value of a stimulus is in part a function of how temporally distant reinforcement had been prior to the onset of that stimulus. The greater the percentage improvement, in terms of contiguity to reinforcement, correlated with the onset of the stimulus, the stronger a conditioned reinforcer that stimulus will be. Thus, a stimulus associated with a FI 30-s schedule should be a stronger reinforcer if it is preceded by a 120-s period of nonreinforcement than if it is preceded by a 15-s period of nonreinforcement. In the first case, the onset of the FI 30-s stimulus is correlated with an 80% reduction in time to reward (120/150); in the second case, the onset of the FI 30-s stimulus is correlated with only a 33% reduction in time to reward (15/45). Another theory of conditioned reinforcement that is similar in spirit to DRT is the hyperbolic value-added model. It would make the same prediction in the case above since the FI schedule that follows the longer period of nonreinforcement represents greater value added than the same FI schedule following the shorter period of nonreinforcement.

Observing

The major experiments that have been conducted to distinguish between the efficacy of uncertainty-reduction theory and DRT have used the observing-response procedure. Observing responses are those that produce stimuli correlated with schedules of reinforcement but have no effect on the occurrence of reinforcement. For example, two equally probable schedules of reinforcement differing only in frequency of reinforcement – say, VT and EXT – may alternate unpredictably. Effective observing responses would produce stimuli, identifying the schedule in effect.

The study of observing responses has been deemed central to an understanding of the basis for conditioned reinforcement. Does a stimulus function as a conditioned reinforcer (and therefore maintain observing responses) because it is correlated with the occurrence of primary reinforcement (as required by DRT and other conditioned-reinforcement hypothesis views) or does

a stimulus function as a conditioned reinforcer (and therefore maintain observing responses) because it predicts or informs about the availability of reinforcement (the information or uncertainty-reduction hypothesis)? As Bloomfield argued, the critical test for distinguishing between these views is whether or not a stimulus associated with an undesirable outcome, or bad news (in this case, the news that the current schedule is EXT), is reinforcing. The overwhelming preponderance of evidence shows that it is not, a result consistent with the conditioned-reinforcement hypotheses such as DRT. These results have been obtained with humans as well as with nonhumans (including several experiments with pigeons).

Given that stimuli associated with negative outcomes do not serve as reinforcers, we can ask whether the less positive of two stimuli in a situation will serve as a reinforcer. This is a fundamental question since the less positive stimulus is still associated with primary reinforcement. In other words, if a stimulus is paired with an FI 5-min schedule and its availability alternates with an FI 1-min schedule, will the FI 5-min stimulus serve as a reinforcer (e.g., will it maintain observing)? The answer is that it will not. Yet, the very same stimulus (associated with the same FI 5-min schedule) will serve as an effective reinforcer (and maintain observing) if it instead alternates with a FI 10-min schedule (instead of the FI 1-min schedule of the prior example). In the case of the alternating FI 1 and FI 5 schedules, the average time to reinforcement is 3 min. While occurrence of the stimulus associated with the FI 1 represents a reduction in time to reinforcement (from 3 to 1 min), and therefore serves as a conditioned reinforcer, occurrence of the stimulus associated with the FI 5 schedule actually represents an increase in expected time to reinforcement (from 3 to 5 min) and therefore does not serve as a reinforcer. When that same FI 5 alternates with FI 10, however, its occurrence is correlated with a reduction in time to reinforcement (from seven and one-half minutes to five) and therefore functions as a conditioned reinforcer. This is a critical discovery and one that clearly undermines the viability of views based strictly on temporal contiguity (such as the pairing hypothesis discussed earlier). It is the correlation of a stimulus with a reduction in time to reinforcement – not its contiguity with reinforcement – that largely determines its reinforcing strength. A similar conclusion applies to Pavlovian conditioning.

In summary, the research on observing points to this conclusion: only the more positively valued of two stimuli should maintain observing, since the less positive stimulus is correlated with an *increase* not a decrease in time to reinforcement (or a reduction, not an increase, in time to a punishing event). Conditioned reinforcers are those stimuli correlated with a reduction in time to reinforcement (or with an increase in time to an aversive event).

Choice

Most of our behaviors involve making choices about whether to engage in an activity or not (go-no go choice) or choosing among two or more simultaneously available options. The established method for studying choice is to present at least two schedules of reinforcement simultaneously. Technically, these are concurrent schedules of reinforcement. If two VI

schedules are presented concurrently, for example, the organism's responses on each of two response keys are reinforced according to the VI schedule associated with that key. The consequences of responding on each of the two keys may be varied systematically, and the effects upon the organism's choice responses may be measured.

As might be expected, choice in this procedure is remarkably sensitive to the manipulation of independent variables. Thus, organisms distribute more of their choice responses to outcomes with greater magnitudes (or durations) of reinforcement (say 6 s *versus* 2 s of food reward for a pigeon), to more preferred reinforcers (say bananas over lettuce for a monkey), or to the response that requires least effort (say if the force to activate the key is varied across keys). The variable that has been assessed most intensively, however, is the rate of reinforcement (e.g., as in VI 1 min *versus* VI 3 min schedules). The assessment of choice as a function of rate of reinforcement has given rise to elegant quantitative models of choice behavior.

The Matching Law

With concurrent interval schedules, the organism obtains a higher rate of reinforcement for responding on both schedules. This results from the fact that on interval schedules, reinforcements become available with the passage of time. If the organism responded exclusively to the preferred key (all other variables being equal, the one associated with the higher rate of reinforcement, i.e., is the richer VI schedule), it would obtain all the reinforcements available from that VI schedule but none from the other (less rich) VI alternative. But by responding at least occasionally on both alternatives, rate of reinforcement may be maximized. For example, if the organism were presented with a concurrent VI 1 VI 3 schedule, it would receive one reinforcement per minute if it responded exclusively on the VI 1, but 1-1/3 reinforcements per minute if it responded occasionally on the VI 3 schedule as well.

Richard J. Herrnstein took advantage of this characteristic of concurrent VI schedules to study how an organism's choice responses varied as a function of the relative rates of reinforcement on each of two concurrently presented VI schedules. He exposed pigeons to a series of conditions, each with a different pair of concurrent VI schedules, and plotted the percentage of choices made to one alternative as a function of the percentage of reinforcements received for responding on that alternative. For example, with a concurrent VI 1 VI 3 schedule, the percentage of reinforcements obtained on the VI 1 alternative is approximately 75%. What is the corresponding percentage of choices made to the VI 1? Herrnstein found that the answer approximated 75%. The results fell on a straight line with a slope approximating 1.0. In other words, the pigeons tended to 'match' their choice proportions to the reinforcer proportions arranged by the experimenter. In symbolic form:

$$R_1/(R_1 + R_2) = r_1/(r_1 + r_2)$$

where R denotes response rate, r denotes reinforcement rate, and the subscripts identify the two alternatives. A comparable matching relation has been shown to describe the amount of time an organism spends responding on one of two alternatives or engaged in one of two reinforced activities. This matching relation has provided a viable approximation to

choice in many different experiments with concurrent schedules, including experiments with pigeons pecking keys, pressing treadles, or responding in a shuttle box procedure; with rats pressing levers; and with humans performing a vigilance task.

The matching equation has been expanded to apply to a wider range of independent variables and situations by Herrnstein and by several of his students, including variations that help to account for absolute rates of responding on single (simple) schedules. The matching law has also been applied with success to address problem behaviors. References are included in the endnotes.

Alternatives to the Matching Law

There are alternative explanations for matching. Perhaps the most venerable is that associated with Alan Silberberg and Charles Shimp and their students. Their maximizing accounts stress the central role played by the interresponse time (IRT) or the duration of time between responses. Shimp has maintained that matching on concurrent schedules is a by-product of the organism's tendency to maximize reinforcement, that is, to select the option with the highest momentary probability of reinforcement at the time that the choice is made. According to this account, matching is a result of emitting IRTs that maximize momentary reinforcement probabilities. We conclude by noting that while organisms are indeed sensitive to momentary reinforcement probabilities, and that this sensitivity may well account for many instances of matching, it is nonetheless the case that matching has been shown to occur in the absence of measurable momentary maximizing.

Choice for conditioned reinforcers

We have already discussed the central role conditioned reinforcement plays in behavior. One attempt to assess the generality of the matching relation involved seeing whether it applied to choice for schedules of reinforcement that are themselves conditioned reinforcers. For example, consider again a choice between VI 1 and VI 3 schedules of reinforcement. This time, however, the schedules are not available concurrently but are the outcomes being chosen in a concurrent-chains procedure, depicted in Figure 2. This procedure measures choice by the rate of responding emitted in the choice phase, consisting of two equal, concurrently available, VI schedules, each leading to a different outcome (the outcome phase). Since the concurrent VI schedules in the choice phase are equal, differences in response rates between them may be assumed to reflect differences in the reinforcing effectiveness of the outcomes being chosen (in our example the VI 1 and the VI 3). Does the organism match its rate of choice responding to the reinforcement proportions available in the outcome phase, as the matching law would require? The answer is negative. Many experiments have demonstrated that the degree of preference for the richer outcome (here the VI 1) is a function of the length of the choice phase. The longer the choice phase, the more rewarding is the acquisition of either outcome: thus, choice for the preferred outcome tends toward indifference (choice proportion close to 0.50). With a very short choice phase, only the richer outcome brings the organism substantially closer to reward. Hence, choice for the preferred outcome tends toward exclusive preference. In summary, as the choice

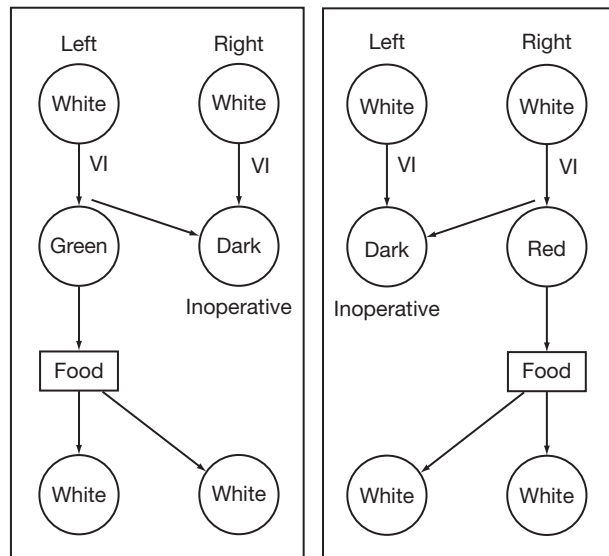


Figure 2 The concurrent-chains procedure, widely used in the study of choice. See text for details. Reproduced with permission from Fantino E (1969) Choice and rate of reinforcement. *Journal of the Experimental Analysis of Behavior* 12: 723–730.

phase increases in duration, the obtained choice proportions vary systematically from exclusive preference (1.0) to indifference (0.50).

Several contemporary models of choice have captured this finding, including two discussed earlier (hyperbolic value-added theory and DRT). The matching law fails here because it has no term for temporal context: it requires a 3:1 preference for the VI 1 over the VI 3 whatever the length of the choice phase. When discussing observing, we noted that a given schedule might be a conditioned reinforcer in some situations but not in others, depending upon the temporal context in which it was embedded. An extensive literature on choice for schedules of conditioned reinforcement also underscores the central role played by temporal context: outcomes may not be judged independently of the context in which they occur.

Self-Control

One of the most important by-products of the study of choice is that of the particular choice we refer to as involving self-control. Self-control involves a choice between an immediate smaller reward (the impulsive choice) and a larger more delayed reward (the self-control choice). Self-control, once thought to be an exclusively human ability, has been demonstrated in nonprimates as well. For example, hungry pigeons were given the opportunity to peck a red key (the impulsive option) and obtain food immediately, followed by a penalty period in which the pigeon waited in darkness for the next trial to commence. However, if the pigeon waited until the red key light turned green, it could peck the green key (the self-control option) and obtain food (in one condition, three times) without a subsequent penalty period (the next trial commenced as soon as the food was consumed). The results (averaged across the data for three pigeons) are shown in Figure 3. Note that while the pigeons demonstrated minimal self-control, their

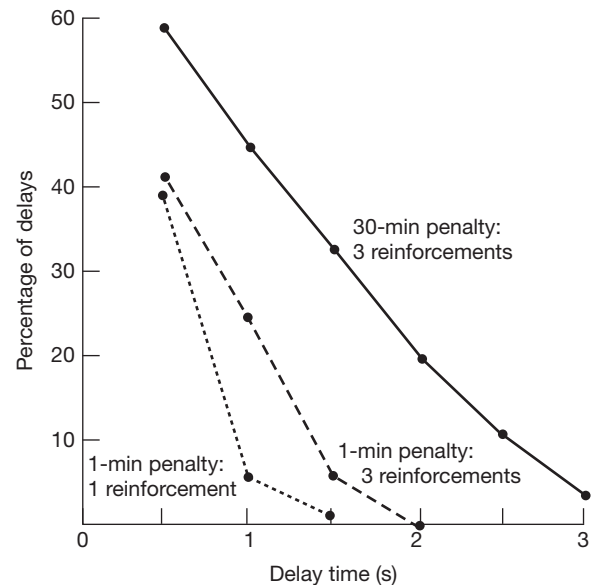


Figure 3 Rudimentary self-control in the pigeon. The more advantageous the delay, the more likely pigeons were to demonstrate self-control. The higher and flatter gradients indicate greater self-control. See text for details. Reproduced with permission from Fantino E (1966) Immediate reward followed by extinction vs. later reward without extinction. *Psychonomic Science* 6: 233–234.

tendency to do so increased in proportion to the advantage of delaying. In a subsequent experiment, pigeons were given the opportunity to avoid the impulsive option (pecking the red key) by making a ‘commitment’ response that prevented appearance of the red key. Some pigeons consistently made the commitment response, thereby demonstrating much higher rates of self-control than observed in the prior study.

A characteristic feature of self-control is preference reversal. Far enough in advance, humans invariably choose the larger, delayed reward (e.g., waking on time to do exercises before work, thus improving long-term health). However, as the actual choice approaches, preference may shift toward the smaller more immediate reward (an extra hour of sleep). Self-control in the larger sense involves rearranging our environment so that we are more likely to choose the larger delayed reward. Thus, in the example above, we may set an alarm clock and place it out of immediate reach, thus increasing the likelihood that we will arise in time for the exercises. The phenomenon of preference reversal is not restricted to humans. In a classic experiment, Howard Rachlin and Leonard Green showed that pigeons’ preference shifted from self-control to impulsivity as the actual choice approached.

In summary, self-control, as all choice behavior, is a product of environmental contingencies, and acquiring self-control involves understanding these contingencies and rearranging our environments to achieve our desired goals.

Other Issues

A complete account of behavior is obviously more complex than that presented in this brief overview. Here, we have

summarized some central conclusions about other important behavioral phenomena.

Aversive Control

We have concentrated on behavior maintained by positive reinforcement. The same principles apply to behavior maintained by negative reinforcement, that is, to behavior that is strengthened by the avoidance of or escape from aversive stimuli. Both positive and negative reinforcements strengthen the behavior they follow. On the other hand, punishment is the opposite of reinforcement in that it weakens the behavior it follows. Although there are subtle differences (punishment may create anxieties and may result in escape from a therapeutic situation), punishment and reinforcement are symmetrical in their effects (though, of course, opposite in sign) and no special behavioral principles are required to understand punishment.

Other Phenomena

Phenomena such as autoshaping, taste aversion learning, and the biological context of conditioning have been the subject of scores of landmark conditioning experiments.

Applications

The principles and methods of operant conditioning have been put to important use in several applied settings, notably clinical (especially in the treatment of autism and phobias) and educational settings. The application to the enhancement of self-control has already been noted, though the range of techniques has not. The methodology of operant conditioning has been exploited with great success in research on psychopharmacology and on brain mechanisms. In addition, cognitive phenomena have been better understood with the application of operant theory and methodology. References and suggested

readings appear in the endnotes. While the applications of operant conditioning may constitute the field's most celebrated contributions (and there are far more applied than basic practitioners), these contributions rest firmly on the theoretical and empirical underpinnings provided by the at least 60 years of research inspired initially by the canonical writings of B.F. Skinner.

See also: [Associative Learning](#); [Classical Conditioning](#).

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Organizational Behavior

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Glossary

Context effects The influences of organizational contexts on individuals and groups in them. The influences of individuals and groups on their organizational contexts. The reciprocal influences of individuals, groups, and organizational contexts.

Macroorganizational behavior Approaches to gaining knowledge about organizations that examine organizations as entities, and account for their structures and reciprocal influences with their environments.

Microorganizational behavior Approaches to gaining knowledge about organizations which focus on internal characteristics and processes, particularly on the behavior of individuals and groups in organizations.

Organizational behavior The systematic study of the antecedents and outcomes of the behaviors of individuals and groups in organizations and of the behaviors of organizations and populations of organizations.

The study of organizations and behavior in them has its roots in industrial, social, and cognitive psychology, organizational sociology, industrial/organizational economics, and public administration theory. Organizational behavior (OB) is the systematic study of antecedents and outcomes of individual and group behavior in organizations and the behavior of organizations and populations of organizations. The objects of study are everything from individuals and groups in organizations, to the organization as a whole, populations of organizations, and the relationship of organizations to larger social structures, such as the state and society. The field's primary goal is to understand behavior in organizational contexts.

The analytical tools of OB are those of social science generally. Data may be drawn from existing databases or collected specifically for a given study; common sources include individual or organizational surveys, laboratory studies, structured interviews, observation and ethnography, or corporate filings, reports, and press releases. Current quantitative analytical methods are similar to psychological, econometric, and epidemiological methods, such as ANOVA, multiple regression, computer simulations and survival analysis. Qualitative methods include grounded theory analyses, comparative case studies, and historical or archival research.

OB research is both interdisciplinary and relatively young. As such, it remains in a state of theoretical development. New theories and concepts are introduced on a regular basis, but there is little agreement on appropriate substantive issues for and styles of inquiry. OB typically divides itself into concern with 'micro' issues, or those issues that focus on individuals and groups in organizations, and 'macro' issues, or concerns for organizations and groups of organizations. Attention is beginning to be given to linking individuals and organizations to one another and to their contexts. This article describes the major research preoccupations in each of these areas.

Microorganizational Behavior

Early contributions to microissues in organizational behavior have their roots in industrial and social psychology. Systematic research on small group phenomena began with Kurt Lewin's

studies of leadership and the examination of small group processes at the Hawthorne works of Western Electric. Both of these activities occurred during the late 1920s and the 1930s.

For a number of years, the major topics of interest to researchers in organizational behavior were motivation, work attitudes, and leadership. Other specialties were more recently added to this body of research. Studies of these issues often ignore context effects.

Motivation

Motivation research in organizational behavior attempts to explain how individuals direct their energy over time toward accomplishing a shared, organizational goal. Motivation is a function of an individual's intensity, direction, and persistence of effort, and, coupled with his or her ability to perform, it accounts for employee performance on a given task.

The history of research in motivation can be roughly divided into earlier theories that espouse a needs-based approach, and contemporary theories that focus on cognitive antecedents to performance. Despite the fact that early theories have little empirical support, they retain importance in the work setting since managers frequently cite them, presumably because they are both intuitively appealing and because they persist in MBA curricula. Key early theories include Maslow's Hierarchy of Needs Theory, which postulates inherent, ordered human needs; MacGregor's Theory X and Y, in which employees are viewed as either inherently disliking and resisting work or as amenable and willing to participate in work; Herzberg's Two-Factor (Motivation-Hygiene) Theory, in which intrinsic factors are related to job satisfaction and extrinsic factors are related to job dissatisfaction; and McClelland's Three Needs Theory, which divides employees by their need for achievement, power, and affiliation. One of the earliest attempts at examining motivation is Skinner's Reinforcement Theory, in which behaviors are environmentally caused (e.g., if you do X, you will get Y). It is important to note that reinforcement is often excluded from theories of motivation because it does not account for the initiators of behavior.

Contemporary theories of motivation include Locke and Latham's Goal-Setting Theory, Cognitive Evaluation Theory,

Bandura's Self-Efficacy Theory, Adams' Equity Theory, and Vroom's Expectancy Theory. The key finding of Goal-Setting Theory is that high specificity in management goals is positively related to high performance on a task, and particularly that goals with high difficulty, when accepted by employees, produce high performance. Cognitive Evaluation Theory demonstrates that extrinsic rewards (such as pay) for a behavior that was previously intrinsically motivated decreases overall motivation, suggesting that pay should not be contingent on performance. Bandura's Self-Efficacy Theory, also known as Social Learning or Social Cognitive Theory, focuses on an individual's belief that he or she is capable of performing a task, and develops tools to stimulate this belief. Equity Theory argues that employees compare the ratios of their effort on the job and pay relative to a judgment of a comparison employee's effort and pay; the individual then adjusts one or more components, such as his or her effort, to achieve equity. Current research in Equity Theory attempts to address not just the rewards allocation and comparison group, but also the distributive, procedural, and interactive justice of certain decisions. Expectancy Theory is the most current of the contemporary theories of motivation; its key result is to emphasize the cognitive links between effort and performance (expectancy), performance and rewards (instrumentality), and rewards and personal goals (valence). Expectancy Theory admonishes the manager to focus on clearly linking and aligning organizational goals, individual rewards, and employee goals.

Work Attitudes

A second frequently researched topic in organizational behavior is work attitudes, or positive or negative evaluations about various aspects of one's work. Much of the work is concerned with developing attitudinal measures and searching for antecedents and consequences of work attitudes. Newer lines of research explore the basic nature of affect (emotion), the relationship of moods and work, and the expression of emotion at work. Despite substantial evidence that job satisfaction is not consistently linked with performance, it still remains the most frequently studied topic, followed by job involvement and commitment.

Considerable debate has swirled around whether work attitudes are inherent within individuals or whether they are a product of the environment. A weak but significant correlation has been found between twin work attitudes, suggesting there may be a genetic link. This position is questioned by researchers who provide evidence that situational factors influence emotion. For example, individuals' attitudes are often shaped by the attitudes of others around them, the amount of pay they are given to do a job, their position as a demographic minority or majority among their coworkers, or the financial performance of their employers. Some theorists propose that job attitudes are the result of an interaction between individuals and their environments. For instance, narcissists are more likely to enjoy tasks where there is ample recognition for their achievements, whereas the attitudes of individuals who are less narcissistic are likely to be unaffected by this characteristic of the task. In the interactionist approach, what matters for job attitudes is the match between an individual's personal values and the values of an organization. Yet, some research

cautions that this middle-ground is still an oversimplification of the relationship between individuals and their roles and does not adequately account for how both personalities and situations respond to each other and change through time.

Leadership

Leadership is probably the largest, yet most nebulous area of management research. In general, the field is concerned with an individual's capacity to influence a group toward a shared set of goals, particularly through the development of vision, strategy, organizational alignment, and individual inspiration. Researchers predominantly agree that there is a difference between *management* and what a manager does versus *leadership* and what a leader does, even if the those roles are occupied by the same person; both are concerned with satisfaction and performance, though a manager focuses on the 'engineering' tasks of planning and implementing, while a leader focuses on the 'visionary' tasks of clarity and change. In both the research and managerial spheres, this difference is often described as a distinction between transactional and transformational forms of leadership. Transactional leadership centers on social exchange principles, and emphasizes role and task clarification and rewards schemes to motivate followers. Transformational leadership, often partnered with charismatic leadership, focuses on leader-follower identification, and emphasizes consideration and intellectual stimulation to inspire followers to transcend personal self-interest for the organizational good.

The field has gone through three basic stages of development, and, despite recent theoretical advancements, it remains relatively weak empirically. The first set of theories focused on the personal traits that make leaders different from others – first on physical traits, such as height and appearance, then later on charisma and across the Big Five personality characteristics. The main difficulty with this early work is a lack of convincing causal relationships. For instance, while extraversion strongly predicts leadership emergence, it has no relationship with effectiveness as a leader. Another problem is that charisma, a key construct in leadership, is itself still poorly understood.

While the first set of theories argued that leaders are born, the second set argues that leaders can be made, promoting the situational and behavioral aspects of leadership. Two famous studies (by Ohio State and University of Michigan researchers) came to similar conclusions about critical behaviors that are associated with high-performance leadership. First, individuals can be trained to display an employee-oriented focus, emphasizing interpersonal relations characterized by trust, respect, and consideration. Second, individuals can be trained to display production-oriented (or initiating structure) focus, in which they develop task structure according to job design precepts and clearly assign roles to improve goal attainment.

The third set of theories used results from trait and behavioral theories to develop contingency models of leadership, meaning that the appropriate leadership style depends on other things. Fiedler's Contingency Model deals with relationship- or task-oriented leadership styles, which are assumed to be fixed within a person, with three main situation types: leader-member relations, task structure, and position power. A key finding from this research is that

task-oriented leaders perform best in situations of high and low control, while relationship-oriented leaders perform best in moderate control situations. Cognitive Resource Theory describes stress as 'situational unfavorableness,' and identifies leaders as those who can use their intelligence and experience to mitigate stress. Although it has poor research support, Situational Leadership Theory added critically to the debate on leadership by drawing attention to the role that followers at different levels of readiness, ability, and desire play in the leadership dynamic. Leader Member Exchange (LMX) Theory is a social exchange perspective which argues that, due to time pressures and other constraints, leaders establish special relationships with a small group of their followers who are trusted, get a disproportional amount of their attention, and play a special role in influencing decisions. In turn, other followers get less attention and are relegated to the social out-group. Finally, Path-Goal Theory argues that the leader's task is to provide resources to achieve the common goal, and that this is evidenced through four main types of leader behavior: directive, supportive, participative, and achievement oriented.

The most current stream of research in leadership examines the construct in a network context. The 'New Science of Leadership' describes leadership as the effective leveraging of skills and resources by maintaining a strong network position, coupled with the capacity to systematize behavior in others. As such, one core finding is that leadership effectiveness is greater when an individual maintains diverse connections to groups that don't mutually know each other, thus avoiding 'echo chambers' caused by clique membership.

Ethics and Responsibility

Driven in part by regulatory pressures and whistleblower provisions, as well as the fear of bearing costs from negative press and litigation, corporations are turning to the formal adoption of ethical principles in their management. Organizational research in ethics and corporate responsibility builds on principles from philosophy to develop ground rules of ethical conduct for managers and employees. For example, Galinsky's Principles of Value-Based Reasoning build on traditional philosophical tensions, such as duty versus utility and intentions versus outcomes, and modern psychological research to provide a route to generate value-ordered preferences applicable in business situations. Especially in a global context, where cultures and contexts differ, it is important for organizations to develop clear beliefs about relativism, the unintended consequences of incentives, and standardized versus contingent norms of conduct.

Research in organizational ethics includes insights from clinical and social psychology, as well as economics and political science. Chen and Santos' research on how monkeys fairly 'pay' each other with food demonstrates a seemingly fundamental sense of fairness that trumps even self-interest. Functional magnetic resonance imaging studies conducted at Princeton University show differential brain activity across choices to act in two scenarios involving people at risk of being killed by a trolley. Of course, nearly all social psychology plays some role in ethical conduct. Two particularly important research streams include Milgram's studies on psychological distance in which subjects are ordered to administer

punishment to a confederate, and Staw's studies on escalation of commitment, which emphasizes the incremental process by which people can unintentionally yield to unethical behavior. Work by Thaler and Sunstein, an economist and a political scientist, on opt-in versus opt-out organ donation programs describes how management can set default values framing choices in terms of gains or losses from which individuals are unlikely to change; this observation has become known as 'paternalistic libertarianism.'

Judgment and Decision Making

Organizational research on judgment and decision making (JDM) exists at three levels of analysis. At the individual level, JDM research focuses on cognitive pathways and heuristics that tend to bias decision making. At the group level, it focuses on how groups amplify or suppress decision quality and task performance. At the organizational level, JDM describes how organizations agree on courses of action, develop rules, and maintain collective memory. This summary addresses the first two levels of analysis; a summary of the organization level appears in the macroorganizational section of this entry.

A decision is defined as a choice among alternative courses of action. At the individual level of analysis, organizational behavior research in JDM complements work done in clinical and social psychology and in behavioral economics. As in these fields, early models of rational decision making (where decision-makers know all the choices and their outcomes in advance, have a utility function that rates outcomes in rank order of preference, and generates an expected utility function) have been supplanted by more realistic behavioral models. Research conducted by the administrative theorist Herbert Simon and his Carnegie School colleagues (including James March, Richard Cyert, and others), and based on the earlier work of Chester Barnard, promoted a conception of the 'bounded rationality' of actors in a firm. Bounded rationality describes how people attempt to act according to a rational calculus, but are prevented by limited time, resources, awareness of alternatives and preferences, and information processing capacity. Unable to properly optimize decisions, individuals instead 'satisfice,' or choose the first decision option that meets a sufficient base set of criteria. Moreover, they often cut short the decision-making calculus altogether by relying on heuristics, or cognitive 'rules-of-thumb' that simplify based on set routines or patterns of stimuli.

Much of JDM research is concerned with the conscious and nonconscious heuristics that can bias decision making. There are dozens of decision-making biases, but many sort into those resulting from the availability heuristic, in which readily available instances are more salient, the representativeness heuristic, in which a phenomenon's chance of occurring is likened to that of similar occurrences, and anchoring-and-adjustment, where initial given values are uncritically relied on in making assessments. Two often-cited biases in organizational research are fundamental attribution error and escalation of commitment. The former describes an individual's tendency to attribute one's own action to a situation, but the actions of others to a person – thereby assuming or divesting responsibility for consequences. The latter describes an individual's tendency to invest additional time, money, or effort into a failing course

of action; this bias is driven by an aversion to admitting mistakes, the effects of sunk costs, and by the consequences of risk aversion described in Kahneman and Tversky's Prospect Theory.

Groups and Teams

Modern research in group dynamics traces its roots to the Hawthorne Studies at Western Electric Company. The original hypothesis was that the level of work place illumination influenced productivity; the findings were that regardless of level of illumination worker productivity increased (even when light level was reduced to about the level of moonlight). On further examination, researchers found that a number of group properties strongly influenced individual behavior – among them that formal and informal groups served different functions.

Since that time research on groups has come and gone in a cyclical fashion. Common research themes include the performance of work groups under various conditions, the identity and perception of group roles, conflict of roles between members, the development and maintenance of norms of conduct, status differentials between members, and cohesiveness of groups over time. Conformity to group norms and the capacity of minority members to influence majority thinking have also been explored in various settings, especially among juries. Studies on negotiation within and between groups have examined ways groups gain the necessary resources for their goals and how status, credit, and rewards are divvied out to group members.

Several emergent decision-making phenomena are evident at the group level of analysis. The first is the simple observation that people must not only attempt, in some form, to align their decision processes, but also that they must agree on outcomes in order to commit to a course of action. In general, group decision making is typically more effective than individual decision making, but is almost always less efficient, as it takes more time to reach consensus. One observation about group decision making is that groups produce outcomes that are more accurate than the outcome of its average member, but less accurate than its most accurate individual member. Groups also enable transactional memory, in which groups are able to remember more collectively than any individual member. Research by Jehn, Kilduff, and others on task-oriented conflict in groups shows that cognitive diversity among group members tends to lead to more optimal and more creative solutions. Other research shows that mere participation in a decision-making process leads to better individual buy-in to the group decision, even if the individual's personal views were not incorporated in the final decision. Group-level decision making also introduces biases produced by norms, conformity pressures, group image, and minority/majority effects. For example, groupthink is a means for a group to protect its positive image by reinforcing assumptions and the majority position, pressuring doubters, and creating illusions of unanimity. Group polarization, groupshift, or 'risky shift' is the tendency of groups to exaggerate an initial position to a more extreme decision than any individual member would be willing to proffer.

In recent years, attention has shifted from the group to the team. Groups are appropriate for tasks requiring pooled

interdependence – these tasks require members to share information and resources in support of each others' areas of responsibility, but do not require frequent adjustment of goals between group members. Teams are appropriate for tasks requiring reciprocal interdependence – simply pooling information is not sufficient for these tasks, frequent exchange of resources and realigning individual goals is necessary. A group of reporters can independently produce a newspaper, but an integrated team of health care professionals is usually needed to produce health in a given patient.

As work becomes more complex and multidimensional, there has been a growing emphasis on the dynamics of teams, and on the maintenance of coordinated relationships between members. However, teams are not unambiguously better than groups. Developing and maintaining teams generally require resources and incentive arrangements that groups do not. For instance, because work group performance is the summation of individual performance, accountability and rewards are often centered on individuals. A similar accountability and reward scheme in a team setting may not only fail, but may be pathological to overall performance.

McGrath and his colleagues identify three levels of dynamic interaction among teams – local, global, and contextual. Both Kozlowski et al. and Marks et al. have developed theories that describe inputs, processes, and outcomes that develop over time as teams interact. While these models differ slightly, each recognizes the underlying notion that teams are complex, dynamic systems existing in larger contexts of people, tasks, technologies, and settings.

Organizational Culture

In organizational behavior, the adage 'The more things change, the more they stay the same' has been empirically investigated in attempts to understand how organizational cultures develop over time. Schein has described organizational culture as 'shared basic assumptions' that are retained and taught to new members. Stated rules, norms, and artifacts of culture provide anthropological insight into the organization's critical assumptions. In studies of IBM employees, Hofstede used dimensions of culture, such as power distance and individualism versus collectivism, to describe the similarities and differences expressed across countries. Schneider proposed that organizational culture is shaped by three processes: attraction, selection, and attrition (A-S-A). First, individuals with values similar to those of an organization are attracted to apply for positions in it (attraction). Next, the organization selects and retains those individuals who best fit its culture (selection). Finally, any remaining individuals who do not fit with the organizational norms eventually leave the organization (attrition). This three-step process leads organizations to become more homogenous over time. The A-S-A model is widely considered fundamental to the development of organizational culture and is generally accepted within the field. In a recent revision, two additional processes were added to the A-S-A model to account for the abilities of organizations to shape individuals and for individuals to shape organizations. Transformation refers to the fact that even if people do not initially fit the organizational culture, their attitudes and behaviors may be molded through socialization and training to improve their

fit. Manipulation, on the other hand, describes the process by which, consciously or unconsciously, individuals may shape the organizations they are in to better fit their individual values and habits.

Emotion

Much attention has been given recently to the role of emotions in how individuals perceive and react to situations within organizations. Research in the perception area focuses on how individuals feel emotions, and the consequences to decision making, creativity, and organizational good citizenship behavior. Research in the reaction area focuses on how individuals display emotions, and the links to group performance. The tight, reciprocal relationship between emotions and cognition is still being explored.

One of the main objectives of research on emotions within organizational behavior is to understand how emotional reactions are socially constructed and how the perception of emotional responses is likewise shaped by organizational contexts. Some roles within organizations require individuals to express particular kinds of emotions; for example, Rafaeli and Sutton's work with bill collectors shows how anger is expressed as a means of social influence. Hochschild's work with flight attendants demonstrates how expressing emotion becomes uncompensated 'emotional labor,' creating stress for individuals who must conceal their true emotions. Research has also investigated how individuals' sensitivity to the emotions of those around them may improve or hinder their work performance, and how emotions from home might spillover into work and vice versa.

Creativity and Innovation

Creativity and innovation are essential means by which an organization competes in a market – yet a comprehensive theory for these concepts is still lacking. Organizational creativity refers to the production of a novel product or process, and organizational innovation to the application of ideas, both novel and adapted from another source or for another purpose, in an organizational context. Identification and measurement remain challenges for creativity research in particular, with expert assessment generally present at some stage.

As with leadership, the earliest conceptions of creativity focused on individual trait-based, or 'genius,' explanations. While these eventually gave way to a focus on creative process, the systematic study of creativity really began in earnest with Guilford's 1950 address to the American Psychological Association. The critical observation driving most research in the twentieth century was the importance of divergent thinking in producing creative ideas. Individuals are, in general, not very creative (cf. Ward's alien drawing task). Groups bringing together diverse perspectives tend to trade off efficiency, but gain the constructive benefits of task conflicts over interpretive ambiguity. In this way, groups are almost always more creative than individuals. Extensive case studies of the creative process of design firms are testimony to the divergent thinking theory. In the organizational context, researchers have sought to understand how organizational structures and roles can be designed to enable greater intellectual flexibility and encourage

divergent ways of thinking. Kanter's 'let a thousand flowers bloom' notion stresses the structural, collective, and social conditions that encourage or discourage the adoption of innovation.

Contemporary research in creativity and innovation continues group divergent thinking, but also focuses on elucidating cognitive and affective processes. A series of new methods and perspectives on creativity, including Csikszentmihalyi's systems model, neuroscience studies of brain and behavior, and cognitive computer modeling, are being used to make progress. Nonetheless, several open debates still remain, such as the association between negative affect and creativity and whether intelligence and creativity are part of the same mental process.

Macroorganizational Behavior

The macroperspective is traditionally associated with the disciplines of sociology and political science, and focuses on the emergent social effects apparent at the organizational, field, or population level of analysis. Foundational sociological pieces by Max Weber analyzing bureaucracy and authority in Europe, as well as early studies by Michel, Crozier, and Gouldner, direct attention to the importance of roles and situations. Similar foundational pieces by Wilson, Barnard, and others in the administrative theory tradition of political science focus on governance, authority, and how organizations persist over time.

As seen by macroorganizational theorists, the elements of organizations are social structure, participants or actors, goals, technology, and environments. Social structure refers to the patterned or regularized aspects of relationships among participants in organizations. Organizational participants are those people who make contributions to organizations for a variety of inducements. Goals are considered to be conceptions of desired ends, and are among the most controversial of organizational components. Technologies consist of not only machines and mechanical equipment, but also the technical knowledge and skills of participants. Environment consists of specific physical, technological, cultural, and social aspects of the larger social system in which an organization resides.

There are several ways to present the macroorganizational perspective. A common approach is to use Scott's rational, natural, and open typology, which defines an organization in terms of mechanistic versus organic construction and its relationship with the environment. We have chosen to present this perspective of four topic areas commonly found in the literature.

Organizations as Meaning-Making Systems

Early research on macroorganizational behavior portrayed organizations as tools for efficiently coordinating the actions of individuals. Recognizing the disparities between an organization's actions and its stated goals, theorists began to critically question this rational perspective. The first institutional theories stressed the importance of unofficial procedures within organizations, and the ways organizational routines are shaped as compromises between competing interests (e.g., unions and managers). More recent institutional ('neo-institutional')

theories stress that organizations are constrained by societal institutions, such as governments and professional associations, and that organizational survival is ensured by being considered legitimate to other organizations. Environmental pressures drive organizations within a given field to abide by the 'myths and ceremonies' by which that field operates. Powell and DiMaggio describe three pressures that shape organizations: coercive, normative, and mimetic. Coercive alludes to regulatory and other pressures from the state; normative, to pressures from professional organizations or other certifying bodies; and mimetic, to pressures to copy successful organizations in order to attain success. A core element of neo-institutional theory is that these pressures are not just norms and values of a given institution, but are diffuse and 'taken-for-granted.' In this way, neo-institutional theory describes the constraint that culture and cognition place on organizational actions. More recent theorizations attend to the ways individuals and organizations agentically construct meaning.

Organizations as Networks

Since the 1970s, organizational behavior research has increasingly portrayed organizational actors, both individuals and groups of individuals, as nodes within complex networks. The relationships between organizations or persons are compared to 'pipes' through which resources and information can flow and 'prisms' that yield systemic effects. Network theory spans several disciplines including information science, where the diffusion of innovations is a central focus, and epidemiology, which examines the spread of disease across individuals. Contemporary research uses the distance and strength of ties between nodes, the central or peripheral location of nodes, the number of nodes between two actors, the structural holes between two focal groups or cliques, and other measures to describe social effects, such as how resources and information move from actor to actor.

Research in the organizational realm includes Granovetter's differentiation between strong and weak ties between individuals, where weak ties yield information benefits, such as job opportunities; and Burt's description of the creativity and social capital benefits that accrue to individuals holding a brokerage position between unconnected groups. More recent work includes more mathematical approaches to simulating simple and complex diffusion, and deeper examinations of the content of individual nodes and the effect of network position on individual choice.

Organizations as Decision Making and Learning Systems

Research in decision making at the organizational level is concerned with the issues of decision making that emerge from, but are not merely reducible to, the limits of individual rationality and interpersonal relations. The members of Herbert Simon's Carnegie School of theorists are generally considered the founders and standard-bearers for theory development in this area. Having jettisoned the idea of the hyper-rational 'Homo economicus' in favor of a more realistic behavioral model of 'bounded rationality,' organizational theorists attempt to reconcile how political and institutional issues affect decisions in organizations.

In *The Behavioral Theory of the Firm*, Cyert and March rectify the classic economic view of the firm with the reality of firms as organizations with multiple goals, decision making by satisficing, and subject to imperfect markets. They describe how organizations are adaptively rational systems, composed of coalitions of individuals with common goals who constantly bargain to receive side-payments of slack resources. They also posit that organizations have memories stored in standard operating procedures which are used to pursue a 'negotiated' environment free of uncertainty. In another core research piece, Cohen, March, and Olsen describe the process-oriented Garbage Can Model of organizational decision making. The model argues that organizations are subject to ill-defined preferences, unclear technology, and fluid participation, and that these pressures lead them to become 'organized anarchies' of solutions seeking out problems, rather than vice versa. This conception of decision making focuses on viable matches of problems and solutions, and diminishes traditional calculations of efficiency.

Building on the decision-making literature related to routines and stability, research in organizational learning (and forgetting) finds that routines in organizations develop incrementally through feedback from the organization's history and environment. The consequences of organizational learning processes can be negative as well as positive. For instance, Levitt and March describe a 'competency trap,' in which organizations depend on historically successful procedures without experimenting with or modifying them over time. Levinthal and March expand on this arguing that the decomposability of problems in an organizational context of specialization leads to an overall 'myopia of learning.' In other words, overlooking temporal and spatial disjunctions and discounting errors for the positive feedback of success leads an organization to over-privilege conservatism, or 'exploitation,' at the expense of experimentation and discovery, or 'exploration.' Therefore, organizations have a propensity to fall into 'failure traps,' where their avoidance of risk by relying heavily on exploitation leads them to avoid the beneficial learning of more costly exploration activities.

Organizations as Populations

Population ecology is a theory that describes the organization as one among many organizations competing for resources in the greater environment. Once structured, the organization enters the environment and grows or dies as a consequence of circumstances largely beyond its control. Density dependence is a key feature of population ecology, which describes how populations of similar organizations occupy a resource space, or 'niche.' In the early period of an organization's life, legitimacy, or the extent to which it is deemed to meet appropriate standards befitting an organization of its type, plays the largest role in determining whether the organization survives. Once many organizations have occupied the niche, competition for resources takes over as a force to determine survival. The graph described is an inverted-U shape, where the carrying capacity is the maximum number of organizations that can survive in the niche. Thus, the theory is considered a selection-based theory, because the manager has very little control of the organization's fate once it is put in motion.

Newer incarnations of population ecology ease the strong anti-managerial and anti-adaptationist propositions in the foundation pieces. In particular, Hannan and Carroll's Resource Partitioning Theory describes how managers can choose particular niche spaces where they can compete more effectively; the concept of Mutualism describes how organizations have alternatives to direct competition, through, for example, symbiotic relationships; and, at the very least, Barnett and Hansen's Red Queen Theory demonstrates how organizations can make gains individually, yet fall behind relative to other organizations in the competitive space. Ecological approaches have also taken a recent turn toward considering how organizations choose and construct which categories of organizations they belong to and the effects of categorization on organizational performance.

Context Effects

Presumably, the uniqueness of behavior in organizations is that the organizational context somehow shapes it. Yet, until recently these context effects were largely ignored. Where it does exist, the traditional approach to studying organizational context correlates perceptual measures of context with self-reported attitudes and intentions. It is difficult to know whether such relationships tell us more about the context or the respondent. Today some studies measure context more directly. Some research examines how contexts affect individuals and groups, some looks at how individuals and groups influence contexts, and some looks at the reciprocal relationships among contexts and people.

How Contexts Influence Individuals and Groups

Sociologists portray contexts in terms of opportunities or constraints they provide for individuals or groups. Most organizational behavior researchers are unaccustomed to thinking of their work in this way despite the fact that the distinction between opportunities and constraints is often implicit in their view of organizations. For example, job enrichment techniques might be viewed as mechanisms for enhancing opportunities, while goal-setting can be seen as a control device that constrains behavior.

A study of the role eunuchs played in administering the Ming Dynasty demonstrates how the interpretation of behavior can change when one's view of context changes. Castration was thought about as a technique used by those in power to ensure civil servant loyalty and commitment. It was viewed as a control mechanism or constraint to eliminate competition with the interests of the emperor. The fact that castration was often voluntary suggests an alternative interpretation. Becoming a eunuch provided an otherwise unavailable avenue for upward mobility. The traditional path into the Confucian civil service included an expensive education. Poor men could attain powerful positions and wealth by becoming eunuch administrators, who were almost as powerful as Confucian scholars. Thus, a phenomenon commonly viewed as a constraint might alternatively be viewed as an opportunity and a situation in which context influences individual behavior.

A study of how technological change influenced radiology illustrates different ways contextual proximity influences

organizations. Computer tomography scanning changed individual skill levels, dyadic interactions, department structure, and organizational status. The technology was invented in the 1970s and slowly diffused into hospitals in the 1980s, with a series of reverberations. It initially modified tasks, skills, and other nonrelational variables, which in turn shaped role relations. These altered role relations either changed or buttressed social networks that comprise occupational and organizational structures.

The Influence of People and Groups on Contexts

Three means by which individuals or groups influence organizations are discussed in the literature. The first means is when autonomous people or groups pose as organizations by taking actions that reflect their preferences but claiming such actions reflect organizational policies. The second means is when powerful people (or groups) take actions that influence organizational structures, process, or performance. And the third means is through the aggregation of individual (or group) attributes that influence the organization as a whole.

For example, powerful leaders can influence organizations both by enacting personal decisions that influence the organization, as well as by shaping the thoughts, feelings, and actions of organizational members. Leaders provide explanations, rationalizations, and interpretations of their organizations' activities, and these in turn provide an important contextual lens for followers to make sense of their individual and organizational performance.

Reciprocal Relationships among Contexts, Individuals, and Groups

Because of the effort required in data collection and analysis (e.g., longitudinal studies), little research has been conducted on the complex interplay among contexts, individuals, and groups. One example of successful research of this sort is an examination of the decision to build and operate the Shoreham Nuclear Power Plant by top management of the Long Island Lighting Co. The study shows how the interplay between top management actions and the organizational and political context created by these actions led the company to spend over \$5 billion on a plant initially estimated to cost \$75 million, and which never became fully operational.

When Context Does Not Matter

Sometimes contextual aspects of organizations have little influence on individuals or groups because they are buffered from or simply ignore them. An example is a study examining the relationship of work demands and stress symptoms among newcomers to organizations. The study found that stress symptoms found 9 months after entry were more strongly predicted by stress symptoms reported before organizational entry than by work demands 6 months after entry. Most stress research is cross-sectional, assessing relationships among measures taken closer together in time. If this research had failed to measure stress prior to organizational entry it may well have concluded what most stress research concludes – that stress is predicted by organizational demands.

Conclusions

The field of organizational behavior provides insight into the dynamics of groups and organizations, and of the individuals which compose them. Individuals form into collectives in order to perform work that is otherwise costly, ineffective, or impossible when performed alone. In the past several decades, we have seen the role and diffusion of technology increase, the costs of travel and communication decrease, work integration across a wider range of socioeconomic strata and the growing influence of network design and thinking. These changes have allowed people to work together in new, exciting, and value-creating ways. However, they have also created increasingly complex work tasks, organizational dynamics, performance expectations, and consequences of error. Thus, we argue that research in organizational behavior, and particularly the integration of micro- and macrofindings, will only grow in importance in the coming years. We draw particular attention to topics such as the coordination of relationships, organizational learning, and systems thinking and the reliability, resilience, and sustainability of organizations over time.

See also: Judgment; Leadership; Work Efficiency and Motivation.

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Our Cognitive Map

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Glossary

Cognition A general term associated with thought processes, including information processing, storage of knowledge, and reasoning.

Cognitive map Mental representation of the world around us resulting from experience, direct and indirect learning, and knowledge integration and processing. The body of knowledge we use to make decisions that require spatial and geographic information/knowledge.

Encoding The process of perceiving the world around us and storing what is perceived in memory; information perceived by any of the senses can be encoded. Encoding is highly dependent on motivation and type of behavior.

Landmark knowledge Knowledge for discrete entities and their place in the world. Landmarks knowledge is the basic building block of our cognitive map and is often the first type of knowledge we acquire about a new place. Landmark knowledge can be stored about places that have been visited and perceived directly or through indirect learning such as from maps, books, movies, or stories. Landmark knowledge is closely associated with declarative knowledge.

Map Accurate representation, usually in two dimensions, of a three dimensional space. Maps are most commonly used

to present Earth and parts of Earth that cannot be seen from one vantage point.

Procedural/route knowledge Knowledge for associations between and among declaratively known places and things, such as landmarks. Procedural knowledge is limited to the direct association or connectivity of places and is essential for route knowledge.

Scale Geographic term associated with both maps (the ratio relationship between the map and the size of the space in reality being represented) and geography. In geography, scale is sometimes used as synonymous with size such that large scale spaces are spaces that are large and small scale spaces are small.

Spatial behavior Acts exhibited as part of goal directed spatial decision making and generally the outcome of processing spatial knowledge held in the cognitive map in response to an internal or external directive.

Survey knowledge Knowledge for configurational relationships between and among places in a cognitive map that supports judgements, decisions, and behaviors that rely on metric knowledge of the world. Survey knowledge allows for accurate judgements about relationships that have not been directly experienced, such as traveling on a shortcut between two known places along a path that has not previously been followed.

When we are lost, we often turn to paper maps to find our way and learn about our surroundings. Similarly, when we are finding our way through the world or facing spatial, geographic, or environmental decisions, we consult another type of map, our cognitive map. Our cognitive map is the internal mental representation of the world as we know it and the accompanying affective responses associated with this knowledge. It functions as the repository of all that we know about the spaces and places we have visited or learned about directly and indirectly. While we rely on this mental representation when making decisions requiring geographic and/or spatial understanding of the world, it is also distorted, incomplete, and a patchwork of what exists in reality that contains metric and nonmetric knowledge. The term 'cognitive map' refers to a cognitive representation of space and geography. The differences between our cognitive understanding of reality and reality itself make it very unlikely that this representation is at all 'map-like.' The term map is a useful reminder of the centrality of space and geography to what is in our cognitive map and how we use that information. Researchers at the intersection of spatial cognition, geography, computer science, philosophy, neuroscience, and education contribute to our evolving understanding of how we come to know the world around us, how we use that knowledge, and the range of individual and group differences associated with our cognitive map.

Cognitive maps are highly dependent on, and play an important role in, human spatial behavior. As we experience the world we acquire spatial knowledge and accumulate that knowledge in our existing cognitive map. The nature of the behavior we are exhibiting or activity we are participating in plays an important role in what we direct our attention to and what spatial information is added to our cognitive map. For example, if we are a passenger in a vehicle driving through a city we will pay attention to quite different things than if we are the driver. If, as the passenger, one is told that they will be required to drive the vehicle on the return trip, attention will again be paid to different features in the environment. At the other end of the cognitive mapping spectrum is the nature of the behavior that requires the use of our cognitive map. We are likely to call upon different information if we are asked to give directions from one place to another as opposed to being asked to walk or travel there on our own, even though the resulting action or activity undertaken for both parties would be very similar. It is also important to differentiate among our cognitive map, the map of geographic information that we hold in our head, and the various ways we use that representation. Depending on why or how we are using our cognitive map different components of it or different depths of its complexity will be called upon. If a task is straightforward or simple, there will be no need to use all that is known about an environment;

such behavior might indicate to an observer that we do not know as much as we do. If someone is asked to travel from one place to another and does so successfully this does not tell us much about what they know of the world beyond that single path. Understanding the ways we use our cognitive map include studying how people find their way in new settings or how we choose a neighborhood in which to live. It is also important to understand the structure, development, and processes that are all part of our cognitive map independent of context specific applications (like navigation, environmental reasoning, opinions and judgements about places, etc.). A variety of theories and conceptual frameworks have emerged to understand how spatial and geographic knowledge is coded, stored, accessed, and processed in our cognitive map. A defining feature of our cognitive map is the importance of individual differences in all aspects of cognitive mapping. Individual differences in how we interact with the world, acquire spatial and geographic knowledge, how knowledge is stored and associated, processing that knowledge for discrete tasks, and externalizing what we know about the world is an essential element of our cognitive maps and makes studying these structures so interesting.

Our cognitive map exists because so much of what we interact with in the world has important spatial character. Verbal and textual descriptions of places and spaces are converted in our cognitive map to a representation that includes spatial properties represented in those descriptions. Viewing maps of spaces that are much larger than what in reality could be experienced in one interaction (maps of the world, continents, countries, cities, etc.) will produce a cognitive map that can be used to find one's way in that space, and subsets of that space, even if we have never visited it or experienced it directly. The richness of our cognitive map, the way we acquire and process the knowledge stored there, and the ways we integrate that knowledge in our day to day lives, makes understanding our cognitive map significant and challenging. As such, there are many approaches to understanding the nature and use of our cognitive map. These include brain focused neurological studies involving advanced scanning techniques (PET and MRI based scans), scientific experiments involving real world and psychometric settings, educational interventions, and qualitative approaches such as interviews, observation, and surveys. The benefit of such a breadth of approaches in how our cognitive map is studied lies in the triangulation of how we develop our knowledge of the world around us, how we transform and manipulate that knowledge, and how it affects the decisions we make and behaviors we exhibit.

Structure and Form of Our Cognitive Map

The knowledge held in our cognitive map is stored in a variety of different ways. The most primitive form of knowledge is declarative; in our cognitive map this is knowledge for places and things, as well as discrete nonspatial information about those places and things. The latter might include size, colour, category, etc., and provides important contextual understanding between and among individual things. In most cases declarative knowledge is associated with discrete objects, like landmarks, locations, places, etc.; however, linear features and areas can also be stored and understood in this manner, such

as rivers, roads, and towns. As will be discussed later, declarative knowledge is generally the building block from which more complicated spatial knowledge is developed. However, there are many instances when such knowledge is useful without being associated spatially with other knowledge. When learning about places and environments indirectly our understanding is anchored by declarative knowledge that might exist as a picture or discrete description. For example, having never been to Paris I do not know the location or relative positions of many of its famous places (Louvre, Eiffel Tower, Champs Elysees, etc.), but I hold in my cognitive map declarative knowledge of these places and their existence within a space called Paris (about which I know very little). The association of these discrete places with another place is an example of how we store spatial and geographic knowledge in a hierarchical fashion when such an encoding scheme is relevant. When multiple places are known and can be related to one another spatially more complicated forms of knowledge can be achieved. These more complicated forms of spatial knowledge include procedural and configurational knowledge.

Before considering procedural and configurational knowledge it is important to understand how the location or position of elements of our cognitive map can be encoded. Encoding and relating knowledge of different elements of our cognitive map relies on frames of reference. Frames of reference can be exocentric (based on things or frames external to the space or object in question), relative (based on the positions of other things in the space), or egocentric (based on one's own position in the space or related to the space). Exocentric frames of reference are structures for storing spatial knowledge that utilize information external to the space in question for knowing or establishing a location. Such frames can be global (cover all of Earth), regional, and local reference systems that relate an object's location to an abstract external frame such as a Cartesian or Polar coordinate system (like the latitude and longitude or Universal Transverse Mercator coordinate systems). Exocentric frames can also be less abstract and related to information that is locally associated with the space in question but still external to the environment in question, such as a street layout and building numbering system. Reference frames of this type are useful for defining locations in large spaces, at a global or national level or even relatively consistent spaces like cities. However, these systems are infeasible in small spaces, like buildings or rooms. Not only do they not lend themselves to these smaller types of spaces, they are unrealistic for cognitive mapping due to their abstract nature and primary utility in defining specific locations or extracting information regarding multiple locations based on the coordinates of each discrete feature. Frames of reference that can establish accurate locations do not necessarily lend themselves to efficient encoding or using spatial knowledge about arrangements of things. For these situations, which are often more intimate spaces, we employ relative frames of reference. Locations in these less formal frames are known with respect to other occurrences in the space or other local spatial information. Examples of these more local reference frames can include street intersections, well known buildings, and the general arrangement of items in a space. When using a truly relative frame of reference one might indicate position with respect to another object in space or with respect to one's body. The latter is called an egocentric

frame of reference, which is commonly used in small spaces through which limited movement is required or possible (such as rooms or tabletops).

As suggested above exocentric relative frames of reference are not limited to global absolute systems; they can include systems in which the referent object is a dominant feature outside the space in question. The referent object of larger spaces might be the surrounding environment itself, or some part of the environment that is not a single object but a linear or areal feature or configuration of features; this could include boundaries (the fence, the wall, the grass, etc.), or a nonsingular object in the environment (a desk, her/him, basketball hoop). The preceding examples provide some location information, but likely not enough information to be sure of an object's location. Such relative reference systems can be used to provide topological, imprecise, ambiguous, or qualitative position such as 'in the geography office' or 'on the right side of the cash register' or can utilize more accurate and even metric distance as in 'the car is 200 ft from the corner.' In the example of the car's location it becomes clear that the accuracy of the location of the referent object relies on the accuracy of the information held by the individual, and that relative distance is critical to the estimation of location in a variety of spaces. The frame of reference used and its inherent ability to provide an accurate location have important implications for the overall accuracy of the corresponding cognitive map.

In addition to storing and processing declarative knowledge as we experience the world around us, we inevitably integrate what we learn with what we already know or what we have recently experienced. Drawing associations between and among what is known is called procedural knowledge, particularly when the associations are between pairs or series of places or location. The existence of procedural knowledge supports our ability to use the spatial knowledge of our cognitive map to solve spatial and nonspatial problems. Being able to string together multiple locations allows us to create or follow routes from one place to another and associate specific knowledge regarding decisions along the way. Procedural knowledge is distinguished by the nature of the connections between and among declarative pieces of knowledge; the interconnections are ordered and as such represent a more holistic (and personal) knowledge of the environment.

Configurational knowledge is developed as our knowledge of an environment becomes more complex and complete. Independent of the theory of knowledge acquisition, configurational knowledge is composed of both declarative and procedural knowledge but provides the user additional knowledge associated with the interconnections among discrete or linked knowledge and information. Most importantly, configurational knowledge allows for judgments and decisions that require knowledge of the angular or directional relationship between and among places in space. Because we are able to make such complicated judgments regarding the relationships among places based on configurational knowledge it is generally accepted that configurational knowledge is both metric and quantitative. The frames of reference necessary are more complete and complex, and likely more closely associated with abstract frames of reference; however these frames of reference are unlikely to resemble latitude and longitude or Cartesian coordinate systems. Furthermore, the connection between

pairs or groups of places does not have to have been experienced or learned directly but can be the result of incrementally increasing the metric knowledge of where things are located on Earth and their relationships to one another. Configurational knowledge might only exist as portions of our cognitive map. This level of knowledge will exist for those places that we know well or with which we have a great deal of experience. The ability to successfully traverse a space along paths that have not previously been traveled is one outcome of having configurational knowledge, as is being able to give directions for travel along such paths or accurately estimate directions among places in known spaces. The declarative, procedural, and configurational categories of spatial knowledge are commonly referred to as landmark, route, and survey knowledge, respectively, in models in of cognitive map development.

Building Our Cognitive Map

Cognitive maps develop over our lifespan and during discrete episodes of experience. The former is called ontogenesis, while the latter is called microgenesis. The dominant microgenetic model of our cognitive map was established in the 1970s and borrows liberally from child development work on spatial reasoning and thinking. This dominant model has its origin in human development and therefore suffers from relying on a developmentally inspired transition from landmark to route and finally survey knowledge of environmental space. The developmental inspiration results in a model for acquisition that explicitly limits the acquisition of more complicated knowledge until declarative and more basic knowledge is acquired to some necessary level. While this is consistent with how ontogenetic cognitive map development occurs as children develop new cognitive abilities and certain skills and processes emerge in their growing brains, it places unfair limitations on how our cognitive map develops in adulthood when experiencing an environment for the first time. In the dominant (ontogenetically inspired) framework, landmarks are discrete occurrences (objects) in the environment while route knowledge is developed by stringing landmarks together and is characterized by the ability to recall and follow that string of landmarks in order to traverse the route. Survey knowledge is characterized by the ability to integrate multiple discrete routes and landmarks in the same cognitive map. Transitions between these phases of spatial knowledge acquisition are qualitative and are not necessarily marked by the acquisition of quantitative metric knowledge of the environment. The dominant framework suggests that humans do not acquire metric information from the environment during early stages of experience with a new environment, and that only the topological relationships between features are encoded during these early stages of microgenetic spatial knowledge acquisition. This limitation is a direct result of the developmental nature of this model for spatial knowledge acquisition and the fact that children do not exhibit the capacity for metric knowledge or spatial judgements in the early developmental periods. Route knowledge is typically described as a sequence of landmarks connected by experienced paths of movement. This model implies that route knowledge connects those anchor points, while the information between landmarks is

irrelevant and incidental to maintaining a course. In the dominant model of cognitive map development, judgments of inter-landmark distance are difficult and uncertain because of the qualitative nature of how they are known and associated with one another. At the most complex level, survey knowledge is a mental representation of metric spatial relationships (e.g., distance and angle) between and among different sets of environmental information. Survey knowledge can include landmarks and/or routes, as well as configurations of locations and features in the environment. It is not until this final stage of development that the adult cognitive map begins to support quantitative and metric judgments (distance and direction) about spatial arrangements.

Taking this fundamental oversight as inspiration, Montello has proposed an alternative framework of microgenetic spatial knowledge acquisition for adults, suggesting that metric information is encoded during the earliest phases of interaction with a new environment and throughout interaction. Furthermore, his framework outlines quantitative changes in the accuracy and completeness of knowledge for a new environment over time. This framework for the microgenetic acquisition of spatial knowledge of adults allows for the stage-like structure of the dominant framework but accounts for an adult's complete cognitive development and the use of all available tools of perception and cognition while acquiring knowledge about the environment. Qualitative changes from nonmetric to metric understanding of space characterize human development, while refinement of metric knowledge characterizes increased experience by a fully developed adult. In summary, the purely microgenetic framework has substituted experience for development as the temporal scale over which knowledge is acquired while preserving the set of abilities afforded by adult cognition.

Rather than basing a model of microgenetic spatial knowledge acquisition solely on developmental conceptualization, a model of spatial knowledge acquisition integrating spatial hierarchies, spatial anchors (regional anchors), and stage development has also been developed. The initial phases of spatial knowledge acquisition are based on a small set of primary anchors around which a subset of the individual's spatial activity takes place. These anchors are fundamental to learning about the spaces that surround and occur between anchor points. Although accurate knowledge of the locations of features surrounding anchors is not necessarily present, features are organized hierarchically and associatively around anchors. Some examples of anchors might include home, work and your regular grocery store. By combining hierarchical concepts and regionalization (around individual anchors) the anchor point hypothesis incorporates additional geographic models of spatial knowledge structures and acquisition. By blending the Siegel and White framework with regionalization and hierarchical organization the anchor point hypothesis provides a single model in which all three can be integrated. One of the advantages of incorporating a hierarchical component is that such tools (hierarchies) are an inherent part of how we store and process many types of knowledge. Hierarchical storage allows for associations to take the place of individual connections between declarative knowledge. For instance, whether Saskatchewan and Nova Scotia are north of Mississippi does not require a person to know

anything about the relationship of Saskatchewan and Mississippi or of Nova Scotia and Mississippi; by knowing that Saskatchewan and Nova Scotia are in Canada, Mississippi is in the United States, and that Canada is north of the United States, allows that individual to answer the specific question about the relationship between each subordinate geographic entity. Evidence for such hierarchical structures has been shown through cases where such mechanisms do not produce correct responses (Is Reno, Nevada east or west of San Diego, California?). The power of hierarchies and segmenting or grouping spatial knowledge is still an active area of research in the realm of cognitive mapping. The importance of hierarchical structures has been uncovered for global and local scale spatial and geographic knowledge and its relevance for the process of spatial knowledge is an ongoing area of research.

The Future of Our Cognitive Map

We use our cognitive map everyday and rely on it to find our way, make important geographic and spatial decisions, and use it to store knowledge and solve problems about a wide variety of spaces and places. Despite our cognitive map not being a direct or complete replication of the world around us or having many map-like qualities it is a wonder of human cognition in that it supports almost all our spatial decision making and behavioral needs. From time to time we might find ourselves lost and unable to find our way, however, it is rare for anyone to stay lost. When lost we tend to find a way to restore spatial and geographic order to our lives. It is the product of the efficiencies and idiosyncrasies of our cognitive map that this is possible; furthermore, it is these idiosyncrasies that make our cognitive map unique. In essence the only cognitive map we need is the one we have in our own head, as it has developed according to our personal experiences and needs, and performs in situations unique to us. Understanding the complexity of how we deal with such a preponderance of different information and situations represents a rich opportunity for research and learning.

See also: Associative Learning; Brain and Behavior Relationships; Chunking; Decision Making (Individuals); Embarrassment and Blushing; Environmental Psychology; Operant Conditioning; Planning; Problem Solving; Reasoning; Spatial Orientation; Spatial Perception.

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V.S. Ramachandran, MD, PhD., is Director of the Center for Brain and Cognition and professor with the Psychology Department and the Neurosciences Program at the University of California, San Diego, and Adjunct Professor of Biology at the Salk Institute. Ramachandran trained as a physician and obtained an MD from Stanley Medical College and subsequently a PhD from Trinity College at the University of Cambridge, where he was elected a Senior Rouse Ball Scholar. Ramachandran's early research was on visual perception, but he is best known for his work in neurology.

He has received many honors and awards, including a fellowship from All Souls College, Oxford, an honorary doctorate from Connecticut College, a gold medal from the Australian National University, the Ariens Kappers Medal from the Royal Netherlands Academy of Sciences for landmark contributions in neuroscience, and the presidential lecture award from the American Academy of Neurology. He is also a fellow of the Neurosciences Institute in La Jolla and a fellow of the Institute for Advanced Studies in Behavioral Sciences at Stanford. He was invited by the BBC to give the Reith Lectures on 'The Emerging Mind' in 2003 and is the first physician/experimental psychologist to be given this honor since the series was begun by Bertrand Russell in 1949 – these lectures were subsequently published as *A Brief Tour of Human Consciousness: From Impostor Poodles to Purple Numbers*.

In 1995, he gave the Decade of the Brain Lecture at the 25th annual (silver jubilee) meeting of the Society for Neuroscience and more recently, the inaugural keynote lecture at the Decade of the Brain conference held by NIMH at the Library of Congress and a public lecture at the Getty Museum in Los Angeles. He also gave the first Hans Lucas Teuber lecture at MIT, the D.O. Hebb lecture at McGill, the Rudel–Moses lecture at Columbia, the Dorcas Cumming (inaugural keynote) lecture at Cold Spring Harbor, the Raymond Adams neurology grand rounds at Massachusetts General Hospital, Harvard, and the Jonas Salk memorial lecture, Salk Institute.

Ramachandran is a trustee for the San Diego Museum of Art and has lectured widely on art, visual perception, and the brain. Ramachandran has published over 120 papers in scientific journals (including three invited review articles in *Scientific American*), coauthor (with Sandra Blakeslee) of *Phantoms in the Brain* that has been translated into eight languages and formed the basis for a two-part series on Channel Four TV in the UK and a one-hour PBS special in the United States. His work is featured frequently in the major news media including BBC and PBS. *Newsweek* magazine recently named him a member of 'The Century Club,' one of the "hundred most prominent people to watch in the next century."

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David M. Buss received his BA from the University of Texas at Austin and his PhD from the University of California at Berkeley. He served in professorial positions at Harvard University, the University of Michigan, and the University of Texas, where he is currently professor of psychology. David Buss received the American Psychological Association (APA) Distinguished Scientific Award for Early Career Contribution to Psychology, the APA G. Stanley Hall Award, and the APA Distinguished Scientist Lecturer Award. The University of Texas awarded Buss the President's Associates Teaching Excellence Award. He served as President of the Human Behavior and Evolution Society (HBES). He is currently Head of the Individual Differences and Evolutionary Psychology Area of the Psychology Department at the University of Texas at Austin.

Buss's books include *The Evolution of Desire: Strategies of Human Mating* (Basic Books; translated into 11 languages); *Evolutionary Psychology: The New Science of the Mind* (Allyn & Bacon); *The Dangerous Passion: Why Jealousy is as Necessary as Love and Sex* (Free Press; translated into 13 languages); *The Murderer Next Door: Why the Mind is Designed to Kill* (Penguin; translated into 12 languages); *The Handbook of Evolutionary Psychology* (Wiley), for which he served as editor; *Why Women Have Sex* (Holt; co-authored with Cindy Meston; translated into 16 languages); and *The Evolution of Personality and Individual Differences* (Oxford University Press). Buss has more than 250 scientific publications to his credit.

Buss has extensive cross-cultural research collaborations and lectures widely within the United States and abroad. His primary research interests include the psychology of sex differences, human sexuality, mating strategies, conflict between the sexes, why people kill, warfare, terrorism, stalking, and the psychology of prestige, status, and reputation.



Richard B. Buxton received his BS (1976) and PhD (1981) degrees in physics from the Massachusetts Institute of Technology, followed by a postdoc in biomedical imaging (PET and MRI) at the Massachusetts General Hospital. He has been on the faculty of the Department of Radiology at the University of California, San Diego, since 1990. Buxton's primary research is in functional magnetic resonance imaging (fMRI), focused on understanding the connections between neural activity, blood flow, and energy metabolism in the human brain. His experimental work combines arterial spin labeling (ASL) methods with blood oxygenation–level dependent (BOLD) methods to estimate changes in brain oxygen metabolism in response to a stimulus or a drug. His more theoretical work involves mathematical modeling of the imaging methods, the BOLD effect, and oxygen transport from blood to tissue. Buxton is based at the Center for fMRI and served as the center's founding Director (2000–2007). He has written a textbook on fMRI, now in its second edition, published by Cambridge University Press (2009).



Nicholas Christenfeld received a bachelor's degree in psychology and social relations from Harvard, and a doctorate in social psychology from Columbia, and joined the faculty at the University of California – San Diego and has remained there for two decades. His research program comprises multiple, changing, only partly overlapping areas. He has addressed such topics as why some people say 'um' so often, whether babies look like their mothers or their fathers, how we choose which box of cereal to buy, why a baseball season is ten times as long as a football season, which parts of the month carry the greatest risk of untimely death, whether the support of a woman is better for one's blood pressure than that of a man, what sort of music might be useful in stress reduction, whether some initials extend and some shorten the lives of their bearers, if people who live in, or even just visit, New York City are at risk of heart attacks, and whether story spoilers do spoil stories. Currently, Christenfeld is also exploring the role of forgiveness in poststress cardiovascular recovery, the impact of crying on hormones, and the nature of a sense of humor. An overarching theme, if one exists, might be the empirical exploration of the everyday phenomena of the world.



Orrin Devinsky is professor of neurology, neurosurgery, and psychiatry at New York University (NYU). He directs the NYU Epilepsy Center and St. Barnabas Institute of Neurology. His research on epilepsy includes phenomic-genomic relations, sudden unexpected death in epilepsy, surgical therapies, new medicines and devices, quality of life, cognition and behavior, and neuroinflammation. His research on behavioral neurology includes hyperfamiliarity, delusions, autonomic nervous function, and anterior cingulate cortex functions. He founded the organization Finding A Cure for Epilepsy and Seizures and cofounded epilepsy.com and the Epilepsy Therapy Project. He serves on the boards of these organizations and has served on the board of the American Epilepsy Society and Epilepsy Foundation. His other interests include the history of neuropsychiatry, evolution, anthropology, and animal intelligence.



Albert M. Galaburda is a cognitive neurologist and neuroscientist, specializing in developmental cognitive disorders in adults and children. He received his medical degree from Boston University in 1971, trained in neurology at Harvard Medical School from 1973 to 1976, and began his research on dyslexia in 1979, when with neuropathologist Thomas Kemper, he reported for the first time minor cortical malformations in the brain of an adult dyslexic who had died in an accident. Following that original report, he published several other cases with similar malformations and launched a research program modeling these malformations in rodent models, which continues to this date.

He uses RNAi and transgenic technologies in his present research to induce cortical malformations in rat and mouse brains, which in turn are tested anatomically, molecularly, and behaviorally in collaboration with Glenn Rosen, Joseph LoTurco, and Holly Fitch, respectively. This latest research has shown that manipulation of dyslexia candidate gene homolog's 1 rodent embryos results in molecular interference with neuronal migration, cell autonomous and noncell autonomous effects on cortical development that mimic the changes seen in dyslexic brains, and behavioral changes affecting auditory perception. *Ex vivo* imaging of the brains of genetically manipulated animals discloses changes in cortical circuits affecting corticocortical and corticothalamic relationships.

Galaburda is presently the Emily Fisher Landau Professor of Neurology at Harvard Medical School, and Head of the Cognitive Neurology Unit at Beth Israel Deaconess Medical Center in Boston. He has published more than 150 scholarly articles on various topics of cognitive anatomy, cognitive

neurology, and dyslexia, as well as several books on related topics. Galaburda has received the Pattison Prize in Neuroscience, the Neuronal Plasticity Prize from the IPSEN Foundation of France, Scientist of the Year from the Association for Children with Learning Disabilities (now, Learning Disorders Association), and has been elected to membership in the American Neurological Association. He has delivered the Rita Rudel Memorial Lecture, the Norman Geschwind Memorial Lecture, the Sylvio Conte Decade of the Brain Symposium Lecture, and the Curt von Euler Memorial Lecture, among others. His research is funded by the Eunice Kennedy Shriver National Institute of Child Health & Human Development. His teaching is funded by the National Institute of Neurological Disorders and Stroke.



William Hirstein is Professor and Chair of the Philosophy Department at Elmhurst College, Elmhurst, IL, USA. He received his PhD from the University of California, Davis, in 1994. He is the author of several books, including *On the Churchlands* (Wadsworth Publishing, 2004), *Brain Fiction: Self-Deception and the Riddle of Confabulation* (MIT Press, 2005), and *Mindmelding: Consciousness, Neuroscience, and the Mind's Privacy* (Oxford University Press, 2012). His other interests include autism, sociopathy, brain laterality, sense of self, and the misidentification syndromes.



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He studies the development of common mental disorders, focusing on the genetic liability for substance abuse and antisocial behavior. He is past president of the Society for Psychophysiological Research (SPR). He has also received the Distinguished Contributions to Psychophysiology Award from SPR for his lifetime contributions to this field. In addition, he has been awarded the Distinguished Scientist Award from the Society for a Science of Clinical Psychology. His research is funded by grants from the National Institute of Mental Health, National Institute on Drug Abuse, and National Institute on Alcoholism and Alcohol Abuse. He currently holds a National Institute of Health MERIT (Method to Extend Research in Time) Award for his research achievement. He has published over 350 scientific articles.



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HOW TO USE THE ENCYCLOPEDIA

The *Encyclopedia of Human Behavior* is intended for use by students, research professionals, and interested others. Articles have been chosen to reflect major disciplines in the study of human behavior, common topics of research by professionals in this domain, and areas of public interest and concern. Each article serves as a comprehensive overview of a given area, providing both breadth of coverage for students and depth of coverage for research professionals. We have designed the encyclopedia with the following features for maximum accessibility for all readers.

Articles in the encyclopedia are arranged alphabetically by subject. Complete tables of contents appear in all volumes. The index is located in Volume 3. Because the reader's topic of interest may be listed under a broader article title, we encourage use of the index for access to a subject area, rather than use of the table of contents alone.

Each article contains a glossary, cross-references, and a further reading list. The outline allows a quick scan of the major ideas discussed within each article. The glossary contains terms that may be unfamiliar to the reader, with each term defined *in the context of its*

use in that article. Thus, a term may appear in the glossary of another article defined in a slightly different manner, or with a subtle nuance specific to that article. For clarity, we have allowed these differences to remain so that terms are defined relative to the context of each article.

Each article has been cross-referenced to other related articles in the encyclopedia. Cross-references will always appear at the end of an article. Where multiple cross-references apply to an article, the cross-references will be listed alphabetically. We encourage readers to use the cross-references to locate other articles in the encyclopedia that will provide more detailed information about a particular subject.

The further reading section lists recent secondary sources to aid the reader in locating more detailed or technical information. Review and research articles that are considered to be of primary importance to the understanding of a given subject area are also listed. The further reading lists are not intended to provide a full reference listing of all the material covered in the context of a given article, but are provided as guides.

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PREFACE

The social scientists have a long way to go to catch up, but they may be up to the most important scientific business of all, if and when they finally get to the right questions. Our behavior toward each other is the strangest, most unpredictable, and almost entirely unaccountable of all the phenomena with which we are obliged to live.

Lewis Thomas

Psychology, the study of the human mind, has made many rapid strides during the past four decades. There is now, more than ever before, a real need for a standard reference work covering all aspects of human behavior. The *Encyclopedia of Human Behavior* is the most up-to-date and comprehensive collection of reviews currently available. The essays will be of interest not only to clinical and experimental psychologists but also to students in fields such as psychiatry, neuroscience, philosophy, cognitive science, and medicine. Indeed, given the enormous range of topics covered, no one interested in human nature can fail to find something of interest in each volume. The format of the volumes lends itself just as readily to casual perusal as it does to serious inquiry.

My colleagues and I are often asked questions such as: What is the superego? What is repression? How reliable is eyewitness testimony? How much sleep do we need? What do we know of the psychology of laughter, language, cruelty, or politics? Or of love, cunning, and deceit? We have all experienced the frustration of not being able to answer such questions or find the answers quickly without recourse to extensive library research. This encyclopedia should prove to be an invaluable resource in such situations. Also, students of psychology and related health professions will find this collection of articles useful as a starting point when they embark on new research projects dealing with specific aspects of human behavior.

The study of human behavior is an enterprise that covers an enormous variety of subjects, ranging from the minutiae of neurophysiology to such familiar but poorly understood topics as Freudian psychology. Psychology is a science that is still very much in its infancy even though it has had a very long history, almost as long as that of physics and biology. Anyone interested in the history of ideas should be puzzled by the differences between advances in biology and advances in psychology. The progress in biology has been characterized by a number of landmark discoveries, each of which resulted in a breakthrough in understanding, for example, the discoveries of cells, Mendel's laws of heredity, chromosomes, mutations, and most recently DNA and the genetic code. Psychology, however, has until recently been characterized by an embarrassingly long sequence of 'theories,' each of which was really nothing more than a passing fad that rarely outlived the person who proposed it. I have always found this contrast to be quite remarkable and can think of no simple explanation for it other than the fact that human behavior is inherently more complex, quixotic, and difficult to fathom. Fortunately, the picture has changed radically over the past four decades, particularly in psychiatry and cognitive neuroscience. There are two reasons for this change: First, there has been a growing dissatisfaction with metaphorical explanations (Peter Medawar calls explanations of this kind "analgesics," for "they dull the ache of incomprehension without removing the cause") and a healthy trend toward replacing them with more mechanistic explanations. Second, progress has been aided by the advent of several new technological innovations for studying the structure and function of the human brain. This encyclopedia covers as many of these recent advances as possible within a three-volume set.

My own experience is mainly in neuropsychology, medicine, and visual science, and I am therefore indebted to the editorial advisory board, as they selected the authors in other areas and saw each essay through the long process of peer review, revisions, and copy-editing. Most of the entries are by acknowledged experts in the field.

Given the nature and scope of this enterprise, some degree of overlap among the essays was not only inevitable but also desirable since our goal was to ensure that each article was a self-contained summary of one specific aspect of human behavior. Given the space limitations, each author was encouraged to provide an overview and convey the general flavor of an area of research rather than attempt an exhaustive review. The result is a very stimulating and informative collection of essays.

I have no doubt that this work will prove useful to specialists. If it also succeeds in kindling a spark of interest in some aspect of human behavior among undergraduate and graduate students, then our efforts will have been amply rewarded, for no enterprise is more important to the future of our species than an understanding of human nature in all its diverse manifestations.

V S Ramachandran

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Pain

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Glossary

Allodynia A hypersensitive pain form of low-intensity stimulation which normally would elicit only nonpain sensation.

Central pain Pain caused by a lesion in the central nervous system.

Central sensitization Changes in the central nervous system of pain due to chronic peripheral pain.

Dyesthesia Unpleasant abnormal sensation.

Hyperalgesia Increased sensitivity to pain stimulus with lowering of the pain threshold.

Neuralgia Peripheral nerve pain.

Nociceptor Harmful body tissue endangering stimulus.

Pain threshold Lowest level of sensitivity to pain.

Pain is the most common symptom of human diseases. It is defined as an unpleasant experience which may or may not be primarily associated with tissue damage. Pain experience has two different components – the specific sensory discriminative components and the nonspecific emotional-cognitive components. Melzack and Casey divided the pain system into three dimensions: the cognitive or central control, motivation-emotional, and sensory discriminative dimensions.

In various cultures, pain has a different social meaning. In the Judeo-Christian cultures, for example, the passion of the soul (as Aristotelians defined pain) has a close relationship to guilt and punishment. The word pain is derived from the Greek word *poine* and the Latin word, *poene*, meaning punishment. In the Old Testament, the Hebrew word, *tsaar*, which means sorrow, was used to determine pain.

Although pain is usually combined with sorrow, fear, depression, or agitation, an intensive manifestation of the emotional modality can appear separately and independently from the discriminative modality. Our knowledge of psychiatric diseases has taught us that a pain reaction which is compatible with all pain criteria may not necessarily be accompanied by tissue damage. The different characteristics of acute, chronic, cutaneous, or visceral pain justify the assumption that pain is a result of a complex, multimodal mechanism. Knowledge of the different components of the system is essential for the understanding of this most important phenomenon of human disease.

Anatomy and Neurochemistry of Pain

The Peripheral System

In the past, the question of pain origin was explained by two major theories – the summation theory of intensity theory and the specific theory. At the end of the nineteenth century, Goldscheider postulated that there were no specific pain receptors and that each sensory stimulus, with sufficient intense stimuli, produces pain sensation.

The specific theory suggested that pain, similar to thermal and mechanical stimuli, has a specific ascending tract with a specific pain center located in the brain. This theory which is postulated today, teaches that there is an intermediate position

between both theories. The peripheral system is conducted through the skin, muscles, joints, and somatovisceral stimuli from the periphery to the spinal through axons of the neural cells. The cell bodies are located in the dorsal root ganglia behind the spinal cord. At present, it is well established that two types of axons respond to transduce the pain sensation from the peripheral to the centers – the A_α and C fibers. The primary efferent fibers are coated with sheaths of lipoid substances of different diameters known as myelin.

Generally, the peripheral axons are divided into three major groups (classified by Elanjen and Gasser): A, B, and C, according to the thickness of myelin. Fiber group A is subdivided into another four subgroups: A_α , A_β , A_γ , and A_δ . The thickness of the myelin is directly proportional to the conduction velocity. The primary afferent fibers of the C group are covered by a very thin myelin layer measuring 0.1–1.0 μm usually defined as unmyelinated C fibers characterized by a slow conduction velocity of 0.5–2.0 m s^{-1} . The thin myelinated A_δ fibers (1–4 μm) have a moderated conduction velocity of 12–20 m s^{-1} .

Pain has no specific receptor. Axon fibers detach themselves from the myelin sheaths and terminate as nerve endings in the skin. There are five recognized types of afferent nociceptives which conduct the impulse of pain stimulation. (1) High-threshold A_δ mechanoreceptors respond to moderated intense or noxious mechanical stimuli. (2) Myelinated A_δ mechanothermal nociceptives respond to noxious heat stimuli over 45 °C and intense mechanical stimuli. (3) Pure heat-sensitive A_δ nociceptive. (4) A_δ and C low-threshold cold receptors. (5) C-polymodal nociceptive afferents (CPN). This extremely important group of CPN consists of about 95–98% of the sensory C-units in the skin. They have a high threshold to intense mechanical stimulation (more than 1 g), a graded threshold to heat stimulus (between 38 and 49 °C), and a sensitivity to mechanical stimulus. On repeated mechanical stimulation, the response of the CPN becomes fatigued and on repeated thermal stimulation, its response becomes sensitized.

The visceral nociceptive axons transduce pain stimuli characterized by an aching type of pain in the chest, abdomen, and pelvis. The visceral fibers contain a very high amount of C fibers compared to A_δ fibers (a ratio of 10:1 in the visceral nerve and only a ratio of 1:2 in the dorsal root). Only 10% of the dorsal root consists of visceral fibers which are connected

to the sympathetic fibers. These fibers can also be divided into three main groups: peptidergic nerve growth factor (NGF) (responsive unmyelinated C fibers), glial cell line-derived neurotrophic factor (GDNF) (responsive unmyelinated C fibers), and nerve growth factor (NGF) (myelinated C fibers).

Specification channels – transient receptor potential cation (TRP) – which react to temperature and pH changes in the presence of vanilloid ligands, are involved in the transduction of special thermal modalities. The transduction of the membrane depolarization along the axon is induced by the activation of the voltage-gated sodium channel, especially Na_v 1.7 and Na_v 1.8 (in addition, the following subtypes may be present – Na_v 1.1, Na_v 1.2, Na_v 1.6, and Na_v 1.9). There are two voltage β subunits expressed by the primary sensory neurons. The effect is based on the sodium influx in reaction to membrane depolarization. Each of the various types of the voltage-gated sodium channels has a different role in the sensory pathway.

Neurochemistry of the Peripheral System

Peripheral pain stimulation is caused by the releasing of endogenous chemicals when local tissue is damaged. The pain produces a substance that also has, besides direct receptor stimulation, an influence on the vessel diameter and the permeability of the capillaries. These vascular changes influence the area of the nociceptive receptor and increase their sensibility.

Three groups of chemical substances influence the peripheral nociceptive receptors: (1) A chemical with a direct influence on the afferent nociceptive fibers of which bradykinin and potassium belong. The kinins, by-products of the clotting system found in the plasma, are released into the tissue and accept the direct pain which induces a reaction and have a vasodilatory effect. The most well-known member of the cytokine group is activin, and the chemokines, which include CCL_3 , protectin, trypsin, and the tumor necrosis factor (TNF) β , also play a key role in this mechanism. (2) The second group consists of substances that enhance the reaction of the bradykinin. Prostaglandin, a product of polyunsaturated fatty acids (arachidonic type), also belongs to this group. Although high doses of prostaglandins can produce mild pain, the main physiological effect is the potentiation of the kinin's reaction (especially PGE_{1+} , PGE_2). (3) The third group, substance P (SP), was first described by Euler and Gaddum in 1931. It is synthesized in the spinal ganglions and has an antidromic peripheral effect (transmission in the cutaneous direction and not to the spinal cord). Substance P affects the veins by the extravasation of plasma and changing of the permeability of the capillaries and vasodilatation of the small vessels.

The Dorsal Horn

The primary afference of pain fibers reaches the spinal cord after transversing the tract known as the Lissauer tract. In the cord, the impulses are potentiated or attenuated within the different layers of the gray substance. The root contains the separation – myelin-poor fibers on the outside portion and myelin-rich fibers on the inside portion. Lissauer proved that partial separation resulted in the disappearance of pain in a selective interruption of the lateral part of the bundle. This finding is the basis for pain therapy by selective lateral

rhizotomy. Presently, we are aware of the theory that all sensory fibers that penetrate the spinal cord via the dorsal horn are correct. It was demonstrated that pain sensation can also be produced by ventral tract stimulation. Thirty percent of the ventral fibers were found to be unmyelinated. It is presumed that the ganglion of the dorsal horn sends two processes – superficial and deep somatic projections. This finding is a reasonable explanation for the cutaneous distribution of deep visceral pain. Pain in the left shoulder and chest in heart attacks is a well-known example of this phenomenon. Most of the fibers terminate in the spinal gray matter of the same side, some extend contralaterally, and others reach one or two segments above or under the terminated segment. The gray matter was divided by Rexed into 10 laminae. Laminae 1–6 belong to the sensory dorsal horn, laminae 7–9 belong to the motor ventral horn, and lamina 10 contains interneuronal corrections building the area around the central canal of the cord. The pain fibers reach certain areas; the fine myelinated A_δ fibers travel into the medial portion of the dorsal horn and reach areas I, II, and V. A_δ and C visceral fibers terminate in areas I and V, but also reach the laminae IV, VI, and VIII.

The different kinds of neurons are found in the dorsal horn:

1. Neurons that respond to a mechanical and thermal input mode (LTT) with a low threshold to noxious and non-noxious stimulation.
2. Wide dynamic range (WDR) neurons found partially in deeper layers: the WDR neurons respond to different inputs of thermal, mechanical, and chemical stimuli. The WDR activity range is wide and nonspecific. They consist of one-third to one-half of the neurons of the ascending system and are the most common neuron type in the deep V lamina.
3. Specific nociceptive neurons with an exclusive response to pain. These neurons were found in lamina I and also in lamina V. They contain specific small and large cells (Wahldayer) of a different structure, which are divided into two subgroups – cells activated only by mechanoreceptive A fibers and those activated by mechano- and thermoreceptors of A_δ , as well as C fibers.

In examining these neuron groups, group 3 (NG) has a specific reaction to pain response. Group 2 (WDR) responds to pain and to other stimulations also, and group I (LTT) does not respond to pain at all. It seems that the WDR neurons have a central role in the modulation of the sensitivity of the nociceptive cells to pain stimulation.

It has been shown that WDR neurons can be inhibited by painful stimulation, a phenomenon known as diffuse noxious inhibitory controls (DNIC). This inhibition was suggested to be the main component of the pain signal function.

The neurotransmitters and receptors known to be involved in the synaptic transmission of the dorsal horn are as follows: (1) the two fast and active neurotransmitters of the glutaminergic ionotropic receptors – *N*-methyl-D-aspartate (NMDA) receptors and α -amino-3-hydroxy-5-methylisoxazole-4-propionic acid (AMPA); (2) the intense and sustaining active transmitter of substance P and calcitonin gene-related peptide (CGRP), activator of the CGRP1, CGRP2, and neurokinin 1 receptors; (3) the presynaptic receptors, including the voltage-gated calcium channel and the inhibitory effective α aminobutyric acid (GABA_A) and GABA_B receptors which also have postsynaptic

effects; and (4) the postsynaptic receptors of cannabinoid receptor 1 and various opioid receptors (μ , δ , and κ).

Ascending System

A pain message is transmitted from the periphery through the dorsal horn to the supraspinal structures almost entirely via the pathways of the anterolateral tracts. There are two types of ascending routes that characterize the ascending system and each one of them has a different anatomical physiological and phylogenetical origin. One of the tracts, known as the neospinothalamic system, is characteristic in humans and primates containing the most important spinothalamic tract which transmits the nociceptive impulses to specific areas in the thalamus to the ventroposterolateral (VPL) nucleus in the thalamus. Another spinothalamic tract is the ventrospinal, which is located in the anterior section of the spinal cord. This route was usually considered the only one for pressure and touch stimuli. It has been recently proved that the ventrospinothalamic tract is also involved in pain transmission explaining the occasional pain sensation that remains even after total dissection of the lateral pathways.

The second group of ascending tracts, known as the paleospinothalamic system, contains the medial part of the spinothalamic tract, known as the spinoreticular tract and the spinomesencephalic tract. These tracts are more paleogenetic in nature than the neospinothalamic system and transmit pain sensation into the nuclei of the brain stem and into the non-specific thalamic nuclei – the medial and interlaminar nuclei which are nonsomatotopic in nature. Fiber projections to the limbic system and the hypothalamus transmit this message to the emotional and autonomic centers. It appears that the paleospinothalamic system is responsible for the creation of the effective-motivation component of pain. The stimulus that terminates in the hypothalamus is responsible for the autonomic reaction to pain, sweat, and increase in blood pressure and pulse. The spinoreticular tract projects the stimulus from neuron cells in laminae VII and VIII of the spinal cord to the reticular formation in the midbrain, pons, and medulla. It seems that this tract has a connection with the arousal and motivation of the reticular system. The spinomesencephalic tract originates in the cells of laminae I and V and transmits the stimuli to various nuclei in the brain stem, especially to the periaqueductal gray matter. Its role is in the production of the emotional reactivity to pain and in the modulation of pain by the descending system.

We are aware of the fact that besides the neospinothalamic and paleospinothalamic system, there are other pathways that play a role in the transmission of nociceptive impulses. Their significance in the pain system is uncertain. One system, the propriospinal multisynaptic ascending system, is located almost entirely in the dorsal part of the spinal cord and presumably plays a role in chronic and visceral pain.

The dorsal columns, which are considered a completely proprioceptive, nonnoxious system, contain almost 7% of nociceptive-anxious fibers.

Pain and the Supraspinal System

The spinothalamic, spinoreticular, and spinomesencephalic tracts terminate in different nuclei in the brain stem, thalamus,

hypothalamus, and ventral forebrain. The neospinothalamic bundle terminates in the specific thalamic nuclei, while the paleospinothalamic system reaches the nuclei of the brain stem and the nonspecific medial and intralaminar nuclei in the thalamus.

Brain stem terminus

The paleospinothalamic system projects fibers of the nociceptive stimulus to the reticular formation in the medulla pons and mesencephalon. The periaqueductal gray matter is an important target of these fibers. The reticular formation is dissipated throughout the entire brain stem. It contains different kinds of neurons with short and long axons. A wide development of fibers with massive projection the thalamus, subthalamus, and hypothalamus structure causes a rapid integrative response when stimulation occurs in this system.

The periaqueductal gray substance is the main terminating target of the spinomesencephalic tract. This structure is connected to the gigantocellular substance of the reticular formation, the medial nuclei of the thalamus indirectly with the cortex (S_2 area) and the limbic system. It was demonstrated that the periaqueductal gray and the gigantocellular cells are almost entirely responsive to pain sensations. The integrative function of these structures and the dense interneuronal connections intensify the efficacy of these structures in mediation of the effective emotional component of pain sensation. The role of the brain stem in opioid and placebo mechanisms was also examined, as well as in pain processing. The modulatory effects on pain are created by activation of the network system converging in the brain stem nucleus cuneiformis.

Thalamus terminus

The thalamus is the relay center for afferent sensory inputs, beginning in the periphery and ending in the brain. The primary afferent pain fibers reach two areas of the thalamus – the neospinothalamic system and the trigeminothalamic tract which terminate in the VPL and the VPM nuclei. Most of the fibers originate in laminae I and V of the spinal cord and project into the subnuclei VPLo (oral) and VPLc (caudal) of the VPL group. The organization of the VPL and VPM is somatotopic and is transmitted to the primary and secondary cortex via thalamocortical fibers. These structures play a central role in the process of the specific discriminative aspect of pain. The paleospinothalamic tract terminates in the paleospinothalamic nuclei, the medial and interlaminar nuclei, and the nonspecific and nonsomatotopic portion of the thalamus. The ventral medial posterior nucleus (VMP), which lies on the spinothalamic insular pathway, has a special role in this mechanism. Selective damage to this pathway induces hyperactivity of the spinothalamic cingular pathway, which can reduce persistent and chronic central pain.

Some of the paleothalamic structures are exclusively sensitive to pain stimuli. Short nociceptive cells, which are activated by A_δ fibers, and long cells, responding to stimuli of C fibers, are found in the thalamus. The nonspecificity of this structure can be demonstrated by local electrical stimulation of the medial and interlaminar nuclei and a burning pain sensation, without exact anatomical localization, is produced. The projection from these nuclei reaches the cerebral cortex, mainly the limbic system. The wide, diffuse connections are part of

the nonspecific activation and modulation and the cognitive aspects of pain sensation.

The limbic system and pain

The limbic system, a paleogenetic section of the brain, plays the main role in the creation of affective and emotional expression. Wide reciprocal projections between the limbic system, cortex, brain stem reticular formations, and thalamus are responsible for modulating emotional and mood aspects of pain. A particularly important role in the creation of the pain process is played by the pathways between the brain stem reticular formations and the limbic forebrain structures, especially the amygdala, hippocampus, cingulate cortex, and the septal area. The hippocampus and the related forebrain structures have the main influence on the modification of pain-related behavior. Stimulation of these areas produces an evoked response to pain. Electrical stimulations of other limbic system areas produce aversive pain behavior depending on the intensity of the stimulation. Disruptions of the cingulum bundle between the hippocampus and the frontal lobe diminish the negative effect and increase the pain tolerance. The central role in pain-related affective behavior is the amygdala. It seems that the nonsomatotopical projections between the brain stem, hypothalamus, thalamus, and limbic system create a dynamic system of behavior changes, motivation, and emotional changes, according to the pain stimulus.

Pain and the cerebral cortex

Contrary to the limbic system, the cerebral cortex receives inputs mostly from the specific thalamus nuclei (VPL, VPM), and to a lesser extent, from the postero- and ventrobasal thalamic groups. The majority of the somatotopical sensory fibers, which originated in the VPL-VPM, reach the primary sensory area in the postcentral gyrus. The primary sensory area (SI) has a typical somatotopic pattern (a specific representation for each part of the body). The secondary sensory area (SII) is located near the Sylvian fissure in the parietal lobe and has pathways from SI and the postero- and ventrobasal thalamic nuclei. The sensory cortex, together with the specific thalamocortical fibers, has a central role in adapting the discriminative component of pain stimulations. The importance of the anterior parietal area is controversial. It is widely accepted that there is no direct pain sensation in the anterior section of the thalamus. Nevertheless, studies which examined traumatic injuries in this area have proved that there is a total disappearance of superficial pain and a partial decline in deep pain sensation. Vascular events and epileptic foci in this area are occasionally accompanied by severe pain. Intense pain, with the disappearance of superficial sensitivity, is known as thalamic pain (Dejerine-Roussy syndrome) in thalamic damage. Similar clinical features were described in corticoparietal lesions. Dejerine and Mouzon described another parietal lobe syndrome as a pseudothalamic syndrome with the disappearance of all modalities of sensation, including pain. The central role of this area in creating the discriminative pattern of pain is shown in the clinical picture of pain hemiagnosia. In this symptom, the paralytic patient reacts to pain stimuli on the same side only, with emotional and autonomic components, without even understanding the meaning of pain. It seems that this clinical feature is a result of selective activation only

of the thalamolimbic connections. In asymbolia of pain, the inability to understand painful sensations in the body is accompanied by the disappearance of any adequate emotional or autonomic reaction. It seems that in such a symptom, the lesion is of the posterior parietal lobe with a disruption of the transcortical tracts.

Other cortical pathways having an important influence on the pain adapting mechanism are the frontal lobe tracts reaching the input from the nonspecific thalamic nuclei, the limbic system, and particularly, the gyrus cingulate. Lesions of pathways projected to the orbitobasal area of the frontal lobe influence the personality and behavioral aspects of pain. Removal of the frontal lobe (lobotomy) as a surgical treatment for intractable pain results in the continuation of the pain without, however, the subjective, negative, and emotional aspects; one may feel the pain, but it does not disturb the person.

The corticotemporal area also receives the pain input mainly in connection with the amygdala and the hippocampus memory center. Its importance is probably in the emotional character and memory of pain experience.

The prefrontal cortex

The prefrontal cortex region plays a role in the decreasing of pain sensation by inhibition of the pathway between the medial thalamus and the midbrain. Activation of the dorsolateral section of the prefrontal cortex has occurred in the study of the mechanism of placebo action. This phenomenon is explained by the functioning of the prefrontal cortex maintenance and integration of the pain relief. The anterolateral section of the prefrontal cortex regulates the anticipatory anxiety of pain. The activation of the prefrontal cortex is mostly parallel to the activation of the periaqueductal gray and the ventral tegmental area, and also to the cortex, posterior insula, and the anterior portion of the cingulate gyrus.

The Descending Pain Control Mechanism

The existence of a pain-modulating control system was suspected since Reinolds demonstrated a loss of sensation produced by electric stimulation of the periaqueductal gray. This theory has been confirmed in recent years and was the basis for understanding the pain mechanism. Electrical stimulation by implantation of microelectrodes in diverse structure of the diencephalon and the brain stem demonstrated a stimulation-produced analgesia (SPA) by inhibition of neurons in laminae I-V of the spinal cord. The following are the two most important centers that play a central role in the modulating pain system:

1. The periaqueductal gray has an intense connection to cortical, limbic, and thalamic structures. Reciprocal connections exist with nuclei of the reticular formation in the brain stem. The role of the periaqueductal gray in the pain-modulating system is also proved by the increase of pain complaints in experimental local lesions.
2. The nuclei in rostral medulla, especially the nucleus raphe magnus (NRM) and the nuclei magnocellularis, are probably the most important relay centers of the descending modulating pain system. Electrical stimulation, injection

of morphine, and direct input from other supraspinal structures, especially the periaqueductal gray, evoke pain depression. The inhibitory stimulus is transmitted along the tracts in the dorsal portion of the lateral fasciculus. The inhibitory input reacts mainly on cells in laminae I, II, and V.

Besides the modulatory effect of the mesencephalon and medulla, there is evidence of a direct depression effect on the cortex. Stimulation of primary and secondary sensory centers (SI, SII) may have a pain inhibitory effect. It seems that the inhibitory modulation is transmitted by motor fibers of the corticospinal tract and extrapyramidal system. Electrical stimulation of the medial part of the hypothalamus may also decrease the pain sensation by direct activation of the hypothalamospinal pathway or via activation of the periaqueductal gray.

The neurochemistry of the descending system and the opioid analgesia

Two main descending pain control systems play a role in pain modulation: norepinephrine-containing pathway and the serotonin-containing system. These systems are activated and react upon a number of peptides and monoamines, and inhibitory and excitatory neurotransmitters. The epinephrine system transmits stimuli from the dorsolateral pontine nuclei to neurons in laminae I, II, IV–VI, and X in the spinal cord and have an inhibitory effect and an excitatory effect as well. The serotonergic descending system contains fibers from the rostro-ventral medulla which terminate in laminae I and II. Injections of epinephrine or serotonin antagonists given intrathecally may abolish the inhibitory effect and increase the pain sensation. Several peptides influence the descending modulating system.

A calcitonin gene-related peptide (CGRP) is localized in the dorsal root ganglion and in 5% of the lamina I cells. It is of therapeutic significance in cancer pain and nonmalignant bone pain, as in Paget's disease. The corticotropin-releasing factor (CRF) known as somatostatin and the gut peptide cholecystokinin (CCK) are other spinal neurotransmitters. The somatostatin was extracted for the first time from the hypothalamus. It is found in 10% of laminae I and III cells, has an influence on the pinprick sensation test, and no effect on opiates. CCK is a very common neurotransmitter and is frequently accompanied by substance P (SP) without having any specific effect.

SP, which is located in the dorsal horn and in the periaqueductal gray as well, is a specific excitatory peptide having major importance in the pain pathway. It has a hyperalgesic effect (excessive sensitivity to pain) and is inhibited by opiates.

Neurotensin has a role in the pain control mechanism by acting in the hypothalamus, periaqueductal gray, and dorsal horn. Experimental intracisternal injection of neurotensin produces a comparable analgesia.

Opioid analgesia

Opiates have a central role in the decline of pain sensation. Since Portoghesi postulated the cellular receptors for morphine, five main groups of opioid receptors were discovered. The μ receptor is mostly activated by morphine and highly naloxone-sensitive (morphine inhibitor). Other receptors are the κ , σ , δ , and ϵ . μ Receptors are heavily dissipated in the periaqueductal gray matter, brain stem, limbic system, and the dorsal spinal cord,

while other receptors are less active in the pain-modulating system. Three groups of endogenous opioid peptides were found: enkephalin, highly concentrated in the spinal and supraspinal systems; dynorphine, found in the hypothalamus, periaqueductal gray matter, reticular formation, and spinal dorsal horn; and β -endorphins, concentrated in laminae I and II and also, IV, V, and VI of the spinal cord. They inhibit the releasing of SP, reduce the site of the peripheral receptive fields, and act on the excitatory postsynaptic potential (EPSP). Their effect, is therefore, pre- and postsynaptic. The pain-transmitted C fibers are more sensitive to opioids than the A_δ fibers.

The Psychobiology of Pain

Acute and chronic pain are psychobiological experiences with essential effective and cognitive components which produce an intense alteration of emotions. Their intensity can also be modified by attention, mood, or changing of perception. Impressive examples of this modifying system are pop-out and spotlight, phenomena which define the ability to selectively choose different elements of pain and processing an interpretation. Autosuggestion and hypnosis are two clinical methods that use these phenomena for pain therapy.

Fear and anxiety are greatly influenced by mood, motivation, and cognitive factors. Anxiety, as a warning signal prior to a familiar recurrent threatening situation (trait anxiety), is much more cognitive and emotionally dependent than the anxiety that appears during the pain itself (state anxiety).

Personal-individual and socioenvironmental factors significantly influence the sensitivity to pain – the subjective meaning of the unpleasant element, especially the threshold to pain (the least recognizable pain sensation of a subject). Lack of sufficient information, uncertainty concerning the personal circumstances, helplessness, and the loss of individual orientation influence the sensitivity of pain and suffering. Social and environmental factors also modify the interpretation of pain. Various cultures, races, and religions tolerate pain in different ways. The ceremonial torture ritual in primitive cultures and the maturity accompanying the adolescent to manhood are proposed to elevate the threshold of pain. The various understandings to the meaning of suffering in the Judeo-Christian and Far Eastern cultures are expressed by the different personal relations to pain.

In childhood, logical thinking is developed only at the age of 11 since any formal logical thinking in youth is impossible. In early childhood up until the age of 9, there is no clear understanding of the motivation of pain, and until the age of 7, there is no understanding of the linkage between pain and illness. These factors are responsible for the different aspects of pain response in children. Their total dependence on adults makes the role of parents highly important and the social and individual aspects extremely significant in the modulation of pain in childhood.

The Theories of Pain

Several theories, some incompatible with the physiological facts, were published during the last 200 years. The specificity

theory, which indicated a specific pain receptor, pain pathways, and a pain center in the brain, contraindicated the intensity theory which postulated the nonspecificity of pain sensation. According to this theory, every type of intense stimulation may be expressed as a pain sensation. Both theories contradict the Aristotelian hypothesis of pain as an affective aspect.

An extremely important development in the search for a unique concept was the gate theory by Melzack and Wall in 1965. The first step in this theory was the finding that in a decerebrated cat, stimuli of C fibers induce a positive potential in the dorsal root and the stimulation of the A_δ fibers induces a negative potential. This hypothesis postulates that the small (C) and the large (A_δ) fibers have a different and eventually contrary physiological activity in the dorsal horn. They presumed that both fibers activate a T transmission cell which transmits the stimuli toward the brain. Simultaneously with the T cell activity, the C and A_δ fibers have a contrary effect on the interneuron known as I inhibitory cell. These I cells depress the T cells and, therefore, suppress the transmission of pain. A_δ and C have opposite reactions on the I cells. A_δ inhibits, while C fibers increase their activity. The mechanism of both fibers reflects the inhibitory effect of the A_δ fibers on the T cells with a decrease in the pain sensation and an increase on the C fibers with intensification of pain. This hypothetical explanation of the pain mechanism explains several phenomena, but fails to explain other clinical observations. The findings of certain dorsal root neurons (WDR) which are powerful inhibitors of pain stimuli, and the phenomenon of diffuse noxious inhibitory control, can be explained in connections with the gate theory. Transcutaneous electrical nerve stimulation (TENS), a therapeutical method of using a high-frequency, low-intensity stimulation for diminishing pain sensation, can also be explained by the pain theory.

In 1968, Melzack and Casey modified the pain theory by including the role of the ascending system. They suggested that there were three different aspects of pain – discriminative, motivation-effective, and cognitive – which ascend through different pathways – the paleospinothalamic and the neospinothalamic tracts. In 1982, Melzack and Wall expanded this theory by also taking into consideration a cognitive control and descending brain stem inhibitory control system which modulated the pain system in the dorsal root. The involvement of endogenous opioids (opioid analgesia system) in the inhibitory interneural system must also be considered.

The Pain Model

Pain was defined in 1979 by the International Association for the Study of Pain (IASP) as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. The definition was limited by an additional note: many people report pain in the absence of tissue damage or any likely pathological cause; usually it happens for psychological reasons. The pain model can be conceptualized in two different ways based on the various disease entities.

Biomedical model of disease

As defined by Engels, it is a simple cause-and-effect explanation by linear causality. A further explanation is that it is involved

in the expression of provable and detectable physical body processes. According to this theory, there is a direct relationship between the significance of the tissue damage and the intensity of pain complaints. This direct disease–brain connection can lead to expectation of pain and its intensity in the presence of various diseases.

Biopsychological model of disease

This archetype was conceptualized and was based on the earlier defined general system theory. It presents the theory that no system can exist in isolation, and the influence environment is an obligatory part of this existence. The primary local systems produce a hieratical continuum of a complex system which stays in equilibrium with the primary system. According to Engel's model, health reflects a high harmony of intersystems and intrasystems.

Types of pain models

Looser's framework

According to J.D. Looser, there are four interacting hierarchical systems – nociception, pain, suffering, and pain behavior. Each of them can have a key role in the genesis of pain and should be directly investigated and treated.

The Glasgow illness model

This form was conceived and eventually published by G. Waddell and colleagues. It includes a framework which defined four main domains: physical problem, psychological distress, illness behavior, and social interaction. The model underscores the importance of psychological distress and illness behavior as separate systems of interest and necessity for therapeutic intervention. It was originally postulated for specifically low back pain patients.

The psychological model of flor and herman

This type of model is based on the learning theory. It was determined that pain is the reflection of multicomponent behavioral responses to aversive stimuli. The remembrance of pain persists at the various levels of the central nervous system, unrelated to the primary physical noxious experience. The pain itself is responsible for the reorganizational changes in the central nervous system.

Siddall and cousin's persistent pain theory

According to their hypothesis, there are discernable objective pathological and anatomical changes along the central nervous system by continued input of pain stimuli (secondary pathology). Influencing factors, such as social and psychological conditions, but also genetic characteristics, are defined as tertiary pathology.

Pain as homeostatic emotion

This theory was researched and published by A.D. Craig and was based on the assumption that pain is an emotion and is, in general, a reflection of bodily changes. Pain was specifically characterized by Craig as follows: Pain is represented by an unforeseen novel pathway in the human brain being a part of a hierarchical system of interoception subserving homeostasis, a sense of physiological conditions of the body, and a subjective awareness of feeling and emotion.

Clinical Implications of Pain

Acute Pain

Acute pain is produced by a sudden injury and ischemic damage to the skin or a visceral organ. Acute cutaneous pain is characterized by two different stages of pain coined as double response (by Lewis). The first stage, which develops immediately after an injury and has a pricking sensation, is caused by the transmission of the pain signal via rapid myelinated fibers (A_δ). One or two seconds later, there is a burning, unpleasant pain which is characteristic of the second stage. This pain pattern is caused by transmitting the signal via slow unmyelinated fibers (C).

Acute visceral pain has an aching, sometimes, sharp, penetrating character – lightening pain, which also appears as a burning, unlocalized sensation, combined with referred pain. The diffuseness of this pain pattern is explained by the high proportion of C fibers which overlap the different receptive fields and wide innervation areas.

Chronic Pain

Chronic pain is a persistent painful sensation whose duration is longer than that of acute tissue injury. As a rule, the time limitation for this type of chronic pain is between 1 and 6 months. Chronic pain is directly related to psychological aspects, such as anxiety, especially the trait anxiety state, isolation, feelings of loss and helplessness, emotions often accompanied by chronic pain. These circumstances influence not only mood, but perception as well.

The pain learning and initiation processes are emphasized more in chronic than in acute pain. The cultural and socioeconomic factors also brutally influence the relation to prolonged pain. As the meaning of suffering and pain varies according to the different cultures, chronic pain depends not only on the individual's cognitive and emotional condition, but also on the socioenvironmental aspects. Autonomic responses (sweating, increase in blood pressure and pulse, and widening of the pupils) very often accompany acute pain, and rarely, the chronic form.

Central Pain

Central pain is defined as that which is associated with a disorder of the central nervous system. The pain may lead to extreme distress and be classified as an intolerable complaint. According to the most updated literature, this type of pain is more intractable to treatment. The pain begins generally days or weeks after a traumatic event. The pain manifestations can present just after the insult or even lifelong.

The anatomical classifications of central pain can be divided into the following:

1. Brain-related central pain – continues in a certain pattern which lasts for a long time or lifelong; has been classified as thalamic pain, pseudothalamic pain, super thalamic pain, or anesthesia dolorosa.

The most common neurological disorders associated with central pain are the following:

1. Stroke – central poststroke pain (CPSP); 90% of brain-related central pain is of vascular origin;

prevalence – ranges from 6% to 11% of stroke patients; some studies report a prevalence of 21%, 32%, and 35% after 4 and 16 months; males more frequent than females; increase of prevalence dependent on age.

2. Multiple sclerosis – 18% prevalence of pain among multiple sclerosis patients.
3. Cancer patients – prevalence of 2%.
4. Parkinson's disease.
2. Spinal cord injury pain (SCIP) – may change its characteristics during its duration; the most predominant cause is trauma, especially road accident – prevalence 20–25%; the most involved population is young adult.
3. Central sensitization pain.

Various clinical features of central pain

1. Constant spontaneous pain, with the following characteristics: aching, burning, lacerating cramping pain.
2. Spontaneous intermittent pain – lacerating pain; 10–20% of cases.
3. Evoked pain – allodynia, hyperalgesia, hyperpathia; elicited by mechanical or thermal stimuli; poor localization, manifestation of ipsi – or contralateral neurons.

Central poststroke pain (CPSP)

The characteristics of pain include the following: band-like muscle; constrictive pain; dysesthesia, hyperpathy, allodynia (in about 50% of patients), lacerating, circulatory, and visceral pain. According to the classification of the International Assessment for the Study of Pain, nociceptive pain is divided into the following: musculoskeletal muscle pain, bone, trauma, inflammatory, visceral pain, and nonlocalized neural pain.

SCI patterns of pain

1. Pain below the level of lesion (possible involvement of the posterior spinal cord tract).
2. Possible segmental band-like pain sensation.
3. Syringomyelia (a pattern that is posttraumatic or not traumatic in cystic enlargement of the spine central canal).

Pathophysiology of central pain

1. Isolated thalamic lesion theory. The theory that the isolated thalamic lesion is the only inducer of central pain (thalamic pain) was changed into the assumption that a lesion may involve various locations along the corticothalamocortical (CTC) pathway. These would include the primary sensory region (S_1), secondary sensory region (S_2), and nonspecific nuclei. In the thalamus, the most involved nuclei associated with central pain are the venteroposterior–inferior nuclei (VPI) (thermo-specific and nociceptive-specific) and the venteromedial (VM) nuclei. The last contain neurons which transduce input from skin by A_δ and C fibers toward layer 1 of the anterior cortex. Stimulation of these thalamus nuclei neurons induces pain. It is noteworthy that after selective damage of the venteromedial–posterior nuclei (VMp) in the thalamus, there is hyperactivation of the spinothalamic cingular pathway.
2. The deafferentation theory.
3. The dynamic reverberation theory. This is associated with dysarrhythmia-hyperactivity of bursting activation in the thalamus and sensory regions.

4. Neuropharmacological theory. This includes the derangement of GABA transmitters (gamma-aminobutyric acid – the inhibitory brain transmitter) by GABA cell loss following brain damage.
5. Neuroplasticity theory. This involves the anatomical features and location of brain activation changes with neuroplasticity reactions in the central nervous system following the deafferentation process.

Central sensitization

This is a condition of prolonged suffering from injury or inflammation with chronic continuous pain over 3+ months. It is a result of the pain facilitatory state and continued neuronal excitation in the dorsal horn of the spine and leads to chemical and structural neuronal changes localized in the pre-synapses and postsynapses of the dorsal horn of the spine and brain with mediation by NMDA downstream activity. The end result is a fixation of peripheral pain on the central–spinal and brain levels.

Intractable Pain

Intractable pain is a permanent severe pain condition mostly unaffected by drug administration. It can be the result of malignant or nonmalignant disease and also be associated with a psychiatric illness without any identifiable symptom. This type of pain in cancer patients is caused by direct penetration of the tumor mass into the diverse organs by nonmalignant complications of cancer (e.g., pathological fractures), neoplastic remote symptoms, and as a complication of chemotherapy or radiation (e.g., neuropathy). The psychological condition of the cancer patient is a very important factor in the development of intractable pain. The hopelessness of the situation and the depressive stage can intensify the pain sensitivity and even decrease the threshold of pain.

Causalgia

Causalgia is a pain disorder of the peripheral nervous system having a sustained obstinate burning character. It can develop after a traumatic peripheral nerve lesion such as complications of limb injuries which can occur from high-velocity missiles during warfare. The incidence of such a pain disorder in limbs of wounded soldiers is ~1.5–2%.

Causalgia is a very distressing and intense pain disorder which usually attacks patients severely during normal daily activities. It is usually combined with the median nerve injury in upper limbs and the sciatic nerve in the lower extremities.

Emotional and behavioral factors can distinctly influence this pain either by aggravating or relieving its intensity. It is certain that dysfunction of the sympathetic nervous system plays the main role in this disorder. It has also been proved that hypersensation of the WDR cells in the dorsal horn and dysfunctioning of the C and A_δ activities are the physiological changes in causalgia. The main role of the sympathetic system is demonstrated by the complete abolishment of pain sensation by total disruption of all sympathetic fibers to the injured limb. This finding is the basis for effective therapy of surgical sympathectomy in causalgia.

Referred Pain

Referred pain is one of somatic visceral origin which is projected to a fixed distant location. The best examples for this disorder are the projection of cardiac pain in the left shoulder and arm: pain in the right shoulder, pain in gallbladder diseases, and back pain in peptic ulcer. The explanation for the referred pain is a simultaneous activation of both processes of the dorsal root ganglion cells in the superficial skin branch and the deep somatic process. By stimulation of the visceral branch, the superficial branch activates and also depresses the activity of the visceral area. In the interaction between two different visceral pains (cardiac and gallbladder or pancreas and peptic ulcer pains), the fixed distant location moves in the vertical direction. This dislocation of the referred pain is known as aberrant referred pain. It very often happens when there are other defects in the same area occurring simultaneously with referred pain. The reflex paralysis is a well-known combination of limb, skin, pain, and muscle weakness in the same distribution. The close relationship between sensory and motor fibers explains this phenomenon.

Phantom Pain

Phantom pain, a postamputation disorder, is pain in the area of the body where a limb existed previously. This pain phenomenon is mostly associated with limb amputation, but can also develop after nose, ear, tongue, breast, or penis excision. This type of pain has no particular identifying character and may present in a burning, throbbing, aching, or crushing form. Its intensity and duration also vary radically from patient to patient. Very severe intractable pain, a mild unpleasant sensation, or a sensation without a painful component (phantom) may be the presenting symptoms. Cognitive, emotional, and behavioral factors play a role in the onset of this disorder. Patients suffering from emotional rigidity, in a depressive state, with feelings of helplessness and insomnia, are most likely to develop phantom pain, and possibly, with even more intensity.

Theories concerning the importance of preamputation factors, such as the last position of the leg before it was amputated, were previously reported. Currently, it seems that there is no relationship between phantom pain and preamputation conditions. The mechanism of phantom pain is uncertain. Peripheral, dorsal horn, supraspinal, and psychological causes were hypothesized. It seems that multifactorial causes are responsible for the development of this unusual disorder.

Medication (analgesics, antipsychotic, and antidepressant drugs), surgical intervention, physio- and psychotherapy, hypnosis, and acupuncture are investigated, but later were found to have only limited efficacy. The usefulness of each therapeutic method is individualistic in nature and varies from patient to patient.

Pain and Psychiatric Diseases

Many psychiatric diseases are associated with long-standing chronic pain. The intensity of pain in psychiatric patients can become intractable without even any evidence of physical lesions.

In neurosis and hysteria, pain is of a somatoformic phenomenon, resulting from an emotional dysfunction. Forty percent of neurotic and hysteric patients, mostly males, complain of having pain. In its extreme form, pain can be the presenting symptom of a psychiatric disorder and may be totally unresponsive to analgesic medications. This condition is usually associated with anxiety, fatigue, depression, or irritability, and sometimes with a neurological localized deficit, such as paralysis or an atypical pricking sensation of the limb. The complaints, in contrast to organic physical pain, may be of a very localized character, such as spot location in headache and the localized cardiac pain in cardiophobia. Prolonged, intractable pain often leads to medical misdiagnosis. In Briquet's syndrome (acute abdominal pain as a result of hysteria), many females, diagnosed as suffering from appendicitis, peptic ulcer, extrauterine gravidity, or even heart attack, may undergo unnecessary recurrent surgical intervention. Pain associated with muscle contractions, which is characteristic of many of these cases, aggravates the somatoformic pain in neurotic hysteric patients.

Pain is very closely related to anxiety which decreases the pain threshold. On the other hand, anxiety can be induced by pain, especially when it is of a visceral origin and associated with autonomic symptoms. In a situation of extreme stress with an overfunctioning of the sympathetic system, severe anxiety can be combined with the insensitivity and elevation of the pain threshold. War injuries, incurred at war during combat, mountain climbing, and road accidents, are examples of such stressful conditions.

Another, less common pain disorder in psychiatry is known as delusional pain which occurs in 2% of schizophrenic patients. In this case, it is difficult to differentiate between delusional pain and the extreme increase of the tolerance threshold to external pain stimuli. Schizophrenic patients with serious life-threatening medical conditions, such as heart attacks, perforation of peptic ulcer, or multiple injuries from road accidents, may be free of pain. Neurochemical mechanisms, such as changing of the serotonin or bradykinin levels, were postulated as the cause of this phenomenon. Delusional pain is mostly a part of a complex psychotic picture and is treated by the administration of antipsychotic medication.

Pain in the Elderly

The subdiscipline of pain in the aged is of increased interest. The characteristics of this elderly patient population are not yet clear. There is evidence of the intensity of pain between middle age and elderly subjects in the various modalities, even though special patterns of suffering are found in some of the clinical types of pain probably because the psychosocial factors are different for these two age groups. The pathway from catastrophic incidence to pain severity and the role of depressing fear of reinjury among the older subject may have a dominant effect on the specific pain features among these patients.

Each of the modalities has different characteristics. The threshold and tolerance to one modality are unrelated to the other. For example, the duration and affected area of the heat contact stimulus, which is transduced by the A δ and C polymodal nociceptors, are much shorter than that of the cold

pressure pain. Spatial and temporal summation of stimuli is another aspect of the pain stimuli analysis. The clinical pain's pathways are divided into the acute pain tract and the chronic pain tract. The most commonly used clinical acute pain type nomenclature are acute postsurgical pain, migraine pain, acute renal colic and acute abdominal pain, and postsurgical pain. The most commonly used clinical chronic pain type nomenclature are rheumatoid arthritis pain, low back pain, fibromyalgia, oral and facial pain, neuropathic pain, and cancer pain.

Pain – Sex and Gender

Data from previous clinical research have led to the assumption that males endure more pain, are less sensitive to it, and have a higher tolerance to all kinds of pain sensation. It was even determined that pain was an abnormal sensation for males. At the very least, this assumption was a result of the social-dependent expectation for each gender. However, it is well known that the prevalence of various chronic pain types is different in males and females. Among females, the prevalence of migraine, trigeminal and suboccipital neuralgia, causalgia, burning tongue, fibromyalgia, and proctalgia fugax is significantly higher than among males. On the other hand, it can be found that the prevalence of cluster headache, SUNCT syndrome, and postherpetic neuralgia is higher among males. In some of the other pain disorders, the dependency of gender is also age-dependent, such as in osteoarthritis which is more common after the age of 45 among females, and in males, up to the age of 45. The complete data of gender and sex dependency of pain sensitivity and tolerance is not yet clear, and additional study is necessary to fully investigate this subject.

Nevertheless, the results of some studies in this area have been informative. In 2007, a consensus report on pain was published. It was entitled 'Studying Sex and Gender Differences in Pain and Analgesia.' The report stated that the pain field has moved from debating whether sex differences in pain exist to recovering the influence of this difference. They recommended that all pain researchers consider testing their hypothesis in both sexes, or if restricted by practical means, only in females. It was also recommended to test pain sensitivity and tolerance across estrogen cycles in animals during the menstruation cycle, and in humans, to take into account various psychosocial factors, such as age, race, and ethnic cultural factors; plus the subject's individual history and clinical factors such as comorbidities, disabilities, medication usage, and cognitive and other affecting factors.

There have been some study vehicles that let us assume the tendency of sex and gender dependency in each of the clinical and experimental types of pain:

Sex differences in response to experimental stimuli pain

1. Pressure pain stimuli – females have lower pain threshold and tolerance and are more sensitive to this type of pain.
2. Ischemia pain stimuli – there is no evidence supporting the assumption that there is a sex difference in pain threshold or tolerance in this type of pain; however, there is a discrepancy between the results of the different studies.
3. Heat pain stimuli – there is evidence that females are more sensitive to heat stimuli; they define heat stimuli as more unpleasant in males and the females have lower

thresholds for tolerance; the minimal grade of temperature which induces pain is lower among females.

4. Cold pain stimuli – there is a sex difference with the induction of cold pain stimuli with lower tolerance and threshold.
5. Electrical pain stimuli – it seems that females are more sensitive to the electrical pain model.
6. Capsaicin-evoked pain – there is a high sensitivity to this type of pain among females; the sensitivity changed dependent upon the phase of the menstrual cycle; in the oral use of capsaicin, there is no difference between male nonusers of contraceptives females with contraceptive users having higher sensitivity.
7. Glutamate and hypertonic saline injections – females are more sensitive than males.
8. Temporal summation of pain – the temporal summation of pain is more significant among females.
9. Spatial summation of pain – there was not enough data to support any conclusion.

Sex differences in clinical pain trials

1. Cancer pain – there was no evidence in cancer pain; depression is more common among females.
2. Neuropathic pain – there was a greater sensitivity among females.
3. Lumbosacral pain – there was no difference in pain intensity and tolerance.
4. Osteoarthritis pain – there was a greater pain sensitivity among females and a higher intensity of depression.
5. Oral pain – there is a difference in sensitivity and tolerance among sex, especially in the age group of 45–65.6.
6. Abdominal pain – the data among abdominal pain was controversial.
7. Postsurgical pain – females report a higher intensity of postsurgical pain.

Children and adolescents

There is a higher prevalence of chronic pain, headache, and back pain in females than in males; the difference is more prominent during puberty.

Mechanisms leading to sex differences in pain

1. Hormonal factors – there was evidence of hormones playing a role in clinical pain; either the increase or decrease in estrogen level has an effect on activation of pain (e.g., in thermal stimulation). Different pain stimuli thresholds are dependent upon the phase of menstruation. Higher progesterone level may also lead to increased pain sensitivity (cold pain stimuli). The exact mechanism of effect is not yet clear. It may be an inflammatory and C fiber activation induction effect or activation of NMDA receptor, nitric oxide, and sympathoadrenal systems.
2. Endogenous opioid system – females have a greater opioid receptor activity and binding than males; higher estradiol-level response to increased μ -opioid receptor availability.
3. Dopamine – was found in fibromyalgia.
4. Serotonin – was found in migraine and inflammatory bowel syndrome.
5. NMDA receptors – there is a direct estrogen effect on NMDA and a sex-related NMDA receptor expressed in the dorsal root ganglia (DRG); the enhancement of opioid

antinociception is greater in males than in females in laboratory animal model studies. This phenomenon probably has an effect in the temporal summation of pain among both sexes.

6. Psychosocial cognitive and affective factors included coping, catastrophic sizing, effecting distress, and depression.
7. Anatomical brain physiology – there is an anatomical difference in the periaqueductal gray (PAG)-rostral ventromedial medulla and the dorsal horn of the spinal cord pathway between males and females. This pathway has an important role in the pain mechanism. Not only morphine, a μ -opioid receptor antagonist, but also κ and δ , have a direct effect on the PAG. The difference in activity between males and females by opioid receptor antagonists can be explained by the anatomical and structural difference of this system among sex.

Genetics

Data about genetic mutation influencing pain comes from animal model (mouse knockout and transgenic) studies and human ones (twin studies, SNP, and polymorphism analysis).

Conduction of Pain Genetics

Sodium channelopathy

Voltage-gated sodium channels play an important role in nociceptive transmission. The nociceptive stimuli depolarize the membrane, open the voltage-gated sodium channel transiently, and induce the flow of sodium ions apparently along the concentration gradient. This generates the action potential in the excitable cells and activates a transmission along the axons.

Voltage-gated sodium channels are heteromultimers which contain large pore-forming α -subunits and smaller β -subunits. The genes that decode voltage-gated sodium channels are as follows:

1. SCN 11A which encodes the voltage-gated sodium channel Na_v 1.9 and is activated near the resting membrane potential and plays a role in setting pain threshold. It is influenced by inflammatory mediators.
2. SCN 9A which encodes the voltage-gated sodium channel 1.7 and is located on chromosome 2. It is highly concentrated in the dorsal root ganglion and sympathetic ganglion; it amplifies small depolarizations and acts on the threshold and modulation of excitability of the channel. Mutations in the gene are responsible for the following diseases – paroxysmal extreme pain disorder (IEPD), along with extreme pain of the perirectal, perioral, and trigeminal area; plus, inherited erythromelalgia – a mechanical pain with episodic attacks in the foot and hand associated with chronic inflammation.
3. SCN 10A encodes the Na_v 1.8 channel and contributes to electrogenesis primary pain pathway and has a direct influence on inflammatory modulators and activation of cold pain stimuli.

The regulation of the voltage-gated sodium channel by transcriptional and post-transcriptional expression is by the following:

1. Neuron-restricted silencing element (NRSE) and its protein factor (NRSF) and repressor element 1 (RE1) and its protein REST.
2. Modulation of transmitter – KCNQ-encoded potassium channel. It acts in reducing excitability. Clinical importance is in hyperalgesia and allodynia.

Transduction of Pain

1. Heat pain sensation. Heterogeneous expression of mouse PIR1 enhances the channel of activity of transient receptor potential channels (TRPV₁) nociception, which responds to heat and capsaicin stimuli. It is located on chromosome 17p13. TRPV₂, vanilloid receptor (VR), is located on chromosome 17 and is detected by thermal sensory neurons which differ in this response threshold. TRPV₃, vanilloid-like receptor 3 (VRL), is located close to chromosome 17p13 and responds to temperature sensations and TRPV₄.
2. Cold pain sensation. Direct activation of TRP M8 and TRPA₁, inhibition of K⁺, and reduction of electrogenic pump activity. The TRP M8 gene is located on chromosome 2q37 and is related to VR1. Its expression is on cold metal receptor 1 (Cur1) and VR1 in the target cells and induces a temperature – cold or hot sensation. The mechanism was thought to be the cause of misinterpretation of noxious cold stimuli, such as burning pain modified by endogenous menthol-like ligand. TRPA₁ is located on chromosome 8p13 gene. It is an ankyrin-like protein with its transmembrane domains 1 (ANKTM 1) and is a cold-activated channel with lower activation temperature than normal. It is a cold and mental receptor and coexpresses in heat and capsaicin receptor II.
3. Mechanical pain sensation. It is initiated by direct activation of TRPV₄ and TRPC/P. TRPV₄ is located on chromosome 12q 2.1. Its main role is that of normal pressure detection. It has a high-threshold sensory complex and is also activated by heat pain sensation.
4. Acid sensing ion channel (ASIC) which is an activating mechanoreceptor.

Transient Receptor Potential Channels (TRPV)

TRPV – four subtypes

1. Type 1 – activated by a heat temperature more than 42 °C; proteins and endocannabinoids; located in dorsal root ganglion (spine), trigeminal ganglia, brain, and viscera.
2. Type 2 – activated by a heat temperature more than 52 °C, mechanical osmotic and diphenyl substance; located in the dorsal root ganglion, spinal cord, brain, and viscera.
3. Type 3 – activated by a heat temperature more than 34 °C, capsaicin, diphenyl, and camphor; located in the dorsal root ganglion, trigeminal ganglion, brain, spinal cord, and skin.
4. Type 4 – activated by a heat temperature more than 27 °C, osmotic, epoxylic, trienoic acid, and PVFA; located in the dorsal root ganglion, trigeminal ganglion, brain, and viscera.

TRPA

1. TRPA is activated by cold temperatures lower than 18 °C, mechanical stimuli, calcium ion, and icilin; located in dorsal root ganglion, and fibroblast and hair cells.

TRPM – two subtypes

1. Type 1 – activated by temperatures 15–35 °C, calcium ion; located in viscera.
2. Type 2 – activated by temperatures lower than 28 °C, menthol and icilin; located in the dorsal root ganglion, trigeminal ganglion, and viscera.

TRPC – two subtypes

1. Type 1 – activated by mechanical stimuli; located in viscera.
2. Type 2 – activated by diacylglycerol and exocytosis; located in the brain.

Synaptic transmission in pain

This occurs through the following:

1. Voltage-dependent Ca²⁺ channels (CACNA) 1A subunit 5 and located on chromosome 19 p13 and CACNA 2D₁.
2. Ionotropic glutamate receptor AMPA (α -amino-3-hydroxy-5-methyl-4-isoxazole-propionate)-GRIA 1 (location 5q33), GRIA 2 (location 4q32) and GRIA 3 (location Xq25-26) and GRIA 4.
3. Neurokinin 1 receptor = substance P receptor (location 2q11).
4. NMDA receptors and ionotropic glutamate receptor.
5. Kainate 1 (location 21q22), 2 (location 6q21), 3 (location 1p34–33), 4 (location 11q 22.3) and 5 (location 19q 13.2).

Genetic Mutations Decrease Pain

Hereditary syndromes

1. There are 13 currently identified variants of the SCN9A gene involving the voltage-gated sodium channel (2 subunits).
2. Others include hereditary sensory and autonomic neuropathy I–V.

Pain is reduced in the average population having the following:

1. Variation of micro-opioid receptor gene (OPRM 1), type Mu 1 (location 1 p 36.1 – p 34.3), and type delta 1 (1 p 36.1–p 34.3).
2. Variation of catechol-O-methyltransferase gene (COMT) associated with increased morphine sensitivity (location 14 q 22.1–q 22.2).
3. Variation of guanosine triphosphate cyclohydrolase 1/ dopa-responsive dystonia gene (GTP cyclohydrolase 1, GCH1) (location 14 q 22.1–q 22.2).
4. Melanocortin 1 receptor gene (MC1R) associated with increased opioid analgesia of micro-opioid receptor agonist and κ -opioid agonist (in females).

Intense opioid effect

1. Duplication of cytochrome P 450 206 gene
2. Melanocortin 1 receptor gene
3. Catechol-O-methyltransferase (COMT V 158 M).

Hereditary Sensory and Autonomic Neuropathy (HSAN)

Here are some hereditary disorders associated with the severe form of loss of pain.

1. HSAN 1 – gene location 9q22.1-q22.3; misuse mutation in serine palmitoyltransferase long chain base subunit 1 (SPLC 1); apoptotic loss of sensory and autonomic neurons; pain and heat less.
2. HSAN 2 – gene location on 12p 13; misuse mutations of protein kinase PRKWNK1.
3. HSAN 3 – familial dysautonomia; sensory cell loss; loss of sensation; Riley–Day syndrome; gene location q13; splicing deficit on IKB KAP protein; deficit in sensory neuron development; insensitivity to pain.
4. HSAN 4 – familial dysautonomia type II; gene location 1q21-q22; loss of functional TrKA receptor, small fibers neurons loss; insensitivity to pain; combined with amyloidosis.
5. HSAN 5 – gene is located 1p 13.1; congenital insensitivity to pain.

Assessment of Pain Therapy

The management of pain therapy depends on the efficacy of therapy modality and the physical and psychological condition of the patient. Drug treatment, surgical intervention, physiotherapy, psychotherapy, psychological management, including hypnotherapy and acupuncture, are categories of pain therapy.

Drug Therapy

Nonopioid analgesics

These drugs are nonselective cox inhibitors, such as acetaminophen, acetylsalicylic acid, (aspirin) and selective cox inhibitors or nonsteroidal anti-inflammatory agents – NSAIDs (ibuprofen, naproxen, indomethacin, suprofen, diclofen, celecoxib, and etoricoxib). The effect is mainly through their influence on the peripheral pain system. Most of the substances inhibit the prostaglandin synthetase enzyme and the kinin production. The central effect is also postulated, but only with a limited clinical importance. These drugs are usually administered in muscle and joint pain, rheumatic complaints, and inflammatory diseases associated with pain and headache, and some have a specific effect on migraine. This drug category does not induce tolerance, physical dependence, or influence mood and alertness.

Opioid analgesics

Opioid analgesics are agents which eliminate pain by activating the opioid analgesic system in the spinal horn and supraspinal structure. The analgesic effect is induced by binding the exogenous opioid substances of different opiate receptors, especially the μ receptor. Morphine, meperidine, methadone, codeine, and oxycodone belong to the exogenous opioids. Some of the drugs (pentazocine) have an agonist and antagonist effect on the system. Others have combined effects with antipain mechanisms (tramadol- μ -opioid receptor agonist and monoamine reuptake inhibition).

Opioid analgesics are very effective in severe, visceral, post-traumatic operation, and cancer pain. Its efficacy on the peripheral nerve lesion with causalgia, phantom pain, and psychiatric disorders is less prominent. The drug category is associated with side effects, such as vomiting, constipation,

and even respiratory distress, and is characterized by the development of tolerance to the substance and addiction. Addiction to these opiates is highly individual.

Antidepressants

The tricyclic antidepressants (amitriptyline, doxepin, and imipramine) are based on the effect of balanced monoamine reuptake inhibition and effective medications against peripheral-neuropathic pain, headache, and fibromyalgia. The effect of these drugs is associated with the psychiatric, antidepressive, sleep-regulating, and mood-stabilizing results with a specific effect on the serotonic and norepinephrine turnover by preventing the reuptake into cell bodies. A beneficial effect was also shown in antidepressants known as serotonin selective reuptake inhibitors (SSRI) and serotonin noradrenalin reuptake inhibitors (SNRI), for example, venlafaxine and duloxetine, which have to be investigated in patients with neuralgia, neuropathic pain, and fibromyalgia.

Serotonin agonists and antagonists

Serotonin receptors play a central role in the pain mechanism, especially in migraine headache. At least five different presynaptic and postsynaptic serotonin receptors (5HT receptors) are differentiated by dividing them into two groups – 5HT₁ and 5HT₂. 5HT_{1B} and 5HT_{1D} agonists (sumatriptan) have a strong antagonist (pizotifen) that has a preventive effect. α_2 , H₃, μ -opioid, and somatostatin were found in the trigemino-vascular fibers (fibers of the trigeminal nerve surrounding the cranial vessels) and may play a role in antimigraine therapy. Medication which has a direct stabilizing effect are as follows: voltage-gated sodium channel blockers (carbamazepine, phenytoin, and lamotrigine), α_{25} subunit of presynaptic voltage-dependent calcium channel blockers and reducers of presynaptic transmitter release, which was found to be efficient in peripheral pain, and inhibitors of glutamate release and the action of AMPA and kainate receptors, for example, Topiramate, which has been found to be effective especially in migraine and headache.

Other Antipain Methods

Surgical intervention is a radical, but nevertheless effective method in the treatment of severe, prolonged pain. Physiotherapy and psychological management are helpful in the elimination of aggravating emotional and cognitive-negative aspects of pain. Physiotherapy can help relieve muscle contraction and joint pain, which severely intensifies pain sensation from other origins. The use of TENS, a high-frequency, low-intensity stimulation, is effective in peripheral and spinal pain. This mechanism is independent of the opioid analgesic system and the effect is not reversible by administration of naloxone.

A prolonged inhibitory effect of TENS on the spinothalamic tract without abnormality in the peripheral nerve conduction and a spinal depressing activity by selective C/A fiber stimulus, according to the gate theory, are postulated as the mechanisms of TENS.

Acupuncture depresses pain sensation probably by activating the opioid analgesic system. A low-frequency, high-intensity stimulus has a similar effect; however, both physical therapies are partially reversible by naloxone administration.

Hypnotherapy and biofeedback are other options in pain management. The relaxin-imaginary exercises may influence the autonomic system and induce self-regulation of pain by controlling cognitive and autonomic functions. Other non-pharmacological treatments tried in refractory central pain have repetitive transcranial magnetic stimulation (rTMS), deep brain stimulation (DBS), invasive motor cortex stimulation, and vestibulocochlear stimulation.

See also: [Anxiety and Fear](#); [Perceived Control](#); [Schizophrenia](#).

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Paranoia

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Glossary

Delusions Faulty interpretations of reality that cannot be shaken, despite clear evidence to the contrary, and that are not shared by other members of the community.

Ideas of reference The misperception of oneself as the target of others' thoughts and actions; for example, a person seeing others laughing might relate the event to himself, and see himself as the target of their laughter.

Paranoia A disordered mode of thought that is dominated by a pervasive, exaggerated, and unwarranted suspiciousness and mistrust of people, and a corresponding tendency to interpret the actions of others as deliberately threatening or demeaning.

Paranoid illumination The point at which the paranoid realizes that he has been singled out for mistreatment, and

others are working against him; suddenly, everything begins to make sense.

Projection A psychological defense often associated with paranoid thinking, in which the individual attributes one's own unacceptable motives or characteristics to others.

Pseudo-community A delusional system in which the paranoid organizes a variety of unrelated persons into a structured group whose primary purpose is to engage in a conspiracy against him.

Self-focus A behavioral style characteristic of paranoia, in which the individual is especially prone to be aware of himself as an object of attention to others.

Therapeutic alliance A tactic frequently used in treating paranoids, in which the therapist acknowledges the patient's delusional beliefs as understandable, in an attempt to build trust.

Paranoia, although originally referring (in Greek) to almost any kind of mental aberration or bizarre thinking, is currently used to describe a disordered mode of thought that is dominated by an intense, irrational, but persistent mistrust or suspicion of people, and a corresponding tendency to interpret the actions of others as deliberately threatening or demeaning. Because of the general expectation that others are against them or are somehow trying to exploit them, paranoid persons tend to be guarded, secretive, and ever vigilant, constantly looking for signs of disloyalty or malevolence in their associates. These expectations are easily confirmed: the hypersensitivity of paranoids turns minor slights into major insults, and even innocuous events are misinterpreted as harmful or vindictive. As a result, a pernicious cycle is set in motion whereby expectations of treachery and hostility often serve to elicit such reactions from others, thus confirming and justifying the paranoid's initial suspicion and animosity. Of all psychological disturbances, paranoia is among the least understood and most difficult to treat.

Paranoid Syndromes

Paranoid features are found in a variety of different psychological conditions. Although these conditions are often regarded as distinct, the criteria for distinction are not entirely clear and the practical utility of the distinction, in terms of etiology or treatment implications, has not been established. Thus, it may be useful to consider the different paranoid disorders as related syndromes existing along a continuum which varies in terms of the frequency and severity of paranoid thoughts, the degree to which reality is allowed to influence perceptions, and the extent to which functioning is impaired. The continuum extends from paranoid personality disorder, which is

nondelusional, but where suspicion and its sequelae occur so regularly that work and family life are often disrupted; to delusional (paranoid) disorder, involving a chronic, dysfunctional delusional system, although apart from the delusion, reality testing is good and behavior is not obviously odd; and finally, to paranoid schizophrenia, a severe, incapacitating psychosis, involving a serious loss of contact with reality in which all thought is affected by the delusion.

Paranoid Personality Disorder

Anyone starting out in a new situation or relationship may be cautious and somewhat guarded until they learn that their fears are unwarranted. Those with paranoid personality disorder cannot abandon those concerns. Although not of sufficient severity to be considered delusional, theirs is a rigid and maladaptive pattern of thinking, feeling, and behavior, usually beginning by early adulthood, which is built upon mistrust, vigilance, and hostility. The conviction that others 'have it in for them' represents their most basic and unrelenting belief; they feel constantly mistreated, and have a high capacity for annoying and provoking others.

Seeing the world as a threatening place, these individuals are preoccupied with hidden motives and the fear that someone may deceive or exploit them. They are inordinately quick to take offense, slow to forgive, and ready to counterattack at the first sign of imagined criticism, even in their personal relationships. Disordered paranoid personalities see references to themselves in everything that happens. If people are seen talking, the paranoid knows they are talking about him. If someone else gets a promotion, that person's advancement is seen as a deliberate attempt to humiliate him and downgrade his achievements. Even offers of help and concern are taken as implied criticisms of weakness or as subtle manipulations of

indebtedness. The constant suspicions and accusations eventually strain interpersonal relations to the point where these individuals are in constant conflict with spouses, friends, and legal authorities.

Given their hypersensitivity, any speck of evidence that seems to confirm their suspicions is blown out of proportion, and any indication to the contrary is ignored or misinterpreted. Trivial incidents become accumulated and unconnected 'facts' are fit together to create false, but unshakeable beliefs regarding their mistreatment. Because of their conviction that others are undermining their efforts or ruining their achievements, they tend to see themselves as blameless, instead finding fault for their own mistakes and failures in others, even to the point of ascribing evil motives to others.

Those with disordered paranoid personalities also tend to overvalue their abilities, and have an inflated sense of their rationality and objectivity, making it extraordinarily difficult for them either to question their own beliefs or to accept or even appreciate another's point of view. Unable to recognize the possibility of genuine dissent, simple disagreement by others becomes a sign of disloyalty. The resulting obstinacy, defensiveness, and self-righteousness exasperates and infuriates others, and elicits responses that exacerbate the conflict and confirm the original paranoid expectations.

In addition to being argumentative and uncompromising, paranoids appear cold and aloof, and emotionally cut off from others. They avoid intimacy, partly because they fear betrayal, partly in an attempt to maintain total control over their affairs, and partly because of profound deficits in their capacity for joy, warmth, and nurturance. The resulting social isolation, by limiting the opportunity to check social reality and learn from others, only reinforces their egocentric perspective.

Compared to some other paranoid pathologies, those with disordered personalities tend not to progressively worsen, but rather reach a certain level of severity and stay there. They show considerably less disorganization of personality, and they do not develop the kind of systematic and well-defined delusions found in delusional disorders. However, the proverbial kernel of truth is often greater in the suspicions of disordered paranoid personalities than in those with delusional disorders; their accusations have more plausibility and their paranoid attitudes are more diffuse. Because of the complexity and pervasiveness of personality disorders, these individuals may have more impoverished lives, although some do manage to function adequately in society, often by carving out a social niche in which a moralistic and punitive style is acceptable or at least tolerated.

Delusional (Paranoid) Disorder

The cardinal feature of this disorder is the presence of a delusion that is so systematic, logically developed, well-organized, and resistant to contradictory evidence, that others are often convinced by it. Delusions are faulty interpretations of reality that cannot be shaken, despite clear evidence to the contrary. Although the delusions in this disorder are nonbizarre (unlike those found in paranoid schizophrenia) and involve situations that may occur in real life, in fact they have no basis in reality, and are not shared by others in the culture. Delusional systems are usually idiosyncratic, but some themes or combination of

themes are more frequently seen than others, and psychiatric diagnoses of this disorder are now specified by the predominant theme of the delusions present.

Delusions of persecution, in which the paranoid believes that 'others are out to get me,' are the most common form of this disorder. While those with a paranoid personality disorder may be suspicious that colleagues are talking about them behind their backs, persons with delusional disorder may go one step further and suspect others of participating in elaborate master plots to persecute them. They often believe that they are being poisoned, drugged, spied upon, or are the targets of conspiracies to ruin their reputations. Many of them tend to be inveterate 'injustice-detectors,' inclined to take retributive actions of one sort or another, and are constantly embroiled in litigation or letter-writing campaigns, in an attempt to redress imagined injustices.

Persons with delusions of grandiosity have an exaggerated sense of their own importance. In some cases, these beliefs are related to persecutory delusions, in that the paranoid eventually comes to feel that all the attention he is receiving is indicative of his superiority or unique abilities. Such exalted ideas usually center around messianic missions, extremist political movements, or remarkable inventions. Persons suffering from delusions of grandeur often feel that they have been endowed with special gifts or powers and, if allowed to exercise these abilities, they could cure diseases, banish poverty, or ensure world peace. When these efforts are ignored or thwarted, as they almost inevitably are, the paranoid may become convinced of a conspiracy directed against him.

Another theme frequently seen is that of delusional jealousy, in which any sign – even an apparent wrong number on the phone or a short delay in returning home – is summoned up as evidence that a spouse is being unfaithful. When the jealousy becomes irrationally pathological, and the paranoid becomes convinced beyond all reason that his spouse is cheating and plotting against him in an attempt to humiliate him, he may become violently dangerous.

An erotic delusion (also known as erotomania) is based on the belief that one is romantically loved by another, usually someone of higher status or a well-known public figure, although the other, presumably, cannot acknowledge it openly. Because of unrealistic expectations about the likelihood of living with the celebrity, these delusions often result in stalking or harassment of famous persons through incessant phone calls, letters, visits, and surveillance. When their love is not returned, these delusional individuals feel a sense of betrayal that may turn to rage and hatred. Although this disorder has been reported most often in women, it occurs in men as well (perhaps the best example being John Hinckley, whose erotomanic delusions involving the actress Jodie Foster led to his attempted assassination of then-President Ronald Reagan).

Those with somatic delusions are convinced that there is something very wrong with their bodies – that they emit foul odors, or have bugs crawling inside of them, or are misshapen. These delusions often result in an avoidance of others, except for physicians who, despite being accused of conspiring to deny the problem, are consulted continuously regarding the imagined condition.

The thinking and behavior of these individuals tend to become centered around the delusional theme in a pathological

'paranoid construction' that, for all its distortion of reality and loss of critical judgment, provides a sense of identity, importance, and meaning not otherwise available. The meaningfulness of delusions is also suggested by the fact that they often reflect the person's position in the social universe: women and married men are most likely to have delusions with sexual content; foreign immigrants are most prone to have paranoid delusions; and people from higher socioeconomic levels are the most likely to have delusions of grandeur.

Once the basic delusion is accepted, other aspects of behavior, including emotional responses, may be described as appropriate and more or less conventional. Delusionally disordered persons do not suffer hallucinations or indications of other mental disorders, and their personalities do not change drastically; there are few exacerbations or remissions. There is a relatively high level of cognitive integration skills in areas that do not impinge on the delusional thought structure. Despite their mistrust, defensiveness, and fear of being exploited, they can sometimes function adequately, especially when their suspicions are limited to one specific area; for example, if they suspect poisoners everywhere, they may be satisfied if they can prepare all their own food. Their lives may be very limited and isolated, but they are just as likely to be regarded as harmless cranks than someone requiring the help of a mental health professional.

Sometimes, however, the consequences of the delusions are debilitating and not so easy to manage; for example, a person suffering from delusions of persecution may assault an imagined persecutor or spend a fortune fleeing enemies and pursuing redress for imagined wrongs. In other instances, the disorder may be dangerous. In particular, paranoid delusional disorder may be overrepresented among fanatical reformers and self-styled prophets and cult leaders. These individuals may be especially attracted to an enterprise that encourages blaming others, regarding themselves as a victim, and putting themselves at the center of things. Especially in times of social cataclysm or uncertainty, their grandiosity and moralistic tendencies, as well as the logical and compelling presentation of their messianic or political delusions, can often attract disciples. In addition, their garrison mentality is quite capable of provoking events which then serve to confirm their apocalyptic prophecies.

Much of the difficulty involved in diagnosing paranoid disorders is because of the slipperiness of the concept of delusion. Even in the real world, it is not always possible to determine the truth or falsity of an idea: Does the government keep track of unsuspecting individuals? Is our air and water filled with unseen toxins? Does our boss really have our best interests in mind? Some ideas that are patently false are held with sincere conviction by many; and even when an idea is held as preposterous by the majority, that majority may be wrong. How, then, do we evaluate the irrationality of an idea, or decide whether clearly eccentric and convoluted thinking merits the designation 'delusional?' Although it may be difficult to distinguish reality from illusion, particularly when the belief system develops around a potentially real injustice, other indications may be diagnostically helpful. An inability to see facts in any other light or to place them in an appropriate context, a glaring lack of evidence for far-reaching conclusions, and a hostile, suspicious, and uncommunicative attitude when delusional ideas are questioned usually provide clues of pathology.

Paranoid Schizophrenia

This major mental illness is one of the most common types of psychotic disorders. Paranoid schizophrenics may be distinguished from those with delusional disorder on the basis of the extreme bizarreness of their paranoid delusions, such as the belief that their thoughts or actions are being controlled by external forces, and by the presence of hallucinations (e.g., hearing voices) and other indications of a serious break with reality. The delusions of schizophrenics are not organized and systematic, but fragmentary and unconnected. Although these individuals may be suspicious and very much threatened by outside influences, their reaction, unlike that of the disordered paranoid personality, is usually hesitant and confused; their anger has no concentrated intensity. The behavioral, cognitive, and perceptual disorders of paranoid schizophrenics are so dysfunctional that performance on the job or at home almost invariably deteriorates, and emotional expressiveness becomes severely diminished.

These individuals commonly suffer from delusions of persecution, wherein they are convinced that they are constantly being watched or followed, and that strangers or government operatives or even alien beings are plotting against them with fantastic machines, undetectable poisons, or extraordinary mental powers. Of course, given the exceptional cunning and duplicity of these diabolical forces, virtually anything – a look, a sound, a bodily sensation, for that matter, even the absence of anything, a particularly shrewd maneuver – is seen as confirmation of one's suspicions. When the schizophrenic experiences the 'paranoid illumination,' and recognizes that all this overwhelming evidence fits together, the sense of his own visibility and vulnerability is profoundly increased, as is the tendency to misperceive himself as the target of other people's stares, comments, and laughter. In some cases, persecutory beliefs are accompanied by delusions of grandeur: that they are the target of these forces is only because they are special or powerful or dangerous. They may recognize that others reject them and their message, but they interpret these negative reactions as persecution based on jealousy, hostility, or enemy conspiracies.

Some paranoid schizophrenics avoid detection for long periods because their extreme suspiciousness encourages them to keep their 'precious knowledge' secret. Moreover, although these individuals are deeply disturbed and are subject to intense panic (given their sense of imminent danger) and extreme excitement (over their irrational 'discoveries'), many of them are not overtly bizarre or belligerent.

Other Paranoid Disorders

Some paranoid thinking manifests itself in a less persistent form. Acute paranoid disorder, in which delusions develop quickly and last only a few months, sometimes appear after a sudden, stressful social change, such as emigration, prison, induction into military service, or even leaving a family home. Although these conditions are multifaceted, they all are associated with extreme social isolation, unfamiliarity with the appropriate customs and rules of behavior, a sense of vulnerability to exploitation, and a general loss of control over life, psychological factors which may play an important, albeit temporary, role in inducing episodes of paranoia.

Paranoid symptoms may also be a byproduct of physical illness, organic brain disease, or drug intoxication. Among organic illnesses, hypothyroidism, multiple sclerosis, Huntington's disease, and epileptic disorders, as well as Alzheimer's disease and other forms of dementia are common causes of paranoia. In some people, alcohol stimulates a paranoid reaction even in small doses, and paranoia is a common feature of alcohol hallucinosis and alcohol withdrawal delirium. Chronic abuse of drugs, such as amphetamines, cocaine, marijuana, PCP, LSD, or other stimulants or psychedelic compounds may produce some of the symptoms of paranoid personality disorder, and in high doses, may cause an acute psychosis that is almost indistinguishable from paranoid schizophrenia. These drugs may also exacerbate symptoms in persons already suffering from a paranoid disorder.

Prevalence

It is difficult to estimate the frequency of paranoia in the general population because many paranoids function well enough in society to avoid coming to the attention of professionals and because their suspiciousness and intellectual arrogance usually prevent them from volunteering for treatment. While clinical diagnoses of paranoid disorders are rare, a more realistic picture of its actual occurrence is suggested by the many exploited inventors, morbidly jealous spouses, persecuted workers, fanatical reformers, and self-styled prophets who are often able to maintain themselves in the community without their paranoid condition being formally recognized.

Estimates of prevalence are further complicated by the fact that almost everyone engages in paranoid thinking at one time or another. Most people can think of an occasion when they thought they were being watched or talked about, or felt as if everything was going against them, or were suspicious of someone else's motives without adequate proof that such things had actually occurred. Recent studies have shown that for a significant number of people, these paranoid beliefs represent a relatively stable personality pattern. Such paranoid personalities – although characterized by suspiciousness, self-centeredness, scapegoating tendencies, and a generally hostile attitude – apparently are capable of functioning reasonably well in society.

Causes of Paranoia

Biological Bases

Genetic contribution

Although there is little research on the role of heredity in causing paranoia, there is some evidence from twin studies indicating that paranoid symptoms in schizophrenia may be genetically influenced. In addition, family studies suggest that features of the paranoid personality disorder occur disproportionately more often in families with members who have either delusional disorders or paranoid schizophrenia, suggesting that these syndromes may be genetically related.

Biochemistry

No identifiable biochemical substrate or demonstrable neuropathology relates specifically to paranoid thought or delusions; that is, there is no brain system whose dysfunction would

specifically produce the psychological characteristics associated with paranoia. Although the abuse of drugs, such as amphetamines, may lead to paranoid symptoms, thus suggesting a possible biochemical pathway, no such pathway has been identified; whatever drug effects have been found may be psychologically, and not biochemically, mediated.

Psychological Bases

In the absence of a clear organic basis or effective drug treatment for paranoia, most researchers have sought to identify the psychological mechanisms that explain how paranoid ideas become fixed in the mind.

Psychodynamic theory

Of all psychological theories, Freud's is perhaps the best known, although it is increasingly challenged. He believed that paranoia was a form of repressed homosexual love. According to Freud, paranoia arises, at least in men, when a child's homosexual feelings for his father are preserved but driven into the unconscious, from which they reemerge during an adult emotional crisis, converted into suspicions and delusions by projection – the attribution of one's own unacknowledged wishes and impulses to another person. That is, before reaching consciousness, the impulses undergo some kind of transformation that disguise their homosexual origin; for example, a man suffering from paranoid jealousy, unable to acknowledge that he himself loves another man, projects that feeling onto his wife, and becomes convinced that it is his wife who loves the man.

Although Freud's theory of unconscious homosexuality has been largely discredited, projection is still recognized as a basic mechanism used by paranoids to defend against their feelings. Paranoids will explain their sense of helplessness by pointing to the control exerted by others; or self-critical ideas are transformed into the belief that others are criticizing them. Viewing others as hostile not only justifies the paranoid's feeling of being threatened, it may actually elicit the other's anger, thus confirming the paranoid's original assumption. As a result, paranoids are left feeling weakly vulnerable, but morally righteous.

Faulty development

Rather than emphasizing unconscious dynamics, other approaches have viewed paranoid thinking as the outcome of a complex interaction of personality traits, social skills, and environmental events, some of which may be traced to early family dynamics. Paranoids, even as children, are often described as aloof, suspicious, secretive, stubborn, and resentful of punishment. Rarely was there a history of normal play with other children, or good socialization with warm, affectionate relationships. Their family background was often authoritarian, and excessively dominating and critical. Paranoid persons may dread being watched and judged because, it has been suggested, it reminds them of their parents, who were distant, demanding, and capricious.

This inadequate socialization may have kept them from learning to understand others' motives and points of view which, in turn, may have led to a pattern of suspicious misinterpretation of unintentional slights. Social relationships

tended to be suffused with hostile, domineering attitudes that drove others away. These inevitable social failures further undermined self-esteem and led to deeper social isolation and mistrust. In essence, these individuals emerged from childhood with deeply internalized struggles involving issues of hostility, victimization, power, submission, weakness, and humiliation. In later development, these early trends merged to create self-important, egocentric, and arrogant individuals, who maintained their unrealistic self-image and a sense of control by projecting blame for their problems onto others, and seeing weaknesses in others that they could not acknowledge in themselves. Their suspicion and hypersensitivity were made even more problematic by their utter inability to see things from any viewpoint but their own.

The paranoid 'illumination' and the paranoid pseudo-community

Other theorists have focused, not on early family history, but on the later emergence of a fixed, unyielding paranoid belief system. Given the paranoid's rigidity, self-importance, and suspiciousness, he is likely to become a target of actual discrimination and mistreatment; and ever alert to such occurrences, the paranoid is likely to find abundant 'proof,' both real and imagined, of persecution. The cycle of misunderstanding is then perpetuated by the paranoid's subsequent responses. The belief that others are plotting against him results in hostile, defensive behavior. This in turn elicits the others' anger and irritability in response to the paranoid's apparently unprovoked hostility, thus confirming the paranoid's original suspicion that they are out to get him. This cycle of aggression and counteraggression has also been offered as one explanation for the greater prevalence of paranoia among males than females. The paranoid's inability to consider the others' perspective – that the other may be operating out of defensiveness against the paranoid's antagonism and belligerence – only exacerbates the conflict.

As failures and seeming betrayals mount, the paranoid, to avoid self-devaluation, searches for 'logical' explanations. He becomes more vigilant in his scrutiny of the environment, looking for hidden meanings and asking leading questions. Eventually, a meaningful picture, in the form of the 'paranoid illumination,' crystallizes and everything begins to make sense: he has been singled out for some obscure reason, and others are working against him. Failure is not because of any inferiority on his part, but rather because of some conspiracy or plot directed at him. With this as his fundamental defensive premise, he proceeds to distort and falsify the facts to fit the premise, and gradually develops a logical, fixed delusional system, referred to as the 'pseudo-community,' in which the paranoid organizes surrounding people (real and imaginary) into a structured group whose purpose is centered on his victimization. As each additional experience is misconstrued and interpreted in light of the delusional idea, more and more events, persons and experiences become effectively incorporated into the delusional system. Because the delusion meaningfully integrates all the vague, disturbing, amorphous, and unrelated 'facts' of his existence, the paranoid is unwilling to accept any other explanation and is impervious to reason or logic; any questioning of the delusion only convinces him that the interrogator has sold out to the enemy.

Anomalous perceptions

Another theory offers the intriguing hypothesis that delusions are the result of a cognitive attempt to account for aberrant or anomalous sensory experiences. For example, research has shown that persons with visual or hearing loss – because of both heightened suspiciousness and an attempt to deny the loss – may conclude that others are conspiring to conceal things from them. The experience of many elderly people, who are a high risk group for paranoia, provides a particularly good example of this phenomenon. These individuals, because of physical disability or social isolation, often feel especially vulnerable. These realistic feelings may be converted to paranoia by an unacknowledged loss of hearing. That is, an awareness of oneself as a potential victim of greedy relatives or petty criminals, together with an increased sense that others are whispering, may contribute to a growing suspicion that others are whispering about them, or harassing them, or perhaps planning to steal from them. When the others angrily deny the accusation, it only reinforces the conspiratorial delusion, and intensifies the cycle of hostility and suspicion.

The occurrence of paranoia in those with degenerative brain disorders, such as Alzheimer's disease, may be explained through a similar process. These diseases commonly involve a disruption of memory that victims may be unwilling to acknowledge. As a result, failures of memory become an anomalous experience that needs to be explained. For example, not being able to locate one's keys is transformed into the belief that someone else has stolen or misplaced them. This suspicion may then be incorporated with actual perceptions, such as seeing one's child speaking to the doctor, to produce the conviction that others are conspiring to confuse the patient in order to put them away.

The general hypothesis that anomalous experience may be the basis for paranoia assumes that the process by which delusional beliefs are formed is very similar to the process that operates in the formation of normal beliefs; that is, delusions are not the result of a disturbed thought process, but arise because of abnormal sensory or perceptual experiences. Anomalous experiences demand an explanation, and in the course of developing hypotheses and testing them through observations, the delusional insight is confirmed through selective processing of 'evidence.' This explanation offers relief in the form of removing uncertainty, and the relief in turn works against abandonment of the explanation.

Stress

A related explanation may account for the often observed association between paranoia and stressors such as social isolation, economic deprivation, and abrupt situational changes. These conditions generally involve feelings of confusion, vulnerability, and a loss of control, suggesting that, in some ways, paranoid thought may serve to impose meaning and control in an otherwise uncertain and threatening environment. The paranoid belief that others are responsible for one's own misfortune, although threatening and irrational, may still be preferable to the belief that one is responsible for one's own misfortune or that such misfortune is a purely random event. In this regard, it is possible that the paranoid thinking which often develops as a result of acute drug intoxication (e.g., amphetamine abuse), or aging (and its concomitant sensory

loss and social isolation), or degenerative brain disorders (such as Alzheimer's Disease), may be mediated by the confusion and vulnerability often found in these conditions.

Biases in information processing

Some of the approaches discussed thus far have emphasized the fact that, apart from the paranoid construction itself, the cognitive functioning of paranoids is essentially intact. In fact, given their delusional system, paranoid reactions are not unlike the biased tendencies of many individuals with strong belief systems, who are likely to exaggerate, distort, or selectively focus on events that are consistent with their beliefs. Once the paranoid suspects that others are working against him, he starts carefully noting the slightest signs pointing in the direction of his suspicions, and ignores all evidence to the contrary. With this frame of reference, it is quite easy, especially in a highly competitive, somewhat ruthless world, for any event, no matter how innocuous, to be selectively incorporated into the delusion. This, in turn, leads to a vicious cycle: suspicion, distrust, and criticism of others drives people away, keeps the paranoid person in continual friction with others, and generates new incidents for the paranoid to magnify.

Although these information processing biases serve to maintain the paranoid's beliefs once they are established, they do not address the question of the origin of paranoid beliefs. That origin, however, may also be related to cognitive biases. The essence of paranoia is a malfunctioning of the capacity to assign meanings and understand causes for events. Ordinarily, these cognitive processes operate in a reasonably logical and objective fashion. In paranoia, such objective assessments are overwhelmed by judgments and interpretations that bear little relation to what actually happened, but instead are perverted in accord with the paranoid's own concerns and interests. The persistent misperception of oneself as the target of others' thoughts and actions, referred to as an idea or delusion of reference, is the hallmark characteristic of almost all forms of paranoid thought. Even when there is no basis for making any connection, paranoids tend to perceive others' behavior as if it is more relevant to the self than is actually the case as, for example, when the laughter of others is assumed to be self-directed, or the appearance of a stranger on the street is taken to mean that one is being watched or plotted against. Why does the paranoid consistently feel singled out or targeted by others?

Paranoia and self-focus

Part of the answer may lie in the characterization of paranoia as a very self-focused style of functioning. Recent studies have suggested that self-awareness, or the tendency of the individual to recognize himself as an object of attention, heightens the likelihood of engaging in paranoid inferences. In essence, to see oneself as an object of attention, particularly to others, leaves a person susceptible to the paranoid idea that he is being targeted by others. Apparently, as a result of recognizing the self as an object of attention, the self is more likely to be interjected into the interpretation of others' behavior, thus transforming insignificant and irrelevant events into ones that appear to have personal relevance for the self. Self-focus not only relates directly to paranoid ideas of reference, it has important implications for other critical aspects of paranoid thought.

Personalism and intent

Unfortunate things happen to everyone, and usually they are dismissed as random or chance events. But paranoids rarely accept the idea that bad things just happen; because of their self-focus, they are likely to perceive those negative events as the result of someone else's intentional doing. Research has suggested that when events are taken personally, or are seen as uniquely targeted toward the self, they are more likely to be understood in terms of others' personal characteristics or intentions. For the paranoids, the negative event itself is evidence for others' malevolent intentions toward them. Eventually, the accumulation of such events constitutes evidence for a fundamentally irrational view of the world as a hostile and threatening place. Once the assumption of ubiquitous danger is accepted, the other manifestations of paranoia become comprehensible: suspicion and guardedness; selective attention and memory for signs of trickery or exploitation; misinterpretation of apparently harmless events as malevolent; and blaming others for all of one's difficulties. Moreover, when negative events are seen, not as fortuitous occurrences, but as personally intended by others, hostilities become intensified and enemies are found everywhere.

Egocentricity

One of the critical elements of paranoid thinking is the utter inability to understand the motivations and perspectives of others. Not only are paranoids more likely to misinterpret other's behavior, they are less likely to correct that misinterpretation by altering their point of view. The narrowness and rigidity of paranoid thought – the failure to examine events critically or in a broader context, the ability to fit anything into one's belief system, the unwillingness to ever consider changing one's mind – are, in large part, the result of being locked into one's own perspective. Although social isolation may account, in part, for this deficit in role taking, self-focused attention may also contribute to the self-centeredness of paranoids. Attention directed toward the self interferes with the ability to take the role of another or appreciate the existence of alternative perspectives. As a result, paranoids are likely to assume that others share their own view of events, and fail to appreciate the way in which their own actions are viewed by others. Thus, in a typical encounter, they are unlikely to consider the way in which their own behavior provokes the hostility of others, but instead are likely to see themselves as the innocent victim of the other's hostility. Self-focus may also play a role in the egocentric tendency of paranoids to project their own characteristics onto others.

Treatment of Paranoia

Treatment of paranoia is extraordinarily difficult for a number of reasons. First, little is known about the causes that presumably are to be treated. Secondly, it is difficult for the paranoid to recognize a problem when he is locked into his own perspective and is reluctant to accept another's viewpoint. Finally, it is nearly impossible for therapists to penetrate the barrier of suspiciousness. For all these reasons, paranoids are unlikely and unwilling to enter therapy; and once in therapy, their wariness often leads them to sabotage treatment, or break it

off prematurely. Paranoids also generally refuse to take responsibility for their treatment because the only problems they see are those created by the people intent upon harming them. In addition, those aspects of therapy that require disclosure of personal information may represent a loss of control, especially to male paranoids.

Mistrust obviously serves to undermine the therapeutic relationship. Any expression of friendliness or concern by the therapist is likely to arouse suspicion or be taken as confirmation that others are trying to humiliate the paranoid client. Questions or suggestions are seen as criticisms or attacks. Even if therapy improves other aspects of the paranoid's functioning, their delusional system is so strenuously defended, and so easily confirmed by 'clues' detected in the therapeutic situation, that it often remains intact, yielding a highly unfavorable prognosis for complete recovery.

Because of the paranoid patient's guardedness and insistence on their own correctness, an effective therapeutic approach usually focuses on trust building rather than direct confrontation of the delusional beliefs. Perhaps the most powerful strategy is to establish a rapport by forming a 'therapeutic alliance' in which the therapist recognizes whatever kernel of truth exists in a paranoid system, and acknowledges the delusional beliefs as powerful, convincing, and understandable. The therapist may then try to identify the ways in which these beliefs may interfere with the patient's goals or create frustration for others as well as for the patient. The patient's paranoid reactions have usually driven others away or incited them to counterattack, heightening the cycle of suspicion and hostility. The therapist can sometimes bring about change by providing a different, empathic response that serves as a model of nonparanoid behavior. The task is then to help the paranoid become more competent at discriminating real threats from perceived ones, and the final step is the development of more adaptive responses to real or even ambiguous threats.

Behavioral theory assumes that paranoids have learned to be hypersensitive to the judgments of others and, as a result, they behave in ways that invite just the sort of reaction they anticipate and fear. As others begin to avoid them, they

become socially isolated and develop increasingly elaborate suspicions that maintain the isolation. Behavior therapy tries to break the cycle by first using relaxation and anxiety management to teach the patient to be less sensitive to criticism, and then improving social skills by training the patient to act in ways that will not invite attack or avoidance. The patient can also be given help with recognition and avoidance of situations that produce or increase delusions. Paranoid thinking can in some cases be altered by aversive conditioning or the removal of factors that reinforce maladaptive behavior.

See also: [Confabulation and Reality Filtering](#); [Delusions](#); [Personality Disorders](#); [Schizoid and Schizotypal Personality Disorder](#); [Schizophrenia](#); [Self-Esteem](#); [Separation Anxiety](#).

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Parenting

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Glossary

Internalization of values When children's compliance with the attitudes or values of the social or cultural group is motivated by internal factors and not external factors (such as fear of punishment).

Mutual reciprocity/responsiveness A quality of a dyadic relationship that is characterized by high rates of reciprocity and feelings of mutual obligation to other.

Negative reinforcement When a behavior is strengthened by the removal of a negative or aversive condition or stimulus.

Proactive regulation A parenting technique in which parents anticipate sources of conflict for the child

and structure or control the environment in such a manner to limit this conflict. For example, mothers may anticipate conflict in particular isles in the supermarket and avoid these isles.

Security Feelings of trust in the caregiver's responsiveness in times of stress and protection.

Socialization When parents or others assist with the acquisition of the knowledge and skills necessary to participate in social and cultural groups.

Warmth Noncontingent displays of affection between partners.

There is little doubt that parents play a number of significant roles in the lives of children. Parents are sources of comfort and protection; sources of warmth, affection, and support; providers of control and discipline; and teachers who guide children's learning. Ultimately, parents are responsible for ensuring that children acquire all of the social and cultural knowledge and skills that they will need to be successful within the broader cultural setting. Thus, it is not surprising that the role that parents play in shaping children's development has captivated scholars from all theoretical perspectives throughout the history of psychology, including (but not limited to) psychoanalytic theorists who were interested in the role that parents played in managing children's psychosexual impulses; behaviorists who were interested in how parents shape children's behavior through reinforcement and punishment; and more modern parenting theorists who have focused on the styles, dimensions, and practices that parents use to socialize children.

Contemporary research on parenting and socialization has changed little in its conception of the types of parenting that are assumed to promote optimal child outcomes. In general, research has supported the idea that authoritative parenting, that is, parents who are warm and nurturing and who use reasonable behavioral control with children, generally have children who are the best adjusted. Parents who are warm and too lax in control (permissive) or who are more strict and less warm (authoritarian) raise children with less optimal outcomes, although the effects of each of these parenting styles depend to some extent on the cultural and socioeconomic status of the family. Despite the fact that the research on parenting styles continues to dominate some portion of the current research, more cutting-edge conceptions of parenting have argued that it is too simplistic to focus on the effects that parenting styles have on children. These researchers have argued that parenting styles tell us little about what it is that actually influences child outcomes (e.g., is it warmth or flexible control that matters?). Similarly, such an approach has been criticized because although it tells us something about the

emotional climate that children are raised in, it tells us relatively little about how the specific practices parents use (e.g., corporal punishment) actually influence child outcomes. In addition, it seems likely that the specific practices that parents use are moderated by the broader emotional climate of the family. For instance, the occasional use of corporal punishment in the context of an otherwise warm and supportive relationship has a different meaning to a child than corporal punishment in a harsh and rejecting parent-child relationship. Finally, traditional work on parenting styles has been criticized for being too unidirectional in its focus (assuming that parents influence children and not the reverse). More modern conceptions of parenting and socialization have taken a more bidirectional approach to parenting, highlighting how children influence parents and how children take an active role in shaping and interpreting the nature of the interaction between the two.

Ultimately, both traditional and modern socialization theories argue that parents have broad influences on children and a total review of the entire literature on parenting is beyond the scope of this article. Instead, we try to focus on a narrower range of topics. We begin with a discussion of parental goals and briefly discuss the role that goals play in influencing parenting practices and approaches. We then highlight the recent research and theorizing on the role that emotion plays in influencing parenting. We then discuss three broad indicators of relationship quality between parents and children that have been implicated as important influences in socialization: attachment security, warmth, and mutual responsiveness. Following this, we discuss the complex issue of parental control and then highlight some of the specific practices that parents use to socialize children, including reinforcement and punishment, modeling, proactive regulation, parents' use of routines and rituals, and guided learning. We end with a brief discussion of the active role that children play in interpreting, evaluating, and accepting or rejecting parental attempts at socialization.

Parenting Goals

Modern theories on parenting have emphasized the influential role that parenting goals play in shaping the practices that parents use to socialize children. Original research in socialization operated as if parents had only a single goal, that is, children's internalization of parental values and compliance with these values in the absence of the parent. More recent theorizing on the influence of parental goals has recognized that many parents have varied long-term goals for their children. For example, whereas some parents may desire children's internalization of values, other parents may be more interested in maintaining relational harmony with children, fostering children's abilities to make good choices with regards to values, and/or fostering children's abilities to compromise or negotiate. This different perspective on the varied types of goals that parents have leads to very different assumptions about how children's noncompliance is viewed. Originally, children's noncompliance with parental requests was assumed to be an indicator of a failure of socialization, but this is no longer believed to be the case by most modern socialization theorists. Instead, there are good reasons to believe that parents might be willing to accept only partial compliance with their requests (or in some cases even noncompliance), especially if parents are committed to maintaining positive relationships with children and are more interested in fostering autonomy than compliance. Thus, the types of behaviors that parents see as acceptable change depending on the type of goals that parents have and the relative importance parents assign to those goals. Parents who are interested more in fostering autonomy (than promoting acceptance of their values) might be willing to tolerate some degree of negotiation with regards particular values, especially within domains that they do not view as extremely important. However, even these parents may require more strict compliance in domains such as safety, health, and morality, in order to ensure children's survival and cultural success. In contrast, parents who are more concerned with children's internalization of values may take a more strict approach to parenting across all domains.

It is important to realize that parents have a number of both short-term (e.g., getting the child to school on time in the morning) and long-term goals (e.g., fostering academic achievement) that guide their interactions with children. In addition, it is important to realize that some of the goals that parents hold may be self- or parent-oriented (e.g., getting the child to school on time to make it to work on time), some may be child-oriented (e.g., teaching the child an important value), and some may be relationship-oriented (e.g., maintaining strong bonds with children). It is not particularly clear which of these goals predominate in any given interaction between parents and children, but some research suggests that the context of the parent-child interaction. Parents are more likely to focus on short-term and more parent-centered goals in public situations and are more likely to focus on long-term child-centered socialization goals in the context of private interactions. In addition, there seems to be individual variation in the relative focus of parents (between parent-focused vs. child-focused goals) and these differences in the tendency to prefer parent- versus child-centered goals are likely linked in meaningful ways with the techniques that parents use. Parents

who report more child-centered goals tend to use more reasoning and less power-assertive techniques with children. Parents who report being more concerned with immediate and parent-centered goals tend to use more power-assertive techniques to ensure children's immediate compliance.

Parenting and Emotions

As anyone who has ever been a parent knows, parenting is an intensely emotional experience. Children have the capacity to evoke both strong positive emotions (e.g., joy, pride, and love) and strong negative emotions (e.g., anger, fear, distress, and anxiety) in parents, and there is little doubt that the emotions evoked in the context of parenting influence the quality of the parenting that children receive and children's outcomes. For example, high levels of positive emotions in parents have been linked with parental sensitivity and responsiveness and with children's prosocial and empathic behavior. In contrast, parents who are depressed or who experience high levels of distress or anger are prone to being hostile, rejecting, insensitive or abusive and have children who experience externalizing and internalizing problems. Thus, a number of researchers have argued that the emotional health of parents reflects the broader emotional climate and success of the family.

The links that emotion has with parenting are likely more complex and have not been sufficiently examined by researchers. However, a number of researchers (especially Theodore Dix) have written extensively on the role that emotion likely plays in influencing parenting, and thus, a number of conclusions can be drawn. First, stress outside of the parent-child relationship (including marital problems, occupational concerns, and financial stress) can undermine the quality of parenting, mainly because of the effects that these stressors have on parental emotion. Second, the emotions evoked in the parent by the child in any given interaction depend upon the goals that parents have in any given situation. Whether parents experience positive versus negative affect in any given interaction with a child depends on whether or not both the long-term and short-term goals of the parents are met by the behavior of the child and how significant these goals are to the parent. Parents can facilitate their own goals and promote positive affect by adopting empathic strategies and coordinating their interests and goals in ways that are compatible with the goals and behaviors of their children. When interests conflict, however, parents can either elicit the cooperation of the child (maintaining positive affect in the parent and child) or they can use more forceful strategies to ensure that their short-term and long-term goals are met. If children comply with these more forceful strategies, it is less likely that negative affect will be evoked in the parent. Over time, however, such forceful strategies likely evoke resistance on behalf of the child. Such resistance may create negative emotion in the parent, particularly in situations in which parents have a strong commitment to a particular goal.

Once emotions are aroused in parents, there are good reasons to believe that such emotions influence parenting. First, emotions motivate parental responses and influence behavioral response tendencies. In the context of negative affect, parents are motivated to comfort, protect, and potentially discipline

children. In the context of positive affect, parents are motivated to engage, respond, and play with children. Second, emotion also influences parental perception and interpretation of events. Negative emotion can lead to more negative expectations and evaluations of children's behaviors and it can disrupt parental attention, monitoring, and problem solving. Positive emotions likely have an opposite effect on parental attention, monitoring, and problem solving, although the effects of positive emotions have been given less thoughtful attention by researchers. Finally, parental emotion likely influences the nature of the communication between parents and children. Emotion serves communicative functions and sends important messages to children. For example, parental anger can signify to a child that their behavior is not acceptable. Moreover, the parent's emotional state influences the child's emotional state through contagion and modeling. Finally, emotions theorists have argued that beyond motivation, particular emotions are also directly associated with behavioral responses that influence parenting. For example, anger is linked with harsh and aggressive behavior (e.g., yelling, condemning, punishing, and striking), and thus, in parents likely evokes similar types of behavior directed toward the child. In contrast, the emotion of joy is linked with engagement with the environment and likely leads to parent's engagement with children's needs.

Indexes of Relational Quality

Relationships between parents and children differ in broad qualitative ways, including in the amount of warmth and affect exchanged between partners, in the amount of shared trust or security, and in the amount of reciprocity and shared positive affect between partners. Although these three constructs (security, warmth, and mutual responsiveness) have often been used interchangeably in the literature and have often been measured together in the context of research on parenting, recent research suggests that when they are assessed independently, they are empirically distinctive and sometimes not overlapping constructs. In fact, in conceptualization, they are quite different constructs. Warmth involves noncontingent displays of affection between partners, whereas security is believed to derive from parental sensitivity or responsiveness to children's needs for comfort or protection (thus, in situations involving negative affect). Mutual responsiveness, in contrast, is a fully dyadic construct that is assessed in situations of low stress and threat. Thus, although all three constructs are indicators of relational quality that have been well-studied in the literature on parenting, there have been recent calls to keep these processes clearly delineated in the literature on parenting, because they may have unique effects on children.

Security

Attachment theorists argue that a child's need for comfort and protection are biologically based motives that are deeply rooted in the human species as a result of evolution. A caregiver's sensitivity, especially in times of threat and stress, offered protection and nurturance that enabled a human infant to survive in the savannah grasslands of human evolution. Moreover, the child's confidence in the adult's protection, in

turn, fostered exploration and competence. Ultimately, the confidence provided by a secure attachment to explore the environment has implications for a modern child's socialization, because it affords a secure base from which to explore other interpersonal relationships and the broader environment. In addition, attachment research has suggested that children in secure relationships with caregivers are more receptive to the socialization attempts of caregivers, more compliant with requests, and more likely to internalize values. In addition, because securely attached children are more socially competent, they experience closer interpersonal relationships with others. These close interpersonal relationships with others provides secure children more opportunities for socialization in the context of other close relationships (e.g., with peers and teachers).

Finally, attachment security is presumed to color a child's approach to subsequent relationships, especially close ones. As a result of their experiences with sensitive care (or insensitive care) in situations of stress, children create mental representations of relationships, or internal working models. These internal working models are filters through which children interpret their relational experiences with others in ways that are consistent with their expectations from past relationships. In addition, these expectations cause children to respond to others in ways that may evoke the kinds of responses from others that confirm their expectations. Thus, a securely attached child may respond to others with compassion, which in turn evokes a positive response from others, cementing the child's trust in the responsiveness of others. In contrast, an insecure child anticipating another's unfriendliness may remain distant and unengaged, which in turn evokes an unfriendly response from a relational partner, and confirms the insecure child's relational expectations. These internal working models also influence children's understanding of others (e.g., other's emotions and intentions), relationships (e.g., through biases and attributions), and themselves (including feelings of self-esteem and worth). Although internal working models are difficult to study, research does suggest that securely attached children show advantages in emotional understanding, social attributions, theory of mind, social problem solving, and self-esteem.

Warmth/Support

Warmth, or noncontingent displays of affection, has been universally recognized as an important influence in socialization in almost all traditional and modern formulations of parenting. In traditional formulations, warmth has been conceived of as characteristic of the parent; however, in more recent formulations of parenting, warmth has been portrayed as a dyadic and relational construct, involving high levels of 'shared positive affect' between parents and children. Either way, warmth and support are influential in socialization for several reasons. First, warmth and support from parents give children the sense that they are loved, respected, and of value. As a result, children develop a willingness to participate in further activities with the caregiver, to share feelings, and to take part in other features of interpersonal experience that provide children with rich opportunities to appropriate cultural values. Second, warmth enhances children's motivation to cooperate and comply with parental directives, in part through their identification

with parents. Finally, high amounts of positive affect and warmth in the context of close relationships with parents promotes positive moods in children, making children more likely to be responsive to the needs of others. In addition, research suggests that children who are in a positive mood are more likely to comply with parental requests and directives.

Mutual Responsiveness

A related, but slightly different portrayal of the influence of parent-child relationships on socialization has been proposed by a number of researchers who argue that parents who are reasonably compliant with children's needs, wishes, and requests elicit from children cooperation with parental requests and directives. This type of relationship has been coined one of 'mutual reciprocity,' in which both partners feel a mutual obligation to the other. Young children who are part of a relationship with mutual reciprocity feel an obligation to respond constructively to socialization initiatives, to accept parental values, and to maintain relational harmony with the parent. Thus, children who are part of a mutually reciprocal relationship are in essence, eager and willing to be socialized by a parent, because they have internalized an obligation to respond to parental initiatives as a result of their history of responsive care from parents. Research does support the idea that children are in fact more likely to comply with parental directives in a cleanup task following an episode of mutually reciprocal play.

Parental Control

The study of the effects of parental control over the years has been complicated by the fact that researchers have used the same word to refer to qualitatively different phenomena. Over the years, some researchers have used parental control to refer to demands for maturity, such as Baumrind's work on parenting styles, and others have used to refer to the way demands are communicated. Probably, one of the most useful distinctions to make, however, is between behavioral control and psychological control. Behavioral control, or control that involves reasonable limit setting and enforcement of rules (as well as parental monitoring), is the type of control that has been considered to be a part of authoritative parent rearing and which has been linked with optimal child outcomes among most children. Excessive use of behavioral control, however, can be associated with poor adjustment in children, especially if it involves feelings by the child of being controlled. For behavioral control to lead to positive child outcomes, control needs to be autonomy supporting, which means that children need to feel as if their own behavior is self-initiated and that they have some control over the outcome experienced. Psychological control, which involves attempts to influence children through affecting the child's emotional state, especially through ways that are manipulate or insensitive, is typically associated with maladjustment in children. Children with psychologically controlling parents typically suffer with regards to self-esteem, are at risk for internalizing and externalizing problems, and tend to exhibit poor academic achievement. Ultimately, psychological and behavioral control are considered to be two conceptually distinct concepts that are differentially related to children's outcomes.

In addition to behavioral control, parents use a number of specific practices to socialize children's behavior including rewards and punishment, modeling, proactive regulation, routines and rituals, and guided learning. These specific parenting practices are considered next.

Parenting Practices

Reinforcement and Punishment

The significance of parental rewards and reinforcement for shaping children's behavior has long been recognized in the literature on parenting. Even before children are verbal, the parent's warmth and affection contribute to children's developing self-esteem and provide the motivation for children to comply with parental requests in attempt to please the parent. Thus, such displays of warmth and affect are reinforcing of the child's desire to be socialized. Negative reinforcement also has powerful effects on child behavior, as the research on children's aggressive behavior suggests. Parents who end aggressive or coercive family conflicts with children by giving in and withdrawing reinforce children's aggression. Ultimately for reinforcement and punishment to be effective as children get older, parents need to be subtle in their use of incentives. Research suggests that children need to respond to internal (i.e., self-derived) incentives rather than external reinforcement of competent behavior. If children attribute their compliance to external rewards (e.g., receiving money for chores) children may comply in the presence of the parent in anticipation of the reward, but are unlikely to comply with parental rules in absence of such a reward. Thus, internalization of values is inhibited by the presences of obvious rewards and punishments.

The role of punishment, particularly corporal punishment, in affecting children's outcomes has been a hotly debated topic in the history of developmental psychology. A number of researchers have argued that parental use of physical discipline has no beneficial effects for children beyond immediate compliance and is associated with children's angry and aggressive behavior. Moreover, a number of researchers have argued that physical discipline undermines the parent-child relationship by creating anger and humiliation in the child and that parent's use of physical discipline puts the parent at risk for abusive parenting. In contrast, other researchers have argued that the effects of an occasional use of mild corporal punishment (spanking) as a backup discipline method has not been sufficiently explored in the literature. These researchers have argued that in the research, the effects of mild corporal punishment have been confounded with more punitive and harsh forms of discipline. These same researchers have argued that spanking can in fact be an appropriate discipline technique if it is coupled with reasoning, not administered in anger, and employed as a last resort when other discipline methods have failed. To complicate the debate on either side, the effects of corporal punishment likely vary by culture and are likely moderated by the child's temperament, age, and the broader relational context in which the corporal punishment is applied. Thus, spanking may have significantly different outcomes depending upon whether it is applied in the context of an otherwise loving parent-child relationship and in context of reasoned

child-centered discipline, as opposed to when it is applied in the context of an angry confrontation between a parent and child in the context of a frequently hostile relationship. The broader question, however, depends upon what type of emotional climate prevails when spanking is used as an everyday discipline strategy.

Other types of parental discipline have been less debated by psychologists. Inductive discipline, which involves discussing the effect of the child's actions on others, has long been a discipline method that is assumed to promote children's development of empathy, guilt, and moral behavior. Research has suggested that parents who use inductive discipline have children who experience high levels of moral emotions (especially guilt and empathy) and who internalize parental values. Inductive discipline is presumed to be an important socialization strategy for a number of reasons. First, by discussing the effects of children's actions on others, parents induce feelings of guilt in children, which in turn promote the children's internalization of parental values. In addition, inductive discipline promotes children's abilities to understand the consequences of their actions on others and this promotes the development of children's empathy. Finally, inductive discipline is optimally arousing in the context of discipline encounters, fostering enough empathy and guilt to promote the child's reflective thinking upon the issues that parents raise in the discipline encounter, but not so arousing that it interferes with the child's processing of parental messages. Other types of discipline, especially those that involve high levels of power assertion or love withdrawal, often evoke so much negative emotion on behalf of the child that the child is not capable of processing parental messages conveyed in the context of discipline.

Beyond power assertion and inductive discipline, other methods of parental discipline have been less studied by researchers. Behaviorists, however, have argued and found some limited empirical support for the idea that other types of punishment, such as the withdrawal of privileges and 'time outs,' are effective sources of discipline, although most of the research is conducted with clinical populations. Some research with nonclinical populations suggests that these two discipline techniques are most effective if they are coupled with parental reasoning and induction. It is important to note, however, that nonbehavioral-oriented psychologists tend to view all forms of aversive punishment (including withdrawal of privileges, corporal punishment, and time outs) as less effective methods of control than parental inductive discipline and use of subtle rewards. Clearly, more research on these alternative discipline techniques in nonclinical settings is needed.

Most of the modern research on parenting acknowledges the fact that parents seldom use a single discipline strategy to socialize children. Parents ultimately adopt and choose specific types of discipline based upon features of the child and the current situation. Research, for example, suggests that parents' discipline techniques vary based on the nature of the misdeed. For example, parents are more likely to use both power assertion and reasoning when children commit antisocial acts, such as lying, and are more likely to use reasoning alone when children fail to show adequate concern for others. Moreover, if given strategy is not effective or based upon children's reactions, parents will often modify, adapt, or change strategies all together. In addition, children respond to parents' discipline

strategies differently depending upon their age and intellectual level, their mood (and broader temperament), their rapidly changing emotions within the discipline encounter, and their interpretations of parental intentions and communications. Thus, every discipline encounter between parents and children is influenced by both partners and effective parenting does not consist of a single discipline strategy used by a parent. Instead, effective parenting likely involves the parent's ability to flexibly adapt his or her discipline strategies within any given context based upon the child's needs and behaviors and based upon their own parenting goals.

Modeling

Imitation has also been considered an important way in which children learn culturally relevant behavior. Although young children are more likely to model the behavior of siblings and peers, evidence still suggests that children model the behavior of their parents as well. A number of theorists have argued that infant's imitation in particular contributes to their emergent understanding of persons. These early episodes of imitation are cognitively complex and involve sophisticated inferences about the parent's intentional activity, including his or her desires and goals. The parent's responsiveness to the infant's imitative efforts engages the child emotionally and contributes to a sense of interactive control. In addition, there is some suggestion in the research that young children's willingness to engage in responsive imitation reflects the child's motivation to accept socialization efforts by the parent. These researchers emphasize that imitation entails the child's active interest in emulating the parent's actions and argue that this same interest underlies young children's responsiveness to other aspects of parental socialization.

Beyond infancy, there is good evidence that children also model parents in a variety of different ways. A good example of the types of processes involved comes out of the literature on emotional expressiveness. This literature suggests that parents are key models of emotional expressiveness, and that exposure to particular profiles of expressiveness by parents appear to promote children's own expression and experience with similar emotions. Parents who frequently experience and express positive emotions have children who exhibit similar profiles of positive expressiveness, and as a result, are well-liked by peers. In contrast, children exposed to parents who frequently express negative, particularly hostile emotions like anger, express similar types of emotion, have trouble regulating negative affect, and are prone to externalizing and internalizing problems. Overall, the processes assumed to underlie these effects are modeling and emotion contagion.

Proactive Regulation

Parents also have an important influence on children's socialization by controlling the environment in such a way to create a desired outcome. Ultimately, there are plenty of examples of the ways in which parents do this. For example, parents may 'child proof' a home in such a way to prevent accidents and injuries. Furthermore, parents may anticipate sources of conflict, such as forbidden objects or tempting isles in a supermarket, and avoid such objects and/or locations. Such proactive

techniques may benefit both the child and the parent. Proactive techniques may lessen the amount of conflict in the parent–child dyad and scaffold the environment in such a way to enhance children’s understanding of appropriate conduct.

In addition, as children get older, parents may also use proactive strategies to help influence children’s values. For example, parents may ‘pre-arm’ children against competing values from others outside of the family by, for instance, giving children exposure to the value conflicts that they will face and by helping children understand the reasons behind their own value adoption. Parents can also monitor children’s exposure to values by monitoring and controlling exposure to media. Finally, when children are young, parents manage children’s exposure to peers and others, by regulating both children’s access (e.g., through transportation) and permission, and by supervising children’s activities when they occur.

Structuring of Routines and Rituals

Parents are also influential in guiding children’s learning and understanding by establishing and structuring the routines and rituals in which children take part on a daily basis. The structure of daily life is important for young children who seek predictability and control and parents vary with regards to the extent in which they provide this structure. Routines are recurrent patterns of family activity in which some or all members of the family participate (e.g., bedtime or meal routines). Rituals are routines that assume meaning for family members, because of their emotional and symbolic significance, such as birthdays, weddings, or anniversaries. Family routines are unique to every family, are heavily influenced by culture, and are one important way in which children learn culturally relevant information. As children get older, children’s participation and negotiation of these routines and rituals increases. Family routines and rituals become one important avenue through which family roles and responsibilities are defined and assigned by parents, family values are communicated, and expectations about everyday events are formed.

Guided Learning

In addition, parents play an important role through guided learning in supporting children’s acquisition of cognitive, social, and emotional skills that are needed for success in their cultural group. Guided learning, involves parents scaffolding the child’s learning by adjusting the amount of support that parents provide to match the child’s level of understanding. Parents who are successful in this process are able to provide sufficient levels of support for the child to promote optimal learning. Although much of the research in this area has highlighted the role of parents in promoting cognitive development (e.g., by parents providing the structure during a storybook reading), there is good reason to believe that parents are also influential in promoting social and emotional understanding through guided learning as well. For example, a number of researchers have argued and found empirical support for the idea that parents who coach children in how to deal with negative affect have more advanced emotional development. Emotion coaching involves not only parents being aware of the negative emotions of their children, but also being

willing to validate, label, and openly discuss and problem solve with their children about how to deal with negative emotion. Children whose parents are willing to directly coach them on how to cope with negative emotion acquire scripts on how to manage and handle negative emotions, and these children have more success with peers and are more psychologically competent. Similarly, parents who talk to children about their past emotional experiences and scaffold these conversations in such a way to provide detail, structure, and feedback have children who have more advanced understanding of emotions and relationships.

The Influence of the Child on Parenting

There has been increasing recognition of the role that the child plays in influencing the effects of parenting on children’s outcomes and on the type of parenting that they receive. Theorizing by Joan Grusec and Jacqueline Goodnow suggests that part of the reason that the past research on parental discipline and control has been so inconsistent is because researchers have failed to take into account the active role that the child plays in accepting or rejecting parental attempts at socialization. For children to embrace parental messages in the context of any discipline encounter, these researchers argue, parental messages need to be both accurately perceived by the child and accepted by the child. Parents can actively influence children’s attempts at accurate perception in a number of ways. If parents frame messages in a way that is developmentally appropriate, that captivates the child’s attention, and that signifies the importance of the message being conveyed, accurate perception is possible, provided the child has resources available to process the message. However, with regards to acceptance, the numbers of variables that intervene are more complex. First, children need to judge that the parental reaction and discipline is appropriate. A number of considerations likely figure into children’s assessments of appropriateness, including whether the punishment matches the misdeed, whether they feel as if they were treated fairly, and whether they see the parent’s actions as being well-intended. Second, children need some motivation for accepting the parent’s message. Broad relational qualities, such as security, mutual reciprocity, and warmth, provide some motivation to accept parental messages and values, but other factors also may play a role. Messages that are inductive and promote empathy and relational understanding likely provide motivation to internalize parental values, and messages that threaten the child’s autonomy and security likely undermine internalization. Finally, children need to feel to some extent that the value is self-generated. Thus, parents need to use punishments and rewards in such a way that reduces the salience of external pressure and that makes sure that children attribute their willingness to comply based upon self-generated motives and not because of external pressures.

Furthermore, there is accumulating evidence that characteristics of the child influence parenting. Most of the research that has been done has looked at how’s children’s temperament evokes different approaches to parenting. For example, there is accumulating evidence that children’s negative emotionality, that is, their proneness to distress, anger, and fear, evokes less

responsive and sensitive parenting from parents. In turn, less supportive and responsive parenting only seems to increase the amount of negative emotionality in children. The links between harsh parenting and negative emotionality are especially problematic with parents who are already at risk for poor parenting (i.e., because they are depressed or economically distressed). In addition, there is some indication that positive temperamental traits are associated with more sensitive and responsive parenting. For example, high levels of effortful control and self-regulation have been linked with more elaboration by mothers in the context of reminiscing and less restrictiveness in terms of parental control.

Conclusions

There is growing recognition of how complex the links between parental behaviors and child outcomes truly are. In the last 20 years, researchers have moved beyond using simplistic parenting styles in attempt to understand how parents socialize children. Instead, modern research on parenting has shifted to trying to understand how parents' goals, cognitions, and emotions shape and influence the nature of the interaction between children and parents. In addition, there has been a recent call by researchers to be clearer about the broad relational qualities they are assessing, in order to understand how different types of relational qualities differentially relate to child outcomes. Furthermore, there is a growing interest in examining how more specific types of parenting practices influence children's behavior and are moderated by the broader emotional climate of the family. Finally, there is a growing recognition of the bidirectional nature of the parent-child relationship and an increasing interest in understanding how children actively interpret, evaluate, accept, and influence parental initiatives.

See also: Moral Development; Parent-Offspring Conflict; Sex Roles; Socioemotional Development; Social Development (Attachment, Imprinting).

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Relevant websites

- <http://apa.org/topics/parenting/index.aspx> – American Psychological Association - Parenting.
- <http://www.tnpsc.com/> – The National Parenting Center.
- www.srcd.org – Society for Research in Child Development.
- <http://www.nichd.nih.gov/> – National Institute of Child Health & Human Development.

Parent–Offspring Conflict

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Glossary

Autonomy Independence or self-reliance; the ability to make appropriate decisions for oneself by oneself.

Conflict The state in which two people, or forces, stand in opposition to each other.

Corporal punishment The deliberate use of physical force to cause the child pain for the purposes of disciplining or to deter wrongdoing.

Internalization The process whereby the child assumes personal responsibility for enacting taught values, rules, and behaviors.

Meta-analysis A statistical method that combines the results of multiple different research studies on the same or related topics to produce a stronger understanding of the overall findings.

Physical abuse Any nonaccidental physical injury inflicted on the child, or any action that results in the child's physical impairment.

Socialization The process by which parents instill in their child societal values and norms of behavior.

Parent–offspring conflict can be defined as a state in which parents and children stand in opposition to one another. The source of conflict between parents and children can vary significantly from relatively trivial issues such as clothing choice or bedtime routine to very serious issues relating to the safety and well-being of the child. One of the principal goals of parenting is the socialization of the child – the process by which parents instill in their child the values and behaviors appropriate to a member of society. That this socialization process frequently leads to conflict if the child resists parental attempts to modify their behavior highlights several truths about parent–child conflict. To begin with, parent–child conflict is inevitable. Parents cannot engage in the socialization process without having to occasionally confront their reluctant child, and children cannot test the boundaries of their developing autonomy without occasionally frustrating their parents.

A second, and perhaps surprising, truth about parent–offspring conflict is that it is not necessarily a negative occurrence. Although we often think about conflict as something to be avoided, there is growing evidence that it may serve as a critical catalyst for children's social cognitive development. Conflict often forces children to take another person's perspective (in order to understand precisely what is upsetting them about the situation), to practice burgeoning negotiation skills, to understand moral and social values, and to effectively regulate their emotions in order to avoid escalating the conflict further.

A final point is that parent–offspring conflict is not a singular phenomenon. The nature and frequency of conflict changes as children develop, as do the strategies for handling conflict. A parent trying to manage their toddler's nap schedule is going to face different challenges than a parent trying to manage their adolescent's curfew. As children develop, they become both more receptive to recognizing and complying with their parents' perspective on issues and more capable of negotiating and resisting their parents' instructions. Likewise, parents' expectations for their children's behavior during conflict situations, as well as their perspective on their own role as a socializing agent, will change as their child develops. With that said,

there also appears to be great continuity in how dyads manage conflict. When a pattern of mutually responsive, effective conflict management in which both partners are free to express their differing viewpoints and work together to resolve the issue is established early in life, it is likely to persist across childhood despite the changing nature of parent–child conflict.

Parent–child conflict is a topic that has received considerable theoretical attention. Therefore, this article begins with a brief comment on theoretical perspectives on parent–offspring conflict. In the following sections, research on the antecedents and outcomes of parent–child conflict is reviewed. We adopt a developmental perspective that focuses on the bidirectional influence of both parent and child behavior during conflict interactions. We conclude this article with a discussion of parent–child conflict that exceeds what can be considered developmentally normative – either because it occurs with greater (or less) frequency than is typically seen, or because it escalates into coercive patterns of interaction or child maltreatment. This focus on nonnormative parent–offspring conflict has particularly practical implications, as the development of successful interventions for families overwhelmed by conflict is of great importance.

Historical Perspectives on Parent–Offspring Conflict

There is a rich variety of developmental theories addressing the role of parent–offspring conflict in child development. Conflict has been proposed to play a significant role in a diverse range of developmental domains, including personality development, emotional development, moral development, and even cognitive development. Although a review of all theories that include parent–child conflict in their developmental model is outside the scope of this article, it should be appreciated that this is an issue that has long held a place in the thinking of psychologists.

To give just one example of the function of parent–offspring conflict in developmental theory, we can examine the work of Viennese neurologist, Sigmund Freud. Given that

Freud's theories are arguably foundational to many current theories of human development, his focus on the role of parent–offspring conflict in shaping personality development suggests the importance of this topic. According to Freud's theory of psychosexual development, adult personality emerges through a series of four stages (oral, anal, phallic, and genital) where children face some sort of conflict between wanting to fulfill their bodily desires and the constraints that society places on their ability to satisfy those desires. Importantly, early in life, these societal constraints come primarily from the child's parents, and thus, Freud believed that parental behavior during these conflicts played a central role in determining whether each stage would have a positive or negative impact on that child's developing personality.

During the toddler years, for example, Freud argued that children in the anal stage of development faced a great conflict between their desire to gratify themselves by emptying their bowels and the newly placed constraints on this behavior as their parents attempt to toilet-train them. If parents are too rigid or too lax in their application of toilet training, children could grow up to become either excessively fixated on cleanliness and organization, or slovenly. Appropriate management of conflict during toilet training, on the other hand, would allow the child to move optimally forward to the next stages of development.

Although many of Freud's ideas, including his stages of psychosexual development, have not been empirically generative, his argument about the lasting impact of early experience, including the experience of conflict between children and their caregivers, remains fundamental to developmental science. Importantly, several neo-Freudians, including Erik Erikson, also carried forth the idea that parent–child conflict is essential to personality development in their theories. Other developmental theorists, including Jean Piaget, Lawrence Kohlberg, and Lev Vygotsky, have likewise described parent–child conflict as an important catalyst for cognitive growth, moral development, and the growth of cultural skills. Furthermore, the research reviewed in the next section largely supports these theories about the transformative role of parent–child conflict.

A Developmental Overview of Parent–Offspring Conflict

As mentioned earlier, one of the major tasks for parents is to instill into their children their own system of values and beliefs. This is accomplished through internalization, whereby the child commits to the value or behavior and takes personal responsibility for enacting it independent of external reinforcing influences. The process of internalization is a major theme of parent–child conflict as the parent strives to shape the child's way of thinking and acting. Traditional considerations of parent–child conflict have focused on this unilateral influence of the parent on the child. A common approach has been to examine which styles of parenting and parental discipline are best able to accomplish the parent's objective of socialization smoothly and with the least resistance from the child. This perspective overlooks the child's active role in parent–child interactions, and an alternative approach has emerged that considers the bidirectional influences of the parent and the child on conflict interactions. The following discussion of

parent–child conflict during each phase of the child's development employs this relational perspective and examines the contributions of both members of the parent–child dyad.

Conflict in Infancy and Toddlerhood

During the first weeks and months of life, the potential for parents to feel as though they are engaging in conflict with their infant stems from the infant's nearly complete reliance on the parent to provide for all of their needs. It is not that the infant behaves in a way that is deliberately oppositional to the caregiver, but rather that the infant's needs often stand in opposition to that of the parent's (e.g., the infant's need for nighttime feedings is in conflict with the parent's need for an uninterrupted night of sleep). The burden falls largely on the parent to minimize this felt conflict by responding appropriately to the infant's signals regarding need states. This parental sensitivity to the infant's rudimentary bids at communication helps establish synchronized parent–infant interactions wherein both partners are attuned to each other and responsive to communications from the other. In contrast, when parents are unable to interpret their infant's signals accurately or meet their needs appropriately, infants become distressed. In these dyads, a cycle of interactions may develop, which is upsetting and frustrating for both members.

Over time, a pattern of synchronized parent–infant interactions builds what is called a mutually responsive orientation between parents and their children. Studies have shown that young children with a mutually responsive relationship history more readily adhere to parents' directives with less likelihood of dispute. Across the toddler and early childhood years, these children internalize parental values and behavioral rules more firmly and with less resistance than children who lack this history of relational experience. Within the first year of the child's life, the parent and the child begin to establish an understanding of their relationship, which will be critical to the tenor of their future disputes. For mutually responsive dyads, the understanding is that, regardless of the details of any specific conflict, both individuals are on the same team and ultimately want what is best for each other.

The child's continual developmental achievements create new potential points of contention between the child and the parent. When children begin to crawl after 6 months of age and walk at the end of the first year, issues of safety become paramount and parents remove dangerous objects but also expect their children to comply with cautionary warnings. Children at this age also form a more sophisticated sense of the self and it emerges, in part, through assertions of autonomy. Toddlers are motivated to take nearly every opportunity to exercise their newly acquired skills, but their burgeoning abilities to fulfill their own desires (by drawing on the walls with a crayon or climbing on the table to reach an interesting object) thrust them into confrontations with parents who may hold directly opposing desires. The regularity with which parents and toddlers seem to conflict about issues such as these have made this age period a challenging one for many parents, but parent–toddler conflicts actually provide important opportunities for children's social cognitive development.

From the toddler's perspective, the reality that the mother does not want you to do the exact thing that you want to do

highlights powerfully the difference between the mental states of yourself and another. Mental states like desires, goals, or intentions are often stated outright during the course of conflict and the emotions evoked make the situation particularly salient. The toddler has a strong personal stake in obtaining his or her desired outcome, while the close, interconnected nature of the parent-child relationship puts a premium on a positive resolution. These features make conflict a uniquely rich setting for toddlers to learn about their influence on others' thoughts, feelings, and reactions and to develop perspective-taking skills. Toddlers carry what they learn about interpersonal interactions during conflict with their parents into other relationships. Their experiences also contribute to their ongoing understanding of the parent-child relationship – whether it is a relationship of mutual understanding or a relationship of competing goals.

Over the second and third year, children's conflict behavior shifts from a reliance on passive noncompliance and direct defiance to negotiation, compromise, and attempts at manipulation. Parents' behavior mirrors this change, with physical intervention giving way to negotiation and persuasion. With the child's mastery of language, the complexion of parent-child conflict changes. Research shows that when mothers engage their toddlers with verbal strategies like compromise, bargaining, or justification during conflicts, their children demonstrate greater internalization of the mother's directives 6 months later. This may occur because these verbal strategies provide children with an explanation of the mother's requests. A similar link has been found between the back-and-forth with which mothers and toddlers discuss past conflicts and children's later internalization. Reminiscing conversations about previous conflict episodes may be particularly useful for children's developing understanding of values and appropriate behavior because they allow children some distance from the emotional intensity of the conflict as they process parents' messages. As the infancy and toddler period comes to an end, verbal communication transforms the ways in which parents and children connect and conflict with each other. This further enriches the unique opportunities conflict provides young children to learn about themselves in relation to important others.

Conflict in Childhood

Parent-offspring conflict during the preschool and elementary school years increases in complexity, as children develop still greater skills to cooperate, negotiate with and defy their parents, as well as the ability to deliberately deceive them. Parents must also update their repertoire of conflict strategies to keep up their children's changing abilities. One such strategy is corporal punishment. Research suggests that a majority of American children experience some form of corporal punishment as a function of parent-child conflict. The phenomenon is particularly common during the preschool years. Research studies have focused on the short-term effectiveness of this kind of discipline as well as on its more general effects on children's well-being. Meta-analyses show that, while corporal punishment may be effective for achieving immediate compliance from children in the given situation, it is not associated with the internalization of parental values in other settings.

Furthermore, the experience of corporal punishment is associated with increased anger and frustration in children, and children whose parents frequently use corporal punishment also act more aggressively with their peers. These findings indicate that the negative consequences of corporal punishment deserve important consideration.

There are limitations to the understanding of the effects of corporal punishment on children, however. Corporal punishment refers to discipline involving mild to moderate hitting, slapping, or spanking, but the point at which physical punishment becomes physical abuse can be unclear both conceptually and in practice. Thus, the frequency or severity of the punishment that drives the association with negative child behaviors is not well understood and deserves greater empirical attention. The relationship between the two may also be explained by other contextual factors that affect both parent and child behavior (e.g., marital discord) or it may be that aggressive children elicit stronger forms of parental discipline like physical punishment than do nonaggressive children. These possibilities challenge a clear causal relationship between corporal punishment and children's problem behaviors. There is also an argument that mild corporal punishment may be effectively used secondarily to other forms of parental discipline.

Power assertion is a form of parental discipline that involves the restriction of privileges and threats as well as corporal punishment. When used alone during the course of parent-offspring conflict, power assertion does not effectively encourage children's internalization of values or stave off future conflict. In contrast, the use of parental induction or reasoning has been linked to desired child behaviors including compliance and internalization of values. In line with toddler research, parent-child discourse on the causes and consequences of the conflict helps transform these situations into constructive socialization experiences in which the child is made a partner in the exchange. Parents who tend to rely on induction during parent-child conflict provide opportunities for children to articulate their own perspective and engage with the parent in a discussion of values leading toward a mutually satisfying resolution. Still, induction is not suited for all conflict scenarios, and effective management of conflict with children involves parents' accurate reading of and flexible adaptation to the situational demands of the child's state and the specific context.

As they develop greater social cognitive sophistication, children distinguish between moral transgressions (e.g., hurting another person) and transgressions of social convention (e.g., not saying thank you), and they evaluate adults on the appropriateness of the match between the punishment and the misbehavior. Thus, an adult who punishes a child for leaving his seat without asking is viewed as being more unfair than an adult who punishes a child for hitting a classmate. At this age, children also establish nuanced expectations of their parents and their behavior within the parent-child relationship just as parents have expectations for their children. Parents adjust expectations of their children's behavior in relation to their developmental abilities, but children also modify their expectations of parental behavior over time. A violation of expectations by either partner often results in conflict. Parents may react more strongly, escalating conflict, when the point of contention has been discussed in the past, and it is believed

that the child should know better. Similarly, children may become particularly recalcitrant when they perceive their parents' discipline as unfair or inconsistent with past behavior, or when parents regulate children's conduct that should be the child's decision alone (e.g., what to do during leisure time). Both parents and children take active roles in maintaining the terms of their relationship and navigating together those times when things go awry.

Conflict in Adolescence

Parent–child conflict often increases during adolescence. Youth pursue more independent and adult-like roles for themselves and these efforts toward autonomy can be especially challenging for the parent–child relationship. These problems stem, in part, from inherent qualities of the parent–child relationship. Compared to peer conflicts, the hierarchical power structure of the family tends to generate disputes involving issues of authority, control, and obedience. This may become more salient and troubling for the child during adolescence than at earlier developmental stages.

A comparison of parents' and adolescents' evaluations of misbehavior and parental authority sheds light on the sorts of situations that spur parent–adolescent conflict. Parents and adolescents agree on parental authority over moral and social conventional transgressions, but differences emerge with regard to the domain of personal preferences. Younger adolescents tend to perceive behaviors like sleeping late on the weekend or not cleaning up one's room as personal preferences that do not fall under parental authority, while their parents often perceive themselves as having authority over these behaviors. The potential for conflict over these everyday issues is obvious, but this also changes with time. The parents of older adolescents more often view these kinds of behaviors as the personal preference of the adolescent. The contrast between how parents and adolescents evaluate the same set of behaviors reiterates the significance of violations of expectations for conflict. The shift in parents' thinking that occurs with adolescent maturation, bringing the parental perspective to a greater alignment with the adolescent perspective, illustrates the critical interplay between both members of the relationship as well as the central role of developmental level in understanding conflict between parents and children.

Despite the common perception of adolescence as a highly troubled and conflictive phase, the empirical evidence for this idea is equivocal. Overall, the picture of parent–child conflict across development is one of continuity rather than discontinuity, and families that struggle with serious and destructive conflict during adolescence most likely struggled with this sort of conflict during childhood as well. While meta-analyses do reveal that the rate of parent–child conflict is elevated during early adolescence, that rate falls during mid-adolescence and again during late adolescence. With regard to negative affect, there is an increase from early to mid-adolescence followed by a decrease in late adolescence. For most families, this is a period when previously established closeness and reciprocity between parents and children are maintained. When parent–adolescent conflict takes the form of a challenging discussion within a supportive, mutually responsive setting, it is associated with an increased sophistication with which adolescents understand

themselves and their relationships with others. Thus, parent–adolescent conflict is often less severe than stereotypes indicate and is an important component of adolescents' developmental transition toward adulthood.

Atypical Parent–Offspring Conflict

As has been discussed, parent–offspring conflict is a normal, and perhaps even essential part of development, spurring on the child's internalization of the parent's rules and values, and providing a context to develop vital social cognitive skills such as perspective-taking and negotiation. And while conflict may escalate during certain periods of development (primarily during the toddler years and early adolescence), it should never become the primary style of interaction between parent and child, nor overwhelm the family environment with negative affect that is not easily resolved. Yet, for some families, this is precisely what happens, and excessive conflict becomes an agent of atypical development and a host of negative outcomes for both children and parents.

Why do certain families experience higher levels of conflict than others? Stressors appear to play a major role. For example, several recent studies have demonstrated elevated conflict in families where the child is experiencing a psychological disorder such as substance abuse or disordered eating. In these studies, conflict did not predict the onset of these problems, but rather seemed to occur as a result of them. This is especially problematic because elevated family conflict has also been shown to disrupt the effectiveness of therapeutic interventions for children's mental health problems. The stress of ongoing angry conflict between parents also appears to contribute to increased parent–child conflict. Socioeconomic stress and lack of social resources appears to play a particularly significant role in predicting an increase in parent–child conflict that results in child maltreatment. The overall quality of the parent–child relationship may also play a role in determining rates of conflict. Insecurely attached children, for example, have been found to initiate more conflicts with their parents than do securely attached children.

Research has also demonstrated that suppressed conflict within the family environment can also be harmful. For example, children from families where conflict is avoided even when it would otherwise be appropriate, or where conflict is entirely one-sided as parents deny children any attempts to express themselves or to dissent, may be at an increased risk of peer victimization. Parent–offspring relationships must, therefore, strike the delicate balance of conflict occurring frequently enough to allow children to practice crucial conflict management skills in a safe, supportive context, but not so frequently as to interfere with the overall functioning of the family. The remainder of this section focuses on two family contexts in which conflict becomes a destructive rather than a beneficial agent of development – when conflicts become part of a coercive cycle of parent–child interactions and when child maltreatment occurs as a result of conflict.

Coercive Family Processes

In the parent–child relationship, there is a hierarchy of power that favors the parent. While children may find this power

differential frustrating, especially during conflict situations, it is also developmentally appropriate and supports many of the positive outcomes of conflict such as negotiation, compromise, and placing limits on potentially risky child behavior. For certain families, however, this power hierarchy becomes reversed, with children having the upper hand during conflicts. This reversal has been referred to as coercive family processes and can have devastating effects on both the family dynamic and children's broader social–emotional development, including their use of conflict in other relationships.

Parent–child conflict within coercive families involves mutually escalating cycles of negative behavior between parent and child. It begins in much the same way as any other conflict interaction – one member of the dyad does something that is aversive to the other. The parent, for example, may insist on the child finishing dinner before dessert. The child then responds with another aversive behavior (e.g., noncompliance), to which the parent escalates the demand (e.g., requiring the child to sit at the table until dinner is finished), to which the child is more resistant (e.g., leaving the table without permission), and the cycle continues. The conflict is resolved only when one partner gives in to the other (e.g., the parent allows the child dessert). If the parent is consistently the one to withdraw from these conflicts, he or she is negatively reinforcing their child's aversive behavior, showing the child that escalating the conflict can lead to the child's desired outcome, and thus is increasing the likelihood that this cycle will occur again in the future. Moreover, when the child 'wins' and calms down, the parent's acquiescing is also negatively reinforced by the child's calm compliance. Thus, coercive family interaction is mutually reinforcing and self-perpetuating, and can lead to entrenched patterns of negative parent–child interaction.

Interestingly, at least in some cases, these coercive cycles appear to have their origins in infancy. Research has demonstrated that infants who are temperamentally demanding (typically those who are most reactive, negative, and persistent in their attention seeking) and who have mothers who are non-responsive demonstrate more coercive behaviors during the toddler and preschool years. Other studies have demonstrated that certain parent characteristics, such as irritability, correlate with sustained, coercive interactions. These findings support the bidirectional model of conflict we have applied throughout this article, and also reflect the significance of the earliest parent–child interactions in setting up patterns of conflict.

As coercive interactions continue throughout early childhood, the normative balance of power favoring the parent shifts, as children 'win' more and more conflict interactions. With time, parents may even stop setting clear and appropriate limits for their children's behavior, in order to avoid further conflict, and develop other kinds of unconstructive parenting practices (e.g., expecting hostility from their offspring before it occurs). The impact of this coercive cycle on children's development is far-reaching. To begin with, children may gain a precocious and inappropriate sense of control and power over their interpersonal relationships. With time, this can extend beyond the parent–child relationship and impact how they interact with peers, teachers, and other important social partners. Unfortunately, many of the other positive aspects of social cognitive development that are spurred on by appropriately resolved parent–child conflict can also be delayed.

Deficits in perspective-taking, empathy, or negotiation and compromise may also contribute to one of those most troubling outcomes of coercive family processes – increased childhood aggression.

Children who lack other strategies for ending conflict may choose to escalate their aversive behavior to physical aggression in order to fulfill their goals in the interaction. Children from coercive families are more likely to bully and victimize their peers, and may be particularly likely to be ineffectual aggressors – children who engage in protracted, aggressive conflict but typically wind up losing the fight. Aggressive behavior appears to be both a consequence of coercive family processes and a catalyst for it, with aggressive children being found to exhibit more frequent episodes of noncompliance with parental demands, to persist in aversive behavior once a conflict has begun, and to be the one to initiate conflict more often than their nonaggressive peers. Unsurprisingly, coercive family processes are also associated with increased rates of externalizing problems, and, as children reach adolescence, become associated with delinquency and even criminal behavior.

Child Abuse

Distinguishing between appropriate corporal punishment and physical punishment that constitutes child abuse is a difficult task. One distinction is that physical abuse results in nonaccidental physical injury to the child, while corporal punishment may cause temporary discomfort, but should not result in lasting harm. What is clear, however, is that parent–offspring conflict plays an important role in several different types of child maltreatment, including physical abuse.

When research has focused on parent–offspring conflict and physical abuse, several patterns of findings emerge. To begin with, abuse frequently seems to result from poor parental management of conflict. Parents often report losing control during the course of a conflict episode and resorting to physical violence. This escalation appears to be profoundly related to coercive family processes. Abusive parents are more likely to report perceiving their children as holding the majority of power during conflict situations, and thus feel the need to reassert their dominance through physical means. Furthermore, aggressive behavior in children has also been found to provoke aggression in parents. What may distinguish abusive families from those characterized by the coercive family processes described previously is that in an abusive family, the cycle of escalating aversive behaviors is terminated, not by the parent abandoning the conflict, but instead by responding with physical aggression against their child.

As with all investigations of parent–child conflict, a developmental perspective is important. As children develop, the eliciting events for abuse may change. During the infant and toddler years, the majority of conflict-to-abuse incidents revolve around the child's need for nurturance (e.g., conflict around feeding routines) or the toddler's inability to regulate their behavior in response to parental instructions (such as during toilet training). In middle childhood, abusive incidents more often revolve around the child's refusal to comply with social standards, such as lying to their parents. As would be anticipated, as adolescents gain both more freedom and more

responsibility, abuse during this developmental period tends to stem from conflicts around obedience and compliance. Rates of abuse also appear to increase as children get older, with more than 25% of reported abuse cases concerning adolescents. Indeed, abusive patterns of interaction may emerge for the first time during adolescence as parents find the balance of power shifting and their previous strategies for discipline and conflict management ineffective against their newly autonomous adolescents.

Conclusion

What becomes clear from even this brief review of parent–offspring conflict is that it is a topic seemingly full of contradictions. Conflict, in general, appears to be a vital catalyst of children’s social cognitive development, but too much (or poorly managed) conflict within the family context can quickly come to hinder these developmental processes. How parents and children perceive and manage conflict is subject to both great continuity and great change as children develop from helpless infants to independent adolescents. For example, previously held views that certain periods of development, such as adolescence, are highly conflictual receives only equivocal evidence from the empirical literature. Instead it appears that, while overall rates of conflict may increase somewhat early in adolescence, families which have a long history of successfully managing conflict will weather this period unscathed.

Another thing that is clear from this review is that much future work is needed. The positive role that parent–offspring conflict can play in development is a topic that has received insufficient empirical investigation, despite long being a cornerstone of developmental theory. Research on parent–offspring conflict is critical for our understanding of both typical and atypical child development, and deserves greater consideration than it has received thus far.

See also: Adolescence; Child Abuse; Childhood Mental Disorders; Individual Differences in Temperament: Definition, Measurement, and Outcomes; Moral Development; Parenting; Peer Relationships and Influence in Childhood; Social Development (Attachment, Imprinting).

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Relevant Websites

- <http://www.oslc.org/> – Website for Gerald Patterson’s Oregon Social Learning Center, focusing on interventions for coercive family processes.
- <http://www.preventchildabuse.org/index.shtml> – Website for the Prevent Child Abuse America Organization.

Peer Relationships and Influence in Childhood

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Glossary

Clique A small group of friends.

Crowd A reputation-based peer group.

Friendship A voluntary, close relationship reciprocally recognized by two individuals.

Homophily A phenomenon in which social contact is higher among people who are similar rather than dissimilar.

Hostile attribution bias The tendency to interpret ambiguous harm as being intentionally caused.

Peer acceptance Refers to how much a child is liked by peers.

Peer rejection Refers to how much a child is disliked by peers.

Perceived popularity Refers to how much a child is perceived as 'popular,' or socially prominent, by peers.

Rejection sensitivity The tendency to defensively expect, readily perceive, and overreact to rejection.

Relational aggression Aggression meant to manipulate or disrupt relationships, often initiated covertly.

Social information processing (SIP) theories Theories devised to explain online processing and decision-making that happens before, during, and after social interactions.

Sociometric assessments Measures in which children are asked to report on how much they like or dislike their peers.

Temperament A biological basis for the affective arousal, expression, and regulatory components of personality.

Working models Expectations and assumptions about interactions and relationships with other people which affect behavior in social interactions.

Introduction

Typically, children and adolescents spend considerable amounts of time interacting with peers, in and outside of school. Although much research in developmental psychology has focused on the influence of parents and family, peer relationships are of significance for positive social and emotional development. In fact, the ability to initiate and maintain positive relations with peers and friends is an important developmental accomplishment. Through peer interaction, children learn about their social worlds, establish identities, and develop close, intimate friendships. Children who experience success with peers are on track for adaptive and psychologically healthy outcomes whereas those who have difficulty are considered at-risk for all manner of adjustment problems.

In this article, we survey the literature on child and adolescent peer relationships. First, descriptions of children's friendships, characteristics of children who have friends, and the consequences of friendship for adjustment are examined. Next, the article focuses on peer groups, cliques, and crowds. Following this, the behavioral, social-cognitive, and affective correlates and longitudinal outcomes of being liked or disliked by peers and of being considered 'popular' are reviewed. Then, a discussion of cultural variation in peer relationships is presented. Finally, both the biological and parental origins of peer relationships are examined, and subsequently, a brief discussion of peer influence processes is described. The article begins, however, with an overview of relevant theory pertaining to child and adolescent peer relationships.

Theoretical Perspectives

Theoretical discussion of the importance of child peer relations can be traced back to the early decades of the twentieth century. Jean Piaget proposed that, in contrast to relationships with parents, children's peer relationships were more balanced and egalitarian. Thus with peers, children experience opportunities to examine conflicting ideas, to negotiate and discuss their perspectives, and to compromise with the ideas held by age-mates. Harry Stack Sullivan also theorized that children gained understandings of mutual respect, equality, and reciprocity from peer interaction, but he additionally emphasized the significance of best friendships in the process through which children develop abilities to recognize and value each other's personal qualities. George Herbert Mead contributed the idea that peers help children to develop the ability of self-reflection and a sense of identity through social comparison.

Social learning theory, ethological theories, and group socialization theory have also guided current research on children's peer relationships. The main contribution of social learning theory has been the principle that children learn about their social worlds, and how to behave within these contexts, through direct peer tutelage and through observation of their fellow peers. Additionally, peers can affect and change the behavior of each other through punishment (e.g., ignoring, criticizing) and reinforcement (e.g., smiles, laughter, attention). Ethological theorists, such as Robert Hinde, have also provided valuable perspective in the study of children's peer relations. They argue that social behavior and social structures are limited by biological constraints and serve evolutionary

functions insofar as personal and group relationships are concerned. Moreover, with contemporary ethological theory came renewed emphasis on observing children in natural settings, adding more objective descriptive information about behavior within peer contexts. Relatively recently, Judith Harris proposed Group Socialization Theory in which she challenged the view that parents are the primary agents of socialization for their children. Instead, she suggested that peers play a significant role in personality development. In short, the theory hypothesizes that, beyond genetic contributions, peer group norms influence behavior and identity more so than parents. Altogether, many theoretical perspectives have contributed to peer relations research, each highlighting the significance of peer interactions and groups for development. Of particular significance in childhood, adolescence, and throughout life is the close, dyadic peer relationship of friendship.

Friendships

Friendships are voluntary, close relationships reciprocally recognized by two individuals. Peer relationship researchers measure friendships by asking children or adolescents to nominate their friends or best friends. If two individuals nominate each other, it is considered a reciprocal (or mutual) friendship. Typically, ~75% of children have at least one mutual friend and about 50% of children have a mutual best friend. Friendships, especially best friendships, are typically stable over the school year, with friendship stability increasing as children get older.

Friends, especially best friends, are typically of the same sex, although cross-sex friendships increase with age. Additionally, friends tend to be similar to one another on both demographic characteristics (e.g., race), behavioral characteristics (e.g., social competence, aggression), and interests (e.g., music). Homophily in friendship may stem from both initial attraction (i.e., children are attracted to those similar to themselves) and socialization (i.e., as friends spend time together, they influence each other). For additional information on socialization and peer influence (see the sections 'Socialization Within Peer Groups' and 'Peer Influence').

Descriptions of friendships change with age, indicating that the functional benefits of friendships may vary by age as well. When young children are asked to describe friendships, their narratives focus on play and companionship. Shared-play allows children the opportunity to develop self-regulation skills. In middle-through-late childhood, friendship descriptions center on sharing, cooperation, and help, and gradually develop into an emphasis on similarity and loyalty. Friendships during this period provide opportunities for children to learn about social norms, provide support, and help them to learn the interpersonal skills necessary for later intimate relationships. Finally, adolescents' friendship descriptions include expectations for shared intimacy and emotional support, and ultimately friendships at this age provide a context to express and regulate emotion and establish identity.

The benefits of friendship are evident when comparing the social and emotional adjustment of children who do and do not have close friends. Children who have friends report less

loneliness and higher self-esteem than children without friends. Children with friends are also less likely to be victimized by peers than are children without friends. Friendships are also beneficial for children normally considered 'at-risk.' Having friends seems to protect children who do not have supportive parents or who have stressful home lives from later maladjustment.

The quality and stability of friendships is also a determinant of the benefits derived from them. The degree to which a child's friendships are high in emotional and instrumental support, intimacy, validation, and conflict resolution is related to positive adjustment. Children with high-quality friendships are less lonely, exhibit fewer externalizing or internalizing problems during life stressors, and are better adjusted after school transitions. Children with stable friendships are also less lonely compared to their peers with unstable friendships.

Groups

Beyond friendships, children also spend a large proportion of their time in both informal and formal group settings. In childhood, small groups of friends, or cliques, are predominant. However, in adolescence, participation in reputation-based crowds becomes more prevalent. Crowds are larger collections of individuals who share the same image or status among peers, even if they spend little time interacting with each other (e.g., 'jocks,' 'geeks,' 'populars,' 'goths,' 'loners,' and 'druggies'). These changes in group structure suggest that older children rely on a group of trustworthy peers for social support, whereas adolescents strive to acquire a sense of group identity that is different from their parents.

Groups can be measured in several ways, but the most popular techniques include social network analysis (SNA) and social cognitive mapping (SCM). With SNA, children are typically asked to list up to ten friends with whom they hang out most often in the school. A computer program, NEGOPY, then clusters children into groups who report having relatively high contact with one another. With friendship nominations, NEGOPY can report group members, liaisons, dyads, and isolates. Group members are those individuals who belong to a rather exclusive social group, with at least three individuals who have at least half of their friends in the same group and who are all connected within the group. Liaisons are individuals who have friendships with group members, but are not group members themselves. Dyads are individuals who have one reciprocated friendship link, either to each other or to another individual. Isolates are children who have no reciprocated friendships.

In contrast, the SCM technique assesses peer groups by asking children to report on peers who 'hang around together a lot' and whom they, themselves, 'hang around with.' Based on the reports of all children, a matrix is constructed based on the number of occasions that any two individuals are named as being in the same group. Each participant's group-membership profile is generated based on the frequencies of nominations of group-membership with every other child in the class. A profile similarity index is derived by correlating pairs of individual group-membership profiles and then children with similar group-membership profiles are clustered into the same group.

Socialization Within Peer Groups

The peer group represents a social context influenced by the collective functioning of members based on group norms and values and is not simply reducible to the characteristics of the individuals who compose the group. Children in the group are bound together, constrained by common interests and group norms. Thus, these group norms guide how children and adolescents behave in various social situations.

Interactions within peer groups socialize children and adolescents in several major ways. For example, from group activity, children learn how to cooperate to achieve collective goals and the skills needed to both lead and follow others. Youth learn how to control aggression toward their fellow group members, and simultaneously, how to direct aggression toward out-group members. Groups also forge emotional connections among members and serve as sources of social support. In short, frequent contact, common activities, and affective connectedness among group members may make children's groups a particularly strong socialization influence.

Crowd membership contributes to adolescents' social functioning, partly because of its influence on social contacts. For example, the stigma associated with certain crowds constrains adolescents into relationships with members of their own group, and prevents changes in group membership. Crowd membership also leads to the stereotyping of peers; adolescents are biased in their use of reputational information about particular groups, especially when presented with social information about those groups that is ambiguous.

Thus, peer groups may have far-reaching effects on individual social, emotional, and behavioral functioning and adjustment. Although peer groups may initially be formed based on child characteristics, the profile of peer networks significantly predicts subsequent adjustment. For example, peer groups contribute to school motivation, school drop-out, pregnancy, and delinquency. See the section below on peer influence for additional information.

The prevalence of larger peer groups declines in the late adolescent years, partly due to increased cross-sex groups and dyads. Eventually, groups divide into couples and adolescents feel more comfortable approaching each other, even without support from a crowd. Additionally, in late adolescence, youth become more secure creating their own identity and deciding on their own personal values and morals apart from a crowd.

Peer Acceptance and Rejection

Often used as an indicator of child adjustment, peer acceptance and rejection refer to how liked or disliked a child is by his or her peers. In this section, methods of measuring peer liking and disliking are briefly surveyed. Second, the behavioral and social-cognitive characteristics associated with acceptance and rejection are reviewed, followed by a discussion of the long-term outcomes of peer rejection.

Peer acceptance is typically measured through a sociometric assessment, in which children are provided with a class roster and are requested to nominate up to three classmates with whom they like to play or work, or whom they simply like the most. Children are also asked to nominate peers with whom they do not like to play or work, or those whom they

like the least. Some researchers limit the number of nominations that children can make for 'liked most' and 'liked least' to three, whereas others allow children to make unlimited nominations. The number of nominations a child receives is summed and then divided by the number of possible raters to compute a proportion of how many classmates (or grade-mates) like and dislike each child. Scores are standardized within each class (or grade) to control for group size. Children who receive few 'liked most' nominations and many 'liked least' nominations are labeled as 'rejected' whereas children who receive many 'liked most' nominations and few 'liked least' nominations are labeled as '(sociometrically) popular' or as 'well-accepted.' Other groups of children can also be identified, including children who are 'average' (near the mean on liked and disliked nominations), 'controversial' (many liked and disliked nominations), and 'neglected' children (few liked and disliked nominations). As an alternative to using nominations, it is also possible to measure acceptance using a rating-scale sociometric procedure. Children are provided with a class roster and asked to rate each classmate on a scale (e.g., 1 = 'not at all' to 5 = 'very much') pertaining to how much they like to play or work with each person.

Not to be confused with sociometric popularity (being liked or accepted by peers), perceived popularity, or social prominence, is the degree to which children are labeled as 'popular' by peers. Perceived popularity is measured by standardized, proportioned nominations of 'most popular' and 'not popular.' The proportion of 'not popular' nominations received by each child is subtracted from the proportion of 'popular' nominations, and this score is standardized within class (or grade and sometimes gender). Teacher nominations of popularity have also been used to study perceived popularity. The association between perceived popularity and sociometric popularity ranges from moderate to strong, but generally decreases in magnitude during adolescence.

Behavioral Correlates of Peer Acceptance and Rejection

In an effort to understand why some children are liked versus disliked by peers, research on associations with child behavior has been prominent. Child behavior can be measured in numerous ways, including peer-, teacher-, parent-, and self-reports, as well as through observational methods. In the peer relations area, child behavior is most commonly measured through peer reports of behavior. Children nominate classmates who fit different behavioral descriptions (e.g., 'starts fights,' 'shy,' and 'helps others'). These nominations are also proportioned and standardized within class.

Observing children in naturalistic or laboratory settings is another method to measure child behavior, which may offer more objective assessments compared to peer-, teacher-, parent-, or self-reports. Laboratory or analogue assessments are useful for observing behaviors that may be hard to detect or may occur less frequently in natural settings. From these observations, researchers can deduce what is age and gender typical in social situations. Behaviors that deviate from these norms are typically associated with peer rejection.

Generally, sociometrically popular (or well-accepted) children are identified by peers as being skilled communicators and good leaders. Well-accepted children are also perceived

by peers as being sociable, helpful, sensitive, agreeable, and cooperative. They also tend to be good athletes, good students, and have good senses of humor. Further, observations of sociometrically popular children have revealed that they are more successful at entering group activities than rejected children, likely because they take the group's frame of reference and say something on topic without drawing undue attention to themselves. Further, in conflict, well-liked children are more likely to negotiate and compromise than their disliked peers.

In comparison, there is more heterogeneity in the characteristics of peer-rejected children. Between 40% and 50% of rejected children are considered aggressive by their peers. Observations of the interactions of unfamiliar children over time have shown that the behavior that most clearly predicts whether peers increasingly dislike a child is how much that child uses instrumental and reactive aggression in his peer interactions. Additionally, if children are both aggressive and disruptive, the likelihood of being rejected by peers increases greatly. However, aggressive behavior and peer rejection are correlated more within groups of younger children than within groups of older children.

Further, if children have other peer-valued characteristics, then the association between aggression and peer rejection decreases. For example, aggressive children and adolescents who are also considered athletic and 'cool' may not be rejected by peers. In fact, the group of 'cool,' aggressive children may be part of the group of children that was described above as being perceived as popular. Perceived popularity has been linked to a diverse list of characteristics, including aggression and dominance, as well as prosocial behavior, academic and athletic abilities, having a good sense of humor, and being attractive, stylish, and wealthy.

This mix of valued characteristics with dominant/aggressive behavior may be what distinguishes the perceived popular group from other status groups. Longitudinal research has found that youth who become perceived as popular by peers subsequently increase their use of aggression, particularly relational aggression, perhaps as a means to maintain their status during adolescence. Relational (also sometimes labeled indirect or social) aggression is meant to manipulate or disrupt relationships and is often initiated covertly. Although, overt aggression (i.e., direct physical or verbal aggression) has also been associated with perceived popularity, these associations have been explained through the relations of both constructs with relational aggression.

Returning to the behavioral characteristics of rejected children, ~10–20% of these children are shy, withdrawn, and/or socially anxious. Withdrawn children are not likely to approach unfamiliar peers, they appear overly compliant to peers' requests, and seem unconfident and wary in the company of peers. They are also more victimized by peers, perhaps because they are viewed as 'easy marks.' Additionally, withdrawn boys are more likely to be rejected than withdrawn girls, perhaps because withdrawn behavior violates male gender norms.

Withdrawn behavior has been differentiated into three forms, each of which is differently related to peer rejection. Solitary-passive behavior comprises solitary exploration and/or constructive activity in the company of others and is

considered normal for young children, but becomes increasingly associated with peer rejection with increasing age. Solitary-active behavior comprises the display of solitary sensorimotor activity and/or dramatic play in the company of others. It is viewed as abnormal throughout childhood and is associated with peer rejection as early as preschool. Finally, reticence consists of watching others from afar and avoiding social activity altogether. Reticence has been found to reflect internalized feelings of social anxiety and, beginning in early childhood, also elicits peer rejection.

Once a child is rejected by peers, the experience may reinforce both aggressive and withdrawn behavior in those children who are predisposed. For example, anxious-solitary children who were excluded early in kindergarten evidenced more stability in their behavior over time compared to peer-accepted anxious-solitary children, whose anxious solitude decreased over time. Similarly, researchers have found that peer rejection predicts increases in aggressive behavior over time, especially for children who are initially more aggressive than peers. In this regard, there appears to be a dialectic relation between behavior and rejection. Behavior may initially result in peer rejection, but the experience of rejection evokes greater maladjustment.

Social-Cognitive Correlates of Peer Acceptance and Rejection

Researchers have investigated the social cognitions of children in the different sociometric status groups and of children with different behavioral tendencies. Social information processing (SIP) theories explain online processing and decision-making that occur before, during, and after social interactions. Most SIP models suggest that individuals enter social situations with unique interpersonal histories, which include beliefs, schemas, scripts, and working models, all of which influence how they interpret social interactions and how they behave. Typically, SIP models also outline a series of sequential steps that explain how children attend to, encode, and interpret social information and how they choose, evaluate, and enact both goals and behavioral strategies. Recent revisions of these models also include temperament, emotional regulation, and affective reactions as contributors to cognition and subsequent behavior in social interaction.

Generally, rejected children are less likely than their well-liked counterparts to formulate prosocial goals and generate sophisticated strategies. However, a majority of SIP research has focused on children who are both rejected and aggressive. Typically studied by asking children to respond to vignettes in which they are harmed but is unclear whether the offense was intentional (e.g., someone bumps into you in the cafeteria and your milk is spilled on your shirt), rejected-aggressive children are more likely to judge an ambiguous harm as being intentionally caused and respond in a hostile manner. This tendency has been termed the hostile attribution bias.

Children who are both aggressive and rejected are also more likely to choose aggressive/hostile goals and strategies in social situations. For example, these youth are more likely to endorse revenge and dominance goals as well as aggressive behavioral strategies in both ambiguous situations and very minor conflicts of interest. Aggressive children also view aggression as a more legitimate response in social situations,

anticipate greater rewards and fewer consequences for aggression, and they expect that aggression will lead them to feel better about themselves and will be less hurtful to victims.

In comparison, far less research has examined the SIP patterns of withdrawn children. Research that has focused on this group finds that withdrawn children are more likely than aggressive or typical children to anticipate failure in social situations. When withdrawn children do encounter social rejection, they are more likely to attribute it to their own dispositional characteristics rather than to external causes. Additionally, withdrawn children are more likely to suggest adult-dependent and avoidant strategies and less likely to generate assertive social strategies to resolve interpersonal conflicts.

Interpersonal schemas may also predict how children react in peer situations, and ultimately are related to their sociometric status. For example, rejection-sensitivity, defined as the tendency to defensively expect, readily perceive, and overreact to rejection, has been associated with peer rejection and child behavior. First, peer rejection predicts increases in rejection sensitivity over time. Furthermore, angry expectations of rejection are positively associated with teacher-rated aggression and negatively linked with social competence. Moreover, child and young adolescent anxious expectations of rejection have been linked with social anxiety and social withdrawal. While this is still a relatively new topic of investigation, it seems that rejection-sensitivity is a construct that may prove useful in further SIP-guided research.

The self-system

Henry Stack Sullivan argued that peer relationships shape children's self-concepts. In support, researchers have found that rejected children view themselves as less socially competent and have lower self-worth than nonrejected children. Further, it appears as if peer rejection predicts decreases in social self-concept over time. However, not all rejected children have negative self-views. Aggressive-rejected children tend to think more positively about themselves and underestimate how disliked they are compared to nonaggressive-rejected and withdrawn-rejected children. Aggressive-rejected children may be less likely to be treated poorly by peers, or perhaps, they are more likely to employ self-protective mechanisms and ignore negative feedback.

Loneliness

It is not surprising that rejected children are generally lonelier than typical or nonrejected children. Examining subgroups of rejected children, submissive/timid/withdrawn-rejected children, when compared with average-status and aggressive-rejected children, report higher levels of loneliness. Additionally, those whose rejected status is stable over time become increasingly lonely over time. The association between peer rejection and loneliness may be explained, in part, because rejected children have fewer friends and are more likely to be victimized by peers.

Outcomes Associated with Peer Rejection

Focusing on both externalizing and internalizing problems, this section briefly reviews research on peer rejection and later adjustment outcomes. Research in this arena has been

guided by several theoretical models, proposed to explain how sociometric status, behavior, and later adjustment are related. The 'causal model' states that rejected peers interact with their peers in a negative manner causing them to receive poorer treatment which eventually leads to subsequent adjustment difficulties. The 'incidental model' assumes that peer rejection does not affect later adjustment but is only a by-product of the child's behavioral style and it is behavior, alone, that affects later adjustment. More recently suggested, the 'additive model' states that relational risk factors, like peer rejection, increase the likelihood of later dysfunction beyond the risks associated with behavioral characteristics. Alternatively, the 'moderated risk-adjustment model' suggests that relational risks (e.g., peer rejection) exacerbate maladjustment among children who are behaviorally at risk. Finally, examining forces outside of the child and the peer group, the 'transactional model' proposes that the child's dispositional and biologically based characteristics, parents' socialization practices, relationships within and outside of the family, and culture, stress, and social support determine both peer relationships and the positive or negative outcomes that follow.

Externalizing problems

Externalizing difficulties comprise behaviors that are disruptive, destructive, harmful to others, and in violation of societal norms (e.g., delinquency, aggressive behavior, criminal involvement). Children who are rejected by peers are at an increased risk for externalizing difficulties in adolescence and beyond. Theoretically, research about how peer rejection and aggression are associated supports components of the additive, interactional, and causal models. For example, peer rejection in early childhood has been linked with later misconduct and conduct problems, even after controlling for initial levels of behavioral problems. In some cases, the pathway from peer rejection to conduct problems is exacerbated by the initial level of behavioral problems. It may be that social rejection serves as a social stressor, increasing children's tendencies to behave aggressively beyond their initial tendencies.

Internalizing problems

There is much evidence for both concurrent and longitudinal associations between anxious-withdrawal and internalizing problems. Withdrawn behavior early in childhood is related to depression, loneliness, anxiety, and negative self-worth years later and, empirical support has been found for the causal, additive, moderated risk-adjustment, and transactional models. For example, because peer rejection and anxious-withdrawal are associated, researchers have proposed that the combination of anxious-withdrawal and peer rejection is associated with an increased risk for later internalizing issues. Indeed, anxious-solitary children who are also excluded by peers subsequently display more depressive symptoms years later than anxious-solitary children who are not excluded by peers.

In conclusion, peer-rejected children are at risk for both externalizing and internalizing problems. Children who act aggressively or are withdrawn are likely to be rejected, and peer rejection exacerbates these behavioral tendencies. In combination with these behavioral risk factors, peer rejection is associated with an increased likelihood of later maladjustment.

Culture and Peer Relationships

Most of what has been learned about child and adolescent peer relationships has been based on research from North America and Europe. However, child behavior, social and behavioral norms, and the formation and function of peer relationships and peer groups are directed by cultural conventions, norms, and values, and thus, vary cross-culturally. This section briefly focuses on cultural variation in the meanings and correlates of peer acceptance, friendships, and peer groups.

Although it appears to be a universal finding that children who are cooperative, friendly, and sociable are well-liked by peers, cultural values greatly influence standards for rejection of children who are prototypically aggressive or withdrawn among their peers. Whereas aggression is typically associated with peer dislike, when the larger group within which the child is a member is aggressive, its association with peer rejection is nonsignificant. Interestingly, aggressive behavior is associated with loneliness in China but is not in Western cultures. As aggressive and dominant behavior has been linked to perceived popularity in the United States, there may be fewer social sanctions against it, whereas in China, aggression is more prohibited.

Furthermore, social withdrawal is associated with peer rejection in cultures that value assertiveness, expressiveness, and competitiveness. Thus, social withdrawal is associated with peer rejection in countries such as Argentina, Canada, Greece, Italy, the Netherlands, and the United States. Yet in China, research in the 1980s and 1990s indicated that shy and inhibited behavior was positively linked with peer acceptance; it was argued that in China, quiet, reserved, compliant behavior was a reflection of self-regulation. More recently, with historical changes occurring such that the Chinese economy and political climate is becoming more similar to Western nations, researchers have noted that shy, reserved, and especially socially withdrawn behaviors are becoming more associated with peer rejection among urban Chinese elementary school children. The same findings have not been reported for children residing in traditional, rural regions.

The functional roles that children's friendships fulfill may vary across cultures as well. For example, whereas friendship is considered voluntary in Western cultures, friendships may not be freely chosen everywhere, but instead may be considered predetermined or permanent. Additionally, the salience of friendship provisions may vary as defining features of friendship. For instance, intimacy is a more important criterion in the friendships of Korean adolescents than their US counterparts. Furthermore, whereas children from both Indonesia and the United States rate intimacy as being similarly important to friendships, American children also define friendships by companionship whereas Indonesian children derive companionship more from their family members than from their friendships.

Researchers have just begun to explore variation in friendships by race and ethnicity within culturally diverse nations. In one US study, ethnic minority adolescents, from low-income, urban contexts, conceptualized and expressed intimacy with friends differently than their white or middle-class age-mates. Low-income urban adolescents stressed instrumental aid (e.g., sharing money and other resources) with friends as a powerful signifier of trust and closeness, whereas middle-class white adolescents traditionally focused more on intimate disclosure.

Without additional research, it is not possible to know whether these differences were due to race, ethnicity, socioeconomic status, or other community features.

Biological and Parental Influences on Peer Relationships

As noted above, children's social skills are associated with, and predictive of, the quality of their peer relationships. Thus, knowledge about the origins of these skills is valuable and may be used to develop prevention or intervention programs for those at risk for peer rejection and its negative consequences. In this section, we briefly review research on the origins of these skills, focusing on biological or dispositional factors, such as temperament, as well as parent-child relationships and parenting behaviors.

Temperament

Temperament is defined as a biological basis for the affective arousal, expression, and regulatory components of personality. Temperament seems to play a powerful role in social skill development; longitudinal evidence following children from early childhood through adolescence indicates that about half of the variation in social skills may be accounted for by temperamental characteristics.

Focus has been on three main groups of traits: manageability, reactivity, and inhibition. Children low on *manageability* lack attention regulation, are low on agreeableness, and have trouble ignoring rewarding stimuli. These children tend to be boisterous, socially immature, and unresponsive to parents' and teachers' attempts to regulate their activities. With peers, these children are socially unskilled and are more likely to display other externalizing problems. Children who are highly *reactive* are easily angered, frustrated, and provoked by peers, and have difficulty controlling the expression of negative emotions. The probability of these children being rejected and of developing externalizing and internalizing difficulties is much greater than for children low on temperamental reactivity. Finally, *inhibited* children refrain from interacting with unfamiliar peers because of dispositionally based fear or anxiety. As noted above, shy, inhibited children are more likely to be rejected and develop internalizing problems, in part because they act less competently and employ less active coping strategies. Finally, children who are well-regulated emotionally and are sociable develop those social skills that endear them to their peers and friends.

Parent-child relationships

Parents serve many influential roles in their children's development of social skills and positive peer relationships. As outlined in attachment theory, the parent-child relationship provides a 'secure base' allowing the child the freedom to explore his or her social environs, thereby enhancing the development of social competence. Additionally, within parent-child relationships, children begin to develop 'working models,' or expectations and assumptions about interactions and relationships with other people that subsequently affect their behavior in social interactions. According to attachment theorists, parents who recognize their young child's emotional signals, consider their child's perspective, and respond contingently to their child's needs have children who rely on their parents for protection,

nurturance, comfort, and security and who develop the belief systems that others are generally trustworthy and that the self is worthy of positive treatment. When parents do not meet these standards, children may develop insecure attachments to parents, and subsequently, working models that interpersonal relationships may be rejecting or neglectful.

Research linking attachment and peer relationships abounds. In both childhood and adolescence, youth who experience a secure relationship with their primary caregivers (usually mothers) are rated by peers and teachers as more likeable and sociable compared to insecurely attached peers who are reported to be more aggressive or withdrawn. Longitudinal research has also revealed that infants identified as being insecurely attached to mothers are more likely than their secure counterparts to display aggressive or socially wary and withdrawn behavior years later. Security of attachment has also been related to subsequent friendship formation and maintenance; children with insecure attachment relationships have fewer friends and have poorer quality friendships compared to children with secure attachments.

Parenting behaviors

Parenting behaviors influence child social skills and peer relations in many ways. Here, we focus on two primary means: (1) parental warmth and control, and (2) parental provision and monitoring of opportunities for peer interaction. First, much of the research on parenting and peer relationships has examined two dimensions of parenting: warmth and control. Warmth refers to parental praise, encouragement, physical affection, both physical and psychological availability, and approval. Control refers to the consistent enforcement of rules accompanied by an ability to make age-appropriate demands on the child. Researchers consistently find that parents of peer-rejected children use more harsh and authoritarian disciplinary and socialization practices compared to parents of well-liked children who use more feelings-oriented reasoning, warm control, and are more positive during communication. The association between parenting behaviors and peer acceptance is likely accounted for by the child's behavior with peers. For instance, parents who are more physically punitive and rejecting or are overly permissive have children who are more aggressive with peers. Additionally, parents who are overprotective and overcontrolling have children who are shy or withdrawn with peers. In fact, parents may inadvertently exacerbate childhood aggression or shyness and social anxiety by serving as models of these behaviors.

Second, parents affect children's peer relations by providing opportunities to interact with peers (especially in early childhood), monitoring their peer activities, and by coaching them through difficult peer tasks. Young children whose parents arrange play dates have more play partners, are more socially competent, and are better liked by peers. Further, children whose parents monitor their peer contacts are less likely to be aggressive or delinquent in adolescence. Finally, parents can offer helpful advice about how to handle challenging peer interactions; mothers of well-liked children encourage them to employ positive and assertive strategies for handling interpersonal problems involving peers in comparison to mothers of rejected children who support more avoidant coping strategies.

Peer Influence

There is a rather strong and consistent association between the individual child's own behaviors and those of their peers. As noted above, friends tend to both befriend similar peers (i.e., selection) and become more like their friends over time (i.e., socialization). In this section we focus on peer influence processes, sometimes referred to as peer contagion, and how peer relationships and the characteristics of friends shape adolescent behavior.

Several mechanisms for peer influence have been offered. The first is peer pressure, in which children and adolescents directly try to influence each other's behaviors and attitudes. Second, based on social learning theory, another influential factor may be peer modeling, or peers mimicking each other's behaviors; this is especially true for the modeling of peer group leaders' behaviors. Third, youth may also use antagonistic behaviors, such as teasing, ridicule, or even bullying to control each other's behavior. Fourth, peers may create structural opportunities that facilitate behavior without directly encouraging it. Fifth, when an adolescent is labeled by peers as being a part of a certain crowd, this label may lead them to act in ways that are self-fulfilling. And finally, friends and peers may subtly reinforce and encourage each other to continue or increase behaviors in which they are already engaging.

Peer influence is prevalent in early childhood and throughout adolescence, affecting youth aggression, risk-taking behaviors, social attitudes, and much more. For example, aggressive children tend to interact with other aggressive children, escalating their aggression over time. The subtle ways that deviant friends encourage each other are revealed through observations of their discussions. When deviant or aggressive children interact, they reward each other for talking about deviant behaviors, through laughter and extended discussion. This has been termed 'deviancy training' and has been observed in the interactions of children as young as 5 years old.

Social influence can be both harmful and healthy, depending on the characteristics of peers. For example, longitudinal research indicates that the academic performance of a child's friends is associated with the later academic performance of the child. More specifically, if a child's close friends obtain higher grades, the child is more likely to demonstrate academic improvement; however, if the child's close friends perform poorly, then the child's performance is likely to suffer. Peer crowds are also important. Highly motivated students receive more reinforcement from their crowd members for on-task behavior, whereas low-achieving youth are rewarded more by their crowd members for off-task behavior.

The extent of peer influence depends on both individual characteristics as well as situational and relational factors. For example, at the individual level, those with low self-esteem are more susceptible to peer influence. A youth's perception of social norms is also significant; for example, teenagers adjust their alcohol consumption to be similar to their perceptions of group norms. Contextually, the power dynamics of a relationship affect which individuals are more susceptible to group influence. Peers are more likely to be influenced by higher status peers than they are by low-status peers. Moreover, interactional processes between friends affect subsequent adjustment. For example, co-rumination, or joint, extensive

discussion about negative events in each other's lives, is associated with increased depressive symptoms among girls.

In conclusion, we have surveyed the literature on child and adolescent peer relationships. We have found that friendships provide youth a safe, supportive relationship in which they gain self-regulatory skills, and learn about social norms and themselves. Peer cliques and crowds are also socializing agents, providing a source of identity in adolescence. Further, the extent to which children are liked or disliked by the larger peer group is influenced by their behavior and social cognitive skills, which in turn are also affected by cultural norms, child temperament, parent-child relationships, and parenting behaviors. Thus, from our reading of the literature, it would appear safe to conclude that peer relationships significantly influence social, emotional, relationship, and academic development.

See also: [Developmental Psychopathology](#); [Friendship](#); [Personal Relationships in Everyday Life](#); [Parenting](#); [Socioemotional Development](#); [Social Development \(Attachment, Imprinting\)](#).

Further Reading

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Perceived Control

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Glossary

Learned helplessness The 'giving-up reaction' or 'quitting response' that results from believing that behaviors do not produce desired responses.

Perceived control Classic definitions focus on beliefs involving *influence*, including beliefs in *influence* over one's own actions and contingency beliefs that a given response will *influence* an outcome.

As a Darwinian imperative, survival is predicated on 'cause-effect' associations. An animal will not survive unless it engages in the necessary behaviors to catch its prey. *Objective control* is used to describe these cause-effect relationships in which a given response influences or produces an intended outcome. A desire to exert influence over one's environment has even been proposed as a basic human motive. The motive to strive for control is reflected in folk expressions that permeate our day-to-day language, such as 'The early bird gets the worm' and 'If at first you don't succeed, try and try again.' Striving for control is also a central theme in literature and poetry, as illustrated by the common refrain 'I think I can, I think I can' in Piper's famous bedtime story about the *Little Engine that Could*, and in the advice to pray for 'the courage to change the things I can' in Niebuhr's *Serenity Prayer*.

Successfully producing a desired outcome (objective control) is invariably accompanied by beliefs or *perceptions of control* about one's influence over such outcomes. Unlike objective control, *perceived control* is phenomenological. Often times, it is the subjective perceptions that predict subsequent behavior, not the objective reality of whether one can actually produce an outcome. The focus of this article is on control at the subjective level, *perceived control*.

Historical Development of Perceived Control

Perceived control arose as an area of scientific inquiry with the emergence of the 'cognitive revolution' in the mid-twentieth century. Perceived control has been featured in many broad theories of human motivation and behavior, such as in Rotter's original *Locus of Control Theory* and, more recently in Pekrun's *Control Value Theory*. During the 1980s, the construct was embraced by researchers studying health, as is evidenced by its inclusion in the *Health Belief Model*, the *Protection Motivation Theory*, and the *Theory of Reasoned Action*, later revised to the *Theory of Planned Behavior*. Finally, many theories imply the importance of perceived control even though it is not explicitly stated. This is the case, for example, in Weiner's *Attribution Theory* of motivation and emotion in which individuals seek causal explanations (attributions) in an attempt to understand the 'rules' that govern cause-effect relationships.

Conceptual and Theoretical Developments

During the second part of the twentieth century, many theorists and researchers contributed to the conceptual and

theoretical developments in perceived control. In 1959, White introduced his theory of *effectance motivation* that portrayed humans as possessing an innate need to investigate, master, and effectively handle their environment. In the 1960s and 1970s, a seminal body of animal research that examined objective control contingencies provided a backdrop for one of the major theoretical contributions in the field. In this research, dogs were exposed to learning conditions in which their responses to influence a desired outcome (escape of a shock) were futile. This led to an expectancy that generalized to other new learning situations: having previously learned that their attempts to escape a shock were futile, the dogs simply gave up trying to escape future shocks. Seligman coined the term *learned helplessness* to describe the pattern of passive, withdrawn, and apathetic behavior that ensued.

Following these animal studies that expressly manipulated *control contingencies* and focused on observed behaviors, the 'learned helplessness' paradigm was extended to the study of humans. Experiments exposed participants to uncontrollable noxious conditions, including electric shocks, loud noises, and painful stimuli like cold water. For example, in one experiment that exposed participants to an aversive stimulus (electrical shocks) while working on a task (puzzle), participants were informed that solving the puzzles would terminate the shocks. This study showed that it was not the objective influence over the termination of shocks that affected cognitive and physiological stress responses, it was the belief their responses (solving the puzzle) influenced the outcome (shock termination).

In addition to Seligman, many others have contributed to the conceptual and theoretical advances in the study of perceived control. The two others who are most often credited are Rotter and Bandura. Rotter's pioneering work on the *locus of control* construct separated beliefs about the causes of environmental outcomes into those controlled by *internal* factors (one's own actions and characteristics) or by *external* factors (powerful others, luck, chance, etc.). Subsequently, Bandura argued that individuals need to believe that an outcome is contingent upon a certain course of behavior or response (outcome efficacy), but that it is equally (if not more) important to believe they possess the capacities to produce that behavior/response (self-efficacy). Because *self-efficacy* involves beliefs about the possession of the abilities/skills/tools/behaviors necessary to influence a desired outcome, it presumably provides the incentive to act. Bandura argues that "there are countless response-outcome pairings that people understand but do not pursue because they judge themselves to lack the

capabilities for them . . .,” implying that self-efficacy is even a ‘better’ predictor of behavior than is ‘outcome efficacy.’

Definitions of Perceived Control

Beyond locus of control and self-efficacy, other classic concepts such as *mastery*, *agency*, and *self-determination* emerged that are all generally subsumed under the umbrella term ‘perceived control.’ Skinner developed a taxonomy that helped to differentiate the subtle variations between these concepts. Each can presumably be classified in relation to its emphasis on the ‘agent–means–end’ sequence, in particular whether it describes an ‘agent–means,’ ‘agent–ends,’ or ‘means–ends’ relationship. The ‘agent’ refers to beliefs about the agent of control (the role of the self); the ‘means’ refers to beliefs about the way in which control is exerted; and the ‘end’ refers to the desired outcome over which control is exerted.

Despite the different emphases in the classic concepts, the definitions share a common core: each focuses on beliefs about *influence*. The focus might be on a belief that certain actions will generally *influence* an outcome (running fast will allow one to escape from an attacking bear) or on whether one believes he/she possesses the essential qualities to *influence* his/her actions (I believe I have the strength and endurance to run fast) and/or whether this allows for one’s *influence* over outcomes (running fast will allow me to escape from an attacking bear).

Some researchers continue to use the *perceived control* label in the classical way to refer to beliefs about *influence*; whereas, others use it more liberally to describe a psychological state of control, that is, whether one feels ‘in control’ or ‘out of control.’ Beliefs about influence are tied to specific outcomes, but the psychological state of control is broader. Just as people can report whether a specific outcome produces happiness, they can also report a broader, overall state of happiness that extends beyond the outcome.

To avoid confusion in this article, when it is useful to distinguish *perceived control* from the broad psychological state of control, we adopt *sense of control* as a label to refer to the psychological state. We subsequently use the *perceived control* label in its narrowest, classic manner (i.e., beliefs about influence), not as an endorsement of this classic view, but rather, to avoid confusion.

Perspectives and Approaches to Studying Perceived Control

A researcher’s approach to studying perceived control is partly determined by the extent to which it is viewed as a trait, or as a state. The *trait perspective* regards perceived control as being much the same as a dispositional or personality characteristic, conforming to a *generalized* individual difference. Thus, at a global level, these perceptions may serve as ‘self-fulfilling prophecies’: If you believe you can, you can! Because these traits generalize across time, if one perceives control over her academic performance today, her perception will be the same tomorrow. However, these traits need not generalize across domains; a student might believe she can influence outcomes in the academic domain, but not in the health domain.

In contrast, the *state perspective* regards perceived control as arising, not only from beliefs that can change from domain to domain (or setting to setting) but also from moment to moment. Thus, the state perspective could, not only lead to predictions about domain-specificity in that perceived control can vary across situations (e.g., a student can believe he has considerable influence over getting a good grade on an upcoming exam but believe he cannot influence his weight loss), but also to predictions about the time dimension (lifespan trajectories).

Domain Specificity

Variations in perceived control have been examined in a wide range of domains, such as stress, social relationships, occupations/workplaces, housing, athletics, advertising, decision making, leisure activity, intellectual development, memory, and academic achievement. Although the research findings are not definitive, Lachman and Weaver showed that adults’ reports of perceived control were higher in some domains than others. The least perceived control was reported over sex life and finances and the most over marriage and life overall.

The most frequently studied domain in which perceived control has been assessed is health. Wallston’s *Health Locus of Control* scale is perhaps the most commonly used domain-specific scale that assesses perceived control over health in general. Other measures have also been developed within the context of specific health problems such as arthritis. Moreover, perceived control has been studied among individuals with a variety of specific health conditions, including AIDS, Parkinson’s disease, cancer, and arthritis, to name a few.

Lifespan Approaches

Although the research is insufficient to allow conclusions about changes over the *life course* in perceived control, some studies do suggest a shift toward externality in later life. A lifespan pattern is proposed by Wolinsky and Stump in which perceived control (i.e., mastery) gains strength throughout childhood and into early adulthood, plateaus in mid-life, and declines in later life as people experience losses. Specifically, they identified an ‘inflection point’ around the age of 50, at which time increases in perceived control were shown to wane and eventually decline.

Despite the limited empirical evidence, it is logically plausible that shifts in perceived control might occur over the life course. Although each person’s perceived control trajectory would develop in unique ways, some overall patterns may indeed exist. The following developmental trajectories serve as illustrations of such hypothetical patterns.

Response-outcome contingencies clearly begin to emerge at the earliest stages of development when a baby learns that his cries will result in feeding or when an infant learns to use her hands to manipulate an object. The pride on a child’s face when she accomplishes even the simplest task of tying her shoe suggests that she believes she is influencing/controlling an important outcome. Thus, the infant becomes more capable of exerting influence over more outcomes, and the young child increasingly gains proficiency at achieving goals through contingent response-outcome pairings.

Response-outcome pairings have traditionally been viewed as distinct, disconnected episodes. However, a developmental perspective suggests that the frequent and sequential response-outcome pairings become consolidated into ingrained series that constitute ‘contingency chains.’ Contingency chains may also produce expectations about influence over future outcomes. If contingency chains are only beginning their consolidation during infancy, infants should perceive very little control (influence) over their environments. Interestingly, however, infants are rarely depicted as being ‘out-of-control,’ a description that is reserved for later points in development.

Although infancy and young childhood would generally be regarded as a time when response-outcome contingent pairings and perceived control are increasing, these patterns presumably change during development. For example, contingency in response-outcome relationships might become more pronounced as adolescents or young adults begin to navigate their social worlds; their approaches to pursuing relationships might not always produce favorable outcomes. Moreover, during adulthood, limits are imposed when there are only brief windows of opportunity for objective control over important life goals, such as selecting a career or having children. Outside these windows of opportunity, contingency is likely to be eroded when responses do not produce the intended outcome.

Perhaps the *contingency limit* is most pronounced in late life when aging is often associated with a loss in resources (e.g., financial capacity), physical and functional capacity (e.g., immune system capacity; inability to perform daily activities), and social supports (e.g., loss of loved ones). Although the largely (objectively) uncontrollable environment would predict that perceived control should decline, Lachman and Weaver’s analysis shows that this is not universally true in all domains. Paradoxically, many older adults continue to report perceived control (influence) in some domains.

Antecedents of Control

Figure 1 provides an organizational heuristic to link our discussion of the next two sections on the ‘Antecedents of Control’ and the ‘Consequences of Control.’ Specifically, we consider the antecedents of the psychological *sense of control* (Path A), allowing for an inclusive approach that extends beyond the classical focus on *influence*. Although an analysis could consider a wide range of antecedents such as demographic characteristics, social resources, or cultural and societal factors,

we instead focus on the cognitive antecedents, drawing on conceptual and theoretical work in three areas: beliefs about *influence*, *explanatory (causal) thinking*, and *control beliefs* (see Figure 1).

Beliefs About Influence

When a response-outcome contingency exists such that a response *influences* an outcome, a psychological sense of control will arise (Path A, Figure 1). Even the *perception* that one can influence the outcome fosters the psychological sense of control. That is, even in the absence of true influence, one can believe he can control outcomes. This is captured in Taylor and Brown’s notion of the *illusion of control* that can exist when influence over an outcome is thought to be possible but, in reality, it is not. In essence, one’s beliefs about influence are not always aligned with reality.

Beliefs about objective influence that are based on response-outcome contingency clearly contribute to a psychological *sense of control*, yet, they are not the sole antecedent. In fact, a singular focus on beliefs about influence could oversimplify the cognitive processes that individuals engage in when attempting to understand cause–effect relationships. This would ignore the possibility that the perceiver engages in an in-depth cognitive analysis of outcomes, suggesting a need to consider individuals’ appraisals of the causes of outcomes.

Explanatory (Causal) Thinking

A consideration of explanatory (causal) thinking could provide further insight into the antecedents of a sense of control (Path A, Figure 1). Weiner’s *Attribution Theory* offers a compelling example of how causal thinking might foster people’s beliefs about influence and, in turn, their psychological sense of control. To the extent that individuals attribute failure outcomes to uncontrollable causes, beliefs about personal influence are likely to be eroded. For example, upon failing an exam, one might engage in causal search, appraising the cause of failure as bad luck. This presumably undermines beliefs about perceived control (influence) over future performance. In contrast, attributing a poor grade to insufficient effort fosters a belief that future grades can be influenced if one exerts more effort. Habitual attribution patterns may even shape beliefs about influence over time and the accompanying sense of control.

Little is known about the developmental sequence of the link between attributions and beliefs about perceived control

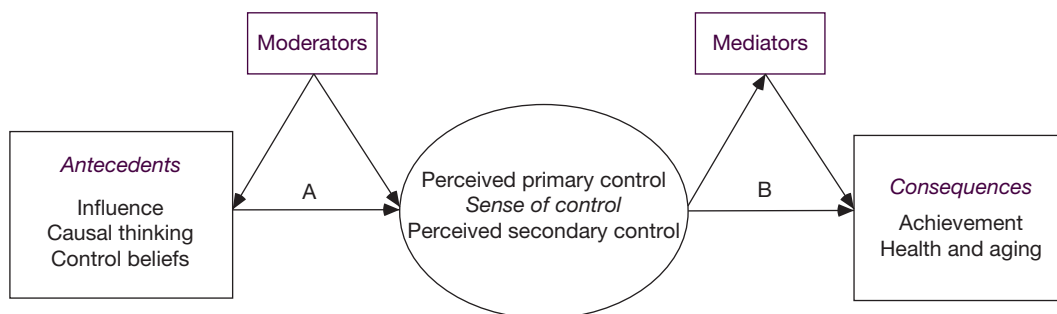


Figure 1 Antecedents and consequences of sense of control.

(influence). So, for example, although we present causal thinking (attributions) as an antecedent, the relationship to perceived control (influence) might indeed be reciprocal. Individual differences in preexisting beliefs about influence might promote the selection of specific causal attributions, and causal attributions might then refine and reshape an individual's subsequent perceptions about whether they can influence outcomes.

Control Beliefs

Rothbaum, Weisz, and Snyder's *two-process model of control* provides additional unique insights into causal beliefs as antecedents to the sense of control (Path A, Figure 1). This model identifies *primary control* beliefs that correspond to the classical view involving beliefs about 'influence' over behaviors/outcome (e.g., beliefs about effort, persistence, R-O contingency, etc.). However, the *two-process model* also identifies complementary *secondary control* beliefs that operate when direct influence cannot be achieved. Secondary control thinking involves cognitive reinterpretation through the adjustment of beliefs, hopes, goals, interpretations, and attributions, presumably allowing an individual to achieve a 'goodness of fit' with the environment and simply 'go with the flow.' Examples of how one reinterprets negative outcomes include, for example, optimistically comparing oneself to worse-off others; positively reappraising a situation to find benefit; and downgrading personal expectations or accepting personal limitations.

What was most provocative about the notion of secondary control is that these beliefs were presumed to bolster the psychological sense of control. This was the first acknowledgment that an overall sense of control could arise, not only from primary control beliefs about influence but from complementary secondary control beliefs that exist even in the absence of beliefs about direct influence. Although Rothbaum et al. did not propose that primary versus secondary control beliefs led to different and unique psychological states, we adopt the labels *perceived (primary) control* and *perceived (secondary) control* to differentiate between them.

To illustrate, an elderly man suffering paralysis following a sudden heart attack might believe he is incapable of exerting direct influence over many daily activities, thereby leading to a lack of *perceived (primary) control*. However, he might believe he is 'better off' than his neighbor who has terminal cancer, fostering his *perceived (secondary) control*. Thus, despite being unable to influence his daily activities and having low perceived (primary) control, he would feel that things are under control and that life is indeed still manageable. In short, if an assessment of his overall sense of control were based only on beliefs about influence over outcomes (and the accompanying perceived primary control), it would ignore the control-enhancing effect of secondary control beliefs that operate in the absence of influence. This would result in an underestimate of his overall psychological sense of control.

Rothbaum et al.'s theory departed from other views that regarded beliefs about influence as the single antecedent of the psychological sense of control. A radical shift in the study and definitions of perceived control accompanied the recognition that the sense of control can exist *both* when influence *is* and *is not* possible. Moreover, this acknowledgment that secondary control beliefs can act as antecedents to the sense of control

facilitated our understanding of how people face challenge. For example, this helps to explain what we refer to as the *control paradox*: even when exposed to a barrage of objectively uncontrollable outcomes in which influence is not possible, older adults paradoxically retain a psychological sense of control.

As implied in Figure 1, the role of these antecedents on the sense of control may be *moderated* by other factors. For example, secondary control beliefs might be more strongly linked to a sense of control for women than men. This linkage might also be stronger in later life, relative to earlier points in the lifespan. Although we know of no studies that have directly examined the potential moderating role of these antecedents on the sense of control, studies have examined the moderating effects of these antecedents (e.g., control beliefs) on more distal outcomes, as suggested in the next section on consequence of control.

Consequences of Control

Figure 1 depicts a model in which beliefs about influence are *antecedents* to the *overall sense of control* (Path A) that, in turn, has *consequences* on outcomes (Path B). Because research on the consequences of gaining, maintaining, and losing control have relied on classic control conceptions (e.g., internal locus of control, mastery, and self-efficacy), we restrict our review of these studies. Overall, the findings that examine the classical conception of perceived control are overwhelmingly consistent with regard to both the *beneficial* consequences of gaining and maintaining control, as well as the *detrimental* consequences of uncontrollability.

These effects have been replicated across many contexts. However, due to space limitations, we present only selected findings in two dominant contexts: *achievement* and *health and aging* (Figure 1, Path B). Embedded in this review are also examples of conditions under which the effects of perceived control (or perceived primary control) are qualified (*moderators*) and of the mechanisms (*mediators*) that may explain the effects.

Consequences for Goal Attainment in an Achievement Context

Generally speaking, the more one believes he/she can influence outcomes (i.e., the stronger the perceived control), the more motivated he/she will be to engage in goal-directed behavior, making goal attainment more likely. This applies to a broad array of human endeavors where goals are pursued, from dating (social settings) to goal performance (athletic and achievement settings). A well-developed body of literature on the consequences of perceived control (influence) for goal attainment exists in settings that consider academic achievement.

This relationship between perceived control and achievement is intuitive to the extent that beliefs about being able to influence outcomes will promote proactive academic behaviors such as studying, attending class, and taking notes that, in turn, positively affect achievement. Indeed, research shows that classical measures of perceived control are correlated with higher grades, greater persistence, and more adaptive learning strategies, including critical thinking and elaboration. The consequences of this notion of perceived control are also indirectly implicated through the application of remedial, control-enhancing interventions.

Attributional retraining (AR) was introduced as a remedial, cognitive treatment intervention designed to restructure individuals' explanations about the causes of negative outcomes by replacing certain uncontrollable attributions that are maladaptive and self-defeating with more controllable, adaptive, attributions. For example, in an academic achievement setting, individuals are encouraged to take personal responsibility for failure by attributing performance to controllable factors such as effort or strategy that involve influence. At the same time, students are discouraged from making uncontrollable attributions for failure, such as low ability or bad luck. Thus, dysfunctional attributions are replaced with attributions that are more adaptive and self-enhancing.

AR research in elementary schools confirms that persistence is enhanced by teaching children to attribute academic outcomes to controllable causes, such as effort rather than to uncontrollable causes, such as ability level. AR interventions are also effective in secondary school students. For example, adolescent girls who were encouraged to attribute achievement to their own level of effort reported greater perceived control, improved self-concept, and better performance in traditionally male-dominated subject areas such as chemistry and physics.

Research by Haynes, Perry, Supnisky and Daniels demonstrates positive AR effects with young adults in competitive achievement settings. Positive effects are shown on cognitions, motivation, behavior, and performance (see review by Haynes). College students who received AR reported stronger perceived control (influence) as assessed by Perry's classic measure of perceived academic control; they engaged in more critical thinking; they were less likely to withdraw from courses; and they outperformed their no-AR counterparts in terms of homework assignments, final grades in Introductory Psychology, first-year grade point averages, and overall cumulative grade point averages. Students who received AR attained cumulative grades that were over a full letter grade higher than students who did not receive AR! The assumption in this research is that by fostering adaptive attributions students can come to believe they have influence over outcomes, ultimately improving their achievement.

Consequences for Health in an Aging Context

Early animal experiments that manipulated objective influence provided insight into the health consequences of the classic notion of perceived control. Negative health-related physical changes were systematically documented in experiments that exposed animals to R-O noncontingency that produce uncontrollable environments. R-O noncontingency resulted in various deficiencies, such as suppression of tumor rejection, increases in tumor growth, gastric ulceration, unhealthy autonomic reactivity, and increased catecholamine levels. Some of these effects were replicated with humans who were exposed to uncontrollable stimuli. They experienced increases in blood pressure and magnitude of skin conductance responses; impairments in cellular components of immune function; and increases in stress-related hormones. Catecholamine levels were elevated and the ability of helper cells to mobilize effective responses was suppressed.

Consistent findings were produced from human studies that involve large-scale, longitudinal field studies employing descriptive survey designs and epidemiological approaches.

The findings fully support the conclusion that classic measures of perceived control (e.g., mastery, self-efficacy) have protective consequences for subsequent health in general as well as for health outcomes in the context of specific diseases, such as cardiovascular disease and arthritis. The positive consequences appear to extend to outcomes in the context of disease etiology, course of illness, management of symptoms, recovery from surgery, and adaptation to medical procedures as well as to psychological well-being. It has been shown, for example, that believing one has control is associated with life satisfaction, morale, self-esteem, psychological adjustment, quality of life, happiness, and positive emotional profiles more generally. Moreover, the debilitating effects of uncontrollability have been documented in terms of negative emotions, ruminative thought, anxiety, depression, distress, boredom, and stress.

Much of the research on the health consequences of perceived control has examined older adults, in part, because health problems are common in later life. It is typical for older adults to simultaneously struggle with multiple chronic health problems such as cancer, arthritis, and diabetes, providing a unique opportunity to assess the effects of perceived control when health is compromised. That perceived control is a critical personal resource in later life underscores the strategic importance of its relevance in gerontology. This is further implied in that perceived control is characterized as a 'cornerstone' of successful aging.

Langer and Rodin conducted one of the pioneering intervention studies that manipulated objective control by encouraging institutionalized seniors to care for a potted plant and to take responsibility (exert influence) for the scheduling of daily events. The study showed that health was better for older adults who received (vs. did not receive) the intervention, presumably due to their enhanced perceived control. Perceived control was even shown to be associated with longevity: those receiving the control-enhancing intervention had a greater likelihood of surviving at 18 months follow up than those who had not received the intervention.

Although Langer and Rodin's conclusions were limited by sample size, Chipperfield's subsequent analyses of a large, representative sample of community-dwelling adults (age 65–111) replicated the link between perceived control and longevity. Compared to those adults who perceived they had influence/control over managing their health care, those who perceived little control had an increased odds of mortality 12 years later. Krause and Shaw also replicated this effect when examining older adults' beliefs about influence over important roles such as spouse, grandparent, and friend. Interestingly, they showed that a lack of control predicted mortality, but *only* with regard to perceived control over the role deemed as most important by the participant. This finding implies that the consequences of perceived control on health-related outcomes are qualified or *moderated* by other factors, as depicted in [Figure 1](#).

Two conclusions have emerged from studies that have examined what *moderates* the consequences of control on outcomes. First, the findings from a set of studies by Chipperfield and colleagues indicate that the salutary effects of believing one can influence health are restricted to those who are most compromised. Although perceived inability to manage health care (perceived uncontrollability) predicted 12-year mortality,

this was *only* true among individuals whose health was initially comprised. In another study of older adults with arthritis, being lower on internal locus of control was associated with more frequent hospitalizations, but *only* for those adults who were highly restricted by their arthritis. A final study suggested that the relationship between perceived control and health was limited *only* to those with functional impairment. Moreover, this relationship was shown to be further moderated by age: it appeared *only* among the very oldest individuals. Taken together then, these findings suggest that the consequences of controllability are most evident when this protective resource is most needed.

Second, a few studies lead to an opposing conclusion: that there may be conditions under which perceived control is detrimental. This might happen, for example, if perceived control is enhanced but subsequently eroded, as suggested in an early study by Schulz and colleagues who allowed participants influence over scheduling social visits and then withdrew this. Potential detrimental effects might also arise when an 'exaggerated' perception of control (influence) is at odds with reality. In such a case, the unrealistic perception of control fosters proactive approaches that doom one to fail. That exaggerated perceptions of control can lead to repeated failure might explain why increasing levels of perceived control among adults with severe pain was found to be associated with deficits in daily mood. Perhaps it is dysfunctional to hold false beliefs that one can influence pain when this is not possible.

Although a handful of studies have documented conditions under which perceived control might be detrimental to health, it is overwhelmingly shown to predict a broad range of positive health-related outcomes in older adults, from better global self-reported health and fewer chronic conditions to objective measures of fewer physician visits and hospitalizations. Thus, the robust finding and the clear conclusion from this body of work is that perceived control is beneficial for health. The financial implications of this relationship are illustrated by Chipperfield's research on older adults with arthritis-related restrictions. Those adults with low perceived control were hospitalized more frequently than their high-control counterparts, and the estimated costs for their hospital stays were *double*!

In addition to examining moderators of perceived control, researchers have asked what *mechanisms* might explain the consistent effect of these classic measures of perceived control on the quality and quantity of life. In technical terms, this is a question of what *mediates* the relationship between perceived control and health outcomes (Figure 1). As previously described, physiological factors such as hormones and immune functioning have been proposed as potential mechanisms to explain why perceived (primary) control so consistently predicts health, well-being, and survival. Other possible mediators are emotions, for example, perceiving little control can lead to emotions like hopelessness and boredom.

Still other potential mediators are motivational/behavioral factors, such as health behaviors. Animal studies showed that inescapable shock in animals produced sickness behaviors including decreased intake of food/water and reduced physical activity. The underlying premise in theories such as the *Health Belief Model* is that perceived uncontrollability (perceived lack of influence) produces behavioral apathy and/or that perceived controllability promotes proactive behaviors that,

in turn, foster health. The viability of this premise is illustrated by findings in which individuals who believe they are responsible for their own health outcomes are more likely than their counterparts to seek out health information and engage in adaptive health behaviors (regular check-ups, taking prescribed medications, etc.).

Complexities, Controversies, and Challenges

The research on perceived control has been complicated by definitional and operational confusion and theoretical controversies. Opposing theoretical views of the meaning, role, and definitions of secondary control have added further complexity. The field will have much to gain if researchers embrace a challenge to resolve some of labeling confusion and remain receptive to the merits of various theoretical positions.

Conceptual and Operational Challenges in Studying Perceived Control

As the field evolved, confusion arose due to the linguistic tendency to use the words *control* and *influence* interchangeably. Some researchers have continued to use the perceived control label interchangeably with beliefs about influence; some use it to refer to the psychological state that is determined by beliefs about influence; and others use it in its the broadest way to describe a psychological state that can be achieved both when influence *is* and *is not* possible. This signals the need for researchers to clearly articulate their meaning of the label *perceived control*.

Instead, researchers could consider the potential value of adopting a separate label to depict the overall psychological state of control. *Sense of control* seems a suitable descriptor in that it avoids the implication that the psychological state is simply about influence. However, because the sense of control label has also been used interchangeably with perceived control, researchers would again need to clearly articulate their conceptual meaning of the label.

Of course, many other alternative labels could be introduced. Any attempts to do so, however, should seek a label that is broad enough in scope to depict both primary and secondary sources from which the psychological state of control originates. The approach in this chapter provides an example of the use of separate labels to capture the psychological state that can arise from proactive beliefs and behaviors involving influence (*perceived primary control*) and from the complementary beliefs and behaviors that do not involve influence (*perceived secondary control*).

These conceptual and labeling complexities are accompanied by measurement challenges. To the extent that there is an overall psychological state of control that we call sense of control, how can it be assessed? One possibility is to simply ask about the degree to which individuals feel 'in control' or 'out of control.' This would potentially capture a sense of control that is derived both when one believes he/she *can* and *cannot* influence outcomes. New operational definitions of this broad state of control should avoid measures that capture only perceived primary control since this would underestimate the role of secondary control beliefs that operate when influence is not possible.

Conceptual and Theoretical Issues in Studying Secondary Control

The secondary control concept, as originally proposed by the *two-process model of control*, has more recently been featured in the *lifespan theory of control (LTC)*. By conceiving secondary control in terms of strategies, the LTC has bought about a shift in emphasis to control *striving*. Researchers from this perspective typically see no need to study a psychological state of control because the function of secondary control striving is *not* to facilitate a psychological sense of control, but rather to protect self-esteem and to promote the motivation for primary control striving.

The introduction of the LTC has resulted in perceived control losing its prominence in control theory. The field has since become divided into proponents of the *two-process model of control* or the *LTC*. However, Morling and Evered recently provide an analysis that may undo the theoretical schism. They contrast *control-focused secondary control* that promotes the potential for control striving and is consistent with Heckhausen and Schulz's theory with *fit-focused secondary control* that encompasses 'adjustment' and 'acceptance' and is consistent with Rothbaum et al.'s theory that emphasizes how individuals psychologically 'fit into' an objectively uncontrollable environment.

Concluding Comments

Schulz and colleagues point to the positive impact of perceived control; they describe it as representing 'one of the most impressive success stories in the social sciences,' having had 'positive impacts on large numbers of individuals of all ages.' Although the consequences of perceived control have been demonstrated for outcomes in many areas, we limited our analysis to the areas of academic achievement and health and aging. Clearly, the promotion of perceived control (and the associated sense of control) has implications for the intellectual capital of our youth and the health of seniors, both of which society cherishes. This may even have implications for the future financial strains on the health care system that will accompany the demographic shifts in our aging population.

Western cultures as well as others value the persistence and effort that is embodied in mastering our environment. The *little steam engine's* effort and determination to reach the summit was driven by the belief in his (or her) capacity to influence the outcome. Although this profound metaphor for the American dream accurately captures the value we place on primary control striving, it can overshadow the adaptive value of secondary control.

Just as the value of primary control is captured in everyday folk beliefs (e.g., 'the early bird gets the worm'), so too is the value of secondary control (e.g., 'every cloud has a silver

lining'). Likewise, the message in Niebuhr's *Serenity Prayer* to develop 'the courage to change the things I can,' is counterbalanced with the idea of striving for the 'serenity to accept the things I cannot change.' The combined message is that it is not adaptive to *always* and *under all conditions* strive to control (influence) every outcome. Rather, it appears adaptive to know how to accept uncontrollable outcomes and reinterpret them to soften the blow. In other words, despite an ongoing scholarly debate over definitions of secondary control, it is generally agreed that there is wisdom in knowing when to exert primary control and when to shift to secondary control.

See also: Attribution; Motivation; Personality Development and Aging; Self-Efficacy; Stress and Illness.

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Perceptual Development

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Glossary

Constructivism A theoretical approach that posits that individuals construct reality and meaning from prior experiences.

Core principle An innate, genetic, endowment that guides humans in reaching their understanding of new objects or events.

Differentiation The active search for stable features of the environment that exist in a constantly changing world.

Habituation The gradual waning of a response through repetitive stimulation. Dishabituation is a return to the original level of attentive responding.

Maturation The unfolding of biological and genetic influences that impact an individual's development relatively free of experience.

Module Specialized information processing systems that share many characteristics, such as speed, autonomy, and output of perceptual categorical information that can be accessed by consciousness.

Phoneme Individual sounds within a particular language used to form words.

Selective attention The focusing of one's mental efforts toward one aspect of the environment while simultaneously ignoring others.

Recently, an experiment was reported by Yale and Duke University developmental psychologists, simple in design yet profound in its implications. Researchers Cheries, Mitroff, Wynn, and Scholl wanted to know if infant perception was guided by a theoretical principle of object persistence called cohesion, which is that an object must maintain a single bounded contour over time. Two groups of 10–12-month-old infants participated. Infants began the test trial of the experiment on the floor, held by their mothers. Each infant in one group watched an experimenter split a half of a large graham cracker into two pieces, placing them with separate motions into one container, and then place a single small graham cracker into another container. The contents of the containers were not visible to the infant. Another group of infants saw the same event except that the larger cracker was presplit into two. Each infant was verbally encouraged to crawl to the container of their choice to obtain his/her crackers. Twenty out of 26 infants in the No-Split condition, a significant majority, chose the container with the larger quantity of crackers while only 12 of 26 infants in the Split condition did so. The researchers concluded that the cohesion principle operates as a constraint on perceptual processing, powerfully affecting the overt behavior of infants less than a year old. In contrast to object representations encoded during uninterrupted perceptual experiences, object representations encoded during a disrupted act of perceptual knowledge acquisition do not seem to persist over time in an intact form. We will use this experiment to frame and introduce enduring questions and controversies about the nature of human perceptual development.

Constructivist and Ecological Views of Perceptual Knowledge Development

Constructivist Views

With utter ease, the human mind apprehends a version of reality – people, crackers, containers, a stable crawling surface,

and encouraging words – by first registering energy in several separate sense modalities. Energy is transformed many times by the neural structures of the brain into objects and events, forming mental representations and sometimes propelling us to act, especially if there is food to act upon. The constructivist position explains perceptual development as learning to make appropriate inferences about sensory impressions by drawing on previously constructed memories gained through similar experiences. This view of how infants accrue knowledge is rooted in the philosophical tradition of seventeenth to nineteenth century British empiricists whose work formed the foundation of modern information processing psychology. One prominent constructivist was Jean Piaget, who argued that infants' increasingly more accurate perception of objects in a spatial frame of reference was achieved by learning associations between visual, auditory, touch, and muscular sensations, constructing knowledge that he termed 'sensorimotor.' Most current information processing accounts of perception and perceptual development are constructivist due to their emphasis on defining levels of processing and the interactions between them. As an example, Les Cohen and Cara Cashion recently proposed that perceptual development in one domain (event causality) progresses from lower (parts) to higher (holistic) levels, and that infants are biased to begin a single act of event processing at the highest developmental level attained, except when information overload occurs.

Ecological Views

Two crucial philosophical arguments made by the early constructivists, the ambiguity argument and the capability argument, were not seen as valid by the originators of the ecological view of perception, James and Eleanor Gibson. The Gibsons' primary assertion is that perception is 'direct,' meaning, does not require inference. Human visual and auditory systems do not deliver single, static representations to the mind that must be disambiguated through further higher-order

inferential analysis. Instead, because humans move while perceiving and because the eyes and ears gather information from two different vantage points, the transformations over time of the optic and acoustic array are highly specific to arrangements of information in scenes and events. Some proponents of the ecological view claim that certain assumptions, or constraints, have evolved to assist humans in their interpretation of potentially ambiguous events. James Gibson showed that the perception of 3D form could result from neural mechanisms that have evolved specifically for the task of computing optical transformation information using geometry, information that changes over time when either the observer or object is in motion. The principle of cohesion identified in the cracker-retrieval experiment is another example of a perceptual processing constraint that is either inborn or matures within the first year and assists us throughout life.

Perceptual Processing Research in Infancy

Neural and Sensory Competencies

The brain

Considering the fact that more than 50% of the cerebral cortex is devoted to sensory and perceptual processing, the importance of perception to human function and evolution cannot be overstated. Prenatal development is the most critical time to ensure optimal sensory functioning. At 18 weeks gestation, virtually all cortical neurons have been formed and have migrated to their genetically preprogrammed locations. Unlike some mammals, human infants are born with well-functioning sensorineural systems. Differentiation and synapse formation, the process of forming tree-like branches to other neurons, is mostly completed during a period of 'blooming' in 2–6-month-old infants, forming approximately double the number of adult neuronal connections. Between the ages of 1 and 10 years unstimulated dendritic connections are 'pruned,' or eliminated; although, new connections are formed throughout life. Early in infancy myelin sheaths rapidly form around neuronal axons, assisting sensory responses and the coordination of activities across brain regions by vastly increasing the speed of neural impulse conduction. Changes in synaptic efficiency are important in understanding the slow rate of maturation of auditory cortex. The relatively slow neural responses through the brainstem in the auditory pathways affect young infants' absolute thresholds to detect sounds in the 4000–8000 Hz range. Two neuronal systems serve visual processing, cortical pathways, and more primitive subcortical pathways. During the first 2 months of life, infant visual behavior is thought to be controlled primarily by the subcortical pathways.

Visual sensory system

Some aspects of newborn visual sensory processing are fairly well-developed in the newborn infant, such as peripheral acuity. The ability to make oculomotor adjustments is also fairly well developed, allowing the infant to use distance information perceptually. Several aspects of the ocular system are extraordinarily undeveloped in the newborn. For example, cone receptors are spaced 4 times further apart in the neonate fovea, allowing them to catch only 2% of the light. In addition, two types of cones do not mature until 2 months of age and

a third type until 4 months. This affects visual perception because photoreceptors in the retina make it possible for us to see color and to discern patterns and changes in surfaces and orientations of objects. At around 20/400 Snellen units, newborn visual acuity is far worse than adults, but improves to adult levels by the age of 8 months. The ability to detect light intensity variations, or contrast sensitivity, is also not impressive in young infants, but is sufficient to detect coarse boundaries between common objects and spatial layouts within close proximity. Finally, the ability to detect direction of movement and velocity of object motion emerges by the infant's third month of life.

Auditory sensory system

The human fetus responds to sounds by 28 weeks of prenatal development. At birth, the inner ear is mature, but sound conduction through the external and middle ear is inefficient. The ability of newborn infants to detect low frequencies is mature at birth, however, for higher frequencies maturity is not reached until the age of 6 months. At this time, infants can discriminate changes in frequency fairly well at higher frequencies, but frequency discrimination at low frequencies is poorer, with the greatest rate of improvement occurring in early childhood. Adult performance levels in many facets of auditory sensory processing are not reached until late childhood. These limitations may be implicitly understood by adult speakers who may speak more slowly and slightly louder to a young child compared to an adult.

Chemical and vestibular senses

Consistent with a proximal-to-distal developmental trend, infants' tactile and vestibular sensory systems develop somewhat in advance of their more remote-sensing visual and auditory systems. The constellation of senses in the somatosensory system, including receptors located in the skin for touch, pain, and temperature, completes development by the twenty-fourth week of gestation. The full-term newborn infant reacts to common invasive procedures, such as a heel stick for blood sampling, with the same expression recognized as painful in adults. Newborns, although they cannot sense saltiness, are able to discriminate sweet, sour, and bitter tastes. The preference for sweet tastes, over the other taste sensations, is evidenced even prior to birth. Rounding out the newborn infant's toolbox of sensory abilities is a well-developed sense of smell.

Visual Perception

Object perception

Neurophysiological research in the 1960s, and subsequent behavioral research, revealed that forms and patterns are perceived using several layers of analysis, beginning with parallel processing of an object's features along many dimensions such as motion, edge orientation, and luminance. While spatial information about the features is preserved at this point in perceptual processing, objects are not recognized until the features are integrated with attention. Newborns are likely equipped for parallel feature analysis and detection, and they have some 'tools' to organize features for object perception, however, some tools take many months to develop as infants gain more experience in the world.

Recent research demonstrates that young infants can use some, but not all, Gestalt principles of perception to organize visual patterns, so that they know which edges and contours form different objects. In one experiment, researchers Paul Quinn, Ramesh Bhatt, and colleagues used what is called the familiarization/novelty-preference procedure to test 3–4-month-old and 6–7-month-old infants' ability to organize a visual pattern with the principle of form similarity. In the first, or familiarization, part of the experiment, infants were presented with stimuli from the top or the bottom group in **Figure 1** for six 15-s periods. Immediately afterward, infants were shown test stimuli, consisting of both novel and familiar stimuli displayed on two screens, and the percentage of time they looked to the novel organization was calculated. Only the older infants looked reliably longer at the novel organization, which indicates that they had used the principle of form similarity to organize the pattern in the familiarization phase. Previous research had found that even newborn infants can use a different Gestalt grouping principle, lightness similarity, to organize visual patterns.

When an object is seen from one angle, and the object is rotated in the third dimension, the image projected to the retina changes. Does a newborn baby perceive the real shape of the object to have changed? Research shows that newborn infants use a perceptual organization tool called shape constancy, allowing them to perceive the object's real shape despite changes in orientation. Size constancy, the ability to perceive that an object is the same size despite changes in distance, is also present in the first days of life. A newborn participant in a size constancy experiment is shown in **Figure 2**.

Researchers also speculate that another important perceptual organizational tool is innate, the perception of unity of object parts when the some of the parts are occluded and other parts are visibly in motion. Although, full attainment of perceptual unity from common motion depends on the rapidly maturing visual sensory abilities of detecting velocity and direction of motion of object parts. This 'edge-insensitive' tool would assist an infant to correctly perceive, for example, that the top and bottom ends of a rake moving behind a narrow tree belong to the same object. In contrast, 'edge-sensitive' perceptual processing emerges much later, after

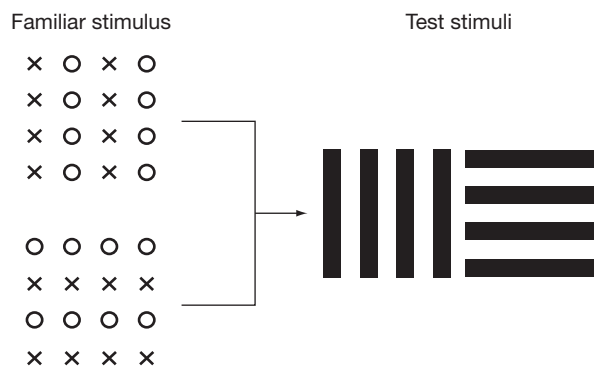


Figure 1 Example stimuli used in testing infants' ability to group according to the similarity principle. Reproduced from Quinn PC, Bhatt RS, Brush D, Grimes A, and Sharpnack H (2002) Development of form similarity as a Gestalt Grouping Principle in infancy. *Psychological Science* 13: 320–328, with permission from Blackwell Publishing.

6 months of development. If the partially occluded objects do not move behind the occluder, the information available to the infant is insufficient for determining the form of an object – if the rake does not move and it is the 5-month-old infant's first time ever seeing this object, she/he might infer that there are two objects behind the tree instead of one object with connected parts.

Space perception

Infants crawling over to their chosen container to reach the crackers were performing complex perceptual and motor activities. Prior to the onset of crawling, infants are processing kinematic, or motion-carried information about objects and paths in a spatial layout based primarily upon information gained through object motion or head movements from a stationery position. Evidence is consistent with the claim that very young infants are capable of interpreting motion cues of objects, however, they may not use as many of these cues during perceptual processing as an adult would. Once they can self-locomote, the nature of spatial perception changes considerably, because perceptual processing must include both object-motion and observer-motion cues in order to be accurate.

When looking while reaching inside the container to retrieve the crackers, a 10-month-old infant uses two types of visual depth perception cues, stereoscopic and pictorial. Stereoscopic perception is the ability to mentally compute the angular difference between two pieces of information registered by two spatially-separated retinas from eyes aimed at the same point on an object. This perceptual milestone is rapidly and fully achieved at the age of 4 months, probably due to maturation, specifically, the development of cell assemblies in layer 4 of visual cortex. Infants' ability to perceive most pictorial cues to depth (familiar size, interposition, texture gradients, linear perspective) arises at the same time, at age 6–7 months. The simultaneous appearance of a group of pictorial depth perception abilities also occurs in macaque monkeys, leading some investigators to conclude that these perceptual abilities have ancient phylogenetic roots. Yet, a structuralist perspective on pictorial depth perception is also implicated in explaining perceptual achievements by learning,



Figure 2 Display of example research paradigm used in assessing infants' ability to process objects according to the size constancy principle. Reproduced with permission from Slater A (2001) Visual perception. In: Bremner G and Fogel A (eds.) *Blackwell Handbook of Infant Development*. Malden, MA: Blackwell.

for example, to compute the depth between familiarly-sized people and objects on a television screen.

Face perception

One aspect of infant perceptual processing has inspired more curiosity and controversy than any other – face processing. Early research found that newborn infants visually track a moving face pattern farther than a pattern with scrambled face features, they show greater sucking responses and visual preferences for their mothers' faces over strangers' faces, and surprisingly, will look longer at attractive faces than unattractive faces (as judged by adults) within 6 days of birth. On what basis are brand new babies making facial discriminations? In the 1990s there was wide consensus that the newborn infant's preference to look toward human faces was guided by an innately-given module for processing structural facial information, enabling rather sophisticated face processing during the very first exposures to human caregivers. However, more recent research has been able to clarify the nature of this early mechanism, which seems to be subcortical, and therefore, cannot be construed as an innate cortical processing module. Moreover, as with everything else seen in the first 2 months of life, face perception is also affected by infants' developing visual acuity and contrast sensitivity abilities.

Face processing improves very rapidly in the first months of life, when infants are gaining exposure to particular types of faces within their environment. Several interesting findings have recently emerged related to early visual face processing experience. For example, patients with congenital cataracts whose visual input to the right hemisphere was restricted during the first months had more difficulty with face processing once the cataracts were removed later in life than did patients with input restriction to the left hemisphere, showing hemispheric asymmetry in face processing that begins with infants' earliest experiences. Controversy exists as to the specific localization of face processing in the brain of infants older than 3 months. Proposals are that it is located within the right hemisphere, the fusiform gyrus, or alternatively, within primary visual cortex.

Infants generally see a lot of people in their first few months of life, including themselves. Beginning around 2 months, parents report that they place their infants in front of mirrors, allowing their infants the opportunity to encode a representation of themselves. Indeed, research has shown that even 3-month-old infants can distinguish their own face from the face of another infant. Gender biases in face processing have also been found in 3-month-old infants, with infants preferring to look at female faces when those faces appear alongside male faces – however, the opposite effect is obtained in infants whose primary caregiver is a male. The 'other race effect,' which is the ability to discriminate and recognize faces from one's own race, but not another, has been observed even in young infants. Yet, if infants are raised in one racial environment and adopted into another during early childhood, they find it easier to discriminate faces from their adoptive culture when they are adults. This research finding exemplifies the malleability of the perceptual processing system.

Early experience nudges the perceptual system to begin a path of development that will eventually include the attainment of expert levels of human face processing. At an early step

along this path, 6-month-olds, 9-month-olds, and adults display an equal precocity at discriminating two human faces; however, 6-month-old infants are actually better than adults at discriminating two monkey faces. This remarkable early ability that is apparent only in 6-month-old infants but lost within 3 months, is the very same developmental pattern seen in speech perception research on phoneme discrimination. And yet, if infants view a great number of monkey faces between 6 and 9 months, they retain their ability to discriminate faces from the specific species they viewed. Parallel research findings on face and nonnative language exposure during this early 'sensitive' period leads to the hypothesis these vastly different perceptual systems share common mechanisms that tune us to frequently occurring categories of perceptual stimuli presented within our unique environments.

An adult can accomplish far more with their face processing system than can an infant, however. One necessary, but not sufficient, marker of expertise in face processing is argued to be the ability to encode faces on the basis of second-order relational properties. Faces have a common configuration that includes each eye, the nose, and the mouth, but individual faces vary in terms of the specific spatial relationships between features. Research conducted by Laura Thompson investigated whether or not 7–8-month-old infants attend to these second-order relational properties of female faces. Infants were shown black-and-white photographs such as those appearing in Figure 3. On every trial, a nonmodified face was shown on one computer screen, and a modified face was shown on the other. Modified faces were created using software that spliced



Figure 3 Photographs of females used as stimuli in the experiment. The two photos on the left are nonmodified. The face on the upper right was shortened, and the face on the lower right was lengthened. Reproduced from Thompson LA, Madrid V, Westbrook S, and Johnston V (2001) Infants attend to second-order relational properties of faces. *Psychonomic Bulletin & Review* 8: 769–777, with permission from Psychonomic Society.

out or added very small horizontal segments to the lower regions of the face, resulting in faces that were structurally different from the original. Infants looked reliably longer at the nonmodified faces. The results show that infants form a prototype of a face type (young adult female) in memory by attending to the spatial relationships among facial features, and that they compare new instances of female face to their stored prototype.

Of course, one of the reasons infants find human faces so fascinating to look at is because they convey facial emotional expressions which are instrumental to human communication and language learning. Research reveals that 5–7-month-old infants are able to discriminate the basic human emotional expressions of fear, anger, surprise, and happiness. More impressive is their ability to categorize these expressions, so that when one person expresses a particular emotion, the same expression on a different person's face is seen by the infant as belonging to the same emotional category. One cautionary note must be made, however, before assuming that faces always captivate infants' attention. Recent findings reveal that 5–7-month-old infants, when viewing persons engaged in repetitive activities such as brushing their teeth or hair, preferentially attend to their actions, and not to their faces.

Auditory Perception

Language perception

In order to respond to the verbal encouragement of crawling to one of the two containers of crackers, infants must perceive these auditory sounds as components of language. In addition to processing information commonly associated with all types of sound such as frequency, intensity, and the temporal pace of the frequency and intensity, language also needs to be parsed out from background noise, broken down into a series of varying linguistic components, and eventually processed as meaningful instruction. Whereas some aspects of early language perception might reside in innate tendencies seen in neonates, such as the preference for animal vocalizations over artificial sounds, later tendencies, such as the preference of human vocalizations over rhesus-monkey vocalizations seen at 3-months old, may originate from experience.

One of the most basic and researched components of language perception involves the infants' ability to discriminate between fundamental sounds, phonemes, present in the infant's native language. Although infants are initially sensitive to all phonemes used in all languages, this sensitivity changes as the infant gets older. Researchers including Janet Werker and colleagues, through a series of studies over the past few decades, have mapped out the seemingly counterintuitive development of phoneme sensitivity. While infants 4–6 months of age are able to discriminate between pairs of distinct phonemes in both their native language and between pairs of distinct phonemes not in their native language, the nonnative discrimination ability drops off rapidly from ages 10 to 12 months of age. In comparison, adults have difficulty identifying sounds not common in their native language, and only with significant training can they pick up this ability.

This developmental trend in phoneme detection may seem paradoxical because as the infant nears closer to the age of language production, the sensitivity to some phonemes tends

to drop. However, while this sensitivity to nonnative language sounds decreases, sensitivity to native language sounds continues to increase. At 14 months of age, infants begin to discriminate between similar sounding familiar words, such as *ball* and *doll*, when associated with a picture of each as well as with similar sounding unfamiliar words, such as *bin* and *din* when associated with a picture of an object supposedly representative of the word. The refinement of this ability to separate similar sounds into categorical classes suggests that infant perception of language helps lay the groundwork for subsequent word learning and language production.

Music perception

Music perception parallels language perception in many ways, such as needing to follow a set of identifiable rules to convey auditory information. Often the identifiable distinction between the two is that music does not include the semantic meanings associated with the sound as language does. However, this distinction tends to become blurred when considering motherese, or child-directed speech, which often includes fluctuations in pitch and an expanded range as well as a rhythmic regularity. Sandra Trehub and colleagues recorded mothers' speech to their child on two separate occasions and found that mothers tended to use and repeat very distinct tunes (i.e., particular interval sequences) in their communication that were unique to their individual dyad. Much like infant language perception, Trehub also found that at the age of 6 months, infant's sensitivity to a foreign musical rhythm was greater than 1-year-old infants. Furthermore, the 1-year-old infants became somewhat more sensitive to the foreign rhythm after exposure, while exposure did not affect the adults participants' perception ability.

Multimodal and Amodal Perception

Thus far in the short history of the research on perceptual development, investigators have focused on understanding the development of abilities involving a single sense modality. Yet, most events and the people in them are perceived using more than one sense modality, in other words, humans use multimodal information in everyday perception. A human speaker conveys the intended meaning of an utterance along multiple modalities, making available to infants all kinds of information including auditory speech, the emotional tone of speech, facial expressions of emotion, visible lip movements, gestures, and more – but what can infants do with all of this information? A lot.

To start with, infants exhibit the ability for matching sensory information across modalities, seeming to perceive that the properties specified to separate sensory systems nevertheless belong to the same object or event. For example, at 1 month, infants will choose to gaze at the nubby pacifier on the screen in front of them instead of the smooth one if they previously sucked on the nubby one. They can detect the synchrony of voice and mouth movements (visible speech) by the age of 2 months. At 4 months of age, infants are able to match vowel sounds and visible speech on the basis of the spectral information available in auditory sensory input. By 6 months, infants can match faces and voices on the basis of emotional expression, gender, and age of speaker. Intersensory matches of faces and voices are even

made in early infancy for emotional expressions of other species, including macaque, monkeys, and dogs, which may cause one to speculate, 'What will Mother Nature think of next?'

With regard to multimodal perceptual processing, there truly is a lot more information than meets the eyes and ears. James Gibson argued that the sensory modalities were in fact part of one large perceptual system, whose separate components were working together to pick up information that the sensory modalities had in common. Amodal information is that which overlaps across modalities such as timing, intensity, rate, space. For example, watching and listening while someone beats on a drum, the infant encodes overlapping visual and acoustic information that specifies the rate and rhythm of the drumbeats. In addition to human infant studies, many animal studies have shown that temporal amodal information such as synchrony, rhythm, and tempo is attended to and veridically processed.

The common methodological paradigm for testing infant amodal perceptual processing is the habituation paradigm. Infants sit in front of a computer monitor, and watch and listen to the stimuli presented on the screen. An experimenter watches the baby from directly behind the monitor, measuring time spent looking at the screen before turning away. Infants are presented with the same stimulation on every trial, until their looking time reaches a criterion, usually 50% of the amount of initial looking time. Then, the stimulation is changed so that a new aspect to the multimodal event occurs. After the change, if the infant's looking time increases significantly above the habituated level, they are said to have become 'dishabituated,' and researchers can draw conclusions about the type of information infants were able to perceive as they were becoming habituated to the stimulation. For example, 3-month-old infants can discriminate a change in the tempo of a toy hammer tapping when both video and sound convey the tempo. However, when infants are habituated to the tapping sound without visual cues, or the sight of the hammer tapping without sound, they do not dishabituate when the tempo is changed. As infants get older, they have the capability of encoding amodal properties of events with just one modality of information. With just the sound of the crackers hitting the bottom of the container, the 10–12-month-old infants in the 'No-Split' condition had enough perceptual information to count the crackers.

Perceptual Development Beyond Infancy

Although understandably the majority of research in child perception focuses on identifying abilities in infants under the age of 15 months, findings in children above 15 months of age can also yield important contributions.

Holistic-to-Analytic Shift

Prior to the tidal wave of infancy research, in the 1970s and 1980s, researchers began to address the question, how does perception develop in childhood? Comparisons were made between young and older children and adults, on their responses to the question, 'Which two go together best?' in various perceptual classification tasks. If, for example, a small

grey square, a slightly larger and slightly greyer square, and a large grey square are presented, a majority of 4-year-olds' responses would be that the two smallish, grayish squares belong together; however, a majority of 10-year-olds' responses would be that the small and large squares that were exactly the same color belonged together, and the same thing would happen when exact values on size are presented. The young child's response pattern with these stimuli was notably the same as adult responses with compounds varying on the perceptually integral dimensions of saturation and brightness, implying that the two dimensions form a single perceptual whole. Thus, the original conclusion was drawn that young children's perceptions of adult-separable dimensions are holistic, or 'integral-like,' and that perception shifted to an analytic mode later in childhood. However, in 1994, Laura Thompson reported experiments in which models of different strategies were compared to individual children's response patterns, and, while the holistic-to-analytic shift hypothesis was found to characterize group-averaged data across development, it was not found to be true of individual modes of responding. Consequently, she argued that the holistic-to-analytic shift claim was false.

If a 4-year-old child was encouraged to crawl in the cracker munch experiment, she might just furrow her brow, point to the container with more crackers, and ask you to please bring it over. Underlying the plausibility of this scenario is the notion that perceptual development is fairly complete by 4 years; so, without a fundamental shift in children's way of perceptually categorizing stimuli, is there any development in childhood significant enough to mention? Many researchers would say yes. For instance, throughout childhood, children develop a better ability to discriminate featural differences along dimensions that are perceptually separable. The differential-sensitivity account offered by Greg Cook and Richard Odom posits that each child differs with respect to how stimulus dimensions, such as color, shape, size, are organized in terms of their salience. For one child, color might be very salient but to another child, similarities and differences among objects' colors are initially not noticed, rather, their shapes might be. Increased perceptual experience facilitates detection of relations between less salient dimensions, raising them up in the salience hierarchy. Research by Thompson and others supports the differential-sensitivity account, and extends it by showing that perceptually salient dimensions are processed more accurately and more quickly than less salient dimensions at an early level of stimulus processing.

Recent Findings

In infancy, the relationship between motor development and visual perception develops as the infant becomes increasingly mobile through crawling and walking. The infant needs to accurately perceive the surrounding environment in order to identify which motor skills to put into use. For example, an infant in the beginning stages of learning to walk who sees a desired toy on the other side of the living room may choose to crawl to the toy rather than walk, as crawling, at the time, may still be a quicker and more efficient mode of travel to the toy. Jodie Plumert and colleagues at the University of Iowa have

been assessing perceptual-motor development issues such as this in older children (ages 10 and 12 years) and adults. However, unlike our example of a child moving toward a static object, these researchers evaluated how children and adults would move in response to other moving objects in their surroundings. Namely, participants in their study made decisions as to when to cross intersections on a bicycle in a simulated environment. In this simulated bicycle environment, simulated cars would pass on the road in front of the participants at different rates of speed with different spacing gaps between the vehicles. The children, especially the 10-year-olds, compared to the adults, often ended up with less time to spare. This difference is attributable to their mismatch of how they perceive their abilities relative to the environment.

Questions and Controversies Concerning Perceptual Knowledge Development

What Perceptual and Attentional Processes Acquire and Maintain Perceptual Knowledge?

Modular systems

In 1983, philosopher Jerry Fodor introduced a provocative theory about the nature of the mind. His main premise was that human mental architecture consisted of a three-layer functional system, beginning with a set of sensory transducers. The next layer is a set of computational-input systems, or modules, whose outputs are fed to computationally autonomous central resources for further processing. The domain-specific modules perform their computations only on specific types of input such as phonetic codes, and their operations are not under volitional control. Processing in the modules is extremely fast and ‘informationally encapsulated,’ because processing must be completed within a single module before incorporating the outputs from other modules. The modules have ‘shallow’ outputs to the central system, which are at the level of basic perceptual categories. Further, the modules are associated with fixed neural architecture, and exhibit specific breakdown patterns that are unlikely to influence the operations of the other modules. Finally, the pace and sequencing of computations performed by modules suggests that their ontogenetic development is innately specified. Fodor suggested plausible candidates for modular systems, including a spoken language grammar parser and mechanisms for detecting melodic and rhythmic structure in audition, and in vision, shape analysis, color perception, 3D spatial analysis, visual-motion guidance, and face recognition. The notion of a modular mental architecture is one that has received much empirical support in the field of developmental science. Criticisms of this proposal include the relative lack of specificity of higher-level cognitive activities, and the nativist assumptions, promoting researchers to hypothesize that at least some modular operations are acquired through learning.

Intersensory redundancy hypothesis

In 2000, Lorraine Bahrack and Robert Lickliter proposed a developmental account of attention and perceptual processing in infancy. They argued that the foundation for what is perceived and learned is selective attention. Consequently,

in order to achieve the richest understanding of perceptual development, developmental research should be focused on understanding what guides the development of selective attention. Their account, termed the intersensory redundancy hypothesis, explains how temporally synchronous and spatially coordinated information, presented across separate modalities, provides redundant intersensory information which promotes the detection of amodal information in multimodal events. During early infancy, the amodal stimulus properties that are detected are more salient and selectively attended to, and these properties are processed sooner than are the unimodal stimulus properties. When only unimodal information is available for processing, selective attention is used to encode modality-specific properties, such as the color of the drumstick beating the drum. When there is no competition from intersensory redundancy of amodal properties of events, the unimodal properties are salient to infants, and modality-specific properties are likely to be explored rather than amodal properties. With perceptual development, infants become more facile in the ability to use selective attention in detecting amodal properties in both unimodal and multimodal situations.

Two functionally dissociable perceptual systems

The image of a baby crawling over to a container illustrates a fundamental reality about the development of perception, namely, that it is inextricably linked to the development of action. In 1979, James Gibson wrote, “We must perceive in order to move, but we must also move in order to perceive” (p. 223). But how should we construe the nature of the interdependence between a perceptual system for seeing ‘what’ crackers are inside a container and a perceptual system for telling us ‘how’ to get over to the container? Bennett Bertenthal argues that there are two functionally dissociable perceptual systems, one for perceptual control and the other for object recognition. These systems are very different from each other in terms of their processes, but necessarily interlinked. Object recognition uses processes that connect presently encoded information to previously stored representations, while the action system is directed toward monitoring the present and looking forward into the near future. Object perception involves an allocentric coordinate system while perceptual action involves an egocentric reference system. Object representations are stored in modality-specific form, while the action system uses an amodal format using sensory input translated into muscle action, or body-scaled, information. Lastly, object recognition operates with selective attention so that perceivers know when they have perceived the sought after information, while self-motion and action usually occur without awareness. There is mounting evidence that both systems operate in coordinated fashion from the first moments of life, while they both also undergo considerable refinement through experience.

What Is the Best Way to Describe How Perception Develops?

Core principles, differentiation, enrichment, selective attention

Researchers sharing the core-principles viewpoint of perceptual development, such as those who conducted the cracker-splitting experiment, do not focus on the rapid improvement

of perceptual skill exhibited by humans in their first year. Rather, one might say that the core principles account is focused on the end result of an extraordinary amount of evolutionary adaptive change leading up to the innate endowments of modern-day infants.

If one needed to explain how perception develops in childhood with just a few apt words, perhaps the first words out of the mouth of a researcher sharing the ecological perception viewpoint would be 'differentiation, enrichment,' and the next words, 'selective attention.' For the last edition of the *Encyclopedia of Human Behavior* we wrote: "According to the ecological perceptionists, human perception is guided by a search for order and invariance in a highly fluctuating environment. It is a lifelong nonexistential search for meaning." The first sentence of the quote refers to the process differentiation, and the second sentence, to enrichment. When meaning is attached to stimulus variables through the processes of experiential learning, and this ability to form meaning cannot be explained with a maturational account, enrichment is thought to occur.

Since our sensory systems hand over far more information than our perceptual systems can work with at any given moment, the search is a necessity of life, and infants are born knowing something about how to do it. But, to differentiate well, the search must be conducted quickly, and with precision, as infants become attuned to the relevant perceptual features holding significance for them – and that is what happens with maturation and experience with the development of the brain, the sensory systems, the attention system, and the memory systems. Researchers holding the constructivist view may not resonate to the concept of differentiation and enrichment to the extent that ecological perceptionists do, but they share with them a focus on how more general cognitive functions such as working memory, selective attention, and categorization processes assist young humans in accurately perceiving their world.

Dynamical systems view

The typical characterization of the important questions developmental psychologists must address is a set of dichotomous poles of possibilities, including whether an ability is innately endowed or learned, and whether the path of development is continuous or discontinuous. The dynamical systems approach views this characterization as far too simplistic. New forms of knowledge, including perceptual meanings, can be explained by the processes of self-organization, in the same way that all biological systems are organized. There is a complex system of layers of influence on perceptual learning, from the lowest molecular levels, to the cultural level, all continuously interacting in a process that unfolds over time and never stops changing. Novel meanings are discovered, not because there are explicit instructions in the human genetic code, or because a baby has discovered a regular pattern and associated it with something else in memory, but because new patterns of behavior emerge from older patterns in continuous

small moments of time. The system of behavior will often settle into some preferred way of seeing, or acting, and then, with the right combination of change in other parts of the system, will move out of that preferred mode, and the infant will appear to have learned something. Each person's unique constellation of interacting layers of experience and physiological makeup provides a lifelong stage for perceptual learning and growth to take place.

See also: [Ecological Psychology](#).

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- <http://infantstudies.psych.ubc.ca/> – Infant Studies Centre at the University of British Columbia (Janet Werker).
- <http://www.wjh.harvard.edu/~lds/> – Laboratory for Developmental Studies at Harvard University (Elizabeth Spelke).
- <http://www.yale.edu/infantlab/Welcome.html> – The Infant Cognition Center at Yale University (Karen Wynn).

Personal Relationships in Everyday Life

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Glossary

Attachment The style of approach to relationships that is possibly learned in infancy and which might then affect later adult relationships.

Provisions of relationships The resources that are provided by a relationship in terms of psychological and communicative benefits derived from it.

The Study of Personal Relationships

Personal Relationships, or for some, the ‘science of relationships,’ is an area of study that has grown in the last 20 years from the seeds first planted in the 1950s by Theodore Newcomb’s attempts to predict interpersonal attraction in a group of students living in a college housing facility. It grew from Tony Smith’s clever method of determining the direction of causality in the liking–similarity correlation (using attitude scales ‘filled out by another student’ [who was actually bogus: the forms were filled out by the experimenter]), which finally enabled researchers to discover the causal effects of specific levels of similarity on the dependent variable of attraction. From these and other inventive approaches sprang considerable subsequent attention by psychologists to the experimental manipulation of the degree of liking or attraction felt toward another person by a particular subject, in particular the monumental work by Donn Byrne.

Ellen Berscheid and Elaine Hatfield published, first in 1969 and then again in 1978, two landmark surveys, which are generally recognized as the beginning of the consolidated recognition of the field of study of interpersonal relationships. However, such researchers, mostly social psychologists, treated attraction as essentially an individual attitudinal response to a target person. Despite this one-sided view of the initiation of complex relationships, such research did not overlook cultural factors (e.g., some cultures find slimness attractive while others find plumpness attractive) or the fact that initial attraction did not straightforwardly predict long-term success of relationships. In recent years, work on initial attraction, having served its purpose, has evaporated and been replaced by a multidisciplinary effort to understand the workings of everyday-life personal relationships in the long term, viewing them as complex processes of negotiation and reiteration, routine and novelty, reinvention and continuation.

Personal relationships are long term, socially structured, organized, and relatively enduring interpersonal phenomena that are founded in each person’s liking for the other but are much more than that. Personal relationships involve mutual recognition and mutual influence in ways not necessarily true of feelings of initial attraction. They are also both a reflection of a culture’s influence and a reflection of the fact that the individuals can create a form of relationship that suits them personally. Thus, two partners may marry (cultural form), but conduct that marriage in a way that contains a number of unique elements and practices.

Historically the field of research into personal relationships was greatly influenced by the research in interpersonal attraction and many leaders in the relationships field were also prominent in the older field at first. However, the research has diversified as researchers have become less satisfied with the idea that attraction ‘causes’ relationships or is in any significant way a predictor of relational outcomes. Also increasingly rejected is the idea that any form of relationship can be determined by the activities or preferences of one person (as is implicit in the notion that one person’s attraction to another is the cause of relationships). Finally, the recent emphasis in the personal relationships field on the communicative activity that connects the members of a partnership has caused a move away from an approach that essentially presumed that (success in) relationships could be predicted on the basis of the knowledge of the characteristics of the two partners before they even met. This latter idea is a favorite of the dating agencies, which measure similarities between two people who have not met and then pretend to be able to predict relationship success from there. However, the increasing variety of research has now inevitably replaced this simplistic idea and places far greater emphasis on the interaction that occurs between two people. Some prominent researchers such as John Gottman have been very successful in predicting the outcomes of relationships on the basis of short periods of interaction, particularly during conflict episodes.

The Provisions of Relationships

Nevertheless, all human beings have needs that are satisfied only by relationships and are not simple individual ad hoc creations between two people. Robert Weiss (1998) proposed that there are seven ‘provisions’ of relationships, that is to say, seven different resources that are provided by relationships which people desire. These provisions are as follows:

1. *Belonging and a sense of reliable alliance*: a sense of membership, acceptance, and availability of others to whom one can turn in times of emergency.
2. *Emotional integration and stability*: a sounding board for our opinions and emotional responses against which we can assess the appropriateness of our own reactions to events and experiences in the world, including reactions to, and assessment of, the other people in that world.
3. *Opportunities for communication about ourselves*: a chance to express our own opinions and values and to ventilate the matters that concern us.

4. *Provision of assistance and physical support*: relationships offer us physical support or help with activities that are too laborious or difficult to be performed alone.
5. *Reassurance of worth and value*: evidence that someone cares about and values us for 'who we are.'
6. *Opportunity to help others*: relationships offer people the chance to feel good by doing good to others.
7. *Personality support*: relationships offer validation and support for our ways of doing things and our ways of constructing and understanding experience: individuals tend to select others who have similar outlooks and therefore can support one another.

Recently, researchers have been concerned to discover how a person's approaches to relationships as an adult reflect not only the need for these provisions but also previous experience (usually previous experience in childhood) and the structure of a person's personality.

Mental Models of Relationships: Childhood Experience and Adulthood

Since John Bowlby's classic suggestion that maternal deprivation in infancy causes social delinquency in adolescence, developmental psychologists have shown great interest in the parent-child relationship as a seed-bed for later relational predilections. Mary Ainsworth and her colleagues demonstrated the existence of three styles of attachment of a parent (secure, anxious/avoidant, and ambivalent). A secure style, where the child feels entirely comfortable in relationships, is apparently derived from a parental style where care giving is readily and freely available to the child and the parent is available, attentive, and responsive to the child's needs. An anxious/ambivalent style, where the child is insecure and finds it hard to trust others, is apparently derived from a parental style that is anxious, fussy, out of step with the infant's needs, and so is responsive to the child's needs only unreliably. An avoidant style, where the child tends to be active in avoiding relationships, is apparently derived from a parental style that is unresponsive, rejecting, or inattentive.

Some researchers began to speculate that adult romantic attachments would show a similar pattern and might actually be based on infant experience. Cindy Hazan, Phillip Shaver, and their colleagues showed that the three patterns were indeed present in adults as assessed in a variety of situations and by a variety of methods. Much work has followed. It must be said that virtually none of it conclusively demonstrates continuity between childhood experience and adult preferences, though there is plenty of evidence for parallelism between reports of childhood styles of experience and later adult reports of relational experience. However, our own styles, backgrounds, and preferences influence and modify the form of relationships in which we end up, irrespective of general human needs for certain kinds of provisions from relationships.

Kim Bartholomew was one of several researchers to prefer a 2×2 model of attachment in which there was a differentiation between a person's model of self and the person's model of others developed during the early years of life. Thus, a person

could form an impression of self as either a positive or negative stimulus to other people (valued or not valued) and could also simultaneously form an impression of other people as either reliable or unreliable from their relational behaviors. This creates four possible styles of belief about oneself in relation to others. *Secure* people have a positive impression of self and treat other people as reliable and essentially positive. Such individuals enter relationships without fear or concern, assuming that relationships and other people are both positively desirable and that other people will on the whole tend to like them. *Preoccupied* people have a positive model of others but a negative view of self and therefore tend to be highly dependent on other people's feedback about their own value. *Dismissive* people have a high positive view of self and a low view of others. They are therefore dismissive of what other people say, not needing confirmation of their own positive feelings and dismissing negative comments as being of no value (because they come from an untrusted source). *Fearful* people are those who have a negative view of self and other people and are in the most complex position because they would really like to have positive feelings about themselves but do not recognize other people as a reasonable source of such information. They are therefore in a constant dilemma of high dependence on others and also high avoidance.

Although early experiences and personal attachment styles have been rigorously and systematically researched in the last 25 years, very few researchers believe that this is the whole story about the way in which relationships are developed and maintained. Its long-term deterministic overtones are unacceptable to those scientists who pay attention to the way in which individuals conduct their own lives in their daily communications and who have systematically created an understanding of the ways in which individuals strategize the development and maintenance of their relationships.

Strategies in Developing and Maintaining Relationships

If relationships are not simply caused by the individual characteristics of persons entering them, then they may be affected by the specific behaviors of the participants on particular occasions. Some researchers, especially communication scholars, have asked themselves the broader question of what strategies people use to maintain and develop their relationships. William Douglas has explored the ways in which, at the start of relationships, people make tests of one another's interest, for example, by asking a particularly difficult favor or by allowing the conversation to lapse to see whether the other person is interested enough to pick it up. These tests are direct and calculated ways to establish the other person's interest in continuing a relationship and are strategic actions that are independent of any personal characteristics of the other person.

Leslie Baxter also examined the ways in which people make tests of the commitment of a partner even at later stages of relationships. She found that there were some interesting methods used, most of them to do with the creation of a jealous response in the partner, the extent of which could be used to gauge the partner's interest in the relationship. Another test involved the implicit recognition of the relationship by

others (e.g., if a person were invited to visit the partner's parents and accepted that invitation, then the implication is that the person does not mind that the parents know that the relationship exists).

Kathryn Dindia and Leslie Baxter also looked at the strategies that partners use to maintain their relationships once they have been formed. The frequent strategies covered a very large range of options, including general strategies involving openness and honesty, the sharing of feelings, or optimism and being cheerful with one another, to help them to feel better. Other strategies included such things as ceremonies (e.g., commemorating the origin of the relationship by special dates or reminiscing about it in ways that celebrated the relationship and special occasions within it) or minor pieces of routine behavior (such as a lunchtime phone call to check how the partner's day was progressing). Another strategy was to ensure that a certain period of time was set aside each week for the partners to be alone together and do whatever they liked, uninterrupted. It is therefore clear that relationships are often the result of careful management just as much as they may be affected by chance, but are by no means simply created from the matching of attributes of the people entering them. Although this picture is richer than reported by the first researchers into attraction, it is not complete until it takes full account of the role of outsiders and of the talk that takes place between people in the everyday interactions of relating.

The latest version of such an approach (*Relational Dialectical Theory*, Baxter, 2010) recognizes the way in which individuals are constantly confronted with tensions and contradictions in their relationships, which require that they balance out certain kinds of competitive forces in the comments of their daily lives. For example, it is a cultural prescription that individuals in such relationships are open and honest with one another and yet it is also perfectly acceptable in a culture for individuals to maintain some degree of privacy. A privacy–openness dialectic therefore creates tensions in individuals at moments of intimate disclosure, and somehow the two individuals in the relationship have to manage these tensions. It is also clear that in developing a relationship, individuals necessarily give up some of their independence and autonomy to become members of an interdependent relationship. The negotiation of the autonomy–connectedness dialectic is one that is particularly noticeable in the development of relationships in their early stages, but it can still reemerge in relationships that have some history.

Particularly important in the development of exclusive romantic relationships is the way in which partners negotiate their retraction from the social networks in which they have previously been immersed so that they can spend less time with friends and more with their romantic partner. Their withdrawal from their previous connections with other people outside the dyadic relationship stresses the importance of the role of outsiders in relationship activity and this has recently become a matter of great concern to researchers. Leslie Baxter's work mentioned above has paid close attention to the different forces and stresses to which partners must attend – not only to their own concerns and feelings and their influence on the internal dynamics of particular relationships but also the stressful influence created within the dyad by the knowledge that a relationship must be played out in the context of observation by others.

The Role of Outsiders in Relationship Activity

The influences of outsiders on relationships have also been explored. Many younger people meet or become involved with their dating partners through mutual friends or as the result of being members of the same group of friends, for example. However, the opportunities provided by go-betweens or mutual acquaintances are not the only influence of outsiders. In some teenage gangs, members are implicitly forbidden to date members of other gangs, and most people are keen to have the approval of their parents for possible marriage partners.

As a relationship with a particular partner becomes more intense and involved, the partners withdraw from their own networks of personal friends to spend more time with one another, and the management or juggling of all their relationships as a whole – and the time that they take up – can present difficulties and constraints for the partners. For example, it is a common finding that romantic partners spend only about a third of the time alone with other friends after marriage as they do before marriage. Nevertheless, it remains true that the inception of a close romantic relationship has consequences on other relationships in which the persons are involved, and the management of those issues is likely to have psychological and social consequences. Once again, the issues involved in creating relationships are not reducible to the simple actions of the partners themselves but must be seen in the context of other forces and constraints in life.

Organization of Roles and Time Management

Relationships do not occur in a vacuum as early work on attraction tended to imply. In real life, everyday relationships present partners with various roles and duties to perform, chores to complete, and tasks to undertake. In a relationship such as marriage, there are issues concerning 'who does what' and these have to be managed and negotiated between the partners. Such negotiation and discussions have an impact on the ways in which the relationship itself is experienced by the partners, and affect the development of the relationship.

Leslie Baxter's work mentioned above has paid considerable attention to the complex balancing of different forces and stresses in the development of relationships. For example, she and several colleagues addressed the ways in which teenagers check out the rules for developing relationships and conducting them once established. This is carried out in contexts that make reference to other members of the network, who provided both direct and indirect advice (in the form of gossip and stories about relational successes and failures) that made clear that the individuals in a relationship must adhere to codes of social performance that are accepted in the relevant peer group. In short, they must attend not only to their own concerns and feelings but also to the pressures and influences invoked by those outside their relationship, but who nevertheless have a stake in the way it will be allowed to work.

As part of the influences on the internal dynamics of relationships, it must be recognized that exterior forces such as pressures from work and other demands on one's time are also relevant to the experiences of the individuals within the

relationship itself. Several researchers have explored the 'spillover' effects of work into the experience of a marriage or committed relationship, and recently, the spillover from other sources and directions has also been explored. Not only do poor days at work tend to lead to disruption at home but also vice versa. Likewise, trouble in a major relationship can cause withdrawal from other relationships while the two partners sort out their own troubles.

In part, these issues reflect the significant time that we devote to relationships of one kind or another. The management of time and roles in particular relationships can sometimes become a problem. How much time is the 'right amount' to spend with the family, at work, with a romantic partner, with an aging parent? How is that relational time to be balanced and parceled out between different competing commitments? It is evident from much research that this form of dilemma is experienced in most forms of relationship and that much of it is managed in the daily discourses that make up everyday life.

The Role of Daily Life and Everyday Talk

A late addition to the research on relationships has been the recent focus on the conduct of everyday talk. Given that relationships are not merely emotional creations but are also social organizations and role managers, or products of strategic behavior, it is clear that the partners need to conduct their negotiations somehow and that talk is the natural medium for doing this. Second, it is also the case that people just do spend a lot of everyday talking to one another and that talking to friends and partners is probably one of the biggest slices out of the total talk that people produce in a day. Third, talk is a means by which attitudes and values are expressed and also a way in which instrumental tasks (such as obtaining favors or asking someone out on a date) are accomplished. Talk can also be a very considerable signal of the strength and involvement of a relationship, often being an indicator of the feelings that people have for one another. This happens not only in the obvious ways in which people address explicit emotional messages to one another ('I love you'), but also as a result of some of the other actions that have already been discussed here. For instance, as couples organize the roles and behaviors and duties in their relationship, they also organize the language. Several studies have shown that intimate couples develop private languages or 'personal idioms' that encode the two partners' nicknames for other people, shorthand terms for parts of the body or sexual activities, and generally playful ways of communicating affection, request, or desires. The extent of development of such personal idioms is a useful measure of the intimacy of a relationship.

The functions of language in the conduct of relationships have been classed as instrumental (as above), indexical (or indicative of the emotional tone of a relationship), or essential, by Steve Duck and Kris Pond. The 'essential' role of language is

to embody the relationship and make it happen. In a series of studies, it was shown that relationship partners report that their most frequent daily conversations with partners had no really important content to them, but were, nevertheless, relationally important. The very fact that the conversation happened was important to the life of the relationship. This is part of what is meant by the essential function of talk in relationships.

Such work also analyzes the role of talk as a presenter of ideas and values to others, such that it presents opportunities to test out the values and attitudes that the other person exposes and to test them for validity or for similarity to one's own (as Robert Weiss had suggested above). The focus on talk thus creates the chance for partners to compare some of the items that have been discussed above in the conduct of everyday life. However, it goes further than this and proposes that talk is a rhetorical act and serves not only to present ideas but also to persuade others to accept them. It does not necessarily do this in the obvious sense that partners may seek to influence one another directly, but it also does it by presenting 'rhetorical visions' (i.e., persuasive images or representations of the world) that the other person may simply adopt or accept without being the subject of strong direct influence. In short, by presenting and exposing the speaker's attitudes to the world, or his or her system of meaning, the conversations of everyday life can create opportunities for others to share the representations that are offered there and to find them relationally persuasive. From such everyday conversations, relationships, liking, and many of the other forceful factors described above can be initiated.

See also: [Friendship](#); [Leadership](#); [Peer Relationships and Influence in Childhood](#).

Further Reading

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- www.iarr.org – International Association for Relationship Research.
- <http://myweb.uiowa.edu/blastd> – Steve Duck's Website.

Personality Assessment

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Glossary

Ecological momentary assessment Measurement of psychological variables using technology that permits gathering data at random intervals during the course of the day.

Idiographic assessment Interpretation of assessment data based on comparing one person's score on two or more scales.

Nomothetic assessment Interpretation of assessment data based on comparing a person to general patterns in the population.

Objective measurement Measurement of psychological variables based on items that permit a limited set of response alternatives such as multiple-choice items.

Projective measurement Measurement of psychological variables in a format that allows the respondents wide latitude in how they respond to ambiguous stimuli.

Reliability A statistical concept having to do with the degree of consistency across multiple measurements of the same construct.

Utility The degree to which a measurement device is useful in applied or practical settings.

Validity A concept having to do with the degree to which a measurement instrument provides accurate information about the construct that instrument is intended to represent.

The concept of personality is a complex one. It has been used as a superordinate term for concepts that reflect an individual's sense of personal identity, their characteristic interpersonal patterns, their aspirations, and their global tendencies when construing events in the world. Personality overlaps with other important psychological concepts such as attitudes, values, vocational interests, and psychopathology. However, the concept of personality is broader than any of these, reflecting the sum total of a person's distinctive and characteristic style of interacting with and adapting to the social environment. The optimal characterization of personality is elusive since cultures and languages differ on which dimensions of personality seem to be the most important, and even on how to define those dimensions. Psychologists interested in the measurement of personality have been challenged by its broad and amorphous character, and this challenge is reflected in controversies over measurement models applied to the study of personality, the accuracy of personality measures, and continuing efforts to develop a sufficient model of personality. Though measures of personality are often used in the context of theory development and validation in the field of personality psychology, the term 'personality assessment' has special relevance to the applied or practical use of personality measures.

This article reviews major issues in personality assessment. These include a review of measurement models used in personality assessment, a brief history of personality assessment, methods for evaluating personality measures, the relationship between personality assessment and personality theory, and the applied use of personality measures.

Measurement Models in Personality Assessment

Objective Measures

Historically, measures of personality tended to be clustered into two groups referred to as 'objective' and 'projective' instruments. The prototypical objective personality test demonstrates the

following features. First, test stimuli are semantic in nature. Second, the number of acceptable response alternatives to any test stimulus is circumscribed and set by the test developer. Third, this format permits complete standardization in administration and scoring. Fourth, objective measures tap into the respondent's conscious awareness of themselves or their environment.

The prototypical objective personality test comprises a set of multiple-choice items. These tests are generally consistent in the number of response alternatives offered for each item, with two-choice items (e.g., true-false items) and four- or five-choice items representing the most popular alternatives. Among the most popular exemplars of the objective multiple-choice model are the NEO personality inventory (NEO-PI) and the Minnesota multiphasic personality inventory (MMPI), though the latter is sensitive to both personality and psychopathology. Multiple-choice objective personality measures are often referred to as rating scales because the anchors associated with the response options typically define a dimensional rating. For example, five-choice items are often anchored with terms on a scale from 'strongly agree' to 'strongly disagree.'

Another common item format is the use of checklists, where the respondent checks off those items that are self-descriptive or descriptive of others. The checklist format has been particularly popular with test stimuli that are adjectives, so the respondent is asked to check those adjectives that describe him or her. However, some instruments that are called checklists do not use the checklist format: the Symptom Checklist-90 uses a four-choice multiple-choice format, for example. The checklist format has fallen out of favor in recent years because it leaves uncertain whether failure to check an item indicates that the respondent does not consider that adjective to be self-descriptive, or the respondent skipped that adjective.

When the items are self-referential, objective measures are often referred to as self-report measures. The self-report objective measure represents the most commonly used measurement model in personality assessment, presumably because

of its relative efficiency and low cost. Many observer-based systems for measuring personality-relevant behavior in others also use the objective measurement model. For example, the NEO-PI Form S is completed about a person by knowledgeable informants, and various objective measures have been developed for the observation of children in interpersonal situations to detect interpersonal style. In recognition of the complex character of personality, many of the most popular personality measures are actually inventories, meaning they comprise a battery of scales tapping different elements of personality.

It is important to recognize that the term 'objective' in this context has to do with the existence of a clear set of response options. It does not imply the results are objectively accurate, a point the later discussion of response bias will make clearer.

Projective Measures

The prototypical projective measure meets the following conditions. First, test stimuli are ambiguous in some important way. For example, the Rorschach Inkblot Method presents the respondent with a series of inkblots and the question 'What might this be?' The thematic apperception test (TAT) requires the respondent to create a story based on a picture in which people are engaged in unclear behavior. Second, the number of acceptable response alternatives to the stimuli is usually infinite. Though some responses may be considered unacceptable, such as refusing to provide a perception for an inkblot, any response that is cooperative with the instructions would be acceptable. Third, these methods are specifically intended to detect idiosyncratic patterns of responding, such as unusual percepts or justification for percepts on the Rorschach, or unusual story content or story structure on the TAT. Fourth, because of their less structured format, administration and scoring of projective instruments often requires specialized training. Fifth, this additional effort is considered warranted by some psychologists because such instruments are thought to be capable of revealing aspects of personality not generally detectable through more direct methods such as self-report rating scales.

The reference to certain personality instruments as projective has recently fallen into disfavor. In particular, the implication in this term that the value of such instruments stems primarily from the psychodynamic process of projection is inconsistent with much of the evidence concerning their use. As an alternative, some authors have taken to associating these measures with implicit cognitive and emotional processes.

Comparing Objective to Projective

An important distinction for understanding the role that objective and projective measures play in the understanding of personality was described by Cronbach and Gleser. Broadband measures potentially tap into a variety of elements of personality. For example, relatively brief stories on the TAT can be a sign of resistance to the test, cognitive difficulties, anxiety, or a lack of creativity. As a result, broadband measures tend to be of relatively low fidelity; that is, the use of some score as a measure of a specific psychological construct is problematic. An elevated score on a low-fidelity measure can have multiple meanings. In contrast, narrowband measures are sensitive to

a relatively small cluster of personality variables. This tends to be associated with higher fidelity.

As a general though not universal rule, projective measures are perceived by psychologists to be of relatively higher bandwidth but lower fidelity than objective measures. Their higher bandwidth tends to make projective measures popular in certain applied assessment situations, where clinical psychologists, for example, are interested in a relatively broad screening instrument of personal style. On the other hand, their low fidelity makes the interpretation of the results more complicated and raises concerns about validity.

This last concern would seem to be contradicted by the results of several meta-analyses finding little difference in the criterion-related validity of the MMPI and Rorschach. However, it is possible this finding reflects a disproportionate emphasis in the research literature on the Rorschach scales that are the most valid. More compelling is evidence indicating that certain scales derived from projective measures are of relatively good validity. Examples include the measurement of achievement motivation using the TAT and prognosis for psychotherapy using the Rorschach.

Another important line of research finds little association between objective and projective measures that ostensibly measure the same construct. Increasingly, it is recognized that implicit and explicit cognitive processes operate in parallel and measures of one will not necessarily converge with the other. These findings raise doubts about the existence of a homogeneous concept such as anxiety that accounts for both self-perceptions and information processing.

Alternative Measurement Methods

Other measurement methods have emerged in the study of personality. Various attempts to map physiological variables (heart rate, skin conductance, cortisol levels, etc.) to personality variables have met with mixed success, and these methods are often relatively expensive. However, growing sophistication in neuroscience and genetics has sparked optimism for the future of biological approaches to understanding personality.

Since personality is largely manifested through social behavior, the direct observation of behavior would seem to be a particularly promising approach to the study of personality. However, behavioral observation also represents a more expensive method than self-report. Compounding this cost is the contextual element of social behavior. No dimension of personality manifests itself universally, so optimal behavioral observation occurs across multiple settings. Some researchers have relied on self-reported behavioral tendencies, but this approach suffers from the same reliance on self-perception as other self-report instruments.

A relatively recent development has been the application of implicit measures previously used primarily for the study of social attitudes, such as the implicit association test (IAT) or the Stroop color-word test, to measure elements of personality and psychopathology such as self-esteem or anxiety. For example, the IAT is used to evaluate processing speed when the respondent is required to make associations between different pairs of concepts. An application relevant to the study of personality might involve evaluating whether self-reported extroverts respond more quickly than introverts when they are

required to make associations between self-referential words and words having to do with social involvement.

Modern implicit measures demonstrate features of both objective and projective measures. On the one hand, the stimuli are quite clear, only a certain number of response options are available, they are narrowband measures, and the results have a relatively narrowband of reasonable interpretations. On the other hand, they are consistent with projective measures since it is an element of behavior during the testing that represents the variable of interest rather than self-evaluation. It is also assumed that the IAT is capable of detecting aspects of personal style not directly accessible via self-report. The use of implicit measures is complicated by evidence that different implicit measures do not converge with each other. As is the case with projective (broadband implicit) measures, they also do not correlate well with self-report measures.

Ecological momentary assessment (EMA) represents another recent addition to the strategies available for measuring personality-relevant variables. This approach requires the use of portable technology that can be used to gather information at random during the course of the normal day. The data collected can be objective; for example, to gauge general well-being, the respondent may be signaled at random intervals to make a 1–5 rating of level of satisfaction. The data can also be behavioral; for example, the device may record speech at random intervals. With advances in the technology, the options will continue to expand. For example, the use of smartphones that contain global positioning equipment or an accelerometer creates new possibilities that have only recently begun to be explored.

Standardization in Measurement

Regardless of the model of measurement, an important characteristic of any formal personality assessment method is standardization. This term implies equivalence across test users and respondents in terms of the administration of the instrument, its scoring, and its interpretation. Standardization in administration and scoring is often easier to achieve for measures that restrict the set of response options. The MMPI or IAT can be administered successfully after a few minutes of familiarization, and the entire scoring can be completed by computer. Interpretation is often based on comparison of the respondent to a normative or standardization sample. Finding that a respondent's score on a MMPI scale is 1.5 standard deviations above the normative mean is generally treated as evidence of an interpretable deviation from the norm, for example.

The History of Personality Assessment

Francis Galton initiated the modern study of personality in the last quarter of the nineteenth century when he proposed that personality and intelligence are heritable qualities just like physical features, and are capable of scientific study. He pioneered the use of projective techniques by administering a word association task to himself and the use of objective techniques when he asked eminent scholars to describe their temperament using a checklist of terms drawn from Galen.

The development of formal psychological measures began soon thereafter. Early successes in the measurement of intelligence by Binet and Simon around the turn of the century inspired psychologists to generalize the methodology to other domains of psychological functioning. Reflective of the close association between personality and psychopathology, the Woodworth Personal Data Sheet is sometimes described as the first measure of personality. In fact it focused exclusively on emotional adjustment, and was intended to be used to screen American recruits for service in World War I as a method of reducing the rate of shell shock. It was not completed until the war had ended, however.

The first popular measure of personality was the Bernreuter personality inventory (BPI), published in 1931. It consisted of four scales: Neurotic Tendency, Self-Sufficiency, Introversion–Extroversion, and Dominance–Submission. Two additional scales were added later, tapping Self-Consciousness and Solitariness. The BPI was innovative in that it was the first multidimensional inventory of personality attempting to tap a set of key personality dimensions. It quickly became a popular instrument particularly in employment settings.

An important turning point in the measurement of personality was a series of studies conducted by Hartshorne and May in the 1920s demonstrating that many of the children for whom they had strong evidence of cheating on an academic task denied having done so. This finding alerted psychologists to the potential for misrepresentation in self-report. Several important changes in assessment practice resulted from this realization. First, developers of self-report measures began to integrate bias indicators intended to detect invalid responding into the instruments they developed. Patterns of invalid responding are called response sets or response styles, and several have been described in the literature. Perhaps the best-researched is social desirability or positive impression management, which refers to the tendency to self-describe in overly positive terms. Efforts to detect positive impression management usually involve the use of items that suggest an overly positive self-representation, for example, items that indicate denial of lying or swearing or admission of superior functioning. A high score compared to the normative mean is taken as probative evidence of misrepresentation in the positive direction. A second response style that has been discussed more frequently in the literature on psychopathology than personality assessment is malingering or negative impression management, the tendency to self-describe in overly negative terms. Scales intended to detect negative impression management consist of items based on unusually negative self-statements.

Other forms of response bias have been identified that involve inattention to the content of the items. These include random or careless responding, yea-saying (the tendency to respond in the affirmative), and nay-saying (the tendency to respond in the negative). Several strategies have been suggested for detecting inattention to content. One consists of items that are answered infrequently in the keyed direction, for example, answering true to 'I studied watchmaking in Switzerland.' Another approach uses pairs of items that are semantically inconsistent with each other when endorsed according to the key, for example, responding true to 'I feel blue' but false to 'I am sad much of the time.' Though the use of

bias indicators, sometimes called validity scales, remains popular, some researchers have concluded the case for response bias as a factor in responding to personality scales has been exaggerated.

A second consequence of concerns over misrepresentation had to do with the strategy used to develop scales. Early self-report measures were developed using a purely rational-intuitive approach, where the test developer created items that were intuitively related to the construct of interest. The original scales of the MMPI were instead developed primarily using an external approach. This involved developing a large battery of items that was administered to contrasting groups such as normal individuals versus individuals with depression. The depression scale then comprised those items that significantly discriminated between the groups. The result was the inclusion of so-called 'subtle' items, items that were not intuitively related to the criterion. While subtle items were considered desirable for many years, more recent studies have consistently demonstrated items that are conceptually related to the criterion are more valid than empirically derived unintuitive items. Currently a sequential strategy of scale development is preferred in which rationally derived items that are then evaluated on the basis of their external correlations as well as evidence of strong relationships with each other.

Finally, during the 1930s concern over misrepresentation created interest in the use of projective measures on the grounds that their ambiguity would render them more resistant to faking. The dominance of the psychoanalytic model, which emphasized the importance of mental processes outside of conscious awareness, contributed to the belief that instruments encouraging projective activity would provide a deeper level of insight into personality style than would be possible from self-report alone.

Over the next generation, several lines of criticism emerged that ultimately had important influences on the field of personality assessment. One emerged out of the growing behaviorism of the 1960s. Concerns were raised about the extent to which personality measures were capable of predicting ecologically important behavioral outcomes. Supporters of personality assessment responded to this challenge by recognizing the importance of the person-situation interaction to the prediction of behavior, as well as by providing additional evidence that personality measures can predict important life outcomes.

The MMPI also came under attack for lack of compliance with best practices from a statistical perspective. The developers of the MMPI were criticized for allowing item overlap between the scales, which complicated the interpretation of correlations between scales; scales that were extremely heterogeneous in item content; and unbalanced scoring keys. The most extreme example of this last point was a scale on which every item was scored false. Ultimately, these issues were addressed through revision of the MMPI, and inventories developed in recent times have generally avoided these pitfalls.

A more aggressive critique emerged surrounding the use of projective measures. This included concerns about low fidelity; lack of reliability; and unstandardized administration, scoring, and interpretation procedures. As a result of this critique, the popularity of projective measures declined substantially, to the point that some formerly popular techniques have dropped out of assessment practice completely. The Rorschach Inkblot

Method has been relatively resistant to this trend compared to other projective measures because of efforts to establish a more empirical base for the use of the instrument. However, the instrument remains controversial, and many of the scales developed in recent years have yet to be thoroughly validated.

Evaluating Personality Measures

Reliability

The adequacy of a personality assessment instrument can be evaluated on three grounds, referred to as reliability, validity, and utility. The concept of reliability emerges from psychometric theory, and has to do with the degree to which scores on an assessment instrument are stable across observations. By definition, then, the evaluation of reliability requires comparing results across multiple observations of the underlying construct.

The matter of generating multiple observations of the construct has been addressed in three ways in the literature on test reliability. In the case of a multi-item objective measure, the different items can represent the multiple observations. For example, the items of the Beck Depression Inventory can each represent an observation of the common construct depression. This approach to evaluating reliability is called internal reliability, since the measurements are internal to the scale. When interpreting internal reliability it is important to recognize the difference between reliability and item homogeneity. Even if the reliability of a scale is quite high, factor analysis can indicate the scale contains several conceptually distinct subsets of items. Good internal reliability is not a sufficient basis for concluding that the items are all measuring the same construct.

A second approach is referred to test-retest reliability and involves administering the measurement instrument at two or more times. The two administrations of the instrument should occur within a time frame where it is reasonable to assume the underlying construct is unlikely to undergo substantial change. Since personality variables are often expected to be stable for long periods of time, some test-retest reliability studies of personality measures use intervals of several years or more. In contrast, some elements of adjustment and emotional distress can change over relatively brief periods and so test-retest intervals should be much shorter.

The final approach applies to observer-based ratings. Interrater reliability has to do with the degree of consistency across multiple raters. In some studies, the multiple raters know the target in different contexts, which can reduce reliability. For example, research suggests that when the Child Behavior Checklist is completed by a parent and a teacher, the reliability of ratings can be quite poor.

The statistic of choice for both test-retest and interrater reliability is called the intraclass correlation coefficient, of which coefficient alpha is actually a special case. The intraclass correlation theoretically can vary between 0 and 1. Values below 0.60 are generally considered evidence of inadequate reliability. Values above 0.80 are considered particularly good, though some commentators have suggested instruments with reliabilities below 0.90 should not be used for the evaluation of individuals in applied settings. Most popular personality measures demonstrate internal reliability of 0.60–0.90.

Though there is a tendency to refer to ‘the’ reliability of an instrument, it is possible to compute different forms of reliability for the same instrument. The observer version of the NEO-PI allows for the computation of internal reliability across the multiple items of each scale, interrater reliability if two knowledgeable informants complete the instrument, and test–retest reliability if they complete the instrument a second time after some delay. The different forms of reliability will not necessarily agree with each other, since each is influenced by different factors.

Validity

The concept of validity has to do with the degree to which the instrument allows one to make inferences about the construct the instrument is intended to represent, that is, it has to do with the degree to which the behavior of the instrument is consistent with the expected behavior of the construct. A variety of approaches are available for evaluating the validity of a psychological instrument. Face validity has to do with the degree to which items comprising a measure intuitively are reflective of the underlying construct. For example, a measure of depression is face valid if each item reflects an intuitively sensible aspect of depression. Content validity is the degree to which the items comprising the instrument tap the universe of item contents relevant to the construct. For example, the Beck Depression Inventory demonstrates good content validity since each item is intuitively based on a different aspect of the construct depression. Factorial validity has to do with the extent to which factor analysis of the items of a measure produce a structure that is reasonable given the understanding of the underlying construct. Criterion-related validity is perhaps the most commonly studied approach to validity, having to do with the degree to which the instrument correlates with other variables that should be related to the construct of interest. Finding that a depression measure is negatively correlated with a measure of self-esteem and positively related to subsequent suicide attempts is evidence for the criterion-related validity of the measure. The concept of discriminant and convergent validity takes this concept a step further, suggesting that one can hypothesize there are certain variables with which the measure should be relatively well correlated and other variables with which it should be relatively uncorrelated. Finally, the term construct validity has been used to refer to the sum total of validity evidence and the degree to which it justifies concluding that outcomes on the measure can be used to draw valid inferences about the underlying construct.

Utility

The utility of an instrument is the degree to which its use enhances outcomes in applied settings; that is, it has to do with the degree to which the instrument is practically useful. Good reliability and validity are necessary but not sufficient conditions for utility: various other factors affect a measure’s usefulness. The lower the base rate of that which the assessor is trying to detect, the more difficult it is to detect it. Even a highly valid measure has a difficult time detecting a very low probability phenomenon. The utility of an instrument also depends upon its costs. As noted earlier, projective instruments often

require individual administration by a professional with specialized training. Such instruments have a relatively high cost in terms of professional time compared to a self-report measure. Those costs may outweigh any benefits, especially if projective measures tend to be of relatively low fidelity, except perhaps in very high-stakes testing as with public safety candidates. It was noted earlier that projective and objective measures of the same construct often do not correlate well with each other. There is evidence indicating that in some cases this lack of convergence occurs because projective and objective measures tap different aspects of the underlying construct. Under those circumstances, projective measures can enhance the prediction of important outcomes over self-report measures, a phenomenon referred to as incremental validity. This pattern has also recently been found with the IAT as well.

Personality Assessment and Personality Theory

Personality measures are used for two primary purposes. The first is to advance the understanding of personality. Over the last 30 years theorizing about personality has coalesced around what is called the Five Factor Model of personality. This model suggests that five basic dimensions provide an organizational structure for understanding the perception of personality, at least among English speakers. These dimensions are called Neuroticism (alternatively called Emotional Stability, which reverses the keying of the scale), Extraversion, Openness to Experience (though some studies suggest this factor should be labeled Intellect or Culture), Agreeableness, and Conscientiousness. The NEO-PI is the most popular measure of the Five Factor Model though other measures of the model exist.

One important aspect of the Five Factor Model is the hierarchical organization of personality, so that each factor encompasses a set of more specific facets of personality. [Table 1](#) provides the list of facets associated with each of the five factors NEO-PI. The acceptance of a hierarchical structure raises questions about whether the five factors offer the most generally useful level in the hierarchy. Some critics of the Five Factor Model have argued that reducing personality to five factors is overly incorporative, and a more differentiated level such as that represented by the 30 facet scales of the NEO-PI is more useful. Still others argue even five factors are unnecessary and have suggested further reduction to three or even two factors. The optimal level of differentiation between personality constructs probably depends upon one’s goals. Simple and efficient communication about personality may best be served by the five factors, while maximal prediction of behavioral outcomes might be better achieved at a more differentiated level.

Other objections have been raised to the adequacy of the Five Factor Model. Several studies have concluded that even in English, a sixth factor is reliably detectable referred to as Honesty or Humility. Cross-cultural research indicates that when individuals from non-Western cultures are administered items reflecting the five factors, those factors reliably emerge, suggesting the respondents can recognize the five factors. However, when the language used to describe personality language is analyzed other factors tend to emerge, suggesting the primacy of the five factors is culturally derived.

Table 1 NEO personality inventory-revised facets

Model domain	Facets					
Neuroticism	Anxiety	Angry hostility	Depression	Self-consciousness	Impulsiveness	Vulnerability
Extraversion	Warmth	Gregariousness	Assertiveness	Activity	Excitement seeking	Positive emotion
Openness to experience	Fantasy	Esthetics	Feelings	Actions	Ideas	Values
Agreeableness	Trust	Straightforwardness	Altruism	Compliance	Modesty	Tender mindedness
Conscientiousness	Competence	Order	Dutifulness	Achievement striving	Self discipline	Deliberation

A second important topic related to personality assessment is personality development. Among children, research has focused on the concept of temperament. This term refers to early behavioral predispositions that potentially reflect genetic and/or biological influences and that provide the basic building blocks for the development of adult personality. As one might expect, many elements of adult personality such as Neuroticism or Conscientiousness are believed to be presaged by certain tendencies observable even during early childhood. There is also growing evidence that personality continues to evolve in a positive direction as people advance into middle age and beyond: Neuroticism tends to decline while Conscientiousness and Agreeableness increase.

Applied Uses of Personality Assessment

The second use of personality measures is in the context of applied assessment. Personality measures are used extensively for employee selection and development. In the Five Factor Model, Conscientiousness tends to emerge as the best single predictor of job performance. Other models of personality have been proposed specifically for their relevance to understanding occupation behavior. The best-known example was proposed by Holland, who hypothesized the existence of six personality types relevant to the optimal choice of a career path. He labeled these types Realistic, Investigative, Artistic, Social, Enterprising, and Conventional. Each suggests that different types of job activities will be maximally rewarding to the individual. Several measures developed specifically for use in occupational settings rely on Holland's model.

The assessment of normal personality has also been influential in clinical settings. For example, the dimensional perspective on personality has been used to critique the categorical model of personality disorders contained in the current system for the diagnosis of mental disorders. This critique has become very influential in thinking about personality disorders, to the extent that reports indicate the next edition of the diagnostic manual will incorporate dimensional elements. At this point, the specific details have not been released.

When personality tests are used in applied settings for the evaluation of individuals, two approaches to test interpretation are possible. Nomothetic assessment involves comparison of the individual on a scale-by-scale basis to normative information. Reporting an individual is two standard deviations above the mean on a measure of extroversion, and drawing conclusions about the individual from that finding is an example of nomothetic assessment based on interindividual comparisons. Applied personality assessment also frequently

involves gathering data on a number of dimensions of personality, which makes it possible to consider a single individual's standing on multiple dimensions. Idiographic assessment has to do with interpreting the scatter among scores within an individual. Finding a person is much higher on a measure of extroversion than on a measure of openness to experience says something about his or her relative investment in different types of activities. This is an intraindividual comparison. These terms were introduced into the discussion of assessment by Gordon Allport and represent complementary approaches to understanding the implications of a personality assessment.

Final Comments

The study of personality continues to evolve. Some researchers have focused on the interstitial spaces in the Five Factor Model, for example, on the implications of a person being high on Extroversion but low on Conscientiousness. Others are working on developing a cross-culturally valid model of personality. Others are exploring the relationships between traditional measures of personality and more innovative approaches such as EMA. Personality assessment remains a vibrant area of research within psychology, and one that is likely to continue to make contributions to the applied and theoretical understanding of human behavior.

See also: Attitude Formation; Big Five Model and Personality Disorders; Individual Differences in Temperament: Definition, Measurement, and Outcomes; Personality Development; Psychopathology: Diagnosis, Assessment, and Classification; Social Values (Influence on Behavior).

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Relevant Websites

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- <http://www.ipip.ori.org> – International Personality Item Pool.
- <http://www.personality.org> – Society for Personality Assessment.

Personality Development

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Glossary

Cumulative continuity principle The observation that individual differences become more stable (or less malleable) with age.

Dispositions Stable tendencies to think, feel, and behave in certain ways.

Heterotypic stability Consistency in the same underlying personality disposition across development that may nonetheless demonstrate different behavioral manifestations at different ages.

Homotypic stability Consistency in the same manifestations of personality across development.

Intrinsic maturation hypothesis The perspective that changes in levels of personality traits in adulthood are generated by biological processes residing within the individual.

Life course hypothesis The perspective that adult personality changes result, in part, because of investment in adult social roles.

Maturity principle The observation that personality trait changes in adulthood facilitate the fulfillment of adult roles (e.g., increases in agreeableness and conscientiousness).

Mean-level stability Consistency in average levels for a given trait across developmental periods.

Rank-order stability Consistency in the relative ordering of individuals for a given trait across developmental periods.

Temperament The term usually refers to the dispositional attributes of young children. However, temperament can also generally refer to biologically based individual differences regardless of developmental period.

Personality refers to an individual's stable tendencies to think, feel, and act in particular ways. The field of personality psychology focuses on understanding and assessing these individual differences in thoughts, feelings, and behavior. Accordingly, the subfield of personality development generally seeks to (1) describe patterns of stability and change in personality dispositions across the life span, (2) evaluate the influence of genetic and environmental factors on personality development, and (3) identify the processes that generate both consistency and change in personality dispositions from infancy to old age. Researchers typically address these types of questions using longitudinal designs in which the personality attributes of the same group of participants are assessed repeatedly across an appreciable span of development. Personality is most frequently assessed via self-reports and ratings of the participant by knowledgeable others (peers, parents, teachers); other commonly used assessment methods include observations of behavior in standardized situations; reaction times and other measures of cognitive processing; experience sampling; and a wide range of physiological measures. In this article, we outline three general levels at which personality can be conceptualized, discuss several types of personality stability and change, and then summarize the most recent findings and conclusions emerging from this exciting and interdisciplinary branch of psychology.

Considering Personality at Multiple Levels

What are the building blocks of personality; that is, what are the fundamental ways in which individuals differ from each other? McAdams and Pals have proposed an integrative approach that conceptualizes personality at three levels of

individual variability. The first level reflects those dispositional traits that reflect an individual's general style of adjustment and approach to the social world. Although there are thousands of dispositional traits, personality psychologists generally agree that these traits can be usefully organized into five broad domains: *extraversion* (talkative, enthusiastic vs. quiet, reserved), *agreeableness* (kind, sympathetic vs. critical, quarrelsome), *conscientiousness* (reliable, self-disciplined vs. disorganized, careless), *neuroticism* (anxious, easily upset vs. calm, emotionally stable), and *openness to experience* or simply *openness* (imaginative, novelty seeking vs. uncreative, conventional). These trait domains (commonly referred to as the 'Big Five') are relatively consistent over the life course, generalize across cultures, and emerge in childhood. The Big Five have been linked to a variety of genes, neurotransmitters, brain structures, and neural activation patterns. These domains also predict a wide range of important life outcomes, including academic achievement, crime and delinquency, health and longevity, job performance, personality disorders, and relationship satisfaction.

The other two levels in the framework of McAdams and Pals are characteristic adaptations and life narratives. Characteristic adaptations capture differences in motives and social cognitive processes such as the internal representations of key relationship partners (e.g., parents, romantic partners). These elements of personality are more contextualized than dispositional traits, and thought to be more responsive to situational forces. The third level captures those ongoing personal stories or narratives that individuals use to construct meaning from their lives. This level of individuality captures an individual's 'life story' and is the bedrock of identity.

Most research on personality development has focused on the level of core dispositions. In other words, more is known about the development of the Big Five domains than

characteristic adaptations and life stories. This will probably change in the future as researchers use large-scale longitudinal designs to study constructs at the other two levels of individuality. Nonetheless, this article focuses on dispositional traits because of the dearth of developmental research on the other two levels. However, it is important to keep in mind that there are other ways of characterizing individuals and these other levels of personality also have a developmental dimension.

Defining Different Types of Stability and Change

Just how stable are personality dispositions across the life span? There are no easy ways to answer this question because there are different ways of conceptualizing and measuring stability and change in personality. A broad distinction is often made between homotypic and heterotypic stability (or continuity). Homotypic stability concerns the degree to which people express the same thoughts, feelings, and behaviors across time. This kind of stability focuses on the same manifestations of personality across time.

In contrast, heterotypic stability refers to the consistency of the underlying personality traits that are theorized to have different observable manifestations at different ages.

The investigation of heterotypic stability requires a conceptual understanding of the underlying personality disposition. That is, researchers must draw on a theory to specify how the same underlying personality disposition will appear to outside observers at different ages. The central issue is that many of the more salient behaviors associated with particular personality traits seem to change with development. A shy child might cling to his or her parent in the middle of a crowded room, whereas a shy adult might simply avoid large social gatherings altogether. Likewise, an aggressive toddler might bite classmates and throw temper tantrums, whereas an aggressive teen might use hostile words to insult classmates or use weapons to assault strangers. A theory about the nature of the underlying personality traits (shyness and aggressiveness, respectively) should be able to explain how these different surface manifestations reflect the same underlying personality dispositions.

In contrast to heterotypic stability, the assessment of homotypic stability is less conceptual and more statistical. Homotypic stability concerns the evaluation of different kinds of change using the same measure of personality across time or across age groups. This broad category includes several specific types of stability and change. One type concerns the psychometric properties of the measurement instrument and is investigated under the term *measurement stability*. Two other types of stability and change are typically examined at the level of the sample and refer to particular personality attributes: *mean-level stability* and *rank-order stability* (also referred to as differential stability). Researchers can also investigate stability at the individual level by determining whether a particular individual increased or decreased in his or her absolute or relative trait standing over time.

Investigations of measurement stability evaluate developmental changes in the measures used to assess personality attributes. This kind of stability is important because it helps researchers confirm that they are assessing the same psychological construct at different points in time (e.g., in childhood

and adolescence). If measurement stability is not found, then researchers may wrongly infer that personality change has occurred when all that has happened is that the measure is tapping into a different construct across assessment occasions. Measurement properties can change even if the same items and item responses are used at two separate time points.

A great deal of research in personality development focuses on mean-level stability, which refers to consistency in the average or typical level of a given trait across different developmental periods. One approach is to compare average scores for a personality attribute across different age groups, such as comparing the average level of shyness in samples of children, adolescents, and young adults. Results from these kinds of cross-sectional studies suggest that middle-aged adults (e.g., adults age 40–50) are higher in conscientiousness than teenagers. One problem with this research strategy is that age differences are conflated with birth cohort differences. Although middle-aged adults may actually be more conscientious than teenagers, it is also possible that individuals born in the 1950s are higher in conscientiousness than individuals born in the 1970s due to changes in cultural norms and expectations. The effects of age and birth cohort are inseparably confounded in a cross-sectional study. A better approach is to examine personality changes by following the *same* individuals over time using a longitudinal design. This method allows researchers to test whether average levels of conscientiousness increase for the same group of individuals as they mature from adolescence to adulthood.

Investigations focused on average levels of personality attributes at different ages are sometimes called investigations of 'normative' personality differences because they provide information about the personality characteristics of the so-called 'typical' person at different stages of life. A concern is that average trends may obscure a great deal of individual variability in the way people change. Although conscientiousness may increase on average from adolescence to middle age, it is possible that it increases substantially in some individuals, in some only slightly, and in some it actually decreases. Given this possibility, some researchers prefer to focus on individual trajectories of personality development to determine how well each person in a sample follows the overall mean-level trends for the sample. Techniques for these analyses range from sophisticated growth curve models applied to multiwave data to fairly simple indices of real change, based on difference scores computed across two measurement occasions.

Another popular area of research in personality development concerns the study of rank-order stability. A longitudinal design is required to investigate rank-order stability as it is typically measured using the correlation between the same personality measures administered at two time points but across an interval of sufficient length that will allow for the possibility of real personality change (e.g., more than a few months). These correlations are often called stability coefficients and they reflect the degree to which the relative ordering of individuals on a given trait is consistent over time. If researchers observe a high degree of rank-order stability for aggressiveness, it would mean that relatively aggressive adolescents tend to grow into relatively aggressive adults, regardless of any normative increases or decreases in aggressiveness that may co-occur with age. Rank-order stability is distinct from absolute stability

because individuals may experience an overall decline or increase in absolute levels with age but nonetheless maintain their same position relative to others (e.g., there are large normative increases in height across development, but individuals generally maintain a similar rank ordering). A high degree of rank-order consistency is integral to the concept of a personality disposition.

In summary, there are a number of conceptually and methodologically distinct ways of addressing questions about personality stability and change. This diversity requires the use of precise language to specify the exact type of consistency and change under investigation. Nonetheless, researchers strive to address all types of stability to provide a comprehensive picture of personality development. We now turn to summarizing basic findings about personality development across the life span.

Early Emerging Personality Attributes: Child Temperament

Do emotionally reactive and difficult toddlers become aggressive adults? Do fearful infants become anxious adults? A key research issue in personality development concerns these questions about personality coherence or whether instantiations of individuality in young children are elaborated into adult personality traits. To be sure, individual differences are noticeable in even very young children. Some newborns are extremely fussy and difficult to soothe whereas other newborns are tranquil and easy to comfort. As newborns develop throughout infancy, they exhibit increasingly complex responses to the environment. Emotional reactions, ways of interacting with caregivers, and responses to the broader environment become more differentiated and patterned with age. At some point, these characteristics coalesce into the early emerging individual differences that are commonly referred to as attributes of childhood temperament.

Mary Rothbart and John Bates provided one of the most widely used definitions of temperament: “constitutionally based individual differences in emotional, motor, and attentional reactivity and self-regulation.” An important element of this definition is the emphasis on dimensions of individuality that are thought to be rooted in biology. However, temperament researchers acknowledge that nearly all early emerging individual differences are affected by life experiences as well as by genetically influenced tendencies and other physiological factors. A second important element of this definition is an emphasis on emotional processes as many of the separate dimensions of temperament reflect individual differences in the functioning of affective systems that motivate behavior in either an approach or avoidance fashion.

As with the research on the structure of adult personality traits that seeks to identify a set of basic domains that can be integrated into a hierarchical structure ranging from broader to narrower dispositions, researchers also seek to identify the basic dimensions and organizing structure of childhood temperament. One prominent model for childhood temperament identifies three broad dimensions – positive emotionality, negative emotionality, and constraint versus disinhibition. Positive emotionality captures the tendencies to approach the environment and engage in interactions with others

(i.e., extraversion). Negative emotionality captures the tendencies to become distressed, experience aversive emotions, and feel threatened (i.e., neuroticism). Constraint versus disinhibition captures the ability to exercise control over impulses and direct behavior toward achieving longer term goals (i.e., conscientiousness).

A largely complementary approach classifies temperamental dimensions using childhood analogs of the Big Five dimensions of adult personality – extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience – to organize the dimensions of childhood temperament. Indeed, some researchers actually consider the Big Five to be the dimensions of temperament. These domains are evident in adolescents and even in children as young as 5 years of age. The one caveat is that openness to experience may not have a clear parallel in childhood temperament. The difficulty in linking openness to experience with childhood temperament is perhaps not surprising given that openness seems to have the least consistent link with neurological systems in the brain.

As it stands, there is evidence for a connection between childhood temperament and adult personality. A complication is that longitudinal research focused on the same dispositions from childhood to adulthood is fairly rare. This should change as more and more longitudinal studies are designed to explicitly address this important question.

One of the most recent and impressive examples of personality coherence comes from a study of the Hawaii Personality and Health Cohort. Investigators of this project have followed roughly 2404 individuals from the time they were elementary school children in the early 1960s to the present. A team of investigators video recorded a subset of these individuals when they were middle-aged adults. These recordings were then coded for a diverse range of personality attributes by trained coders. There was an appreciable correlation between the ratings of the individuals made by their elementary school teachers and the observer ratings of those same individuals at midlife. Individuals rated as talkative by teachers in elementary school developed into middle-aged adults who were rated as socially dominant and assertive by observers. Individuals rated as able to cope with new situations and face uncertainty were rated as cheerful and self-confident as middle-aged adults. A key message from this study is that there is a meaningful personality coherence from childhood to middle age.

In a similar vein, researchers studying a cohort of individuals born in New Zealand have found meaningful associations between ratings of 3-year-old children made by clinical interviewers and adult outcomes at age 21. Children who were rated as being irritable and impulsive at age 3 were more likely to be dependent on alcohol and to have been convicted of a violent crime by age 21. The fact that there is a connection between preschool attributes and problems with alcohol and violence during early adulthood is impressive evidence for the coherence of traits related to difficulties with impulse control. This work also points to personality coherence across development even when considering the personality attributes of very young children.

All in all, efforts to integrate childhood temperament with adult personality are progressing as researchers converge on a set of basic dimensions that are relevant for adaptation across the life span. This effort at integration will take some time,

however, because it will be years and even decades before participants in newly initiated studies mature from children into adults. Nonetheless, efforts to unify research on childhood temperament and adult personality represent an exciting area of synergy between developmental psychology and personality psychology that may help to curb the 'jangle fallacy' that permeates psychological science (i.e., if two constructs have different names then they must be different).

Mean-Level and Rank-Order Stability of the Big Five Across the Life Span

What are the patterns of normative personality development? What is the pattern of rank-order stability across the life span? Summarizing research on these topics has been greatly facilitated by a number of meta-analyses that were conducted in the last decade. A meta-analysis is a statistical approach for summarizing research literatures and essentially involves averaging the results from all available studies. This method permits researchers to quantify findings across the entire research literature and is perhaps optimal to narrative reviews, which simply provide qualitative impressions of previous work.

A meta-analysis by Roberts, Walton, and Viechtbauer provided a summary of average levels of the Big Five traits using data from 113 longitudinal samples involving 50 120 participants ranging in age from adolescence through old age. These researchers divided the extraversion domain into two facets: social dominance (traits related to independence and dominance) and social vitality (traits related to positive affect, activity level, and sociability). Average levels of social vitality tended to be fairly flat across the life span, although there was a slight spike upward from adolescence to young adulthood followed by a plateau until the mid-50s when there was a slight decline. Social dominance, on the other hand, showed a more pronounced trend such that there was a consistent absolute increase from adolescence to the early 30s where mean levels remained consistent until the mid-50s, after which the lack of studies precluded further analyses. Agreeableness and conscientiousness showed gradual increases in absolute scores across the life span whereas neuroticism showed gradual decreases. Finally, openness showed a mean-level increase from adolescence to young adulthood and then mean levels remained constant until the mid-50s when it started to show a slight decline in average levels.

One of the more interesting results that emerged from this meta-analysis concerned the adolescent period. Contrary to the popular belief that adolescence involves tumultuous changes in personality, the Roberts et al. meta-analysis demonstrated that the largest mean-level changes in personality occur during the young adult years (i.e., the 20s). This is the phase in the life span when individuals assume the roles of worker, committed romantic partner, and in many cases, parent and caregiver. Furthermore, it is easy to see how increasing levels of agreeableness and conscientiousness and decreasing levels of neuroticism facilitate the successful enactment of the roles of worker, parent, and committed romantic partner. Thus, average levels of traits change in ways that coincide with the time in the life span during which individuals assume mature social roles, a pattern referred to as the maturity principle of adult personality development.

In summary, the available data indicate that average levels of agreeableness and conscientiousness increase with age whereas average levels of extraversion (in the aggregate), neuroticism, and openness decline with age. There are two dominant explanations for these mean-level differences in the Big Five domains across the life span. The *intrinsic maturational position* holds that normative age-related changes in personality are driven by unfolding biological processes related to aging whereas the *life course position* posits that changes stem from investment in particular social roles and the life experiences that accompany these roles. Researchers are currently debating which perspective has the most empirical support. One of the complicating factors is that critical tests of these two explanations are nearly impossible because experimental manipulations of either biological factors or important social roles are neither ethical nor feasible.

At least two different meta-analyses have investigated rank-order stability across the life span. Roberts and DelVecchio examined test-retest correlations from 152 longitudinal studies and found that the rank-order stability of personality increases across the life span, ranging from a low around 0.30 in childhood to a high of 0.70 in late adulthood. This pattern generally held for men and women and for all five of the Big Five traits. A more recent meta-analysis by Ferguson reached similar conclusions, although in his analysis rank-order stability reached a plateau earlier in development than in the Roberts and DelVecchio analysis (perhaps because he corrected the rank-order stability estimates for measurement error).

The finding that the rank-order stability of personality increases from childhood to adulthood is known as the cumulative continuity principle of personality development – that is, personality becomes increasingly stable with age (when viewed through the lens of rank-order stability). This naturally raises questions as to why rank-order stability increases with age. Lower stability is expected when individuals respond to experiences differently or experience personality-altering environments at different times. The transition from childhood to adolescence involves rapid maturational changes, shifting societal demands, exploration of new identities and roles, and initiation of new peer and romantic relationships. These changes may impact individuals in relatively unique ways, thus shifting their relative ordering on a trait and thereby reducing stability coefficients. In contrast, the transition to adulthood is accompanied by fewer maturational changes and social transitions that begin to stabilize. Likewise, a hallmark of adulthood is the increased ability to select environments consistent with individual dispositions. These broad developmental considerations may explain the cumulative continuity principle. Indeed, researchers are now moving beyond simply documenting patterns of mean-level and rank-order stability to testing hypotheses about the underlying mechanisms that produce personality consistency and change.

What Mechanisms Account for Personality Stability and Change?

What specific mechanisms account for the stability of personality over time and, conversely, what account for change? Contemporary research suggests that personality stability and change result from complicated transactions between

persons and situations. Three processes in particular might promote stability in personality by producing a correspondence between personality traits and characteristics of the social environment.

First, personality traits 'draw out' or otherwise evoke corresponding responses from the social environment. This matching between the underlying dimension and the environmental response or reaction may reinforce both the disposition and the individual's social ecology. This process would tend to promote personality continuity. For example, individuals who are aggressive may evoke more hostile responses from classmates and coworkers. These hostile responses may then accentuate the initial tendency toward aggressiveness. In short, it seems as if many individual dispositions generate responses in social environments which end up reinforcing those very dispositions.

Second, personality traits shape how people interpret social situations that can have real consequences for behavior and its effects. The same objective environment, such as a cocktail party, may prove stimulating and exciting to an extraverted individual but terrifying to an introverted person. These different construals of the same objective environment might facilitate self-fulfilling prophecies. The scared introvert might act awkward and stand-offish to fellow party guests, thereby generating unpleasant and strained interpersonal encounters. The upshot is that this process would also tend to reinforce initial personality dispositions.

Third, personality traits can influence the settings that individuals select and create for themselves. One of the consequences of human agency and autonomy is that individuals have the freedom to seek out, modify, and even create environments that are consistent with their individual characteristics. The characteristics of individuals and the characteristics of their social situations are therefore correlated. For example, what people do for a living and how they structure their environments may reflect their personalities. These social contexts may then help to maintain the personality characteristics that were initially responsible for the selection processes in the first place. Individuals who are outgoing and sociable may choose careers that fit well with these tendencies and shun solitary occupations with limited potential for social interaction. Such a career may enhance and sustain these extraverted tendencies.

The upshot of these three mechanisms is that many life experiences serve to deepen and intensify the personality characteristics that were partially responsible for the environmental or social experiences in the first place. This is known as the *corresponsive principle* of personality development. The principle would naturally promote personality consistency across developmental periods.

A different set of mechanisms, however, may explain how personality change occurs. These mechanisms might have particularly important applied value for those wishing to promote certain personality attributes or modify existing ones (e.g., parents, teachers, or therapists). The first mechanism of personality change stems from the observation that individuals are responsive to contextual features of the situation, in other words, behavior changes in response to the salient cues, rewards, and punishments of a given setting. One possibility is that long-term exposure to specific contingencies may produce lasting personality changes. Life events such as marriage, parenthood, or military service may launch individuals into new

environments with clear and salient reward structures that produce enduring changes in personality.

The other processes might involve more complicated social cognitive processes. Observing others might serve as the second process of personality change. The catalyst for this kind of personality change follows from the basic principles of social learning theory. For example, observing that a hardworking coworker is financially rewarded with a year-end bonus might promote imitation of that behavior to achieve a similar reward. Likewise, feedback from others may create personality changes. For example, having a daughter or son who looks to a parent as an important role model might help generate personality changes in the direction of increased maturity for that individual. A countervailing force is perhaps the tendency for individuals to process feedback from others in ways that confirm preexisting self-views. Last, deliberate self-reflection helps generate lasting personality changes. The idea that self-reflection and deliberation can lead to behavioral change is the essence of many psychotherapies. However, an important and perhaps even essential ingredient in these three processes of personality change beyond the responses to situational contingencies might be a strong initial motivation to change. Without this kind of motivation, the individual might not pay attention to particular models, process feedback from others in a way that can promote change, or otherwise invest effort in the process of self-change.

Conclusion

The subfield of personality development is an exciting area of synergy that combines insights from behavioral genetics, clinical psychology, developmental psychology, personality psychology, and social psychology. There has been a dramatic accumulation of new knowledge in this area over the past few decades. Researchers have considerably more insight into how to conceptualize personality at multiple levels and how to describe and statistically model different types of personality stability and change. Key insights from the field of personality development are that personality exhibits a degree of coherence from childhood to adulthood. Nonetheless, there are characteristic changes in personality that seem to accompany aging that reflects increasing psychological maturity and the capacity to fulfill important adult roles. Likewise, individual differences in personality appear to become increasingly stable with age when viewed through the lens of rank-order stability such that childhood personality is probably more malleable than adult personality. Even so, personality changes can occur at all periods of the life span as there is no time in the human life span in which personality attributes are completely fixed. Ultimately, the most important message from the field of personality development is that personality stability and change result from dynamic processes that involve a complicated interplay or transaction between individuals and their environments.

See also: Big Five Model and Personality Disorders; Temperament and Individual Differences.

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Personality Development and Aging

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Glossary

Cohort A group of individuals with a common defining characteristic, that is, age group.

Cross-sectional data Refers to data collected by observing many individuals at the same point of time or without regard to differences in time.

Differential stability Refers to the degree to which the relative ordering of individuals on a given variable is maintained over time.

Individual differences in change Implies that some people change whereas others remain stable and also that people differ in degree and direction of change.

Longitudinal data Refers to data collected by tracking the same individuals over time.

Mean-level change Refers to change in the average level of a variable in a population or a sample.

Personality traits Relatively enduring patterns of thoughts, feelings, and behaviors, which are expected to remain stable over time and are consistent across situations.

Structural stability Refers to the stability of the fundamental structure over time, implying similar correlational patterns among a set of variables over time.

Introduction

How do our personalities develop across the adult lifespan into old age? And why do some people change while others remain stable? There have been a number of theories developed by prominent psychologists such as Freud and Erickson to answer these questions. Four, but not mutually exclusive, theoretical perspectives on development might be helpful in visualizing personality development and aging. They are (1) the age-dependent perspective, (2) the life-event perspective, (3) the active-individual perspective, and (4) the lifespan development perspective. The first perspective relies upon the assumption that a person's personality may or may not change as a function of biological aging. The second perspective considers effects of normative life transitions and nonnormative life events on personality development and provides an understanding of how life circumstances can influence people's thoughts, feelings, and behaviors. It assumes that the developing individual is responsive to certain kind of life circumstances and transitions (e.g., retirement) as well as to unexpected events (e.g., death of a child). The third perspective supposes that persons actively regulate their emotions, cognitions, and behaviors, and thus are active agents of their development. In other words, what an individual brings to the context with his or her personality shapes and changes the context itself, which, in turn, may also influence the individual. Finally, the fourth perspective assumes that development is a lifelong process covering all periods of the lifespan. This perspective places emphasis on the potential plasticity of personality as a function of individual and contextual variables and compensatory behavioral changes to biological aging. The main argument is that complex dynamic interactions between individuals and their environment result in personality change (and stability) throughout the lifespan. This perspective provides a broad theoretical background for this article.

The purpose of this article is to give an overview of theoretical and empirical work on personality development and aging from a lifespan development perspective. In the first part,

we introduce personality traits as units of analysis and use the well-known 'Big Five' personality taxonomy to describe the trait domains that can be studied across the lifespan. In the second part, we present the theoretical background of the lifespan development perspective in relation to personality traits. Finally, in the third part, we give an overview of empirical research on personality trait development across the adult lifespan into old age by means of different types of change and stability.

Personality Traits as Units of Analysis

It is common in personality psychology to distinguish between structures and processes of personality. Structures refer to the content and organization of personality, whereas processes reflect the dynamics of personality. In other words, the two aspects refer to the 'having' and 'doing' sides of personality. A structural approach to personality concerns how the parts of personality are organized together into distinct areas of personality and what those areas of personality are. It focuses on how a person is different from other persons. For example, this approach examines how many factors best describe individual differences in thoughts, feelings, and behaviors. A process-related approach to personality concerns how the different parts of personality influence one another and affect individuals' behaviors and reactions to situations. This approach focuses on what goes on inside a person and thus aims to study the psychological functioning. For example, it examines how people regulate their emotions in daily life. Hooker and McAdams have proposed a personality model, called the six foci of personality, that integrates structures and processes within a levels-of-analysis framework and includes traits, personal action constructs such as goals, and life stories as structural components and states, self-regulation, and self-narration as the parallel process constructs. Personality traits, the first level of the model, refer to enduring patterns of thoughts, feelings, and behaviors that are relatively consistent across a

wide variety of situations and over time. They are organized in the conceptual framework of the 'Big Five' or Five-Factor model, that is, neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Briefly, neuroticism, or conversely, emotional stability, contrasts even-temperedness with the experience of anxiety, worry, anger, and depression. Extraversion refers to individual differences in the propensity to be sociable, active, assertive, and experience positive affect. Openness to experience refers to individual differences in the proneness to be original, complex, creative, and open to new ideas. Agreeableness refers to traits that reflect individual differences in the propensity to be altruistic, trusting, modest, and warm. Finally, conscientiousness reflects the propensity to be self-controlled, task- and goal-directed, planful, and rule-following. The personality model contrasts traits with states as dynamic processes of personality (e.g., moods, emotions) that are transient and involve short-term change. Personal action constructs reflect motivational constructs such as strivings, goals, motives, and developmental tasks. They are contextualized in time, place, and social role and are less broad than traits. The processes, when related to personal action constructs, can be called self-regulatory processes. Finally, the life story is the individual's narrative understanding of the self. People create life stories that reconstruct the past and anticipate the future to provide their lives with some sense of meaning, unity, and purpose. Self-narration reflects parallel processes related to the life stories.

The personality model emphasizes differential changeability of personality and suggests that some constructs of personality are more responsive or sensitive to change than others. Specifically, regarding the development of structural components of personality, the model assumes that traits change the least and life stories the most, whereas mid-level personality features such as goals are more stable than the latter, but more responsive or sensitive to change than the former. Hence, the time that is needed to accurately capture systematic change in the respective constructs of personality is an important developmental aspect. Time intervals that are too short or too long in relation to the nature of the phenomenon being studied can produce data that, in some cases, are overly sensitive to measurement errors and carry-over effects and, in other cases, are insensitive to variability and change. With respect to personality traits, the expected rate of change may, on average, be quite slow as compared to processes such as states or self-regulation.

In this article, we focus on the development of personality traits rather than other important personality constructs such as goals, motives and life stories, or process constructs, given space constraints, and because most systematic work on personality development and aging refers to this level (for a detailed discussion of the development of other personality constructs, see McAdams and Olson and Mroczek and Little).

A Lifespan Development Perspective

The lifespan development perspective provides a way for understanding development and aging. This view that is based on the theoretical work of Paul Baltes and colleagues seeks to explain the general principles of development at all

ages and seeks to understand why some people exhibit different trajectories of development in different domains of psychological functioning compared to others. Moreover, this view seeks to identify the extent to which these domains can be changed or enhanced at different points during the lifespan. The lifespan perspective recognizes that multiple dimensions of psychological functioning such as personality or cognition can change, that change is multidirectional and multiply caused, and that interdisciplinary approaches are the key for understanding change. Finally, this perspective recognizes that change occurs in social, cultural, and historical contexts. We briefly outline four basic concepts of the lifespan development perspective, which bear relevance for personality development and aging: (1) development as a lifelong process, (2) variability of development, (3) multidirectionality of development, (4) contextualism and development (for an extensive discussion of the lifespan development perspective, see Baltes et al.). These concepts have important implications for personality development and aging as they may offer insights into the structures and processes of personality and thus have the potential to advance the understanding of personality development across the lifespan into old age.

Personality Development as a Lifelong Process

The key assumption of the lifespan development perspective is that development – be it in such diverse domains as cognition, emotion, motivation, or, in this case, personality – is not completed at a specific age or life period (e.g., young adulthood or midlife), but rather extends over the entire lifespan into old age. However, it is assumed that every age period in the lifespan (e.g., infancy, childhood, adolescence, adulthood, and old age) has its own developmental agenda and includes sensitive periods in which the developing individual is especially responsive to certain kind of developmental tasks or life experiences. For example, adolescence is the period of psychological and social transition between childhood and adulthood that includes profound physical changes. Developmental tasks in this period might be that adolescents have to learn to establish intimate relationships and to have other exchanges that support a sense of self-identity and sensitivity for the needs of others. Another example refers to retirement as a period of different changes from the work life to retirement that comprises processes of adaptation to new situations.

Adopting this lifespan development concept for personality traits implies that personality development is a lifelong process. However, in personality research, the question of whether and how much personality changes in adulthood was a controversial issue, resulting in two broad and opposite hypotheses regarding personality trait change. On the one hand, the plaster hypothesis suggests that the adult personality is relatively stable. It assumes that personality is more or less fixed or crystallized at a certain point in young adulthood (e.g., around the age of 30 years) and that personality is thereafter relatively stable. It is argued that stability of personality traits is largely due to biological underpinnings such as genetic influences and environmental stability such as relative, stable parental demands, teacher expectancies, and peer or partner influences. Contrasting this view, the plasticity hypothesis asserts that personality traits remain changeable throughout the lifespan into old age.

Even though there is considerable stability in personality, personality traits are thought to have the capacity to change. Included in this hypothesis is the assumption that personality traits remain open systems that can be influenced by the environment at any age and thus remain susceptible to the pressures of life and the potential socialization effect of life experiences. This does not imply that the social and cultural contexts necessarily influence personality or that the traits must change, rather it assumes that they have the capacity to change at any age and eventually adapt to environments. The main argument is that complex interactions between an individual and its environment produce changes in personality across the lifespan. This idea is consistent with the concept of development as a lifelong process.

Multidirectionality of Personality Development

One central concept conveyed by contemporary work in lifespan development is that lifelong development involves diverse change patterns that differ, for example, in terms of timing (e.g., onset, duration, and termination), direction (e.g., increase, decrease, or stability over time), and order (e.g., change and then stability). With respect to personality development, this implies that developmental trajectories of personality traits can show age trends in every direction and also with different magnitude. In fact, as we show below, previous research has clearly demonstrated that the Big Five personality traits are characterized by multidirectionality in their developmental course across the lifespan; while some traits increase with age, others remain relatively stable or decrease. The concept of multidirectionality of development is strongly related to the concept of multidimensionality. This idea supposes that development may vary between different domains of functioning (e.g., cognition, emotion, motivation, or personality) and may also vary within the respective domains. Pertaining to the 'Big Five' as the conceptual framework for individual differences in personality traits, it implies that each of the traits can develop differentially. As we outlined above, personality can be conceptualized as a multilevel and multifaceted construct that includes both structures and processes within different levels. Taking this idea into account, different developmental trajectories with respect to different structural and process aspects of personality might emerge. Therefore, the concept of multidimensionality emphasizes the importance of comparing developmental trajectories across domains as well as within domains.

Variability of Personality Development

The lifespan development perspective assumes individual differences in development. That is, individuals might differ in their development at every level, not just between persons of different ages or between different persons of the same age but also within an individual over time. Individuals can differ markedly from each other in whether they are stable or changes in their psychological functioning such as cognition, emotion, or personality traits. This idea is embodied in the concept of interindividual differences in intraindividual change, which implies that some people change whereas others remain stable and also that people differ in degree and direction of change. The term 'interindividual differences'

emphasizes the differences among individuals, whereas the term 'intraindividual change' indicates variability within individuals. The lifespan perspective assumes that development across the lifespan is characterized by intraindividual variability. Variability is not a source of error variance, but rather it indicates the potentials for change that individuals have for different levels of psychological functioning. Depending on the life conditions and experiences of a given person, not everyone is characterized by the same developmental trajectories in personality traits. Hence, the capacity to adapt to a changing environment implies a bandwidth of intraindividual variability. To conclude, variability in development speaks to the unique patterns of development particular to individual lives.

Contextualism of Personality Development

Finally, the lifespan development perspective assumes that development is embedded in historical and cultural contexts as well as in more proximal social contexts such as work and family contexts and thus is sensitive to contexts. Put in other words, the contexts are the stages of life in which development of each individual takes place. That is, individuals are integrated in a changing world and in life environments that create opportunities for and limitations to individual developmental pathways. For example, contextual factors such as life circumstances and events in the life cycle – for example, getting married, having children, getting divorce, the empty nest, the death of a spouse, and the development of physical disability and cognitive problems in older age – may influence development. According to Baltes, development is influenced by a dialectical interplay between three sources of contextual influences: (1) age-graded or normative, (2) history-graded, and (3) nonnormative influences. First, age-graded influences include biological (e.g., physical maturity, menopause) and environmental aspects (e.g., social clock, developmental tasks) that have a strong age correlation and shape development in relatively normative ways for all individuals. For example, as individuals move through their life, they are faced with quite similar challenges or developmental tasks and/or demands, such as becoming an adult, finding a place in society, establishing a family, starting a career, and/or being productive in other ways; finally, individuals have to deal with the end of their own life and those of loved ones. Second, history-graded influences denote biological and environmental factors that are associated with historical time and bring about the development of individuals different across cohorts and generations. Examples for this source of influence are wars, changes in technology, or changing social norms. Finally, nonnormative influences are idiosyncratic events that impact only some individuals and do not follow a predictable course. Some individuals experience specific positive life events such as getting an unexpected promotion, whereas others are subject to negative life events such as having a serious car accident or losing the job. Other people, in turn, report multiple life events, whereas others do not exhibit any major change in life circumstances.

With respect to the three sources of contextual influences, it is important to consider that some life circumstances are age-graded and expectable, whereas others are unexpected or off-time. It is assumed that the former might help to bring about change, particularly when clear information is provided

about how to behave adaptively or how to change oneself. The latter, on the contrary, may accentuate individual personality differences. Novel, ambiguous, and uncertain situations might violate expectations, undermine predictability, or generate discomfort and create a strong press to behave in certain ways. Because of the lack of information about how to behave adaptively, precisely at these times, diverse ways in adapting to transitions might be observed. Regarding the developmental period of old age, many challenging developmental tasks in the form of changing life circumstances and negative life experiences (i.e., retirement, illness, widowhood) require adaptation that probably involves personality change. Particularly, changes in health status, changes in social support, and a decrease in autonomy (i.e., the need to have a sense of choice and being the initiator of an action) have been shown to be associated with changes in personality traits.

Social Roles Include Contextual Information

Although we assume that environments may have an influence on development, the issue of conceptualizing and measuring contextual aspects is rather complex. Brent Roberts and colleagues proposed a psychologically meaningful way to investigate contextual influences via the social role concept. They argued that rather than investigating the influence of objective contextual variables on personality development, it may be more meaningful to examine 'subjective' environment in the form of social roles (e.g., worker role, parent role) and to investigate the relation between changes or stability in social roles and personality development. The idea is that roles contain cultural, societal, and individuals' expectations of how to behave in social roles and that an active, psychological commitment or investment to the roles might be associated with personality change. In line with this idea, the work domain might reflect an important social context that might be related to personality change and vice versa. In this context, the transition from work life into retirement is an example of how change in the living context and in a social role (i.e., work role) can have an influence on personality development. First, empirical results in the domain of work suggest that this environmental change, in general, decreases people's pace and activity. Furthermore, people on average get less competitive and argumentative in the new social role of a pensioner. It could be assumed that after adapting to the role of the pensioner, a stable living context has a stabilizing influence on the individual's personality. Likewise, social relationships such as family or romantic relationships might be another way in which social environments and changes in social contexts can influence personality and vice versa. One of the most consistent findings in the aging literature is a decrease in the number of social network partners as people age as well as a decrease of social roles in the late middle and older adulthood. Although older people may have smaller social networks than younger people, they are as satisfied with their relationships as younger persons, feel strong bonds to close friends, and frequently report greater emotional investment in their social relationships because often they have given up their ties to more peripheral relationships. Regarding very old adults, however, more and more individuals of their close social network are passing away. These relationships, in particular, seem to be very difficult to replace with similar close

and intense contacts. Findings indicate that a decrease in social contacts and an increase in loneliness are associated with an increase in neuroticism in very old adults.

To conclude, the concepts of the lifespan development perspective provides the theoretical background for addressing personality development and aging. In the next section, we give an overview of empirical research on personality trait development.

Different Types of Change and Stability

Based, in particular, on the outlined idea of development as a lifelong process, we would expect that our personalities have the capacity to change across the lifespan into old age. Indeed, previous cross-sectional and longitudinal research has shown that both change and stability mark personality trait development across the lifespan, albeit differentially depending on the types of change and stability one considers. In the following sections, we clarify what we mean by change and stability and present empirical evidence for personality trait development organized according to different types of change and stability.

Change and stability are multidimensional constructs, and each conceptualization offers unique perspectives to evaluate personality trait development, both conceptually and empirically (for details, see Roberts et al.). Each type of change and stability offers a particular understanding to personality trait development. Consequently, to draw clear conclusions about personality trait development across the lifespan into old age, it is necessary to define what exactly is meant by the terms 'change' and 'stability.' To that end, we briefly outline three types of change and stability based on samples or populations of individuals and emphasize the establishment of general developmental principles: (1) structural stability, (2) differential stability, and (3) mean-level change. Finally, we describe two additional types of change and stability that are underrepresented in the literature on personality trait development: (4) change in interindividual differences and (5) individual differences in change. The latter type of change addresses the patterns of individual development particular to individual lives and emphasizes the understanding of change and stability within an individual.

Structural Stability of Personality Traits

At the foundation of the different types of change and stability is structural stability, which refers to the stability in the interrelations among a set of variables across different age groups and over time. With respect to personality trait development, this type of stability reflects stability in the structure of personality trait covariances. Consequently, a stable structure would imply that the positioning of traits relative to each other remains stable, suggesting that their meaning remains unaffected by age and aging. This type of stability can address the question of whether the covariation pattern among a set of variables is stable across age groups and time. Change in the structure of personality trait might be indicative of maturation of personality in young adulthood or might reflect aging processes in old adulthood. For example, studies have shown that the personality trait structure matures in adolescence and

becomes more differentiated in late adolescence and young adulthood. Put differently, the results indicated that the correlations among the personality traits decrease during that age period. For example, if the negative correlation between extraversion and neuroticism decreases, it would imply that one could be extraverted without necessarily being emotionally stable. By contrast, a strong correlation would imply that being extraverted is closely connected to low neuroticism. Another theoretically plausible interpretation of structural change in personality might be borrowed from models of cognitive aging. It has been suggested that, as adults grow older, specialized cognitive abilities become less differentiated, that is, they become dedifferentiated and more highly correlated. This dedifferentiation is thought to result from a decrease in the integrity of the physiological systems related to the cognitive abilities, which reduces the specificity of particular skills. Another possible suggestion is that aging effects reflect decline in process-specific functions such as different abilities.

Regarding personality traits, cross-sectional and longitudinal research has demonstrated relative high levels of structural stability in traits over time and across age groups in adulthood. However, it is not clear whether the factor structure remains stable in old age. There is preliminary evidence for structural change in the Big Five traits in old age, suggesting that personality might become less differentiated or, in turn, more dedifferentiated over time in old age. Investigations of structural stability (and also other types of stability and change) often include the testing of measurement invariance or equivalence. This psychometric issue touches the question of whether psychological constructs are comparable across different age groups and/or across measurement occasions for the same individuals. Frequently, in lifespan developmental studies, it is implicitly assumed that the measurement process of constructs is similar across age or time. However, there may be age differences or age-related changes in the conceptual frame of reference in interpreting or reacting to a given item of a questionnaire or stimulus materials in experimental studies, thus altering the way the latent construct underlying the item or stimulus is measured. Therefore, it is important to systematically establish that the same attribute (e.g., neuroticism) is being measured in the same way across different groups (e.g., age groups) or on different measurement occasions. Measurement invariance or equivalence is considered a prerequisite for making meaningful inferences about change and stability of personality traits.

Differential Stability of Personality Traits

This type of stability, also called rank-order stability, refers to the degree to which the relative ordering of individuals on a given variable is maintained over time. It explicitly requires longitudinal research and is typically assessed through test-retest correlations or stability coefficients of measurement occasions separated by a specified time interval. This type of stability can address the question of whether people retain their standing on a trait dimension relative to others over time. A high test-retest correlation would implicate either that individuals are stable in a given trait over time or are changing, but in more or less the same way. This situation can occur when a normative developmental event such as

retirement impacts all individuals in the same way (e.g., if retirement causes everyone to decrease or increase in a personality trait by the same amount). By contrast, a low test-retest correlation indicates that individuals are changing over time and there are individual differences in the direction of change, implying that some individuals are increasing in a personality trait whereas others are decreasing. This can occur when nonnormative events impact personality traits (e.g., if some individuals get divorced and decline or incline in a particular personality trait whereas others do not experience this life event and maintain the same personality trait level). In addition, a low test-retest correlation can also occur when the factors that influence the personality trait are normative, but individuals have unique reactions to these events (e.g., if retirement causes some individuals to increase in a personality trait but causes others to decrease in the same trait). Finally, from a methodological point of view, a low test-retest correlation could also simply reflect measurement error or less reliable measurements.

Longitudinal studies have been conducted to investigate differential stability of the Big Five personality traits. In order to test whether trait stability maximizes and stabilizes at a specific period in the lifespan, Roberts and DelVecchio conducted an extensive meta-analysis and included 152 longitudinal studies. Estimates of mean population test-retest correlation coefficients showed that the overall trait stability increased from 0.31 in childhood to 0.54 during the college years, to 0.64 at age 30, and then reached a plateau around 0.74 between ages 50 and 70. Their findings suggest that there is a tendency for increasing relative stability of personality traits from childhood to old adulthood, a pattern that has been termed the 'cumulative stability principle.' Moreover, differential stability did not vary markedly across the Big Five traits, nor across assessment method (e.g., self-reports, observer ratings, and projective tests), or gender. A slightly different pattern of trait stability is found for very old adults (i.e., 80–100 years). Results from previous studies indicate a decrease in differential stability in personality traits such as emotional stability (or inversely, neuroticism), imagination, sensitivity, and dominance in very old age. Hence, personality seems to become more plastic and prone to change again in very old age. To conclude, although a relatively high differential stability coefficient around 0.70 is found in late middle and older adulthood, it is not perfect (1.0) and leaves room for individual change. As mentioned above, individual change can be due to unexpected life events or off-time lifespan transitions. The decrease in trait stability in very old adults might point to an increase in vulnerability as social and psychological resources diminish with age. For example, cognitive impairments, which are quite prevalent in very old individuals, can also decrease the stability of certain personality traits.

Mean-Level Change of Personality Traits

This type of change, also called absolute change, refers to the extent to which the average level of a variable changes systematically across different age groups and over time. With respect to personality trait development, it reflects (1) cross-sectional age differences and (2) longitudinal age-related change in the average levels of personality traits. This type can address

the question of whether average scores of individuals show systematic age differences or age-related change over time. Mean-level change is often equated with 'normative change' in personality. Normative change occurs when most people change in the same way during a specific period within the lifespan (e.g., adolescence). Change in the mean levels might be thought to result from maturational and/or contextual processes (e.g., cultural and historical influences) shared by a population. These shared processes could be biological in origin, such as the general period when adolescence begins or when menopause occurs in women. The timing of these biological phenomena is partially driven by genetic factors and tends to happen within a specific period of the lifespan for most people in the particular population of interest. Likewise, it is also possible that normative change in personality traits arises due to similar life tasks and an engagement and investment in age-graded life tasks and social roles (see above).

Previous research on mean-level change in personality traits found a mixture of different patterns of how people change with age. Roberts, Walton, and Viechtbauer conducted an extensive meta-analysis and included 92 samples from longitudinal studies. Their results indicated that on average individuals became more socially dominant (a facet of extraversion), especially in young adulthood. They became more conscientious and emotionally stable and less neurotic through midlife. Although much of the change on agreeableness was positive, the findings indicated that the increase was only statistically significant in old age. Other studies reported a positive association between agreeableness and age in adulthood. Finally, people demonstrated gains in social vitality (another facet of extraversion) and openness to experience in adolescence and the equivalent decreases in old age for both of these trait domains. It seems that, on average, as people age, they appear to get better at dealing with the ups and downs of life. In particular, they tend to become more responsive, more caring, and more pleasant in social interactions and also more forgiving. Many of these longitudinal personality trait development patterns are similar to those found in cross-sectional studies despite the potential cohort confound. Mixed results are found regarding mean-level changes in very old adults. While some studies did not find any change at all, other investigations showed increases in agreeableness and decreases in extraversion. An increase in agreeableness in very old age might reflect differential survival because low levels of agreeableness are related to coronary heart diseases, whereas a decrease in extraversion might reflect an adaptation to lower general energy level in old age. Further research on mean-level changes in very old adults is needed.

Change in Interindividual Differences in Personality Traits

Irrespective of the level of differential stability and mean-level change in personality traits across age and time, the amount of interindividual differences (divergence) in personality traits might increase, decrease, or remain stable across age groups or over time. Empirically, this type of change can be examined by comparing personality trait factor variances cross-sectionally and, preferably, longitudinally. An increase or decrease of personality trait variances would indicate – even under conditions of perfect differential stability and no mean-level change – that the amount of change is different for different persons. Thus,

the examination of age differences and age-related changes in variances in personality traits across the lifespan into old age is of particular importance to our understanding of the self. Simply focusing on the age variable neglects the fact that aging is differential, that is, people show different age trajectories. Regarding a broad array of person variables, it is assumed that variability increases with age. Indeed, with respect to cognitive functions and processes, there is empirical evidence for increasing variability with age regarding variables such as reaction time, memory, or fluid intelligence. This phenomenon is called 'aged heterogeneity.'

Pertaining to personality development, there are numerous reasons why increasing differences among individuals might arise. For example, homogeneous developmental trajectories might reflect a more biologically driven developmental process, whereas increasing variances might denote changes triggered by external influences that are socially driven. Hence, the amount of interindividual differences should be relatively stable if personality traits are more genetically based. By contrast, increasing differences among individuals might arise as a consequence of the combined effects of individuals' unique experiences over more years that would produce increasing differences among them. The genetic influence or the timing of genetic activity on interindividual differences vary widely according to age and thus cause individuals to diverge. Also, older people, somewhat freer from societal constraints, would be more likely to choose their own courses of action. In addition, significant changes in physiological and functional status in later adulthood may also produce change of divergence with age. Although this type of change and stability offers additional information about personality trait development, very few studies focused on this type and the results were mixed. Regarding long-term change in old age, there is preliminary evidence for increases in interindividual differences in some personality traits such as openness to experience, suggesting that older participants became more heterogeneous with respect to being open. Increased heterogeneity might result from events or life circumstances that impact only some individuals. Not every older adult is hit by cognitive or physical problems that constrain his or her daily life.

Interindividual Differences in Personality Trait Change

Although the four discussed types of change and stability, particularly differential stability and mean-level change, conceal important information on individual differences in personality traits, the fact that some individuals may be stable, and others changing, is hidden by the aggregate nature of the accompanying statistical techniques for estimation, that is, correlations and repeated-measures means. If individuals change differentially, this does not necessarily lead to mean changes, but it must lead to either change in the rank order of individuals or change in variance. Lifespan development researchers have advocated the idea of individual differences in intraindividual change, which implies that some people change whereas others remain stable and also that people differ in degree and direction of change. These are changes that deviate from the population mean-level patterns of change. This type complements the other types of change and stability by addressing unique patterns of development particular to individuals.

Specifically, it emphasizes change and stability within the individual and implies that individuals change differentially, that is, the degree and direction or pattern of change (e.g., linear, quadratic) may vary across people. Although the investigation of individual differences in personality trait development may offer an understanding of each individual's unique pattern of development, the phenomenon of individual differences in change of personality variables has until recently been largely overlooked. One reason for this is that for many years, there was a lack of adequate statistical models to estimate change accurately. However, a variety of methods are now available that allow to model change over time, particularly the assessment and prediction of intraindividual change. With respect to personality trait development, there is now growing evidence for the existence of systematic interindividual differences personality trait change in young, middle, and old adulthood. There is preliminary evidence showing that individual differences in rate of change seem to be more influenced by nonnormative events than by normative events.

Taking a perspective of interindividual differences in individual change may result in an important developmental question whether changes in different personality traits are related over time across individuals, and if so, to what degree. While differential stability addresses the rank order of change in a single personality factor, the aspect of correlated change covers the amount of correspondence in rank orders of change across several personality factors such as the Big Five personality traits. Investigating correlated change can address the question of whether there is an overall commonality in change in personality traits. Empirically, correlated change may be addressed by correlating intraindividual longitudinal change scores in different personality factors. The issue of correlated change is underrepresented in the personality development literature, whereas it is more prominent in other fields of research, particularly in research on cognitive aging. It is an open question, however, whether changes in the Big Five personality traits are related or not across individuals. It might be that the same underlying causes of change such as social roles, life events, and social environments (for a comprehensive review of potential mechanisms of change and stability, see Caspi and Roberts; Roberts et al.) operate simultaneously on multiple personality constructs such as the Big Five personality traits.

To conclude, previous findings on personality trait development across the adult lifespan into old age imply that although there is evidence for average personality trait changes, there are reliable differences in change between individuals.

Summary

Personality development is an important issue in personality and developmental science. Four take home messages stand out. First, personality is a multidimensional construct with different units of analysis. In this article, we focused on personality traits as structural components of personality. However, personality traits represent only one part of the big picture of individual differences. Therefore, it is important for future research to concurrently consider the multidimensional nature of personality. The levels-of-analysis framework could be a point of departure for such research efforts because it integrates

both structural and process units of analysis and also emphasizes that some units of personality are more responsive or sensitive to change than others. Second, the lifespan development perspective provides a helpful theoretical background for visualizing personality development and aging. Moreover, such a perspective offers broad theoretical explanations for personality development. In this article, we emphasized four important concepts with respect to personality trait development. The key hypothesis is that personality trait development is a lifelong process and that complex dynamic interactions between biological underpinnings and social, cultural, and historical contexts account for change and stability. Third, change and stability are multidimensional constructs. Therefore, a complete understanding of personality development requires attention to several conceptually and statistically distinct types of change and stability. In this article, we summarized empirical research on trait development based on five types. Fourth, there is now considerable empirical evidence for both change and stability of personality traits across the lifespan into old age. At the same time, research has clearly demonstrated individual differences in personality development. To conclude, recent theoretical advances and empirical findings suggest that the future is bright for the scientific study of personality development and aging.

See also: [Aging and the Brain](#); [Aging and Cognition](#); [Alzheimer's Disease](#); [Coping](#); [Divorce](#); [Family Systems](#); [Friendship](#); [Personality Development](#); [Personality, Structure](#); [Retirement](#); [Social Support](#); [Stress and Illness](#).

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Personality Disorders

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Glossary

Kappa score An estimate of reliability, for instance, a kappa of 0.50 between two diagnostic systems means that a diagnosis in one system accounts for half of the variance in diagnosis under another system, after accounting for chance agreement.

Paranoid pseudocommunity The conspiracy network of persons an individual with paranoid personality disorder perceives as against him/her.

Personality disorder Chronic disruptive adjustment patterns, found as a formal diagnosis on Axis II of the DSM system.

Personality type Patterns of behavior that operate as a predisposition to a personality disorder.

Personality disorders (PDs) are static, cognitive, emotional, and behavioral patterns that result in significant impairment for the individual. Notably, elements of the patterns may be active (e.g., parasuicidal behavior) or passive (e.g., failure to recognize emotional context). PDs are generated at an early age, likely as coping mechanisms to manage particular life challenges. These patterns may even emerge as effective coping mechanisms, becoming maladaptive only later in life as interpersonal relationships become more complicated and intricate. The more distorted or disturbed that environment is, the more distorted a coping pattern will emerge. At least as much as any other psychiatric diagnoses, PDs represent violations of social norms and are therefore largely culturally defined.

PDs are therefore not as clearly bizarre as psychosis, nor do they include the clear anxiety symptoms of mood and anxiety disorders (traditionally known as the 'neuroses'). However, PDs are severely maladaptive, because (1) the cognitive, emotional, and behavioral patterns dominate the person's interpersonal presentation and are thoroughly integrated in the personality, (2) having formed in adolescence or earlier, these patterns are maximally chronic, and (3) persons with PDs commonly avoid treatment and may be difficult to treat if for some reason they enter treatment. In fact, their presence in therapy is usually stimulated by some social or legal coercion.

The same patterns may be present to a lesser (or less rigidly applied) degree, such that they do not result in diagnosable levels of dysfunction. In fact, the pattern may simply persevere within socially accepted boundaries. Within this perspective, such a personality type (a behavior pattern seen as within the normal range of adjustment) may be a way-station on the developmental road toward a full-blown PD diagnosis.

Personality Disorder Diagnosis: DSM and ICD Classifications

While we default to discussing the diagnostic methodology of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) below, we clarify differences with the International Classification of Diseases (ICD-10) where relevant.

ICD-10 and DSM-IV identify 8 and 10 separate PDs, respectively. The ICD-10 system excludes narcissistic PD, and classifies schizotypal PD elsewhere under 'schizophrenia, schizotypal and delusional disorders.' Notably, this latter difference may leave schizotypal PD a billable disorder in any system that excludes compensation for treatment of PDs in general. Comparison studies show that the ICD and DSM systems are quite reliable with each other regarding the presence or absence of a PD (kappa scores in the mid-high 90s, meaning that a diagnosis in one system accounts for almost all of the variance in diagnosis under the other system after accounting for chance agreement). Individual PD-specific differences in the two diagnostic systems, including those with poorer inter-system reliability, are addressed in the sections below on the individual PDs.

The DSM-IV-TR PDs have traditionally been grouped into three clusters. Cluster A includes those PDs denoted by peculiar or eccentric behavior, such as the paranoid, schizoid, and schizotypal PDs, as. Cluster B focuses on dramatic and emotionally labile behavior: it includes the histrionic, narcissistic, antisocial, and borderline PDs. Cluster C, which emphasizes chronic fearfulness and/or avoidance behaviors, includes the avoidant, dependent, obsessive-compulsive, and passive-aggressive PDs. Following is a discussion of each individual PD, organized by DSM clusters.

Paranoid Personality Disorder

Paranoid PD (PPD) can be thought of as anchoring the least disturbed and fragmented end of a continuum of paranoid disorders. Paranoid schizophrenia lies at the opposite end with the greatest degree of fragmentation and departure from reality. However, since there is neither a thought disorder nor even a well-formed delusional system in PPD, it is not listed under the DSM paranoid disorders and is not a psychotic condition.

Behavioral, Interpersonal, and Cognitive Patterns

Individuals with PPD manifest hyperalertness toward the environment and have a chronic mistrust of most people. They see

themselves as morally correct, yet vulnerable and envied, and see others as far less than perfect. As a result, their information base is continuously distorted and their affect is constricted. Consequently, they find it difficult to adapt adequately to new situations or relationships, which is paradoxical because of their hyperalertness to their environment. Paradoxically again, they will frequently be correct in assuming that other people are against them. Due largely to their mistrust of others and ability to elicit distrust from others, individuals with PPD have trouble developing intimacy and are continually seeking various ways to be self-sufficient. They avoid the emotional complexities of working out a meaningful relationship and tend to be litigious. For example, they may write negative letters to public figures or bring lawsuits on minimal grounds.

The concept of the paranoid pseudocommunity holds that a person with PPD is unable to communicate freely with other persons and has a pattern of finding fault with others as a result of inadequate social development. The culmination of this personality pattern is the individual's misconception of himself as the center of a community of persons who are in a conspiracy against him. Because the situation does not exist as the person with PPD perceives it, he/she is said to be living in a pseudocommunity.

Diagnostic Considerations

The DSM-IV-TR requires evidence of chronic, pervasive, and unreasonable mistrust of others, such that the motives of others are perceived as malevolent, beginning by early adulthood as indicated by at least four of the following behaviors: (1) unreasonably expects exploitation or deception, (2) is preoccupied with unsupported concerns about loyalty or truthfulness of friends or associates, (3) is reluctant to confide in others due to fear that what is said will be used maliciously against him/her, (4) perceives communications as demeaning or threatening without supporting evidence, (5) persistently holds grudges and is unforgiving, (6) perceives unwarranted character attacks and is quick to anger or counterattack, and (7) has recurrent unwarranted suspicions of partners' infidelity. Finally, the occurrence must not be exclusively during the course of schizophrenia or a psychotic mood delusional disorder.

Therapeutic Considerations

In order to relate to, or even treat the individual with PPD, it is essential to gain their trust through empathy, but not through participation in the disorder patterns. It is especially necessary to empathize with and articulate the consequences of such an individual's behavior, such as the sense of being isolated and not understood or the interpersonal rejection that appears unfair to the person with PPD. Underlying beliefs with which individuals with PPD often struggle with are (a) I am unique and others are jealous; (b) others will exploit my mistakes; (c) it always pays to be wary, accusatory, and adversarial (some individuals with PPD do make good trial lawyers); (d) people who are trusting or content are fools, that is, I cannot be that way; and (e) negative events are generated purposefully by others.

Schizoid Personality Disorder

The essential feature of schizoid PD is impairment in the ability to form adequate social relationships. As a result, people with schizoid PD are shy and socially withdrawn or, as novelist Joan Didion states in *The White Album* (p. 121), "only marginally engaged in the dailiness of life." They have difficulty expressing hostility and have withdrawn from most social contacts. But, unlike agoraphobia, the behavior is ego-syntonic (i.e., the individual is at least minimally comfortable with the behavior).

Behavioral, Interpersonal, and Cognitive Patterns

The daily life of a person with schizoid PD is characterized by distancing behaviors and alienation. The individual with schizoid PD reacts to disturbing experiences and conflicts by apparent detachment from the environment rather than by manifesting normal coping responses. Like the person with an avoidant PD (discussed later in this article), a person with schizoid PD has inadequate interpersonal relations. But unlike a person with an avoidant PD, an individual with schizoid PD does not care, so therapy is quite difficult. Temperamentally, people with schizoid PD gravitate toward jobs that require solitude, such as work as a nighttime security guard. As they age or become vocationally dysfunctional, they are likely to move into a 'skid row,' particularly if they are males. Despite an excessive engagement in fantasy and peculiar communication styles, these individuals do not show the loss of contact with reality characteristic of a psychotic disorder.

An example of an individual with schizoid PD is Walter Mitty, the hero of James Thurber's novel and the movie *The Secret Life of Walter Mitty*. Mitty is essentially detached from his environment and is much more absorbed in his elaborate, heroic fantasies. Given the situation of an idle moment or a disturbing experience, he plunges into his imaginings, rather than utilizing normal coping mechanisms. Most schizoid persons are considered to be cold and withdrawn because they do not seem to respond to their environment. Walter Mitty, however, seems more warm and likeable, although no more reachable, than other schizoid personalities.

Diagnostic Considerations

In the DSM-IV-TR, schizoid PD is marked by social-relationship detachment, introverted behavior, and constriction of expression or emotion in social settings. While people with schizoid PD have few, if any, friends, they show no communication disturbance (i.e., they have the social skills to maintain relationships). Thus in order to fulfill a basic requirement of functional impairment, the individual with schizoid PD must cause vocational or social disruption by the individual meeting at least four of the following: (1) no desire or enjoyment of close relationships, including with family; (2) almost always seeking solitary activities; (3) having little or no interest in sexual experiences with a partner; (4) taking pleasure in few or no activities; (5) lacking close friends, confidants, other than first-degree relatives; (6) appearing indifferent to praise or criticism; and (7) being emotionally detached, cold, or flat. Schizoid PD demonstrates one of the poorest reliabilities

between the DSM and ICD (kappa scores estimate as low as 0.32, meaning that a diagnosis in one system accounts for just under one-third of the variance in diagnosis under the other system, after accounting for chance agreement).

Therapeutic Considerations

To develop a therapeutic relationship with an individual with schizoid PD, the therapist must work cautiously to develop trust and not distress the patient with initial confrontations. Initially, the therapist can support the patient's need for interpersonal distance and focus more on practical matters. As trust builds, greater emphasis can be placed on relationships and the need for insight.

Individuals with schizoid PD experience numerous cognitive thought distortions, such as (a) any disruption of my emotional routine (however minimal the emotions are) is scary and messy – in that sense they are analogous to an individual with obsessive-compulsive disorder's fear of disruption of external routines; (b) I can survive alone (maybe not optimally, but at least predictably), and need space to do that; and (c) it is necessary to be free and independent.

Schizotypal Personality Disorder

Schizotypal PD is a PD characterized by the need for social isolation, marked behavioral peculiarities, and unconventional thinking and beliefs. These individuals may seem dysfunctionally detached, have few ties or responsibilities, may seem cognitively confused, self-absorbed and ruminative, and have either an anxious wariness and hypersensitivity or emotional flattening or lack of affect.

Behavioral, Interpersonal, and Cognitive Patterns

There are many similarities between schizotypal and schizoid personalities. Most notable of the similarities is the inability to initiate or maintain relationships. The difference between the two is that those labeled as schizotypal avoid social interaction because of a deep-seated fear of people. Individuals with schizoid PD simply feel no desire to form relationships because they see no purpose in social interaction. Individuals with schizotypal PD are much more likely than people with schizoid PD, to show dysphoria and anxiety. Additionally, people with schizotypal PD exhibit odd thinking patterns and are more likely to develop eccentric belief systems and become involved in fringe religious groups. The individual with schizotypal PD is also more likely to be emotionally labile, overtly suspicious, and hostile of others than is a person with schizoid PD. Many individuals with schizotypal PD also appear to meet the criteria for the Borderline PD. Any therapist's attention must be directed not only toward the interpersonal withdrawal processes, but also to the emergent disturbances in affect and thinking that are common.

Diagnostic Considerations

Schizotypal PD is marked by static interpersonal deficits, cognitive or perceptual disturbances and unusual behavior. According to the DSM-IV-TR, in order to diagnose an

individual with schizotypal PD at least five of the following symptoms must be present: (1) ideas of reference; (2) evidence of magical thinking or odd beliefs that are not subculturally determined; (3) unusual perceptual experiences, including bodily illusions; (4) odd thinking and speech; (5) suspicions or paranoid ideation; (6) inappropriate or constricted affect; (7) odd, eccentric, or peculiar behavior or appearance; (8) lack of close friends or confidantes other than first-degree relatives; and (9) excessive, nonhabituating social anxiety that tends to be associated more with paranoid fears than with negative judgments about self.

A family history of schizophrenia is not unusual. If symptoms of schizophrenia begin to emerge, the schizophrenic diagnosis takes precedence and the schizotypal diagnosis is considered 'premorbid.'

Histrionic Personality Disorder

Individuals with histrionic PD (HPD) seek attention and are often overreactive, with the response being expressed more dramatically and intensely than is appropriate. This category has traditionally been labeled the 'hysterical personality.' However, 'hysterical' wrongly suggests a disorder that parallels the causes and symptoms of what has been traditionally labeled 'hysterical neurosis.'

Behavioral, Interpersonal, and Cognitive Patterns

Individuals with HPD may elicit new relationships with relative ease, as they appear to be empathic and socially able. However, they turn out to be temperamentally and emotionally insensitive and have little depth of insight into their own responsibilities in a relationship. Even though they may be flirtatious and sexually seductive, there is little mature response or true sensuality. If one accepts the apparent sexual overture in the behavior, the histrionic individual may act as if insulted or even attacked. Individuals with HPD quickly avoid blame for any difficulties of interpersonal relationship and, in that sense, show a degree of the projection that is characteristic of paranoid disorders.

Diagnostic Considerations

People with HPD show attention-seeking and excessively emotional behaviors, apparent by early adulthood. According to the DSM-IV-TR, in order to diagnose an individual with HPD at least five of the following symptoms must be present, as evidenced by at least five of the following: (1) discomfort when not the center of attention; (2) interactions often marked by inappropriate sexually seductive or provocative behavior; (3) rapidly shifting and shallow emotional expression; (4) consistent use of physical appearance to draw attention to self; (5) impressionistic, nondetail speech style; (6) self-dramatization, theatricality and exaggerated emotional expression; (7) suggestibility; and (8) perception of relationships as more intimate than is actually the case.

Treatment Considerations

Individuals with HPD are more responsive to dramatic forms of communication and will, at least initially, be more

responsive to a short-term dramatic therapy approach; a therapy approach lacking drama and exaggeration may be viewed as invalid by some with HPD simply because of the lack of intensity.

To establish rapport, the therapist may need to exaggerate their own emotions, show support, while allowing the individual with HPD to be the center of attention. Once the patient is engaged in therapy, a shift can be made to focus on disturbed interpersonal relationships and avoidance of responsibility. Eventually, group therapy is recommended.

Individuals with HPD experience numerous cognitive thought distortions, such as (a) being responsible or attending to details means the loss of 'zest for life'; (b) rejection is disastrous; (c) people will not love me for what I do but what I pretend to be, or what I present to entertain/entice them; and (d) being 'special' means never having to say 'I am sorry' (or at least I do not have to feel it or mean it).

Narcissistic Personality Disorder

The term narcissistic PD (NPD) has its roots in the mythical Greek character, Narcissus. As divine punishment for being cruel to those who loved him, the gods cursed the beautiful narcissus to fall in love with his own reflection. He wastes away and dies, unable to focus on anything but himself. So, too, do persons with NPD exhibit a pathological focus on themselves to the exclusion of others. In individualistic (e.g., North American) societies, such a personality pattern frequently yields substantial social gain in the form of career success, notoriety, or even political power. As a character in Peter de Vries's novel, *Consenting Adults*, describes, 'I have this crush on myself – but the feeling is not returned.'

Behavioral, Interpersonal, and Cognitive Patterns

Individuals with NPD manifest an unrealistic sense of self-importance, resulting in substantial problems in interpersonal relationships. Individuals with NPD share this characteristic with those diagnosed as antisocial PD, except that they are not so aggressive or hostile and their value systems are more asocial and hedonic than individuals with antisocial PD. In 1984, Otto Kernberg introduced the subdiagnosis of malignant narcissist. It was first applied to people like Adolf Hitler and Joseph Stalin, and recently it has been suggested as fitting Saddam Hussein.

Diagnostic Considerations

An individual with NPD shows a static pattern of grandiosity, need for admiration, and lack of empathy, apparent by early adulthood. According to the DSM-IV-TR, in order to diagnose an individual with NPD, at least five of the following symptoms must be present: (1) grandiose self-importance; (2) preoccupation with fantasies of unlimited success, power, brilliance, beauty, or ideal love; (3) belief in one's specialness or uniqueness and consequent belief in only associating with or being understood by certain others; (4) a need for excessive admiration; (5) a sense of entitlement; (6) interpersonally

exploitive behavior; (7) lack of empathy; (8) envy of others or belief that others are envious of him/her; and (9) arrogant and haughty behavior or attitude. Individuals with NPD have poorly integrated personalities and may experience brief psychotic episodes.

Treatment Considerations

Treatment of an individual with NPD may be even more difficult than a person with antisocial PD to engage in therapy. The likelihood that they would choose to enter therapy is low and their participation in therapy is often due to the coercion of a loved one. The person with NPD may have been threatened by a loss of a dependency role, as in a marital situation. Psychodynamic techniques and modeling techniques may be well suited to confront the pathology of narcissism. The therapist can work to channel the psychopathology into 'productive narcissism' by role playing, utilizing a multiple marital-group setting, or in imagination.

Individuals with NPD experience numerous cognitive thought distortions, such as (a) I am special, unique, elite; (b) I like to challenge or compete with others, but because of both 'a' and the fact it is psychologically necessary for me to prevail, I may play by other rules (usually known only to me); (c) any defects I have come from my bad parents and/or background; (d) recognition, admiration, and respect are necessary and others exist to provide it, and indeed, promote it; and (e) sharing, serving others, or selfless behaviors are signs of weakness and signal disintegration of myself.

Antisocial Personality Disorder

Antisocial PD (ASPD) essentially connotes someone who shows chronic disregard for social rules and laws. This is an interesting diagnosis that deserves special consideration in light of its evolution as a concept. The first reference to the classic notation 'psychopathic' (meaning a disease originating in the mind) occurred in 1891, and was an attempt to characterize extreme social deviance as congenital. Hervey Cleckley, a pioneer in this area, described psychopathy as having a 'mask of sanity,' or the absence of the usual indicators of insanity. These are persons who discard meaningful relationships, goals, and success for reasons that others cannot understand. More recently, the term 'Sociopathic personality pattern' was adopted by the American Psychiatric Association for DSM-I (to emphasize that this pattern is largely a result of social conditioning). While ASPD started with a broader definition, subsequent DSM editions yielded the behavioral diagnostic description below.

Since the emergence of ASPD in the DSM, knowledge about the personality origins of criminal behavior has actually made an interesting return toward earlier thinking on the topic. Research, originated by Robert Hare, has reshaped conceptualizations of ASPD. This work has essentially demonstrated, over the course of nearly three decades, that the earlier conceptualizations of psychopathy can be measured reliably, and have greater predictive validity than do the more behavioral conceptualizations of ASPD in the DSM.

Behavioral, Interpersonal, and Cognitive Patterns

Individuals with ASPD exhibit chronic violations of moral and legal rules. People with ASPD show an inability to delay gratification, difficulty with authority, and narcissism in interpersonal relationships. Those with ASPD often show: (1) a very low level of anxiety and little avoidance learning; (2) significant resistance to standard social-control procedures; and (3) high degree of stimulation-seeking behaviors.

Diagnostic Considerations

According to the DSM-IV-TR, in order to diagnose an individual with ASPD, at least three of the following symptoms present by the age of 18, with a pervasive pattern of disregard or violation of others and evidence of conduct disorder with onset before the age of 15: (1) failure to conform to socio-legal norms as denoted by repeated acts that are grounds for arrest; (2) irritability and aggressiveness, as seen in repeated fights or assaults; (3) consistent irresponsibility in work or financial obligations; (4) impulsivity or failure to plan ahead; (5) deceitfulness, as indicated in lying or conning; (6) reckless disregard for one's own or others' safety; or (7) lack of remorse.

Antisocial (DSM) and dissocial (ICD) disorders show poorer reliability with each other than most DSM/ICD pairs (kappa score estimates as low as 0.50). One criticism of the DSM approach is that the required connection to conduct disorder allows nearly infinite combinations of symptoms for any individual fitting the ASPD diagnosis. The resulting increased heterogeneity of the diagnostic group may make inter-system diagnostic reliability more difficult.

Treatment Considerations

Individuals with ASPD are not likely to enter treatment and are most prevalent in institutional and family therapy settings. In treatment, attention should be paid to the stimulation-seeking nature of these clients. An individual with ASPD needs to develop prosocial activities to fulfill their stimulation-seeking nature or they may revert to more deviant patterns.

Borderline Personality Disorder

At first glance, borderline PD (BPD) may seem to overlap with the schizotypal PD, as both imply an easy transition into a schizophrenic adjustment. However, individuals with BPD are neither as consistently withdrawn socially or as bizarre in symptomology as are individuals with schizotypal PD. BPD diagnosis covaries most commonly in inpatients with a diagnosis of HPD. BPD is one of the most consistently diagnosed personality disorders and constitutes ~1–2% of the general population. The combination of symptoms classified in the DSM under BPD, harkening back to the traditional psychodynamic conceptualization of the disorder, is known in the ICD system as 'emotionally unstable PD,' focusing on the key diagnostic criteria for the disorder. In the ICD system, EUPD can have 'Impulsive' or 'Borderline' subtype.

Behavioral, Interpersonal, and Cognitive Patterns

Persons in the BPD category do show significant emotional instability, are impulsive and unpredictable in behavior, and are irritable and anxious. They also often show 'soft' neurological signs, and avoid being alone or experiencing the psychological emptiness or boredom to which they are prone. There is some evidence that as these individuals improve, they show more predictable behavior patterns, yet this is combined with increasingly evident narcissism.

Those with BPD are intense and labile emotionally and cognitively, and are draining to a significant other (and therapists). They fear facing their own intense negative emotions over time, and so find it hard to grieve the many relationship losses they generate. They maintain a facade of competence and independence, yet desperately want various types of help, and then react negatively when it is not forthcoming.

Individuals with BPD seem to decrease symptomology in their thirties, although much of the underlying psychopathology is still there. On occasion, someone with BPD may exhibit 'pseudologia phantastica,' in which he/she engages in pathological lying. This lying may be the individuals attempt to enhance self-esteem. Some individuals with BPD may or may not be aware of their lying.

Diagnostic Considerations

According to the DSM-IV-TR, in order to diagnose an individual with BPD, at least five of the following symptoms must be present: (1) frantic efforts (excluding those behaviors in #5) to avoid actual or imagined abandonment; (2) an unstable and intense interpersonal relationship pattern, with extremes of idealization and devaluation; (3) persistent and markedly disturbed or unstable identity or sense of self; (4) two impulsive self-damaging behaviors (excluding #5); (5) recurrent suicidal behaviors, gestures, or threats or self-mutilation; (6) affective instability due to marked mood reactivity, usually a few hours, not more than 3 days; (7) chronic feelings of emptiness; (8) inappropriate, intense anger or lack of anger control; and (9) transient, stress-related paranoid ideation or severe dissociation.

Treatment Considerations

BPD is often treated with a psychological technique called dialectical behavioral therapy (DBT). This form of treatment, developed by Marsha M. Linehan, a psychological researcher at the University of Washington, United States, is the first empirically validated method to treat BPD. DBT combines psychological theories from Western (cognitive behavioral techniques for emotional regulation) and Eastern (Buddhism-based reality techniques, such as mindfulness, distress tolerance, and acceptance) traditions. The technique is effective for BPD, other mood disorders, and behaviors associated with self-injury.

DBT draws heavily on interpersonal intervention. Thus the DBT therapist must attend vigilantly to how the therapist and client reciprocally influence each other. For example, a client with BPD may become verbally aggressive every time the therapist tries to address a presenting problem. As a result,

the unassuming therapist may discontinue discussion of this topic. In this example, the client punishes the therapist's therapeutic behavior, and the therapist reinforces the client's aggressive behavior. A DBT therapist uses the tension created by not responding in the typical manner to encourage the client to create more effective and flexible coping behaviors.

Treatment of BPD with the DBT protocol is divided into two components, individual and group-based sessions. Individual therapy focuses on weekly events recorded on diary cards. Self-injurious and suicidal behaviors take precedence, followed by behaviors that interfere with therapy. Eventually, behaviors that interfere with quality of life are considered and new skills are discussed. The second component includes weekly group meetings that focus on the development of mindfulness skills, interpersonal effectiveness skills, emotion regulation skills, and distress tolerance skills. Most people with BPD gradually improve, but changes are usually slow and about 50% still meet criteria at follow-ups 4–7 years later.

Many therapists feel frustrated, incompetent, or hopeless in the treatment of individuals with BPD because of the treatment-resistant nature of the disorder and behaviors that interfere with therapy. These patients may be difficult to keep in therapy, frequently fail to respond to therapeutic efforts, become very angry at the therapist, and make considerable demands on the emotional resources of the therapist, particularly when suicidal behaviors are prominent.

The following beliefs are common: (a) I am afraid I will be alone forever, as no one who really gets to know me will want to love me; (b) If I ignore my own needs, I can entrap some people into relationships, but, since I cannot control my feelings, and I need the relationships, I will be very unhappy; (c) though I need people, they will eventually hurt or reject me, so I must protect myself; (d) I deserve any bad things that happen to me; and (e) my misery (and/or 'badness') is how people recognize me as a unique self.

Avoidant Personality Disorder

These individuals are shy and inhibited interpersonally, yet at the same time desire to have interpersonal relationships, which distinguishes them from those with the schizotypal or schizoid PD. They also do not show the degree of irritability and emotional instability seen in the BPD. This is a common secondary diagnosis in inpatient populations.

Behavioral, Interpersonal, and Cognitive Patterns

Avoidant PD (AVPD) is close to the anxiety disorders, since there is a degree of anxiety and stress, and low self-esteem is common. However, behaviors that produce the distress are relatively ego-syntonic. Their depression and anxiety are more related to the perceived rejection and criticism of others. This common disorder is seen more often in men. Any disorder in childhood that focuses on shyness predisposes one to the AVPD.

Other cognitions common to a person with AVPD include (a) if people really got to know me, they would see how inadequate (or odd) I really am, and they would reject me; (b) I am unable to cope with unpleasant people or situations;

(c) not thinking about a problem or unpleasant situation or not trying to cope with it may allow it to go away; (d) you will never leave me because I will make sure I leave you first; and (e) nothing ventured, nothing failed.

Diagnostic Considerations

According to the DSM-IV-TR, in order to diagnose an individual with AVPD, the individual must experience a combination of social inhibitions, feelings of inadequacy, and hypersensitivity to negative evaluation apparent from early adulthood, and exhibited by at least four of the following symptoms: (1) avoidance of occupations with significant social contact because of hypersensitivity to negative evaluation; (2) avoidance of interpersonal involvement unless sure of being liked; (3) restraint in intimate relationships because of fear of shame or ridicule; (4) preoccupation with social criticism or rejection; (5) inhibitions in new interpersonal situations as a result of feelings of inadequacy; (6) belief that one is socially inept, personally unappealing, or inferior; and (7) unusual reluctance, because of potential embarrassment, to engage in personal risks or new activities.

Treatment Considerations

To develop a therapeutic relationship with an individual with AVPD, the therapist should minimize negative feedback, offer frequent reassurance, and model a more 'laid-back,' relaxed interpersonal style. Social skills training, programmatic relaxation training, and assertiveness training is helpful in the treatment of an individual with AVPD. Someone with AVPD is often more concerned with the risk in relationships and may benefit from existential and confrontative therapy approaches.

Dependent Personality Disorder

In one way, individuals with dependent PD (DPD) can be seen as successful individuals with AVPD. They have achieved a style that elicits the desired relationships, though at the cost of any consistent expression of their own personality. They show elements of agoraphobia, not crystallized, and they lack any real self-confidence.

Behavioral, Interpersonal, and Cognitive Patterns

People with DPD have a pervasive need to cling to stronger personalities who are allowed to make a wide range of decisions for them. They are naive and show little initiative. There is some suspiciousness of possible rejection, but not to the degree found in the AVPD. If the individual is not in a dependent relationship, anxiety and upset are common. Even if enmeshed in a dependent relationship, there is still residual anxiety over the possibility of being abandoned.

Underlying cognitive systems that are often included are (a) I am perpetually at risk of being alone in a cold and dangerous world; (b) I am not able to cope with and/or enjoy life without a supportive other; (c) a loss of self is a fair price to pay in order to obtain a relationship with a supportive other, even if they periodically abuse me in some fashion;

and (d) I need constant access to this other, with as much intimacy as I can elicit, so I will be as subservient and inoffensive as I need to be.

Diagnostic Considerations

According to the DSM-IV-TR, in order to diagnose an individual with DPD, at least five of the following symptoms must be present: (1) inability to make everyday decisions alone; (2) allowing others to assume responsibility for major life areas; (3) difficulties in expressing disagreements with others, from a fear of loss of support or approval; (4) difficulties in self-initiation, from self-image problems rather than deficits in motivation or energy; (5) excessive efforts to gain support or nurturance from others, to the point of doing things he/she finds unpleasant; (6) feeling of discomfort when alone, related to fears of being unable to care for him-/herself; (7) quick replacement of relationships to get care and support; and (8) unrealistic preoccupation with fears of having to care for oneself.

Treatment Considerations

Many individuals with DPD believe that dominance and abuse are forms of love, even with adequate early nurturance. Thus, to facilitate the therapeutic relationship the therapist may need to take on a more dominant, protective, and nurturing role than he/she normally would. Eventually, assertiveness training and methods help clients gain insight into their dependent behavior, via feedback from a group, from catharsis, or from other consciousness-raising techniques.

Obsessive–Compulsive Personality Disorder

This disorder is occasionally confused with the obsessive–compulsive disorder (which is an anxiety disorder), but there are significant differences between the two syndromes. First, the individual with obsessive–compulsive PD (OCPD) seldom becomes obsessed about issues. Second, for the person with OCPD, the term compulsive refers to a lifestyle in which compulsive features are pervasive and chronic, but it does not refer to a specific behavior such as persistent hand-washing. Third, the person with an OCPD is not upset, anxious, or distressed about his/her lifestyle, whereas anxiety is generic and often obvious at times in the functioning of the person with obsessive–compulsive disorder.

Behavioral, Interpersonal, and Cognitive Patterns

According to Sigmund Freud, the essential characteristics of a person with OCPD are that they are ‘exceptionally orderly, parsimonious and obstinate.’ They are preoccupied with rules and duties, are unable to express warmth and caring except in limited situations, are highly oriented toward a lifestyle marked by productivity and efficiency, are temperamentally and emotionally insensitive, and are generally distant from other individuals. They are inclined to be excessively moralistic, litigious, and hyperalert to criticism and perceived slights from others. They can be described as workaholics without warmth.

The extent to which the ritualistic and conforming behavior is generalized throughout the person’s life and, more importantly, the degree to which it is functional must be taken into consideration before a diagnosis is made. For example, a pilot develops rituals for determining that his plane is safe before takeoff. If a part of the ritual is omitted by a copilot, the pilot may experience considerable distress and may actually risk alienation by insisting on the performance of the ritual. The pilot’s insistence on carrying out a ritualistic check of the instruments makes him appear obsessive, but it also keeps him alive.

It is true that a degree of compulsivity is effective, particularly in our society. It becomes a problem when it overwhelms the rest of the personality. Paradoxically, individuals with OCPD are often indecisive in their thinking and poor planners of their time, a result of their narrow focus and concern with precision, even when precision may be irrelevant.

Typical underlying beliefs such as (a) to err or worse, to fail, is anxiety-provoking, will allow others to criticize me, and makes me feel less than a whole person; (b) to lose control is anxiety-provoking; (c) my obsessiveness and/or compulsivity are powerful enough to avoid errors, failure, or finding myself with nothing to do, yet; (d) regarding meaningful decisions, rather than ‘Better to have tried and failed than to never have tried at all,’ my motto is ‘Better to have not tried at all, than to have and failed’; (e) details are important, that is, if you can see trees, no need to look for the forest; (f) I am responsible for myself and others; and (g) I hate others when they do not follow ‘the rules,’ (i.e., my rules) and especially if they get by with it.

Diagnostic Considerations

To diagnose an individual with OCPD, he/she must exhibit excessive attention to orderliness, perfectionism, and control, and a lack of flexibility, openness, and efficiency, apparent by early adulthood. According to the DSM-IV-TR, in order to diagnose an individual with OCPD, at least four of the following symptoms must be present: (1) preoccupation with details, to the exclusion of an overall perspective (they see the trees rather than the forest, and not even all of the trees); (2) perfectionism that interferes with tasks; (3) excessive devotion to vocation and productivity; (4) overconscientiousness, scrupulousness, or inflexibility in matters of morality or values (and not accounted for by subcultural or religious factors); (5) hoarding worthless objects that are without sentimental value; (6) reluctance to delegate or cooperate as a result of control issues; (7) financial miserliness toward self and others, to save for impending catastrophes; and (8) rigidity and stubbornness.

Treatment Considerations

Individuals with OCPD have often experienced backgrounds with adequate caregiving and nurturance combined with (1) ‘performance’ as a condition of love–attention; (2) judgments of failure and/or invidious comparisons with siblings or peers; (3) rules presented as impersonal abstracts; and (4) demands for persistence even where success (at least as defined by parents) is unlikely, and then punishment for ‘mistakes.’ Therefore, to initially develop a therapeutic relationship,

the therapist needs to provide consistent though not 'overly emotional' support, accept the patient's hierarchical view of the world, and provide a diagnosis by logic and schemata (patients prefer to follow the DSM-IV-TR diagnosis, as it provides a sense of mastery and some evident goals).

The therapist may have difficulty developing rapport, as individuals with OCPD lack emotionality and a sense of humor. Often, the therapist will have to prove they are competent before the patient will allow rapport to build. The use of covert sensitization technique can be utilized to eliminate compulsive patterns. Another technique is the use of paradoxical intention, where the patient strives to do the thing he/she fears or dislikes. The goal is to reduce the behavior, ironically by increasing the behavior first. Thus, a person who fears rejection may be instructed to keep asking for dates until he/she finds out that it is not so anxiety-provoking to be rejected. Eventually the patient is instructed to vary the circumstances and quantity of the behaviors avoided. Over time, the individual with OCPD develops a greater sense of control over his/her behaviors and may then choose to give them up. Group therapy is recommended to continue with the reinforcement of the new behaviors. At times, the group may be upset by the patient's judgmental behaviors and condescension.

Looking Forward

The DSM-V revision has been slated for release some time in 2013 with the 11th ICD revision coming 2 years later in 2015. However, criticisms about the DSM development process threaten to delay that release (many would argue, appropriately so). In general, these criticisms allege that the goal to effect a diagnostic paradigm shift via the DSM-V is not sufficiently grounded in empirical evidence. The most significant element of the proposed changes is toward a continuous

(rather than categorical) conceptualization of disorders. Interestingly, PDs have long been conceptualized as extremes on the continua of personality traits that cross into diagnostic status when they substantially interfere with functioning. Thus it is unclear the degree to which any such formal change in DSM-V will affect PD diagnoses.

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Relevant Websites

- <http://www.hare.org/> – Robert Hare's website devoted to Psychopathy.
- <http://www.borderlinepersonalitydisorder.com/index.html> – National Education Alliance for Borderline Personality Disorder.
- <http://www.tara4bpd.org/tara.html> – Treatment and Research Advancements - National Association for Personality Disorder.

Personality, Structure

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Glossary

Affect Perceived emotion or mood.

Anxiety sensitivity Dimension that describes individual differences in the fear of anxiety-related sensations and their consequences.

Aspect An intermediate trait level between domains and facets.

Big Five A model of personality traits consisting of neuroticism, extraversion, agreeableness, conscientiousness, and openness to experience.

Big Three A model of personality traits consisting of negative emotionality, positive emotionality, and disinhibition versus constraint.

Clinical trait Personality trait that is believed to increase risk for one or more psychological disorders.

Domain Broad dimension of personality (i.e., a 'Big' trait).

Facet A narrow, specific trait that is subsumed within a broader trait.

Factor analysis A statistical method that identifies unobserved dimensions ('factors') that account for correlations among observed variables.

Hierarchical structure Organization wherein broader entities may be divided into more specific entities, which themselves may be further divided.

Level of abstraction A particular section within a hierarchical structure.

Taxonomy System of classification.

Trait Dimension along which individuals vary with regard to behavioral, emotional, and cognitive tendencies that show consistency across time and situations.

Personality traits describe individual differences in behaviors, emotions, and thoughts that tend to be relatively consistent over time and across situations. Dating back to ancient civilizations, humans have attempted to categorize interindividual differences along various dimensions and to understand how these traits relate to one another. For example, the ancient Greeks described four 'humors' or temperaments that define consistent patterns of human behavior: sanguine (cheerful, courageous), choleric (easily angered), melancholic (depressed, irritable), and phlegmatic (calm, unemotional). Throughout the past century, personality researchers developed multiple models of basic personality traits, resulting in many different trait taxonomies and individual traits that overlap with one another to varying degrees. Thus, it became important to understand how these traits covary with one another; in other words, researchers needed to know to what extent different traits represented overlapping characteristics that co-occur within the same individual. This pattern of trait covariance – referred to as 'personality structure' – is essential to the interpretation and synthesis of the large body of literature on personality traits.

Elucidating the structure of personality is important for several reasons. First, it is only by identifying basic personality traits and understanding their associations with one another that we can study how personality characteristics relate to behaviors and outcomes of interest, such as job performance, psychological disorders, and social functioning. Furthermore, particularly because personality traits are strongly heritable, understanding personality structure may shed light on the causes and development of individual differences in behavior, attitudes, emotions, and psychopathology. Thus, an accurate and comprehensive model of personality structure is needed in order to clarify the causes and consequences of individual differences.

Major Models of Personality and Trait Affect

Big Five/Five-Factor Model

The 'Big Five' or 'Five-Factor Model' is a well-replicated, hierarchical taxonomy of normal personality traits. The groundwork for the Big Five dates back to 1936, when Allport and Odbert extracted all of the words in the English dictionary that were relevant to personality. Their approach was rooted in the lexical hypothesis (originally proposed by Sir Francis Galton), which states that most socially meaningful variation among people has been encoded in language. Allport and Odbert made a list of ~18 000 words relevant to personality; roughly 4500 of these terms specifically described personality traits. Starting with Raymond B. Cattell in the 1940s, numerous psychologists conducted factor analyses on this list over the next several decades. Factor analysis is a statistical method that identifies unobserved dimensions ('factors') that account for the pattern of correlations among observed variables. As such, it was an ideal tool for examining whether this large pool of personality terms could be reduced to a relatively small number of basic, underlying traits.

These analyses eventually converged on the Big Five as broad traits that capture much of the interindividual variance, yielding five broad domains: neuroticism (frequency and intensity of negative emotions, maladaptive cognitions and coping strategies, stress reactivity), extraversion (sociability, assertiveness, energy, experience-seeking, positive emotions), agreeableness (empathy, humility, cooperativeness, trust), conscientiousness (persistence, neatness, organization, caution, planfulness), and openness/intellect (creativity, open-mindedness, intellectualism). The Five-Factor Model – most commonly assessed with Costa and McCrae's Revised NEO Personality Inventory (NEO PI-R) – was developed later based on analyses of personality questionnaires, and converged on traits very

similar to those noted above. However, openness in the Five-Factor Model is broader than intellect from the Big Five tradition, in that the former tends to emphasize characteristics such as curiosity, esthetic interests, novelty-seeking, and originality, in addition to those associated with intellect (e.g., being insightful and sophisticated).

The Big Five has been widely validated and replicated, across cultures and languages. Working from the lexical hypothesis, factors similar to the Big Five have been uncovered in a wide range of languages, including Dutch, German, Italian, Chinese, Czech, Hebrew, and Russian. However, Western languages and cultures show more similarity to the English Big Five than do non-Western languages, illustrating that personality models are affected by culture and language. Replicability tends to be strongest for agreeableness, conscientiousness, and extraversion across languages and cultures. In contrast, intellect/openness tends to vary the most from culture to culture, with a range of different emphases and subtexts, from intellect to unconventionality. In further support of the validity of the Big Five, these five traits are evident not only when individuals rate themselves but also when they are asked to rate other people, whether they may be strangers or long-term romantic partners. These ratings tend to have good agreement with the target's ratings of their own personality, although the level of agreement varies by trait (it is strongest and most consistent for extraversion) and as a function of the level of acquaintance between judge and target. Overall, the Big Five is a very robust model of personality, showing substantial consistency across methodologies, cultures, and languages.

The Big Three

The Big Three is another prominent trait taxonomy, consisting of three primary traits: neuroticism or negative emotionality, extraversion or positive emotionality, and disinhibition versus constraint. Negative and positive emotionality refer to individual differences in the tendency to experience negative and positive emotions, respectively. Disinhibition versus constraint describes individual differences in undercontrolled versus overcontrolled behavior: Whereas disinhibited individuals tend to be impulsive and reckless, constrained individuals are risk-avoidant and planful. Whereas the Big Five was developed largely in 'normal' samples (i.e., nonclinical samples), the Big Three was developed in the context of – and is often applied to – 'abnormal personality,' that is, traits in individuals with significant psychopathology. The Big Three has its roots in the work of Hans Eysenck (largely conducted from the 1940s to the 1970s); note that in Eysenck's original model, the trait that maps onto disinhibition versus constraint is labeled 'psychoticism.' Subsequent to Eysenck's work, other personality researchers (e.g., Tellegen, Watson & Clark, Gough) have converged on similar models of the Big Three. This more recent work has helped to clarify our understanding of all three trait domains, particularly disinhibition versus constraint.

Connections to Trait Affect

As suggested above, two of the Big Five and Big Three traits exhibit close links to trait affect. Extensive evidence has established that neuroticism measures are strongly correlated with

individual differences in negative emotionality, whereas extraversion is strongly associated with positive emotionality. To emphasize the close association between these constructs, we refer to them jointly as neuroticism/negative emotionality (N/NE) and extraversion/positive emotionality (E/PE) in this article. N/NE and E/PE are closely connected to more general biobehavioral systems that evolved to address very different evolutionary tasks. Specifically, N/NE is a component of the withdrawal-oriented behavioral inhibition system, which serves to protect organisms by inhibiting behavior that might lead to pain, punishment, or some other undesirable outcome. In contrast, E/PE is a component of the approach-oriented behavioral activation system, which directs organisms toward situations and experiences that potentially may yield pleasure and reward. It has become clear that N/NE and E/PE represent basic dimensions of temperament that (a) are strongly stable over time, (b) are at least partly attributable to innate biological factors, and (c) have emotional products as core, defining features.

Development of a Consensual Hierarchical Structure

Throughout much of the twentieth century, trait psychologists produced countless studies of personality structure that appeared to yield confusing and contradictory results. Finally, starting in the 1980s, considerable progress began to be made toward the articulation of a consensual, comprehensive taxonomy of traits. The first major development was the explicit recognition that personality traits are ordered hierarchically at different levels of abstraction or breadth, a point for which supportive evidence has continued to accrue. For example, the broad higher order trait of conscientiousness can be decomposed into several distinct yet empirically correlated facets, such as deliberation, dependability, and industriousness. As a higher order trait, conscientiousness may be thought of as representing the shared variance among these facets, accounting for the correlations between them. The development of hierarchical models permitted the integration of general factor models – such as the prominent Big Three and Big Five schemes – with multidimensional, primary trait models that were the focus of most older personality inventories.

The second key development was the recognition that the Big Three and Big Five models – which originally had appeared to be somewhat incompatible in their nature and scope – actually define very similar trait structures. The accumulating data established that two common higher order traits – N/NE and E/PE – are included in both models. Moreover, correlational and factor analytic evidence revealed that the third Big Three dimension (disinhibition versus constraint) essentially combines the Big Five dimensions of conscientiousness and agreeableness. The final Big Five factor (i.e., openness, intellect, or culture) is virtually unrelated to the Big Three. Each level of the hierarchical structure of personality will be further described throughout the remainder of the article, but [Figure 1](#) provides a summary of the contents and interrelationships of different levels of personality structure.

The hierarchical structure of personality allows for a large degree of both flexibility and precision in research contexts, in

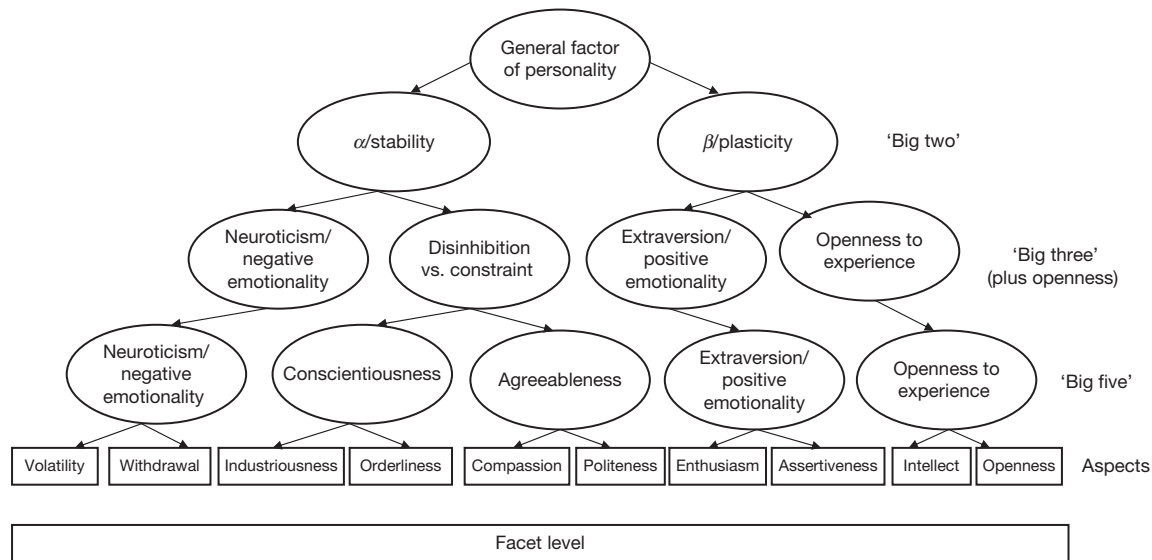


Figure 1 Hierarchical model of personality, showing each level of abstraction. Note that facets are not listed because there is not currently a complete consensual structure at this level.

that one can select the level of abstraction that is likely to be maximally informative and interesting. For example, if one is interested in a general phenomenon such as diurnal variation in relation to personality, it may be best to focus on one of the broad, upper levels of the hierarchy. In contrast, if one wants to study traits that might differentiate closely related constructs (such as depression and anxiety), it may be most informative to select more specific traits from the lower levels of the hierarchy. In addition, by simultaneously including multiple levels of abstraction in the same study, one may determine which level is primarily responsible for the association with a given construct and, therefore, describe more precisely how that construct relates to personality traits.

Personality Superfactors

The Big Two

The traits in the above models of personality were hypothesized to be independent of one another. However, it has been known for some time that there are weak to moderate correlations among the traits in the Big Five, as well as (to a lesser extent) among the traits in the Big Three. Numerous explanations have been put forth for these correlations, including that they are method artifacts of particular instruments or individual raters, or that they reflect social biases to evaluate some traits positively and others negatively. However, subsequent research has found that although these biases may inflate the magnitude of coefficients somewhat, the intercorrelations among the Big Five and among the Big Three remain substantial and consistent even after controlling for them.

Digman was among the first to systematically study these intercorrelations, conducting a meta-analysis examining the associations among the Big Five. He found that two higher order dimensions emerged from these associations, which he called α and β . Alpha consists of low N/NE, high agreeableness,

and high conscientiousness, whereas β is defined by high E/PE and high openness to experience. Other studies have identified a similar structure across a variety of measures and methods, incorporating the Big Three traits (wherein α corresponds to low N/NE and low disinhibition, and β essentially represents E/PE) and using informant data. Furthermore, when two factors are extracted from lexical studies, these factors are quite similar to α and β (called social propriety and dynamism, respectively). DeYoung has referred to α as 'stability' to reflect the fact that high levels of this factor are likely to facilitate socialization and getting along with others; he called β 'plasticity' to denote that high levels of the trait are likely to contribute to personal growth and exploration.

General Factor of Personality

Even at the level of the Big Two, stability and plasticity are significantly correlated, leading to recent interest in 'the Big One,' that is, a general factor of personality that is situated at the apex of the personality hierarchy. This trait may be comparable to Spearman's g in the domain of intellectual ability and consists of high levels of both stability and plasticity; as such, it can be interpreted as adaptiveness or social desirability (i.e., the extent to which someone is functioning well versus poorly). A recent meta-analysis of 212 studies supported a model in which the Big Five domains load onto stability and plasticity, which then load onto the general factor of personality. For the most part, these results did not depend on the type of sample or measure used. This general factor of personality also seems to be relevant to some important behavioral criteria, such as job performance as rated by supervisors. However, research on the general factor of personality is quite new, and it is currently unclear whether we should interpret the general factor of personality as a meaningful construct, or if it is best viewed as an artifact of social desirability biases or problematic statistical procedures.

Lower Order Traits

Aspects of the Big Five

Traditionally, each of the traits in the Big Five or the Big Three has been divided into numerous lower order traits called facets. However, DeYoung and colleagues have argued for an intermediate level between domains and facets that they referred to as 'aspects' of the Big Five. They argued that this intermediate level is interesting because behavior genetic studies have indicated that the genetic variance tends to cluster into two subfactors per domain, rather than into numerous individual facets. It is important to note that this study included several measures of facet-level Big Five traits, and thus was not limited by the idiosyncrasies of a specific measure.

Factor analysis revealed two aspects within each of the Big Five domains that then were correlated with factor scores reflecting shared genetic variance among Big Five facets; the results of these analyses suggested that these aspects reflect distinct biological substrates. In the N/NE domain, the first component was marked primarily by anxiety and sadness (referred to as withdrawal), and a second component was defined primarily by anger and hostility, and also included impulse control problems and emotional lability (volatility). E/PE consisted of assertiveness, which was marked by dominance and an ability to lead others, as well as enthusiasm, which was related to positive emotionality, gregariousness, and friendliness. Conscientiousness was broken down into industriousness (efficient, disciplined, achievement-striving) and orderliness (organized, perfectionistic). Agreeableness consisted of compassion (empathy, altruism, tender-mindedness) and politeness (cooperation, compliance), whereas openness contained intellect and openness, two components that were described previously. Although this structure was tested in multiple samples and corresponds well to previous genetic analyses, it should be replicated in additional studies.

Facet-Level Traits

There is currently little consensus regarding the contents of the facets – that is, the most specific traits in the personality hierarchy – that fall within each of the Big Five domains. This is partly due to the fact that few lower order measures of personality traits exist, and most research includes only one of these facet-level inventories. This limits our understanding of how the structural schemes modeled by these different measures might relate to one another. A comprehensive model of the facets within each domain – cutting across different measures – is needed to allow researchers to create a shared, consensual trait taxonomy. Determination of a lower order taxonomy is further complicated by the fact that some facets seem to be a blend of two or more domains, rather than falling neatly into a particular higher order domain. We review here three Big Five domains – N/NE, E/PE, and conscientiousness – in which research has been conducted to synthesize different facet-level conceptualizations into a larger, inclusive model.

N/NE facets

A comprehensive review of the faceted personality models – including models in the tradition of the Big Three, Big Five,

trait affect, and others – reveals many different conceptualizations of the contents subsumed within the N/NE domain. However, several trends may be identified across most or all of the N/NE models. First, nearly every model has a facet related to individual differences in anxiety/fear. Although anxiety and fear are distinguished from one another in many theoretical models, they are often combined when assessing personality traits. Second, numerous models contain both a depression/sadness facet and a stress reactivity or vulnerability facet. Note that in some models, a single facet combines aspects of fear/anxiety, depression/sadness, and/or stress reactivity, as the first two constructs have a close empirical relation, and the third assesses the perceived or experienced likelihood that negative affects such as anxiety and depression will be triggered under stressful circumstances. Finally, despite its substantial secondary loading in the Big Five agreeableness domain, a hostility/anger/aggression facet is present in nearly all N/NE models. Thus, these four components – anxiety, sadness, angry hostility, and stress vulnerability – appear to represent central N/NE facets.

Two other N/NE facets appear in two or more models of the domain. First, mistrust/suspiciousness/cynicism has traditionally been located in the Big Five agreeableness domain, rather than neuroticism; however, it appears to be a blend of low agreeableness and low N/NE, and so sometimes is included in models of the latter. Second, numerous models contain content relevant to dependency, approval-seeking, and the need for emotional support.

Thus, in synthesizing the N/NE models as exemplified by major personality inventories, six specific facets can be identified: anxiety, sadness, angry hostility, stress vulnerability, mistrust, and dependency. In addition, there is evidence that stress vulnerability may be best conceived as a broad nonspecific component of N/NE that describes the elicitation of negative affect, rather than being an independent facet within this domain. When this model – consisting of anxiety, sadness, angry hostility, mistrust, and dependency as facets, with stress vulnerability marking the shared variance among them – was tested in independent samples of college students and psychiatric patients, it was found to fit the data well in both groups.

E/PE facets

Based on an extensive review of data and contemporary models of E/PE, Watson and Clark created an integrative model of E/PE that synthesizes the major elements included in current conceptualizations of the construct. This integrative model has four central facets: affiliation (consisting of warmth and gregariousness), positive affectivity or emotionality (consisting of joy and enthusiasm), energy (consisting of liveliness and activity), and ascendance (consisting of exhibitionism and dominance).

In this model, two other facets are also considered to be part of E/PE, but have a less primary role: venturesomeness (excitement-seeking and desire for change) and ambition (achievement and endurance). Venturesomeness bears some resemblance to impulsivity, which was a central feature in some prominent early models of extraversion. However, impulsivity has since been found to be a separate construct and is generally not considered to be a facet of E/PE, although some debate remains regarding this issue. The status of ambition as a facet of extraversion has also been questioned, as it is

often instead included in the conscientiousness domain. However, there is evidence that ambition/achievement overlaps with E/PE as well, particularly with the positive emotionality component of E/PE.

An empirical test of a model similar to the one described above was conducted in independent samples of college students and psychiatric patients; however, ambition was excluded. This study identified a replicable structure for E/PE, consisting of four facets: sociability, positive emotionality, ascendance, and fun-seeking. Three of the E/PE facets correspond closely to the above model: both contain ascendance facets, sociability is equivalent to affiliation, and fun-seeking is very similar to venturesomeness. The only notable difference is that the positive affect and energy facets in the earlier model formed a single facet (i.e., positive emotionality) in these analyses. Although positive affect and energy are theoretically separable, they may not be empirically distinct when considered in the context of other closely related facets of E/PE.

There currently is some debate over the nature of E/PE and whether sociability/interpersonal components or positive emotional components provide the 'glue' that holds together the individual facets of the trait. There is evidence to support the centrality of both sociability and positive emotionality to E/PE. In terms of sociability, increased social activity has been found to increase state positive emotionality in between- and within-subject analyses, and both trait positive emotionality and extraversion are moderately associated with average hours of social activity. On the other hand, studies have also found support for the centrality of positive emotionality, in that elevated levels of state positive affectivity are associated with increased social behavior, as well as an increase in other nonsocial pleasurable activities. Furthermore, the E/PE facets of ascendance, ambition, and affiliation are all more strongly related to positive emotionality than to one another, suggesting that positive emotionality is largely responsible for holding together the various facets of E/PE. Finally, several studies have pitted these two hypotheses regarding the core of E/PE against one another. They concluded that positive emotionality is the central organizing feature of E/PE, and that enjoyment of social activities is simply one manifestation of high positive emotionality. Although it is likely that the influence of positive emotionality and sociability is bidirectional, the evidence to date indicates that positive emotionality is stronger and more central to higher order E/PE.

Conscientiousness facets

A structural analysis of several faceted measures of the conscientiousness domain yielded six facets: industriousness (hard-working, ambitious, resourceful), order (effectively plans and organizes tasks), self-control (cautious, delays gratification, patient), responsibility (cooperative, dependable, of service to others), traditionalism (compliant with rules, norms, and traditions), and virtue (acts according to accepted rules of good or moral behavior). Industriousness, order, and self-control are most strongly associated with one another, and self-control is most closely associated with higher order conscientiousness. It appears that industriousness and orderliness are most specific to conscientiousness, with the other facets showing more prominent secondary loadings with other domains. In addition, research has shown that these conscientiousness facets are

differentially associated with various relevant behaviors, such as drug use, work dedication, preventative health behaviors, and traffic risk behaviors.

Clinical Traits in the Personality Hierarchy

Clinical traits are dispositional constructs that were developed within the psychopathology, rather than the personality, literature. These lower order traits are hypothesized to be particularly relevant to one or more psychological disorders, often as vulnerability factors that predispose individuals to develop these disorders. Because clinical traits are dimensional and vary continuously across individuals, they can be studied in both normal and clinical populations. We focus here on several clinical traits that have been widely studied and are relevant to numerous psychological disorders: self-criticism, perfectionism, and anxiety sensitivity.

As illustrated previously, the hierarchical position of Big Five facets is relatively straightforward, in that each is intended to relate strongly to one of the higher order Big Five domains and only weakly to the others. However, the location of clinical traits in the hierarchy is more complicated. Broadly speaking, these three clinical traits are facets of N/NE, as they clearly show the strongest relation with this general trait. However, they also have more moderate correlations with other higher order traits. In addition, some data are available regarding how these clinical traits relate to specific facets within the Big Five and Big Three models, allowing us to characterize these traits more precisely within the hierarchy of normal personality.

Self-Criticism

Self-criticism is defined as the tendency to engage in negative self-evaluation that results in feelings of worthlessness, failure, and guilt when expectations are not met; it was originally seen as particularly relevant to the development of depression. Correlations between self-criticism and N/NE are strong ($r_s = \sim 0.50-0.65$), with a particularly strong association with the depression facet. Self-criticism also has a weaker but moderate negative correlation with extraversion of ~ -0.30 to 0.40 , and is most strongly related to the positive emotionality component of E/PE. In addition, there is some evidence for a moderate negative correlation with conscientiousness and agreeableness.

Perfectionism

Generally speaking, perfectionism is characterized by the setting of excessively high standards of performance. In addition, many definitions of perfectionism include a tendency toward negative emotional responses that follow the failure to meet one's standards; this tendency shows a close empirical association with self-criticism. There is now a consensus that perfectionism broadly consists of two primary components: (1) maladaptive perfectionism/evaluative concerns/self-critical perfectionism, and (2) adaptive perfectionism/personal standards/achievement-striving.

The strongest correlate of maladaptive perfectionism is N/NE, with correlations ranging from roughly 0.30 to 0.60 ,

depending on the measure. Specific N/NE facets from the NEO PI-R that relate to maladaptive perfectionism are anxiety, angry hostility, depression, vulnerability, and self-consciousness, although the depression facet was the only significant predictor of maladaptive perfectionism scores in a multiple regression. There is also some evidence for an inverse relation with E/PE (particularly positive emotionality), agreeableness, and conscientiousness. In contrast, adaptive perfectionism is most strongly correlated with conscientiousness and has moderate correlations with all six of its facets; industriousness has a particularly strong relation with adaptive perfectionism. In addition, adaptive perfectionism is positively related to the assertiveness and activity facets of E/PE. When the conscientiousness facets are regressed onto adaptive perfectionism, industriousness and dutifulness are both significant predictors. Thus, maladaptive and adaptive perfectionism clearly have different locations in the personality hierarchy. Maladaptive perfectionism looks very similar to self-criticism, characterized primarily by high N/NE (particularly, sadness/depression) and low E/PE. Adaptive perfectionism is primarily related to high conscientiousness (particularly, industriousness) and high levels of the energy and assertiveness components of E/PE.

Anxiety Sensitivity

Anxiety sensitivity describes individual differences in the fear of anxiety symptoms, due to a belief that these symptoms are likely to have harmful consequences. Anxiety sensitivity was originally seen as a vulnerability factor for the development of panic disorder. It is conceptually distinct from anxiety itself and instead involves one's response to anxiety symptoms, or the 'fear of fear.' Based on studies of several different measures of anxiety sensitivity, this trait is moderately correlated with N/NE ($r_s = 0.30-0.50$) and is most specifically related to the anxiety and self-consciousness facets of the NEO PI-R. E/PE has a weaker correlation with anxiety sensitivity, and the sociability components of E/PE appear to be primarily responsible for this association. It is interesting to note that the trait of absorption (a component of openness to experience), which reflects a tendency to become engrossed in imagined or actual sensory experiences, may also be weakly related to anxiety sensitivity.

Conclusion

Personality researchers have made significant progress in elucidating the contents of – and associations among – the domain level and higher order traits in personality structure, particularly with regard to the Big Five and Big Three. Furthermore, by articulating the hierarchical nature of these models, we now have a powerful and efficient taxonomy that can be utilized at varying levels of specificity. However, further clarification is needed at both the highest and lowest levels of the personality hierarchy. At the highest levels, it will be helpful to explore further the utility and meaning of the Big Two and the general factor of personality. At the lowest levels, there

currently is no consensus regarding the facet-level contents of the hierarchy, with numerous hypothesized models containing different sets of specific component traits. Relatedly, it remains unclear exactly where prominent clinical traits fit into the hierarchy. With further research, we will move closer to the ultimate goal of articulating a comprehensive, consensual model of the structure of personality.

See also: Extraversion–Introversion; Personality Assessment; Temperament and Individual Differences.

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Relevant Website

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Persuasion

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Glossary

Attitude A global evaluation of a person, object, or issue indicating the extent to which it is liked or disliked.

Attitude accessibility How readily an attitude comes to mind in the presence of the attitude object.

Attitude certainty A belief held about an attitude that reflects the conviction with which the attitude is held, or an assessment of the correctness of the attitude.

Attitude strength The extent to which an attitude is persistent and resistant, and impacts thinking and behavior.

Central route Persuasion through effortful thought and extensive elaboration that involves generating cognitive responses.

Peripheral route Persuasion through less effortful mechanisms including mental shortcuts, simple associations, and impact of contextual cues.

Persuasion The process by which attitudes are changed.

Resistance The extent to which attitudes remain firm when confronted with an attempt to persuade.

Persuasion is the process by which attitudes are changed. Persuasion processes can change three aspects of an attitude: valence – whether the attitude is positive or negative, extremity – where the attitude falls within a given valence, and strength – whether the attitude is consequential or not. Persuasion processes can be broadly divided into those that require extensive thoughtful consideration of information relevant to the attitude object, and those that require comparatively little thought relevant to the attitude object. Situational and personal variables determine whether more thoughtful or less thoughtful processes are likely to occur. Variables that determine the extent of elaboration are important to understand, because thoughtful processes result in stronger, more consequential attitudes, whereas less thoughtful processes result in weaker attitudes. Understanding the variables that determine the type of processing that is likely to occur makes it possible to predict the likely consequences of any persuasion attempt. As attitudes are generally the best predictors of behavior, understanding the processes through which attitudes are changed is critical to understanding changes in behavior.

Persuasion Attempts

A persuasion attempt refers to any effort to produce attitude change. It is common to experience numerous persuasion attempts each day, from a car commercial portraying a drive on a gorgeous day with great friends or a famous actress advertising cell phones, to political candidates expressing positions on policy or a lawyer making closing arguments in a criminal trial. In each case, the goal is to persuade the audience to change their attitudes in order to produce changes in behavior (e.g., purchases, voting).

To help to identify all of the aspects of a persuasion attempt that might produce attitude change, it is helpful to look at three elements: the source, the message, and the audience. Persuasive attempts contain a variety of attributes intended to enhance attitude change, which could include an attractive source, a message containing convincing arguments, or efforts to make

the topic seem personally relevant to the audience. Persuasive communications contain a variety of attributes intended to enhance persuasion, which could include an attractive source, a message containing convincing arguments, or efforts to make the topic seem personally relevant to the audience. Although it is useful to look at source, message, and audience variables to identify elements that potentially impact persuasion, the type of processing that the recipient of a message engages in is the most critical determinant of what impact a persuasion variable has on attitude change. After describing high and low thought persuasion processes, we explain how any given variable (e.g., source credibility or a person's emotions) can produce attitude change under both high and low thinking conditions.

Two Routes to Persuasion

There is general agreement among those who study persuasion that it is critical to distinguish between attitude change that involves extensive thought, as you might expect from a conscientious jury member during a trial, and attitude change that involves little thought or cognitive effort, such as someone flipping aimlessly through ads in a magazine. The elaboration likelihood model (ELM), proposed by Petty and Cacioppo, places persuasion along a continuum from processes that require extensive thought (central route to persuasion) all the way to those that require hardly any thought at all (peripheral route to persuasion). Overall, the extent to which an individual is motivated and able to process issue relevant information determines whether the central or peripheral route to persuasion is taken. Understanding which route to persuasion is taken is important, because this determines whether the resulting attitude is likely to be a strong attitude that is stable, resistant, and consequential for behavior or a weak attitude that is not.

Peripheral Route

Under circumstances when an individual does not have either the motivation or the ability to thoughtfully consider information that is relevant to the attitude object, it is likely that

attitudes will reflect the influence of peripheral route processes. Low motivation to process information could occur because the attitude object is not relevant to that person, or the person is one who generally does not enjoy thinking (i.e., the person is low in 'need for cognition'). Low ability to process could occur because of outside distractions or because the individual does not have the knowledge to understand the persuasive message.

When either motivation or ability to process information is low, a variety of peripheral route processes are more likely to be responsible for persuasion. When the peripheral route is taken, attitude change reflects elements of the persuasive communication that do not require extensive thoughtful processing, like attractiveness and credibility cues, classical conditioning, mere exposure, and various heuristics (e.g., more arguments are better). For example, someone who is uninterested in cars and who is just flipping through a magazine could form associations between a car in an ad and the beautiful scenery or an attractive endorser, or he or she might notice the large number of features the car has without reading them, and each of these could lead to attitude change about the car on the basis of the peripheral route. Although the peripheral route can produce attitude change, the resulting attitudes are relatively weak, because they are not based on the extensive elaboration of issue relevant information and so are not integrated into existing memories. These weak attitudes are less likely to persist over time, resist future persuasion attempts, or predict behavior.

Central Route

Under circumstances when individuals are highly motivated and able to process information relevant to the attitude object, it is likely that attitudes will reflect the influence of central route processes. High motivation to process information could occur because the attitude object is personally relevant or the person enjoys thinking in general. High ability to process occurs when there are few distractions and the person has the knowledge to understand the information presented. Central route processes require extensive thought and elaboration on information relevant to the attitude object. For example, someone who has the time and is interested in buying the kind of car presented in an ad would carefully consider the attributes of the car that are enumerated in the ad, including the safety record, fuel mileage, and resale value and relate this information to their existing needs. High elaboration processing is typified by careful consideration of the presented information in which it is compared and integrated with existing information in memory.

Persuasion under high elaboration conditions is determined by the thoughts that are generated. If the thoughts are in the direction of the persuasion attempt (positive toward the car), then attitude change will move in that direction; however, if the thoughts are predominantly against the direction of the advertisement, then the attitude will change in a direction opposite to the intended direction, referred to as a boomerang effect. This can occur when an individual successfully counter-argues the presented arguments by using the information available in memory to undermine the persuasion attempt. Because elaborative thought reflects the integration of new information

with existing memories, the resulting attitudes tend to be strong ones that persist over time, resist persuasion attempts, and predict behavior.

Under high elaboration conditions, attitude change reflects object-relevant thoughts that are generated, including whether they are positive or negative and the number of thoughts. In addition, when thinking is high, people also consider the validity of their thoughts. The self-validation hypothesis holds that the confidence with which thoughts are held is critical because it determines the extent to which thoughts influence attitudes. When thoughts are held with confidence, they are more likely to impact attitudes, whereas when people have doubts in their thoughts, they are less likely to impact attitudes. A variety of circumstances can undermine thought confidence, including feedback indicating that the quality of thoughts is not good, body cues undermining thoughts such as sitting in a slumped posture or shaking one's head, or experiencing negative feelings for reasons unrelated to the persuasive message. Everyday experiences such as feeling sick, sleepy, or light-headed could also lead someone to doubt the thoughts he or she has at the moment, making these thoughts less likely to influence attitudes. On the other hand, when someone is feeling particularly mentally sharp and awake and the thoughts come to mind easily, the thoughts he or she generates are more likely to impact his or her attitudes because they are held with high confidence. In this way, confidence in thoughts, as opposed to doubt, leads to a closer relationship between the valence of thoughts generated and attitudes.

Researchers have developed techniques to assess whether message recipients are engaging in high as opposed to low elaboration processing. One commonly used approach is to develop two messages designed to persuade in the same direction on the same issue, where one message provides strong cogent arguments and the other message provides weak and specious arguments. The extent to which strong arguments lead to greater attitude change than weak arguments indicates the extent to which recipients of the message carefully considered the content of the message. On the other hand, if participants do not carefully consider the content of the message, then attitudes will be influenced less by the quality of the arguments presented. Manipulating argument quality allows researchers to assess the extent to which a variable, such as motivation or ability to process the message, can impact whether the central or peripheral route to persuasion is taken. Studies have shown that when a topic is personally relevant to the recipient, when the recipient is someone who likes to think, when there is little distraction in the environment, and when the recipient has the knowledge needed to process the message, the impact of argument quality on attitudes is greater than when each of these elements is not present. A second method of assessing the extent of elaborative processing is the relationship between the valence of the issue-relevant thoughts and the attitude. A closer relationship between the valence of thoughts and attitudes indicates attitudes that reflect high elaboration processing, whereas a weaker relationship indicates that attitudes reflect something other than thoughts, indicating low elaboration processing. Thus, using manipulations of argument quality and measurements of thoughts provide assessments of the extent of elaboration that is taking place.

Multiple Roles: The Case of Incidental Emotion

To this point, several ways that variables impact persuasion have been described: serving as cues under low elaboration conditions, serving as arguments or affecting the valence of thoughts or confidence in thoughts under high elaboration conditions, and by influencing whether the central or peripheral route to persuasion is taken (i.e., whether people are placed under high or low elaboration conditions in the first place). Under the ELM, the same persuasion variable has the potential to impact persuasion in each of these ways depending on whether elaboration likelihood is constrained to be high, constrained to be low, or is not constrained. This potential for a single variable to play multiple roles is illustrated in the case of incidental emotions. Incidental emotions are emotions produced outside of the persuasive communication itself (e.g., emotion that comes from a television program in which an advertisement is embedded). Whether in the laboratory or in real life, incidental emotions can result from experiences that evoke an emotional response, including reading about or writing down events that evoke either positive (e.g., happiness) or negative (e.g., sadness) emotions, or simple events such as winning a monetary prize. The research presented next indicates that emotion that is elicited outside of the persuasive communication can serve multiple roles in persuasion.

Low elaboration

When either the motivation or the ability to process issue-relevant information is lacking, incidental emotion serves as a peripheral cue, consistent with the peripheral route to persuasion. Therefore, incidental affect influences the resulting attitudes in the direction consistent with its valence, and so positive feelings produce more positive attitudes whereas negative feelings produce more negative attitudes.

Two processes have been identified that can produce this simple cue effect of emotion under low elaboration conditions, classical conditioning, and misattribution. With classical conditioning, a simple association is formed between an object and the stimuli that evoked positive or negative responses. A variety of research has shown that pairing an attitude object with positive or negative stimuli, such as receiving a free lunch as opposed to smelling a noxious odor, has a direct impact on the attitudes expressed towards unrelated objects. These conditioning effects occur even when the stimulus is presented so quickly that it falls outside of the awareness of the observer and little or no time is allowed for reflection, illustrating that no effortful thought is required for this process, consistent with low elaboration processes.

Emotion can also impact attitudes under low elaboration conditions when the emotional response is misattributed to the attitude object. For example, rather than evaluating the merits of a persuasive message, the recipients might misattribute their current emotional state to their response to a persuasive message. Therefore, with positive emotions, the attitude moves in the direction advocated by the message to a greater extent than with negative emotions. Incidental emotions can also be directly attributed to the attitude object in the absence of a persuasive message. In this case, an individual simply asks himself or herself how he or she feels about the attitude object, and if he or she is feeling good as opposed to bad, for example

because of the weather, then this can lead to the expression of a more positive as opposed to a more negative attitude.

According to the ELM, these direct cue effects of emotion are expected particularly under low elaboration conditions, whereas other processes are expected to operate under high elaboration conditions. In a study directly testing this view, some participants were told that they could choose an attitude object (a pen) to take home, leading to high personal involvement with the product, whereas others were told that they would choose another unrelated product, leading to low personal involvement when learning about the pen. They were then exposed to a television program that produced a positive or neutral mood, and this was followed by a set of commercials including one about the pen. In both high and low involvement conditions, positive mood led to more positive attitudes towards the pen, but through different processes. Under high involvement, the positive mood led to more positive thoughts about the pen than the neutral mood and this explained how mood influenced attitudes, whereas under low involvement, attitudes did not reflect the positivity of the thoughts. The absence of effects of thoughts suggests that mood had an impact on attitudes through low elaboration processes such as conditioning or misattribution which operate in the absence of thoughtful processing.

High elaboration

Under high elaboration conditions, attitudes are a function of cognitive responses to a persuasion attempt. In the study reviewed above, when the attitude object (a pen) was highly personally relevant, mood biased attitudes because mood influenced whether thoughts were more positive or less positive. As thoughts did not play a role under low personal relevance, this shows that high elaboration conditions are necessary for thoughts to explain the biasing effect of mood on attitudes.

Evaluating persuasive arguments sometimes requires forming judgments of the likelihood of an event occurring. When events are associated with specific emotions, individuals already experiencing those emotions judge the likelihood of those events occurring to be higher. For example, feeling angry makes angering events seem more likely to occur, while feeling sad makes saddening events seem more likely to occur. As these likelihood judgments influence the assessment of the persuasive arguments presented, these changes in likelihood judgments impact attitudes. Taken together, evidence shows that incidental emotions can have an impact on evaluations through cognitive responses, in the form of thoughts in response to a message or likelihood judgments, which is consistent with high elaboration processing. Thus, when elaboration likelihood is constrained to be high, persuasion variables that have an impact on attitudes, such as incidental emotion, do so by influencing cognitive responses.

In addition to affecting the valence of the thoughts when thinking is high, emotions can also serve in other roles. For example, if the emotion is salient after a persuasive message has already been processed, then emotions can affect the confidence people have in the thoughts they have generated. More specifically, if people are made to feel happy after generating thoughts, they become more confident in these thoughts than if they are made to feel sad after thinking. This means that if the thoughts generated were largely favorable to the message,

then placing people in a happy state after processing will enhance persuasion because people will be more confident in and rely more on their positive thoughts. However, if the thoughts generated were largely unfavorable, then placing people in a happy state after processing will reduce persuasion because people will have greater confidence in their negative thoughts and rely on them more. The opposite occurs if people are placed in any emotion associated with doubt following the message such as sadness.

Unconstrained elaboration likelihood

The discussion to this point has focused on circumstances where elaboration likelihood is constrained to be either high or low because of variables related to the motivation and ability to thoughtfully process information. When this is not the case, persuasion variables can have their impact by influencing the extent of elaboration, determining whether high or low elaboration processes are likely to influence attitudes. The impact of traditional motivation and ability variables like personal relevance and distraction has already been discussed; however, other variables including incidental emotions can also impact extent of elaboration so long as elaboration is not already constrained to be either high or low by other variables (e.g., distraction). Two accounts for the impact of incidental emotion on extent of elaboration are discussed below.

According to the feelings-as-information account, moods and emotions provide information about the status of the current environment and through this can impact the motivation to engage in effortful processing. In particular, negative affect indicates that the environment is problematic, and this is associated with a higher level of effortful processing in order to address the issues in the environment. On the other hand, positive affect indicates that the environment is safe, and so is associated with less effortful processing. Indeed, a number of studies appear to show that experiencing positive mood makes engaging in effortful processing of a persuasive message less likely. However, a close review of the methods used by researchers showed that the persuasive communications used in this research are often counterattitudinal topics, such as nuclear waste and tuition increases, which are likely to elicit negative moods and emotions. This suggests that those experiencing positive affect were avoiding effortful processing of these messages as a way to maintain their good mood, rather than because they used a simple mood-as-information cue. According to this hedonic contingency viewpoint, those who are feeling happy are particularly sensitive to the hedonic consequences of a persuasive message, and so will choose to avoid extensive processing of persuasive messages that are likely to lead to negative feelings, but they will extensively process persuasive messages that appear likely to produce positive feelings. As those experiencing negative feelings are less concerned about maintaining their current state, their level of effortful processing is unrelated to whether the message is positive or negative. Evidence shows that when presented with proattitudinal messages, those in a positive mood engage in high elaboration processing, as illustrated by a strong effect of argument quality on attitudes. Thus, evidence suggests that incidental affect can also influence whether high or low elaboration processing takes place.

Attitude Strength

Strong attitudes are those that remain stable over time, resist future persuasion attempts, and are predictive of behavior. Weak attitudes are less consequential in these ways. Attitudes that result from the central route tend to be stronger than those resulting from the peripheral route. A variety of indicators have been developed to assess whether an attitude is likely to be strong or weak, including the extremity, accessibility, importance, and certainty with which the attitude is held. In general, attitudes that are more extreme, those that are more likely to come to mind spontaneously, those that are more important, and those held with more certainty are more consequential than attitudes lacking these attributes.

Strength indicators can be divided into those that directly reflect structural aspects of the attitude, such as attitude accessibility, and metacognitive indicators of strength that reflect beliefs about the attitude, such as the certainty with which the attitude is held. Metacognitive indicators reflect secondary thought, meaning that they are thoughts that reflect on other thoughts, in this case the attitude itself. On the other hand, structural components indicate a component of the attitude itself, so attitude accessibility is proposed as a direct assessment of the link between the representation of the object in memory and its evaluation. Both structural and metacognitive strength indicators are associated with strength consequences. Attitude accessibility is the most widely studied structural strength indicator, and attitude certainty is the most widely studied metacognitive indicator.

Attitude Accessibility

The accessibility of an attitude is an indication of how readily the attitude comes to mind in the presence of the attitude object. Accessibility can be assessed simply by measuring how quickly an individual is able to respond when asked to express his or her attitude. Research shows that the more quickly an attitude comes to mind, the more likely it is to remain stable over time, resist future persuasion, and predict behavior. More accessible attitudes have been shown to better predict a variety of behaviors from voting in elections to preferences for games, and purchasing decisions. On the other hand, an attitude that does not come to mind at all in a given instance is unlikely to predict behavior.

A number of variables have been shown to influence the accessibility of an attitude, including expressing the attitude multiple times and having direct behavioral experience with the attitude object. For example, if a person is asked multiple times for his or her view on a new movie or a political candidate, or if he or she had direct experience watching the movie or meeting the candidate versus just hearing about it indirectly, the attitude will come to mind more quickly and easily. Of most relevance to persuasion is the finding that more extensive thought about the attitude object enhances attitude accessibility because more thought leads to greater integration of the new evaluation formed with existing memories, consistent with the high elaboration processes described in the ELM. There are two common accounts for the processes responsible for the consequences of attitude accessibility. The first account

is that more accessible attitudes are simply more likely to come to mind directly making the attitude more consequential. However, a second account holds that individuals form impressions of how easy or difficult it is to bring an attitude to mind, and these metacognitive judgments of accessibility are responsible for the consequences of accessibility. Thus, there remain interesting questions regarding what structural properties accessibility reflects as well as the mechanism for the consequences of accessibility. Regardless of the outcome of these alternatives, accessibility remains the most broadly supported structural indicator of attitude strength capable of producing each of the strength consequences.

Attitude Certainty

Attitude certainty is a belief held about an attitude that reflects the conviction with which the attitude is held, or an assessment of the correctness of the attitude. Certainty is measured using questionnaire items that assess the extent to which the individual feels certain, confident, and sure about the attitude. Greater certainty is associated with attitudes that exhibit greater persistence, resistance, and prediction of behavior. As a metacognitive indicator of strength, attitude certainty consists of thoughts about the attitude.

According to the ELM, greater extent of elaboration is associated with stronger attitudes. Consistent with this, results show that antecedents of elaboration like distraction and whether or not someone likes to think influence attitude certainty. One process through which this occurs is that antecedents of elaboration produce an increased amount of thought and individuals form a perception of this amount of thought. If the perception is that a lot of thought has gone into an attitude, then it is held with greater certainty than if the perception is that little thought has gone into the attitude. The experience of resisting a persuasive attempt also has consequences for attitude certainty, but in this case the impact depends on an assessment of the resistance situation. If an individual believes that strong arguments were easily resisted, then higher attitude certainty results. However, if an individual believes that it was difficult to resist weak arguments, then lower certainty will result. In sum, attitude certainty reflects metacognitive perceptions people form about their responses to persuasion attempts including the amount of thought and the perceived ability to resist persuasion. Both accessibility and certainty provide indicators of which attitudes are likely to exhibit attitude strength.

Resistance

Resistance is the extent to which an attitude remains firm when confronted with an attempt to persuade. That is, if attitude change is motion, then resistance is the friction that goes against attitude change. Resistance is achieved through a number of different processes, and can be triggered through environmental cues such as forewarning of persuasion, and enhanced practice in counterargument such as inoculation. In addition to these two topics, metacognitive perceptions that individuals form regarding how successful they were at counterarguing persuasion are also relevant to resistance, as reviewed earlier.

Forewarning

The phrase, 'And now a word from our sponsors,' is an example of a forewarning, because it warns the audience of an upcoming persuasion attempt. Forewarning has different impacts on persuasion processes prior to and after the actual message is received. Prior to the message, the impact of forewarning depends on whether processing is likely to be more or less thoughtful, consistent with the ELM. Being forewarned under high personal relevance leads individuals to bolster their attitudes prior to receiving the persuasive message, resulting in increased resistance. However, being forewarned under low personal relevance leads individuals to acquiesce or give in to the message, even before it is received, in order to maintain a more positive view of the self as someone who is not overly malleable. One way advertisers avoid forewarning effects is by placing product tie-ins directly into programming.

Inoculation

Attitudes can be particularly susceptible to persuasion attempts when they lack an extensive cognitive foundation in memory. This can make it difficult to resist counterattitudinal persuasive messages. This lack of cognitive foundation is common in the case of cultural truisms, which are widely accepted but generally go unexamined during day to day life. Truisms include the value of 'freedom of speech,' and, 'brushing your teeth every day.' The notion of inoculation is that just as immunizations make people more resistant to disease, showing people arguments attacking their attitudes and training them to counterargue them increase resistance to future attempts to change these attitudes. The inoculation approach of training individuals to counterargue the persuasive message, is more effective at increasing resistance than providing individuals with additional support to bolster their existing attitude. Thus, inoculation provides an effective way to increase the resistance of attitudes, because it increases the ability and motivation to counterargue persuasive messages that are counterattitudinal.

Dissonance: Persuasion from Behavior

Leon Festinger was the first to describe cognitive dissonance, which provides a striking example of how our own behaviors can lead to attitude change. According to cognitive dissonance theory, any two thoughts that are related to each other can either be consonant or dissonant. Dissonant cognitions occur when one thought does not follow from or fit with the other (e.g., I am an environmentalist; I drive an SUV) Holding two dissonant cognitions in the mind simultaneously leads to an aversive state of arousal that individuals are motivated to reduce. Dissonant cognitions often arise when an individual thinks about a past behavior and realizes that it was inconsistent with an attitude that he or she holds, such as holding a positive attitude towards safe sex, but failing to use a condom. Under these circumstances, as it is more difficult to change the behavior than to change the attitude, the most common way to resolve the inconsistency is to change the attitude to be in line with the behavior. While changing the attitude typically requires cognitive effort, the negative affective state

associated with dissonance is a powerful motivator to engage in biased elaborative processing. The result of dissonance processes is that individuals persuade themselves to change their attitudes to be in line with their behaviors. In this way, the dissonance resulting from a failure to use condoms could most readily be resolved by changing the attitude to be more negative towards condoms.

A number of experimental paradigms have been used to illustrate dissonance in the laboratory, and these provide explanations for some surprising phenomena in persuasion. Dissonance explains what happens to people who agonize over a difficult decision, whether it is a simple purchase or a major life decision, and then after the decision express more positive views of the chosen option, and more negative views of the nonchosen option. This is referred to as the 'spreading of alternatives,' and it occurs because the negative attributes of the chosen option and the positive attributes of the option not chosen are dissonant with the behavior of the choice that was made. Another example of dissonance occurs when people who are humiliated during an initiation to join a group like a fraternity or the armed forces, end up liking these groups more than if there was no hazing. As going through humiliation to join a group is dissonant with any negative aspects of the group, the attitude toward the group is changed to be more positive. This is referred to as 'effort justification' because the attitude change results from having to justify to the self the willingness to go through so much to join the group. These are just two examples of the paradoxical consequences of dissonance for persuasion (see the dissonance entry for more in-depth discussion).

Application: Problem of Sustainable Behavior Change in Health Communication

With roughly half of all causes of mortality in the United States being due to factors directly influenced by behavior, including smoking, drug use, and sedentary lifestyle, the importance of developing effective health communications is clear. While it is common in a health campaign to focus only on increasing the factual knowledge of the audience, evidence shows that simply increasing knowledge does not result in behavior change. For example, knowing a lot about safe sex and condoms is not a good predictor of sustained increases in condom use. As attitudes are generally the best predictors of behavior, rather than knowledge, theories of persuasion like the ELM provide clear proscriptions on how to improve the effectiveness of health promotion campaigns so that they produce prohealth attitudes that are strong in that they resist future persuasion and predict behavior. Resistance is also critical as other sources of persuasion like old drinking buddies or a potential sexual partner can quickly overwhelm weaker attitudes.

According to the ELM, taking the central route to persuasion is the key to establishing strong attitudes to produce sustained behavior change. In particular, procedures that increase the formation of highly elaborated, accessible, and confidently held attitudes will be the most likely to result in actual and sustained behavior change. Messages that are tailored to the particular concerns of the recipients of the

messages, such as whether they are using condoms to reduce the transmission of STDs or to prevent pregnancy, are effective at increasing the personal relevance of the messages, and as a consequence make it more likely that recipients will take the central route to persuasion. In general, anything that increases the personal relevance of the communication will have this effect. In addition, it is important that messages are presented in a way that allows for thoughtful processing. As medical information is often technical, pretests should be conducted to assess whether a given population can understand the message before it is more widely distributed. Presenting the message in a medium that is self-paced, like a written flier, allows the audience to set a comfortable pace that allows for thoughtful processing, whereas audio and video media have a set presentation speed, and so do not allow for self-paced consideration. In addition, circumstances where there are few distractions and the information is presented at the correct knowledge level for the audience are likely to increase their ability to process the message extensively. Once the circumstances are established for high elaboration processing, attitudes will be influenced by whether the arguments are strong or weak. Therefore, it becomes critical under these circumstances to establish ahead of time that the arguments to be presented are seen as cogent and strong within the intended population. In this way, the basic understanding of persuasion processes and the distinction between the central and peripheral routes to persuasion and their distinct consequences can assist in the development of more effective health promotion campaigns in the future.

See also: Attitude Formation; Cognitive Dissonance Theory; Consumer Psychology; HIV/AIDS: The Role of Behavior and the Social Environment in a Global Pandemic; Motivation; Prejudice, Discrimination, and Stereotypes (Racial Bias).

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Relevant Websites

<http://changingminds.org> – Changing minds and persuasion.

Phobias

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Glossary

Classical conditioning The learning of an association between an unconditioned stimulus (e.g., sting) and a previously neutral conditioned stimulus (e.g., bee).

Conditioning The process by which a conditioned stimulus (e.g., bee) is paired with an unconditioned stimulus (e.g., sting) until the conditioned stimulus evokes a conditioned response, such as fear, even in the absence of the unconditioned stimulus.

Exposure therapy Repeated and systematic exposure to a feared stimulus.

Extinction learning A reduction in fear as a result of new learning that occurs during repeated exposure to the feared

stimulus that supersedes the original conditioning information.

Habituation A decrement in response (e.g., psychophysiological response or subjective fear) as a result of repeated exposure to the feared stimulus.

Operant conditioning The forming of an association between a behavior (e.g., escape) and a consequence (e.g., reduced anxiety).

Phobia An intense and persistent fear that is cued by the presence or anticipation of a specific object or situation.

Vasovagal response A physiological response that characterizes blood-injection-injury phobias consisting of a brief acceleration in heart rate followed by a deceleration, bradycardia, drop in blood pressure, and possibly fainting.

Overview of Specific Phobias

Diagnostic Definition of Specific Phobias

A phobia is defined as an intense and persistent fear that is cued by the presence or anticipation of a specific object or situation. Exposure to the specific object or situation consistently provokes an immediate anxiety response. The phobic object or situation might be endured with great distress, but is more typically associated with a strong avoidance tendency despite the knowledge that the fear is excessive or irrational. To be considered a phobia, the avoidance, anxious anticipation, or distress associated with the feared object or situation must be marked enough to cause significant interference in daily routine, occupational or academic functioning, social activities, or relationships.

Specific Phobia Subtypes

The diagnostic manual published by the American Psychiatric Association identifies five subtypes of specific phobias which are distinguished by the focus of the fear or avoidance. Animal subtype refers to fear that is cued by animals or insects (e.g., spiders, snakes, dogs, mice). Natural environment subtype refers to fear that is cued by objects in the natural environment (e.g., storms, heights, water). Blood-injection-injury subtype refers to fear that is cued by seeing blood or an injury, or by receiving an injection or an invasive medical procedure. Situational subtype refers to fear that is cued by a specific situation such as flying, driving, enclosed places, or elevators. Other subtype is a residual category reserved for fears that are not captured by the aforementioned subtypes, and includes phobias of vomiting, choking, loud noises, and costumed characters. Much heterogeneity exists between the subtypes of specific phobias. As described

below, the subtypes differ with respect to age of onset, type of onset (traumatic vs. nontraumatic), familial pattern, and physiological response to the feared stimulus.

Clinical Picture

Fear upon exposure to a phobic object or situation is the most characteristic emotional response in specific phobias. Fear is characterized by an organism's defensive response to imminent threat and is typically defined by three response systems: physiological, verbal-cognitive, and overt behavior. For most phobias, exposure to the feared object or situation produces heart rate acceleration and in some cases might result in situationally bound panic attacks with prominent physical symptoms. The blood-injection-injury subtype is unique in that it is characterized by a dyphasic vasovagal response consisting of a brief acceleration in heart rate followed by a deceleration, bradycardia, drop in blood pressure, and possibly fainting. The cognitive symptoms of fear typically involve subjective appraisals of danger and attentional biases toward feared stimuli. The behavioral symptoms of fear involve either freezing or fleeing from the feared stimuli.

Although fear is the most characteristic emotional response in specific phobias, recent research suggests that disgust is also a common emotional response associated with certain phobias, particularly blood-injection-injury and spider phobias. Disgust is characterized by revulsion toward stimulus identified as disgusting or revolting in nature or as potential sources of contamination. Similar to fear, disgust is defined by three response systems. While both fear and disgust are associated with avoidance behavior, they differ with respect to cognitive appraisals and physiological symptoms. Fear is associated with heart rate acceleration and cognitive appraisals of a stimulus as potentially threatening or dangerous, whereas disgust is

associated with heart rate deceleration and cognitive appraisals of a stimulus as being revolting or a contamination threat. There is some evidence that fear reduces more quickly than disgust when an individual with a specific phobia is exposed to the feared stimulus for a prolonged period.

Phenomenology of Specific Phobias

Prevalence

Phobias are very common in the general population but do not always result in sufficient distress or impairment to warrant a diagnosis of specific phobia. Prevalence rates for specific phobias vary depending on the subtype being assessed and the threshold used to determine distress or impairment in epidemiological studies. The lifetime prevalence estimates for specific phobias range from 6% to 23%, making them the most common anxiety disorder and among the most common psychiatric disorders in the community. Phobias of heights, spiders, mice, and insects are most common among individuals in the community, whereas claustrophobia (fear of enclosed places), blood-injection-injury phobias, and small animal phobias are most common among treatment-seeking individuals.

Gender

The ratio of women to men with specific phobias is ~2:1; however, the sex ratio varies across phobia subtypes. Approximately 75–90% of individuals with the animal, natural environment, and situational subtypes are female, and ~55 – 70% of individuals with the blood-injection-injury subtype are female.

Age of Onset

Specific phobias can develop at any point in the lifespan, but symptoms typically first develop in childhood or early adolescence. The age of onset varies across subtypes. For example, phobias of animals and objects in the natural environment tend to develop in early childhood and blood-injection-injury phobias also tend to develop relatively early. Age of onset for the situational subtype has a bimodal distribution, with a first peak in childhood and a second peak in the mid-twenties.

Course

Many fears that develop during childhood (e.g., strangers, darkness, animals, imaginary creatures) are transitory experiences that remit spontaneously. Developmental milestones and life experiences appear to influence the content and course of phobias. For example, the most common childhood fears tend to relate to physical harm and injury, and the fear of heights tends to develop as a child becomes increasingly mobile. The child's cognitive capacities for recognizing potential dangers are also likely to influence the development of phobias. Developing a specific phobia in adolescence increases the likelihood of persistence of symptoms or the development of additional specific phobias. Phobias that persist into adulthood rarely remit spontaneously.

Theoretical Perspectives on Specific Phobias

Psychodynamic Model

According to psychodynamic theories, phobias develop as a result of repressing unresolved unconscious conflicts. For example, Freud proposed that some individuals develop phobias due to an unresolved Oedipal conflict characterized by unacceptable sexual impulses toward the opposite sex parent and aggressive impulses toward the same sex parent. If an individual is unable to repress these impulses, the anxiety associated with the unresolved Oedipal conflict is displaced upon an object or situation that is less relevant and threatening.

Behavioral Models

Mowrer's Two Factor Model

The most influential early theory of fear acquisition was Mowrer's Two Factor Model, which developed out of Pavlov's theory of classical conditioning and Watson's theory of instrumental conditioning. The Two Factor Model proposes that fears are acquired by classical conditioning and maintained through instrumental conditioning. Classical conditioning is the process by which a conditioned stimulus (e.g., a bee) is paired with the unconditioned stimulus (e.g., pain) until the conditioned stimulus evokes a conditioned response, such as fear, even in the absence of an unconditioned stimulus.

For example, an insect phobia might develop after being stung by a bee. The sting stimulates the pain receptors and represents the conditioned stimulus. The pain evoked represents the unconditioned stimulus. Through associative learning, pain of the sting becomes paired with stimuli associated with the unconditioned stimulus (e.g., conditioned stimuli such as bees and parks). As a result, the conditioned stimuli provoke a conditioned fear response, the strength of which depends on several factors including the intensity of the unconditioned stimulus (e.g., sting) and the number of pairings of the unconditioned stimulus (e.g., sting) and conditioned stimulus (e.g., bees). In addition, stimuli resembling the conditioned stimuli (e.g., wasps, hornets) can become fear evoking through the process of stimulus generalization and second-order conditioning. According to Mowrer's Two Factor Model, extinction naturally occurs when the conditioned stimulus (e.g., bee) is presented over successive trials without the unconditioned response (e.g., sting), until eventually the conditioned stimulus (e.g., bee) stops eliciting the conditioned response (e.g., fear). In phobias, however, this process is reduced or prevented by actions that allow an escape or avoidance of the conditioned stimulus. Avoidance and escape behavior is reinforced because it reduces fear in the short term, but it ultimately impedes fear reduction in the long term.

Although the Two Factor Model has received a great deal of empirical support, it has also been criticized on a number of grounds. First, empirical data suggest that a significant percentage of individuals with specific phobias report having always been afraid of the phobic object (e.g., animals, water), in the absence of conditioning. Second, the Two Factor Model assumes that all neutral stimuli can become phobic objects, but it is found that some objects are more likely to become conditioned stimuli than others. For example, harmless spiders are more likely than knives and electrical outlets to become

conditioned stimuli that elicit escape and avoidance behavior. Thus, it has been argued that some stimuli are 'biologically prepared for conditioning,' a limitation of conditioning not accounted for by the Two Factor Model. Third, contrary to the model, not all individuals who have traumatic experiences with phobic stimuli develop phobias, perhaps because they had many previous nonaversive encounters with phobic stimuli. Thus, subsequent theories have been developed to expand the model to account for phobias that do not appear to be acquired through direct classical conditioning.

Rachman's pathways

Rachman proposed that phobias develop via three pathways. First, as proposed by the Two Factor Model, a previously neutral object or situation might become associated with a conditioned fear response due to a traumatic event through classical conditioning (direct conditioning). Second, a phobia might develop as a result of observing another individual model fear behavior (modeling) or witnessing another individual experience a traumatic event (vicarious learning). For example, an individual might develop a water phobia after witnessing a near drowning or a child might develop a bat phobia in response to witnessing his or her mother scream and run away each time a bat is encountered. Thus, the model's anxious response acts as the observer's unconditioned stimulus and evokes a fearful or anxious unconditioned response in the observer. The pairing or contiguous presence of this unconditioned stimulus (e.g., model's fear response) with a conditioned stimulus (e.g., bat) leads to an association between the two, and the conditioned stimulus (e.g., bat) subsequently evokes a conditioned fear response when it is encountered on its own. Third, Rachman proposed that a phobia might develop as a result of being warned about the dangerousness of an object or situation and being instructed to avoid it (parents – instructional transmission) or as a result of being given information about the dangerousness of an object or situation (media – informational transmission). For example, a child might develop a snake phobia after his or her parents repeatedly warn about the dangerousness of snakes or an individual might develop a flying phobia after watching media coverage of a fatal plane crash. Rachman's pathways account for the acquisition of a greater number of phobias than the original Two Factor Model; however, epidemiological studies suggest that ~50% of individuals with specific phobias have no memory for conditioning events associated with the development of their phobias, and that modeling, vicarious learning, and instructional transmission are rarely implicated in the development of phobias. Given that many phobias develop in childhood and are typically investigated retrospectively many years later, one potential explanation for this finding is that conditioning events are simply forgotten. However, current epidemiological research suggests that many phobias cannot be accounted for by conditioning events. As described in the nonassociative model below, a fourth nonassociative pathway is thought to account for certain innate phobias.

Cognitive – Behavioral Models

Cognitive theories of phobia acquisition and maintenance elaborated upon the behavioral models by considering the role of cognitive mechanisms such as expectations and

memory representations of the conditioned and unconditioned stimuli. According to cognitive theories, fear and avoidance behavior are determined by the expectation that a behavior will lead to an aversive consequence, and is maintained by confirmation of the expectation (e.g., watching media coverage of plane crash or experiencing turbulence while flying). Moreover, the avoidance behavior prevents disconfirmation of the irrational expectations.

According to cognitive theories, individuals with specific phobias exhibit cognitive biases that serve to maintain phobias. For example, they overestimate the probability of threat and consequences of harm, scan the environment for potential threats, and interpret ambiguous situations as those that are likely to lead to worst-case scenarios. Recently, the cognitive perspective has been enlarged because of findings suggesting that negative cognitions about phobic objects can occur at an automatic level that is implicit and beyond self-report.

Looming Vulnerability Model

According to the Looming Vulnerability Model, individuals with anxiety disorders, including specific phobias, have mental representations of dynamically intensifying danger and rapidly escalating risk. Thus, individuals with specific phobias not only overestimate threat, but they also appraise the threat as moving through time and space. Threat is perceived as rapidly rising in risk, progressively worsening, or actively accelerating. For example, individuals with spider phobia spontaneously imagine spiders as jumping or crawling toward them in the absence of actual movement.

Network Model

According to the Network Model, cognitive representations of feared stimuli (e.g., bees, hornets, parks), response information (e.g., subjective fear, escape behavior), and meaning information (e.g., danger) are all linked in fear structures or networks in long-term memory. These fear structures evoke fear and motivate avoidance or escape behavior when they become activated by incoming information that matches information stored in the fear network. By avoiding or escaping the feared stimulus, corrective information regarding the actual safety of the stimulus cannot be incorporated into the fear network.

Biological Model

Biological Preparedness Theory

Certain fears appear to be inborn. Seligman proposed that certain classes of objects, such as animals and reptiles, are more likely to become phobic objects than others, such as electrical outlets and knives, despite being objectively less threatening. Seligman's Biological Preparedness Theory proposes that humans and other organisms are biologically prepared to acquire phobias of objects with evolutionary significance. That is, organisms are hard-wired to fear certain objects that, at some point in evolution, could potentially threaten the survival of the species, and these particular fears should be more resistant to extinction (i.e., more difficult to unlearn the fear association). In support of the biological preparedness theory, research has demonstrated that Rhesus monkeys are more likely to acquire phobias of reptiles than phobias of flowers after observing another Rhesus monkey

behaving fearfully toward the object. However, evidence from human studies has been less conclusive. Further, although it was initially proposed that biologically prepared phobias would be more resistant to extinction, they are generally no more difficult to treat than other phobias.

Nonassociative Model

The Nonassociative Model acknowledges that evolutionary-neutral phobias are acquired through learning or conditioning processes, but asserts that most evolutionary-relevant phobias (e.g., heights, water, spiders, strangers, separation) are innate and arise without any direct or indirect associative learning. According to this model, natural selection has favored individuals who displayed fear when first encountering a dangerous object or situation, and most members of a species will fear certain evolutionary-relevant stimuli given normal maturational processes and background experiences. Whereas conditioning models assert that phobias are learned, nonassociative models conceptualize phobias as innate fears which have not yet been unlearned. It is assumed that innate fears persist due to poor habituation or insufficient opportunities during critical developmental periods for safe exposure experiences (i.e., non-threatening interactions with the feared object or situation). Individuals are thought to recover from phobias by learning to stop responding fearfully to predisposed or prepared stimuli.

The nonassociative model has been challenged on the basis that it predicts more fear than is actually observed in the general population and does not adequately explain why some individuals habituate poorly to predisposed fear stimuli. Further, while the inability to recall a conditioning event is interpreted as supporting the nonassociative model, this finding could also be accounted for by childhood amnesia (i.e., the inability of adults to recall events that occurred prior to age 4). Finally, it would be assumed from nonassociative models that innate evolutionary-relevant phobias have a strong genetic component, but behavioral genetics studies report only moderate heritability and a large impact of specific environmental factors.

Rather than conceptualizing phobias dichotomously as resulting from associative or nonassociative processes, more recent integrative models propose that phobias are best conceptualized on a continuum with respect to the extent of association or learning required to evoke fear, ranging from purely innate phobias requiring no associative processes to purely learned phobias resulting from aversive conditioning events.

Genetics Model

The transmission of specific phobias appears to have a familial component. Individuals with specific phobias are significantly more likely to have a relative with specific phobias compared to individuals without specific phobias, and genetics studies report higher concordance rates among monozygotic twins than dizygotic twins. Both an overall 'phobic predisposition' (e.g., neuroticism, behavioral inhibition, anxiety sensitivity) and stimulus-specific genetic contributions have been implicated. Collapsing across the different subtypes of phobias, the average heritability of phobias, or the percent of variation in a phobia that is due to additive and nonadditive genetic factors, has been estimated at 40%. The heritability estimate for each

subtype of specific phobias has been reported as follows: 58% for animal phobias, 43% for blood-injection-injury phobias, 37% for natural environment phobias, and 23% for situational phobias. It is generally assumed that the genetic predisposition interacts with conditioning experiences to increase the risk of developing specific phobias.

Treatment of Specific Phobias

Psychodynamic Therapy

Psychodynamic therapy aims to explore past traumatic events in order to increase an individual's awareness of the symbolic nature of the phobia (e.g., to become aware that the phobia is connected to sexual or aggressive impulses). The goal is to both expose and reduce unconscious psychological conflicts and to gain greater conscious control over the conflicts. Psychodynamic therapy is not considered an effective treatment for specific phobias.

Cognitive – Behavioral Therapy

Specific phobias are among the most treatable of psychiatric disorders, and cognitive – behavioral therapy (CBT) is considered the most effective treatment. A recent meta-analysis reported that the average participant receiving cognitive and behavioral interventions showed more improvement than 85% of nontreated individuals. Although behavioral and cognitive interventions arose from distinct theoretical traditions, the interventions are typically combined in practice. A fundamental component of CBT is repeated and systematic exposure to feared stimuli. An exposure hierarchy is created consisting of feared situations that are ranked from least distressing to most distressing (see [Table 1](#)). The individual begins by confronting an object or situation ranked low on the exposure hierarchy in a gradual and predictable manner that maximizes the patient's perception of control. The individual is encouraged to remain in the situation until anxiety reduces by at least 50% rather than escaping from the situation when anxiety becomes too intense.

Exposure therapy can be conducted in a number of ways. In vivo exposure involves coming into direct contact with the feared stimulus. An individual with a spider phobia might begin exposure therapy by observing photos of a spider and

Table 1 Sample hierarchy of feared situations for spider phobia

<i>Feared situation</i>	<i>Distress (0–100)</i>
Most distressing: allow large spider to crawl on arm	100
2nd most distressing: touch large spider with finger	90
3rd most distressing: allow small spider to crawl on arm	80
4th most distressing: touch small spider with finger	70
5th most distressing: walk within 1 ft of large spider	60
6th most distressing: stand in room with large spider, walk within 5 ft of spider	50
7th most distressing: walk within 1 ft of small spider	40
8th most distressing: stand in room with small spider, walk within 5 ft of spider	30
9th most distressing: view photo of real spider, then touch it	20
10th most distressing: view cartoon photo of spider, then touch it	10

then move through the exposure hierarchy by touching photos of a spider, being in the same room as a spider, moving progressively closer to a spider, touching a small spider, and then eventually touching a large spider. In vivo exposure has demonstrated robust effect sizes across a variety of types of specific phobias and is considered the most effective form of exposure therapy. In vivo exposure is often conducted in conjunction with participant modeling, a technique grounded in social learning theory in which the patient observes the therapist confronting the feared stimulus effectively before attempting the exposure on his or her own. In some cases, imaginal or virtual reality exposure might be used if it is not practical to perform in vivo exposure (e.g., fear of hurricanes) or if the phobia is sufficiently severe such that in vivo exposure would be too distressing in the early stages of treatment. For example, an individual with a spider phobia might imagine a spider in graphic detail and later imagine touching the spider and allowing it to crawl up his or her arm. Systematic desensitization is an approach that combines imaginal exposure with relaxation training. The rationale behind this treatment is that repeated exposure to feared stimuli in conjunction with the use of an anxiety-incompatible response (i.e., relaxation) should eliminate the conditioned fear response. Although it has been found to be an effective treatment for specific phobias, the addition of relaxation training does not appear to improve outcome beyond the effect of exposure therapy alone. Regardless of the exposure method used in therapy, homework between sessions, consisting of exposure exercises conducted either alone or with a helper, is considered a core component of CBT.

Due to the physiologically different processes operating in blood-injection-injury phobias, traditional in vivo exposure therapy requires modification to reduce the vasovagal response and potential for fainting. Patients are first taught to recognize early signs of drop in blood pressure and then practice tensing and then releasing the tension in the body. Muscle tension is then used in combination with in vivo exposure exercises. This applied muscle tension technique has been found to be an effective treatment for blood-injection-injury phobias.

Individuals taking part in imaginal or in vivo exposure therapy typically move up the exposure hierarchy at a gradual pace over a number of treatment sessions. However, research has demonstrated that a massed approach to treatment with prolonged exposure within one session can also be effective. In one session treatment (OST), patients are exposed to their entire hierarchy, starting with the least distressing situation and moving up to the most distressing situation, within a single 3 h session. In flooding therapy, patients immediately confront a feared situation ranked at the top of the exposure hierarchy. Both of these treatment approaches are quite cost and time effective; however, flooding therapy requires a very motivated patient who is willing to remain in a situation that provokes intense anxiety.

Habituation is one potential mechanism by which exposure therapy reduces conditioned fear responses. Habituation refers to a decrement in response (e.g., psychophysiological response or subjective fear) as a result of repeated exposure to the feared stimuli (see [Figure 1](#)). Habituation theory assumes that prolonged exposure will result in fear reduction; however, habituation has been questioned as a mechanism of change in exposure therapy because some patients do not experience

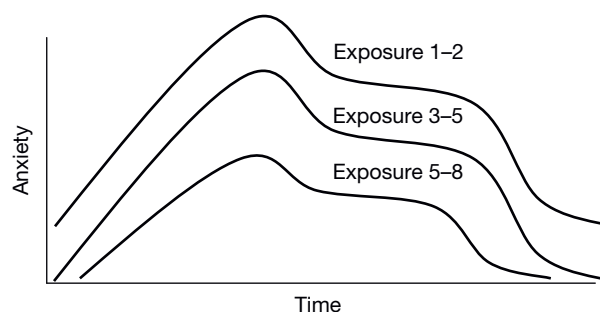


Figure 1 Habituation/extinction learning curve.

fear reduction with prolonged exposure. Further, some patients experience reductions in physiological responding during exposure without a corresponding reduction in subjective fear, a finding that cannot be reconciled with habituation theory. The mechanism currently thought to best account for fear reduction is extinction learning. Patients learn not only to unlearn a previously learned association (e.g., spiders are dangerous) during exposure therapy, but more importantly, they learn to attribute novel significance to the conditioned stimulus (e.g., spiders are relatively safe). During this process, separate mental representations (e.g., spiders are dangerous and spiders are safe) exist simultaneously and compete with one another. Which representation is selected depends on the match or mismatch between the context in which extinction learning occurred and the context in which the fear cue is subsequently encountered. One implication of extinction learning is that the extinction of learned fear during exposure therapy does not easily generalize to new situations unless the new situation contains salient stimuli that were present during extinction learning trials, thus, many exposure exercises should be conducted across a variety of contexts. The extinction learning theory is also compatible with the emotional processing theory, which proposes that fear reduction during exposure therapy requires the learning and integration of new information that is incompatible with the existing representations of threat that are coded in memory.

The cognitive component of CBT aims to elicit and challenge negative automatic thoughts regarding the perception of threat and the inability to cope effectively with threat and to replace these automatic thoughts with more realistic and adaptive thoughts (see [Table 2](#)). Exposure exercises are also viewed as an important component of cognitive therapy; however, the rationale for exposure differs in cognitive therapy. Rather than habituating to the feared stimuli or extinguishing learned fear, exposure exercises are framed as behavioral experiments or hypothesis testing. Individuals with specific phobias learn that their feared consequences do not occur and their anxiety does not persist at catastrophic levels. The mechanism thought to account for fear reduction in cognitive therapy is expectancy violation. During behavioral experiments, erroneous beliefs regarding the probability and severity of feared consequences are disconfirmed and corrective information regarding the threat is incorporated.

Pharmacological

Relatively few studies have examined the efficacy of pharmacotherapy for specific phobias, either alone or as an adjunct to

Table 2 Sample thought record for dog phobia

<i>Situation</i>	<i>Emotion</i>	<i>Automatic thoughts</i>	<i>Evidence</i>	<i>Countering statement</i>
Encounter a dog on the street.	Fear (90%)	The dog will bite me and I will get rabies.	<p><i>For:</i> Some dogs bite. Some dogs have rabies.</p> <p><i>Against:</i> It is rare to get bitten by a dog. I am not provoking the dog. The dog is on a leash. Most domestic dogs get rabies shots.</p>	Although it is not impossible to get rabies from a dog bite, it is extremely unlikely especially if it is a domestic dog and I am not provoking it. There are effective treatments to prevent rabies if a dog bites me.

psychological treatments. Benzodiazepines might temporarily be helpful in acute situations, such as when taken before a flight or medical procedure, but anxiety returns without medication. Although benzodiazepines might decrease anticipatory anxiety associated with a phobic situation, reduce phobic arousal, and increase motivation for undertaking uncomfortable treatment, the reduction of symptoms might actually be counterproductive if the medication prevents activation of the fear network during exposure exercises. Pharmacotherapy is not currently considered an effective treatment for specific phobias, particularly in the long term.

One recent development with potential promise has been the augmentation of exposure therapy with d-cycloserine, a partial agonist of glutamatergic *N*-methyl-D-aspartate (NMDA). The medial prefrontal cortex and amygdala, and the connections between them, have been implicated as the primary neural system underlying fear extinction. The medial prefrontal cortex plays an essential role in regulating the amygdala-mediated expression of conditioned fear during the process of extinction by inhibiting the retrieval of previously learned fear associations. Activation of NMDA receptors within the amygdala appears to be essential for extinction learning, and NMDA receptor agonists have been shown to enhance the extinction of fear memories and thus facilitate the process of extinction learning. d-cycloserine is administered acutely and intermittently prior to exposure exercises, and the augmenting effects appear to occur between sessions during the postextinction consolidation periods rather than within exposure sessions.

Summary

Specific phobias are prevalent anxiety disorders characterized by an intense and persistent fear or disgust response that is cued by the presence or anticipation of a specific object or situation. A variety of theoretical models have been developed to account for the onset and maintenance of specific phobias, including those emphasizing classical and operant conditioning, cognition, biological preparedness, and genetics. Specific phobias are among the most treatable of all psychiatric

disorders and CBT is currently considered the most effective treatment approach.

See also: Anxiety and Fear; Anxiety Disorders; Associative Learning; Classical Conditioning; Cognitive Behavior Therapy; Disgust; Evolutionary Clinical Psychology; Operant Conditioning.

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Phonetics

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Glossary

Allophone A variant of a phoneme; different sounds within a group that convey the same meaning.

Articulation Speech production; the postures and movements of the speech organs in speech production.

Coarticulation The overlapping of articulatory gestures in the production of adjacent speech sounds.

Feature A distinguishing attribute of a linguistic unit.

Formant A vocal tract resonance; in the spectrogram, they are observed as bands of concentrated acoustic energy. Relationships between formants characterize vowels.

Fundamental frequency The lowest frequency of a periodic wave; in speech, fundamental frequency corresponds to the rate of vocal fold vibration.

Phonation Voicing that occurs when the vocal folds (vocal cords) open and close, causing the airstream from the lungs to vibrate.

Phone A speech sound or segment.

Phoneme A minimal contrastive unit of speech; the smallest unit of speech that conveys meaning.

Prosody Phonetic aspects of speech that apply across segments, such as stress and intonation.

Source-filter theory A theory of speech production that quantifies the relationship between articulation and the acoustic output of the vocal tract.

Spectrogram A visible record of speech that provides information regarding frequency, intensity, and time.

Phonetics is the study of speech sounds. It involves description of the possible sounds of the languages of the world, investigation of how the human vocal tract produces those sounds, and the attempt to understand how such sounds are perceived. Historically, phonetics was taken to be the study of speech sounds without regard to their linguistic function. Contemporary phonetics is concerned with the aspects of sound that are necessary to convey meaning from the speaker to the listener, with explanations for the patterns of speech sounds used within and across languages, as well as with the changes that occur in those patterns over time. Although the latter concerns used to be considered exclusively the domain of phonology (the study of how sounds are organized into systems used in languages), it is apparent that speech production and perception influence and are influenced by linguistic function. Advances in technology coupled with the interplay of theory, experiment, and modeling have made it possible to explore these influences in new ways.

Why Study Phonetics?

Henry Sweet was a nineteenth century phonetician on whom George Bernard Shaw's Professor Henry Higgins of *Pygmalion* was based. He considered phonetics to be the foundation of all study of language, applied or theoretical. At the applied or practical level, phonetics is useful for teaching pronunciation to nonnative speakers of a language or to the deaf. Actors, politicians, broadcast journalists, and others may wish to acquire or eliminate an accent or affect a dialect. Teachers of reading can benefit from a thorough knowledge of phonetics to better understand the relationship between written and spoken language. Speech pathologists who diagnose and treat speech disorders must be able to describe disordered speech accurately, to understand how that speech is being produced,

and to determine appropriate courses of correction. Engineers who design speech transmission devices, speech recognition systems, or speech synthesizers must have knowledge of phonetics. Linguists use phonetics to describe and catalog the sounds of the languages they study, patterns of sound change in the historical development of a language, and the sequence of events in language acquisition.

On a theoretical level, phonetics relates the physical aspects of how speech sounds are produced and perceived with their function in language. Phonetic theory should account for the sounds observed in human languages and the relative frequency with which they occur. It should make sense of the data acquired by linguists who phonetically describe the observed sequence of events in language acquisition and the types of sound changes that occur in languages. In addition, it should be able to account for the effects of physical damage to or deformities in the speech organs, as well as neurophysiological deficits.

A Brief Historical Perspective

Phonetics had its beginnings in the work of the Sanskrit grammarian, Panini, in the fourth century BC. Sir William Jones brought the Sanskrit work to light in the West in 1786. In the Indian writings, phonation and articulation were understood to be distinct processes, and the larynx was known to be the site of phonation. Places of articulation were used to classify speech sounds.

In the second half of the eighteenth century, phonetic science focused on how the different sounds in speech could be produced by the vocal apparatus. C. G. Kratzenstein developed one of the earliest speech synthesizers in order to obtain a prize offered by the Imperial Academy of Sciences of St. Petersburg for explaining the physiological differences between the five

vowels of the Russian language. Wolfgang von Kempelen also produced an early speech synthesizer, or 'talking machine,' built primarily of wood and leather with the vocal cords represented by a reed and the airstream supplied by a bellows. C. J. Ferrein sought a physiological explanation for how the vocal cords produced phonation.

In the mid-nineteenth century, the relationship between physiology and phonetics was still at the forefront of phonetic science, culminating in Johannes Müller's source-filter theory of speech production which still guides much of phonetic research. Also influential was A. M. Bell's *Visible Speech*, a system of speech classification designed for use in teaching the deaf to speak. In addition, Bell established the notion of cardinal vowels, vowels that serve as reference points for the articulatory description of the vowel inventory of a language. Henry Sweet elaborated on Bell's visible speech, producing a speech classification system which ultimately served as the basis for the International Phonetic Alphabet (IPA).

In the early twentieth century, Jean Pierre Rousselot produced a body of experimental work designed to obtain measurements of articulatory positions and to create permanent records of speech sounds. Jan Baudouin de Courtenay pointed out the distinction between a *phone*, or speech sound, and a *phoneme*, or a group of speech sounds which have no significant differences in meaning in the language under study. During this time period, phonetics began to be treated as a science separate and distinct from phonology, or in Baudouin's terms, psychophonetics. Phonologist Ferdinand de Saussure contributed to the view with his notions of *parole* versus *langue*. He believed that although speech ('parole') was the substance of language ('langue'), it was essentially unrelated to linguistic function just as the substance of which chess pieces were made was unrelated to the game of chess. In a different vein, the work of R. H. Stetson in the early 1900s introduced the notion of motor phonetics with studies of speech as a set of 'audible movements' rather than sounds produced by movements. He defined the syllable as being delimited by a chest pulse, contrary to the prevailing view of his colleagues that syllables were bounded by points of minimum sound. His work anticipated the contemporary interest in the relationship between speech production and speech perception.

Since the 1950s, improvements in the technologies used to quantify the production and perception of speech have allowed empirical tests of traditional phonetic theory. Results from the studies converge on the notion that phonetics and phonology overlap, that is, the perception and production of speech are intimately linked with each other as they are with linguistic function.

Preliminaries to the Study of Phonetics

One aspect of a phonetician's job is to understand what happens when human beings speak, which includes understanding how the speech sounds are produced and what the acoustic characteristics of the speech sounds are. Articulatory phonetics is the particular branch of phonetics concerned with the description of speech sounds in terms of postures and movements of the speech organs. Acoustic phonetics is concerned with how articulatory positions and movements shape speech

sounds and how speech sounds may be classified on the basis of acoustic characteristics. To study phonetics, it is necessary to have some knowledge of (1) the anatomy and physiology of the speech organs, (2) basic acoustics, and (3) the instrumentation and methods used to describe and analyze speech. The next three sections are devoted to these topics.

Anatomy and Physiology

The speech production apparatus is typically divided into three physiological components: the respiratory system, which furnishes the airstream that powers speech, the larynx, or voice box, which is the source of sound energy, and the supralaryngeal vocal tract, which consists of air-filled cavities that act as an acoustic filter (see [Figure 1](#)).

The respiratory system consists of the lungs and respiratory musculature. The muscles involved include the internal and external intercostals, the diaphragm, and abdominal muscles. The external and most of the internal intercostals muscles are involved in inhalation, while some internal intercostals and the abdominal muscles can act during exhalation to maintain steady air flow from the lungs. In quiet respiration, exhalation lasts about as long as inhalation. During speech, the duration of exhalation is markedly increased and is determined by the length of utterance. The steady air flow generated by the lungs during exhalation essentially powers speech.

The second physiological component, the larynx, is a cartilaginous group of structures which contains the vocal cords (more accurately called the vocal folds) and the glottis. The vocal folds are, literally, folds of ligament attached to the arytenoid cartilages on each side of the larynx. During normal breathing, the arytenoids are quite far apart, but for speech, they move closer together to narrow the glottis (the opening between the vocal folds). When the vocal folds are in complete contact, the glottis disappears. Phonation or voicing occurs when the vocal folds move together and subglottal air pressure builds up sufficiently to push them apart. Air rushes through and the vocal folds again come together as a result of their elasticity and the suction (Bernoulli force) generated by the airflow through the narrow glottis. Thus, the larynx acts as a valve to change the steady air flow from the lungs into a series of quasiperiodic pulses of air.

The third component is the supralaryngeal vocal tract (henceforth, the vocal tract). It encompasses the structures above the larynx, including the nasal cavity, oral cavity, and pharynx, and it acts as a variable acoustic filter on the source of acoustic energy to produce the characteristic resonances of speech sounds. The oral cavity serves as a resonating chamber with highly variable size and shape. The nasal cavity is partially filled and divided into several smaller cavities by membranes; thus, it is a relatively poor resonator. The pharynx, or throat, is a resonating cavity behind the oral cavity and above the larynx.

Anatomical structures of the vocal tract which are important for classifying speech sounds with respect to articulatory position are shown in [Figure 1](#) (left side). The *lips* are used to close, constrict, or change the length of the oral cavity. The *teeth* are a point of constriction for some speech sounds. The *tongue* is a mass of muscles. Its base is attached to the hyoid bone which, in turn, is connected by a membrane to the top of the larynx. Although phoneticians generally divide the tongue into several

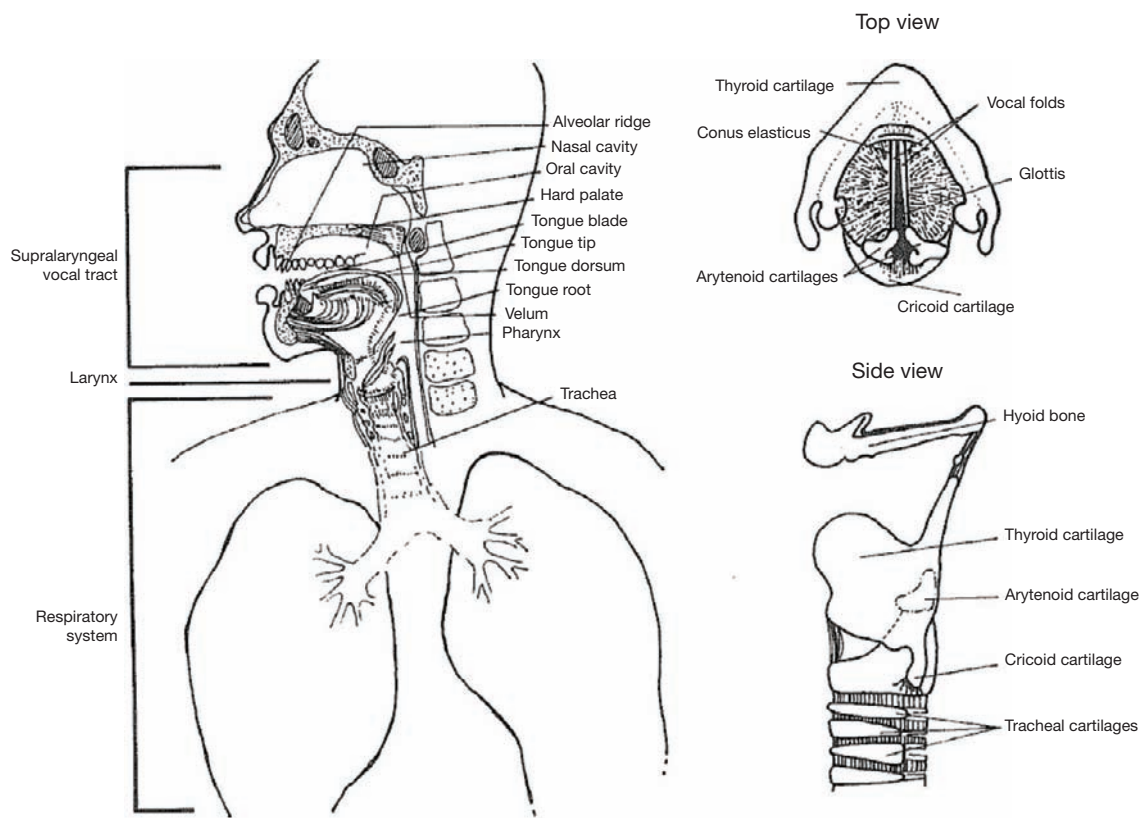


Figure 1 Major anatomical components of the speech production system with the top and side view of the larynx.

functional regions, including the tip (or apex), blade, dorsum, and root, the boundaries between regions are not anatomically distinct. The flexibility of the tongue allows significant manipulation of the shape and size of the oral cavity. The *hard palate* is the hard, bony part of the roof of the mouth. An important landmark on the hard palate is the *alveolar ridge*, the rough-textured ridge directly behind the upper front teeth. The *velum*, or *soft palate*, is at the back of the roof of the mouth; it can be raised to close the nasal cavities off from the rest of the vocal tract, or lowered to open the velic port and introduce nasal resonance.

Basic Acoustics

Sound results when a vibrating source first compresses nearby air molecules creating a region of increased air pressure. Then as the source moves back past its resting position, it pulls the disturbed air molecules back along with it resulting in an area of low air pressure or rarefaction. In other words, the local air molecules vibrate with the source. Each vibrating air molecule disturbs the molecules near it to produce the alternating high- and low-pressure areas which set up the wave motion of sound. Note that the molecules themselves only oscillate and disturb the next molecules; they do not themselves travel along the sound wave.

To illustrate the important characteristics of wave motion, sine waves are shown in [Figure 2\(a\)–2\(c\)](#), which graph the air pressure of sound waves at a point some distance from the sound source measured repeatedly over time. The physical

characteristics of each wave include its amplitude and wavelength. Amplitude corresponds to the air pressure or strength of disturbance, and wavelength is the space occupied by a single cycle of the wave. The temporal dimensions of sound waves include the period, frequency, and propagation velocity. The period of a wave is the duration of time it takes to complete one cycle. For the wave in [Figure 2\(a\)](#), the period is 0.01 s. Frequency refers to the number of cycles per unit time, usually cycles per second, or hertz (Hz). Thus, the frequency, which is the inverse of the period, is $1/0.01$ or 100 Hz. The speed of propagation of a wave varies directly with the density of the medium through which it travels; thus, a wave travels faster through solids than gases. Propagation speed of a sound wave is about 1100 feet (or 35 000 cm) per second through air at sea level, and is independent of the frequency. Waves may be periodic (each cycle of the wave having the same period) or aperiodic (each cycle of the wave having a different period). An aperiodic wave may be characterized by the range of frequencies of its components, a fact which is important for acoustic classification of fricatives.

The three sine waves in [Figure 2\(a\)–2\(c\)](#) may combine to form the complex periodic wave in [Figure 2\(d\)](#), and complex periodic waves can be fully described as the sum of a number of sine waves, or Fourier components, of different amplitudes, frequencies, and phases. The frequency of the lowest frequency component of a complex wave corresponds to the fundamental frequency (f_0) of the complex wave. Notice that the period of one cycle is the same for the lowest frequency component wave in [Figure 2\(a\)](#) and the complex wave in [Figure 2\(d\)](#).

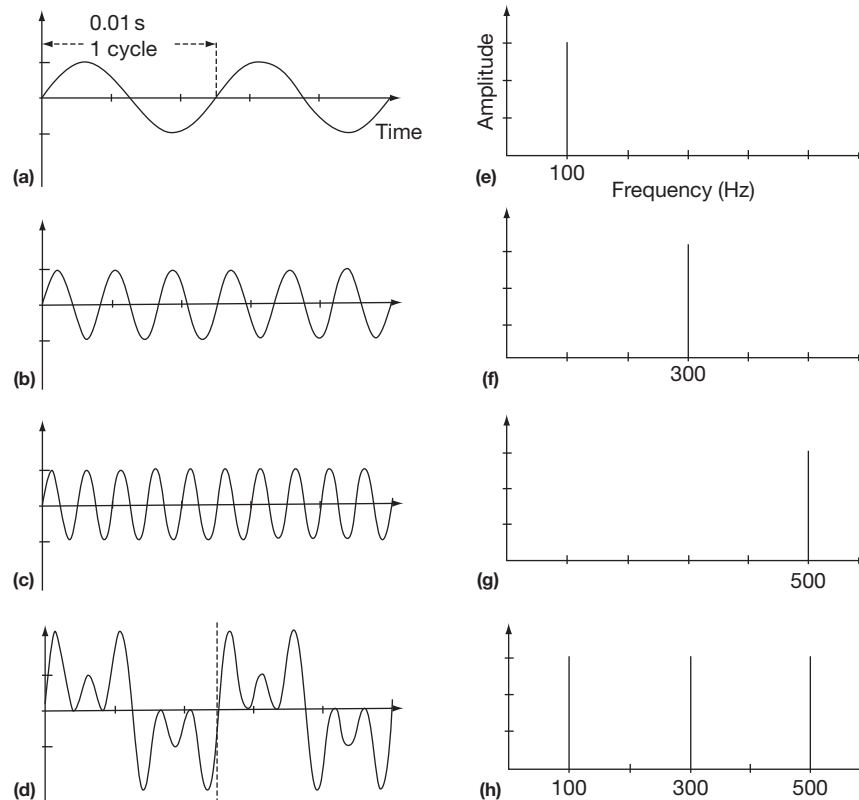


Figure 2 (a) Sine wave with a frequency of 100 Hz. (b) Sine wave with a frequency of 300 Hz. (c) Sine wave with a frequency of 500 Hz. (d) The sum of the three components in (a–c). (e–h) Corresponding amplitude spectra.

The frequency of each higher frequency component of the complex wave is an integer multiple of f_0 . These components are referred to as the second, third, etc., harmonics (f_0 is the first harmonic). Figures 2(b) and 2(c) represent the second and third harmonics of the complex wave. In speech, f_0 corresponds to the rate of opening and closing of the vocal folds, and harmonics arise due to the elastic nature of the vocal folds. The amplitude spectra specify the frequencies and amplitudes of each of the component sine waves (Figure 2(e)–2(h)).

The sound source provided by the vibrating vocal folds is shaped by the vocal tract into resonant speech sounds. The laryngeal source of quasiperiodic pulses of air provides a set of spectral components (fundamental frequency and harmonics) that, on its own, produces a weak buzzing sound. When the laryngeal source passes through the vocal tract, resonance properties of the vocal tract act as an acoustic filter that amplifies some frequencies of the source and suppresses others. Resonance refers to the propensity of an object undergoing forced vibration to oscillate with greatest amplitude in response to applied frequencies near its own natural frequency. Strike a tuning fork and it will vibrate at its natural, or resonant, frequency. Place the vibrating tuning fork near another tuning fork which has the same resonant frequency, and the second fork will begin to vibrate. The irregularly shaped, air-filled cavities of the vocal tract also act as resonators amplifying their natural frequencies. The resonant frequencies of the vocal tract are called formants.

The preceding description essentially summarizes the source-filter theory of speech production first postulated by

Johannes Müller in 1848. Source-filter theory, which continues to be developed, accounts for much current data and allows for the quantification of the relationship between articulation and the acoustic output of the vocal tract. In the source-filter theory, there is a clear separation of the glottal source of sound energy and the filtering of the sound by the vocal tract configuration which amplifies sound energy at certain frequencies and attenuates others. The resonant frequencies are the formants associated with voiced speech sounds which determine, to a great extent, perception. A major strength of the source-filter theory is that it provides a means of quantifying the relationship between articulatory postures and acoustics.

Instrumentation and Methods

Descriptive methods: phonetic transcription

Phonetic transcription is a tool for describing the sounds of speech. One level of phonetic transcription, broad transcription, is concerned primarily with the functional distinctions between sounds. A phone is a speech sound, and a phoneme is a group of speech sounds which have no significant differences in meaning in a particular language. For example, the *p* in *pat* and *spat* are two different phones, but not different phonemes, in American English. Only the first is accompanied by unvoiced airflow (aspiration) on release of the lip constriction. The *p* in *pat* and the *b* in *bat* are different phonemes; they are two different sounds which convey different meanings. When transcription is for the purpose of noting phonemes, or how sounds convey meaning, a simple set of symbols placed

between slashes (/ /) is used. For example, the *p* in *pat* and the *p* in *spat* are both indicated as /p/ in a broad transcription. The small differences in pronunciation of the *p* are ignored. Another level of phonetic transcription, narrow transcription, specifies articulatory details of the production of speech sounds. Narrow transcription has different symbols that are placed in square brackets ([]) for each allophone, or variant, of a phoneme. A narrow transcription of the *p* in *pat* is [p^h], indicating that the *p* is produced with aspiration. A narrow transcription of the *p* in *spat* is [p]. Narrow transcription is particularly useful when transcribing an unknown language or disordered speech.

The most commonly used set of symbols for phonetic transcription is the IPA. The first version of the IPA was published in 1888 and was based on the premise that there should be one symbol for each speech sound possible without regard to language. From time to time, revisions are made to the alphabet by adding or removing symbols and renaming symbols or categories. Many of the symbols are taken from the Roman alphabet, with other letters and diacritics (marks added to a symbol to modify its value) used as necessary. For example, the raised *h* in [p^h] is a diacritic which signifies aspiration, and the colon in [a:] indicates a longer duration. With the development of Unicode, the IPA symbols are readily available for use in word-processed documents and computer displays.

Analytic instruments and methods

The sound spectrograph, first introduced in the 1940s, is an instrument that provides a visual record of sound called a

spectrogram. Spectrograms, including their computerized digital versions, display time from left to right on the horizontal axis, frequency on the vertical axis, and amplitude on a gray scale with greater amplitude producing darker marks or on a color scale. In the spectrogram of a production of *stop now* in the bottom of [Figure 3](#), the formants associated with the vowels can be seen as dark bars. They remain steady while formant frequency is constant, and bend up or down as the configuration of the vocal tract changes over time, indicating the dynamic nature of speech. Fundamental frequency can be observed in the vertical striations which occur during voiced sounds. Blank spaces in the spectrogram indicate the absence of sound energy, as during vocal tract obstruction for the unvoiced stop consonants /t/ and /p/. Frication, as for the /s/, is indicated by relatively intense energy spread over a broad range of frequencies. The nasal sound /n/ is indicated by a dominant low frequency formant with several higher frequency, very low amplitude formants.

Digitized speech waveforms (top of [Figure 3](#)) display the amplitude variations in the acoustic signal over time, and permit fast, accurate measurement of duration and amplitude of speech. The flexibility of computerized digital speech signals allows the speech scientist to choose any segment of an utterance for further analysis. Speech processing software permits editing of the waveform or spectral components for experimental purposes. For example, silent gap duration associated with a stop consonant can be increased or decreased, and the resulting waveform played to listeners. Effects of such manipulations provide a window into the nature of speech perception.

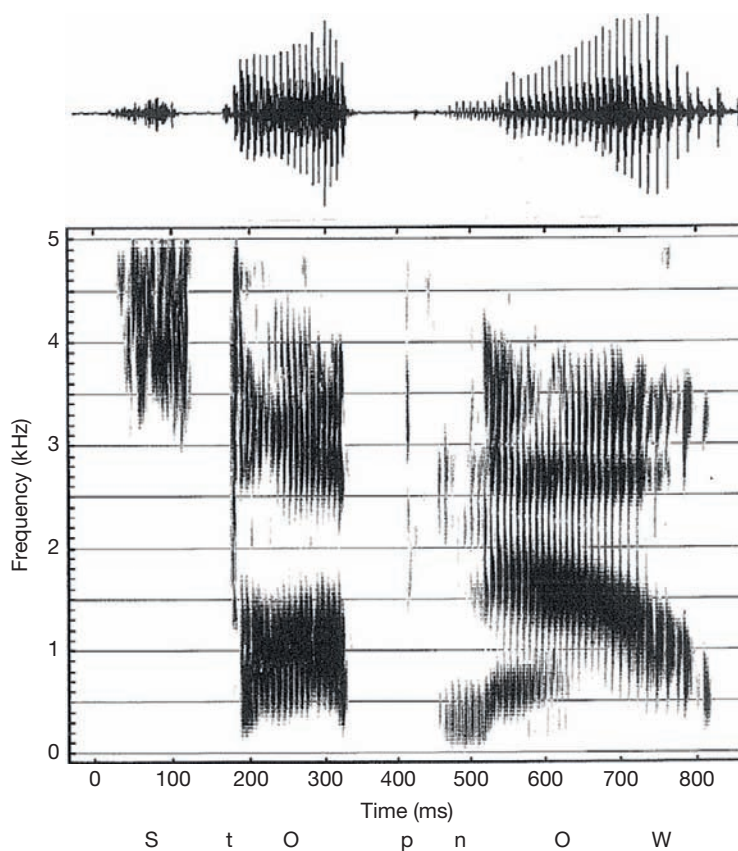


Figure 3 Top: the speech waveform of a digitized production of *stop now*. Bottom: a spectrogram of the same production. See text for details.

The development of speech synthesizers has made it possible to control almost any speech feature of interest, and thus to test hypotheses regarding the importance of the feature for perception. Two basic types of speech synthesizers use either an articulatory or acoustic level of control. Articulatory synthesizers are based on acoustic models of the speech signal. Acoustic synthesizers produce speech based on the manipulation of acoustic parameters over time. The earliest speech synthesizers, such as those of Wolfgang von Kempelen and C. G. Kratzenstein in the 1800s, were mechanical models of the vocal tract. The Vocoder, an acoustic synthesizer developed by Homer Dudley in the 1930s, first analyzes input speech, then reconstructs the acoustic signal. A later development, the use of operator-specified control signals instead of input speech, made the Vocoder more suitable for use in experimental phonetics. A significant improvement in speech synthesis occurred with the development of the Pattern Playback at Haskins Laboratory in the 1950s. The Pattern Playback is an acoustic synthesizer that uses hand-painted patterns, usually formant tracks, on transparent acetate that are scanned with a beam of light and converted to an acoustic signal. Manipulation of the number, duration, and frequencies of the formants provided much new data regarding the acoustic information for speech perception. With digital computers, both acoustic and articulatory syntheses have become more rapid and flexible. Of the two basic types of synthesis, acoustic synthesis is less complicated and efficiently produces relatively high-quality speech. Articulatory synthesis is particularly useful for testing hypotheses about articulation directly. With the development of noninvasive, safe imaging techniques, such as magnetic resonance imaging (MRI), ultrasound, and alternating magnetic field devices, detailed information about vocal tract configuration during speech production has become available, and articulatory synthesis has been enhanced.

Articulatory and Acoustic Classification Schemes

In this section, classification schemes for the two major classes of speech sounds, consonants, and vowels, are described. Although both articulatory and acoustic classification schemes have been devised relatively independently, here they are intertwined in order to highlight the intimate relationship between articulation and the acoustic characteristics of speech sounds. Although most of the examples are from English, the principles apply across languages.

Consonants

Consonants are produced with a degree of obstruction of the vocal tract. They are typically described according to the place of articulation (the place of the major vocal tract constriction), the manner of articulation, and the presence or absence of voicing. **Table 1** lists and describes significant places of articulation and provides selected examples of phonemes produced in those places.

The manner of articulation refers to the way in which the airstream is obstructed. The categories of the manner of articulation include stops, nasals, fricatives, affricates, and approximants (glides and liquids), as well as flaps, taps, and trills.

Table 1 Some places of articulation

Place	Description	Examples	As in
Bilabial	Made with two lips	p, b, m	Pat, bat, mat
Labiodental	Lower lip to upper front teeth	f, v	Fat, vat
Dental	Tongue tip to upper front teeth	θ, ð	Thin, then
Alveolar	Tongue tip to alveolar ridge	t, d, n, s, z	Tip, dip, nip, sip, zip
Retroflex	Tongue tip to back of alveolar ridge	r	Rat
Palatoalveolar	Tongue tip to postalveolar palate	ʃ, ʒ	She, pleasure
Palatal	Tongue dorsum to hard palate	j	Yes
Velar	Tongue dorsum to soft palate	k, g, ŋ	Kate, gate, sing

Stop consonants are produced by stopping the airstream through the vocal tract. Plosives are a type of stop consonant. A plosive occurs when the velum is raised to block the passage of air through the nasal cavity and a complete closure is formed at some point in the oral cavity. Air pressure builds up behind the closure and is released explosively when the articulators are opened. Examples are /p, t, k, b, d, g/, the initial sounds in *pad*, *tad*, *cad*, *bad*, *dad*, and *gad*.

Acoustic characteristics of stop consonants include a silent period of about 50–100 ms duration, a transient burst of energy of no more than 40 ms duration upon release of the vocal tract occlusion, and formant transitions. Stop consonants may also be categorized according to their voicing characteristics. The time interval between the release of the stop and the onset of vocal fold vibration is called voice onset time (VOT).

Nasals occur when there is a closure at some point in the oral cavity and the velum is lowered to open the velic port to permit passage of air through the nasal cavities. The nasal stops in English are /m, n, ŋ/, as in the initial sounds of *map* and *nap* and the final sound in *sing*. When the velic port is open, the vocal tract is a relatively long tube from the larynx to the opening at the nose with a side branch in the oral cavity. As longer tubes are associated with lower frequencies, nasal consonants typically have a dominant low-frequency resonance of about 300 Hz called a nasal murmur.

Fricatives result from narrowing the vocal tract at some point by the close approximation of articulators. As the airstream moves through the narrow constriction, turbulence occurs producing the 'noisy' quality associated with aperiodic waves. Fricatives may be voiced or voiceless. Voiceless English fricatives include /s, ʃ, f, θ/, the initial sounds in *so*, *show*, *fin*, and *thin*. The corresponding voiced fricatives are /z, ʒ, v, ð/ as in *zoo*, *pleasure*, *view*, and *the*.

Affricates are combinations of a stop consonant and a fricative having the same place of articulation as the stop. The initial sounds in *chair* and *jump* are examples of English affricates that result when /t/ and /ʃ/ are combined and /d/ and /ʒ/ are combined, respectively. Approximants are sounds made when articulators are moved into approximation, but not so close as to produce the turbulence associated with a fricative. They are divided into glides, or semivowels, and liquids. There

are only two English glides, /w/ and /j/ as in *wet* and *yet*. The liquids in English include /l/ as in *led* and /r/ as in *red*. Liquids have well-defined formant structures like those of glides and vowels. As is true for stops, the articulatory movements associated with liquids are quite rapid, resulting in relatively short acoustic transitions.

A flap, or tap, can be heard in the medial sounds of *latter* or *ladder*. It is made with a very rapid movement of the tongue tip to and away from the alveolar ridge. The primary acoustic feature is its brief duration compared to distinctive production of /d/ or /t/. A trill is produced aerodynamically; air passes through a constriction formed by a relaxed articulator. The resulting Bernoulli forces cause an oscillation of the articulator toward and away from the point of constriction. This series of brief occlusions imposes periodic modulation on the acoustic signal. In Spanish, there is a phonemic contrast between the flapped [r], as in *pero* which means *but*, and the trilled [r] as in *perro* which means *dog*.

The sounds that have been described so far have all been produced with a *pulmonic egressive* airstream mechanism. *Pulmonic* refers to the lungs, and *egressive* means that the air flows outward. There are a number of speech sounds in a variety of languages that are produced in other ways, with an inward air flow (*ingressive*), by moving the closed glottis up or down (the *glottalic* airstream mechanism), or by raising or lowering the velum to move the column of air in the oral cavity (the *velaric* airstream mechanism). For example, one class of such sounds, ingressive velaric clicks, is common in North American Indian and South African languages. The *tsk-tsk-tsk* sound of disappointment or admonition is a series of such clicks.

Vowels

Vowels are characterized by a relatively open vocal tract and vibrating vocal folds. In general, none of the articulators come in close contact, and the airstream is relatively unobstructed. Acoustic classification schemes for vowels are based on formant patterns which are shaped by the relative positions of the articulators along several dimensions: the front-to-back position of the highest point of the tongue, the relative height of the tongue body, and the degree of lip rounding. Lips can be rounded, neutral, or spread. In /u/ as in *food*, the lips are rounded, in /i/ as in *feed*, the lips are spread, and in /ə/ as in the initial vowel sound in *about*, the lips are in a neutral configuration. Lip rounding is often associated with back vowels, while spreading is associated with front vowels. Thus, distinctions between vowels are not typically made on rounding alone. There are exceptions to this rule, and some languages do make use of front rounded or back spread vowels. For example, the /y/ as in *tu* in French is a front, rounded vowel, and can be demonstrated by trying to pronounce /i/ as in *feed* while rounding the lips.

Four vowels, /i, u, ɑ, æ/, represent the extremes of the articulatory positions and form the vowel quadrilateral. When the vowel /i/ as in *feed* is produced, the tongue is in the extreme high, front position with the lips spread. When /u/ as in *food* is produced, the tongue is in the extreme high, back position, and the lips are rounded. The /ɑ/ sound as in *father* is made from the extreme low, back position with the lips in a neutral configuration. The /æ/ as in *bad* is a low, mid front (the tongue

cannot move as far forward in a low position as when it is in a high position) vowel with lips spread. There is a set of eight reference vowels defined along the periphery of the quadrilateral called the cardinal vowels. The front cardinal vowels (/i, e, ε, a/) are equidistant from one another, as are the back cardinal vowels (/u, o, ɑ, ɔ/). The schwa (/ə/) is a mid, central vowel produced with the tongue in a relatively neutral or resting position; it is represented near the center of the vowel quadrilateral. (Figure 4 illustrates a relative articulatory position of the vowels of the vowel quadrilateral, the cardinal vowels, and the schwa in a vowel space.) The first three formants are sufficient to identify a given vowel (see Figures 5 and 6 for schematic representations of the formant patterns and articulatory postures, respectively, associated with the vowels /i, I, ε, æ, ɑ, ɔ, u, u/ as in *heed, hid, head, had, hod, hawed, hood, and who'd*). The specific formant values and articulatory positions of vowels in the space are for canonical vowels. Much variability occurs when the vowels are actually produced, even in isolation.

Certain pairs of vowels share most of the same articulatory features, but differ primarily in tongue root position or in tenseness of tongue muscles. These are the tense – lax pairs,

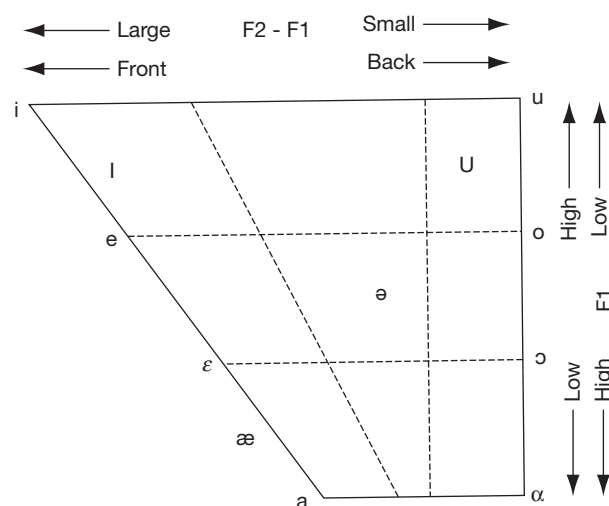


Figure 4 The relative articulatory positions and acoustic relationships of the vowels of the vowel quadrilateral (/i æ ɑ u/), the cardinal vowels (/i e ε a ɑ ɔ o u/), and the schwa (/ə/) in a vowel space. Front-back and high-low refer to the tongue position.

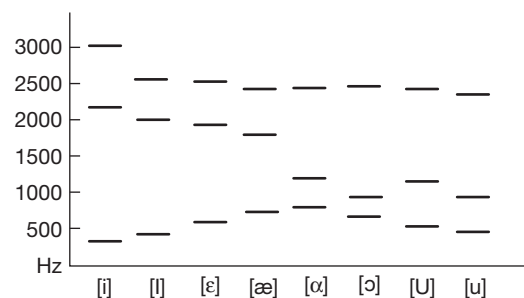


Figure 5 Schematic representations of the formant patterns (F1, F2, and F3) for indicated vowels.

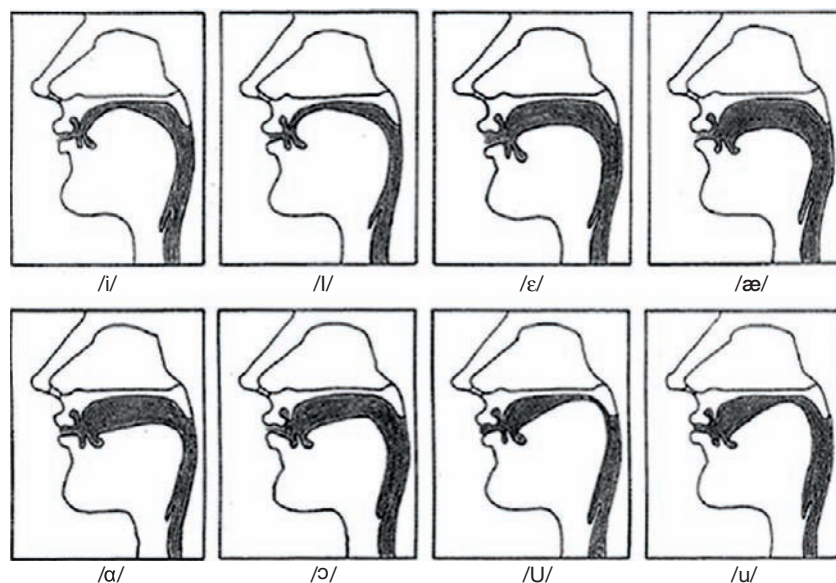


Figure 6 Schematic representations of the articulatory patterns for the vowels in [Figure 5](#).

and include /i/ as in *beet* versus /I/ as in *bit*, /u/ as in *food* versus /ʊ/ as in *good*, and /e/ as in *bait* versus /ɛ/ as in *bet*.

Examples of a rhotacized, or r- colored, vowel are found in *bird*, *herd*, *purr*, or *pearl*. This single-vowel sound is called the *schwar*, and it can be produced in several ways. The front of the tongue can be retracted, the back of the tongue can be bunched, or the tongue root can be retracted into the pharynx.

Nasalized vowels occur when the velic port is open, as is often the case when a vowel precedes a nasal consonant, for example, in the word *bond*. As with consonants, nasalization of vowels results in a low-frequency nasal formant. In English, there is no vowel distinction based on nasalization; however, such distinctions are made in other languages. For example, in French, *mon* (meaning *my*) pronounced [mɔ̃] contrasts with *mot* (meaning *word*) pronounced [mo].

Diphthongs are like vowels in that they are produced with a relatively open vocal tract and have well-defined formant structures. In general, they cannot be adequately characterized by a single vocal tract shape or single formant pattern. The diphthong /aɪ/ as in *eye*, for example, begins with the formant structure for /a/ and ends with the formant structure for /i/.

Prosody and Suprasegmentals

The phonetic aspects of speech that apply across segments, such as stress, pitch, and timing, are referred to as suprasegmentals or prosodies. Vowels and consonants are the segments of speech that combine to form syllables. Although people intuitively know what a syllable is, there is no entirely adequate objective definition of the term. Syllables are usually defined as a pulse of air, bounded by either the production of a consonant as in the syllables *pop*, *op*, or *pa* or a self-imposed reduction of air flow as in the string of syllables *ah-ah-ah*. However, while this allows for general agreement on the number of syllables in such words as *phone* (one), *phoneme* (two), *phonetic* (three), and *phonological* (five), it does not account for the

disagreement for words such as *pool* or *fear*, which may be considered to have either one or two syllables.

Stress can be defined as giving emphasis to one or more syllables in a word or phrase and it is most commonly associated with, but not equivalent to, variations in loudness. In general, stressed vowels will be louder, longer in duration, higher in pitch, less subject to modification by context, and contain a more distinct vowel than unstressed syllables. In unstressed or weakly stressed syllables, the vowel tends to be reduced toward the schwa. In English, stress can play a grammatical role, indicating whether a word is being used as a noun or a verb. Consider *to construct* versus *a construct*. In the case of the verb, primary stress is on the second syllable, while for the noun, primary stress is on the first syllable. Stress can also serve a contrastive function as in the sentence *I have a DOG, not a cat*.

Variations in pitch are used to convey both linguistic and nonlinguistic information. Absolute values of pitch are used to convey nonlinguistic information regarding the speaker's gender, age, and emotional state. It is the relative changes in pitch that convey linguistic information at the phrase or sentence level (intonation) or the word level (tone). Although English and most other Indo-European languages are not tone languages, a majority of the world's languages are. In tone languages, differences in pitch can signify different words. For example, in Chinese, the word *ma* spoken with rising pitch means *hemp*, and spoken with falling pitch means *to scold*. In some tone languages, differences in the pattern of pitch changes within a word can convey syntactic information, such as tense or possession. Most languages, including English, use an intonation pattern of falling pitch to signal the end of a grammatical unit. A variation in that pattern signifies a change in meaning. For example, in the declarative sentence, *She ate squid*, pitch falls, signifying the end of the sentence. However, when pitch rises at the end of the same sentence, it signifies a question: *She ate squid?*

Timing variations may also convey linguistically relevant information. For example, the vowel in *cab* is longer than the

vowel in *cap*. In general, vowels are longer when they precede a voiced consonant as opposed to a voiceless consonant. In addition, there are many languages in which variations in duration of vowels or consonants result in semantic differences. In Italian, *papa* means *father* and *pappa* means *porridge*. The two words are distinguished on the basis of the longer double consonant or geminate. In English, such distinctions based on geminates occur across, but not within, word boundaries, as in the phrase *cite Ed* versus *cite Ted*. Timing variations in the pattern of relationships among syllable durations determine the rhythm of a language. For example, English is a stress-timed language, which means that the duration between stressed syllables tends to be (loosely) the same. Compare ‘The boy ate the peanut’ and ‘The elephant ate the peanut.’ *Elephant* has more segments than *boy*, yet the time from stressed syllable to stressed syllable is about the same in each sentence. In syllable-timed languages such as French, the duration of syllables rather than stress groups remains relatively constant.

In general, it is the relative values of stress, pitch, and timing that contribute to the semantic or syntactic information conveyed by the speaker to the listener. Inappropriate application of the suprasegmentals by nonnative speakers of a language, the deaf, or those with speech disorders results in perceptual errors and speech that does not sound natural.

Features and Feature Detection

One theory of speech perception, feature detection theory, was based on the distinctive feature theory proposed by Roman Jakobson, Gunnar Fant, and Morris Halle in 1963 that is still recognizable in the phonetic descriptions of sound in the section ‘Articulatory and Acoustic Classification Schemes.’ Jakobson, Fant, and Halle recognized that speakers of any language use only a subset of all possible speech sounds. For example, the first sound in *think*, /θ/, is a common speech sound in English, but it is not used in French. Clicks are common in some American Indian and South African languages, but not in English. Yet, despite many such differences in the inventories of speech sounds used in the various languages of the world, there are regularities within and among languages. Jakobson, Fant, and Halle proposed that all speech sounds in all languages could be described by the presence or absence of 12 features. Noam Chomsky and Morris Halle, in their 1968 book *The Sound Pattern of English*, extended the list to more than 30 distinctive features (see Table 2 for some of the Chomsky–Halle features and their descriptions).

The notion that each abstract linguistic unit could be described as a unique ‘bundle’ of distinctive features led to the hypothesis that neurons in the auditory nervous system were selectively responsive to each feature, as instantiated in the acoustic signal. Feature detection theory was appealing because it provided a physiological mechanism devoted to speech, which could account for the fact that speech is rapidly processed (human beings produce and perceive about 20 phonemes per second) and that infants seem innately predisposed to perceive phonetic categories. Although feature detection theory was generally abandoned because it failed to account for the finite number of features or the relative importance of acoustic and phonetic features, distinctive features continue to be useful for describing speech sounds.

Table 2 Some Chomsky–Halle features for classifying segments

Features indicating	Feature name	Description
Place of articulation	Anterior	Obstruction in front of palatoalveolar region
	Coronal	Blade of tongue raised from neutral
	Distributed	Constriction extending in the direction of air flow
	High	Tongue body above the neutral position
Manner of articulation	Rounded	Narrowing of lip orifice
	Tense	Deliberate, maximally distinct gesture
	Nasal	Lowered velum, open nasal passage
	Lateral	Lowered mid section of the tongue at one or both sides
Phonation	Strident	Acoustically noisy sounds
	Continuant	Accompanied by little or no turbulence
	Voiced	Vocal cords in position for spontaneous voicing
Major sound	Consonantal	Radical obstruction in the midsagittal region of the vocal tract
Classifications	Vocalic	Produced in the oral cavity, constriction not greater than for high vowels, and vocal cords in position for spontaneous voicing
	Sonorant	Spontaneous voicing possible

Coarticulation

The articulatory and acoustic classification schemes that have been described may lead to the misconception that conversational speech is a collection of distinct segments strung together like beads. However, speech is a dynamic process. It is not made up of static postures corresponding to phonemes with movements simply connecting one phoneme posture to the next. Speech sounds, as they are produced, are modified by the phonetic context in which they occur. For example, ‘I want to go home’ is usually produced more like ‘I wanna g’home,’ and ‘I have to go home’ is usually produced more like ‘I hafta g’home.’ In the modification, or coarticulation, of *want to*, the stop consonants are completely assimilated, and the /u/ in *to* is reduced to the schwa vowel. In the case of *have to*, the voiced labiodental becomes voiceless, the stop consonant is only partially assimilated, and the /u/ in *to* is reduced to the schwa. The coarticulations involve the overlapping of articulatory gestures due to the requirements for rapid production and processing of speech and exhibit the tendency of speakers to expend the least amount of articulatory effort necessary to convey the message. Factors such as stress, rate of speaking, and formality of the situation in which speech occurs affect the degree of coarticulation, but even in the most precise productions, the sounds are coarticulated.

Experimental Phonetics

Thus far, the articulatory basis of speech sound production and the acoustic consequences of articulation have been examined. However, speech communication also includes the listener’s

perception of the speaker's message. It seems obvious that what the listener perceives is the acoustic signal produced by the vocal tract, but this, ultimately, turns out to be a superficial explanation. Experimental phonetics is the application of experimental methods and investigative techniques to test hypotheses about speech perception and production. It is concerned with such issues as determining the features that signal contrasts between sounds, defining the units of speech perception, discovering how context affects speech perception, understanding the neural representation of the speech code, and establishing the relation between speech perception and speech production.

See also: Language Development; Reading and Phonological Processing; Sign Languages; Syntax.

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- <http://www.haskins.yale.edu/> – Haskins Laboratories: The Science of the Spoken and Written Word.
- <http://www.fonetiks.org/> – Fonetiks Online Pronunciation Guides.
- <http://sail.usc.edu/span/index.php> – Signal Analysis and Interpretation Lab: Speech Production and Articulation Knowledge Group, University of Southern California.
- <http://www.langsci.ucl.ac.uk/ipa/> – The International Phonetic Association.
- <http://phonetics.ucla.edu/> – UCLA Phonetics Lab Data.
- <http://speech.umaryland.edu/> – Vocal Tract Visualization Laboratory, University of Maryland.

Planning

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Glossary

Circadian rhythm A roughly 24-h physiological cycle that determines our sleep and arousal patterns.

Ego depletion The idea that self-control or will power is an exhaustible resource that can be used up.

Frontal lobe The front portion of each hemisphere of the brain. Responsible for higher intellectual functioning, including planning.

Implementation intention A simple plan that states links a situational cue (e.g., time, event, thought) to a desired behavior.

Planning fallacy The tendency to underestimate task-completion times.

Procrastination The act of putting off actions or tasks to a later time.

Subgoal A lesser goal that forms part of a greater goal.

Working memory Short-term mental storage of information created by consciously thinking about something. Working memory is needed for complex tasks such as comprehension, reasoning, comparing, and planning.

Introduction

Understanding the complex nature of human behavior requires consideration of how we mentally represent past experiences, respond to present events, and prepare for future events. This article focuses on the last of these: planning and goal-setting. To be able to carry out, effectively, behaviors necessary to achieve future goals requires planning. Planning has a variety of definitions, but at its core it is a mental activity that prepares us for future action. We make travel plans, plan a meal, plan our next move in a chess match, or plan how we will engage the attractive person sitting across the room at a party. Plans can be quite simple (e.g., mailing a letter) or relatively complex (e.g., writing an article on planning).

Elements of Planning

Planning requires several steps. We must first develop a mental representation of our goal as well as the context in which we wish to achieve it. Then we must imagine different possible actions that might help us reach this goal, comparing them to determine which will be the most effective. Comparing mental representations, of course, requires that we are able to store them, at least temporarily, in our working memory.

Planning is useful because it allows us to explore different possibilities, without committing to them, changing our minds as we mentally simulate different possible solutions to a problem or goal. Although planning can consume cognitive resources, the alternative – action without planning – certainly has potential costs of its own.

Planning also encourages creative solutions, as you think about the world in ways that might not be possible physically. For example, you might work backwards, starting from your goal (e.g., say a location on a map) in order to determine the most effective path to it.

Early Research on Planning

Early work on planning was based on the relatively simple idea that we formulate plans to resolve discrepancies between an undesirable present state and an imagined ideal state (i.e., a goal). Resolving this discrepancy required one to act on the environment in such a way that the ideal state could be achieved.

This early model assumed that individuals would operate in a kind of feedback loop where they continued to engage in behaviors aimed at accomplishing their goal, repetitively comparing their present state to their desired ideal until it was achieved. Thus, this model purported that, when planning a solution to a problem, rather than choosing our actions blindly, we select actions most likely to lead us to the final goal, and evaluate the impact of those means. However, a major limitation of this model was that it could not account for adapting to the situation by alternating between different goal-related behaviors or even changing the goal entirely. In short, it was a little too simple. Moreover, this model emphasized efforts to return to a state of equilibrium, thus avoiding change. Of course, we now know that people will create discrepancies even when they are not lacking anything – that is, besides merely satisfying deficiencies, people can identify goals that seek development and growth.

More recent work on planning has focused primarily on examining how factors such as the difficulty (easy or hard), time frame (long or short term), and the degree of detail (general or specific) particular to a given plan can impact goal achievement. Studies that investigated these factors found evidence that regardless of whether goals were short or long term in nature (although breaking down large goals into more manageable subgoals is beneficial – more on this idea will be discussed below), the degree of difficulty and specificity was especially important, with more specific and more challenging goals tending to lead to greater achievement. Specificity appears to be important because it provides guidelines that enable individuals to determine how well they are adhering to their

plan: in other words, how people know if their best is good enough without an objective set of criteria to base it on. Difficulty is also important in that it defines a higher level of achievement as necessary for goal attainment, thus motivating greater effort expended toward accomplishing a goal.

The role of developing a plan with specific, objective performance goals versus planning on simply doing well (and on having fun) became a central focus in research on academic goal-setting. In one study that examined outcomes associated with performance-oriented goals (i.e., to get good grades) and mastery-oriented goals (i.e., to simply enjoy learning the material), students with mastery goals reported greater interest in the course material but tended to have lower grades; the opposite was true for students who had set performance goals. Thus, these findings suggest that the nature of the goal one sets influences the type of outcome: if your goal is to do well relative to an objective standard, you tend to perform better; if the aim is to simply 'get the most out of it that you can,' you will not perform as well, although you are more likely to enjoy yourself. However, a follow-up study revealed that the students who had set mastery-oriented goals were more likely to enroll in related courses the following semester as compared to students who had set performance-oriented goals (although the same pattern in grades was also found). These results suggest that how we plan out a specific goal not only affects the relevant outcome but may also impact subsequent plans we make.

Measures of Planning Ability

Tower of Hanoi

The most commonly used tool to study planning, especially by cognitive psychologists and neuropsychologists, has been the Tower of Hanoi, a puzzle created by the mathematician Édouard Lucas in 1883. In the classic version of this game, there are three rods, and between four and nine disks of increasingly smaller diameter. The goal is to move the stack of disks from the first rod to the third while following these two rules:

1. You may only move one disk at a time
2. You may not place a larger disk onto a smaller disk

The puzzle can be played with any number of disks, and though it seems impossible to many novices, it is always solvable with a minimum of $2n - 1$ required moves, where n is the number of disks. Researchers usually use a five-disk version, which would require 31 moves, although the typical novice takes about 64 moves to complete the task. Clearly, an individual cannot plan and maintain that many moves in memory. Research on how individuals solve the Tower of Hanoi problem showed that people break their plans down into separate subgoals, usually by first trying to get the largest disk into its final location. Once the largest disk has been placed, a new subgoal of placing the next largest disk is planned. [Figure 1](#) shows the eight moves required of a very simple version of the game with only three disks.

It appears that most people try out different subgoal strategies to determine which is the most effective. People with higher intelligence and greater working memory capacity (which are related to each other) tend to perform better on the task. Performing a secondary task will consume cognitive resources and reduce performance. However, with practice

people can improve solving the puzzle in fewer moves. Rather than merely memorizing all of the moves, practice appears to improve people's ability to choose effective subgoals.

Tower of London

A variation on the Tower of Hanoi is the Tower of London developed to detect deficits in planning that typically accompany brain damage. In particular, damage to the left anterior frontal lobe has been shown to be associated with individuals needing to make a greater number of moves to solve the puzzle. Those with damage to other areas of the frontal lobe (e.g., right anterior, left, or right posterior) do not exhibit this impairment. The ability to withhold responses and direct attention and memory processes to ongoing and future tasks appears to be controlled by neurons in the prefrontal cortex. These neurons, particularly those concentrated in the principal sulcus, enable individuals to coordinate attention and memory in order to develop plans and then act on them. Conversely, damage to the prefrontal cortex is associated with poor impulse control.

Social Cognitive Aspects of Planning

Research on planning used to be the exclusive domain of cognitive psychologists and those studying artificial intelligence. In the past two decades, however, it has become increasingly less common to find studies on planning in cognitive journals (or textbooks!). This is primarily because cognitive psychologists have turned their sights to various aspects of memory and expertise.

The research on planning continues, however, but is now studied primarily by social psychologists who have changed the focus of the research. Planning as studied by social psychologists tends to focus more on the plans needed to meet personal goals that people have for themselves (or that have been imposed upon them by others). Unlike the Tower of Hanoi, which can be completed in a matter of minutes, personal goals, especially self-improvement goals, tend to take much longer.

Examples of personal goals studied by social psychologists range from the mundane to the complex, and include everything from shopping for groceries, to writing a term paper, to losing weight, to getting married. As such, the research questions have changed somewhat. Social psychologists do not disparage cognitive accounts, and often embrace them. But social psychologists also acknowledge the role of desires, fears, and various other social motives. Indeed, a complete examination of how we plan for such far-reaching goals really must include motivation. Consider, for example, two people who are both planning to complete their income taxes by hand: one person expects to have to pay additional taxes beyond what was withheld by the government, and the other person expects to get a refund from the IRS. Of these two individuals, who is more likely to actually finish sooner? Who will plan to finish sooner? We'll get to this answer in a little while.

How to Set Effective Goals

An important part of planning is setting realistically achievable goals. Good goals motivate hard work and lead to improved performance. The concept of effective goal setting

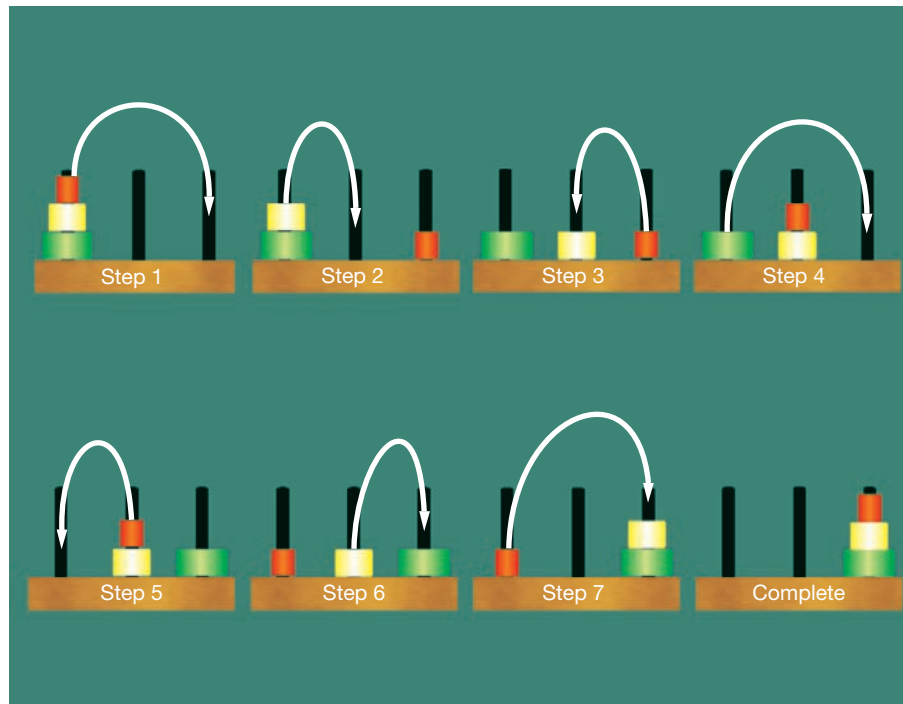


Figure 1 A simple version of the Tower of Hanoi puzzle. The puzzle is always solvable with $2n - 1$ moves, where n is the number of disks. With only 3 disks, 8 moves are required.

is so important in Industrial/Organizational (I/O) psychology that entire management systems have been based on it. As noted previously, we find that specific and difficult goals tend to lead to better task performance than vague or easy goals. The researchers Locke and Latham, who have spent over four decades studying this area, offer four principles of successful goal setting – to which we have added a fifth.

1. Set challenging, but attainable goals. So long as they are within your ability, a difficult goal is more likely to produce higher levels of effort and increase performance than an easy goal. Commitment to very difficult goals does not last long.
2. Set specific rather than vague goals. Specific (and difficult) goals tend to produce higher performance than merely urging people to 'try hard' or 'do your best.' There should be little or no ambiguity about what has to be achieved.
3. Set measurable goals. For goals to be effective, people need feedback about their progress. It is difficult to modify your plan of action if you do not know how you are progressing.
4. Set your own goals; do not let others set them for you. Commitment is higher for goals that you set yourself.
5. Break long-term goals into smaller subgoals. Following from the previous principles, if you have a long-term goal (i.e., get a college degree) you must break it down into smaller subgoals that are specific, challenging, attainable, and measurable.

In the sections that follow, we will outline various difficulties people have in following these rules of goal setting, and also difficulties people have in following the plans they have made for themselves. Finally, we address some biased thoughts people have when planning their future (and past).

Self-Improvement Plans: The New Year Resolution Fallacy

Americans are obsessed with self-improvement. Each New Year, we make a resolution to improve some aspect of ourselves, and each year most of us fail to keep our resolutions, often within the first month! Paradoxically, many of us will make the same resolution next year! Why? As it turns out, resolutions that make us feel good about our future potential self (i.e., thinner, better read, or otherwise improved) are less effective at actually helping us to reach that potential. This is because resolutions that make us feel good about ourselves are poorly structured – they merely restate the goal (e.g., lose weight), but do not elaborate on the steps required to achieve the goal – and also tend to lack concreteness or specific details about the behaviors required at each step. Indeed, people who make poor self-improvement plans tend to feel more energized and actually predict that they have a greater likelihood of success than do those who make good plans. It seems that poor planning can be rewarding, albeit in a short-sighted way.

Delay Discounting

The tendency to focus on the immediate good feelings produced by (poor) self-improvement planning rather than be rooted in a concept called delay discounting. This is the tendency to prefer a smaller, more immediate reward to larger reward obtained in the more distant future. Consider the following two choices:

- Choice A: Receive \$1000 today
Choice B: Receive \$4000 in 10 years

Most people will choose A over B, because the 10-year wait in choice B lessens the appeal of the \$4000. Delay-induced discounting can help to explain seemingly irrational behaviors such as gambling, taking drugs, or failing to save money for retirement in favor of purchasing a big-screen TV. As one might predict, however, individual differences in the tendency to discount long-term gains are (negatively) related to both intelligence and working memory. Further, preliminary evidence suggests that a reduction of brain activity in the anterior prefrontal cortex may exacerbate delay discounting.

Construal Level and Procrastination

Research also shows that events that are distant in time are mentally represented in a more abstract fashion than immediate events which are represented in a more concrete fashion. When an event is distant, abstract thinking dominates, and this tends to focus on whether to engage in the event at all or not ("Should I start working on my chapter for the Encyclopedia of Behavior?"). As an event – in this case, a deadline – grows closer in time, it becomes more important to plan a specific course of action ("I'd better create an outline and start writing"). Interestingly, the opposite is also true. If you are induced to think about an event in less concrete terms (i.e., more abstractly), then you are also likely to perceive the event as more distant, and thus less likely to initiate action. Thus, the level at which you construe an event (abstract vs. concrete) can explain the extent to which you will procrastinate.

Construal level theory is most likely to apply to tasks that are relatively easy and not extremely important to you. For more difficult and important tasks, the case can be made for maintaining at least some high-level representation of the situation. This is because abstraction has been found to improve self-control, presumably by allowing people to focus on the reasons why they are engaged in the difficult behavior in the first place. So, although concrete representations make events seem more immediate, and thus require plans and action, abstract representations can help us stay focused by increasing the perceived importance of the task.

Chronic procrastinators may not benefit from such advice. Indeed, research has shown that they tend to represent tasks more concretely than do people who do not procrastinate. Focusing on task details too much may overwhelm people, ironically causing them to avoid the situation altogether. Clearly, more research is needed in this area.

Self-Control and Ego Depletion

One important predictor of success in life is the ability to delay gratification. A series of fascinating studies has found that children who are able to wait longer to eat a marshmallow tend to do better in school – even as young adults – than do children who cannot wait and eat the marshmallow immediately. Like marshmallows, temptations abound that can derail our goal pursuits. Pursuing one's goals often means forgoing activities that are rewarding in the short term. Unfortunately, overriding temptations requires controlled effort that takes cognitive resources. Put differently, it takes less effort to do

something than it does not to do something. When you are on a diet, it can be much more difficult to turn down dessert than it is to eat it.

A host of other things can deplete the cognitive resources needed to engage in self-control. For example, being depressed, tired, or in a bad mood can reduce self-control. Additionally, resisting one temptation will make it harder to resist a second temptation. Consistent with this notion, it is also true that being in good physical condition, well-rested, or in a good mood can enhance our self-control.

How does this relate to planning? It suggests that we should take into account those situations and times in which we are most at risk for temptations that will derail us from our goals. When planning, we should keep in mind the extent to which our self-control resources might be depleted.

Circadian Rhythms

A related consideration here is one's circadian rhythm. We each have a 24-h biological cycle that determines our sleep-wake pattern. Although environmental factors (e.g., light, noise, temperature) can play a role, your circadian rhythm tends to be stable over your lifetime. Cognitive arousal is usually highest in the first third of the day, lowest in mid-afternoon, and after a sub-peak, drops off quickly right before sleep. There are individual differences, however. Some people prefer to work in the morning, whereas others prefer the evening because they feel more awake. Unfortunately, the increased arousal in night owls also tends to cause greater anxiety and worry about performance, which inevitably leads to procrastination – the tendency to delay a task.

Consider this example: Adrienne has a goal to exercise more. Her goal commitment is high; she considers exercise very important. She is also somewhat of an evening person and thus cannot get up early enough to exercise before work. Thus, daily she plans in her head to run on the treadmill after work. Unfortunately, she also has a demanding job that regularly requires her to stay in the office past 6 p.m. By the time Adrienne arrives home, she is so tired (and hungry) that she is much more likely to have a glass of wine, collapse on the couch, and watch TV, than to run on a treadmill. Clearly she is planning her exercise regimen at the wrong time of day. Her fatigue and hunger will both compromise her self-control. She either needs to change her plans to leave work sooner, or plan to exercise in the morning. After all, running does not require thinking, so if she can find a way to get herself out of bed; this may be a workable solution for her. The next section provides a technique that might help her to do just that.

Implementation Intentions

Peter Gollwitzer has developed a model of volitional planning that relies heavily on what are called implementation intentions. These are specific and (deceptively) simple action plans for how a goal will be attained. Implementation intentions are always stated in an 'if-then' format. Let's call your goal 'Z,' the effective response 'Y,' and the situation cue 'X.' An implementation intention to reach a goal would be stated like this:

When I encounter situation X, I will initiate behavior Y, in order to reach goal Z.

Specific examples of implementation intentions usually imply, but do not explicitly state, the goal. Instead, they focus on the situational cue and the required behavior:

1. After I start the coffee machine, I will take my vitamins.
2. If I feel tempted to eat a piece of chocolate, I will ignore that thought and eat an apple.
3. After I go swimming tomorrow, I will perform a breast self-examination.
4. When I arrive at the office, I will not turn on my computer until I have finished the paperwork on my desk.
5. When I turn on my computer, I will do a literature search before reading my email.
6. If it is Monday, then I will do my math homework.

Following our earlier guidelines for setting an effective goal, the situational cue and behavioral response of an implementation intention should be as specific as possible.

Poor: If it is the weekend, then I will exercise more.

Better: If it is 9 a.m. on Saturday, then I will run 3 miles on the treadmill.

Note the difference between an implementation intention and a simple statement of one's goal, for example, I will floss my teeth more. An implementation intention requires that an explicit connection be made between a situational cue (when the 11 p.m. news comes on) and a behavior (I will walk to the bathroom and floss my teeth). This helps to automate the process so that we need not depend on our memory to remember to do the task. Once the connection is made, the situation automatically cues the behavior. Implementation intentions have a moderate to large effect compared to simple goal intentions (i.e., I will perform a breast self-exam) that do not reference a situational cue (when I take a shower after swimming).

The benefits of implementation intentions are largest when people are confronted with aversive tasks (eat more vegetables) or difficult or complex ones (write a term paper). These sorts of goals tend to suffer from the following problems:

1. Failing to get started
2. Getting distracted
3. Overextending oneself
4. Failing to call a halt to fruitless goal-striving.

Implementation intentions are important because they facilitate both the initiation of desired behaviors as well as maintaining persistence in the face of potential distractions, setbacks, or challenges. But, they can also help us to drop subgoals if it appears that they are not working. For example, consider the amount of time one could spend (waste) researching a topic using a search engine like Google. A useful implementation intention here might be: if I do not find an answer after the fifth page, I will stop searching and move on to the next subgoal. Of course, Implementation intentions are most effective when you have a strong goal commitment. Indeed, you are unlikely to engage in such intentions if you are not committed to your goal.

Implementation intentions are most useful to people who have poor self-regulatory skills (e.g., schizophrenia, drug

addicts in withdrawal, children with attention deficit hyperactivity disorder (ADHD), and people with damage to their frontal lobe), but they are also useful for people who are preoccupied with distracting thoughts and anyone who has recently engaged in an ego-depleting task. As mentioned earlier, self-control suffers if we engage in multiple resource (ego) depleting tasks in a relatively short period. Working hard at one task makes us less likely to find the strength to work hard at a second task. Similarly, resisting one temptation makes a second temptation more difficult to resist, unless we remind ourselves to work harder. Research has found that making an implementation intention while engaged in an ego-depleting task can help us to persist longer and perform better at a difficult second task.

It is somewhat ironic that although the focus of social psychologists has been on long-range personal goals, the most effective solution to goal-striving seems to be to make very simple short-term plans!

Perfectionism

Because implementation intentions help us to stay on task and to worry less, one should find that perfectionists benefit from their use. There are, however, two types of perfectionists. First is the self-oriented perfectionist, who sets his or her own (overly high) standards. These people do benefit from implementation intentions. However, a second form of perfectionism exists, the socially prescribed perfectionist, who has a strong need to meet expectations and standards prescribed by significant others. For these people, implementation intentions can backfire. Rather than inspiring action, forming such intentions instead causes worry and self-criticism that actually interferes with goal progress.

Another limitation to implementation intentions would come in the form of a 'ceiling effect' in which performance is already so high that intention formation does little further good. Such results have been found when predicting class attendance with people scoring high and low on conscientiousness. Those who scored high did not benefit from implementation intentions.

Planning Fallacy

When planning a future task, individuals often underestimate how much time it will take for them to complete it. This optimistic 'planning fallacy' has been shown to occur for predictions about a wide range of tasks, including writing term papers, programing software, doing one's taxes, and Christmas shopping. The interesting thing about the planning fallacy (and the reason it's called a 'fallacy') is the fact that people seem to know that they do it! When told that other people underestimate how long it will take to accomplish a task, most people laugh, because they can think of times in which they have done this. And yet, this knowledge does not seem to help them make better predictions for the future. Why is this?

One reason has to do with a sort of cognitive neglect. When planning a task, people focus too much on the events

that are required to complete the task but neglect to consider any potential distractions that will slow them down. It seems that previous distractions are categorized as flukes, and thus unlikely to happen again. Although any particular distraction may not occur again, it is almost inevitable that some unknown distraction will rear its head before the task is completed.

A second reason for the planning fallacy is wishful thinking – simply wanting to finish. This is especially true when anticipating a desired outcome. As before, consider two people planning to do their taxes, one who expects to receive a tax return, and the other who expects to have to pay additional taxes. Although both people will estimate that they will finish sooner than they actually do, the person expecting the tax refund will show a stronger effect. Consistent with the cognitive neglect mechanism, those expecting the refund gave less credence to their past experiences when making their prediction.

One effective way to reduce the planning fallacy is to use implementation intentions discussed earlier. Note that this reduces the bias not by making people's plans more accurate, but by helping them to finish earlier than they normally would.

It is important to note that not everyone shows the planning fallacy. First, there is evidence to suggest that the bias is less likely to occur when predictions are made privately. Thus, we make optimistic predictions in order to appear more productive and successful to others.

Finally, the planning fallacy is sensitive to individual differences, for example, the extent to which people demonstrate hippie- or yuppie-oriented traits. People with yuppie traits are goal oriented, hard working, and organized, whereas people with hippie traits tend to have a live for the moment philosophy with few concerns for the future or regrets about the past. As you might expect, yuppie traits are associated with completing a task sooner and consequently showing less of an optimistic bias. In contrast, hippie traits are related to both earlier predicted times and later completion times, resulting in greater optimistic bias. People with hippie traits appear to have strong social concerns. This makes them more likely to promise others that they will finish things early, but also more likely to get distracted by opportunities for recreation (e.g., social functions).

Related Areas

Readers interested in the social aspects of planning might also be interested in two additional areas of study: affective forecasting and hindsight bias.

Affective Forecasting

Affective forecasting is the prediction of one's future emotional state. Research has shown that people exhibit an 'impact bias' in which they overestimate their emotional reactions – both negative and positive – to things like sporting events, election outcomes, and romantic events. The reason for this bias is threefold: First, people underestimate their own ability to cope with negative events. Second, people tend to focus too

much on the target event and neglect other events and activities that will occupy their attention and thus reduce the strength of their emotions, whether positive or negative. Finally, when confronted with emotional events we usually spend some time trying to make sense of them, spending time thinking about both their causes and meaning. Rather than strengthening their emotional feelings, as might be expected, sense-making has been shown to reduce it.

Hindsight Bias

Sense-making also produces another bias, called hindsight bias. Hindsight bias is the tendency to believe that one could have predicted an event with greater accuracy than is really the case. Although the bias is not large, it is somewhat akin to the belief that you 'knew it all along.' Many researchers argue that hindsight bias prevents us from learning from the past because our mistakes are less surprising than they should be. The implication for planning, of course, is that people will continue to make the same mistakes in the future. One way to counteract the hindsight bias is to make an explicit prediction for an event before the event occurs. This allows you to compare your (unbiased) prediction with reality and, with any luck, learn from the past so that you can plan for a more successful future.

See also: [Creativity](#); [Intention](#); [Problem Solving](#); [Reasoning](#).

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Play

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Glossary

Locomotor play Nonfunctional gross motor movement.

Object play Not functional use of objects.

Ontogeny Development within a species.

Play Behaviors that are means, not ends, oriented and not immediately functional.

Pretend play Playful interactions where make-believe, or fantasy, is invoked.

Social play Peer play interactions where roles are reversed and reciprocal.

Introduction

This article outlines a definition of play, then describes the ontogeny of locomotor, object, social, and pretend play, and also examines possible functions of each. It argues that some forms of play serve a function, especially during childhood, and may, in fact, be at the vanguard of phylogenetic change.

What Is Play?

Virtually all students of play acknowledge the difficulty of trying to define it. It may be that we really do not need a 'formal' definition of play because most people 'recognize it when they see it.' In fact, there are many cases in which children and adults alike have difficulty recognizing play. For example, there have been empirical studies into the ways in which children and youth categorize behaviors as play or nonplay and there is disagreement, suggesting that some level of definitional consensus is necessary.

Burghardt suggests that there are core criteria, all of which must be present, for a behavior to be categorized as play: The behavior must be voluntary, observed in a 'relaxed field,' the behavior is not functional in the observed context, the behaviors are repeated but the behavioral elements are exaggerated, segmented, and nonsequential in relation to the functional behavior. A relaxed field is one where the individual is safe, healthy, and well fed. Further, the child should choose to, voluntarily, engage in some social, locomotor, fantasy, or object-directed activity that is not directly or immediately functional. The nature and sequence of these behaviors would not resemble those in a functional context. For example, the child would use an exaggerated 'play face' to announce playful intent as he or she approaches a peer, and in the course of wrestling, the players would switch roles. These criteria can be realized in the four domains of play: locomotor (e.g., rolling down a hill), object (e.g., piling blocks in different configurations), social (e.g., play fighting), and pretend (e.g., enacting domestic roles). Further, each of these domains, with the obvious exception of social play, can be either social or solitary.

Locomotor Play

Locomotor play, like all other forms of play, follows an inverted-U developmental course: it begins in early infancy, peaks during childhood, then declines during adolescence and more rapidly in adulthood. The trends in locomotor play in humans appear to show in two successive peaks, reflecting two types of locomotor play, probably with different functions: rhythmic stereotypies and exercise play.

There is only limited evidence documenting infants' locomotor play, the exception being Thelen's longitudinal study of rhythmical stereotypies during the first year of life. Rhythmical stereotypic behaviors are gross motor movements with no ascribed goal or purpose to those movements; examples include body rocking and foot kicking. Stereotypic behaviors tend to peak during the midpoint of the first year of life; at 6 months, some infants spend as much as 40% of a 1 h observational period in stereotypic behavior. After this point, the behaviors gradually disappear from normal children's behavioral repertoires. Across the first year of life, infants spend 5.2% of their time in stereotypic behaviors, with no observed gender differences.

Exercise play means gross locomotor movements in the context of play, such as functionless swinging, marked by positive affect; it can be solitary or social, with parents or peers. Relatively low rates of American parent-infant physical play have been reported, with rates peaking at around 4 years of age. Exercise play with peers increases from the toddler to preschool period and then declines during the primary school years. Specifically, for 2-year-olds, Rosenthal reports that it accounts for about 7% of behavior observed in day-care settings. For children 2–4 years of age, Field reports exercise play accounting for 10% of all day-care behavior. In one observational study in a British nursery school, McGrew found that approximately 20% of 4-year-olds' activity was physically vigorous, such as run, flee, and wrestle. For children aged 6–10 years, exercise play declines, accounting for only 13% of all outdoor behavior observed during school recess periods.

Males engage in exercise play at higher rates than females do. Thus males, because they compete with each other for mates, are bigger, more aggressive, and more active than females. These differences in physical activity form an important basis for the

existence of segregated sex peer groups, as noted earlier, which begin in preschool and wane in early adolescence.

Both rhythmic stereotypies and exercise play have physical training benefits. It could be postulated that infants' rhythmic stereotypies are primarily functional for the immediate benefits of improving control of specific motor patterns. The correspondence between the ages at which these movements occur and cerebral development suggests that, initially, rhythmic stereotypies may be manifestations of immature sensorimotor integration. Play may modify or eliminate irrelevant synapse formations; with maturation, these patterns are used in more goal-directed ways. Such a hypothesis is consistent with the lack of sex differences in these behaviors, because there is no reason to suppose that control of motor patterns at this very basic level of generality is more important for boys than for girls.

With the onset of locomotion, another developmental course may begin, as evidenced by the correspondence between exercise play and muscle differentiation, strength, and endurance. Byers and Walker, in a review of the animal play and motor training literatures, suggest that exercise play may improve skill and economy of movement due to the effects of exercise on muscle fiber differentiation and cerebellar synaptogenesis. Exercise play during the juvenile period may have a lasting effect on subsequent economy and skill of movement.

In children, the age course of exercise play corresponds to the growth of arm and leg muscles and bones during the preschool period. Consistent with this claim, an experimental, longitudinal study of children documented the relation between one form of exercise play, jumping, and bone mineral content. Exercise play during the school years and beyond might continue to benefit muscle and bone remodeling and strength and endurance training; physiological effects.

Object Play

There is little descriptive information about the different ways in which children use objects, including in playing with them, in the child development literature. Where researchers have addressed children's object play they have typically conflated object play with a variety of other uses for objects, often under the label 'constructive play.' Much of the study of children's interactions with objects during childhood has been influenced by Smilansky's questionable adaptation of Piaget's theory of play. According to Piaget, however, construction is not considered to be play per se because it is more concerned with the end product of activity, while play is more concerned with the activity or means than with the end.

What is sometimes considered object and construction 'play' includes not only play and construction, but also exploration and tool use. Play with objects, following the definition of play used in this article probably has a pretend play component in many cases. Using objects in pretense initially entails children simulating someone else's use of those objects. Exploration of objects and using objects as tools are different still. Exploration is exhibited when individuals first encounter objects. Through exploration, children find out that objects are flat or rounded, long or short, used for drinking or for covering

one's head. These attributes and the ways in which they observe others utilizing them, in turn, are related to children's play with those objects.

Regarding tool use, age trends too are evidenced with skills increasing from infancy through early childhood. Studies of tool use in childhood also show increases in facility with age but they are drawn almost solely from performance on experimental tasks. Developmental descriptions of children's use of objects in children's everyday worlds, encompassing exploration, play, construction, and tool use are sorely lacking. One clear exception to this trend is the comparative work of Tomasello and colleagues who have compared tool use of chimpanzees and young children. According to Tomasello, tool use, like exploration and play with objects, is influenced by the social context. Indeed, it may be learned and developed in a social context, probably with children interacting with a significant adult.

Naturalistic, time budget descriptions of children's tool use are important because they are an important step in making functional inferences about different forms of object use. To this end, Pellegrini and Gustafson's observation on a sample of preschoolers across a year using objects in construction, exploration, play, and tool use clarifies this picture. They found that total tool use, object play, construction, and exploration accounted for 24%, 26%, 10%, and 2%, respectively, of all observed behavior.

A difference favoring females for construction was found, consistent with the extant literature. Girls' uses of objects for construction often took the form of art activities, all relatively sedentary activities. Boys used objects in play and marginally more as tools. Boys' play with objects was often embedded in the context of fantasy play, where objects were used to enact superhero themes, consistent with the classic findings of Saltz, Dixon, and Johnson. Also consistent with the ethnographic literature, they found that boys, more than girls, tended to use objects as tools, primarily as weapons. Bock's study of Botswana pastoralists indicated that boys engaged in more object play than girls did. Additionally, boys' object play followed an inverted-U curve accounting for 11% of the observations at 0–3 years, 17% at 4–6, and 3% at 7–9 years. For girls, an inverted-U curve was also observed for object play, but the peak was at a later age: 4% at 0–3 years, 8% at 4–6 years, 11% at 7–9 years, 15% at 10–12 years, and zero at 13–15 years. The trajectory for play pounding for girls paralleled object play: 5%, 16%, 17%, 22%, and zero, respectively.

Functions of children's object play have typically been examined in terms of children's ability to use objects in creative and flexible ways, such as associative fluency and lure retrieval tasks, or the ability to use and create tools to retrieve a toy, results which do not replicate under double blind conditions. Another limitation in all of these experimental studies was the limited time of the play treatment. In all cases, children were allowed to interact with the objects for about 10 min, a seemingly limited dosage of a treatment. To counter this problem, year-long observations of children's exploration, play, construction, and tool use were used to predict children's associative fluency and performance on lure retrieval tasks.

The predictive relations between observed object uses and performance on the associative fluency task and on the lure

retrieval tasks, where children's spatial intelligence was statistically controlled, revealed that neither observed play nor exploration predicted problem solving. That exploration was not predictive may be due to the fact that it is more typical of infants and toddlers than preschoolers, and low levels of exploration were observed. Further, the lack of relations between play with objects and performance on any of the problem-solving tasks in the current results raises a question on the often trumpeted value of play for both convergent and divergent problem-solving tasks with objects, an argument similar to that made by Smith.

Construction and tool use did, however, differentially predict performance on another aspect of using objects flexibly. Construction was a significant predictor of associative fluency and performance on the connected tool retrieval task, possibly because it is an 'ends' oriented behavior and it enables children to coordinate means toward some end product. This set of skills may have been sufficient to solve the simpler, connected, retrieval task and the associative fluency task but less effective with the more complex, unconnected, retrieval task. For the latter task, a more diverse and specific set of skills, reflected in the total tool category, was necessary.

Social Play

Social play takes the form of interaction between children and adults and between peers. The earliest forms of social play occur between children and adults, typically parents. For example, a mother playing peek-a-boo with her infant is one of the earliest, and pan-cultural, forms of social play.

A problem associated with the study of social play is that many writers do not differentiate social interactions which are 'play' as defined in this article, from more general, nonplay, social interactions. For example, in one foundational study, Parten explicitly refers to her categories of social interaction among peers as reflecting children's *social participation*, yet she also sometimes substitutes the word *play* to describe some of these behaviors. For example: 'The child *plays* (emphasis mine) in a group that is organized for the purpose of making some material product, or striving to attain some competitive goal, or of dramatic situations of adult or group life, or of playing formal games.' This section limits the discussion to interactions which are clearly play, peer play in the form of rough-and-tumble play (R&T) during childhood and into adolescence. Social pretend play is discussed in the next section.

R&T was first used in the social and behavioral sciences by Harlow in his discussion of the social play of rhesus monkeys, where it resembled 'play fighting.' Following Harlow, Blurton Jones defined children's R&T structurally in terms of 'play face,' physically vigorous behaviors, exaggerated movements, and soft, open-handed hits or kicks, a pattern clearly different from aggression. R&T is also characterized by reciprocal role taking and self-handicapping, such that players alternate between dominant and subordinate roles; for example, alternating between being on top and on bottom and between being the aggressor and being the victim.

R&T also follows the play-typical developmental, inverted-U, curve, accounting for about 4% of all behavior during the preschool period, peaking during the primary school years at around 10%, and declining again in early

adolescence to around 4%. These data, like the time and caloric costs documented in the animal literature, suggest that the time costs associated with R&T are modest.

There are also robust sex differences in the R&T of many animals, including humans. For example, in a group of 13-year-old American middle school, males' R&T play was close to double that of females.

Traditional accounts for the functions of R&T posit that it affords safe opportunity to practice for fighting and hunting skills that will be useful in later life. There is, however, no direct evidence supporting this hypothesis. A number of researchers posit that a motivating factor in social play is its unpredictability: Will I win or will I lose? Even with this uncertainty, there is a modicum of safety in play, and children are willing to take chances in this context. Children who engage in social play, from this argument, should be less fearful of uncertainty in the play context and behaviorally more flexible in responding to novel events, relative to less playful contexts. The only direct evidence to test this hypothesis showed a positive and significant relation between varied social play (indexed in terms of the variety of subcategories of R&T observed) and novel responses to social problems.

R&T may also relate to social affiliation/cohesion benefits for boys during childhood. Most basically, R&T typically occurs in sexually segregated male groups that are typified by high activity and rough behavior. That most boys enjoy R&T and most girls do not may be reason enough for them to bind as a group, though the relative frequency of physically vigorous behavior that is not R&T is also very important.

R&T may be related to another dimension of social affiliation, social dominance, where dominance is defined as winning and holding resources at the relationship and group levels. At the dyadic relationship level, individual A is dominant to B if in a contest for resources, he or she accesses those resources. These dyadic relationships, in turn, can be used to order individuals within a group hierarchically; for example, $A > B > C$. Exploiting its playful tenor to take advantage can be used to defeat an opponent and access resources. Even without cheating, children say they can determine their own as well as peers' strength from these encounters. So, children may use R&T in an indirect way to display their physical prowess, without using aggression, or blatantly cheating.

This picture changes in adolescence where R&T and aggression co-occur. Neill's pioneering factor-analytic study of 12–13-year-old boys' playground behavior found that R&T and aggression often co-occurred. Results from a study of adolescents by Pellegrini support this finding. In a longitudinal study of adolescent boys, Pellegrini found that asymmetrical choices for R&T were observed during the first year of middle school (12 years), but not the second (13 years), and R&T was significantly and positively related to peer-rated dominance in both years. Thus, in adolescence, in contrast to childhood, youngsters' use of R&T corresponds to using aggression as a way in which to control resources.

Pretend Play

Pretend play is arguably the most thoroughly studied aspect of human play behavior. Pretend has been used as *the* defining

attribute of children's play and considered a paradigm example of children's play. This was reinforced empirically in an interview study conducted by Smith and Vollstedt where pretend was *the* most important defining attribute of play.

For Piaget, symbolic play is an extension of the representational process where children recognize that one thing stands for another and through repeated engagement of pretend play children practice having one thing representing another and separating the symbol from its referent. This ability, in turn, is important for children's more general representational competence. Engaging in pretense, however, may not actually have children 'representing' in the strict sense that they are representing others' mental states when they play. Instead, Harris posits that young children 'simulate' the actions of others in their pretend play and this early form of pretense does not involve young children's representing the mental states of their co-players. Through repeated social interactions in pretend play with peers, children, by 3 years of age, come to recognize that this assumption is not correct, recognizing that they and their peers sometimes do not share the same view of a scenario that is being enacted. At this point, children put their own beliefs and desires about the scenario aside and try to imagine the beliefs and desires of their peers. With this accomplished, children will go back to their original simulation and try to understand it from the points of view of their peers. By 4 or 5 years of age, children understand that they have different beliefs from others. Correspondingly, understanding others' points of views depends on the accuracy of children's simulations, not on the accuracy of their representation of others' beliefs and desires.

A close adult-child relationship, such as the mother-child relationship, is central to the beginnings of social pretend play. Mothers seem to deliberately teach their infants to differentiate pretend from nonpretend behavior, teach them to extend their play themes, and under certain conditions, reinforce children's pretend enactments. Evidence suggests that mothers actually guide children's play to higher levels. Tomasello also stresses the importance of mother-infant interaction in the development of very young children's understanding of the mental states of others. From Tomasello's position that infants check to see if mothers are responding to their efforts to direct attention suggests that they, the infants, are beginning to view others as intentional agents.

Also important for the development of the symbolization processing in both pretend play and language is the realization by children that their imitations of adults can be used to solve social problems. Thus, they recognize that adults are using gestures and vocalizations to get something done (i.e., recognizing adults' intentions) and they use those same strategies to attain a goal. They come to realize that adults' use symbols, language, and gestures, to direct their attention. Correspondingly, by the second year of life, children recognize when adults use objects in pretense indicative of also recognizing adults' intentionality. Continued experiences with adults and peers extend children's ability to understand that others have different views of situations and symbols than they do.

At around 1½–2 years of age, pretense becomes more peer-oriented and peaks in the preschool years, around 5 years of age. The transition to pretend play with peers is a hallmark of preschool children's social cognitive and linguistic

development. Because social pretend play involves the communication and coordination of abstract meaning between people, there is a possibility for ambiguity and the breakdown of interaction. To avoid such breakdowns, children must use decontextualized oral language, where meaning is conveyed primarily through linguistic means, rather than with shared knowledge assumptions or gestures. It is also through these sorts of cooperative peer interactions that preschoolers come to recognize that their views of pretend play bouts and those of their peers differ.

It is worthwhile here to discuss two possible immediate benefits of pretend play: for early literacy skills and theory of mind. Others have been proffered elsewhere. In terms of the benefits of pretense during childhood, Lee Galda and I examined different forms of social pretense in preschool children and their subsequent relations to measures of emergent reading and writing. We argued that social pretense predicts early literacy because they both share the design features of being representational, realized in decontextualized language, and having narrative structure. In our longitudinal work, the level of representation in children's pretense (object transformations, such as feeding a doll, or ideational transformations, such as defining a role as Daddy) predicted children's early writing performance, while use of metalinguistic terms in pretense predicted their subsequent reading, with verbal IQ controlled. These results support the hypothesis that the ambiguity inherent in negotiating meaning in social pretense affords opportunities to verbally explicate meaning and become adept at manipulating different symbolic systems.

There is also evidence for a link between pretend play and theory of mind. Smith reviewed nine correlational studies examining this relation and suggests three possible models to explain the data. He notes that, with verbal ability or intelligence statistically controlled, and of the 46 correlation coefficients reported, 14 were statistically significant. The correlations that were the highest (e.g., 0.49) were between joint pretense and joint proposals in play and theory of mind. He suggests a facilitative but not an essential causal link between pretend and theory of mind. In short, there are a number of ways in which to develop theory of mind and pretend may be one of them.

Conclusion

That play is observed primarily during the juvenile period suggests that the extended juvenile period is crucial to the role of play in developmental plasticity and to assembling the complex set of skills necessary for survival and reproduction. From this position, children use the resources afforded by them (safety and provisioning by a parent) to experiment with a variety of strategies that are effective in that niche. When faced with a relatively novel or uncertain, but safe, environment, play affords opportunities for behavioral and cognitive innovation and subsequent practice of newly developed behaviors and strategies.

With this said, we must also ask why children should play to learn or develop innovative behaviors and strategies when they might more efficiently learn them through direct adult tuition or, less directly, through observational learning. Part of the answer to this is that actual adult tuition has been rare in

human history, until recent times. More fundamentally, however, adult tuition and observation of adults will only transmit existing practices. The possible benefit of play, relative to adult-directed strategies, is that behaviors generated in the context of play can be more innovative and most suitable to the varied niches inhabited by humans. For example, juveniles can take the behaviors they have observed and then, in play, recombine elements of these behaviors into novel routines. In support of the innovative potential of peer play, levels of children's symbolic functional play are more varied and complex when adults are absent, relative to when they are present. The degree to which children's play is more innovative in solitary situations or with peers needs more study, however.

More generally, play is a relatively low cost and low risk way to learn new behaviors during periods of immaturity and thus likely to impact subsequent evolutionary processes. The safety inherent in a protected and prolonged juvenile period supports the sort of innovations in play that could lead to solutions to abrupt environmental changes and thus be copied by peers as well as adults. Exploration and play in one's niche may enable individuals to forecast what their developmental niche will be, a strategy that may be especially important in novel environments. Successful innovations would, in turn, be naturally selected. From this position, play occurs primarily during the juvenile period when resources are abundant, but the benefits may be reaped then or later in development, possibly impacting phylogeny.

See also: [Peer Relationships and Influence in Childhood.](#)

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Pornography

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Glossary

Antiwoman Aggressive behavior, demeaning attitudes, or negative beliefs, directed toward or against women.

Experimental research on pornography effects Research which systematically manipulates exposure to pornography and assesses its causal relationship with consequences of interest (e.g., antiwoman attitudes or behavior).

Naturalistic research on pornography effects Research which seeks to assess the association of exposure to

pornography and phenomena of interest (e.g., antiwoman attitudes or behavior) in a naturally occurring 'real world' settings.

Operationalization Definition of a phenomenon, such as pornography, in concrete and objective terms so that it may be described and studied systematically.

Pornography Sexually explicit material; a variety of functional and content-based definitions appear in this article.

The subject of pornography has long provoked public consternation and scientific scrutiny. More than a century ago, Dr. Ivan Bloch, originator of the term 'sexology,' pronounced that "there is no sexual aberration, no perverse act, however frightful, that is not photographically represented today." Social science has evinced interest in pornography since at least the 1960s, and at the close of the first decade of the new millennium, we find that social scientists have kept up their conceptual and empirical contributions to the study of sexually explicit media. While the characterization of pornography and its impact on behavior are still evolving, it is appropriate to provide an overview of the state of scientific knowledge at present. The current discussion reviews attempts to define pornography, considers the content and history of sexually explicit materials, and reviews evidence concerning the use of sexually explicit material and its effects on feelings, thoughts, and behavior.

Defining Pornography

The term *pornography* is believed to have been derived from the Greek words *porno* and *graphos*, which when combined, translate roughly into 'writings about prostitutes.' Indeed, at one time, the first definition listed in the Oxford English Dictionary referred to pornography as 'a description of prostitutes or of prostitution, as a matter of public hygiene.' In contemporary Western society however, *pornography* has come to denote the general category of sexually explicit materials. We note, however, that in law and legal discussion, the term 'obscenity' is often employed to describe sexually explicit materials that merit state censorship. The daunting challenge is that while a clear definition of the term *pornography* is necessary for conceptualizing and operationalizing these materials for the purposes of scientific study, no consensus has been arrived at by social scientists or in legal or lay opinion concerning the precise definition of such materials.

Functional Approach to the Definition of Pornography

Functional definitions of pornography emphasize the perceived purpose or function of sexually explicit materials.

Using this approach, any material is deemed pornographic if it appears to have been created, selected, or consumed to serve a specified sex-related purpose. Examples of such purposes are varied, and range from materials that appear to be intended to provoke sexual arousal, to materials that employ sex to dehumanize or oppress a class of people, typically women. Most functional definitions of pornography do not classify a material as pornographic if it has not been created to arouse sexual desire, if it is not used to demean individuals or to maintain a sexually driven power imbalance in society, or if it is not typically used as masturbatory aid.

A functional approach to the definition of pornography can be found in the American legal characterization of obscenity. In American law, a work may be considered obscene if "(a) . . . the average person, applying contemporary community standards, would find that the work, taken as a whole, appeals to the prurient interest." (*Miller v California*, 1973). This definition of obscenity is a functional one because it emphasizes the role that such material is perceived as playing in satisfying an unwholesome interest in sexual matters. Beyond the area of jurisprudence, functional definitions also exist in the scientific literature, with some researchers defining pornography as 'media material used to increase sexual arousal.' Functional definitions of pornography often rely on inferences made by external observers regarding the perceived intent or impact of sexually explicit materials. This approach can be problematic because wide variations exist with respect to individual perceptions and reactions to such materials. Functional definitions can also focus upon the objectively measured consequences of exposure to pornography, including sexual arousal and emotional responses.

Content-Based Approach to the Definition of Pornography

Content-based approaches to the definition of pornography have been widely employed to differentiate between pornographic and nonpornographic sexually explicit materials. According to such definitions, a material is considered pornographic if its content portrays a prespecified characteristic or a number of such characteristics. Common examples of content characteristics that some qualify as pornographic include the

explicit depiction of breasts or genitalia, or the manipulation of such body parts, as commonly occurs during sexual behavior. An example of a content approach to the definition of obscenity can be found in the Criminal Code of Canada, according to which, "Any publication the dominant characteristic of which is ... sex and any one or more of the following subjects, namely crime, horror, cruelty and violence, shall be deemed to be obscene" (Criminal Code of Canada, Section 163(8)).

Content focused definitions of pornography appear with regularity in the scientific literature because such definitions are amenable to operationalization and empirical validation, and because it appears scientifically plausible that the content of sexually explicit materials may determine their effects. The use of content-based definitions of pornography also affords the possibility of identifying conceptually and practically important categories of sexually explicit materials based upon their manifest content and the related effects, theorized or actual. In this connection, social scientists commonly distinguish between 'violent pornography' and 'erotica'; the former is defined on the basis of sexual content that portrays and endorses sexual violence, while the latter is defined on the basis of sexual content that portrays and endorses consensual sexual activity. Social scientists have also considered a category of degrading pornography, said to include degrading or debasing content that dehumanizes at least one participant, who is typically female. When the nature of the sexually explicit material under discussion has been categorized by researchers as violent pornography, degrading pornography, or as undifferentiated 'sexually explicit material,' we refer to it as such in this review.

It is theorized that exposure to violent or degrading pornography may encourage the adoption of antisocial attitudes, dehumanizing beliefs, and aggressive behavioral tendencies. In contrast, it is hypothesized that exposure to erotic portrayals of nonviolent and nondegrading sexual content, featuring performers who appear to be participating through positive choice, may foster the adoption of nonviolent, nondegrading, and consensual sexual attitudes and behaviors. Theorists also differ with respect to the likelihood that an individual will adopt attitudes and behaviors that are modeled in violent or degrading pornographic or erotic materials, with some consensus emerging that the likelihood of adoption of modeled attitudes and behaviors will be a function of the individual viewer's existing dispositions in relation to such attitudes and behaviors. However, whether it is the consensual, degrading or violent content of sexual media, or the predispositions of those who choose to consume, or some synergy of the two, that is of primary significance, is an important and unresolved question.

History and Content of Sexually Explicit Media

Historical Perspective

Sexual representations have appeared throughout history and have been found on nearly every continent. Among the oldest sexual representations are rock carvings of women which emphasize the breasts, buttocks, hips, and vulva. The *Willendorf Venus* is an example of this idealized female figure. Carved from limestone and found near the village of Willendorf in

lower Austria, it is thought to be at least 18 000 years old. Sexually explicit etchings and paintings of men, women, and animals, some of which date back to 13 000 BCE, have also been found in caves in France and Spain. From ancient Greece and Rome, we have many examples of medallions, statues, and ceramics that depict nude men and women, as well as heterosexual and homosexual behaviors. Some of the best examples of erotic Roman frescoes and mosaics were discovered in the ruins of Pompeii, which was buried in volcanic ash in AD 79. Sexual representations can also be found in cultures outside of Europe. Examples include Taoist sex manuals that were once common in China (200 BC), the *Kama Sutra* of Vātsyāyana, written for wealthy young men in India (AD 400), and the South American sexual pottery of the Moche (AD 150–800), which featured sexual acts, but rarely depicted penile–vaginal intercourse.

The modern history of the distribution and proliferation of sexually explicit materials is closely associated to the development of technological innovations. It is said, for example, that Poggio Bracciolini's *Facetiae* (1474), a collection of sexually explicit satirical short stories, was printed a mere 19 years after the Gutenberg Bible. Over the next several hundred years, low production costs of printing technology allowed pornographic engravings and novels to flourish as forms of both political satire and sexual entertainment. The invention of photography (~1825) and development of moving pictures in the later 1800s offered new technologies that were quickly adopted to become primary modes of production of sexually explicit materials. Examples of nudity and sexual activity can be found among some of the first photographs ever taken and among some of the first films ever developed for the cinema. Sexually explicit cinema appears to have peaked in the late 1970s when the invention of the videotape player allowed individuals to view such material in the comfort of their own homes. More recently and arguably exponentially more impactful, the Internet emerged in the mid-1990s as a new and highly accessible mode of distribution of sexually explicit text and imagery. Given the range of Internet distribution, it appears that the sheer amount of accessible sexually explicit material worldwide has never been greater. Although reliable figures are difficult to come by, a recent study estimated that over \$97 billion in revenue was generated in 2006 by all forms of commercial sexually explicit media worldwide.

Content of Sexually Explicit Materials

Many attempts have been made to characterize the content of sexually explicit media. Such efforts have reviewed sexual comics, novels, magazines, pay-to-listen audio recordings, videotapes, photographs, and digital Internet content. Although numerous methodological differences prevent comparisons across media, time periods, or studies, several commonalities do emerge from this literature.

Sexually explicit materials typically present two performers engaged in various sexual behaviors. Although presentations of individual women appear with some frequency, pornographic media depicting three or more actors are less common. Female performers are most often attractive, young, and Caucasian, with blond hair and thin bodies, though some studies have found that as many as 10% of models are from a visible ethnic

minority. Less consistency is noted in the features of male performers. Pictorial depictions of minors are virtually absent from the findings of published studies, though textual depictions of minors are reported on occasion.

The five most commonly depicted sexual behaviors include coitus, fellatio, cunnilingus, anal penetration, and orgasm/ejaculation. Convergent evidence across studies suggests that fellatio is more commonly presented than cunnilingus. For most media sampled, anal sex occurs less frequently, but is still represented. The only study to directly compare the frequency of male and female orgasm found that depictions of male orgasm are more frequent. Homosexual representations are also reasonably common, and depict female–female more often than male–male sexual behaviors. The former often appear to be designed for consumption by heterosexual males and the latter for consumption by males with an interest in same-sex sexual activity.

Another feature commonly explored in content analyses concerns power imbalance between the performers. These are often defined as depictions of dominance and submission, or depictions of sexual coercion. While most analyses of pictures and videos find that the vast majority of scenes contain no evidence of a male–female power imbalance, such imbalances have been noted in over 40% of online stories and in more than one-third of erotic novels. Although it is uncertain why such a large discrepancy exists, it is possible that sexual stories have more frequent depictions of power imbalances because real human performers are not required to act out uncomfortable, embarrassing, or humiliating scenes.

Similarly, depictions of the purposeful infliction of pain appear to be uncommon in traditional sexually explicit media, occurring in <6.5% of all scenes in X-rated films, in <2% of all pages in *Hustler*, and in even fewer pages of *Playboy*. Further, the vast majority of such acts in magazines and films appear to be presented as consensual. It is worth noting that recent studies of sexually explicit materials on the Internet suggest that higher rates of violence and lower rates of consent may exist in some contemporary sexual media.

Summary and Critique

Humans have long been interested in producing and consuming explicit sexual representations. Although historic examples reviewed in this paper depict much of the same behavior that is found in contemporary sexually explicit materials, it would be naïve to assume that all such representations were considered sexually explicit or pornographic in their respective times and cultures or to attempt to infer the original intent of these artifacts in relation to our own experiences with sexual media. However, it would be equally presumptuous to assume that no commonalities exist between historic sexual representations and contemporary sexually explicit materials.

For those concerned about the content of contemporary sexually explicit media it may be noted that depictions of pleasurable sexual experiences occurring between consenting adults are most common. While evidence of the existence of violent, nonconsensual, or pedophilic material is beyond question, the frequency of such depictions is low.

It should be kept in mind that the results of existing studies offer a ‘best guess’ as to the type of content that exists and is

consumed in the real world. Although research reports produce exact statistics, encouraging the temptation to compare frequencies between studies and to use these figures to estimate the prevalence of content features in the universe of sexually explicit media at large, such efforts may be misguided. Published research on the content of sexually explicit media does not employ random or probability sampling, and many studies employ different levels of content coding and analysis. Moreover, despite apparent nominal similarities in content categories, operational definitions across studies can be surprisingly different. Given these limitations, it is difficult to be certain about the prevalence of the content features that have been discussed.

Consumption of Sexually Explicit Material

Gender Differences in Consumption of Sexually Explicit Materials

Several studies conducted in North America, Europe, and Asia confirm that men and women have differing degrees of experience with sexually explicit materials, with men generally reporting greater exposure than women. It is unclear whether gender differences in self-regulated exposure to sexually explicit materials are a function of the content of such material, or of the gender-related social and reputational costs of consumption of such material, the gender differences in inherent interest, or other factors.

A recent convenience sample of American university students across several campuses reported that among young adults, 87% of men and 31% of women had been exposed to sexually explicit material within the last 12 months. Among users of such material, the modal frequency of use was once or twice a week for men and once a month or less for women. The American figures reported here represent middle-of-the-road estimates, with some studies reporting that as many as 90% men and 73% of women use sexually explicit materials, while others reporting that as few as 10% of men and 1% of women use such materials. What remains constant is the gender difference in self-reported exposure.

Use of Sexually Explicit Materials and Contextual, Social and Personality Factors

A number of studies indicate that the use of sexually explicit materials is related to contextual, social, geographic, and personality factors. While only a few studies have assessed the social context of exposure, it appears that most users of sexually explicit material consume it alone, with approximately half of all users also reporting some consumption with a partner.

One study concerning social and demographic factors associated with the use of sexually explicit material in the United States found that per capita subscriptions to sexually explicit Internet websites were positively related to average household income, the number of household residents between the ages of 18 and 24, the degree of household education, and residence in an urban (versus rural) locale. The same study found that sexually explicit Internet website subscriptions were negatively related to the number of household residents over 65 years of age. Also, contrary to many expectations, increased

rates of subscriptions to Internet websites were found in areas that have higher rates of marriage and lower rates of divorce. Finally, this study also found that per capita subscriptions to sexually explicit websites were highest in states with conservative positions on religious, gender and sexual issues.

Attempts have also been made to identify personality variables that play a role in men's choice of different types of sexually explicit videos. For example, men's preference for violent pornography was found to be associated with dispositions that are characterized as being antisocial and low in the need to appear in a socially desirable light, as aggressive and dominant, as interested in sexual variation, and as relatively lower in intelligence. Men's preference for consensual erotic material, however, was found to be associated only with dispositions that were characterized as having an interest in sexual variation.

Summary and Critique

Research clearly indicates that men and women have different degrees of experience with sexually explicit material. While men typically report more experience than women, a specific explanation for this difference is not clear. It is also interesting to note the variability in the prevalence of exposure figures reported in existing studies. Two explanations are offered. First, a number of studies differed in their assessment of sexually explicit material use, with some inquiring if participants had ever been exposed to sexual media, while others asked about current use. Second, the lowest prevalence of sexually explicit material exposure was reported in a sample from a country with intense media censorship, indicating that cultural and legal differences in the regulation of access to sexually explicit material play an important role in the prevalence of exposure to such media. A few studies have identified contextual, social and personality factors that relate to sexually explicit media use. Although interesting and relevant, the associations reviewed here should be considered tentative until they are confirmed by additional research.

Effects of Sexually Explicit Material on Feelings, Beliefs, and Evaluations

One approach to research concerning the effects of sexually explicit materials is to consider such stimuli as persuasive messages that consist of implicit and explicit portrayals and endorsements of beliefs, sociopolitical values, and sexual behaviors and themes. It has been theorized that such messages, contained within sexually explicit stimuli, may influence what people feel, what people think, and what judgments they make. Some assert that sexually explicit material of all types – consensual erotica as well as violent pornography – is primarily a communication about the separation of pleasure from social relationships and responsibility (attachment, commitment, etc.). Others go further, contending that such media primarily portray messages that endorse the sexual subordination of one party (typically women or, less typically, minorities) by another (typically white males), while still others disagree, viewing consensual erotica as a communication of sex-positive scripts, values, and messages.

Sexually Explicit Media and Feelings

According to numerous studies, exposure to sexually explicit media can trigger strong sexual arousal and emotional reactions. Among many men and women, exposure to sexually explicit materials leads to, both subjectively reported and physiologically substantiated, increases in sexual arousal. Early work in this area established that men and women experience similar degrees of sexual arousal responses when they were instructed to engage in sexual fantasy or were exposed to sexually explicit stories, pictures and videos. Further work found that married men and women reported the highest degree of sexual arousal response to depictions of casual sex compared to depictions of romantic sex or a prostitute–client relationship. More recent efforts suggest that men's sexual arousal is driven more by actor characteristics, especially gender, than by the behaviors depicted. In contrast, women appear to be less sensitive to the characteristics of the actors, with their sexual arousal more contingent on the types of behaviors that are depicted. Recent evidence also suggests that men may be more sexually aroused by sexually explicit material than women, though the difference is small.

Research has also consistently shown that exposure to sexually explicit materials can provoke both positive and negative emotional reactions, and that highly negative affective reactions do not always preclude positive affective reactions and sexual arousal responses within the same individual. When specific affective reactions are studied, both men and women have been found to react to sexually explicit materials with feelings of boredom, excitement, shock, irritation, and agitation, and that women may react with equally positive but more negative emotions than men. Evidence also suggests that emotional responses to sexually explicit stimuli may be stable characteristics of individuals, and that the content of specific erotic stimuli – including themes of degradation and violence – may contribute to the experience of negative emotional reactions.

A number of studies suggest that experimental long-term exposure to sexually explicit material can modify emotional reactions to such material. For example, it has been found that repeated exposure to sexual stimuli can lead to reductions in sexual arousal responses to similar materials. It has also been shown that such reductions can be reversed with the introduction of new sexual content. Similarly, a number of studies also suggest that sexual anxiety can be reduced by repeated exposure to sexually explicit stimuli, and indeed, this technique has been used by some therapists to treat sexual anxiety disorders.

It is worth noting that the evidence of the habituation of emotional responses to sexually explicit stimuli has been used to suggest that repeated exposure to such material creates a general emotional desensitization, which contributes to sexual callousness and to problems in male–female sexual relations. While this is possible, at this time there exists little evidence that the habituation of sexual arousal and sexual anxiety can be generalized to the wider spectrum of human emotions or that the habituation of such emotional reactions can be generalized to nonsexual situations. What is more, there is little or no nonexperimental evidence to suggest that

those who choose to consume sexually explicit materials in real world situations do, or do not, experience emotional desensitization of this sort.

Sexually Explicit Media and Beliefs

Working from the perspective that various types of sexually explicit materials may teach consumers to divorce sexual pleasure from the context of monogamous relationships, experimental research – involving systematic exposure of young adults, using both university student and nonstudent samples, to sexually explicit stimuli – has shown that exposure to sexually explicit media can influence beliefs regarding a number of sexual topics. Specifically, such experiments have found that repeated exposure to nonviolent and nondegrading sexually explicit materials may increase participants' estimates of the number of people who engage in infidelity and in infrequently practiced sexual behaviors. Massive exposure to similar materials has also been found to increase participants' endorsement of the belief that inhibiting sexual desire can be unhealthy.

Similarly, experimental efforts to show that sexually explicit material encourages beliefs that aid in the oppression of women have found that exposure to violent pornography increases men's acceptance of myths about rape that ascribe responsibility of sexual assault to a female victim. A meta-analysis of 16 experimental studies of the relation of exposure to violent pornography and antiwoman beliefs has confirmed that there is a small association between such exposure and rape myth acceptance in experimental settings. This meta-analysis also revealed that the association was larger when effects of violent pornography were compared to the effects of nonviolent erotica, though the effects for nonviolent erotica were still present.

While experimental studies appear to demonstrate a link between exposure to sexually explicit materials and rape myth acceptance, critics have suggested a number of reasons for a cautious interpretation of these findings. First, it is noted that a number of naturalistic studies have found no association or even an inverse association between men's exposure to sexually explicit materials and their attitudes towards women. For example, nationally representative survey research, as well as research conducted with actual consumers of X-rated videos, has shown that consumers of sexually explicit media may have more positive views of women's rights than nonconsumers of such material. This has been corroborated by a meta-analysis of observational studies of the relation between exposure to sexually explicit materials and rape myth acceptance, which found no evidence of an association between exposure and rape myth acceptance among real world consumers of sexually explicit materials. Second, the close association in time between experimental exposure to sexually explicit stimuli and measurement of rape myth acceptance in these experimental studies has led some critics to suggest that participants' perceptions of what the researchers may have desired to find may have influenced participant responses. If the participants are aware of a study's objectives, they may modify their responses to help corroborate the expectations of the experimenter. In support of this criticism, studies that have been controlled for this possibility by temporally separating

exposure to violent pornography from the assessment of rape myth acceptance have found no association between exposure to violent pornography and rape myth acceptance.

Sexually Explicit Material and Evaluations

Experimental research has demonstrated close associations between individuals' positive or negative emotional responses to sexually explicit stimuli, their positive or negative evaluations of such material, and their weak or strong inclination to restrict access to such materials. It has been observed that individuals may evaluate sexually explicit materials as either pornographic or nonpornographic in order to justify their negative or positive emotional responses to sexual representations.

Experimental research concerning long-term exposure to sexually explicit stimuli has found that such exposure can increase relative acceptance of a range of nonmonogamous sexual behaviors, including premarital sex, extramarital sex, extra-cohabitational sex, and sexual nonexclusivity. Prolonged exposure has also been found to increase relative acceptance of both male and female promiscuity and sex without emotional involvement. Consistent with these findings, exposure to sexually explicit material was also found to result in a devaluation of marriage as an essential social institution, and to a desire for fewer children. Experimental long-term exposure to sexually explicit material has been found to result in changes in sexual satisfaction, with participants viewing massive amounts of such material reporting lower sexual satisfaction, and lesser satisfaction with their sexual partners' level of affection, physical appearance, sexual curiosity, and sexual performance. Finally, results from some long-term exposure studies suggest that exposure to sexually explicit media can have an impact on how people negotiate gender politics. Experimental massive exposure to sexually explicit stimuli has been found to increase acceptance of male dominance and female submission, lead to less support of the women's liberation movement, and result in lower recommended sentences of incarceration in response to a hypothetical rape scenario.

Although these studies generally indicate the antisocial effects of exposure to sexually explicit materials, we must consider the fact that experimental exposure research imposes exposure to sexually explicit stimuli in a fashion not chosen by those exposed to it, and it is unclear whether the findings of experimental massive exposure studies are informative about real world situations, which involve self-regulated exposure to such material. Note also that observational studies in real world settings have not found a relationship between the use of sexual media and antiwoman political attitudes. Finally, as critics have noted, erotica-induced sexual dissatisfaction could be considered an antisocial impact, or instead, could be viewed as a 'good thing,' in which alternative standards of sexual curiosity and performance, as demonstrated by sexually explicit material, may result in healthy strivings for improvement rather than ignorance-bred satisfaction with the status quo.

Summary and Critique

A number of experimental studies indicate that exposure to sexually explicit material can influence feelings, thoughts, and evaluations. The intent of many studies presented in this

section has been to show that exposure to the assumed central messages of sexually explicit material contributes to the breakdown of social order vis-a-vis the family unit or to the male oppression of women. In general, experimental evidence, within the limits of such an approach, appears to be more supportive of the first proposition than the second.

It is essential to note that virtually all the studies discussed in this section were carried out in an experimental setting in which participants were exposed to specific amounts of sexually explicit materials depicting particular content, irrespective of participants' existing inclination to view or to avoid such media. Consequently, the extent to which sexual media content may influence consumers' thoughts, feelings and judgments in real world settings remains unclear. Contrary to expectations, available evidence from naturalistic research suggests that the use of sexually explicit material is not related to antiwoman attitudes. As noted, one study found frequent consumers of X-rated videos to be more politically supportive of women's rights than others, one found that those who frequented erotic movie theatres showed the same prowoman disposition, and another study found more positive attitudes among men who attended a pornographic cinema than men who were enrolled in an undergraduate university course. When it comes to the relationship between sexually explicit media exposure and the outcome at focus, the results of experimental studies discussed in this section are clearly at odds with the findings of naturalistic studies.

Effects of Sexually Explicit Material: Behavior

Evidence for Small, Nonnovel Increases in Sexual Behavior

It is well established that exposure to sexually explicit stimuli leads to sexual arousal in many, if not most, individuals, and sexually aroused individuals may experience an increased motivation to find sexual release. In line with this expectation, experimental studies have consistently found that exposure to sexually explicit materials induces small, short-term increases in nonnovel sexual behaviors. In student samples, increases are typically found among autoerotic behaviors such as masturbation and sexual fantasy. Studies involving participants with readily available sexual partners often find short-term increases in partnered activities including, but not limited to, coitus. Increases in sexual behavior tend to be short-term, dissipating within 24 h of exposure. Experimental studies that have specifically evaluated adoption or performance of novel or low-frequency sexual behaviors, including sadomasochism, group sex, extramarital sex, or the introduction of novel foreplay behaviors or positions of intercourse, have found little evidence that exposure to sexually explicit materials induces changes in such behaviors. Finally, some experimental studies have also found evidence of habituation of sexual responses over time. When participants are repeatedly exposed to similar erotic materials over time, the impact of such material on sexual behavior becomes attenuated.

Limited Evidence of Increases in Novel Sexual Behaviors

Although exposure to sexually explicit material has generally been found to lead to short-term increases in the practice of

nonnovel sexual behaviors, there is also evidence that some individuals report increases in novel sexual behaviors following exposure. One study, for instance, found that 11% men and 4% of women reported using a new or seldom used foreplay technique within 24 h of viewing sexually explicit stimuli. Other studies suggest that exposure to sexual stimuli featuring clitoral self-stimulation in the context of autoerotic or partnered sexual behavior can result in increased clitoral self-stimulation and increased orgasm in some women.

A number of conceptualizations seek to explain why exposure to sexually explicit stimuli may induce changes in new or infrequently practiced behaviors. One view asserts that explicit depictions of sexual behavior may serve to normalize the performance of the depicted sexual acts, disinhibiting willingness to report them or their actual practice *per se*. This view is consistent with the evidence that exposure to sexually explicit stimuli can result in attitude changes regarding the acceptability of a range of sexual behaviors. Similarly, as previously noted, exposure-induced reductions in general sexual anxiety may also remove barriers to the practice of earlier anxiety provoking behaviors. This possibility is supported by a study which found that the anxiety reducing effects of exposure to sexual stimuli are accompanied by an increased motivation to participate in a larger variety of sexual behaviors. It should also be noted that exposure to sexual media may provide the opportunity to learn about previously unknown behaviors by observing and imitating the behaviors of an explicit sexual model. Although this explanation is consistent with the reported motivation to view sexually explicit materials among some individuals (i.e., to learn new techniques), to our knowledge, no study has convincingly demonstrated the significant acquisition of previously unknown sexual behavior through exposure to such material alone.

Sexually Explicit Materials and Aggression

The possible link between men's exposure to sexually explicit materials and their enactment of antiwoman aggression has generated intense research interest. Although concern about a pornography – aggression link probably extends as far back as the 1780s, when the Marquis de Sade penned his violent erotic novels, concern about violent pornography and antiwoman aggression was heightened by feminist discourse in the 1970s and the 1980s. The following section begins by presenting evidence that experimental exposure to violent pornography results in increased aggressive response in laboratory settings. Following this, evidence showing that efforts to generalize experimental findings beyond the constrained laboratory conditions that produced them have generally failed to substantiate a link between sexually explicit media exposure and antiwoman aggression in real-world settings is reviewed.

Experimental research concerning violent pornography and aggression have often adopted the research paradigm employed frequently by scientists who study nonsexual causes of aggression. In this experimental approach, male participants are angered by a female confederate of the experimenter, who is posing as a fellow participant, through acts of verbal aggression and/or painful electrical shocks. Male participants are then shown either violent pornographic stimuli, nonviolent erotic stimuli, or nonsexual material. In a final phase of the

experiment, male participants are told that they will be evaluating the performance of the female confederate, who is still posing as another research participant, on a learning task. The male participants are then instructed to punish the female confederate when she makes predetermined mistakes in her learning task. Male participants are free to choose the intensity of the punishment they decide on for the female, which is allegedly delivered by electric shock, and they are given no alternative but to submit her to electrical shock. In the final phase of such experiments, the male participant and the female confederate are physically separated, communication occurs through an intercom, and the punishment is apparently, but never actually, delivered to the confederate.

Initial experiments using this design found that participants who were shown a sexually explicit film delivered stronger electrical shocks (or, in other versions of these procedures, stronger blasts of noise) to the confederate than participants who saw a neutral nonsexual film. Additional work has found that this effect is attenuated when participants are shown less explicit sexual stimuli like nudes or semi-nudes, but augmented when participants are shown violent pornography in which the victim is depicted as ostensibly enjoying being sexually assaulted. These results have been confirmed by at least one meta-analysis, which has found that experimental exposure to violent pornography and nonviolent sexually explicit stimuli in laboratory settings generally results in increased aggression toward the female confederate in this paradigm, while exposure to simple nudity decreases such aggression.

Although experimental studies in these laboratory conditions indicate that violent pornography and even nonviolent sexually explicit materials can enhance male–female aggression, a number of theoretical and empirical challenges suggest that the results from such experiments may not apply meaningfully to real world settings and are in fact uninformative concerning any relation between sexually explicit materials and aggression in natural settings. First, it has been asserted that the experimental setting in which an angered male is required to aggress against his female tormentor and has no nonaggressive response alternative is essentially guaranteeing that the male will aggress. In this connection, it has been questioned whether angered men would aggress at all if they had a nonaggressive response option open to them. Demonstrating that this may indeed be the case, a study which allowed angered male participants to choose whether or not to aggress against a female confederate who had angered them found that, even after viewing violent rape theme pornography in which the victim appeared to enjoy being assaulted, almost all male participants chose not to aggress at all against the female confederate. Second, we note that the same experimental studies of long-term exposure to sexually explicit stimuli that found a negative attitudinal impact, reported lessened antiwoman aggression after long-term exposure to sexually explicit materials, as a function of lessened overall arousal. We note as well that studies that have used sexual stimuli consisting of simple nudes who are not engaged in overt sexual behavior, and elicited positive emotional responses from men, have also been found to decrease aggression against a female, presumably as a function of positive affect and its incompatibility with hostile aggression. Finally, there is at least one example of an experimental study that involved significant exposure to

violent pornography and which showed, in a later aggression opportunity separated in time from the exposure to violent pornography no effect of exposure on aggression or indeed on rape myth acceptance.

Further evidence suggestive of caution with regard to extrapolation of experimental laboratory results is provided by a considerable number of observational studies that have failed to find any evidence of a link between sexually explicit media consumption and antiwoman aggression in the real world. Specifically, studies examining the prevalence of sexually explicit materials of diverse kinds in Denmark, Sweden, Germany, Japan, and the United States have not found any increase in reports of sexual assault that could be attributed to the legalization of sexually explicit material or its widespread availability. More recently, crime statistics from the United States indicate a decrease in the number of sexual assaults since the introduction and expansion of Internet pornography, which has massively increased the accessibility of all forms of sexually explicit materials, including violent pornography, in that country. Moreover, a number of studies of sex offender populations have revealed that convicted sex offenders may report less experience with diverse sexually explicit materials than nonsexual offenders and nonoffenders. While there are at least isolated exceptions to observational studies of the lack of association between prevalence of sexually explicit materials, use of sexually explicit materials, and sexual crime, given the preponderance of these real world findings, it seems likely that the link between pornography exposure and aggression found in experimental research may be an artifact of constrained laboratory conditions, which do not reflect the circumstances of pornography consumption in natural settings.

General Summary and Critique

The preceding analysis has provided a survey of current knowledge regarding the nature of sexually explicit materials and the effects of exposure to such material. In this review, definitions of sexually explicit material have been shown to be heterogeneous, focusing alternatively on the perceived intent or the perceived content of such material. The cultural and historical ubiquity of sexually explicit material has been illustrated, and research concerning the content of contemporary sexually explicit material has been reviewed and critiqued, and difficulties associated with these assessments have been noted. Patterns of use of sexually explicit material were considered, and men emerged as the gender that most frequently accesses sexually explicit materials. We have also reviewed evidence that exposure to sexually explicit materials can influence the way people feel, think, evaluate, and behave.

Experimental studies in the laboratory setting have generally found evidence that sexually explicit materials can influence feelings, thoughts, evaluations, and sexual and aggressive behavior. Although many take this as evidence that sexually explicit material can induce antisocial changes along a number of dimensions, evidence for any of these effects among real world consumers of sexually explicit material is sparse. For this reason, although we are inclined to believe that self-regulated exposure to sexually explicit material that occurs outside of experimental settings may impact sexual behaviors and

attitudes in both positive and negative ways, we must conclude by admitting that clear evidence for such effects is still lacking. Although it is unsatisfying to leave this summary without firm conclusions, given the publication of two recent reviews, one explicitly concluding that pornography use is a risk factor for sexual aggression at least among certain predisposed individuals, and the other claiming that such an association remains unestablished, we feel that such an approach is appropriate as many of these questions appear to be undecided among social scientists today.

See also: Aggression; Attitude Change; Attitude Formation; History of Film and Music; Internet Behavior; Leisure; Marital Dysfunction; Media Influence on Behavior; Sex Differences; Sexual Behavior.

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Positive Psychology

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Glossary

Broaden-and-build theory of positive emotions The notion that positive emotions broaden momentary cognitive capacity and flexibility, which in turn builds lasting psychological, physical, and social resources.

Character strength A personality characteristic that represents what one does well. These include universally accepted, morally valued, characteristics that are stable across time and situations. Examples include kindness, gratitude, social intelligence, the capacity to love and be loved, or perspective.

Eudaimonic A view of well-being that focuses on increasing virtue and promoting strength of character as opposed to pleasant emotions.

Hedonic A view of well-being that focuses on increasing positive emotions and subjective appraisals of well-being.

Positive intervention A cognitive or behavioral strategy or collection of strategies that aims to increase well-being through promoting the factors that support it.

Subjective well-being A widely accepted definition of well-being that focuses on subjective appraisals. It includes a combination of an affective component, high positive affect and low negative affect, and a cognitive component, appraising one's life as well.

Synopsis Positive psychology is a burgeoning research area that attempts to better understand and promote the factors that relate to human flourishing. Research in positive psychology includes three main areas of focus: positive emotions, positive character traits, and positive institutions. Research on the nature of well-being has furthered our understanding of what it means to live a good life. Applied uses look to further promote human well-being by adopting this knowledge into empirically testable intervention methods. As positive psychology grows it aims to move these interventions to more settings to further support positive institutions and increase worldwide well-being.

Introduction

Ten years ago, Martin Seligman established the field of positive psychology to foster research on 'positive' aspects of living and create a psychology of human strengths and flourishing. Seligman noted that since World War II, psychological research has focused almost exclusively on pathology, neglecting factors associated with well-being. Positive psychology's founding has helped research on these topics flourish. The measurement of once nebulous constructs, such as happiness, has advanced to the point that we now have well-validated and widely used measures. The purpose of this article is to introduce the organizing principles of positive psychology, review important topics and theories, and outline directions for future growth.

What Is Positive Psychology?

Positive psychology is the study of optimal functioning. It examines the psychological resources and characteristics that allow people to function adaptively in the face of the many demands of life. An orienting principle of this approach is that removing the factors that lead to pathology, deficits, or failure is not sufficient to build mental health or promote flourishing. Instead, this requires an understanding of the factors that make life worth living such as happiness, success, and virtue. Positive psychology adopts a strengths perspective, examining what each individual does well. This approach, however, does not replace preexisting paradigms; instead it offers a complement to help promote understanding of the determinants and consequences of living well.

The central tenets of positive psychology include the following: (1) positive and negative aspects of functioning do not lie on a bipolar continuum but instead represent unique dimensions (i.e., happiness is not the opposite of unhappiness), (2) hypothetically moving from a +2 to a +5 requires different techniques than moving someone from a -5 to a -2, (3) working on strengths is more beneficial than working on weaknesses, and (4) psychology needs to understand what allows people to flourish just as it aims to understand the characteristics and factors that predispose individuals to languish. Positive psychology research following from these tenets can be organized in three broad areas.

The Pillars of Positive Psychology

As defined by Seligman and Csikszentmihalyi, the three pillars of positive psychology are the study of positive emotions, positive character traits, and positive institutions. It is useful to consider research in each of these pillars as furthering the objectives of positive psychology.

Positive Emotions

Emotions are physiological and cognitive responses to our environment that motivate and organize behavior to function adaptively. To understand the benefits of positive emotions, it is useful to understand their role in guiding behaviors. Positive emotions are defined as emotions that are positive in valence and resemble positive states (such as satiety, safety, and comfort). These include activated and energizing emotions

such as joy and happiness, as well as more deactivated and calming emotions such as serenity or peace. Positive emotions are a crucial component to well-being and an important area of positive psychological research.

The Role of Positive Emotions

Positive affect may be one of the most important contributors to a person's overall well-being. Increasing positive affect is useful not only because people enjoy pleasant states, but also because they lead to greater success, better job performance, improved social relationships, and better physical health. These benefits result from cognitive and motivational effects of positive emotions. Fredrickson posits in her broaden-and-build theory of positive emotions that these emotions 'broaden' people's momentary thought-action repertoires, which in turn motivate behavior that 'builds' lasting physical and psychological resources.

Positive emotions signal safety in the environment, which presents opportunities to increase long-term survival by building resources. For example, emotions such as amusement lead to a desire to experiment intellectually with new ideas and play physically with others. Interest leads to a desire to explore and integrate new information, and contentment leads to savoring of a situation. These activities can build lasting physical, social, and psychological resources. Furthermore, as opposed to specific tendencies (like fear leading to withdrawal or anger leading to retaliation) from negative emotions, response tendencies from positive emotions are more varied and flexible.

Substantial research literature supports both the 'broaden' and 'build' aspects of this theory. Positive emotions are related to broadened thinking, enhanced flexibility of thought, creativity, and problem-solving. Individuals induced with positive emotions evidence more self-other overlap and show less of their own race bias in responding. Positive emotions also build lasting resources. In times of psychological distress, positive emotions promote psychological resilience. In fact, the experience of positive emotions after significant stressors predicts reduced depressive symptoms and increased posttraumatic growth. Recent intervention research further supports the broaden-and-build theory by demonstrating that an experimental intervention that increases positive emotions also leads to long-term increases in psychological resources such as agency thinking, optimism, savoring, autonomy, and personal growth.

Positive Character Traits

Another aspect of positive psychology focuses on understanding the characteristics that define human excellence. What factors allow some to succeed and flourish? How do we define what a person does well? To facilitate research on these aspects, Seligman and Peterson created a classification of human strengths. A strength is a universally accepted, morally valued, personality characteristic that is stable across time and situations. These strengths elevate those who bear witness to them and are the focus of moral and civic education. Seligman and Peterson identified 24 strengths organized under 6 core virtues, including courage, justice, humanity, temperance, wisdom, and transcendence.

Using character strengths is a strategy to build happiness. Engaging in new activities related to one's signature strengths for a period of 1 week has been shown to create lasting boosts in well-being for as long as 6 months. Using strengths is an important route to happiness because it not only builds momentary pleasure but helps promote engagement and meaning in one's life. Because strengths represent forms of authentic self-expression, working on a strength is intrinsically rewarding and enjoyable and using strengths in the service of others promotes meaning and purpose in one's life. Positive psychology further posits that building and working with an individual's strengths may be more beneficial than working on weaknesses. Using and building character strengths is not as emotionally or mentally taxing as addressing a weakness. Rather, it is fun and leads to further use of that strength.

Positive psychology has expanded the language and knowledge of strengths. Future research can help to better understand how strengths contribute to well-being and how strengths can be promoted and taught through interventions and education.

Positive Institutions

The final focus of positive psychology is to identify positive institutions such as work, school, and government settings and policies that enhance individuals by promoting positive emotions and positive character traits. These institutions provide goals and values that guide individuals to make choices and develop the best aspects of themselves. Institutions that enhance and cultivate character strengths play an important role in promoting optimal functioning of individuals. Another consideration of what makes a positive institution is to consider not just promoting individual wellness but enhancing community wellness. Assessing this requires translation of concepts developed at an individual level to conceptualize wellness at a systems level.

Current attempts in positive psychology to address and focus on positive institutions include applying positive psychology principles to schools in an attempt to create positive models of education. Creating satisfying work environments relies on supporting basic psychological needs such as autonomy and competence. Research on topics such as flow and engagement also highlight aspects of jobs and schools that could be developed to create more intrinsically rewarding experiences. For example, these settings can focus on providing tasks that match the level of demand to individual skills to avoid both boredom and burnout. As positive psychology expands into more applied areas, recommendations for creating and supporting positive institutions will continue to develop.

Well-Being Across Time and Culture

Positive psychology's advancement has drawn on the empirical and theoretical contributions of mainly Western researchers. Definitions of well-being, however, may vary by culture and the specific factors that promote well-being are likely closely tied to what it means to be well or happy within that culture. It is therefore important to consider historical and cross-cultural considerations of the definition of well-being to better

understand how positive psychology can contribute to a more universal view of human flourishing.

A review of the history of happiness in Western societies highlights that the notion of happiness as conceptualized by many modern Americans to cultivate positive feelings and experiences is in stark contradiction with previous views of the nature of happiness. A brief review of these eras reveals that the Homeric era focused on good fortune, the classical view emphasized cultivating virtue, medieval Christian perspectives asserted living in accordance with God's will and plan brings lasting well-being, and enlightenment thought began to enlarge the role of pleasure in conceptions of well-being. Modern views, therefore, have largely departed from classical and medieval notions that contend that virtue or character are more important than feeling good. Instead, as captured by theories which use a subjective definition of happiness, the modern view focuses on emotions and thoughts.

As definitions of what constitutes a 'good life' varies by time and culture, the goals and activities that individuals engage in to promote their own happiness reflect the attitudes and values of their internalization of these values. For example, equating a 'good life' with the frequent experience of positive emotions may be a construction of modern Western culture. In Western cultures 'happiness' is viewed as an important goal. Research supports that in these cultures, happy individuals are even rated as more likely to go to heaven. Indeed, the importance of goal fulfillment in determining satisfaction might help explain the variability across nations in the relationship between income and satisfaction. In some countries or cultures, prevailing values emphasize modest aspirations or non-material strivings (i.e., family, religion). These values mold individual expectations and help explain high levels of individual well-being even in the absence of material wealth. Research in groups such as the Maasai, the Amish, and slum dwellers in Calcutta has revealed higher than expected levels of well-being given their lack of material wealth.

In these cultures and for many individuals, psychological well-being is tied to the various goals set individually and culturally. For one, well-being might stem from achieving status and wealth whereas for another, it might come from connecting with others or devoting one's life to a higher calling. In general, a negative relationship exists between materialism and well-being. This relationship, however, is moderated by those who actually do have the income to pursue material possessions showing less negative impact on their well-being. These findings illustrate the importance of recognizing that even though trends in a certain time or place might suggest certain pathways toward well-being, it is critical to know the values of the individual to better understand the specific aspects that might contribute to one's own well-being.

Another consideration is how to define and therefore measure well-being. Although a majority of psychologists do adopt a subjective well-being perspective and focus on the mental states of individuals to determine well-being, a growing minority define well-being using prescriptive approaches that nominate needs and characteristics necessary to achieve the good life. These 'needing' or eudaimonic approaches highlight aspects besides pleasure which contribute to the good life, such as engagement and meaning, psychological needs such as autonomy, relatedness, and competence, and other

psychological attributes such as self-acceptance and environmental mastery. Current psychological literature supports the theory that achieving these indicators of eudaimonic well-being leads to experiences of happiness and pleasure. Furthermore, strengths of character, such as love, hope, and gratitude, are found to be strongly correlated with hedonic conceptions of well-being such as life satisfaction. These strengths of character connect us to others and are representative of virtues included in medieval Christian as well as classical views of well-being. Historical representations of well-being, therefore, continue to be connected to recent research approaches used within positive psychology.

While creating a field that aims to study human flourishing, it is also necessary to encapsulate the complexities of cultural variations in notions of well-being. Cross-cultural research consistently finds that individuals in Eastern cultures report lower levels of subjective well-being than individuals from Western cultures. These findings, however, do not mean that individuals in Eastern cultures experience less well-being or are functioning less optimally than individuals in Western cultures. Instead, it demonstrates the importance of understanding how emotions and character strengths might contribute differentially to notions of well-being across cultures.

As previously mentioned, cultural norms shape the goals that drive individuals and contribute to well-being. Individuals from Eastern cultures, for example, strive to fit in and meet obligations whereas individuals from Western cultures self-enhance, emphasizing their own accomplishments and successes. Another foundational goal in Eastern cultures is achieving a sense of cognitive and affective balance. Eastern cultures, therefore, will not strive to overly promote positive affect but instead aim at balancing positive and negative emotions. Individuals from Eastern cultures, therefore, are much more reliant than their Western counterparts on negative aspects of experiences when forming judgments of satisfaction. This focus on balance, however, is also supported by research on positive emotions that suggests a critical ratio of 3:1 positive to negative emotions is an important determinant of flourishing rather than unbridled promotion of positive emotions.

Balance in life is also important to Buddhist conceptions of well-being. Many aspects of positive psychology may seem in opposition to Buddhist ideals, which hold that pleasurable stimuli either internal or external are transient and therefore do not lead to true, sustainable well-being. Chasing positive emotions, fostering relationships, and striving toward goals may seem counterproductive to an individual who believes he or she should desire nothing. Craving, which is concerned with obtaining some desirable object, moves the source of well-being from one's mind to external objects. Research bears out that due to adaptation, life circumstances and material goods lead to only transient boosts in positive emotions and satisfaction. According to Buddhism, expectations for happiness that lead to striving for material wealth, recognition, power, or approval actually lead to negative emotions such as anxiety or frustration. A Buddhist concept of well-being, therefore, emphasizes achieving mental balance through cultivating internal well-being that is not dependent on transient positive states, fame, or fortune. Instead, a possible synthesis of Buddhist principles suggests well-being flows from achieving balance of mental skills in the conative, attentional,

cognitive, and affective domains. Motivational concepts from self-determination theory suggest many similar concepts may be important to achieving eudaimonic well-being. These include pursuing intrinsic goals, cultivating mindfulness and awareness, behaving in ways that are consistent with psychological needs, and acting in autonomous ways. The focuses on intrinsic goals and volitional activity maps on to conative balance, mindfulness is akin to attentional balance, and achieving psychological needs helps promote cognitive balance.

Eudaimonic notions of well-being might provide an important point of synthesis, therefore, of positive psychological concepts into Eastern definitions of well-being. Even in Western cultures, pursuing engaging and meaning in one's life leads to higher levels of subjective well-being than pursuing pleasure. This is in line with Buddhist notions that suggest that the search and quest for pleasure is likely to paradoxically hinder its acquisition.

Not surprisingly, eudaimonic conceptions of well-being require characteristics to be ubiquitous; that is, they have to be valued across time and culture to be nominated as a character strength. Indeed, the core virtues of courage, justice, humanity, temperance, wisdom, and transcendence are included in philosophical and religious traditions from around the world, including Confucianism, Taoism, Buddhism, Hinduism, Athenian philosophy, Judaism, Christianity, and Islam. This analysis suggests the importance of human strengths in the worldwide definition of flourishing.

What Is the Good Life?

Pathways to the Good Life

Positive psychology research aims to create an understanding of the factors, characteristics, and settings that create lives full of flourishing and success. This requires, however, a definition of what might constitute the 'good life.' Theorists disagree over how to conceptualize the 'good life.' Some focus on increasing pleasant feelings and evaluations of one's life. These theorists, deemed hedonists, adopt a subjective approach to the good life relying on self-reports. Not all agree, however, that well-being is a sum of pleasant feelings and positive evaluations about one's life. These researchers argue that instead, well-being comes from achieving a sense of mastery over the environment, creating meaningful lasting relationships, and living in accordance with one's true nature. These conceptions, known as eudaimonic approaches, align more closely with the notion that well-being flows from living well or realizing one's potential.

Eudaimonic views of well-being are similar to 'needing' accounts of well-being, which focus on the content of one's life as an important determinant of well-being. These theories identify the objective circumstances required for a good life. 'Needing' approaches have been referred to elsewhere as 'objective list' theories of well-being. In these approaches, well-being is achieved through satisfaction of needs which are listed a priori. Theorists propose different elements on these objective lists. For example, Maslow's hierarchy of needs argues for the fulfillment of basic needs before people can meet their full potential. The capabilities approach similarly argues for essential needs including food, shelter, health, security, and freedom

as a condition for individuals to have the ability to create their own well-being. Objective lists highlight the importance of certain things that are truly valuable to well-being, irrespective of the value that individuals assign to it. These may include things such as education, relationships, career success, democracy, beauty, and material comforts.

The objective lists approach has two advantages. First, like Maslow's hierarchy of needs, they highlight the need for addressing primary needs before indulging in higher pursuits. The second advantage is that these lists provide objective indicators of well-being. Thus, one cannot be considered 'happy' unless he or she is objectively well-off in some sense. Seligman and Royzman provide an example of orphan children living on the streets who might be subjectively 'happy' by engaging in activities that provide momentary pleasure with little concern for the future. The appeal of an objective list approach is that even if these individuals report being happy, they would fall short of being considered 'well,' on the basis of a lack of objective criteria.

Despite these appeals, objective lists have limitations as well. First, there is no general consensus as to which items should be included on objective lists. Although some needs may be universal, other needs are likely to differ across cultures or across individuals who have different values. Second, objective list accounts of well-being are often linked to objective outcomes to determine well-being. Therefore measuring well-being requires the assessment of outcomes such as literacy rates or crime rates. Again, the relative importance of these outcomes may differ by individual values, which introduces a subjective element into this assessment. Lastly, objective lists ignore any subjective evaluation of well-being, which is too strict a criterion for developing a theory of well-being.

In order to address the limitations of both subjective and objective approaches to well-being, some have developed 'hybrid' theories that combine the 'liking' and 'needing' approaches. Seligman's authentic happiness theory is such an example and includes hedonic and eudaimonic elements by positing three distinct pathways (pleasure, engagement, and meaning) that contribute to an individual's well-being. An important component of the authentic happiness theory is that each pathway neither supports nor opposes any other pathway; therefore, each pathway should be cultivated to achieve lasting happiness. Empirical work has demonstrated that these pathways are indeed distinct and that the presence of all three pathways is associated with the highest levels of life satisfaction. This supports Seligman's notion that a 'full life' consists of experiencing positive emotions, pursuing engagement, and obtaining meaning. A brief overview of each of these pathways and how they may contribute to well-being follows.

Pleasure

Pleasure or hedonic accounts of well-being are often adopted by psychologists because they focus on the subjective mental state of the individual. These accounts view well-being as characterized by the presence of pleasure and the absence of pain. Pleasure, however, does not merely include the experience of pleasant affect or the fulfillment of drives. Instead, pleasure encompasses subjective evaluations about one's life, and one's conditions as well. This approach has the considerable

advantage of being face valid. An individual is considered happy if he reports himself as such and each individual is considered the expert on his or her own happiness.

Given the subjective nature of this pathway, these ratings are made most often from self-report measures. Some of the most common assessments of subjective well-being include the Satisfaction with Life Scale and the Positive and Negative Affect Schedule (PANAS). These measures demonstrate considerable reliability and validity. The Satisfaction with Life Scale, for example, is one of the most widely used measures of well-being. This brief five-item measure represents a cognitive judgment of how satisfied one is with one's life. A substantial body of cross-culture research has supported its use in a variety of cultures and populations. Additional measures of well-being tap more affectively based assessments. Measures such as the PANAS and other self-report measures of positive emotions provide evaluations of an individual's affective experience. Frequency of positive emotions is strongly related to more reflective components such as happiness and life satisfaction. Concepts such as happiness blend affective as well as cognitive measures as many individuals interpret happiness as an evaluation of their emotional state.

Engagement

An alternative route to well-being is through engaging in activities that are engrossing and absorbing, a state that Csikszentmihalyi has called 'flow.' Flow is most often experienced during activities that require appropriate demands, given one's level of skill. A flow state is subjectively experienced as being absorbed in the task, a loss of self-awareness, distorted perception of time, and a strong intrinsic reward from the activity.

Given that flow experiences do not lead to pleasure in the moment, how might they contribute to well-being? Reflecting upon a flow experience is often positive. Many hobbies and leisure activities such as sports, games, or horseback riding are pursued because we lose ourselves in these activities. Flow can also reframe important yet mundane tasks into more interesting activities. For example, making a game out of one's math homework by seeing how many problems one could solve in 30 min serves to make the task feel less bothersome and more intrinsically interesting. Indeed, people typically report experiencing more flow at work and school than during leisure time. Individuals who frequently experience flow achieve better outcomes due to increased persistence. Flow states, therefore, may lead to long-term well-being through promoting positive resources – such as nurturing talents, cultivating interest, and honing skills. These resources may lead to an upward spiral of both increased subjective as well as objective well-being. Following from these findings, we would expect that individuals who endorse frequently entering flow in their lives are more productive and achieve higher levels of success, although more research is needed to support this claim.

Meaning

The final pathway suggested by Seligman is to pursue happiness through meaning. Theorists have long proposed that finding meaning in one's life is important to achieve psychological

well-being. Human beings show a tendency to try to understand seemingly ambiguous events by constructing explanations and these explanations can have a powerful impact on how we react and respond to the situation. Although theories differ on the role that causal explanations play, they agree that these explanations influence psychological processes and behaviors. Meaning in life allows one to transcend oneself, either connecting to others or to a higher power. Although the searching for meaning is linked to lower levels of well-being, those who report that their life has significant meaning or purpose report higher levels of well-being. Finding meaning in life may link to well-being through promoting positive social relationships or a sense of one's actions as efficacious and fitting into a larger picture.

The creation of meaning following negative events is one manner in which people cope positively with loss, trauma, and stress. Indeed, Wilson and Gilbert have suggested that finding meaning after events is part of the psychological immune system, which helps us find causes for why things went wrong. Meaning-making has been a proposed mechanism for the process of recovery following traumatic events and an active ingredient in interventions such as writing and other forms of posttraumatic growth. More globally, meaning in an abstract sense allows discovery of one's purpose in life, which can provide individuals with goals that guide action and promote well-being. Pursuing a meaningful or virtuous life may also provide individuals with a feeling of knowing one's true self or being authentic. Authenticity and self-knowledge have been tied to both a sense of meaning in one's life as well as increased well-being.

People search for meaning in a variety of different ways such as religion, work, or volunteering. One way in which individuals may develop a sense of meaning is through pursuing actions that are concordant with one's sense of self – or rather drawing on one's strengths. Various studies have demonstrated that using one's strengths leads to increases in subjective well-being. Working on strengths as opposed to working on deficits may represent an empowering approach to benefiting individuals and thus support autonomy and meaning. Meaning, therefore, can link to long-term well-being through providing important goals, fostering social connections, and providing opportunities to exercise individual strengths.

Positive Relationships

The ability to form strong, lasting relationships is a hallmark of our humanness. In youth, people work to maintain their friendships and these interactions provide opportunities to build physical and cognitive resources. As people age, the task of coupling becomes important to one's evolving sense of self. Relationships contribute to our well-being in a variety of ways. They provide a shoulder to cry on in times of need and companions with whom to celebrate life's successes. Not surprisingly, relationships are one of the most consistent and robust predictors of individual well-being and a major component of the good life. Being happy, full of virtue, or objectively well-off is irrelevant if one lives a life of solitude and loneliness. In fact, good relationships appear to be a necessary, though not sufficient, condition for high well-being. Learning about the characteristics that promote successful relationships and examining

the benefits that flow from these connections is an important area within positive psychology.

Most people aim to couple and all invest considerable effort to build strong and healthy relationships. Relatedness is a fundamental psychological need and fulfilling this need leads to increased well-being. The self-help literature has long catered to people's interest to be more effective 'people persons.' Research psychologists used empirical studies to translate practical wisdom into supported recommendations. In close relationships, the largest predictor of relationship satisfaction is not how couples deal with bad news, but how people react to good news that their partners share. In response to positive news, individuals can respond in either active or passive manner (i.e., engaging in the news or blowing it off) and a constructive or destructive manner (i.e., building on the news or belittling the news). Responding active-constructively to good news serves to enhance the positive experience by reliving the event with the storyteller. This allows the storyteller to further savor the event and in turn strengthens the relationship.

Building better relationships is important because regardless of one's current level of relationship satisfaction, one can always find ways to improve the quality of relationships in one's life. Individuals report that achieving more intimate relationships is a more important goal than developing a large number of friendships. Studies show that most of our intimate interactions take place with the same set of six people. A study of very happy individuals – that is, individuals who score in the top 10% of a sample on measures of happiness – demonstrated that these individuals reported good quality social relationships, spending the least amount of time alone and the most amount of time interacting with friends and family. The number of friends, however, that puts an individual in this category is unclear. Both the quantity and quality of social networks have been linked to better health, coping, and happiness. Thus, further research is needed to unpack this question.

Another reason for increasing relational skills is the growing dearth of interpersonal interaction. In America, social networks have been decreasing with fewer individuals joining clubs and other civic organizations. Over the last 20 years, the average number of confidants or people with whom one can discuss 'important matters' has dropped by one-third from three to two. The decrease of social capital – the social networks one has in society and the associated norms of reciprocity and trustworthiness – may very well be an important issue, although it begs the question of whether this drop is a meaningful one. Typically, studies find a positive relationship between the number of individuals in one's social network and well-being. It is unclear from this overall analysis, however, if the benefits of having more friends demonstrate diminishing returns; that is, if more friends are more beneficial only up to a point. One can imagine that a larger social network might diminish the quality of each of those social interactions as individuals can only devote so much time and energy to each relationship. The meta-analysis found that the quality of social contacts was a better predictor of well-being than merely the quantity of social contacts, suggesting that larger and larger networks are not necessarily more beneficial if quality is sacrificed.

Positive psychology can play a role in reversing this trend by both demonstrating the importance of relationships as well as

developing interventions aimed to improve interpersonal skills. Although positive relationships are beginning to appear as a key area for research in the field, it should be growing over the coming years.

Applied Positive Psychology and Positive Interventions

Currently the field of positive psychology is working to move from the laboratory to the real world. Efforts to translate research include both program creation as well as training opportunities to increase the knowledge base of those who want to apply positive psychology in a variety of settings. Positive psychology programs aim to increase well-being through 'positive interventions,' foster positive character traits, promote resilience, and help individuals achieve optimal functioning.

Defining a 'Positive' Intervention

A major thrust of positive psychologists is to develop empirically supported techniques to increase well-being. These techniques, deemed positive interventions, are cognitive or behavioral strategies, or a collection of cognitive and behavioral strategies that promote well-being by building happiness, satisfaction with life, or positive affect, through processes that lead to well-being such as engagement, meaning, and pleasure. The term positive generally refers to adding something as opposed to subtracting something, or fixing something that is broken. This definition helps clarify the difference between a 'negative' intervention and a 'positive' intervention. The general practice of psychology is to repair deficits, moving people from a minus five up to a minus one or even a neutral point. Positive psychology differs by helping move people from a plus one to a plus five.

Consider a baseball analogy. If a pitcher wants to improve his game, he might accomplish this by fixing the mechanics of his poorly breaking curveball, or he could learn how to throw a proper knuckleball, or he could enhance his already effective change-up. A 'negative' intervention would be noticing that his curveball often does not break and learning to use a better release for getting more spin on the ball. A 'positive' intervention would either develop something new, such as adding a new pitch to the repertoire (i.e., learning how to throw a knuckleball), or it could further enhance a current strength (i.e., increasing the speed differential between the slow pitch and the fastball to develop a more deceptive change-up). All of these interventions would have the net effect of improving overall pitching; however, the focus of each approach is different. Differentiating positive psychology exercises from other interventions and approaches is not to say that other approaches are useless. Different approaches, however, may be targeting a different pathway or offer different benefits. Additionally, positive interventions are sometimes easier, more cost effective, or more fun to do.

Positive Interventions in Practice

Fordyce completed one of the first empirically tested programs of positive interventions. Fordyce developed his program, called the 14 fundamentals, by observing the behaviors of

happy people and incorporated these strategies into his recommendations. These recommendations include: socialize, strengthen close relationships, be outgoing, be a better friend, develop a healthy personality, lower expectations, be optimistic, make happiness a goal, be active, create meaning, get organized and make plans, develop a present orientation, reduce negative feelings, and stop worrying. Teaching these strategies in a classroom setting led to boosts in well-being compared to various control groups who received no such instruction. Further research has extended this line of research by studying these and other strategies in isolation to create specific recommendations of techniques that can promote well-being.

These include varied techniques such as promoting optimism, hope, gratitude, kindness, and meditation. Overall, these interventions are effective at increasing well-being. A recent meta-analysis of positive interventions found that on average, these techniques lead to small-to-moderate boosts in happiness, affect, and life satisfaction. The greater the number of interventions included in a single program, the more effective it is, suggesting that programs like Fordyce's, which include many different strategies, are often wise ways to promote well-being.

Positive interventions have even begun to infiltrate the clinical realm. Positive psychotherapy incorporates positive psychology principles such as building pleasure, engagement, and meaning as a road to recovery from depression. Sessions teach new skills such as expressing gratitude, responding active-constructively, and identifying and cultivating signature strengths through the use of positive psychology exercises. In a randomized controlled trial, positive psychotherapy was more effective at increasing well-being and reducing depressive symptoms than either medication or treatment as usual. Also, fewer participants dropped out of the positive psychotherapy condition, suggesting that clients may enjoy discussing and building strengths, pleasure, and meaning rather than discussing the negative aspects of their lives. This research suggests that positive psychology may be able to contribute to gross human well-being through promotion of mental well-being in individuals with and without mental disorders.

Applied positive psychology is growing in other venues as well. The number of educational programs awarding degrees in positive psychology is steadily increasing. The University of Pennsylvania is offering its sixth year of the Masters of Applied Positive Psychology Program, with each class providing a new crop of experts eager to apply theory and research for education, law, business, and education. New conferences, professional organizations, peer-reviewed journals, and research centers appear each year. The inaugural World Congress for the International Positive Psychology Association in 2009 welcomed over 1500 people from 52 countries. Positive psychology initiatives also look to recast education, prevention, and training.

Future Directions

As positive psychology advances into its second decade, an important indicator of its usefulness to psychology will be its staying power. Is positive psychology merely a fad or does it

have more to offer? Although there is still much to learn about how to promote healthy, happy, productive lives, researchers have greatly clarified the measurement of individual constructs and advanced integrated theories over the past 10 years.

An important goal of positive psychology is to use its knowledge of well-being to actually enhance human lives. The future of positive psychology therefore rests on its ability not just to enhance an understanding of well-being but actually to increase the total amount of well-being in the world. New research examines how to bring positive psychology to the masses, to instill its principles throughout nations, schools, and therapy offices.

Another future direction of positive psychology is to expand its definition of well-being and refine measurement for more facets of well-being. This includes incorporation of national indicators of well-being to better characterize national levels of happiness as well as using eudaimonic conceptions of well-being to ensure that positive psychology does not just make people feel happier but actually makes people more complete, functional, and virtuous human beings. A limitation of current positive psychological research is an overreliance on subjective measures of well-being because they are simple and easy to collect. This has led to an imbalance of research and theory overemphasizing hedonic compared to eudaimonic perspectives. Just analyzing subjective measures, such as positive affect, runs the risk of over emphasizing positive feelings to the absence of other important features of flourishing, such as promoting engagement, meaning, and virtue in life. This view might suggest to some that the goal of positive psychology is to aim to maximize positive emotions and put off pursuit of relationships, success, or political change. Indeed, although the general trend suggests that happiness leads to success, the happiest individuals tend to be less successful and less motivated to pursue change compared to those who have more moderate (although still above average) levels of happiness. Therefore, refining operational definitions of eudaimonic aspects of well-being may help advance the field by expanding the knowledge of factors that lead to a more balanced perspective or, as Seligman notes, the 'full life.' All of these new directions aim to advance the initial goals of positive psychology to move people not just to a point of neutrality by eliminating the factors that create disorder and sadness, but to help promote happy and flourishing human beings.

See also: Hope and Optimism; Human Intelligence; Self-Efficacy; Social Support.

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Posttraumatic Stress Disorder

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Glossary

Avoidance Cognitive, behavioral, or motivational activity that is performed in order to prevent or escape from unpleasant emotion and anxiety associated with the trauma.

Flashbacks One of the reexperiencing symptoms of PTSD that include very vivid images, or visual pictures of some aspect of the trauma that suddenly pop into the mind, as if the trauma is occurring again.

Hyperarousal Physical or emotional tension produced by the fight-or-flight response; a common symptom of PTSD.

Hypervigilance Increased physical arousal, responsiveness to stimuli, and searching of the environment for threats; a common symptom of PTSD.

Posttraumatic stress disorder A chronic psychiatric disorder that results from a traumatic experience and is characterized by intrusive thoughts about the trauma, avoidance of stimuli associated with the trauma, and increased autonomic activity, all of which interfere with normal functioning.

Trauma An event that involves actual or threatened death or serious injury, or a threat to the physical integrity of self or others, such as a natural disaster, sexual or physical assault, being threatened with a weapon or violence, childhood abuse, military combat, exposure to a war zone, imprisonment, torture, or diagnosis with a life-threatening illness.

General Description

As its name implies, posttraumatic stress disorder (PTSD) is unique among the mental disorders in that it is a reaction to a clear precipitating event – a traumatic experience. Although it is to be expected that people will experience distress after a serious trauma, individuals with PTSD continue to be bothered by the traumatic event long after it has passed. They often are distressed at or avoid thoughts or situations that remind them of the trauma. Features of PTSD include prominent symptoms of fear, anxiety, avoidance, and arousal, which are consistent with its classification as an anxiety disorder. However, it also includes depressive symptoms, numbing of feelings, and flashbacks.

Diagnostic and Statistical Manual (DSM) Conceptions

Before the modern conceptualization of PTSD, the syndrome was known by several other names that reflected the hypothesized etiology at the time. For example, during World War I ‘shell shock’ or ‘combat/battle fatigue’ were terms applied to soldiers suffering from symptoms consistent with modern PTSD. During World War II, ‘war neurosis’ or ‘traumatic neurosis’ was more common. Although PTSD first appeared in the *Diagnostic and Statistical Manual for Mental Disorders*, 3rd edn., earlier editions of the Diagnostic and Statistical Manual (DSM) noted disorders triggered by traumatic stressors. A category of gross stress reaction was recognized in the DSM-I, although it was conceptualized as a phasic response limited to combat. This disorder was eliminated in the DSM-II and instead appeared as a combat stress reaction under stress reactions. Once the high occurrence of postcombat syndrome in Vietnam veterans was exposed, related responses to other traumas (e.g., assault, rape, natural disaster) were recognized and a more inclusive disorder called PTSD was termed and classified as an anxiety disorder in the DSM-III.

PTSD symptoms are classified in the DSM-IV into the following three domains: reexperiencing, avoidance and numbing, and hyperarousal. PTSD symptoms typically begin within 3 months after the trauma, and specifiers are used to label onset and duration of these symptoms. When symptoms of PTSD last less than 3 months posttrauma, the disorder is specified as ‘acute,’ whereas symptoms that last 3 months or more posttrauma are ‘chronic.’ Finally, a less frequent presentation of PTSD, ‘delayed onset,’ occurs when symptoms begin at least 6 months or more following the traumatic event.

PTSD Criteria

PTSD consists of affective, cognitive, and behavioral symptoms that some individuals develop in reaction to a traumatic event and that are associated with distress and impairment in functioning. Criteria related to the traumatic event and resultant symptoms are required together to make a PTSD diagnosis.

A person may develop a posttraumatic stress reaction as a result of experiencing, witnessing, or having been confronted with a trauma. For the traumatic event to support a PTSD diagnosis, it must involve ‘actual or threatened death or serious injury, or a threat to the physical integrity of self or others’ (Criterion A1). Examples of events that would meet Criterion A1 include, but are not limited to, a serious accident, a natural disaster, sexual or physical assault, being threatened with a weapon or violence, childhood abuse, military combat, exposure to a war zone, imprisonment, torture, or diagnosis with a life-threatening illness. This definition contrasts with the previous conceptualization of a traumatic stressor in the DSM-III-R as a rare event ‘outside the range of usual human experience.’ It is now estimated that exposure to lifetime trauma may be as high as 81.7%. However, exposure to a traumatic event is a necessary but not sufficient condition for a PTSD diagnosis. In fact, the vast majority of persons exposed to trauma will not go on to develop clinical traumatic

stress reaction. Persistent psychological distress after a trauma may relate to how a person reacted at the time of the trauma. DSM criteria take this into account by requiring that the individual responded to the trauma with 'intense fear, helplessness, or horror' (Criterion A2).

The DSM-IV symptoms for PTSD include the following three clusters: reexperiencing, avoidance and numbing, and hyperarousal (see Table 1). First, individuals must have at least one symptom of reexperiencing, such as intrusive memories, nightmares, flashbacks, or reactivity to traumatic reminders. Second, individuals diagnosed with PTSD must display three or more symptoms of avoidance and/or numbing, such as avoidance of trauma-related thoughts or situations,

Table 1 DSM IV-TR diagnostic criteria for 309.81 PTSD

- A. The person has been exposed to a traumatic event in which both of the following have been present:
 1. The person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others
 2. The person's response involved intense fear, helplessness, or horror. Note: In children, it may be expressed instead by disorganized or agitated behavior
- B. The traumatic event is persistently reexperienced in one (or more) of the following ways:
 1. Recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions. Note: In young children, repetitive play may occur in which themes or aspects of the trauma are expressed
 2. Recurrent distressing dreams of the event. Note: In children, there may be frightening dreams without recognizable content
 3. Acting or feeling as if the traumatic event were recurring (includes a sense of reliving the experience, illusions, hallucinations, and dissociative flashback episodes, including those that occur upon awakening or when intoxicated). Note: In young children, trauma-specific reenactment may occur
 4. Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event
 5. Physiologic reactivity upon exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event
- C. Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by three (or more) of the following:
 1. Efforts to avoid thoughts, feelings, or conversations associated with the trauma
 2. Efforts to avoid activities, places, or people that arouse recollections of the trauma
 3. Inability to recall an important aspect of the trauma
 4. Markedly diminished interest or participation in significant activities
 5. Feeling of detachment or estrangement from others
 6. Restricted range of affect (e.g., unable to have loving feelings)
 7. Sense of foreshortened future (e.g., does not expect to have a career, marriage, children, or a normal life span)
- D. Persistent symptoms of increasing arousal (not present before the trauma), indicated by at least two (or more) of the following:
 1. Difficulty falling or staying asleep
 2. Irritability or outbursts of anger
 3. Difficulty concentrating
 4. Hypervigilance
 5. Exaggerated startle response

anhedonia, interpersonal detachment from others, or emotional numbing. Lastly, a PTSD diagnosis requires the presence of two or more hyperarousal symptoms, such as insomnia, hypervigilance, or heightened startle response.

Duration is another element of the PTSD diagnosis. Although distress is a normative reaction following a traumatic event, most people do not go on to develop a clinical stress reaction. For example, in a study of rape victims, 94% of the sample met criteria for PTSD immediately after the trauma (mean = 12.64 days postassault). However, this number decreased to 65%, 47%, 42%, and 30% at 1, 3, 9, and 12 months postassault, respectively (see Figure 1).

Given the natural recovery trajectory of many traumatized individuals, a diagnosis of PTSD requires that the disturbance is present for greater than 1 month. PTSD is specified as chronic if the symptoms persist longer than 3 months. People who develop significant posttraumatic stress symptoms typically experience them starting soon after the traumatic event. However, in rare cases in which symptoms arise 6 months or more after the traumatic event, the DSM specifies this as PTSD 'with delayed onset.' Similar to other mental disorders, a PTSD diagnosis requires symptoms to cause significant distress or impairment in functioning.

A limitation of the 1-month duration criterion for PTSD in the DSM-IV is that it excludes those victims of trauma who immediately exhibit significant symptoms that may demand clinical attention. Acute stress disorder (ASD) was introduced to fill a diagnostic gap for those individuals experiencing high distress in this acute phase after a trauma. In this case, the diagnosis of ASD can be applied if symptoms emerge within the month after the trauma and last for at least 2 days. A second goal of the ASD diagnosis was to predict who would eventually develop PTSD after a trauma.

The International Classification of Diseases (ICD) is the international standard classification system created by the World Health Organization (WHO). It is currently available in the 10th edition (ICD-10). Like the DSM-IV, the ICD-10 requires a history of trauma exposure along with the three symptom clusters (reexperiencing, avoidance, and hyperarousal). However, there are also several differences in diagnostic criteria between the two systems. First, the ICD-10 does not require the subjective stressor criterion (the person's response involved intense fear, helplessness, or horror). The ICD-10 requires only one symptom of avoidance and does not include numbing. The ICD system also specifies that symptoms onset must be within 6 months of the stressor. Finally, the ICD-10 does not require functional impairment.

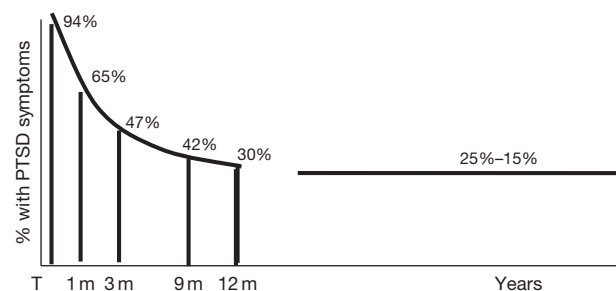


Figure 1 Percent with PTSD symptoms by months since trauma.

Prevalence

As described earlier, a majority of individuals show natural recovery after a trauma. However, many trauma survivors fail to recover and experience persistent symptoms of PTSD. The first National Comorbidity Survey (NCS) found trauma exposure rates of 60–70% and lifetime rates of PTSD in the United States of 10.4% and 5%, for women and men respectively. Although the subsequent NCS replication (NCS-R) yielded a higher rate of trauma exposure (82%), likely due to the less restrictive definition of a trauma, estimated lifetime prevalence of PTSD was similar at 6.8%. Twelve-month prevalence for PTSD was estimated at 3.5%. Epidemiological studies with European samples have reported variable lifetime prevalence rates of PTSD. For example, whereas one study of six European countries estimated prevalence at 1.9%, a large-scale study in Sweden estimated prevalence at 5.6%. Thus, PTSD prevalence may be somewhat specific to nations or regions.

Various demographic factors affect risk for PTSD. As suggested by the numbers above, females are nearly twice as likely to meet criteria for PTSD as compared to males. This sex difference does not appear to be due to overall rate of trauma exposure or type of trauma, but may be due to a greater risk of developing PTSD following assaultive violence. Although some studies have reported higher rates of PTSD among ethnic minorities, these differences did not persist after controlling for sociodemographic variables, such as SES and residential area. Moreover, NCS-R data revealed no significant differences in lifetime prevalence of PTSD across different ethnic groups. Finally, several studies have reported that higher risks of trauma exposure and PTSD are associated with younger age.

Morbidity

Individuals with PTSD have an increased likelihood of past or current psychiatric disorders, with lifetime comorbidity rates of ~80%. Mood and anxiety disorders commonly co-occur with PTSD. For example, in the initial NCS, nearly 50% of participants who reported lifetime PTSD also reported a history of depression. In a separate study, 32% of women with current PTSD met criteria for major depression compared to only 4% of women without PTSD. Elevated rates of alcohol and drug use disorders have also been observed among individuals with PTSD.

PTSD also has been linked with poorer general physical health as well as negative health behaviors. Substantial research indicates that it is associated with disturbances in cardiovascular, gastrointestinal, neuroendocrine, and immune functioning. Based on the most recent national epidemiological study of psychiatric disorders, both trauma and PTSD predicted increased risk for a number of chronic medical diseases, including chronic pain conditions and heart disease. Individuals with PTSD also are more likely to be past or current smokers. Negative health behaviors, such as smoking, and dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis could partly explain the relation between PTSD and physical health. Furthermore, biological studies suggest that hypersecretion of cortisol in PTSD may be associated with age-related memory impairments.

Finally, PTSD results in significant functional impairment and has a large economic impact. It can have deleterious effects on interpersonal functioning. Galvoski and Lyons (2004) reviewed the negative impact that combat-related PTSD has with respect to relationship distress and dissolution and parenting abilities. Economic burden includes greater medical costs, higher rates of unemployment, and lost wages. PTSD has been associated with up to 4000 dollars more in medical costs, even after controlling for other factors. It is also negatively related to employment among veterans, with PTSD associated with more than 3 times greater probability of unemployment in some samples. Even working veterans with a lifetime diagnosis of PTSD had significantly reduced earnings. Similarly, in a large-scale population study, PTSD diagnosis predicted greater work days lost, even after controlling for age, sex, and comorbidity.

Etiology

PTSD is unique among the anxiety disorders because a precipitating event is part of the diagnostic criteria. However, the specific reason for the persistence of symptoms in PTSD remains largely unknown. There are several theories that attempt to explain the development and maintenance of PTSD symptoms. Most empirically supported treatments are based on some variant of learning theory. First, learning theory (e.g., Mowrer's two-factor theory) proposes that initial symptoms develop due to classical conditioning (pairing of the trauma cues with a fear reaction) whereas the persistence of symptoms over time is due to operant conditioning (avoidance is reinforced through reduction of fear). Second, emotional processing theory holds that PTSD emerges due to the development of a fear network in memory that elicits escape and avoidance behavior. Mental fear structures include stimulus, responses, and meaning elements. Any information associated with the trauma is likely to activate the fear structure. The fear structure in people with PTSD is thought to include a particularly large number of stimulus elements; therefore, it is easily accessed. Attempts to avoid this activation result in the avoidance symptoms of PTSD. Third, social-cognitive theories focus on the content of cognitions within a social context. There is supporting research evidence for all three theoretical approaches.

Treatment

Currently, cognitive behavioral therapy (CBT) is the treatment of choice for chronic PTSD. CBT is not a single technique but rather a broad approach that includes a range of techniques. The goals of CBT are to reduce the intensity and frequency of distressing negative emotional reactions, modify erroneous cognitions, and promote functioning. CBT programs for PTSD include variants of exposure therapy, stress inoculation training (SIT), and cognitive therapy (CT). Each of these programs has been administered by itself or in combination with one another. A fourth treatment for PTSD that has received empirical support is eye movement desensitization and reprocessing (EMDR), a treatment that utilizes elements of exposure and cognitive restructuring but with the addition of therapist-directed rapid eye movements or other

bilateral stimuli. Two recent innovations in the treatment of PTSD are the application of imagery rehearsal therapy to PTSD-related nightmares and the use of technology, such as virtual reality technology and delivery of therapy via the Internet. As the research on these more recent treatments is relatively limited, they will not be discussed further in this article.

Exposure Therapy

As described previously, PTSD is characterized by the reexperiencing of the traumatic event and attempts to ward off the intrusive symptoms or avoid the trauma reminders, even when such trigger stimuli are not inherently dangerous. Given these two broad categories of feared stimuli (the traumatic memories and triggers that are reminders of the trauma), the core components of exposure programs for the disorder are (1) imaginal exposure, which involves revisiting the traumatic memory, repeatedly recounting it aloud, and processing the revisiting experience; and (2) in vivo exposure, which involves repeated confrontation with trauma-related situations and objects that evoke excessive anxiety but are not inherently dangerous. The goal of this treatment is to promote processing of the trauma memory and to reduce distress and avoidance elicited by the trauma reminders. Additionally, individuals with pronounced symptoms of emotional numbing and depression are encouraged to engage in pleasurable activities even if these activities do not elicit fear or anxiety but instead have dropped out of the person's repertoire due to loss of interest. The rationale for this latter component is similar to the use of behavioral activation strategies in the treatment of depression.

Exposure therapy programs that have been evaluated in RCT differ in the type of exposure techniques used, how they are implemented, and what other nonexposure techniques are utilized. For example, some researchers have relied exclusively on imaginal exposure, whereas others have relied exclusively on in vivo exposure. By contrast, the prolonged exposure (PE) program developed by Foa and colleagues and a similar program developed by Marks and colleagues utilized both imaginal and in vivo techniques. Exposure therapy programs also differ in the extent to which exposure techniques are the primary focus in therapy, such as the programs developed by Foa and colleagues and Marks and colleagues, or are substantially supplemented with other CBT techniques such as stress inoculation and CT procedures, such as the CBT program developed by Blanchard, Hickling, and colleagues. In some CBT programs, such as Resick's cognitive processing therapy program (discussed in greater detail later) and the Blanchard and Hickling program just mentioned, exposure to the trauma memory is implemented through narrative writing exercises.

Stress Inoculation Training

Veronen and Kilpatrick (1983) adopted Meichenbaum's (1974) SIT approach for the treatment of PTSD symptoms in female rape victims. As applied to PTSD, SIT includes education about trauma-related symptoms plus anxiety management techniques such as controlled breathing and relaxation training, cognitive restructuring, guided (task-enhancing) self-dialogue, assertiveness training, role playing, covert modeling, and thought stopping. Once the various techniques have been introduced, the

therapist and patient work together to select and implement the techniques in a flexible manner to address patient's current concerns or specific symptoms. As with exposure therapy, SIT programs vary from one another, with the most notable difference being that some programs include an exposure component whereas others do not. Although interest in the study of SIT for PTSD has diminished in recent years, one innovative use of SIT has been to target anger among veterans with chronic PTSD and significant anger problems.

Cognitive Therapy

CT for PTSD is derived from Beck's model of treatment for depression and its extension to anxiety, wherein the goal of therapy is to help patients identify trauma-related dysfunctional beliefs that influence emotional and behavioral responses to a situation. Once identified, patients are taught to evaluate the thoughts in a logical, evidence-based manner. Information that supports or refutes the belief is examined as are alternative ways of interpreting the problematic situation. The therapist helps patients to weigh the evidence and consider alternative interpretations before deciding whether the belief accurately reflects reality, and if not, to replace or modify it. CT programs differ in the length and number of sessions. Moreover, some CT programs include an exposure component, such as Resick's cognitive processing therapy and the CT program based on Ehlers and Clark's cognitive theory of PTSD, whereas other CT programs do not.

Eye Movement Desensitization and Reprogramming

In EMDR, the therapist asks the patient to generate images, thoughts, and feelings about the trauma, to evaluate their aversive qualities, and to make alternative cognitive appraisals of the trauma or their behavior during it. As the patient initially focuses on the distressing images and thoughts, and later focuses on the alternative cognition, the therapist elicits rapid, lateral alternating eye movements by instructing the patient to visually track the therapist's finger as it is moved back and forth across the patient's visual field. Originally, Shapiro regarded these eye movements as essential to the processing of the traumatic memory, but the importance of the eye movements has not gained empirical support. Some EMDR programs have replaced the eye movement components with other procedures (e.g., patient alternating finger tapping from the right to the left hand), claiming equivalent mechanisms underlying these various procedures; however, dismantling studies have not demonstrated that these movements affect symptom reduction, and well-designed treatment outcome research studies have found no advantage of EMDR over exposure therapy alone.

Efficacy/Effectiveness of Treatments

According to consensus panels such as the Institute of Medicine (IOM), the National Institute of Clinical Excellence (NICE), American Psychiatric Association, and International Society for Traumatic Stress Studies, the treatment of choice for chronic PTSD is exposure therapy or some other form of CBT. The IOM of the National Academies (2008) reviewed 53 psychotherapy and 37 pharmacotherapy RCTs in the treatment of PTSD and concluded that the evidence was sufficient to

conclude the efficacy of exposure therapies in treating patients with PTSD. However, they found that the evidence was inadequate to reach a conclusion regarding the efficacy of EMDR, cognitive restructuring, coping skills training, other therapies, and psychotherapies administered in a group format. The IOM committee also concluded that the evidence was inadequate to determine the efficacy of pharmacotherapy for PTSD. Similarly, the ISTSS guidelines stated that CBT (imaginal and in vivo exposure), CT, SIT, or CPT is recommended as first-line treatment for chronic PTSD. The [NICE \(2005\)](#) guidelines were similar, stating that drug treatments for PTSD should not be used as routine first-line treatment in preference to trauma-focused psychological therapy.

Overall, the data suggest that the various forms of CBT are effective in treating chronic PTSD with no major differences in outcome between treatments; however, exposure-based treatments have the largest amount of support to date.

Summary

The experience of a traumatic event in one's life appears to have become the rule rather than the exception. Studies show that as many as 80% of people report experiencing a traumatic event in their lifetime. After a trauma, most people report posttraumatic symptoms including reexperiencing, avoidance, and hyperarousal. However, these symptoms largely dissipate over the period of ~1 year. For a significant minority, these symptoms may persist and become chronic without some form of treatment. Thus, PTSD is seen as a failure of the natural recovery process. The evidence to date from all sources (consensus panel recommendations, meta-analyses, and RCTs) suggests that cognitive-behavioral interventions should be considered the treatments of choice for PTSD. Specific recommendations vary depending on the amount of time between the index trauma and the point of intervention. Immediately following a traumatic event, psychological debriefing of all exposed individuals is contraindicated. Rather, a watch-and-wait strategy is preferred. Most trauma survivors experience PTSD symptoms that improve with the passage of time. For those individuals in whom intervention is indicated prior to meeting criteria for chronic PTSD, brief CBT (B-CBT) should be considered. CBT should be considered the standard of care for patients with chronic PTSD. The CBT programs with the largest evidence base to date are the exposure-based treatments. Thus, the major thrust of evidence-based practice should be focused on connecting trauma survivors with CBT practitioners if they continue to experience PTSD symptoms after a period of 3 months.

See also: Anxiety and Fear; Anxiety Disorders; Cognitive Behavior Therapy; Evidence-Based Practice; Terrorism; Violence; War.

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- <http://www.ptsd.va.gov/> – National Center for PTSD.
- <http://www.ptsdforum.org/> – PTSD Forum.
- <http://www.nlm.nih.gov/medlineplus/posttraumaticstressdisorder.html> – PTSD information webpage created by the National Library of Medicine and the National Institutes of Health.
- <http://www.ptsdsupport.net/> – PTSD Support Services.
- <http://www.apa.org/topics/ptsd/index.aspx> – PTSD webpage on American Psychological Association website.
- <http://www.adaa.org/understanding-anxiety/posttraumatic-stress-disorder-ptsd> – PTSD webpage on Anxiety Disorders Association of America website.
- <http://www.nmha.org/go/ptsd> – PTSD webpage on Mental Health America website.
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Preference Judgments (Individuals)

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Glossary

Choice Act of deciding between alternatives by preferring one alternative over other alternatives.

Emotion Object-related affective state; relatively acute, intense, and momentary; grounded in arousal and cognitive appraisals.

Mood Affective state without specific object, relatively low in intensity and enduring.

Preference Difference in overall value associated with objects or alternatives; reflected in relative differences in ratings, rankings, or choice preferences between alternatives.

Preference reversal Change of preference as a function of the presentation of objects or alternatives.

Rational choice Norm that people prefer choice alternatives that maximize utility.

Subjective experience General term that includes a wide spectrum of different experiential phenomena such as mood, emotions, and processing fluency; can serve as heuristic, prime, can interact with other information, and can influence processing strategies.

Utility In decision-making, subjective evaluation of objective values.

Introduction

When do we prefer something over something else? Preference judgments are based on comparisons between objects. The term 'object' refers here to any kind of category that preferences are about (e.g., people, materials, ideas). The most straightforward indicators of preferences are choices between two alternatives. For example, a person may choose to drink a cup of café latte rather than a cup of cappuccino, indicating a preference for café latte over cappuccino. Besides choices, preferences can be reflected in relative evaluations of objects; café latte may be evaluated more positively than cappuccino. If people do not care about a comparison of objects, for example, when they do not drink caffeinated beverages, they are unlikely to prefer one object to another. Objects may be evaluated differently, for example, regarding the amount of milk that beverages contain, yet this evaluation may not constitute a preference. Only if a set of objects are relevant to the self, can we speak of preferences. Despite this specification, the preference concept is broad and preferences are omnipresent in many implicit and explicit judgments and in actions and decisions in everyday life.

Preferences are relative because they may change with the set of objects that is considered, that is, a preference for an object may not occur with the addition of a different object. In addition, perceptions of the overall value or suitability of objects may change, leading to different preferences. That is, the underlying value may vary between people, over time, or between contexts. Many of the potential variations of preferences indicate that preferences are inherently subjective in nature. Objective outcomes of alternatives cannot be equated with subjectively perceived outcomes (*utilities*). In a mathematical sense, negative values and positive values are equally important and both increase in a linear fashion; however, decision-making research has demonstrated that negative values loom larger than positive values, and that the relationship between objective and subjective values is curvilinear: convex for negative values and concave for positive values (see value function of prospect theory). Similarly, objective probabilities of outcomes are unequal to subjective probabilities. Subjective

probabilities are overestimated when likelihoods are generally small, they are underestimated when likelihoods are moderate, and outcomes are perceived as certain when likelihoods are very high (see probability function of prospect theory).

Psychological research has greatly contributed to the understanding of preference judgments. Besides considering the objective situation (e.g., decision problem, task), it is central to examine how people's preferences are affected by their interpretations of particular situations. To shed light on these interpretations, it matters, for example, which information is salient in the situation (e.g., how a problem is presented), how information is encoded and classified, whether a person processes the information automatically or deliberately, how a person is motivated, and how a person is affected by moods, emotions, and other subjective experiences. Explanations of psychological processes that affect preference judgments and decision-making have evolved based on comparing normative (i.e., rational) models of behavior to actual behavior. First, we will give a brief summary of some classic findings, and then we will consider some of the research that has evolved more recently.

How Rational Are Preference Judgments?

Historically important for research on preference judgments and decision-making is John von Neumann and Oskar Morgenstern's Expected Utility Theory. According to this normative theory, the maximization of control (probability of an outcome \times utility of an outcome) reflects rational behavior. Note that other concepts of rationality are possible (e.g., reasoned, nonemotional, logical); however, we will use this particular definition because it was central for the development of research on preferences. In order for behavior to qualify as 'rational,' it has to be consistent with a set of axioms. Unfortunately, human behavior, neither in everyday life nor in the lab, seems to live up to these ideals; in fact, preference judgments often violate these axioms of rationality. The Allais Paradox, the Ellsberg Paradox, preference reversals, and risky

choice-framing effects are important examples of such violations. These phenomena have in common that preferences vary as a function of ‘irrelevant’ changes in the way situations are presented.

Allais Paradox and Ellsberg Paradox

Maurice Allais described a situation that demonstrates how human preferences are incompatible with one of the rationality axioms. The cancellation axiom states that preferences between two options should depend only on the difference between these options – not on a common factor. Allais gave the following example:

Situation 1: Would you prefer Alternative A or Alternative B?

Alternative A: Certain win of 100 mio.

Alternative B: 10% chance of winning 500 mio.
89% chance of winning 100 mio.
1% chance of winning nothing.

Situation 2: Would you prefer Alternative C or Alternative D?

Alternative C: 11% chance of winning 100 mio.
89% chance of winning nothing.

Alternative D: 10% chance of winning 500 mio.
90% chance of winning nothing.

Most people would prefer Alternative A to Alternative B, demonstrating a preference for the *certain* alternative although the expected value (probability \times value) is much higher for Alternative B. To be more specific, Alternative B has a higher expected value of 39 million than Alternative A; yet, people usually prefer Alternative A. Note that Alternative D has a 39 million higher expected value than Alternative C. Now most people would prefer the alternative with the higher expected value. They do so because the amount that could be won is much larger in Alternative D and the probability of winning this amount is only a little less than the probability in Alternative C. We can conclude that even though the objective differences (in expected value) between the alternatives are identical in each situation, preferences for the alternatives vary. To illustrate how these preferences violate the cancellation axiom, consider a lottery with 100 balls in an urn (see also [Baron, 2008](#)).

	Ball numbers		
	1	2–11	12–100 = 100 balls
<i>Situation 1</i>			
Alternative A:	100 mio	100 mio	100 mio
Alternative B:	0 mio	500 mio	100 mio
<i>Situation 2</i>			
Alternative C:	100 mio	100 mio	0 mio
Alternative D:	0 mio	500 mio	0 mio

A person makes a choice between one of two alternatives. Then a ball is drawn, which determines the payoff. The first column (Ball 1) is identical in Situations 1 and 2, and the second column (Balls 2–11) is also identical in both situations,

thus not providing any basis for a change in preferences. The third column (Balls 12–100), however, is not identical between the two situations. Here, the difference between Situations 1 and 2 is a constant (100 million), that is, the alternatives in Situation 1 consist of identical higher payoffs than the alternatives in Situation 2. Strikingly, this difference *between* the situations leads to different preferences *within* each situation. As according to the cancellation axiom the constant must not influence preferences in each situation, we can conclude that people’s preferences violate this axiom.

A similarly famous problem is known as the *Ellsberg Paradox*, introduced by Daniel Ellsberg, and like the *Allais Paradox*, it demonstrates a violation of the cancellation axiom. Imagine an urn that contains 30 red balls and a total of 60 black and yellow balls, the ratio of the black and yellow balls being unknown. One ball would be drawn at random from the urn, and its color would determine the payoff (\$0 vs. \$100). People are then asked to choose between alternatives: betting on color red (Alternative A) versus betting on color black (Alternative B).

<i>Situation 1</i>	Number of balls		
	30	60	
	Red	Black	Yellow
Alternative A:	\$100	\$0	\$0
Alternative B:	\$0	\$100	\$0

In Situation 1, people usually prefer Alternative A to Alternative B. There is no evidence suggesting that Alternative A would be objectively better than Alternative B. People know that 30 of 90 balls are red, but the number of black (yellow) balls can be somewhere between 0 and 60. The preference for Alternative A thus allows people to *avoid uncertainty*. Now consider Situation 2, where people would either bet on a red or yellow ball (Alternative C) or they would bet on a black or yellow ball (Alternative D).

<i>Situation 2</i>	Number of balls		
	30	60	
	Red	Black	Yellow
Alternative C:	\$100	\$0	\$100
Alternative D:	\$0	\$100	\$100

In Situation 2, people usually prefer Alternative D to Alternative C. Again, people prefer the alternative with the *least uncertainty*. The crucial difference between these two urn situations is the addition of \$100 for the yellow ball. However, between the alternatives in both situations, the yellow ball is always worth the same: either \$0 (Situation 1) or \$100 (Situation 2). Switching preferences between alternatives from one to the other situation thus violates the cancellation axiom. Below, we will examine two violations of a different axiom.

Preference Reversals

According to the invariance axiom, a preference between alternatives must not change as a function of the mere presentation when the objective characteristics of the alternatives remain unchanged. Recall that preferences can be measured in very different ways; for example, they can be measured as choices between objects or as independent evaluations of objects. Interestingly, research demonstrates that this variation between these formats affects people’s preferences. For example,

Sarah Lichtenstein and Paul Slovic demonstrated that people frequently change their preferences as a function of whether they choose between gambles (choices) or whether they indicate prices for which they were willing to sell each gamble (bids). In their study, gambles included a probability with which an outcome would materialize (e.g., a 33% chance of winning \$16 with a 67% chance of losing \$2; a 99% chance of winning \$4 with a 1% chance of losing \$1). When making choices between gambles, people usually focus on the probabilities, but when they make bids, they usually focus on pay-offs. Specifically, people prefer high-payoff gambles (e.g., 33% chance to win \$16 with 67% chance to lose \$2) over high-probability gambles (e.g., 99% chance to win \$4 with 1% chance to lose \$1) when selling them separately, but they prefer high-probability gambles over high-payoff gambles when they make choices between these gambles.

Framing Effect

The risky choice-framing effect is another important phenomenon that demonstrates the violation of the invariance axiom. Amos Tversky and Daniel Kahneman demonstrated the framing effect with the – now classic – *Asian disease* scenario:

Imagine that the United States is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

In the gain frame condition, participants read:

If Program A is adopted, 200 people will be saved.
If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved.
Which of the two programs would you favor?

In the loss frame condition, participants read:

If Program A is adopted, 400 people will die.
If Program B is adopted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die.
Which of the two programs would you favor?

In both decision frame conditions (gain vs. loss), participants had a choice between a secure alternative and a risky alternative, each having the same expected value (probability \times value). In the gain frame condition, the majority of participants preferred the secure alternative to the risky alternative. In the loss frame condition, the majority of participants preferred the risky alternative to the secure alternative. This framing effect is typically explained with prospect theory's value function, which describes the deviations of subjective values (utilities) from objective values (see section 'Introduction'). The framing of the decision scenario shifts the reference point either upward or downward, so that people interpret the original values as either negative (resulting from an upward shift) or positive (resulting from a downward shift). Preferences as a function of decision frames thus reflect the difference in subjective values that people assign to the secure and the risky alternatives based on the characteristics of the value function for gains (concave) or for losses (convex). In the example, a gain of 200 has a higher subjective

value than 1/3 of 600, and a loss of 2/3 of 600 has a higher subjective value (i.e., is less negative) than a sure loss of 400. Much research has investigated cognitive and motivational variables that moderate the framing effect. Would people not 'see' the similarities between the alternatives if they thought in-depth about the problem? There is no straightforward answer to this question, but it can be concluded that in-depth processing alone does not help to overcome the impact of decision frames – in fact, some research findings suggest that deep processing increases framing effects.

These classic examples demonstrate how people's preferences are influenced by changes in the presentation format of the task, and how these variations conflict with axioms of rational behavior. This research inspired other researchers who examined more closely the particular processes that underlie preference judgments. Interesting research questions emerged, regarding the impact of particular subjective experiences, personality factors, and processing styles on preference judgments.

How Do Subjective Experiences Influence Preferences?

The term subjective experience refers to a wide spectrum of different experiential phenomena such as processing fluency, mood, and emotions. They can serve as a heuristic or a prime, they can interact with other information, and they can influence the processing strategies that people use.

Processing Fluency

According to Tversky and Kahneman's *availability heuristic*, the ease with which information is retrieved from memory affects people's judgments. Schwarz and colleagues further refined this research by demonstrating that the subjective experience of *ease of retrieval* influences judgments independent of the amount of retrieved information about an object. This type of processing fluency effect has been shown for a large variety of judgments, including political judgments and product preferences. The ease-of-retrieval heuristics focus on subjective experiences of recalling information from memory; another type of fluency effect focuses on *perceptual fluency*, that is, the fluency with which incoming information is encoded. It has been shown that perceptual fluency increases evaluations of objects that are encoded, which seems to parallel the widely documented effects of repeated exposure (mere exposure) of objects. Interestingly, it has been demonstrated that perceptual fluency increases positive (but not negative) affect, which in turn can influence preference judgment.

Moods

A mood state is an affective state that does not require a specific object, and it has a relatively low intensity and long duration. Due to this low intensity, mood has a 'background character,' which causes it to influence people without their awareness.

Mood-congruency effects

When people are in a positive (vs. negative) mood, their evaluation of an object is likely to be more positive (vs. negative). These mood-congruency effects can be explained in different

ways. Mood may function as *prime* by increasing the accessibility of mood-congruent thoughts. That is, positive (vs. negative) mood leads to positive (vs. negative) thoughts about objects, which in turn affects judgments of the objects. Alternatively, mood states can serve as *information*. That is, people may misattribute their mood state to the object in question when making judgments or decisions, as if the object caused the positive or negative response in them. This 'How do I feel about it?' heuristic is especially likely to occur when the judgment target is complex (e.g., life satisfaction), when the judgment is made under time pressure, and when mood is not attributed to target-irrelevant causes. Research suggests that both processing styles contribute to mood-congruency effects, but that the priming process accounts for the effects when processing effort is high and that the heuristic process accounts for the effects when processing effort is low. No matter which underlying process accounts for mood-congruency effects; note that they are common phenomena, often reflected in preference judgments and decisions in the lab and in everyday life.

Mood and processing strategies

Much research suggests that positive mood enhances the use of general knowledge structures (e.g., schemata, heuristics) and global information processing, whereas negative mood enhances the processing of more detailed, specific information. These results are consistent with recent versions of the mood as information approach. Positive mood signals a benign environment, in which the use of general knowledge structures is adaptive. However, as negative mood signals a problematic environment, it is more adaptive to consider the specifics of the situation. Given that processing strategies influence which information people focus or rely on when forming preference judgments (e.g., heuristic cue, quality of arguments), it is essential to recognize these mood effects on processing strategies.

Mood as goal versus mood as resource

A number of studies suggest that people manage their moods such that they process information that preserves positive mood and repairs negative mood. As a consequence of this hedonic principle, people are drawn to information that is positive in nature and avoid information that is negative. Further, people are reluctant to elaborate on unfamiliar information because this information could affect their mood state negatively. However, mood seems to have different effects in self-evaluative situations (e.g., receiving feedback). Negative information about the self is often unpleasant, but self-improvement depends largely on receiving such information. That is, negative self-relevant information often poses a self-control dilemma between the long-term learning benefits and short-term affective costs of processing this information. Research suggests that in these situations, positive mood facilitates preferences for the negative self-relevant information, thus serving long-term learning goals rather than hedonic mood management goals.

Risks and benefits

Especially in risky situations, mood affects people's preferences as it influences whether people focus on *risks* or *benefits*.

In general, positive mood increases perceived benefits and decreases perceived risks, especially under time pressure. Therefore, people in a positive mood are more likely to prefer risky options to safe options. Furthermore, according to the 'risk-as-feelings hypothesis,' affective responses to risky situations sometimes have a bigger impact on preferences than on cognitive evaluations.

Emotions

Compared to moods, emotions are more intense and relatively momentary. Furthermore, emotions are object-focused, as they reflect one's feelings about something or someone. They can differ, for example, in their valence (positive vs. negative) and in their activation/arousal level (low vs. high; the circumplex model of affect). For example, anger and sadness are both negative emotions, but anger has a higher arousal than sadness. Additionally, emotions can be distinguished by their expressions (e.g., facial expressions), physiology, action tendencies, actions, motivational goals, thoughts, and feelings.

Positive and negative emotions

Experienced emotions with the same valence can affect preferences differently, that is, effects of emotions depend greatly on the specific characteristics of the emotions even if they have the same valence. For example, the broaden-and-build theory makes specific predictions for different positive emotions: joy induces a preference to play, interest induces a preference to explore, and contentment induces a preference to savor and integrate. Similarly, there are also differences among negative emotions. For example, sad people prefer pleasurable stimuli, whereas anxious people become more attentive to information.

In addition to the influence of experienced emotions, *expected emotions* (i.e., predictions about the emotional consequences of future events) influence preferences as well. Expected positive emotions induce a preference for decisions that are expected to maximize happiness. Furthermore, according to 'regret theory,' if people expect the possibility of experiencing regret in the future, then they prefer less-risky options (i.e., risk aversion). For example, a person may fear to leave a partner in exchange for a very attractive alternative, especially when the alternative is unsure of committing to a relationship. There is a bulk of research on the influence of expected negative emotions on morality. According to the social intuitionist approach, moral emotions (e.g., disgust, shame, anger, contempt, embarrassment) can function as moral intuitions as they guide judgments of 'right' and 'wrong.' If someone expects the experience of a moral emotion (e.g., one expects to feel guilty if one does not help a friend in need), then this emotion promotes the preference for moral behavior (e.g., helping a friend in need).

Emotion activation levels

As described above, emotions with a different valence can have different effects on preferences. For example, anxiety leads to higher risk aversion and excitement leads to more risk seeking. In addition to valence, the arousal level (i.e., the degree of activation) can also influence preferences. The degree of activation may determine preference by leading people to develop stronger preferences for stimuli that are congruent with their respective level of activation. For example, sad people have a

higher preference for a quieter advertised resort, whereas angry people prefer a more actively framed resort. It can be concluded that both the valence and arousal of specific emotions have an influence on preferences, but it is also the combination of both that needs to be considered.

How Do Personality Factors Affect Preferences?

The extent to which objects or alternatives are preferred is partially dependent on psychological dispositions and personality factors, that is, variations in preferences between people. Such chronic tendencies may affect the value associated with option features, the motivations that underlie preferences, and the way in which information is processed. Many dispositional factors have been identified that affect preferences, some of which are briefly highlighted below.

Generally, people are more risk averse than risk seeking; however, the *extent* to which people are risk averse and risk seeking varies across individuals. For example, *sensation seekers* are typically more risk seeking and less risk averse. Furthermore, people may be risk seekers for risks holding a pleasant form of stimulation (e.g., gambling), independent of whether people are generally risk averse in the context of achieving instrumental outcomes. In addition, people differ in the extent to which affect and sensations associated with a product impact their preferences, reflecting a hedonic consumption style. Research on people's chronic *regulatory focus* makes an important distinction regarding the tendency to which people are motivated to prevent pain (a prevention focus) and to approach pleasure (a promotion focus). As a consequence of the different regulatory orientations, people high on prevention focus tend to prefer safe and stable options, whereas people high on promotion focus prefer alternatives that imply change. For example, having a promotion focus may make a person more inclined to try out different coffees whereas a prevention focus would make him stick to his favorite café latte.

People differ in the extent to which they have a *rational processing style* and also in the extent to which they have an *experiential processing style*, with the former being associated with less nonoptimal decisions and the latter leading to greater reliance on heuristics in making decisions. The rational processing style is related to another common distinction, namely the *need for cognition*. It corresponds to people's chronic tendency to enjoy and subsequently engage in effortful information processing. People high in need for cognition have been found to be less susceptible to decision-making biases and their attitudes are more resistant to change.

How Do Deliberation and (Un)Conscious Thought Affect Preferences?

Will more deliberation contribute to preferences that in turn serve the maximization of utility (i.e., rational behavior)? Dual-process theories assume that preferences and decisions are influenced by either one set of processes or another set of processes. One system is based on automatic, unconscious, and relatively effortless processes, whereas the other system is based on deliberate, conscious, and effortful processes.

Traditionally, deviations from rationality have been attributed to the first system, whereas the second system seemed to facilitate more rational preference judgments and behavior. Recent research, however, suggests that it is less straightforward. Many findings suggest that more deliberate thought can *reduce* the quality of preference judgments and choices, and unconscious thought often leads to better preference judgments and choices. A typical example is the situation when someone is selecting an apartment after having seen several alternatives. The research findings suggest that unconscious thoughts (e.g., when being distracted) regarding the characteristics of apartments lead to better decisions than conscious deliberations of the pros and cons. Taken together, it seems essential to consider additional variables (e.g., task characteristics) in order to conclude which of these processes are beneficial in particular situations.

How Well Do People Predict Their Preferences?

If people were able to predict future preferences, then such predictions would help to maximize experienced utility. However, it seems that predicting future preferences is generally not easy. For example, research by Daniel Kahneman and Jackie Snell suggests that people have little insight into the change of their tastes. That is, predictions of future tastes and actual preferences seem to be uncorrelated. One reason for this low correlation is based on people's belief that their taste changes more frequently than it actually does. The imprecision of predicting one's preferences is in part based on people's lack of insights into the psychological processes that underlie preferences, the limited insight into future affective states, and the temporal distance of future events as psychological distance to events changes our perceptions of these events. That is, people's understanding of their preferences is generally limited; in addition, it is difficult for people to account for the differences between momentary preferences and future preferences. However, understanding the processes that change preferences may provide tools that increase the precision of these forecasts.

How Are Preferences Assessed?

The concept of preferences has been widely used in the domains of economics, economic psychology, decision-making, and social psychology. Consequently, a variety of different implicit and explicit assessments of preferences have been used, each with certain benefits. Three common types of explicit preference measurements are *choice*, *ranking*, and *rating*.

The Oxford Dictionary defines *choice* as the act of choosing between two or more possibilities, and its scientific investigation involves the psychological processes involved in this selection. Choice measures are used when researchers wish to know what option is ultimately preferred, and is broadly adopted across the domains of decision-making research. For example, a person may ultimately choose a café latte rather than a cappuccino, indicating her preference for café latte over cappuccino. Famous uses of choice measures include the *Asian disease problem* and *preference reversal* scenarios. Choice measurements result in dichotomous (nominal) variables and can

hence be analyzed using nonparametric tests such as the *chi-square test* where frequency of choices is compared across groups, using a *binominal test* where choice frequencies are compared to a base level usually derived from a normative prediction, *logistic regression analysis* in which a dichotomous choice is predicted by a single or variety of variables, or *latent class analysis* in which the change of dichotomous category membership can be modeled. Benefits of choices as proxy of preferences include that choices can reveal distinct preferences even when options seem objectively interchangeable and choices are intuitively close to real decision processes in everyday life.

A *rank* reflects the relative position in a hierarchy; with respect to preferences, ranking involves the organization of several options according to hierarchically ordered preferences. *Ranking* preferences may be used when the relative preferences of the options are of key interest, as is often the case in marketing or political psychology. For example, a person may rank café latte as most preferable, followed by cappuccino and then espresso. Because rank measurements result in ordinal variables, common analyses may involve *rank-biserial correlation* in which the association between ranked categories with some interval or ratio level variable is evaluated, *multinomial logistic regression* in which category membership is estimated as function of predictor variables, or *latent class analysis* in which the change of dichotomous category membership can be modeled. Benefits of ranking measures are that direct information is attained concerning the *relative* preferences for each of the options.

Assessing preferences by means of *rating* – a classification based on a comparative assessment of quality, standard, or performance – involves asking people to rate each of the available options according to one or more evaluative dimensions, for example, using Likert-like scales. For example, on a scale from 1 (*very low*) to 7 (*very high*), a person may rate café latte as 6 and cappuccino as 5, indicating that she likes cappuccino less than café latte. Scale ratings are among the most common measurements of preferences in specific and attitudes in general across the domains of the quantitative social sciences. Preference ratings are typically analyzed separately for each rated option or based on computed relative differences between options. Rating measurements are commonly treated as interval variables and common analysis of ratings hence includes *Pearson correlation* in which the association between two ratings is evaluated, *analysis of variance* in which ratings are compared across groups, the *paired-sample t-test* in which different ratings of the same person are compared to each other, *linear regression analysis* in which ratings are predicted by one or several other variables, *structural equation modeling* in which complex relations between the variables are evaluated, or *hierarchical models* in which the ratings embedded in a hierarchical sample structure are evaluated. Benefits of preference ratings are that the measure captures a relatively high amount of information for each option and allows for further computation of relative preferences, preference ranking, and the use of advanced statistical methods with relative ease.

In recent years, psychological research has developed a variety of *implicit* attitude measures. Some of these measures are comparative measures, indicating relative preferences for one object over another object. Perhaps the most common test of implicit preferences or attitudes is the *implicit association test* in which a categorization task is used in order to evaluate the

relative preferences of one object compared to another object. Very briefly stated, people are requested to categorize an object, and response reaction times are compared across trials when the object was presented together with a concept representing either extreme of an evaluative attribute dimension (e.g., the word ‘pleasant’ and the word ‘unpleasant’). Due to prior categorization tasks, the attribute elicits a consistent categorization decision or an inconsistent categorization decision. Relative reaction time differences are subsequently assumed to partially represent implicit evaluative judgments. Results of implicit measures often involve preferences indicated by reaction times expressing the speed of associating a target with an attribute (e.g., positive vs. negative attributes). Implicit measures hold the benefit that they may capture information that is often not assessed by explicit measures, but interpretation of the cognitive underlying processes can be complex.

Summary

Preference judgments are omnipresent, constantly affecting human behavior. Preferences vary over time, between situations, and between people. Research on preference judgments is largely examined in basic and applied psychological research and in economic research. Preferences can be assessed by using very different indicators: choices, rankings, ratings, and implicit preferences. Historically important is research suggesting that variations of preference judgments are incompatible with axioms of rationality because it initiated research questions on the psychological processes that can explain these discrepancies. The presentation of tasks and decision problems, as well as cognitive, affective, and motivational factors, influences how preferences are set and how they affect human behavior. In essence, the investigation of preference judgments relates to the core investigations of human thought and behavior, and a deeper understanding of the sources and consequences of preference judgments may contribute to increases in utilities of human action and subjective well-being.

See also: Decision Making (Individuals); Judgment; Risk-Taking Behavior (Young Male Syndrome).

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Relevant Websites

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Prejudice, Discrimination, and Stereotypes (Racial Bias)

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Glossary

Between-category stereotyping A perspective on stereotyping, which assumes that all group-relevant stereotypes can be applied equally to all group members.

Discrimination The unfair or unjustified treatment of others based on their group membership.

Implicit racial bias A negative evaluation of racial groups that we carry without awareness or conscious thought.

Prejudice A generally negative evaluation of a group and its members.

Racial bias A negative evaluation of racial groups.

Racism Discrimination or prejudice based on a person's race.

Stereotypes Beliefs or overgeneralizations about the characteristics of a group and its members. Stereotypes can be either positive or negative.

Within-category stereotyping A perspective on stereotyping that recognizes that not all group members are equivalent; thus, group-consistent and inconsistent stereotypes can equally apply to group members.

Overview

The term 'stereotype' first came into use during the late 1700s to refer to a printing process, in which metal plates were used to create reproductions of images and prints. It was not until the early 1920s that the term became common parlance when journalist Walter Lippmann likened stereotypes to 'pictures in the head,' or mental reproductions of reality. From there, the term evolved into its current usage – overgeneralizations about social groups. The term prejudice, on the other hand, was not widely used in the research literature until the early 1930s when Katz and Braly linked the negative aspect of stereotypes to prejudice. In the ensuing years, researchers and lay public alike have frequently used the term stereotype erroneously to represent prejudice. It is therefore important to understand the distinction between these terms. Stereotypes refer to both positive and negative beliefs or overgeneralizations about the attributes of a group and its members. For instance, stereotypes about Blacks include both negative (aggressive) and positive (athletic) attributes. Prejudice represents solely the negative aspect of stereotypes. In this case, the association of Blacks with aggressiveness would be considered prejudice. Prejudice is also captured by the negative emotional reactions one feels toward a group, such as fear toward Blacks, in the absence of any concrete beliefs or thoughts about that group.

Early conceptions of stereotypes and prejudice were that they are rigid. More modern conceptions allow for more fluidity, in that they may ebb and flow as the information about a social group is encountered. For instance, one may harbor strong prejudices about a group that may fade as tensions with that group lessen or as the number of positive encounters with that group increases. Moreover, situational influences may also alter the expression or endorsement of a stereotype. That is, the presence of less stereotypic, or even counter-stereotypic, individuals may call to mind a different set of stereotypes than does the presence of more stereotypic individuals. Hence, exposure to these counter-stereotypic individuals will, over time, weaken the stereotype, particularly if exposure occurs across multiple situations with multiple individuals. Stereotypes are not fundamentally bad or even wrong in many cases; they are part

of a normal cognitive process that helps preserve scarce cognitive resources. They are part of the act of categorizing the world around us. It is how an individual acts upon those stereotypes that makes them 'wrong.'

Although prejudice, stereotyping, and discrimination often go hand in hand, there is also the possibility to have one without the others. For instance, knowing the stereotypes about a group is one thing, but to endorse or 'feel' those stereotypes is another thing. Moreover, to act upon those stereotypes in a discriminatory manner takes the knowledge and negativity we feel toward a group even further. Of course, the action is driven by the stereotype or prejudice directed toward that group; hence, discrimination generally does not occur without prejudice, but stereotypes and prejudice can occur in the absence of discriminatory behavior. In this sense, then, discriminatory behavior may separate the racists from those who simply know the stereotypes, but do not necessarily endorse the stereotypes. This defines the distinction between personal and cultural stereotypes, which is one of the primary foci of modern-day research on stereotyping and prejudice. These processes may also work at an unconscious or implicit level such that the individual may be unaware of acting in a discriminatory manner or applying stereotypes when judging others. In fact, the current conception of stereotypes, prejudice, and discrimination is that they are partly automatic and partly controlled and that how one responds to them is due to triggers in the social situation and to the beliefs and knowledge one has about the social group in question.

A Brief History of Research on Stereotypes, Prejudice, and Discrimination

The focus on prejudice as a distinct research area first emerged in the early 1900s and was based upon prevailing race theories that attempted to prove White superiority over other racial groups. These efforts resulted in the rather simplistic assertion that Whites were superior intellectually, and that prejudice was a natural response to inferior races. This perspective changed in the 1930s and 1940s with progress in civil rights and growing

concerns about anti-Semitism resulting from the disbelief surrounding the Holocaust and the atrocities committed by Nazi Germany. Indeed, the events of World War II sparked the development of theories focused on demonstrating that a certain type of person harbors these prejudicial beliefs. In other words, prejudice was inextricably linked to the individual. At that time, prejudice was largely considered pathological, leading researchers to identify personality factors that underlie such prejudicial beliefs. Adorno's conception of an authoritarian personality was borne of these pursuits. The authoritarian personality was considered to be emblematic of rigid thinking and strict obedience to authority and adherence to social rules and hierarchies.

Although the notion of an authoritarian personality has fallen out of research favor, vestiges of this personality-based theory of prejudice still remain in more current work, such as work on social dominance orientation (SDO) and system justification theory (SJT). For instance, SDO holds that people who view the social world hierarchically are more likely than others to hold prejudices toward low-status groups. This is especially true of people who want their own group to dominate and be superior to other groups. Many studies on SDO have linked it to anti-Black and anti-Arab prejudice, sexism, nationalism, opposition to gay rights, and other attitudes concerning social hierarchies. Similar to SDO is the theory of system justification, which proposes that people not only want to hold favorable attitudes about their group but they also want to hold favorable attitudes about the general social order and their group's place in it. A consequence of SJT is that the existing social order is preferred, and that modifications to this order are criticized and not encouraged, particularly by those higher in the social hierarchy. Interestingly, research on system justification has shown somewhat surprisingly that those lower in the social hierarchy often support, to some degree, the existing hierarchy, often at the cost to themselves and their group.

The 1950s through early 1980s saw a cognitive revolution in which the dominant perspective was that stereotypes are cognitive-saving devices – they were considered mental shortcuts used to make quick judgments or evaluations of social groups. To this end, researchers began looking 'inside the head' rather than relying on behaviors or responses that could be open to social desirability concerns or other forms of biased responding. This approach thus used procedures that inferred what a person was thinking rather than directly asking about a person's thoughts (we provide details of the more popular procedures below). Dominant theories of stereotyping and prejudice quickly followed suit. And by the late 1980s, researchers such as Patricia Devine proposed that there is an unconscious or automatic aspect of the stereotyping process that is based on a person's cultural knowledge (as opposed to their personal beliefs) about a particular social group. What then differentiated those who were biased or not was the overt or explicit expression of these beliefs. Accordingly, current research on stereotyping and prejudice has been focused on the dissociation between one's implicit beliefs and the explicit expression of these beliefs. The issue, however, is how then can we tell whether a person's response is due to cultural knowledge or personal beliefs, particularly if the response is made at the implicit level where such cultural knowledge is so

ingrained that it is automatic. In other words, if we know that overt expressions of prejudice are taboo in modern society and we know that implicit expressions are prone to cultural knowledge, then how can we know what a person's true beliefs are about racial groups? To date, no clear, universally accepted answer has been found.

New Perspectives and Current Trends for Research on Prejudice and Stereotypes

Traditional theories in stereotyping have proposed that stereotyping is a purely category-based phenomenon. For example, all females are caring and all males are analytical. In other words, people's perceptions of social groups or categories are so homogenous that a member of a given category is, in essence, perceived as the same as any other member of that category. Researchers more recently have branched out to explore how subtle variations in physical cues that occur between individuals within a category also impact stereotyping. For example, Emily and Aly are female; however, their voices vary in the degree to which they sound feminine within their gender category: Emily's voice is the most feminine while Aly's voice is the least feminine. This variation in within-category 'vocal femininity' itself elicits different gender stereotypic inferences such that speakers with more feminine-sounding voices are more strongly associated with female than male stereotypes just as speakers with less feminine-sounding voices are more strongly associated with male than female stereotypes, regardless of the speaker's gender. Within-category cue-based, as compared to the more traditional between-category-based, biases may better capture the modern state of stereotyping and prejudice.

Over the past half-century or so, strong proscriptive norms have evolved that discourage overt category-based stereotyping and prejudice. On the surface, this seemed effective as numerous studies reported significant reductions in overt expressions of prejudiced attitudes. However, it was soon discovered that more subtle measures focusing on implicit or automatic evaluations and beliefs suggested no discernable reduction in stereotyping and prejudice. In other words, modern-day biased attitudes are just better hidden and/or reflect a more nuanced perception of groups and their members. What makes within-category cue-based stereotyping distinct from other similar subtle measures is the fact that it does not have to rely on perceivers being unaware of the true purpose of the task. People are usually unaware of its effects but even when perceivers are explicitly told that the cues can bias their judgments, they are unable to control their impact. This is because, unlike category-based judgments, which are easier to control because they are a matter of curbing dichotomous decisions (e.g., male vs. female, Black vs. White), within-category cue-based judgments rely on the more fine-grained variation in physical cues. For example, there are many acoustic cues that constitute vocal femininity such as pitch, resonance, variability in pitch, and intensity just to name a few. Moreover, the experience of within-category variation in vocal femininity comes not only from the variation in one of these myriad of cues but also the variation in the constellation of all of these cues. Consequently, curbing within-category cue-based stereotyping would

require monitoring the influence coming from the variation in all of these cues at once, which as one can imagine is probably not feasible.

Within-category cue-based stereotyping has some surprising real-world implications. In modern-day criminal sentencing for instance, there no longer seems to be a relationship between racial category (i.e., Black vs. White) of offenders and sentence length as was the case in the past. However, both Blacks and Whites, within their respective racial category, vary in the extent to which they have Afrocentric cues and this within-category variation in Afrocentric cues strongly impacts sentence length. Specifically, the stronger the within-category Afrocentric cues of the offender, the longer the offender's sentence, regardless of the offender's racial category. This finding seems to hint at a process that involves the relationship between category and within-category cue-based stereotyping. Both category and within-category cues are capable of affecting stereotypic inferences but the former effect seems to be easier to control than the latter. Given societal pressures over the years to curb category-based stereotyping and prejudice, people may have become well practiced at suppressing such biases. Ironically, suppressing category-based biases seems to lead perceivers to rely more on within-category cues as a basis for biased perceptions or even discriminatory behavior. Moreover, researchers have shown that the more perceivers suppress using category, the more they use within-category variation in cues as a basis for biased judgments. In sum, norms that censor people from acknowledging any differences between social categories for the purposes of reducing biased judgments may ironically defeat the purpose because it may make people more susceptible to biases based on cues that are related to a given category, but vary more subtly within the category.

The Effects of Prejudice and Stereotypes on the Self

Gordon Allport wrote in the *Nature of Prejudice* that "one's reputation, whether false or true, cannot be hammered, hammered, hammered, into one's head without doing something to one's character" (p. 142). It is perhaps fair to say that most researchers assume that Allport is talking about beliefs about a person's character that may have an adverse influence on the person's well-being and behavior. This assertion is based on Merton's concept of a *self-fulfilling prophecy* in the sense that what Allport may have had in mind was a process by which the target of prejudice internalizes the negative views of his or her group through the 'hammering' exposure of these negative beliefs and then 'self-fulfills' those internalized beliefs as one would self-fulfill any type of expectancy.

Although this view might be a quite reasonable interpretation of how stereotypes and prejudice can affect a person, it may not be the complete story. Indeed, another possible way in which the negative perceptions of a person's group might come to affect their behavior and psychology is based on situational influences. Aside from whatever effects negative stereotypes may have through its internalization as a self-expectancy, it may also have effects that stem directly from it posing an acute situational pressure on a person's life and psyche. For example, Allport writes that the mere prospect of being seen and treated stereotypically may cause a state of "obsessive

concern" in a person about how he or she will be perceived. For that matter, a Black person, as Allport writes, cannot "enter a store, restaurant, movie, hotel, amusement park, school, train, plane, or boat, to say nothing of a white person's home, without wondering uneasily whether he will suffer insult and humiliation" (p. 140). This leads to a state of uncertainty whereby members of any negatively stereotyped group struggle with the uncertainty of whether other's beliefs about them is due to their race or to them personally. This notion is captured by the theory of attributional ambiguity proposed by Crocker and Major and the theory of stereotype threat proposed by Steele and his colleagues. We now turn to a description of these two self-related theories of stereotypes and prejudice.

Attributional Ambiguity

In many cases, it is clear when members of certain racial groups are treated in a discriminatory or prejudicial manner, but in other cases there may be significant uncertainty about the cause of one's treatment. To be sure, everyone at one time or another feels some amount of uncertainty about how he or she is treated, but this uncertainty may be particularly pernicious for members of stigmatized racial groups, because of how their group is viewed by society. In this case, negative outcomes may be attributionally ambiguous because such outcomes could just as easily be due to poor performance, lack of ability, or other shortcomings as it could be due to the discrimination or prejudice directed toward them as a function of their racial group membership. Hence, when in such an ambiguous situation, members of devalued racial groups (e.g., Blacks) can choose to attribute negative feedback to prejudice and discrimination, thus preserving their self-esteem, something that members of other racial groups (e.g., Whites) are unable to do. The downside of this approach is that members of devalued racial groups may also lose out on the potential benefit of the feedback to improve the self.

Stereotype Threat

In 1995, Claude Steele and Joshua Aronson proposed that the awareness of culturally held stereotypes about one's group may have a profoundly negative effect on how one behaves. This notion of stereotype threat has become one of the most widely applied explanations for the academic disadvantage of many social groups, in particular Blacks in most realms of higher education and women in math-related fields. According to the theory, the concern about confirming or being judged in terms of the negative stereotype (belief in the stereotype's validity is not necessary) usurps cognitive resources and drains emotional reserves for those individuals targeted by the negative stereotypes. Hence, it is the situation and the cues in that situation which 'tell' the perceiver how members of his or her group will be judged and thus poses a burden that undermines their performance. An interesting and critical piece of this theory is that it is the very individuals who care the most, in that they have the skills, desires, and motivation to succeed, who are the ones most afflicted by stereotype threat. Another troubling downstream effect is that repeated experiences with stereotype threat may lead to misidentification with the

academic domain. In this case, the constant threat in the air surrounds targeted group members because they are too burdensome to bear and thus pushes them out of the domain as a way to minimize and/or avoid such threats. Stereotype threat is not unique to academics, as it can apply to any group to which negative ability-based stereotypes apply, making it a powerful explanation for the many group-based differences that exist in society today.

Methods to Study Prejudice and Stereotypes

Historically, the study of prejudice and stereotypes was done at the explicit level, often using self-report or survey-type measures. In this case, respondents were simply asked to indicate how they felt or what they thought about certain social groups. The most common self-report method up until two decades ago was the adjective checklist, first used in the early 1930s. In this method, participants were given a list of trait adjectives and asked to indicate how typical each adjective is of a particular group (e.g., Blacks). The stereotypes of each group were then defined by the set of adjectives most commonly assigned to that group.

This method has served as the model for the majority of stereotype studies conducted until more recently when issues surrounding social desirability concerns led researchers away from such explicit self-report measures. To be sure, social desirability may have been a concern from the start, but only somewhat recently have researchers attempted to minimize or take into account this concern when devising methods to examine stereotypes and prejudice. Nevertheless, it could be argued that the adjective checklist served researchers well in the past because the then social climate was one where endorsement of stereotype groups was more widely accepted. Consequently, participants may have been more willing to express and endorse prejudice and discriminatory behavior toward members of out-groups. It should be noted, however, that the endorsements of the traits usually matched those often portrayed via popular media, raising the issue of whether these endorsements truly reflected an individual's personal beliefs or simply his or her knowledge of cultural stereotypes. The past two decades have seen a rise in popularity among implicit measures of stereotypes and prejudice. The assumption is that implicit measures are capable of assessing a person's true beliefs because they are believed to capture stereotypes or prejudice occurring at a more automatic and uncontrollable level. The rise in interest and use of implicit techniques has largely been commensurate with the advance in technology of the desktop computers. With this advancement, researchers had a powerful way to study those cognitive processes that were once hidden from view. Below, we describe some of the more popular methods for examining stereotypes and prejudice, such as the lexical decision task (LDT), the implicit association task (IAT), and the more general associative type tasks, such as word-fragment completions.

Lexical Decision Tasks

The basic procedure for an LDT is for respondents to be primed with a stimulus (words or pictures usually below conscious

recognition) and then presented with a mixture of letter strings that form a word or a nonword. The respondent's task is to indicate, as fast as possible, usually with a button press, whether the letter string is a word or not. The prime is anything that represents the category of interest. Some examples are a common Black name or even the category label – Black. A selection of the presented words would be stereotypic of the category (e.g., aggressive, athletic). The idea is that the stronger the respondents' stereotypic beliefs about a category, the faster they will respond to a stereotype as compared to other words and nonwords. For instance, when subliminally primed with the category label 'Black,' respondents who hold strong stereotypic beliefs may show faster response to the word 'violent' than to the word 'intelligent' or to nonword letter strings 'thrud.' The logic behind this is that the category label activates knowledge structures that then guide the subsequent lexical decision. Furthermore, if the responses are faster to negative (e.g., violent), relative to positive stereotypic words (e.g., athletic), then it is inferred that respondents are prejudiced toward that category.

Implicit Association Test

The IAT is arguably the most popular technique to measure implicit bias. At the most basic level, the IAT assesses the strength of an association between a target concept and an attribute dimension by measuring the speed at which respondents can press one of the two response keys that have been assigned dual meanings. For example, consider a race IAT. The respondent's task is first to categorize stimuli (e.g., words or pictures) representative of a particular racial group (i.e., Black or White) by pressing one of two response keys. Here, the response keys would be labeled Black or White. Next, the respondent would categorize stimuli that are considered stereotypic or counter-stereotypic (i.e., violent or intelligent) of the racial group in question. Here, the response keys would be labeled 'good' or 'bad.' After this training phase, both types of stimuli pairings are presented at the top corners of the computer screen while a stereotypic word is presented in the center. The respondent's task is to determine, by pressing a predetermined response key, which of the two stimuli pairings (e.g., Black/bad or White/good) is consistent with the presented stereotypic word (e.g., violent). According to the logic of the IAT, faster response should occur when the stimuli pairings are consistent (e.g., Black/bad) with the stereotypic word (violent), compared to when it is inconsistent (e.g., Black/good) because violent is both bad and stereotypic of Blacks. Racial bias is assessed by subtracting the mean response time for the consistent pairings from the inconsistent pairings. A positive value (i.e., faster response times to the consistent, relative to the inconsistent pairings) would indicate bias toward the racial group in question.

It should be noted that the IAT is not without controversy. For instance, many critics of the IAT argue that it does not measure personal beliefs but rather measures knowledge of the cultural stereotypes and hence is prone to the same concerns that plague more explicit measures of racial bias. Also, no clear relationship between a respondent's IAT score and his or her prejudicial or discriminatory behavior toward the racial group in question has been found, calling into question the IAT's predictive power.

The Bona Fide Pipeline

This task was developed in response to the concerns that many of the measures used to assess racial bias did so by priming the stereotype rather than merely the racial group; it was unclear if responses were driven by personal or cultural stereotypes. To get around this issue, the bona fide pipeline (BFP) used faces to activate the race and then measured responses to trait adjectives that were presented immediately after the face prime. The logic of this task is that if respondents are prejudiced toward the racial group reflected by the face, then they should show speeded responses to negative trait adjectives and slower responses to the positive trait adjectives after face primes are reflective of the racial group in question. Thus, by using faces instead of stereotypic traits, it should be possible to demonstrate that faster response was due to personal stereotypes about the racial group, since stereotype content is not confounded with activation of the racial group.

First-Person Shooter

This task is a first-person shooter videogame that presents a series of young men set against realistic backgrounds, who are either armed or unarmed. This task is thus used to investigate whether decisions to 'shoot' a potentially hostile (i.e., armed) target are influenced by that target's race. Participants are instructed to shoot any target who is armed and not to shoot any target who is unarmed. Half of the targets are Black, and half are White. The basic finding is that participants shoot an armed target more quickly and more often when that target is Black, rather than White. Furthermore, participants decide not to shoot an unarmed target more quickly and more often when the target is White, rather than Black. In essence, participants appear to process stereotype-consistent targets (armed Blacks and unarmed Whites) more easily than counter-stereotypic targets (unarmed Blacks and armed Whites). Evidence of racial bias is assessed via the speed of responding as well as by response errors. A variation of this task is the weapon misidentification procedure in which respondents are asked to indicate as quickly as possible whether an object flashed immediately after a Black or White face prime is a weapon or a tool. Racial bias is again assessed via the speed of responding as well as by response errors.

Word-Fragment Completions

Although this task does not rely on speeded responses to assess racial bias, it is nevertheless implicit in the sense that respondents may not be aware of how their responses reflect their bias. For instance, respondents who are in an experimental setting where they have just been exposed to Black and White faces and then are asked, in a second unrelated task, to complete word fragments may be unaware that completing the word fragment, U N, with G U N instead of S U N or F U N, could be used as an indication that they associate Blacks with violence. Again, based on how a person responds – completing word fragments with more stereotypic words, or with more *negative* stereotypic words – researchers can infer a person's level of racial bias.

Reducing Prejudice

Alongside the work dedicated to understanding the experiences of being a target of prejudice and discrimination, there is a large body of work focusing on ways to reduce these adverse effects of stereotypes on one's thoughts, feelings, and behavior. In this section, we deal with some of the more prominent approaches to reducing prejudice and discrimination.

Contact Hypothesis

This method for reducing prejudice is predicated on the notion that racial bias occurs because the different races did not have adequate contact to break down the misconceptions about each other. Essentially, it is an attempt to eliminate the 'fear of the unknown.' Interestingly, this approach was borne approximately at the time that the civil rights movement in America was occurring. Hence, it reinforced the notion that eliminating the separate but equal policy would also tear down racial barriers. Although an attractive hypothesis, merely increasing contact between races did not reduce racial bias. If anything, it reinforced racial biases because the contact was often forced, overly formal, unsanctioned, etc. All was not lost, however, because there were many instances when contact did lead to racial harmony, provided that the contact occurred under certain crucial conditions. These conditions are described below.

Opportunities for contact

When contact is more accessible and varied, when people get to meet many people from the other group in a variety of settings, then this can breed understanding and reduce bias. Thus, frequency and variety of contact reduces conflict especially when the contact is made in many different settings.

Equal status

In general, if the contact occurs between individuals of equal status, regardless of whether they are of high or low status within their group, the contact can reduce racial bias. Of course, it also depends on whether the status is context-dependent. It is not about relative status but whether in that situation the individuals are of equal status.

Casual versus intimate contact

Less structured, less formal, and more intimate contact is shown to be better at reducing racial bias. Intimate contact is defined as one where individuals have more opportunities for self-disclosure, to have a chance to get to know the other person. This intimacy creates bonds and promotes reciprocity in sharing, and by doing so racial bias is diminished.

Institutional support

When the contact is supported or endorsed by a respected institution, contact is more effective. Similar to institutional support is the notion that endorsement from a legitimate authority will also be effective.

Cooperative and competitive factors

This of course relates to one of the more basic of factors that leads to reduction in racial bias via contact. Working together builds mutual trust and respect provided that the cooperative

behaviors lead to a successful outcome (see below about jigsaw classroom). Competition, on the other hand, fuels differences and a goal-oriented style in which the other person is viewed as an 'enemy'; thus, the contact will breed racial bias rather than reduce it.

Personality factors

Depending on one's personality (see the description of the authoritarian personality described above), contact may be more or less effective. For instance, if one is insecure then contact will cause one to lose a scapegoat, a victim to blame when things go wrong. Thus, contact will not lessen a person's racial bias no matter how cooperative, intimate, and equal the contact is. Indeed, this aspect of the contact hypothesis fits well with the conception of an authoritarian personality as it too allows for a form of rigid categorical thinking as one of the underlying forces behind a person's prejudice.

Jigsaw Classroom

One of the most successful methods for reducing racial bias is the jigsaw classroom technique. The jigsaw classroom is a cooperative learning strategy akin to a jigsaw puzzle in that each student plays a critical part for the completion and comprehension of the final product. If each student's part is essential, then by extension each student is essential. Note that just as in the contact hypothesis, the cooperative behaviors need to lead to a successful final outcome, otherwise finger-pointing and scapegoating may occur.

Let us use an example to illustrate the basic idea of the jigsaw puzzle method. Say a jigsaw group is assigned to work on a project about conservation and the environment. Aly is responsible for researching the different ways to recycle, Chris is responsible for researching water conservation, Emily is responsible for researching ways to limit air pollution, Brad is responsible for researching alternative energy, and Meghan is responsible for researching the impact of global warming. The situation is specifically structured so that the only access any student has to the other pieces of the project is by listening closely to each student's report. Thus, if Aly does not like Meghan, or if she thinks Chris is a nerd and mocks him, she will not do well on the assignments. Hence, by relying on the students in the jigsaw group, all students begin to view the other group members as valuable, important, and critical to the group's success, which then translates into general positive perception of the students and their respective social group.

Personal Experience of Discrimination

This is an interactive and experiential approach to prejudice reduction, in which typically nonstereotyped individuals are exposed to prejudice and discrimination. The point is that these individuals experience the very same unpleasant treatment that members of negatively stereotyped groups undergo everyday. And through this experience, they should become more empathetic and understanding of the problems faced by the stereotyped groups. The most well-known example of this approach is depicted in the 1970s film, *The Eye of the Storm*. This film details Jane Elliot's

exercise in which students were treated differently based on the color of their eyes. For one day, the brown-eyed children ruled the classroom and on the next day the blue-eyed children had their turn. The ensuing prejudice and discrimination based on eye color highlighted just how quickly we can turn on each other when provided with a clear social hierarchy in which we find ourselves on top (similar exercises have been used in sensitivity training for public officials such as police officers or prison guards).

Multicultural Ideology

Rather than ignoring differences and promoting what is often called a color-blind ideology (also known as egalitarianism), a multicultural ideology recognizes and embraces the differences between groups. The color-blind ideology is best represented by the notion that America is a melting pot, in which all racial differences are melted into one America. The multicultural ideology is best represented by the notion that America is a salad bowl, in which all racial differences are mixed together. The basic logic underlying the notion of multiculturalism is that it promotes the respect of others and embraces the differences between groups as a way to enhance group harmony. While the color-blind ideology shares the basic tenet of group respect, its downside is that it ignores the differences between groups and these differences may be an important aspect of how one sees himself or herself.

See also: Academic Achievement; Attitude Change; Attitude Formation; Self-Fulfilling Prophecy; Social Cognition.

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Premenstrual Syndrome (PMS)

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Glossary

Anxiety sensitivity The tendency to focus on and catastrophize about the meaning of physical sensations that is linked to increased premenstrual distress and the development of panic disorder.

Biopsychosocial perspective A theoretical model that includes physical, psychological, and cultural factors in the development of diseases and disorders.

Cognitive-behavior therapy A psychotherapy approach that focuses on identifying and challenging negative thinking and schemas in psychological disorders.

Late luteal phase Refers to the 5–7 days prior to the onset of menstrual bleeding (menses).

Menstrual reactivity hypothesis A dual vulnerability model including psychological, social, and physical explanations for premenstrual exacerbation of symptoms.

Panicogenic task Refers to the administration of substances that increase the symptoms (e.g., intense fear, increase in sympathetic nervous system symptoms) associated with a panic attack.

Rumination The tendency to focus on the experience and causes of thoughts, feelings, and sensations associated with dysphoric mood that may lead to increases in depression and anxiety.

Social construction perspectives A model that focuses on social processes that influence the discourse surrounding psychological diagnoses.

In Western and non-Western cultures, fluctuations in menstrual symptoms have been noted for over 2500 years. Since its introduction to the medical nomenclature in the 1930s, the topic of premenstrual syndrome (PMS) has consistently elicited controversy, and differences in methodologies and small sample sizes have led to inconsistent findings. Research on PMS relied heavily on retrospective reports, which are problematic due to bias and overestimation of symptoms. Furthermore, definitions of PMS have not been consistent in the past, and generalization across studies is limited. However, PMS is an important topic of study, particularly when considering prevalence rates, impact, and societal views relating to PMS. The recent focus on using more standardized criteria for PMS has added greatly to the research literature, and the state of contemporary PMS research represents significant advances in our understanding of this condition.

Symptoms, Epidemiology, and Classification

Symptoms of PMS

In general terms, PMS refers to a variety of emotional, physical, and behavioral symptoms that occur after ovulation during the late luteal phase (days 21–28 of the menstrual cycle) and end with the onset of menstrual bleeding (day 1). Although over a hundred symptoms have been associated with the premenstrual phase, the following listed symptoms are the most commonly reported. Emotional symptoms may include anxiety, depression, anger, irritability, and mood swings. Physical symptoms can include breast tenderness, water retention, headache, fatigue, acne, joint pain, and gastrointestinal distress. Behavioral symptoms typically include appetite change, sleep disturbance, crying, social withdrawal, agitation, forgetfulness, and poor concentration.

Epidemiology

Approximately 80% of reproductive age women may report some of these premenstrual symptoms, and most of these symptoms occur at a mild level that does not interfere with daily functioning. Approximately 25% of women may experience PMS, which occurs when symptoms are experienced at a moderate-to-severe level and daily functioning becomes impaired. The International Classification of Diseases (ICD-10) categorizes PMS as premenstrual tension syndrome. More severe symptoms with significant impairment occur in ~2–9% of women and lead to a diagnosis of premenstrual dysphoric disorder (PMDD). Approximately 50% of women may seek medical treatment for their PMS symptoms. Although PMS can be diagnosed in menstruating women of any age who have ovulatory cycles, it is typically diagnosed in women in their thirties and forties.

To be diagnosed with PMS, symptoms must be cyclical and not represent the exacerbation of another disorder. Women who suffer from the following psychological disorders may also experience premenstrual exacerbation of their symptoms: depression, bulimia, binge eating disorder, and panic disorder. Also, women with the following health conditions may experience an increase in symptoms or severity: epilepsy, fibromyalgia, asthma, multiple sclerosis, rheumatoid arthritis, and migraines. Women with PMS are more likely to report excessive menstrual flow, abdominal pain, and bleeding during other phases of the menstrual cycle. Current smoking and passive smoke exposure are associated with anxiety, cravings, water retention, breast pain, back pain, and headache in PMS. Increased alcohol consumption and less physical activity are related to more severe premenstrual symptoms. Increased consumption of caffeine is also linked to more severe premenstrual symptoms.

Classification Issues

Unfortunately, there is a continuing lack of consensus regarding definitions, assessment, and treatment of PMS. However, current diagnostic criteria indicate that in order to qualify for a diagnosis of PMS, symptoms must meet the following criteria: occur in the 5 days prior to menstrual bleeding onset and increase by at least 30% from other times in the menstrual cycle, cease by day 4 of menstrual bleeding, and symptoms must remit during the remainder of the menstrual cycle. More strict criteria require that both physical and emotional symptoms must be present during the 5 days before menses. Another issue to consider is the consistency of PMS symptoms over time. In this regard, prospective, daily recording of symptoms for two consecutive menstrual cycles is considered necessary to establish symptom patterns and the symptoms must be distressing as well as cause impairment in normal, daily functioning.

Biopsychosocial Perspective of PMS

The most current view of PMS derives from a biopsychosocial perspective. A biopsychosocial approach posits that biological factors, psychological factors, and social factors interact to play a significant role in human functioning. Although the menstrual cycle *itself* is not considered a disease or illness, the biopsychosocial perspective can be used as a model to better understand the vast array of conditions that may affect a woman's menstrual experience. Menstruation is a normal and integral biological process for women. However, psychological factors may also play a role in the report, interpretation, and experience of menstrual symptoms. Indeed, research suggests that symptom severity is quite variable and may be more related to psychological factors than biological ones. Social factors, such as age, racial/cultural diversity, and religion, may also play a role. Health care and mental health care providers, thus, need to consider the interaction of these factors in PMS in order to provide the best assessment and treatment for patients. In this article, PMS and PMDD are presented from a biopsychosocial perspective.

Biological Aspects of PMS

Current research indicates that ovulation and ovulation-related processes play a central role in the development of premenstrual symptoms. Support for this model comes from research findings that PMS symptoms disappear when ovulation does not occur. Although the exact mechanisms are not clear, reproductive hormones are thought to play a significant role in symptom fluctuation across the menstrual cycle. During the late luteal phase, progesterone metabolites typically decrease and estradiol levels increase. Interestingly, however, reproductive hormone levels in women diagnosed with PMS tend to fall in the normal range. At present, there are no hypotheses concerning what would account for sensitivity in some women to normal changes in hormone levels.

Progesterone and estrogen are also hypothesized to modulate neurotransmitters (e.g., serotonin, GABA, dopamine, norepinephrine) that are typically associated with changes in

mood and behavior. Decreased levels of serotonin are linked to sleep disruption, appetite change, fatigue, and depressed mood which are associated with PMS. Research has found that women with PMS have lower levels of serotonin during the last 10 days of the menstrual cycle. One hypothesis is that serotonin deficiency could enhance sensitivity to progesterone changes. Support for serotonin as a contributory factor in PMS is bolstered by the efficacy of selective serotonin reuptake inhibitors (SSRIs) in the alleviation of some PMS symptoms. However, it is not known why some women would be more sensitive to these changes. Allopregnanolone, a metabolite of progesterone, has also been linked to PMS. However, low and high levels of it have been found in women with PMS.

Genetic contributions have also been examined in women with PMS. For example, if a woman's mother had PMS, her chances of having PMS were ~70%. If one monozygotic twin had PMS, the other twin had a 90% chance of having PMS. Thus, the role of genetics in PMS deserves more study. Cyclic changes in stress hormone levels (e.g., adrenocorticotrophic hormone, cortisol) have also been found in some women with PMS. This type of research represents an emerging area of interest that needs more study.

Another promising area of interest relates to cyclic changes in the immune system. During the premenstrual phase, cell-mediated immunity is suppressed. This cyclic change is thought to have evolutionary adaptation for the developing embryo. However, there has been no research conducted to test this interesting model of PMS and no hypothesis about why some women would experience symptoms and others don't.

Other potential biological causes of PMS posited are differences in prolactin and aldosterone levels (i.e., hormones that affect fluid balance), thyroid imbalances, glucose metabolism, and insulin imbalances. However, there is no confirming evidence for causality for these hormones in the development and maintenance of PMS symptoms. Potential nutritional differences (e.g., vitamin B₆, calcium, magnesium, caffeine) have also been mentioned as possible contributions to PMS symptoms. Again, there is no evidence to support these nutritional causes when women with PMS are compared to controls. In addition, there is no explanation of why some women might be more affected by these biological changes during the menstrual cycle than others. Given the lack of support for purely biological causes of PMS, researchers have also investigated the role that psychological factors or trait variables may play in PMS experience.

Psychological Aspects of PMS

For women with PMS, quality of life may be significantly impacted. Women with PMS may experience impairment in social relations, personal relationships, hobbies, and household activities. PMS may also result in work disruption, decreased productivity, and increased use of health care. Women with PMS report more daily stress, life stress, perceived stress, and physiological stress than controls. Similarly, women with PMS report experiencing more traumatic events than controls. However, these findings are correlational and do not imply causation.

There are several psychological disorders that are comorbid with PMS. In fact, ~50% of women with PMS report a history

of anxiety or mood disorders. Given that women with PMS often respond to a panicogenic task similar to women with panic disorder, it has been suggested that PMS and panic disorder may share a similar pathophysiological mechanism.

According to the menstrual reactivity hypothesis, some women report more severe premenstrual symptoms based on an array of influences: accurate symptom reporting, biases that relate to past premenstrual experience, cultural attitudes and beliefs, and a predisposition to focus on internal bodily sensations and catastrophize about their meaning. This model has been used to explain premenstrual distress differences between women varying in levels of anxiety as well as to women with asthma. In this dual vulnerability model, some women may experience physiological sensations or symptoms and then mood symptoms may develop in response to those symptoms. As yet, this model has not been tested in PMS.

Sociocultural Factors in PMS

In any discussion of PMS, the potential for the medicalization of the menstrual cycle needs to be addressed. It is clear that the menstrual cycle *itself* should not be considered a problem, disease, or illness that needs to be solved or treated. However, it is also clear that some women will experience moderate-to-severe premenstrual symptoms that may impair their normal functioning. Does receiving a diagnosis of PMS perpetuate a myth that women are emotionally unstable and captives to raging hormones? Does this diagnosis reinforce traditional beliefs about femininity? For these reasons, sociocultural factors are particularly important to consider.

There are inconsistent findings regarding the effect of education, employment, and marital status on PMS prevalence. One study found that work-related stress was a significant predictor of premenstrual symptom severity. Another study found that younger age, high levels of stress, and less education were positively associated with emotional symptoms of PMS. As women age, anxiety, mood changes, and back pain associated with PMS decrease. Women with low BMI tend to report less premenstrual symptoms (possibly due to lower levels of estrogen). Relatedly, women who are obese are three times more likely to suffer from PMS. Preliminary research also suggests that Caucasian women, smokers, and younger women are more at risk for PMS. Clearly, more research on age and weight as they relate to PMS experience is needed.

Although PMS is thought to be found worldwide, culture plays a role in the reporting of symptoms. In one large survey, women of Asian descent reported fewer premenstrual symptoms than Caucasian, African American, and Hispanic women. Anxiety and mood changes were reported less by African American and Japanese women. There are, however, too few studies to be able to definitively say that race and culture may play a significant role in PMS experience.

Assessment and Treatment of PMS

Assessment

Assessment of PMS requires daily monitoring of symptoms for two consecutive menstrual cycles. Given that women may vary in the types of symptoms they experience, symptoms from

the emotional, behavioral, and physical realms should be included. Women should be able to indicate the severity of the symptoms as well as the level of impairment of the daily symptoms in all life domains. In addition, other medical conditions that have similar symptom presentations, such as menopause, hyperthyroidism, hypothyroidism, and polycystic ovary syndrome, should be ruled out.

Recent assessment measures have led to more consistencies in how premenstrual symptoms are measured. For example, the premenstrual symptoms screening tool (PSST), a short survey of 14 items, maps onto current diagnostic criteria for PMDD, and can also be used to screen for PMS symptoms. The daily record of severity of problems (DRSP), a prospective monitoring tool, is completed daily for two consecutive menstrual cycles to obtain a diagnosis of PMS or PMDD. The premenstrual symptoms impact survey (PMSIS), a brief survey of six items, can discriminate between women with clinically significant PMS and controls. With the continued use of such measures in larger samples, study results will be more reliable and generalizable to other populations.

Treatment

Typically, women who seek treatment for their PMS symptoms are prescribed medication. Although there is no support for the progesterone deficiency model of PMS, progesterone-based therapies are commonly prescribed. SSRIs (e.g., fluoxetine, sertraline, paroxetine) are also frequently used throughout the menstrual cycle or just during the premenstrual phase (e.g., luteal phase dosing) with demonstrated efficacy compared to placebo. SSRIs may help reduce depression, anxiety, irritability, and fatigue associated with PMS. However, the long-term efficacy of using SSRIs has not been demonstrated for PMS and ~40% of women with PMS do not have reduction in symptoms.

Another treatment involves the suppression of ovulation and/or menstruation (e.g., GnRH analogs, Danazol, transdermal estradiol patches). However, the long-term use of such medications may include bone loss, menopausal symptoms (e.g., hot flashes, irritability), and cardiac difficulties. Oral contraceptives (OCs) may also be used to suppress ovulation. Research has shown that continuous use of OCs may result in reductions of headaches, fatigue, and water retention.

Dietary changes are often suggested for women with PMS such as reducing salt intake, chocolate, caffeine, nicotine, and alcohol. Eating frequent meals high in complex carbohydrates may help reduce binges and cravings. Intake of vitamin B₆, calcium, magnesium, and vitamin E is also recommended. Moderate aerobic exercise may also help manage PMS symptoms. Stress management techniques may also be helpful in reducing stress associated with work, school, and relationships. Nonsteroidal anti-inflammatory drugs (NSAIDs) may help some women with PMS in reducing muscle tension and headaches. Yoga, acupuncture, relaxation, and social support are also recommended but have no empirical support or controlled trials.

Compared to a wait-list control group, women with PMS who received cognitive-behavioral therapy (CBT) reported a reduction in the negative effects of symptoms and these results were maintained over time. However, the majority of CBT for

PMS studies were not controlled trials and CBT has not demonstrated greater efficacy compared to SSRIs. More research is necessary to determine the mechanisms and which women with PMS might benefit from this type of treatment.

PMDD Diagnosis, Epidemiology, and Quality of Life Impact

Diagnosis of PMDD

Premenstrual dysphoric disorder (PMDD) is a severe form of premenstrual distress characterized by significant increases in physical and affective symptoms during the premenstrual phase of the menstrual cycle. These symptoms are serious enough to cause clinically significant distress and interfere with functioning (e.g., in work, school, home, daily activities, and/or social relationships). Symptoms of PMDD include depressed mood, anxiety, anger/irritability, mood swings, loss of interest, difficulty in concentrating, lack of energy, appetite changes or cravings, sleep disturbance, feeling overwhelmed or out of control, and physical symptoms (e.g., bloating, breast tenderness, weight gain). In women with PMDD, these symptoms are present during the premenstrual phase, improve within the first few days of the onset of menstruation, and remit during the remainder of the menstrual cycle. In other words, PMDD is characterized by dramatic emotional, physical, and behavioral changes that occur cyclically and are restricted to the premenstrual phase. Thus, PMDD is a separate diagnostic entity, rather than a premenstrual exacerbation of another disorder, such as depression.

Epidemiology

PMDD is estimated to impact ~2–9% of women in the United States. Similar prevalence rates have been found in several European, African, and Asian countries. However, no research has examined potential differences between racial and ethnic groups in the United States in terms of prevalence rates, symptom expression, or correlates.

Regarding onset of PMDD, symptoms typically emerge during the mid- to late twenties and follow a chronic course if left untreated. In women with PMDD, symptoms tend to worsen over time but discontinue during interruptions of the ovulatory cycle (i.e., menopause, pregnancy, and ovariectomy). Lifetime comorbidity rates for PMDD are high (30–70%), particularly with other mood disorders. PMDD may put women at risk for later depression, including perimenopausal and postpartum depression. Conversely, mood or anxiety disorders may put women at risk for later development of PMDD.

Quality of Life Impact

Women with PMDD experience significant impairment in quality of life. PMDD is associated with decreased social and parental functioning, as well as occupational performance. Some women with PMDD also report cognitive difficulties (e.g., attention, concentration), although research findings in this area are mixed. PMDD is also related to health-related quality of life impairment in both physical and mental health

domains. Women with PMDD report health-related quality of life burden comparable to individuals with other chronic physical (e.g., arthritis) and mental (e.g., depression) disorders. Although individuals with PMDD are most impaired during the premenstrual phase, they are more impaired in several areas of functioning during other menstrual cycle phases compared to women not diagnosed with PMDD. Overall, it is clear that PMDD has a major impact on the lives of women diagnosed with this disorder.

Biopsychosocial Perspective of PMDD

Biological Aspects

Most research on the etiology of PMDD has focused on biological explanations. However, research on biological models for PMDD has produced mixed findings. The majority of research has investigated the potential role of gonadal hormones. Support comes from evidence that symptoms are not present during interruptions of the ovarian cycle, and research suggesting that oral contraceptives may be an effective treatment. Symptoms may be related to the declining levels of ovarian steroid hormones during the premenstrual phase of the menstrual cycle. Estrogen and progesterone are elevated during the luteal phase, and then drop dramatically in the late luteal (premenstrual) phase. Estrogen is linked to mood through its influence on the serotonin system. Fluctuations in estrogen may also impact the secretion of corticotrophin releasing hormone (CRH), of which decreased levels have been associated with depression. There is some initial research suggesting that women with PMDD may have higher levels of estrogen during the follicular phase, and that PMDD symptoms may vary as levels of estrogen change. However, research has not confirmed relationships between estrogen levels and PMDD, and research does not support a relationship between progesterone levels and PMDD.

Hormone imbalance, rather than fluctuations, may be related to PMDD. For example, a hormonal ratio imbalance between estrogen and progesterone has been implicated. In particular, when estrogen levels are high in relation to progesterone, this may be related to PMDD. In addition, it has been suggested that the pattern of secretion of hormones in women with PMDD may be abnormal. However, some studies have found that levels of ovarian hormones are normal in women with PMDD, and studies have not found differences in hormone levels in women with PMDD compared to controls. Thus, evidence regarding the role of hormones in PMDD is mixed at best.

Neurotransmitters have also been studied relating to the etiology of PMDD. Decreased levels of GABA have been associated with depression and anxiety; therefore, it has been suggested that women with PMDD may have low levels of GABA during the premenstrual phase. Serotonin has also been studied in relation to PMDD, due to its links with other mood disorders. Endogenous opiate withdrawal during the premenstrual phase may be associated with fatigue, depression, and pain sensitivity. However, research on the role of neurotransmitters in PMDD has produced inconsistent findings, and many studies lack a comparison control group. At present, there is no confirmed relationship between neurotransmitter deficiencies and PMDD.

In sum, biological explanations for PMDD have produced mixed findings. However, given that symptoms coincide with physiological changes, it is important to continue to research these factors. Research that investigates biological factors in relation to psychological and social factors may be particularly valuable in understanding this complex disorder. It is likely that PMDD is multiply determined by a combination of biological, behavioral, and cognitive factors such that attempts to assign primacy to any one of them could be misguided. In other syndromes such as panic disorder, it is now clear that unfamiliar bodily sensations stemming from normal physiological variations can be misinterpreted in ways that amplify the original concern needlessly. A similar formulation has been applied to some chronic pain syndromes. The development of negative expectations, together with the operation of conditioning processes, can create a feedback pattern that escalates manageable discomfort into seemingly unendurable distress. In the context of panic disorder, that formulation has proven to be extremely helpful in clarifying etiology and focusing effective treatment regimens that have been demonstrated to have substantial empirical support.

Psychological Aspects of PMDD

Limited research has investigated psychological factors that may play a role in the development of PMDD. Psychoanalytic explanations have focused on the 'meaning' of the symptoms for PMDD. For example, premenstrual symptoms could be interpreted as repressed hostility toward males, who are more favored in society. Another view suggests that premenstrual mood symptoms are caused by a woman's grief over failure to conceive. These explanations are refuted by the pattern of symptom onset and remittance in PMDD, since symptoms actually decrease at the onset of menstruation.

The state of the empirical literature on psychological factors related to the etiology of PMDD is severely lacking at present. However, as research has demonstrated in PMS, the role of beliefs, expectations, and interpretations of symptoms may be influential in PMDD (e.g., menstrual reactivity hypothesis). Research on psychological factors involved in PMS has resulted in two important findings that may shed light on our understanding of PMDD: (1) Women with PMS may respond to emotional changes in a manner that is maladaptive (e.g., rumination, self-blame), and (2) Women with PMS may focus inward on physiological sensations and view these as catastrophic, thus increasing these symptoms (e.g., anxiety sensitivity). Therefore, it is possible that the manner in which women with PMDD respond to their symptoms is related to increased distress during the premenstrual phase. That is, biological changes alone do not account for PMDD per se, but rather women's responses to physiological and emotional changes that result from the menstrual cycle may be related to the experience of PMDD. Given that research on biological factors involved in the etiology of PMDD has yielded mixed findings, incorporating psychological and social factors is likely to provide a more complete explanation of this disorder.

Another line of research has examined potential shared etiologies between PMDD and other psychological disorders. Although PMDD involves symptoms of depression, it also shares similarities with anxiety disorders. Interestingly, irritability and

anxiety are actually reported more often in women with PMDD than sadness or loss of interest. Research in this area has resulted in criticism of the classification of PMDD as a mood disorder. For example, women with PMDD respond more strongly to panicogenic challenges than women with depression, and women with PMDD and panic disorder seem to share underlying etiological factors, such as anxiety sensitivity. Given these findings, it has been suggested that PMDD is particularly similar to panic disorder. Furthermore, there are high rates of comorbidity between PMDD and other psychological disorders, such as anxiety and depression. It is possible that shared vulnerabilities exist between PMDD and these other diagnoses that may make women more susceptible to developing comorbid disorders.

Sociocultural Factors in PMDD

Social constructionist perspectives contend that diagnostic categories emerge out of social processes. As such, psychological disorders are social, not natural, categories. In other words, the etiology of PMDD lies with society rather than individuals. Within this framework, feminist critics have raised concerns over the diagnosis of PMDD. In particular, a diagnosis such as PMDD may serve to subjugate women. Labels such as PMS and PMDD may reinforce women's lower class standing. Furthermore, this classification system can be seen as medicalizing women's sexuality. Labeling women's premenstrual symptoms as a disorder may validate the ideas that there is something 'wrong' with women's bodies, and thus underemphasize social and cultural influences on attitudes and beliefs about menstruation. For example, what girls are taught about menstruation and societal views tend to reinforce is that menstruation is painful, debilitating, and something to be embarrassed about, rather than emphasizing that menstruation is healthy and natural. These views may lead to negative attitudes toward menstruation, which could in turn contribute to premenstrual distress. For example, the menstrual reactivity hypothesis suggests that women may respond to cultural stereotypes regarding the menstrual cycle in addition to actual symptoms. Social constructionist and feminist critics have also pointed out the large financial stake in the PMDD diagnosis, particularly through pharmaceutical sales.

Assessment and Treatment of PMDD

Assessment of PMDD

PMDD is currently listed in the *Diagnostic and Statistical Manual of Mental Disorders* (APA [DSM-IV-TR], 2000) in the appendix as a set of criteria provided for further study. PMDD is diagnosed as a Mood Disorder Not Otherwise Specified. There has been debate over the classification of PMDD, including the number of symptoms required for diagnosis, as well as the location of PMDD in the manual. The state of the classification of PMDD for the updated version of the diagnostic manual (DSM-V) is unknown at present.

According to current diagnostic criteria, PMDD involves five moderate-to-severe symptoms, of which at least one is primarily affective in nature (i.e., depression, anxiety, irritability, loss of interest). Of the ten symptoms listed, only one

involves physical symptoms (e.g., bloating, aches). Symptoms must also cause significant interference in work, school, or social activities/relationships. Additionally, symptoms must not be premenstrual exacerbation of another disorder.

Diagnosis of PMDD is made using prospective ratings of symptoms for two consecutive menstrual cycles. This is typically done using a daily rating form (e.g., DRSP) on which women report the severity of each symptom. Prospective rating is particularly important considering the presence of a significant recall bias for premenstrual symptoms. Many women who retrospectively report meeting PMDD criteria do not meet criteria after rating symptoms prospectively, and retrospective and prospective ratings often do not correlate with each other. The requirement of prospective ratings for two menstrual cycles has been criticized in terms of its practicality. However, it is often possible to make a provisional diagnosis prior to obtaining prospective ratings of symptoms, for example by using a screening tool (e.g., PSST).

It is particularly important to consider differential diagnoses when assessing for PMDD. For example, women with mood or anxiety disorders may experience premenstrual exacerbation of these disorders, which can present similar to PMDD in the absence of prospective ratings. Similarly, mood or anxiety disorder onset could occur during the premenstrual phase but not follow a cyclical pattern, highlighting the importance of rating two consecutive cycles. Additionally, women with menstrual-cycle-related symptoms (e.g., cramps) that occur during the menstrual phase, after the onset of bleeding, could report increased symptoms on premenstrual screening tools, despite the fact that these symptoms do not occur premenstrually.

Treatment of PMDD

In general, treatment of PMDD is similar to that of PMS. Pharmacological treatments for PMDD include psychotropic medications, such as SSRIs and anxiolytics, both of which have demonstrated some success in treating PMDD. Interestingly, some studies show that SSRIs may be effective even when taken only during the premenstrual phase. Oral contraceptives (i.e., birth control pills) have also been used in the treatment of PMDD; however, empirical studies on the success of this intervention have produced mixed findings. Research suggests that oral contraceptives may be most beneficial for physical symptoms compared to the affective symptoms of PMDD. Type of oral contraceptive may also be important. Thus, more research on pharmacological treatments for PMDD is warranted.

Research on psychological treatment for PMDD has demonstrated some promising results. In particular, CBT interventions for PMDD indicate that this may be a potentially beneficial treatment for PMDD. However, research in this area is lacking and more studies are necessary to establish empirical support for the treatment of PMDD with CBT.

Conclusions

Since the 1990s, considerable research has been conducted on women's premenstrual experience. Stricter diagnostic criteria

have been proposed for PMS and PMDD. However, there is still no agreed-upon etiology for the two conditions. Most researchers agree that any causal model of PMS/PMDD must be multifactorial, considering biological, psychological, and sociological factors from multidisciplinary fields. More is known about treatment options, even though this research is plagued by small samples and uncontrolled trials. It is important that researchers continue to tease apart premenstrual exacerbation of existing conditions from primary PMS/PMDD.

See also: [Hormones and Behavior](#).

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Relevant Websites

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- <http://www.nlm.nih.gov/medlineplus/ency/article/007193.htm> – Premenstrual Dysphoric Disorder.
- <http://menstruationresearch.org/> – Society for Menstrual Cycle Research.
- <http://www.mayoclinic.com/health/pmdd/AN01372> – Premenstrual Syndrome (PMS).

Primate Cognition

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Glossary

Encephalization quotient The ratio of an individual's or species' brain to its body weight; humans have the largest EQ among the primates, followed by other apes and then the monkeys. Capuchin monkeys are unusual among monkeys in also possessing a large EQ.

Hominoids The phylogenetic term for the great ape species, including humans, chimpanzees, bonobos, gorillas, and orangutans. The great apes show a marked increase in the encephalization quotient as compared to other primates, except the capuchin monkey.

New World monkeys Five families of primates from Central and South America, including Callitrichidae (marmosets and tamarins), Cebidae (capuchins and squirrel monkeys), Aotidae (owl monkeys), Pitheciidae (titis, sakis, and uakaris), and Atelidae (spider monkeys). These monkeys are typically arboreal and of smaller body size than the Old World monkeys. The New World monkeys and Hominoids shared a common ancestor ~40–50 Ma.

Nonhuman primates Any primate except humans, including prosimians, New World monkeys, Old World monkeys, and apes.

Old World monkeys Two subfamilies of primates from Asia and Africa, including Cercopithecinae (mainly African) and Colobinae (mostly Asian). These monkeys are very diverse; some are arboreal while some are solely terrestrial and range in body size from medium to large. The Old World monkeys and Hominoids shared a common ancestor ~20–25 Ma.

Physical cognition The cognitive skills used to survive in one's physical environment, including foraging skills, defense mechanisms, learning, and problem solving.

Social cognition The cognitive skills used for interacting with others, both opponents and collaborators. These skills include such things as defending one's group, navigating the dominance hierarchy, cooperating, and finding a mate.

Introduction

Cognition is the process by which a species learns, remembers, and solves problems with flexible behavior that may change depending on the situation, motivation level, and environmental pressures. Cognition in nonhuman primates is adaptive because it increases efficiency. Behavioral responses can go beyond trial-and-error learning and use problem solving and reasoning based on input from the environment, past experiences, and knowledge of the social environment. Nonhuman primate (hereafter primate) cognition is important to the understanding of the evolution of human minds, as well as a better understanding of the underlying cognitive mechanisms of primate behavior.

Humans are a primate and a member of the great apes, with chimpanzees and bonobos (to whom we are the most closely related), gorillas, and orangutans. We are next most closely related to the Old World monkeys (common ancestor ~25 Ma), followed by the New World monkeys (common ancestor ~40 Ma) and the prosimians (lorises, lemurs, and tarsiers; common ancestor ~80 Ma). While all primate species are interesting in their own right, those phylogenetically closest to humans are often studied based on the assumption that they are a better comparison to human behavior and cognition.

Cognition is commonly divided into physical and social cognition, both of which are important to individuals' success. Physical cognition addresses the skills used by primates to survive in their physical environment, including foraging skills, defense mechanisms, learning, memory, and problem solving. Social cognition is equally important to survival, as most

primates are highly social, interacting with many other individuals on a regular basis. Social cognition provides skills for interacting with others, both opponents and collaborators, in situations ranging from defending one's group to finding a mate. We first focus on physical cognition, including object manipulation and tool use, features and categorization, numerosity, delay of gratification, memory, and metacognition. Next, we turn to social cognition, including social intelligence, cooperation, decision-making, social learning, communication, deception, and theory of mind.

Physical Cognition

Physical cognition is how an organism understands and manipulates its physical world. Much of this takes place in the context of foraging. The ability to locate, obtain, and manipulate food is at the forefront of survival for all species. Primates also attend to other nonfood objects they encounter in their environment.

Object Manipulation and Tool Use

Object manipulation skills likely evolved in the context of foraging, in particular, extracting and processing food. Tool use opens up further adaptive possibilities by allowing the animal to change their environmental niche. Some tool using species, including (but not limited to) primates, seem to understand the interaction of the tool with the environment; they use tools flexibly, modify tools, and even manufacture tools in novel situations.

Ecological constraints strongly influence the degree of object manipulation. For instance, species showing more interest in object manipulation tend to consume a wider diet and use more flexible foraging techniques. Among primates, prosimians are the least exploratory of objects, possibly due to their restricted diet in comparison with the other primate orders. Monkeys show a more pronounced tendency to manipulate objects in their environments, including such behaviors as seriation, or arranging objects in a series or order. Great apes also excel at object manipulation and can even do fairly precise manipulations such as stacking objects. Human children are the most exploratory and manipulative primate species. In a study comparing juvenile bonobos and human children, the children engaged in more bimanual manipulation and tertiary relating and combining of objects, and could switch attention between objects more quickly and efficiently. In all of these cases, object manipulation and tool use clearly interact.

Tool use incorporates the use of objects in relation to each other and moves beyond simple object exploration. The use of tools demonstrates the ability to recognize the affordances of objects, rather than just their physical features. Tool use requires flexibility and complexity as well as mental representations. Flexibility and complexity are shown by using two or more tools in a sequence, such as when chimpanzees use one tool to open a beehive and another tool to extract honey. 'Metatools,' or using a tool to make another tool, are another form of flexibility and complexity. This may include chimpanzees using a support stone to level an anvil before nut cracking with a hammer stone. Mental representations are shown when a specific tool is chosen for a certain situation without overt trial-and-error and when an individual can adapt a normal pattern of tool use readily in a new circumstance. Both of these cases of mental representation show the use of insight or foresight.

Only some species appear to use tools habitually, including some monkeys (e.g., capuchins) and great apes. These species can make and use tools flexibly and may be relying on some form of mental representations. In captivity, some monkeys use tools even if they are not known to do so in the wild. This could be due to lack of data from the field or ecological constraints, in which they only develop tool use if it is necessary for their habitat. Primates are not the only tool using species. Many corvids spontaneously make or modify tools, rivaling primates in their skill. There is also some evidence of elephants and dolphins using tools.

Tools also provide information about how individuals understand causal relations. The classic observation was made by Kohler in 1925 after working with the chimpanzee Sarah. She showed insight learning in several contexts by fashioning a tool with no previous experience or exposure (e.g., fitting two sticks together to make one long stick or piling up boxes to climb to acquire a banana). Monkeys too appear to be able to understand simple causal relations, particularly in the context of the structure of social interactions (e.g., using vocalizations to interpret events outside their immediate visual field). However, monkeys have repeatedly failed more complex causal tasks, such as the trap tube task, which apes can solve, indicating that apes may understand causal relations better than monkeys.

Features and Categorization

Identifying objects and categorizing types of objects allows individuals to organize and simplify their worlds. These abilities are often tested with discrimination learning experiments, such as learning sets and delayed response tasks. Primates have demonstrated the ability to remember stimuli, categorize objects and phenomena, and learn general rules to use in novel situations. In a classic experiment by Harlow, monkeys learned to choose a correct (rewarded) choice in fewer trials as they gained experience. He argued that this transfer of learning across problems suggested some kind of conceptual mediation, thus speeding the process of learning in subsequent trials. Categorization also extends to social stimuli. In their natural environment, primates classify food items or other things, such as individuals as opponents, kin, or potential mates.

Primates are also able to conceptualize. For instance, primates can place objects into categories based on shared physical features, that is, identifying all triangles as similar, which has been described as the ability to conceptualize based on characteristics in common. In another example, match-to-sample tasks indicate that individuals can match two items utilizing a relational concept more advanced than stimulus-response learning. Several species of primates are able to generalize their knowledge of relational sameness and difference to novel stimuli. In addition, chimpanzees appear capable of using relations-between-relations to solve analogy problems. Although abstract discrimination skills are present in many species, primates typically generalize more rapidly and more widely than other species, indicating a selective premium on this type of conceptual learning, despite a similar predisposition to attend perceptually to physical features of the environment.

Finally, primates may also classify items based on an understanding of natural concepts that are more ecologically relevant. Classification has been extensively studied in a laboratory setting; a typical paradigm requires individuals to sort objects into groups based on shared characteristics. These classifications are not based on any shared physical features, but rather on the things that objects afford. Object sorting is a more difficult form of categorization because it requires both the comparison of objects and the manipulation of the objects according to previously made judgments. Chimpanzees show this ability to classify objects based on their functionality rather than physical similarities when they sort objects into superordinate categories, such as foods and tools, using symbols. Several primate species have been found to be capable of sorting objects based on various qualities, including color and kind, and most do so with little to no training. In fact, language-trained apes are able to sort objects more efficiently than 1- and 2-year-old human children and equivalently to 3- and 4-year olds.

Numerosity

Primates are very adept at quantity discriminations. They make use of these to complete everyday tasks such as foraging (e.g., estimating the quantity of food items available) and social interactions (e.g., estimating the number of potential mates or opponents). Such abilities do not necessarily require a concept of numerosity; they could be based purely on perceptual mechanisms. However, a purely perceptive mechanism cannot explain experimental results in which quantitative assessments

are made when sets are spatially segregated or presented sequentially. For instance, primates can discriminate quantities when they are presented item-by-item, or when they see the items as they accumulate. Apes can also discriminate when food presentation differs spatially or temporally. These types of judgments seem to require an analogical system, rather than a perceptual estimation mechanism.

In experimental studies, primates are very proficient at choosing a group with more items from among several options (cardinality). Apes also appear to use ordinality, which refers to understanding the sequence of these labels or numbers. One chimpanzee, Ai, trained in numerical computer tasks showed evidence of using planning, executing, and monitoring phases when ordering numerals, much like humans.

Primates may also use transitivity, or the ability to recognize a sequentially ordered relationship. The ability to make transitive inferences may be crucial for animals living socially because it allows them to make judgments based on social ranking without having to learn each possible dyadic relationship individually. Humans, monkeys, and pigeons all perform well on serial-order tasks. However, humans and monkeys form mental representations that are well-organized into an associative chain while pigeons rely on discrimination cues. Nonetheless, sociality is clearly critical; in a study comparing highly social pinyon jays and relatively nonsocial western scrub-jays, pinyon jays learned to follow and assess relationships more quickly and accurately than western scrub-jays, indicating that there is more at work than phylogenetic distance from the primates. These studies support the social complexity hypothesis, which states that animals living in highly social groups should display more advanced cognitive skills in the domain of group living.

Delay of Gratification and Planning

Delay of gratification is the ability to wait for a better outcome, and is important in planning and foresight of goal-directed behavior. Such self-control may be particularly useful in primate foraging decisions, as individuals who understand the benefit of postponing a behavior instead of acting on it immediately may reap better rewards in the future. Although delay of gratification exists in nonprimate species such as dolphins, primates appear to be better at inhibition, possibly because of their higher encephalization quotient.

Two typical methods of assessment are the smaller-sooner/larger-later paradigm and the accumulation paradigm. The smaller-sooner/larger-later paradigm assesses an individual's ability to inhibit the impulse to take a smaller but sooner reward and instead wait for the larger but later pay off. The accumulation paradigm examines the individual's ability to inhibit reaching for rewards in order to allow them to accumulate. Studies employing these methods find a relationship among self-control, ecology, and life history. For instance, primates who live in fission–fusion groups show greater inhibitory skills than those in more cohesive primate social groups. This is possibly because social complexity seen in the fission–fusion societies supports higher cognitive abilities, such as inhibition, which is beneficial in a fluid social environment. Feeding ecology also plays a role. Among callitrichids, gum eating marmosets delay longer for food rewards than insectivorous tamarins. This differential ability likely evolved

because marmosets must wait a period of time for the gum to exudate from trees, while tamarins must act quickly and impulsively to catch their insect prey.

The ability to delay gratification may function to increase planning. Apes engage in spontaneous planning behaviors, such as caching, or even manufacturing, tools for use at a later date. This indicates mental foresight of upcoming events. Primates may also use planning in their social interactions with conspecifics. For instance, chimpanzees gather stones to throw at human observers, and other chimpanzees have been described as planning an attack on another individual at night while the caretakers were gone. Finally, while the mechanisms for delaying gratification are largely unknown, primates use many techniques that humans do to increase their ability to wait. For instance, chimpanzees practice self-distraction with objects available in the environment, which allows them to wait for longer periods of time.

Memory

The ability to remember certain elements of the environment and information from one's social group is an important part of a primate's world. We will further discuss memory among social groups later (see section 'Social Cognition'); for now we focus on how memory serves primates in their physical environment.

Primates, like many other animals, must remember the locations of what they are seeking (e.g., the location of ripe food, water, or sleeping sites) and understand where they are in relation to other sites. Primate social groups may cover an extensive range throughout their day and must remember their environment in order to efficiently move throughout their territory and utilize its resources. Some primates travel up to 10 km a day and make use of cognitive mapping skills, or the ability to create and remember a mental representation of the spatial environment, in order to successfully manipulate their environment. Optimal foraging theory suggests animals make use of least effortful routes when foraging, minimizing effort while maximizing gains. Apes, Old World monkeys, and New World monkeys have been shown to use cognitive mapping while foraging both in experimental lab studies and in the wild.

Primates also show the ability to remember different entities within the laboratory. Chimpanzees can recall Arabic numbers in a memory task with an equal or greater success rate than novice undergraduate students. Monkeys can remember serial lists across various sensory domains, including photographs and auditory lists, and when items vary. Monkeys also appear to be able to access their memories to judge their own knowledge. In laboratory studies, monkeys avoid memory tests when their knowledge is lacking and they act spontaneously when they have the knowledge that is needed.

The goal-directed behavior seen in primate spatial movement is not only suggestive of cognitive mapping, but also episodic memory. Episodic memory is the ability to recall specific events in an individual's lifetime. It has been suggested that episodic memory is a uniquely human trait and nonhuman animals do not possess the capability of traveling back in time to a specific event. Experimentally, it is not possible to assess whether primates experience feelings of 'pastness' as is

described in human accounts of episodic memory; so instead, nonhuman animal studies investigate 'episodic-like' memory, or the individual's ability to recall what, where, and when information. There is evidence for these episodic-like memories in apes and monkeys, but also in mice and scrub jays, indicating a fairly widespread ability. However, other species' episodic memory may differ from our own; for instance, in some tasks the time frame is relatively short (10 s).

Metacognition

Metacognition is the ability to monitor and adaptively control one's cognitive processing or thinking about thinking. Self-awareness of one's memory serves the function of allowing individuals to avoid situations where they lack knowledge which is needed. Although research in this area in nonhuman species is relatively new, it is clear that species beyond humans are also aware of what they do and do not know.

In a typical metacognition task, subjects are given a series of increasingly difficult discriminations but can indicate that they do not know. Old World monkeys reliably perform very well, choosing the uncertain response more often when the discriminations are more difficult. All great ape species demonstrate metacognition in a task in which they tried to collect necessary information that was missing before solving a task, such as seeking out the location of food in a tube by looking into the tube before making a decision.

New World monkeys have not performed well in most metacognition tasks. However, some capuchin monkeys recently demonstrate the capacity to opt out of a memory test based on past performance suggesting they are also able to make judgments on their knowledge. Nonetheless, the monkeys do not appear to be able to monitor the detailed contents of their short-term memory as well as Old World monkeys and apes. Although additional research is needed both within the primates and in other taxonomic groups, it appears that there are taxonomic differences which are consistent with other cognitive differences between the primates.

Social Cognition

Primates are good psychologists in their own right. Because most species are highly social, they must be able to interpret and predict others' behavior to maximize their own fitness. They must be able to recognize individuals and their relationships to oneself, recognize others' relationships, make judgments based on their knowledge, and use past experiences to predict the future. In order to do this, they appear to use mental representation of social knowledge and the properties of social relationships beyond simple associations.

There are several hypotheses for the evolution of advanced social cognition. First, it may be that the social pressures themselves drove the evolution of social cognition. The Social Intelligence hypothesis suggests the evolution of intelligence in primate species is a direct result of group living; intelligence has evolved in response to social living and the complexities that arise with it. The related Machiavellian Intelligence hypothesis argues that the brainpower needed to outmaneuver one's group mates motivated the advanced cognition seen in

primates. In this case, cognition is argued to have arisen through individuals' need to cooperate, deceive, and manipulate. Ecological pressures may also have shaped primate intelligence, in tandem with social pressures. Most apes, including humans and some monkeys, live in dispersed social groups or fission-fusion societies (e.g., spider monkeys, baboons, and chimpanzees); this system is socially demanding and is argued to have selected for even more advanced cognition in these species.

Cooperation

Many species cooperate on a regular basis, including with unrelated individuals, or even with individuals of other species. There is clearly adaptive value to cooperation, although the reasons for the evolution of this behavior, and its attendant proximate mechanisms, are still the topic of much debate. In general, cooperation is believed to evolve in the context of indirect fitness (e.g., kin selection), mutual encounters in which there is no risk of defection (e.g., it is in each individuals' benefit to cooperate in each interaction), and in reciprocal interactions. Although all of these situations increase fitness, this latter is the most difficult to explain as there are incentives for individuals to not cooperate, or defect. Cooperation is widely present in ape and monkey species, occurring in foraging contexts (e.g., cooperative hunting) and social contexts, such as the coalitions and alliances used for group defense, dominance, and mating. Several factors seem to play a role in whether or not cooperation occurs. These include whether the cooperative opportunity is intuitive, the level of social tolerance among the interactors, and the structure of the payoffs.

Although it has been argued that reciprocal altruism rarely, if ever, occurs in nonhuman animals because it would require too many cognitive mechanisms, such as individual recognition and memory, many primates meet these criteria. Moreover, reciprocity and interchange (the exchange of different commodities) have been demonstrated in numerous situations in several species of primates. This is true in apes and monkeys, although there is variation between different species. In the field and in observational studies, reciprocity is common in grooming and food sharing, as well as interchanges among grooming, support, food, and mating. Most interactions occur over fairly long-time scales, making this behavior somewhat difficult to study experimentally. This issue of time scales as well as the fact that partner choice (the ability to choose one's partner) appears to be a critical component of reciprocity, may explain why contingent reciprocity has been so difficult to elicit in the lab.

Finally, not all instances of reciprocity need be cognitively complex. Although reciprocity may involve tit-for-tat and calculation, Brosnan and de Waal propose three types of reciprocity which vary on the requirement for calculation. At its simplest, cooperation may be symmetry-based, with reciprocity emerging based on individuals' relationships. At the next level, attitudinal reciprocity, behavior is contingent but not based on explicit calculation; instead individuals who receive favors feel a positive effect, which leads them to return the favor (or reciprocate). Finally, calculated reciprocity is both contingent and, as the name implies, calculated. Although much cooperation research, particularly among the primates,

focuses on the cognition required for cooperation to function, it is clear from studies of other species that quite complex cooperation can exist with little-to-no cognition, as, for instance, among the castes of eusocial species or among cleaner fish mutualisms.

Decision-Making

Primates make myriad decisions on a day-to-day basis. They must decide, for instance, how to allocate their time, where to forage, and which foods to consume, and which partners to seek out and which to avoid. All of these decisions require individuals to evaluate costs and benefits, but many may also require them to explicitly include risk or relative payoff in their decision calculus. Below we discuss two of the better studied situations in which decision-making requires these additional considerations, inequity and 'irrational' decision-making.

Although it has been known for years that humans dislike situations of inequity, only recently has this been demonstrated for other species. This behavior is closely linked to contrast effects, or violation of expectation, but in this case, the expectation is based on what a conspecific received, rather than one's individual experience. In studies comparing how individuals respond when they receive a less good outcome than that of a conspecific, both capuchin monkeys and chimpanzees often refuse foods they typically like if a partner receives better food. This response occurs only in the context of a task of some sort and is limited to differences in outcome; differences in the effort required to achieve an outcome do not lead to these negative responses. This response is also affected by an individual's sex, rank, and relationship to their social partners. Inequity is hypothesized to be a mechanism which functions to support cooperation by allowing individuals to identify partners who are not sharing the outcomes.

Of course, on the surface, turning down an outcome because it is less than a partner's seems irrational, or counter to one's immediate interests. Other behaviors, such as loss aversion and the endowment effect also meet this criterion, leading to a surge in research on irrational decision-making and cognitive biases in primates. For instance, several species of apes and monkeys show an endowment effect, or a tendency to value what is in their possession more than they valued the same item prior to ownership. Primates' interest in increasing their outcomes interacts with risk, likely causing them to value what they have (a certain outcome) over what they could obtain (a risky one). This response occurs for foods, but not for nonfoods, indicating that the evolutionary salience of the item affects decision-making. This may explain some of the variation in the effect in human studies. Supporting this, capuchin monkeys also show loss aversion, a tendency to avoid gambles framed as losses, but not those framed as gains. In these decision-making situations, studying other species may help us better understand how these responses evolved in all primates, including humans.

Social Learning

Primates learn a great deal of information from others. Learning from conspecifics allows individuals to obtain information quickly, without potentially costly trial-and-error.

This may include learning basic information, such as the relevance of a specific location or stimulus (local or stimulus enhancement) or more detailed information, including procedures (copying) and goals (emulation). At its most basic, social learning exists among all of the primates, including prosimians, as well as many nonprimate species. The most complex form of social learning is argued to be imitation, in which individuals learn others' goals and the procedures used to reach these goals. In fact, comparative studies indicate that humans do more imitation than other species (who rely on emulation or less cognitively complex mechanisms). Humans appear to have been selected to imitate exactly, perhaps due to our proportionally greater reliance on socially transmitted information.

Social learning may also lead to more advanced phenomena, such as culture and teaching. There is little evidence for teaching among species other than humans; the mechanism for social acquisition among other species seems to be primarily up to the learner, rather than the model. However, there is evidence for social traditions or cultures in primates, including both monkeys and apes. There are now studies on several species, including nonprimates, showing evidence for behaviors which differ between groups, and cannot be explained by genetic or environmental factors. This leads to the assumption that the behavior must be transmitted socially. For instance, different chimpanzee populations have their own methodology for ant fishing, and some crack nuts while other groups, with the same opportunities for nuts and the availability of potential tools, do not. More recent studies implicate mechanisms such as conformity and prestige in affecting social transmission in primates, as they do in humans.

Communication

Communication is an integral part of daily life in socially grouped primates; it is used to convey information and to influence others' behavior. Primates communicate about many things, from the location of food and the presence of predators to an individual's emotional state and intentions. Communication occurs through several modalities, and different modalities can be used in combination (e.g., vocal and nonvocal communication). Nonvocal communication involves transmission of information through gestures, body posture, or facial expressions. One of the major facilitators of nonvocal communication in primates is the face, which provides information on age, sex, individual identity, underlying emotions, and impending behavior. Recent studies on face perception indicate similar perceptual processes in nonhuman primates and humans, suggesting perceptual mechanisms in facial recognition are preserved throughout the primate lineage.

While faces may be particularly expressive, much communication also takes place through gestures. Some have even argued that gestural communication was the first means of communication in our early human ancestors. Extensive gestural communication seems to be limited to apes and humans, suggesting a shift toward a more flexible and intentional form of communication in the Hominoidea lineage. Gestures are predominately produced together with another form of communication, either facial expressions or vocalizations. This multimodal communication is beneficial because individuals gain greater flexibility, more amplification, and greater

complexity in signal output. Multimodal communication in which gestures are produced along with vocalizations is also seen in human children, and seems to precede language development.

Finally, much primate communication is vocal. There are three primary views on the evolution of vocal communication. The first of these is the classical ethological view that vocalizations evolved because they could change a listener's behavior by acting on the salience of acoustic events and the listener's capacity for affective learning. A second view is that signals act as representations of objects or external events, rather than conveying a signaler's motivational state. This view was prompted by Cheney and Seyfarth's work which indicated, among other things, referential alarm calls in vervet monkeys. Finally, the affect-induction view is that nonlinguistic vocal communication influences the behavior of others through changing their affective state. In this case, calls are not always associated with particular contexts and may not have a meaning-based interpretation. Unlike the previous two theories, this theory puts the focus on the listener's affective state, rather than the vocalizer's. Thus far, all of these theories have at least some support.

There is extensive debate over the presence of language or language-like skills in other species. As discussed previously, the gestural origins of language theory suggests that gestures were the starting point for human language. It is also suggested that language emerged from referential vocal signaling in primates. At the most basic level, language evolution may go even further back than the primates. Recent evidence using looking-time tasks indicates that other species, including birds and primates, can understand basic grammar-like structures. However, humans are unique with respect to language. Historical attempts to teach language to other species, including nonprimates, indicate that while they can learn to communicate using symbols or sign language and achieve quite impressive outcomes, including vocabularies of hundreds of words and syntax comprehension, their language never reaches the degree of proficiency seen in humans.

Deception

Deception allows individuals to manipulate another's behavior for their own gain. In tactical or functional deception, an individual produces a signal outside of its typical context in order to affect listeners' behavior. While deception is meant to change others' behavior, it is not clear if the signaler intends to create false thoughts or beliefs in others. Deception is, by definition, rare if it is to be effective, making it rather difficult to study experimentally. Nonetheless, good evidence exists for at least functional deception in primates.

Deception can be passive or active. In passive deception, an animal refrains from a particular behavior so others will not detect their presence or actions, for example, hiding facial expressions or erections, or withholding food calls. Although such behavior is 'passive,' it may indicate that the animals have awareness that they can manipulate their communicative displays. On the other hand, individuals may also actively mislead or provide false information to others. False alarm calls are a common form of active misleading. Cheney and Seyfarth report a vervet monkey giving an alarm call in the middle of an

intergroup encounter (but in the absence of a predator) that stopped the dispute when the combatants fled. Capuchin subordinates use alarm calls to distract more dominant individuals during competitive situations, reducing some of the costs associated with competition for food in the wild. Although these forms of deception function to manipulate others' behavior, there is no evidence that the intention is to manipulate their psychological states.

Finally, there is some evidence for counterdeception, or individuals taking active countermeasures against a conspecific's deceptive act. For instance, others may learn to avoid the calls of deceptive callers in food or aggressive contexts. In an experimental study involving chimpanzees, one chimpanzee in a group knew the location of hidden food and soon learned to keep the food's location a secret to avoid having it stolen by her ignorant partner. The ignorant chimpanzee then began to follow the knowledgeable chimpanzee, ignoring her attempts at misleading, indicating that he anticipated her attempts at deception. In other experimental procedures, chimpanzees have learned to withhold information – and even provide false information – to competitive human experimenters who do not provide food to the subject in experimental tasks.

Theory of Mind

Theory of mind is the ability to reason about the mental states of both the self and others. The attribution of mental states allows one to know about other's beliefs, emotions, and intentions. Individuals capable of attribution have a competitive advantage because they can predict future behavior, generalize their knowledge, recognize ignorance in others and choose to reveal or withhold information. In a primate's world, the better social strategist, who used their knowledge to their own and their kin's benefit, would have the advantage. Whether or not primates actually know about the psychological states of others is heavily debated.

A basic prerequisite for theory of mind is self-awareness, or viewing the self as a social agent. There is a distinction between conscious self-awareness and self-recognition. Self-awareness is being aware of one's own state of mind and using this to predict and explain one's own and others' behavior. Self-recognition is distinguishing self from others but does not imply any awareness of doing so. Initial research focused on self-recognition. First developed by Gallup, the mirror self-recognition (MSR) test gauges self-recognition in young children and primates. The individual in question receives a painted mark on his/her forehead and then is shown a mirror. If they recognize themselves, they should show behavior directed at the mark, such as touching it, when exposed to the mirror. Critically, they must also act differently than when a 'sham' mark that they cannot see has been placed on their head, to rule out the possibility that tactile, olfactory, or other cues are at work. These studies have demonstrated that chimpanzees and other apes recognize themselves in the mirror, as do elephants and dolphins. Monkeys do not show evidence of self-recognition; however, they can use mirrors to solve problems and they do not treat their mirror image in the same way as they treat a stranger.

Initial attempts to test for further abilities were negative. A series of studies were run to test whether chimpanzees would

recognize when a human was and was not able to help them in a task (e.g., would they be able to understand the experimenter's view of the world). These studies presented chimpanzees with two containers, one of which contained a hidden food item, and allowed them to choose between experimenters to obtain the food for them. One of the experimenters was in a position to know where the food was, while the other was not (e.g., their face was covered, their eyes were averted, or they were facing backwards). Chimpanzees consistently failed to discriminate between the experimenters.

On the other hand, others have found evidence that nonhuman primates, especially chimpanzees, go beyond behavioral rules and understand others' goals and possibly intentions, thus possessing aspects of theory of mind. First, these initial studies have been run in situations which do not rely on the chimpanzee expecting the human to collaborate, to very different results. For instance, when chimpanzees are trying to steal food, they fail to do so more often when the experimenter is able to see them versus unable to see them. Moreover, when the experimenters back is turned, chimpanzees reliably choose options which do not alert the experimenter (e.g., a door which does not squeak), indicating an understanding that nonvisual cues may also alert a competitor. Moreover, additional studies demonstrate that chimpanzees, like human children, understand others' intentions by reacting to a goal rather than the actual behavior of the human experimenter. For instance, chimpanzees will help an experimenter reach an out of reach object, and both chimpanzees and orangutans react differently to a loss of food when it appears to be intentional versus accidental.

No monkey has been shown to succeed in any of these theory of mind related tasks. Although monkeys seem to have a sense of self within their social group, they do not impute motives to others, cannot imitate, do not actively teach, show no evidence for self-awareness (they do not pass mirror tests) and do not appear to reflect upon their own knowledge. On the other hand, they can deceive each other, although functional deception may not require an understanding of others' minds (see section 'Deception'). However, apes possess elements of a theory of mind; they appear to know others have beliefs and they can alter those beliefs, understand others' goals and motives (can imitate), deceive, understand others' knowledge and lack thereof, but cannot attribute false beliefs, and do not engage in active pedagogy. Thus, humans' full theory of mind appears to be an extreme along a continuum, rather than a uniquely human trait.

Conclusion

The study of primate behavior is vital to our understanding of the evolution of cognitive mechanisms. Primates must adapt to both their physical and social worlds and do so flexibly by employing cognition. In order to thrive in their physical

environment, primates must be able to successfully manipulate their resources, which can include problem solving and planning. They must also successfully coexist in social groups and maintain relations with conspecifics. By delving into the minds of our close evolutionary cousins, we learn not only how they navigate in their own world, but how we evolved to navigate in ours.

See also: Animal Cognition; Comparative Primate Psychology; Episodic Memory; Equity Theory; Gestures; Memory; Nonverbal Communication; Social Cognition.

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- <http://www2.gsu.edu/~wwwcbs/research.html> – Dr. Sarah Brosnan's CEBUS lab at Georgia State University.
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Problem Solving

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Glossary

Computer simulation Programming a computer to solve a problem like a human.

Heuristics General strategies for problem solving.

Insight The act of mentally restructuring a problem.

Means-ends analysis A problem-solving heuristic based on setting subgoals.

Problem Any situation in which a problem solver has a goal but does not know how to accomplish it.

Problem representation A phase in problem solving in which the problem solver constructs a mental representation of the problem.

Problem solving Cognitive activity directed at achieving a goal when there is no obvious solution method.

Problem solution A phase in problem solving in which the problem solver devises, carries out, and monitors a plan.

Problem space A description of the given state, goal state, and all possible intervening states.

What Is a Problem?

Definition

A *problem* exists when a problem solver has a goal but does not know how to accomplish it. A somewhat more precise way to express this definition is to say that a problem occurs when a situation is in the given state, the problem solver wants the situation to be in the goal state, and there is no obvious way of changing from the given state to the goal state. As you can see, a problem consists of a given state (i.e., a description of the current situation), a goal state (i.e., a description of the desired situation), a set of operators (i.e., rules for moving from one state to another), and obstacles preventing a smooth transition from the given to the goal state.

The Gestalt psychologist, Karl [Duncker \(1945: 1\)](#) defined a problem in the following way: "A problem arises when a living creature has a goal but does not know how this goal is to be reached." Although Duncker's definition is still valid, it must be updated to include the possibility of problem solving by machines, and so the term *problem solver* can refer to both living creatures and machines. This definition is broad enough to include a physician who seeks to make a diagnosis of a patient's ailment such as a defect in a specific valve in the heart (i.e., goal state) on the basis of patient information including test results and the patient's description of chest pains (i.e., given state). This is a problem because, at least initially, there is no obvious path from the given state to the goal state.

Types of Problems

An important distinction – based on the clarity of the problem statement – can be made between well-defined problems and ill-defined problems. A *well-defined problem* has a clear given state, a clear goal state, and a clear set of allowable operators. For example, finding the value of x in an algebraic equation such as $2x + 5 = 8$ is a well-defined problem because the given state is the equation, the goal state is a value for $x = \underline{\hspace{1cm}}$, and the operators are defined by the rules of algebra and arithmetic. In contrast, an *ill-defined problem* has a poorly specified given state, goal state, and/or operators. For example, choosing an

appropriate education for a career path or determining how to end an economic recession are ill-defined problems because the goal and allowable operators are not clearly specified. Most problems encountered in school are well-defined problems, whereas most crucial problems in everyday life are ill-defined.

Another important distinction – based on the knowledge of the problem solver – can be made between routine and non-routine problems. *Routine problems* are identical or very similar to problems that the problem solver already knows how to solve, and therefore require what [Wertheimer \(1959\)](#) called *reproductive thinking* – reproducing responses that have been produced previously. For example, a routine problem for most high school students is " $5 + 5 = \underline{\hspace{1cm}}$ " or "The headquarters of the United Nations is located in the city of ." In the strictest sense, routine problems do not conform to the definition of problem, since they do not include an obstacle between the given and goal states. In contrast, *nonroutine problems* are different from any problems that the problem solver already knows how to solve and therefore require what [Wertheimer \(1959\)](#) called *productive thinking* – creating a novel solution. Examples for most high school students include writing a computer program to compute the mean and standard deviation of a sample, or working out why Spanish explorers waited several centuries before colonizing California. In school, students often work on routine problems called *exercises*; however, most important problems in everyday life are nonroutine.

A third distinction can be made between problems requiring convergent and divergent thinking. *Convergent thinking problems* have a single correct answer that can be determined by applying a procedure or retrieving a fact from memory. Examples include arithmetic computation problems and answering factual questions. *Divergent thinking problems* have many possible answers, and so the problem solver's job is to create as many solutions as possible ([Guilford, 1967](#)). Classic examples include uses problems, such as "List all the possible uses of a brick," and consequences problems, such as "List all the consequences of humans having six rather than five fingers." Creativity can be measured in terms of the originality and usefulness of the answers, and divergent thinking skills, which underlie creativity, are taught in courses on

creative thinking (Sternberg, 1999). Although divergent thinking is the hallmark of creativity, most school-based problems mainly require convergent thinking.

What Is Problem Solving?

Problem solving is directed cognitive processing aimed at finding a way to achieve a goal when the problem solver does not know an obvious solution method. Mayer and colleagues (Mayer, 1992; Mayer and Wittrock, 2006) summarized four major elements in a definition of problem solving: (a) problem solving is *cognitive* because it occurs internally within the problem solver's cognitive system, (b) problem solving is a *process* because it involves manipulating or performing operations on the problem solver's cognitive representations, (c) problem solving is *directed* because the problem solver is attempting to achieve some goal, and (d) problem solving is *personal* because problem solvers enter the situation with different prior knowledge.

In short, problem solving occurs when a problem solver engages in cognitive activity aimed at overcoming a problem. Duncker (1945: 1) noted that "when one cannot go from the given situation to the desired situation simply by action, then there has to recourse to thinking" and "such thinking has the task of devising some action which may mediate between the existing and desired situations." Similarly, Polya (1981: ix) defined problem solving as "finding a way out of a difficulty, a way around an obstacle." In developing computer simulations of problem solving, Newell and Simon (1972) defined problem solving as a search for a path between the given and goal states of a problem.

This definition of problem solving includes a wide variety of cognitive activities such as in a physician who is given information about a patient and must make a medical diagnosis, a potential renter who must choose between various housing options, a chess player who must generate the next move in a game, a student trying to solve a homework problem in physics, or a scientist who wishes to test a theory about climate change. Each case requires problem solving because the problem solvers seek to generate useful and original solutions when they are confronted with problems they have never seen before.

What is the relation between problem solving and other high-level cognitive processes such as thinking and reasoning? Thinking can be broken down into two types – directed and nondirected thinking. Problem solving is a common and pervasive type of thinking, namely, *directed thinking* in which the thinker engages in cognitive processing aimed at achieving some goal. In contrast, in *nondirected thinking* the thinker engages in cognitive processing that is not aimed at achieving some goal, such as daydreaming or the abnormal thinking of autistic or schizophrenic people. In general, the terms *problem solving* and *thinking* can be used interchangeably, with the recognition that nondirected thinking is excluded.

Reasoning can be viewed as a type of problem solving that is required in deductive reasoning tasks and inductive reasoning tasks. In *deductive reasoning*, the problem solver is given premises and must apply the rules of logic to derive a

conclusion. For example, if you know "all four-sided polygons are quadrilaterals" and "all squares are four-sided polygons," you may logically conclude, "all squares are quadrilaterals." In *inductive reasoning*, the problem solver is given a series of instances or events or examples and must infer a rule. For example, after learning the Spanish words *la casa*, *el libro*, *la escuela*, *el perro*, *la muchacha*, and *el muchacho*, you may conclude that the article *la* goes with words ending in *a* and the article *el* goes with words ending in *o*, a grammatical rule that is not without exceptions in Spanish.

Finally, creative thinking occurs when a problem solver generates ideas and critical thinking occurs when a problem solver evaluates them. Two important criteria in creative and critical thinking are that the ideas must be original and useful.

What Are the Cognitive Processes in Problem Solving?

Problem solving can be divided into two major phases: problem representation and problem solution. *Problem representation* involves building a mental representation of the problem, and includes the cognitive process of *representing* (i.e., building a *situation model*, that is, a mental representation of the situation described in the problem). *Problem solution* involves devising and carrying out a plan for solving the problem, and includes the cognitive processes of *planning* (i.e., devising a plan), *executing* (i.e., carrying out the plan), and *monitoring* (i.e., tracking the effectiveness of the plan).

The cognitive processes involved in problem representation and problem solution may interact, rather than occur in linear order. For example, a student may be given the following word problem: "Sarah has three marbles. David has two more marbles than Sarah. How many marbles does David have?" In representing the problem, the student must translate each sentence into an internal mental representation, such as "Sarah's marbles = 3" and "David's marbles = Sarah's marbles + 2," and mentally integrate them into a situation model, such as a spatial representation consisting of a bar for Sarah's marbles (3 units high), a bar on top of it for the difference between Sarah's and David's marbles (2 units high), and a bar next to these for David's marbles (indicating that Sarah's marbles and the difference set of marbles are subsets of David's marbles). This situation model is presented in Figure 1. Planning involves determining the operations to be performed, such as determining that 3 and 2 must be added together. Executing involves carrying out the operation(s), such as computing that 5 is the sum of 3 and 2. Monitoring involves detecting when a plan is not working, a step was not executed correctly, or an answer is questionable. Although school instruction tends to emphasize execution of basic skills, students' major difficulties are in learning how to represent problems, devise plans, and monitor problem-solving processes.

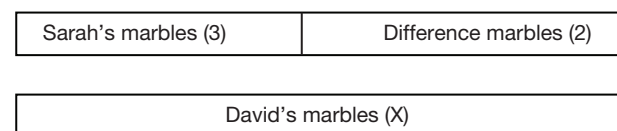


Figure 1 A situation model for the marble problem.

What Kinds of Knowledge Are Required for Problem Solving?

Several types of knowledge are required for successful problem solving: facts, concepts, procedures, strategies, and beliefs (Anderson et al., 2001; Mayer, 2008). *Facts* are elements of a factual knowledge about the world, such as, “There are 1000 milliliters in a liter.” *Concepts* are principles or models (which are elements of conceptual knowledge) such as, “In the number 567, 6 refers to the number of tens,” or categories or schemas (which are elements of schematic knowledge), such as knowing that “What is the probability of flipping a fair coin three times and getting heads all three times?” is a joint probability problem. *Procedures* are step-by-step processes, such as knowledge of the procedure for long division used for 252 divided by 12. *Strategies* are general methods for problem solving, such as knowing how to break a problem into smaller parts. *Beliefs* are thoughts about one’s cognitive processing, such as believing, “I am good at solving statistics problems.” Facts and concepts are useful in the process of representing; procedures are useful for the process of executing; and strategies and beliefs are useful for planning and monitoring. Although school instruction may tend to emphasize facts and procedures, all five kinds of knowledge are needed to support problem solving.

What Are the Approaches to the Study of Problem Solving?

The history of scientific research on problem solving, which is barely hundred years old, has been influenced by three distinct approaches – associationism, Gestalt, and information processing. The associationist approach views thinking as a chain of mental associations, in which one idea is associated with another and so on. The associationist approach motivated the earliest research on problem solving starting around 1900, including Thorndike’s studies of how cats and dogs learn to get out of a puzzle box that has a trap door so they can eat food that is nearby. According to Thorndike’s (1911) theory, the problem solver possesses a set of responses associated with any problem situation based on past experience. When the problem solver is confronted with a problem situation, the problem solver tries the strongest response associated with the situation; if it works, the association is strengthened and if it does not work, the association is weakened. Although associationist theories are useful in describing problem solving in familiar situations, their value in explaining creative problem solving has been criticized.

The Gestalt approach, which developed in the 1920s through the 1940s, viewed problem solving as mentally restructuring the problem, that is, seeing the problem in a new way. The act of restructuring a problem is called insight and often involves overcoming previous experience that blocks new ways of seeing the problem. For example, Kohler observed an ape in a cage with crates on the floor and bananas attached overhead and out of reach. To solve the problem of getting bananas that are out of reach, the ape had to view the crates as a potential staircase rather than as containers; this insight allowed the ape to restructure the problem by using the crates to reduce the distance from the bananas. The Gestalt approach

emphasizes the creation of a novel solution, but the theory has been criticized for lack of precision.

The information processing revolution, which began in the 1950s and 1960s, offers another approach to problem solving. In the information processing approach, thinking is a series of mental operations (or computations) that are applied to knowledge representations in the problem solver’s working memory. For example, Newell and Simon (1972) produced computer simulations of human problem solving, that is, they programmed computers to solve problems in the same way as humans. Successful problem solving required both domain-specific knowledge and general strategies for how to solve problems. Problem solvers must build a problem space – a representation of the given state, goal state, and all possible intervening states – and must use a strategy such as means-ends analysis to find a path through the problem space. In means-ends analysis, the problem solver works on one goal at a time by continually asking, “What do I want?” and “What can I do to get what I want?” The information processing approach, with its emphasis on thinking as making mental computations, is precise; however, it has been criticized for its lack of attention to practical problem solving in realistic social contexts.

More recent directions include a focus on how people solve problems in realistic social situations, which has been called situated cognition (Robbins and Aydede, 2009) and a focus on the brain activity involved in problem solving, which is a subfield of cognitive neuroscience (Anderson, 2007).

What Are Some Enduring Issues in Problem Solving?

Rigidity in Thinking

A major obstacle to effective problem solving is rigidity in thinking. For example, in some problem-solving situations the problem solver must use an object in a new way, such as using a brick as a doorknob or using a pencil as a bookmark. When a problem solver can only conceive of using an object in its most common function, then the problem cannot be solved. Duncker (1945) used the term *functional fixedness* to refer to a situation in which a problem solver cannot think of using an object in a new function that is required to solve the problem. Another example of rigidity occurs when a problem solver uses a well-learned procedure on a problem for which the procedure is inappropriate. For example, if a student solved a long series of arithmetic story problems that all contain the word ‘more’ and require adding the numbers together, the student may incorrectly carry out this same addition procedure for a new problem that actually requires subtracting the numbers from one another. Luchins (1942) used the term *einstellung* (or problem-solving set) to refer to this phenomenon. A goal of instruction in problem solving is to help students avoid rigid thinking.

Problem-Solving Transfer

Transfer is the effect of prior learning on new learning. When the new learning task is a problem to solve, we can use the term *problem-solving transfer* to refer to the effect of prior learning on solving a new problem (Mayer and Wittrock, 2006). *Positive transfer* occurs when previous learning helps you on a new task, whereas *negative transfer* occurs when previous learning hurts

you on a new task. For example, if you have learned arithmetic, it should be easier for you to solve an arithmetic word problem – which would indicate positive transfer. If you learned to drive on the right side of the road in the United States, you may experience negative transfer in trying to learn to drive on the left side of the road in Australia.

How does transfer work? This has been a central research question in psychology and education since Thorndike's (Thorndike and Woodworth, 1901; Thorndike, 1931) pioneering work in the early 1900s, and has generated three alternative explanations: general transfer, specific transfer, and mixed transfer. *General transfer* is the idea that learning task A can help you on task B, even if A and B have nothing specifically in common. For example, the *doctrine of formal discipline* (which is a classic theory of general transfer) posited that learning certain school subjects, such as Latin and geometry, would improve students' minds in general and thereby help them on unrelated tasks in the future. The doctrine of formal discipline was used to justify the establishment of Latin schools, in which the curriculum consisted of learning Latin, Greek, geometry, and similar subjects. In one of the first experiments in the field of educational psychology, Thorndike (Thorndike and Woodworth, 1901; Thorndike, 1931) was able to show that students who learned Latin did not perform any better in learning bookkeeping than did students who had not learned Latin. Subsequent research (Singley and Anderson, 1989) also found little support for the idea of general transfer.

In contrast, *specific transfer* is the idea that learning task A will help you in task B only to the degree that A and B have identical elements in common. Thus, learning Latin may help you learn Spanish because some of the verb conjugations are similar and many of the words are similar. The theory of specific transfer is problematic for educators because it suggests that students need to learn every specific piece of knowledge they will ever need.

Mixed transfer is a compromise between general and specific transfer that involves specific transfer of a general principle, that is, mixed transfer occurs when a learner abstracts a general principle from learning A and is able to apply it to solving a new problem B. The transfer is specific because both A and B can be solved by the same general principle but what is being transferred is a general principle rather than specific behaviors. For example, if students learn to make sense out of text passages by producing summaries, this general method can be transferred to the task of making sense out of a new text passage. Research on teaching cognitive strategies shows that students can benefit from learning general strategies such as summarizing in reading comprehension (Pressley and Woloshyn, 1995; Mayer, 2008).

Promoting positive transfer is a fundamental goal of education, that is, educators seek to help students learn in ways so that they will be able to use what they have learned to solve new problems. Mayer and Wittrock (2006) have described seven ways to promote problem-solving transfer: load-reducing methods, such as helping students build automaticity in basic skills; structure-based methods, such as using concrete models; schema-based methods, such as using advance organizers or pretraining; generative methods, such as encouraging learners to engage in elaboration or self-explanation; guided discovery methods, such as providing hints as someone

solves a problems; modeling methods, such as providing worked examples; and teaching thinking skills, such as training people to use effective methods and strategies.

The Distinction Between Productive and Reproductive Thinking

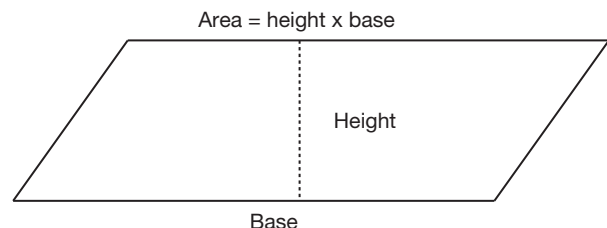
Why is it that some people invent clever solutions when confronted with a problem, whereas other do not? The Gestalt psychologist, Max Wertheimer (1959) attempted to answer this question by distinguishing between two kinds of thinking mentioned above, namely productive thinking and reproductive thinking. *Productive thinking* involves producing a novel solution when confronted with a problem whereas *reproductive thinking* occurs when problem solvers use solution procedures that they already know as a result of solving previous problems.

For example, Wertheimer (1959) described two ways of learning how to find the area of a parallelogram – learning by rote and learning by understanding. In learning by rote (or *rote learning*), the student is taught to measure the height, measure the base, and then multiply height times base, as shown in the top of Figure 2. According to Wertheimer, students who learn by rote perform well on retention tests, such as finding the area of similar parallelograms, and poorly on transfer problems, such as finding the area of an unusually shaped parallelogram. In contrast, students who learn by understanding (or by *meaningful learning*) are encouraged to discover that the parallelogram can be converted into a rectangle by cutting the triangle off one end and moving it to the other end, as shown in the bottom of Figure 2. Students who learn by understanding are expected to perform well on both retention and transfer tests. Thus, rote learning leads to reproductive thinking (as measured by retention tests) whereas meaningful learning leads to productive thinking (as measured by transfer tests).

The Nature of Insight

Insight is the cognitive process by which a problem solver suddenly moves from a state of not knowing how to solve a problem to a state of knowing how to solve a problem (Mayer, 1995). Insight plays a crucial role in creative thinking

Learning by rote



Learning by understanding



Figure 2 Two methods of teaching how to find the area of a parallelogram.

(Sternberg, 1999), in which a problem solver invents novel solutions to a problem. How does insight work? The Gestalt psychologists and others have offered five somewhat interrelated explanations (Mayer, 1995): insight as completing a schema, insight as sudden visual reorganization, insight as reformulation of a problem, insight as removing mental blocks, and insight as finding a problem analog. Selz, working in the early 1900s in the Netherlands, produced psychology's first explanation of insight as completing a schema (Frijda and de Groot, 1982). For example, when given a problem such as "What is a coordinate of baseball?" a problem solver may say, "Let's see. Baseball is a sport. Another sport is football, so football is the answer." In this case, the problem solver is not following a chain of associations, but rather is trying to build a cognitive structure that has a superset ('sport') linked to two subsets that are coordinates ('baseball' and one more); so, coming up with an answer amounts to completing a schema. The idea that meaningful learning requires active construction by the learner is the fundamental theme of many current theories of learning (Bransford et al., 1999).

Kohler, also working in the early 1900s, provided evidence that insight is a process of sudden visual reorganization in which the problem solver literally sees how all the parts of the problem fit together (Kohler, 1925). For example, when an ape was put in an area that had stackable crates on the floor and bananas hanging overhead out of reach, the ape looked around and then in an apparent flash of insight, suddenly stacked the crates to form a sort of ladder leading to the bananas. This approach is consistent with current interest in using computer-assisted visualizations and concrete representations to help people understand how various systems work.

Dunker (1945) described insight as a reformulation of the problem, particularly a restatement of the givens or the goal in a new way. For example, in the tumor problem, you are asked to free a person of an inoperable stomach tumor by using "rays which destroy organic tissue at sufficient intensity" (p. 1). In order to solve the problem, the problem solver must restate the goal as, "lower the intensity of the rays as they pass through the healthy tissue," which leads to the solution of having many weak rays all converge on the tumor. This approach is consistent with the current idea that the most difficult aspect of problem solving is mentally representing the problem in a productive way.

Dunker (1945) also described insight as a process of removing mental blocks, that is, of being able to use an object in way that is different from its conventional use. For example, in the candle problem, the problem solver is given a box containing candles, a box containing tacks, and a box containing matches, and is asked to mount a lighted candle on a wall. The solution – involving using a box as the base, which is tacked into the wall – is much more difficult if the objects are in the boxes rather than next to them. According to Duncker, presenting the objects in the boxes creates *functional fixedness* – the tendency to be able to conceive of only one use of an object even though a problem solution requires using an object in a new way. Removing mental blocks is a key focus of current programs aimed at teaching thinking skills.

Finally, Wertheimer (1959) offered a fifth explanation of insight – finding a problem analog – in which the problem solver abstracts a general principle from one problem and

applies it to a new one. Thinking by analogy is still an important theme in cognitive science, and is the basis for more current views of problem-solving transfer (Holyoak, 2005).

A sixth explanation – insight as nothing new – holds that solving insight problems is no different from solving other problems (Weisberg and Suls, 1973), although Metcalfe and Wiebe (1987) have shown that problem solvers use qualitatively different thinking processes for insight problems and routine problems.

Problem Space and Search Processes

Information-processing theories of problem solving focus on constructing a problem space and finding a path through the problem space (Newell and Simon, 1972; Novick and Bassok, 2005). A problem space consists of a representation of the initial state, goal state, and all intervening states. For example, the problem space for solving the equation, $2X - 5 = X$, has this equation as the initial state, and $X = \underline{\quad}$ as the goal state. Two of the intervening states, directly after the initial state are $2X = X + 5$ and $2X - X - 5 = 0$, which were created by applying legal operators such as add 5 to both sides or subtract X from both sides. Similarly, other states are created by applying operators to these states, and so on.

Once a problem is represented as a problem space, the problem solver's task is to search for a path from the initial state to the goal state. *Means-ends analysis* is a search strategy in which the problem solver works on one goal at a time; if that goal cannot be achieved directly, the problem solver sets a new goal of removing barriers, and so on. This search strategy is commonly used in computer simulations of problem solving and is consistent with the way that beginners solve problems.

Problem Solving in Realistic Situations

Although classic research focused mainly on solving artificial puzzles or formal syllogisms, cognitive science research on problem solving and reasoning has been shifting toward realistic situations including everyday problem solving, expert problem solving, and problem solving in subject areas (Ericsson et al., 2006; Holyoak and Morrison, 2005).

Research on everyday thinking shows that people rarely use school-taught methods to solve problems encountered outside of school (Lave, 1988; Nunes et al., 1993). For example, to determine the best buy in a supermarket – such as 90 cents for a 10 ounce can of peanuts or 45 cents for a 4 ounce can – the school-taught procedure is to compute the unit cost of each item (i.e., 9 cents vs. 11.25 cents, respectively). However, Lave (1988) found that people almost never used the school-taught procedure; instead, they invented arithmetic procedures suited to the situation, such as the ratio strategy in which the problem solver notes that the larger one is a better buy because it costs twice as much and gives you more than twice as many ounces.

Research on expert problem solving compares differences in how novices and experts solve problems in domains such as physics, medical diagnosis, computer programming, and the game of chess. For example, when Larkin (1983) asked experts and novices to think aloud as they solved physics problems, she found that experts were more likely to focus on underlying physics concepts (such as forces and weights) whereas novices focused on surface characteristics (such as pulleys and ropes).

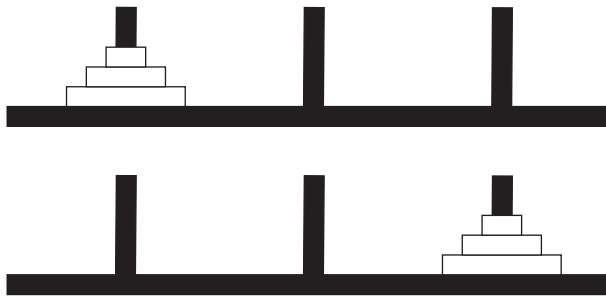


Figure 3 The given and goal state in the Tower of Hanoi problem.

Similarly, when [Chi et al. \(1981\)](#) asked experts and novices to sort physics problems into groups, experts sorted problems based on their underlying physics principle (such as conservation of energy), whereas novices sorted the problems based on their surface characteristics (such as inclined planes and springs). Results of expert–novice studies suggest that experts represent and solve problems differently from novices, and so instruction can focus on helping novices think more like experts.

Another example of problem solving in realistic situations involves theories of situated cognition, which posit that problems should not be seen as abstractions but rather are always linked to the concrete setting in which they arise ([Kirsh, 2009](#)). According to the situated cognition view, the same problem is solved in different ways depending on how it is framed – that is, on the context in which it is encountered.

Past and Future Research Trends

Traditionally, research on problem solving has focused on how people solve artificial puzzles and games in controlled laboratory situations. For example, in the Tower of Hanoi problem, the problem solver is given three pegs and three disks as shown in the top of [Figure 3](#), and the problem solver's task is to move the three disks to the third peg as shown in the bottom of [Figure 3](#). However, the problem solver is allowed to move only the top disk on any peg and may never place a larger disk on top of a smaller disk.

In contrast, recent research has focused on problem solving in more realistic settings. Research on expertise examines differences between expert and novice problem solvers in professions such as medicine, physics, and computer programming. Research on situated cognition examines how people solve problems that occur naturally at work, at home, or at the market. Research on analogical reasoning examines how people use previous problems to solve new problems. Research on intelligence seeks to understand individual differences in problem-solving performance. Research on teaching of thinking strategies focuses on how to help people become more effective problem solvers. Finally, research on the cognitive neuroscience of problem solving examines where in the brain various problem-solving processes take place.

See also: [Creative and Imaginative Thinking](#); [Creativity](#); [Decision Making \(Individuals\)](#); [Gestalt Psychology and the Development of Perceptual Organization](#); [Human Intelligence](#); [Reasoning](#).

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Psychodynamic Psychotherapy: Theory and Practice

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Glossary

Attachment The biologically based bond between a child and its caregiver that ensures the safety, survival, and emotional well-being of the child.

Countertransference The unconscious reactions of the therapist to the patient stemming both from earlier situations in the life of the therapist and from feelings induced by the behavior of the patient.

Mentalization The capacity to be aware of the existence of the mind in oneself and others combined with the recognition that one's own perceptions and those of others are highly subjective, that is, influenced by feelings, thoughts, and life experiences.

Psychodynamic Used interchangeably with psychoanalytic, this term refers to a way of thinking about feelings, thoughts, and behavior that involves unconscious factors, developmental influences, and multiple determinants.

Resistance The unconscious activation of the patient's defenses in the context of psychotherapy or psychoanalysis in order to oppose the therapist's efforts to help.

Self-object A term from self-psychology that refers to the experience of another person as an aspect of the self that is missing or needed.

Transference The patient's emotional experiences and fantasies about the therapist based on experiences with significant figures in the patient's past but influenced by the real characteristics of the therapist.

Modern psychodynamic theory had its origins in the thinking of Sigmund Freud at the end of the nineteenth century and during the first four decades of the twentieth century. The original model that Freud used to explain hysterical symptoms and other psychopathological phenomena was based on intrapsychic conflict. Hence *psychodynamic* originally connoted interacting forces that involved wishes and defenses against those wishes based on intrapsychic agencies within the mind.

In the century or so that has followed the early formulations of Freud, substantial innovations to psychodynamic therapy and theory have been made such that Freud might not recognize the way that current psychodynamic clinicians conceptualize the patient's inner world and the treatment strategies to deal with the patient's concerns. When Freud developed psychoanalysis, there was a great emphasis on the unconscious phenomena in his formulations. Essentially, Freud viewed the human condition as one in which we are consciously confused and unconsciously controlled. His first model of the mind was known as the *topographic model*. In this model, there were three systems: the conscious, the preconscious, and the unconscious. One gained access to the unconscious through slips of the tongue (parapraxes) and through dreams.

His early clinical work involved trying to make conscious what was unconscious. To that end, he would attempt to hypnotize the patient and use suggestions to assist the patient in retrieving memories that had been repressed in the course of development. Freud became disenchanted with this model as he realized that some memories could not be brought back into consciousness, while also recognizing that often the patient's condition did not improve just because memories were retrieved.

Freud also noted that patients often resisted what he was trying to do with them, so this led to his next model of the mind – the *structural model*. This model involved the ego, the id, and the superego. This topic is covered in elsewhere in this encyclopedia. Associated with the ego, id, and superego were

defense mechanisms that defended the patient against recognizing his or her unconscious conflicts. Defense mechanisms are covered in detail in elsewhere in this encyclopedia. In brief, defenses deal with anxiety, conflicts, and forbidden wishes.

Clinical example: Mr. A was a 25-year-old accountant. He kept undermining his success at work and came to treatment to figure out why he was so self-defeating. He feared his boss, who was approximately the same age as his father. In psychotherapy, it became clear to the therapist that one origin of the fear was that the boss would detect his rivalry and contempt for him and punish him for it. The aggressive wishes from the id were in conflict with his superego prohibitions that he had internalized from his parents. Because of his anxiety that his boss would become enraged with him, he used the defense of reaction formation and acted overly ingratiating in all his interactions with him.

Post-Freudian Development of Theory

Since Freud's death in 1939, the theory has evolved in many directions. The structural model turned into ego psychology, in which intrapsychic conflicts between the ego, id, and superego occupy center stage. In this model, a therapist or analyst attempts to understand and explore these conflicts as well as the patient's defensive attempts against accepting them. Beginning in the 1930s and 1940s, the object relations theory came into psychoanalytic discourse, primarily in London, where the focus shifted from drive discharge to the internalized world of relationships and how they manifested themselves in everyday interactions with others.

Beginning in the 1960s, another development in the theory was the focus on the self, which turned into self-psychology. Based largely on the writings of Heinz Kohut, this view evolved in a direction in which self-cohesion and self-esteem were the focus rather than intrapsychic conflict. This model also focused

more on deficit, that is, what was missing in the self, rather than conflicts between agencies.

Attachment theory has also become an important element of modern psychodynamic theory. John Bowlby, working in the UK, wrote a series of books that drew attention to the role that secure attachment plays in healthy development. This point of view has now been integrated into the theoretical underpinnings of psychodynamic theory so that early attachment relationships are seen as highly influential in the development of the child.

Most recently, the field has begun to accept postmodern theories that question objective truths or 'factual' observations about patients. These models involve such schools of thought as intersubjectivity, constructivism, and relational theory. In brief, they view the clinical situation as involving two perspectives: that of the therapist and that of the patient, each stemming from highly subjective experiences that influence the way one views external reality. Hence negotiation is necessary between therapist and patient to take both views into account.

A few core principles run through all psychodynamic theory. These are summarized in [Table 1](#).

In psychodynamic theory, a great emphasis is placed on the unique, the idiosyncratic, and the subjective in each patient. In other words, unlike descriptive psychiatrists, psychodynamic clinicians would not be so concerned about how patients are similar to each other and how they fit into large diagnostic groups. Rather, they would be more interested in how patients are different from each other based on diverse life experience.

Unconscious mental functioning continues to be at the core of psychodynamic thinking since the time of Freud. Contemporary neurobiological research has confirmed that much of mental life operates unconsciously, and, as a result, the understanding of the unconscious has been revised over the years.

Psychic determinism refers to the notion that our symptoms, feelings, thoughts, and behaviors are mentally determined by factors largely outside of our awareness. Different influences from childhood converge to make our behavior meaningful. The choice of profession, romantic partner, and personal choices are often markedly influenced by the patient's early life experience.

The principle that the past is prologue simply refers to the developmental emphasis in all of psychodynamic theory. Genetic factors in concert with early experiences shape who we are as adults. Current genetic research has confirmed the notion that the expression of genes is heavily influenced by life experiences, and the two are inextricably tied together in shaping the human person.

Transference refers to the automatic and unconscious tendency in all of us to look at a clinician as a significant figure

from our past. This phenomenon also occurs outside treatment settings. In short, all of us are unconsciously reenacting our past relationships, attributing qualities and characteristics of significant figures from our past to other people.

The counterpart of transference is known as countertransference. In other words, each time a psychotherapist is sitting with a patient, that therapist is experiencing a number of feelings toward the patient that may derive from the therapist's past. In addition, patients induce certain feelings in the therapist in their unconscious effort to recreate past experiences. Hence countertransference includes both feelings from the therapist's past as well as those induced by the patient.

The last common factor among the psychodynamic theories involves the construct of resistance. Patients may wish to get better, but that wish is opposed by anxiety about change. Hence patients often resist the therapist's efforts to help them by hanging on to patterns of behavior, symptoms, or perspectives on reality. This resistance may manifest itself by not talking in a session, coming late to a session, forgetting a session, or arguing with anything the therapist offers by way of observations or insight.

In the material that follows, we survey each of the leading theoretical perspectives that are in use today among psychoanalysts and psychodynamic clinicians. We then outline the fundamentals of technique in psychodynamic psychotherapy and survey the research data attesting to the efficacy of psychodynamic psychotherapy. The application to dynamic psychotherapy is also briefly addressed in the course of this theoretical overview.

Object Relations Theory

Object relations theory is one of the most popular conceptual models in use among dynamic psychotherapists today. It emphasizes unconscious relationships that have been internalized in childhood and which continue to influence adult relationships. The term 'object' is used synonymously with 'person,' and in object relations theory the self seeks an object from early in life. The building blocks of the individual's inner world are object relations units of the self and another (object) linked to one another by emotional states. These units begin their development in the relationship of infant and parent/caregiver early in life. These relationships are internalized in the first few years of life and are unconsciously repeated over the course of an individual's life. These patterns of relationships are not fixed but are changeable with new experiences, which is a basic premise of dynamic psychotherapy. The restructuring of these patterns can occur within the context of a therapeutic relationship where the clinician offers new forms of relatedness and invites reflection on the old forms.

The development of object relations is credited to Melanie Klein, who initially described a connection between the drives of sexuality and aggression and deeply unconscious internalized relationships. Klein proposed that drives developed in concert with a relationship. An essential component of the theory is the infant's tendency to use early experience in the infant-mother dyad as the template for internal object relations. An example of this phenomenon is the nursing experience. A loving, pleasurable experience occurs when the infant is

Table 1 Basic principles of modern psychodynamic theory

The unique value of subjective experience
The unconscious
Psychic determinism
Past is prologue
Transference
Countertransference
Resistance

nursing. This positive experience is internalized as a satisfied self, an attentive and nurturing mother and a loving emotional state that links them. In contrast, when the mother is not available and the infant is hungry, a different experience is internalized. The infant begins to feel anger and a different object relations unit is laid down in the psyche of the child. This one involves an angry, demanding self, an unavailable, depriving mother, and an emotional state of desperation and rage. The infant keeps the positive object relations unit separate from the negative counterpart to assure that the hateful, angry feelings do not destroy the positive, loving feelings or the loving representation of the mother. This defense mechanism, which persists into adult life, is known as splitting.

Paranoid and Depressive Positions

Klein's theory was derived from her psychoanalytic work with children and was focused on unconscious fantasy. Hence the infant does not internalize an exact replica of reality but rather distorts the object because of fantasy. The child might, for example, internalize a view of the mother as sadistic when unavailable for a feeding even though the mother might be taking care of other children and have no sadistic intent. Klein also believed that the early relationships that were internalized persisted in the form of unconscious fantasy about self and others. Hence, an abused child might have a persistent unconscious fantasy that others will mistreat him.

Klein also maintained that there were two principal positions in development: the paranoid-schizoid and the depressive positions. These modes of organizing experience were persistent and influenced one's adult life in a similar manner to unconscious fantasy. In the first several months of life, the paranoid-schizoid position involved the infant's tendency to use splitting to divide the world into good and bad objects. According to this theory, infants project their own badness onto others and then fear that those containing the projected badness would attack them. Hence they experience paranoid anxiety. The depressive position begins somewhere between age 6 and 9 months and is characterized by the integration of the bad and the good that had been split from each other. Thus the infant feels both love and hate at the same time and is ambivalent toward parents and other significant objects. The leading anxiety is depressive anxiety that the infant can harm those he or she loves.

Clinical Example: Ms. B, a 31-year-old patient with borderline personality disorder, was admitted to a psychiatric inpatient unit because of self-mutilation, suicidal thoughts, and anger that was out of control. Several days after she arrived, she told her doctor that there was only one nurse on the entire unit who was competent. This nurse was empathic, listened well, and truly understood Ms. B. By contrast, the other nurses and aides were 'stupid, cruel, and useless.' Ms. B suggested that they should be fired. She said while she was in the hospital, she would only talk to her favorite nurse and not to the others. This example of splitting, typical of the paranoid-schizoid position, divided up her world of relationships into all-good, idealized figures and all-bad, devalued figures, with no middle ground.

While Kleinian thinking is in use throughout the world by psychoanalysts and psychodynamic clinicians, the theory has

come under criticism for attributing an abstraction ability to the infant that exceeds the cognitive-perceptual capabilities during the first year of life. Hence the developmental timetable is not corroborated by infant observation. Another major criticism is the minimization of the way that real abuse shapes the personality of the child in favor of an emphasis on fantasy. Much of Kleinian theory depends on innate aggression without regard to the environmental influences at work.

The British Independents

Other prominent theorists who contributed to the object relations theory include D. W. Winnicott, W. R. D. Fairbairn, and Michael Balint, who are often referred to as the British Independents. They were sufficiently different from the Kleinians and the traditional Freudians and are recognized as a separate group.

The British Independents viewed the infant's environment as integral to development and deemphasized the drives of sexuality and aggression that were fundamental in Klein's theory. These psychoanalysts viewed the seeking of a maternal object as the primary motivator of the infant instead of gratification of drives as Freud had argued. They also gave greater emphasis to the real environment, in contrast to the Kleinians, who stressed the role of unconscious fantasy.

Many concepts developed from this shift in focus within the object relations theory, including the concept of the 'the good-enough mother,' a term coined by Winnicott. The infant's development depended on a mother or caregiver providing a nurturing and loving environment that met the infant's basic needs. Winnicott also developed the distinction between the 'true self' and the 'false self.' The true self is the inborn tendency to seek self-realization and this can be buried if the responses of the mother/caregiver do not facilitate its emergence. A 'false self' seeking to please the caregiver may emerge instead. Winnicott also made the 'transitional object' part of developmental thinking. This object could be a blanket, or pacifier, or any other object that symbolized the mother during times of separation. The transitional object comforts the child who misses the mother.

Self-Psychology

The theoretical model known as self-psychology was developed by Heinz Kohut and was derived from his observations during the psychoanalytic treatment of patients with narcissistic personality disorder. Unlike object relations theory, which focuses on the internalization of relationships, self-psychology emphasizes external relationships and their impact on the development of self-esteem and self-cohesion. Moreover, Kohut sharply departed from the works of Freud and subsequent ego psychologists by stressing that psychopathology arose from deficits in the self rather than from internal conflict. Hence borderline personality disorder arises from the inability to hold on to others as internal structures who are capable of soothing the self, drug addiction results from a need to fill missing parts of the self, and narcissistic personality disorder arises from being developmentally arrested at an early stage in the evolution of the structure of the self. This developmental

stunting is regarded as secondary to empathic failures in the mother or other caretaker. Subsequently, the personality is forged by attempts at restoring wholeness and balance to a fragmented experience of self.

Mirror Transference

Two fundamental transferences derived from self-psychology and observed in psychodynamic psychotherapy and psychoanalysis are the mirror transference and the idealizing transference. The mirror transference is the patient's attempt to capture 'the gleam in mother's eye' by impressing the therapist. This transference relates to the developmental stage where the child's self-esteem is enhanced by validating responses from the mother or caregiver. If loving and encouraging responses are forthcoming when a young child is performing for the parent, the child's sense of self-worth is validated. On the other hand, when a parent or caregiver fails to empathize with the child's age-appropriate developmental need for a mirroring response, the child has a difficult time developing a healthy self-esteem and is likely to become developmentally arrested at this stage. He is thus 'stuck' in a phase of development in which he is constantly in need of validating, affirming responses from others or he feels fragmented and empty. This mirror transference can be noted during the course of treatment in patients who 'show off' for their therapist as a way of seeking approval.

Clinical Example: Mr. C was a 41-year-old man with narcissistic personality disorder. He came to psychotherapy because he said that his girlfriends, his parents, and the people with whom he worked were constantly hurting his feelings by not giving him the respect and the validation that he warranted. He told the therapist that he was hungry for love and approval, but those in his world were too 'self-absorbed' to provide what he needed. He told the therapist that he was struggling with the same issues that Shakespeare described in Hamlet: 'How weary, stale, flat and unprofitable seem to me all the uses of this world.' Mr. C then looked at his therapist to see if he was getting the response he wished. After a brief silence, he asked his therapist, 'Do you know the play well?' He was showing early signs of a mirror transference in which he hoped to impress the therapist with his knowledge of Shakespeare and capture the 'gleam' in the therapist's eye, a validation of his self-worth.

Idealizing Transference

Idealizing transference emerges in psychotherapy and psychoanalysis when the patient attributes highly positive or even perfect qualities to the therapist or analyst. It stems from a developmental phase when the child's sense of self-esteem and wholeness arises from being in the shadow of an admired and idealized parent who is not only empathic with the child's needs but also provides a positive example for the child. The lack of such an experience is thought to doom the individual to a lifelong search for people in his environment whom he can idealize and from whom he can draw self-esteem. For example, some may seek to be in the company of an idealized politician or rock star because they feel their own self-esteem is enhanced by the reflected glory of the idealized figure.

Kohut proposed that individuals who do not obtain the mirroring or idealization needed from parents will develop a fragmented sense of self and will seek out responses from others to shore up their self-esteem. While Freud suggested that narcissistic needs for self-esteem are ultimately superseded by investing one's love in others (object love), Kohut proposed that these narcissistic needs are never outgrown and that the quest for mirroring and idealization continues throughout life. Those individuals who do not obtain them continue to experience significant psychological distress.

Self-Object

Kohut used the term self-object to describe how others are used as an extension of the self. In other words, a patient in therapy may use the therapist to make up for deficits in the self by trying to influence the therapist to admire and validate the patient. He referred to the patient's need for idealizing and mirroring as self-object functions that were necessary for the maintenance of the self. Late in his career, Kohut viewed these as lifelong needs that are never transcended. He also added a third self-object function, which was described as twinship, or the need to have others who are exactly like the patient. The concept of self-object does not refer to an actual physical person but rather to the responses that the person provides. These responses by others are integral in maintaining a strong sense of self-esteem throughout life. During psychotherapy, a clinician using self-psychology as a conceptual model would seek to strengthen and preserve self-esteem through empathic and validating responses to the patient's needs.

Critics of self-psychology have pointed to its emphasis on parent-blaming, that is, drawing a one-to-one correlation between empathic failures in parenting and subsequent psychopathology in the child. This rather reductive view does not take into account the inherited temperament of the child and the genetic contributions to psychiatric syndromes and personality disorders. This model has also been criticized for minimizing the role of infantile sexuality as a motivator of behavior. However, self-psychology has influenced psychodynamic clinicians to regard the maintenance of self-esteem as a motivator of equal importance to the drives of sexuality and aggression in classical Freudian theory. It has also called attention to the psychotherapist's technique – interpretation of unconscious conflict may need to be accompanied by empathic validation of the patient's needs for self-esteem regulation.

Postmodernist Views

Freud's classical model of psychoanalysis involves a positivist search for objective truth that resides in the patient and is detected and uncovered by the analyst or therapist. A group of psychodynamic models have arisen in response to this modernist position. Collectively, they are known as postmodern theories and they include intersubjectivity, relational theory, and constructivism. They all are skeptical about the existence of absolute truth based on objective observation, and they all hold in common the view that the clinician's perceptions of the patient are inevitably colored by the clinician's subjectivity. They acknowledge the existence of external

reality but stress that both patient and therapist bring their own individually idiosyncratic perspective to bear on that reality. Hence, these theories involve 'two-person' psychologies.

Similar to the British Independents, those therapists who espouse these models tend to view object-seeking as more relevant to human motivation than the pursuit of pleasure. The relational theory of Stephen Mitchell emphasizes conflict like classical ego psychological theory. However, Mitchell conceptualizes the conflict around relational configurations, whereas ego psychology views conflict as involving defense-drive configurations: conflict is between the intrapsychic agencies in the structural model – ego, id, superego.

The intersubjective view is associated with a number of different authors, but the essence is that it is a developmental achievement to fully recognize another person's subjectivity. The theory informs psychotherapy in that it emphasizes the need to see the patient's point of view as growing out of a unique set of experiences in life and working diligently to appreciate that perspective rather than imposing the therapist's perspective on the patient. Moreover, the therapists working from this conceptual model know that they can never transcend their own subjectivity and must take that into account in their efforts to understand the patient.

Constructivism, sometimes referred to as social constructivism, is less concerned about the shift from the drive model to the relational model. This theory emphasizes the need to replace the positivist orientation of the therapist with a constructivist view, namely that there is an ongoing, continuous effect of the therapist's personal involvement on how he or she understands the patient and the therapist–patient interaction. From this perspective, transference is not just the patient's tendency to project figures from his or her past onto the therapist. Rather, the transference is reflecting the REAL behavior of the therapist. In other words, a silent, stone-faced therapist will contribute to a transference in which the therapist is perceived as cold and aloof.

Attachment Theory

Attachment theory was largely developed from the works of John Bowlby, who proposed that attachment is a biologically driven goal of the child to desire physical proximity to the caregiver. Later in life, this converts to a psychological need to develop a bond with a caregiver. The style of attachment can affect an individual's ability to form and maintain relationships with others. Attachment styles are continuous and begin in infancy and are thought to remain relatively stable. Attachment styles are tested in the experimental design known as the Strange Situation in which a toddler is separated from the caregiver, and the toddler's behavior is observed during separation and upon the caregivers return.

During this experiment, four behavior styles have been observed, and later studies have correlated these with attachment styles in adulthood. These behavioral styles are described as secure, avoidant, anxious–ambivalent, and disorganized–disoriented. The secure infant has a desire to be near the caregiver upon return and is able to return to play once this occurs. Adults who show this profile as children usually turn out to be secure and autonomous and value attachment

relationships. The avoidant style involves anxiety with separation followed by being upset with the caretaker on her return. This style correlates with the insecure and dismissing adult who vacillates between idealizing and devaluing past and current relationships.

The third attachment style is the anxious–ambivalent toddler who is observed to have significant distress and anger with separation followed by clinging to the caregiver upon return. This adult version appears as one who is confused and frustrated with past and current relationships. The fourth style, the disorganized–disoriented group, exhibits random and chaotic behavior when coping with the separation. This fourth group correlates with an adult attachment style linked to experiences of trauma or neglect. These adults tend to remain disorganized in attaching with others.

As of yet there are no definitive correlations between these attachment styles and specific forms of psychopathology. However, these modes of relating have a significant impact on adult relationships and may be useful in the dynamic psychotherapy of patients with interpersonal problems. Attachment theory is a foundation in the understanding of neglect and trauma in early childhood and its association with the development of fragmented mental schemas with resultant difficulties in forming and maintaining relationships.

Mentalization refers to a person's ability to conceptualize and understand one's own and others' behavior as a product of their life history, unique subjectivity, biases, thoughts, and feelings. In other words, perceptions are not absolute. They are influenced by one's own mind and do not necessarily correlate with the perceptions of others. This capacity may be impaired in patients with autism spectrum disorders and certain personality disorders like narcissistic and borderline. Mentalization provides a useful conceptual framework for the psychotherapist in understanding the mental state of their patients and its role on behaviors.

This theory evolved from attachment theory and was developed by Fonagy, who noted that the capacity to mentalize grows out of a secure attachment situation in infancy. An individual's ability to mentalize begins during the first few years of life and is believed to be a consequence of the mother or caregiver's capacity to reflect the infant's experiences while providing her own perceptions as well. The mirroring and modeling that occurs during this interaction allows the infant and later adult an understanding of his own internal state. This process is referred to as social biofeedback. The infant finds its own self in the eyes of the mother or caregiver.

The child also learns to interpret interpersonal cues through these early interactions with the mother or caregiver. Core components to this function include understanding affect, emotional regulation, effortful control, the ability to 'read' others, and the development of mental capacities. Thus in adulthood, for example, one can experience a disagreement and understand the other person's emotional state of anger.

All caregiver–infant interactions do not automatically result in one being able to mentalize. These interactions are limited by the congruent mirroring of the caregiver to the infant's emotional state. In addition, the caregiver must be able to simultaneously demonstrate his/her own emotional state as unique from the infants. Hence, a child who injures himself and is saddened can have a caregiver who can identify and

acknowledge this emotion and express empathy. However, she simultaneously expresses her own emotional state of calm and provides comfort to the infant.

Psychopathologic states described in mentalization theory are frequently noted in patients with personality disorders and are the result of failures in the early attachment relationships. Mentalization-based psychotherapy can provide the framework for patients to develop this technique late in adulthood through similar mechanisms as those demonstrated with the caregiver–infant dynamic.

The Use of Psychodynamic Theory in Clinical Practice

As the foregoing material illustrates, psychodynamic theory is not monolithic. The key theoretical perspectives are summarized in Table 2. Psychodynamic psychotherapists are often trained in one particular theoretical model, and they may try to apply that conceptual framework to the clinical material they hear from their patients. Others are deliberately eclectic or pluralistic, drawing from several theoretical models according to which theory seems to fit the patient's problems and personality best. Often psychotherapists develop their own private mixed model that reflects their training, their personal preferences, and their understanding of theory. As all psychodynamic models suggest, therapists will inevitably be drawn to theories because of unconscious factors evolving from childhood experiences. For example, a therapist who grew up with an unempathic mother might well be taken with the model of self-psychology because he/she is still working on issues of self-esteem and self-coherence. Another therapist with a harsh conscience might be attracted to ego psychology because of the emphasis placed on superego forces in that model.

Most psychotherapists would agree that theory should not be artificially imposed on clinical material. The patient's thoughts and feelings must be allowed to go in whatever direction they wish to go. If a theory is not a good fit for the problems of the patient, the therapist must be prepared to think outside of the extant models and learn from the patient. Above all, therapists must tune into the patient to learn about the unique features of each individual regardless of whether there is a perfect fit with a theory.

Technique of Psychodynamic Psychotherapy

Technique in psychodynamic psychotherapy is tailored to the needs of the patient. In general, patients are allowed to set their own goals with the help of the therapist and pursue self-understanding through the process of saying whatever comes to mind and processing personal meanings and patterns that are largely unconscious. Hence the therapist uses a number of interventions with the intent of helping patients become aware of feelings, fantasies, wishes, and relational patterns that may be largely outside of their awareness. Technical interventions are often conceptualized as residing on an expressive–supportive continuum, with the most expressive interventions focused on providing insight through interpretation. The most supportive interventions are designed to bolster adaptive defenses and enhance the patient's self-esteem. Each of these interventions will be briefly defined starting from the most expressive or exploratory and moving toward the most supportive:

- *Interpretation*: an effort to make something conscious that was previously unconscious by explaining a linkage of which the patient was not aware.
- *Observation*: the therapist, stopping short of explanation, simply points out a behavior or pattern to the patient of which the patient was not aware.
- *Confrontation*: the therapist draws the patient's attention to something that was being avoided.
- *Clarification*: the therapist 'repackages' information he/she has brought up to bring greater clarity to it.
- *Encouragement to elaborate*: the therapist simply indicates the wish to have further thoughts or feelings from the patient – for example, 'can you tell me more?'
- *Empathic validation*: the therapist confirms the patient's perspective and acknowledges the patient's feelings.
- *Praise and advice*: these are highly supportive interventions to help the patient's self-esteem or guide the patient through a difficult situation.

All these interventions are used in the context of assisting the patient in the goal of a search for truth about the self. A solid therapeutic alliance must be formed by listening empathically and nonjudgmentally to the patient's life narrative and by

Table 2 Psychodynamic theoretical models

<i>Theoretical models</i>	<i>Major contributors</i>	<i>Core concepts</i>	<i>Key terms</i>
Ego psychology	Sigmund Freud	Conflict between id, ego, and superego	Structural model Defense mechanisms
Object relations theory	Melanie Klein D. W. Winnicott	Unconscious internalized relationships recreated in adult life	Paranoid and depressive positions Transitional object Good enough mothering
Self-psychology	Heinz Kohut	External relationships impact the development of self-esteem and self-cohesion	Mirror transference Idealizing transference Self-object
Attachment theory	John Bowlby Peter Fonagy	Safety based on physical proximity to caregiver	Attachment styles Mentalization
Postmodern theories	Stephen Mitchell Irwin Hoffman	Continuous influence of therapist on patient and vice versa	Intersubjectivity Constructivism

collaborating with the patient in the pursuit of therapeutic goals. Transference is generally not interpreted until it becomes a resistance that interferes with the work. This development could involve negative transference or intensely loving or sexualized transferences.

As the patient talks, the therapist oscillates between empathizing with the patient's subjective view, on the one hand, and offering an outside perspective, on the other, from the therapist's more objective viewpoint. However, therapists must continually monitor their own countertransference, both as a potential interference with the task of helping the patient and as a source of useful information about how the patient affects others in outside relationships. Dreams and fantasies are also carefully explored as valuable sources of unconscious material.

A useful approach to analyzing fantasies and relationship patterns is Luborsky's *core conflictual relationship theme*. This theme usually involves a wish, a fantasy about how others might react to that wish, and then a subsequent response to that reaction. Hence a young man may wish to have a girlfriend, but is convinced that women will reject him. So he avoids the humiliation of rejection by spending all of his time playing videogames. The therapist spends a good deal of time working through these recurrent patterns and themes while attending to resistance, transference, and countertransference. Psychodynamic therapy is usually divided into brief or short-term psychodynamic psychotherapy (STPP) and long-term psychodynamic psychotherapy (LTPP). The former is variously defined as anywhere from 24 to 40 sessions, while the latter is often defined as more than 40 sessions and is generally open-ended, that is, a natural termination is reached when the therapist and patient both agree that the therapeutic work is completed or can be taken over by the patient on his/her own.

In summary, psychodynamic psychotherapy can be usefully defined as a treatment that focuses on thoughtfully timed interpretation of transference and resistance while sensitively appreciating how the therapist contributes to the interaction with the patient.

Empirical Evidence for the Efficacy of Dynamic Therapy

While it was once true that there was little systematic research confirming the efficacy of psychodynamic psychotherapy, there is now a growing body of randomized controlled trials that impressively demonstrate that this form of treatment is highly efficacious. When psychodynamic studies are compared with those of other therapies, the effect sizes for dynamic therapy are as large as those reported for the other forms of psychotherapy. In addition, evidence suggests that patients who receive psychodynamic treatment maintain therapeutic gains and often continue to improve after treatment has ended when follow-up measures are included in the research. In this review of the research, we will first survey the evidence for STPP and then for LTPP.

Short-term psychodynamic psychotherapy

In a meta-analysis of STPP, defined as fewer than 40 sessions, Leichsenring and colleagues found no differences between

STPP and cognitive behavior therapy (CBT) in regard to changes in target problems, general psychiatric problems, and social functioning. The authors concluded that STPP is an effective treatment for a range of psychiatric disorders, including major depression, posttraumatic stress disorder, eating disorders, opiate and cocaine dependence, Cluster C personality disorders, borderline personality disorder, somatoform pain disorder, chronic functional dyspepsia, and social phobia. Another meta-analysis by Abbas and colleagues in 2006 used the same number of sessions to define STPP. The efficacy of STPP was evaluated relative to minimal treatment and non-treatment control subjects for adults with common mental disorders. Outcomes from most categories of disorder suggest a significantly greater improvement, maintained in medium- and long-term follow-up, in the treatment groups versus the control groups.

Long-term psychodynamic psychotherapy

The number of randomized controlled trials that focus on extended or LTPP is smaller than those devoted to STPP, but the number is gradually increasing. Winston and colleagues conducted a controlled trial of 25 patients with Cluster C personality disorders who were treated in dynamic therapy with a mean length of 40.3 sessions. The sample improved significantly on all measures compared with control patients on a wait list. At 1.5 years' follow-up, continued benefits were demonstrated in the subjects.

In a Norwegian study conducted in 2004 by Svartberg and colleagues, therapists were randomly assigned 50 patients who met the criteria for Cluster C personality disorders to 40 sessions of either dynamic psychotherapy or cognitive therapy. The therapists were all experienced in manual guided supervision. The full sample of patients showed statistically significant improvements on all measures during treatment and during the 2-year follow-up period. Patients who received cognitive therapy did not report significant change in symptom distress *after* treatment, whereas patients who underwent dynamic therapy treatment did. Two years after the treatment, 54% of the dynamic therapy patients and 42% of the cognitive therapy patients had recovered symptomatically. The investigators concluded that there is reason to think that improvement persists after treatment with dynamic psychotherapy.

Bateman and Fonagy, in 1999, conducted a study in which 38 patients with borderline personality disorder were randomly assigned to a psychoanalytically oriented partial hospital treatment or to standard psychiatric care as a control group. The primary treatments in the partial hospital group consisted of once-a-week individual psychoanalytic psychotherapy based on mentalizing and three-times-a-week group psychoanalytic psychotherapy similarly geared to mentalization. The control subjects received no psychotherapy. At the end of treatment at 18 months, the patients who received the psychoanalytically oriented treatment showed significantly more improvements in depressive symptoms, social and interpersonal functioning, need for hospitalization, and suicide and self-mutilating behavior. These differences were maintained during an 18-month posttreatment follow-up with assessments every 6 months. Moreover, the treatment group continued to improve during the 18-month follow-up period.

Eight years after entry into the study and 5 years after mentalization-based treatment had stopped, those who received the treatment continued to show clinical and statistical superiority over those in the 'treatment-as-usual' group.

A meta-analysis on the effectiveness of LTPP conducted by Leichsenring and Rabung was published in 2008. Studies of LTPP from 1960 to 2008 were identified by a computer search in this meta-analysis. Only studies with at least 50 sessions or more were included. Eleven RCTs and 12 observational studies made the cut. Effect sizes were calculated for overall effectiveness, target problems, general psychiatric symptoms, personality functioning, and social functioning. These effect sizes were calculated separately for end-of-therapy and follow-up assessment to examine stability of outcome. LTPP showed significantly higher outcomes and overall effectiveness for target problems and personality functioning when compared to shorter forms of psychotherapy. LTPP also yielded significant large and stable within-group effect sizes across various diagnoses and particularly complex mental disorders involving comorbidity of extended duration. Hence the investigators concluded that in the more-difficult-to-treat patients who have a greater comorbidity and more complicated clinical presentations, LTPP may be the best choice.

To gain a greater understanding of the role that length of treatment plays in psychodynamic therapy, Finnish researchers studied 326 outpatients, 84.7% of whom had mood disorders and 43.6% of whom had anxiety disorders. One hundred twenty-eight patients were randomly assigned to LTPP, 101 to STPP, and 96 to solution-based therapy. Forty-two of the patients discontinued treatment prematurely.

To measure outcome, the investigators used standard measures of depression, anxiety, and overall symptomatology. During the first year, STPP was significantly more effective than LTPP. However, at 3-year follow-up, LTPP was more effective than STPP. No significant differences between STPP and solution-based therapy were found at any of the follow-up assessments.

Summary

Psychodynamic psychotherapy is a time-honored mode of in-depth exploration of the patient's internal world and the derivatives of that internal world in the patient's world and daily life. There are a variety of theoretical models that are typically used by psychodynamic therapists, and these models are tailored to the specific characteristics of the patient with the notion that no one conceptual framework explains all the psychopathology. A critical aspect of psychodynamic psychotherapy is to use what transpires within the therapeutic relationship as primary data to understand what happens in relationships outside the therapy. Psychodynamic psychotherapy has now accumulated sufficient empirical evidence

through randomized controlled trials to support it as an efficacious treatment modality. Both STPP and LTPP have been shown to be useful in a range of psychiatric disorders.

See also: [Defense Mechanisms; Id, Ego, and Superego.](#)

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Psychological Predictors of Heart Disease

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Glossary

Coronary heart disease (CHD) Blockage and hardening of the coronary arteries that supply blood to the heart muscle, due to buildup of fatty plaques on the artery wall.

Fight-or-flight response The body's physiological response to significant challenge, involving activation of the sympathetic nervous system and the release of stress hormones.

Hostility Negative thoughts and beliefs about others, including cynicism, mistrust, and denigration.

Self-healing personality A psychosocial reaction pattern that leads to good physical health, characterized by an enthusiastic, positive emotional style, an alert, energetic motivation, and secure, constructive interpersonal relations.

Social support Emotional, informational, or tangible resources provided by family or friends.

Type A behavior pattern (TABP) An emotional and behavioral style characterized by a chronic aggressive struggle to accomplish more and more in the shortest possible time period.

There is substantial evidence that psychological factors predict heart disease and premature mortality. However, the precise causal pathways and causal mechanisms are less clear. Many people assume that stress increases the likelihood of heart disease – a blockage (occlusion) of a coronary artery or an irregular heartbeat (arrhythmia). There is relatively little surprise among observers when a heart attack victim is a stressed-out 50-year-old obese businessman who is known for his habit of chain-smoking cigarettes and compulsively devouring doughnuts while simultaneously screaming into two telephones. The scientific challenge comes in separating fact from stereotype – that is, in discerning which psychological and behavioral patterns predict increased likelihood of heart disease, and why.

There are three basic ways in which psychology and heart disease may be linked. First, psychosocial factors can play a direct causal role in the initiation and progression of coronary disease. That is, specific emotional, cognitive, behavioral, and social aspects of the individual directly and indirectly alter physiological process and cause disease. Second, disease may cause psychological problems. For example, depression may follow a heart attack. In such cases, psychological interventions will obviously not affect health risk unless the factors are also tied through other pathways. Third, underlying (third) variables such as certain genetic patterns can produce both distinctive psychological profiles and elevated disease risk. In such cases, psychological patterns are associated with disease but interventions to affect the psychological factors may or may not have any effect on the likelihood of disease; it depends on the causal paths. All three of these ties between psychological factors and heart disease exist, thus making explanation and simple amelioration a challenge. Nevertheless, much is known about healthier and unhealthier psychosocial living patterns.

Historical Perspective

Psychosocial predictors of heart disease have been noted since ancient times. Biblical proverbs such as “gladness of the heart is the life of a man, and the joy of a man prolongs his days” (Apoc. 30:22) suggested a mind–health connection. The ancient

Greeks were especially keen observers of the relations between psychological factors and illness, and they proposed four bodily humors – black bile (or melancholy, depression); blood (a sanguine, ruddy disposition); yellow bile (choler, an angry bitterness), and phlegm (apathy, lack of feeling). Although their causal mechanisms were wrong, the ancient Greeks correctly observed key psychosocial correlates. Depression, optimism, hostility, and apathy are indeed useful patterns for the understanding of psychology and health.

In the first half of the twentieth century, interest in the psychological predictors of heart disease reemerged, with the influential medical educator Sir William Osler proposing a link between high-pressure activity and coronary heart disease (CHD). The well-known psychiatrists Karl and William Menninger asserted that heart disease is related to repressed aggression. Psychosomatic theorists developed and applied the psychoanalytic notions of Sigmund Freud to their patients, looking for repressed conflict as a cause of chest pain and heart disease, and psychological treatments often seemed helpful. These physicians were trying to account for the dramatic rise in CHD that was occurring in the twentieth century. As the twentieth century was also a time of rapid social and technological change, it made sense to look for explanations in the pressure and demands of modern-day life. However, most of this work was clinical and speculative. It was not until the 1950s that two cardiologists noticed that their patients possessed a distinctive constellation of psychological characteristics and proposed research on the Type A behavior pattern. The cardiologists and their associates began a systematic search for psychosocial predictors of heart disease, which eventually led to four decades of intensive and ever-broadening study, upon which our current understanding rests (even though the initial conceptions were eventually discarded).

Current research indicates that certain people are psychologically vulnerable or resilient because of a combination of temperament and early socialization. When vulnerable people encounter psychosocial environments that are a poor match for their needs, chronic negative emotional patterns often result. These reactions are accompanied by physiological disturbances – high levels of sympathetic activation and

stress-related hormones. Moreover, unhealthy behaviors such as substance abuse also often cooccur. These disturbances interact with disease proneness caused by heredity (e.g., proneness to the buildup of plaque in the coronary arteries) and environment (e.g., diets high in saturated fat), resulting in increased risk of illness that is comparable in size to that of many other commonly noted health risks.

Disease-Prone Personalities

There is strong reason to believe that stress, chronic negative emotions, and poor social relations, usually accompanied by sleep disturbances and unhealthy habits, play a role in the development or triggering of cardiovascular disease and heart attacks. Unfortunately, this psychosocial evidence often receives insufficient attention from a biomedically oriented health care system. For an individual who suffers a heart attack or is diagnosed with CHD, the disease usually has been developing slowly over years or decades. There is a hefty percentage of the population heading for expensive and dangerous coronary bypass operations or coronary angioplasty while psychosocial preventive measures are often given minimal resources.

Initial research (in the 1960s and 1970s) on the Type A behavior pattern focused on individuals who are aggressively involved in chronic struggle to quickly achieve more and more in less and less time (called *time urgency*). However, many active, expressive people often tend to work hard and hurry around like Type A people, but are not at all coronary-prone; on the contrary, they are especially healthy. Research now documents that hurrying around, being very involved with one's job, or working hard is not necessarily unhealthy. Rather, negative emotionality – characterized by chronic negative responses such as hostility, aggression, anger, cynicism, depression, and anxiety – is predictive of disease. Even here, however, the negative emotionality is often not necessarily the cause of the disease. Sometimes, earlier biological predispositions and unhealthy life pathways (involving social instability) are leading to poor coping, negative emotions, and disease.

Use of the statistical technique called meta-analysis (a quantitative method to combine the results of multiple studies) has allowed investigators to address the broad issue of psychological predictors of heart disease by looking at the size of effects, patterns of findings, and reasons for discrepancies in the scientific literature. Across both cross-sectional and longitudinal studies, hostility, anger, and depression are linked to CHD, often even after controlling for many other risk factors (age, sex, smoking, blood pressure, cholesterol, physical activity, diabetes and insulin resistance, social class, and heavy alcohol use).

Interestingly, the same patterns of psychosocial disruptions that predict heart disease also often predict incidence of other diseases and all-cause premature mortality. Therefore, Howard Friedman has developed the concepts of *disease-prone personalities* and *self-healing personalities*.

Social Integration

A variety of sociological and epidemiological investigations indicate that people who are well integrated into a stable community are less likely to develop heart disease or to die

prematurely. Friendly ties with family, friends, associates, and the community – often called *social support* – are beneficial in coping with stressful events and life changes, as well as in promoting healthier life patterns. Conversely, loneliness and the loss of social ties can have negative health effects. Lonely, anxious individuals experience more stress, both objectively and subjectively, and may experience higher levels of chronic physiological arousal. Bereaved individuals, especially men, have an increased risk of heart attack and sudden death – dying from a 'broken heart.'

How does social support work? Social support can influence how an individual views stressful events – the perceived severity of the situation and the need for an ensuing emotional response. Second, social support can help the stressed individual to develop coping strategies by providing practical information. Third, social support can provide tangible resources, such as healthy meals or rides to the doctor. Many times, an individual also benefits by assisting someone else who is facing similar challenges. Each of these types of support can be helpful, although it may be most beneficial when the type, amount, and provider of support match the needs of the recipient. Support might be harmful if it makes the individual feel inadequate, indebted, or unduly manipulated.

Social support is especially important when a person faces a severe challenge such as managing chronic cardiovascular illness. One of the biggest challenges is adhering to medical recommendations such as eating a heart-healthy diet, engaging in daily moderate exercise, and taking medication that will control symptoms, prolong life, and maintain quality of life. Family and friends can provide reminders, encouragement, and motivation to adhere to treatment regimens. However, individuals who need social support the most often receive the least support. Depressed individuals often become apathetic and withdraw from others, losing the chance for benefits that social integration provides. Hostile and cynical people are more likely to have interpersonal conflict, which can destroy social ties while simultaneously exacerbating tendencies toward physiological hyperreactivity (and stress on the cardiovascular system). There is good evidence that people who live in stable families and in stable communities are more protected from heart disease, especially if the quality of these relationships is good, and if there are associated patterns of healthy behaviors such as staying active and avoiding smoking and substance abuse.

Causal Mechanisms

There are two main pathways through which psychological factors can bring about increased likelihood of disease: psychophysiological mechanisms and behavioral mechanisms. Both of these also often involve biopsychosocial predispositions that develop earlier in life.

Psychophysiological Mechanisms (Nervous, Endocrine, and Immune Systems)

In response to danger – real or perceived threats – there is a physiological disturbance involving high sympathetic activation in the autonomic nervous system. Commonly termed

the 'fight-or-flight response,' this activation is an automatic and immediate internal response. Stress hormones such as epinephrine and norepinephrine affect all parts of the body, with both sudden and long-term effects.

An immediate effect may be sudden death via autonomic nervous system-induced arrhythmias of the heart. A severe psychological stress, such as witnessing a shocking scene of mutilation, can be as disruptive as a severe physical stress such as shoveling heavy snow. The heart may beat uncontrollably and irregularly, and then fail, causing sudden death. Such irregular, fatal heartbeats are much more probable when there is partial preexisting heart disease. However, such fatal events are relatively rare, especially as compared to slowly progressing chronic artery obstruction.

Links to chronic CHD are slower and more complex. CHD starts with an accumulation of lipid (fat) within the coronary arteries. To attempt a repair, the body deposits lipoproteins in the artery walls. Calcification (hardening) occurs, forming plaque, and over time the artery walls thicken, partially blocking the artery (called atherosclerosis). As blood flow is slowly impeded or a clot suddenly forms, oxygen needs may exceed supply (myocardial ischemia), and can lead to chest pain (angina pectoris) and unstable heart rhythms (arrhythmia). If enough of the blood flow to heart muscle is blocked, the heart will begin to die and stop beating – a myocardial infarction. Such clinical manifestations of the disease may occur decades after the damaging processes begin, affected in part by psychological and behavioral contributors.

Individuals who show an exaggerated psychophysiological response to stress or face excessive stressful challenges show high levels of what is termed *cardiovascular reactivity* (CVR), evidenced by high blood pressure and heart rate, increased sympathetic activation, reduced parasympathetic deactivation, and increased cardiac output and resistance. Both animal and human studies suggest that CVR contributes to or hastens the development of CHD. For example, in a series of experimental studies with monkeys, social stress (and competition) promoted atherosclerosis among monkeys straining to maintain a position of social dominance. When the composition of monkey groups was changed by the experimenter, the monkeys struggling for dominance faced ill health. Monkeys with the greatest heart-rate reactivity showed the most coronary artery damage and acted more aggressively, again suggesting the relevance of the 'fight-or-flight' physiological response. These experiments confirm clinical studies of humans regarding excessive aggressiveness, hostility, and struggle. All else being equal, the regulation and modulation of sympathetic arousal is likely to promote physical health, in both monkeys and people.

A second but related pathway linking psychosocial factors and CHD is through the endocrine system. In the fight-or-flight response, the endocrine system is also activated, as cortisol and related stress hormones are released. Both nervous system arousal and other forms of psychophysiological imbalance such as depression alter the usual complement of bodily hormones. Stress, helplessness, and depression are linked to high cortisol levels, and stress, anger, and frustration are linked to high levels of catecholamines (such as of norepinephrine). Other stress-related or stress-influenced hormones such as thyroxine and testosterone have also been shown to play a

significant role in stress-related homeostasis and physical health. Depression and the related hormonal irregularities are thus a common correlate but not simply a cause of heart disease. Treating depression may have no effect on the likelihood of recurrent heart disease unless other processes related to the atherosclerotic processes are also affected.

A third pathway linking psychosocial factors and CHD is through the immune system. There is increasing evidence that immune dysfunction is linked to CHD. For example, leukocytes play an important role in tissue repair; when overactive, these can adversely affect the cardiovascular function. After a cardiac event, the immune system helps repair damage; when it is malfunctioning under stress, this repair goes awry. Inflammation – the organism's reaction to infection or injury – involves the immune system and the vascular system attempting to heal the body, and such inflammatory processes are thought to play a role in many disease processes including heart disease. Inflammation can be exacerbated by stress and is known to be associated with chronic depression, and so it is increasingly a focus as a mediating link to disease. However, the links are undoubtedly complex, as inflammation, immune response, stress, depression, and behavior are all known to affect one another.

For each of these psychophysiological mechanisms, research studies have uncovered psychosocial factors that predict reactivity, hormonal imbalance, and disrupted immune function. However, no study has yet followed the whole process in humans, showing for example that hostile people develop certain psychophysiological disturbances that impair metabolism and thereby bring on heart disease, but there is increasing support for the different pieces of the model.

Behavioral Mechanisms

Personality-based behavioral patterns directly influence cardiac health and interact with psychophysiological mechanisms to indirectly influence health outcomes. There is strong evidence that smoking, substance abuse, physical inactivity, poor diet (high in saturated fats and low in vegetables), and obesity increase risk of heart disease. Many of these behaviors are affected by individual differences. For example, hostile, impulsive, and neurotic people are more likely to smoke, drink to excess, overeat, and/or use drugs, thereby increasing their risk of heart disease.

One of the most important health behaviors affecting the course of heart disease is adherence to treatment. Although logically a person with CHD should follow the doctor's recommendations, a host of individual psychosocial characteristics affect whether a patient will take medication, follow a proper diet, return for follow-up, and so on. The patient's sense of self-efficacy, confidence that success is achievable, perceived behavioral control, internal motivation, support by others, and personality traits relate both to healthy behavior and success in changing unhealthy behaviors. In particular, conscientious individuals are likely to adhere to treatment and to engage in more healthy behaviors and fewer risky behaviors. Conscientiousness is a solid predictor of both CVD and risk of all-cause mortality. Hostility and anger can also endanger the doctor-patient relationship, making adherence more challenging. Further, tendencies toward denial, isolation, or excessive optimism may result in a deadly delay in seeking treatment.

Depression is not only associated with a range of hormonal disruptions but is also correlated with a host of behavioral risk factors for disease, including disturbances in eating and sleeping, impaired social relations, and substance abuse. Here again, multiple causal pathways are implicated, but the full causal model has not been tested. Prospective clinical studies of depression and disease in humans, combined with experiments using animal models, could prove especially informative if they also included genetic predispositions, psychophysiological measurement, assessment of health behaviors, and heart disease and other disease outcomes over long periods of time.

Noncausal Effects

A part of the association between psychological variables and heart disease is due to noncausal pathways, or to effects that are only partially causal. This is important because if the psychological predictor is a correlate but not a causal element of disease, then changing the psychology will not prevent or treat the disease.

The development of heart disease can produce dramatic psychosocial changes in the patient's life. Heart attack victims (who survive) may become angry at the world for their plight, or they may become depressed over the new limitations on their activities. They may lose their job or be treated differently by their employers or colleagues. Sexual relations with one's partner may change, as fear, fatigue, or resentment enters the relationship. Immune system alterations may further induce depression and isolation. In all of these cases, psychological and behavioral patterns are a result rather than a cause of heart disease. Nevertheless, these factors or patterns sometimes may then predict or contribute to further deterioration, through the causal mechanisms described above.

Some disease predictors may act differently following a heart attack. For example, anxiety sometimes contributes to the development of heart disease, but not its progression. In fact, anxiety after angina or an attack may prove helpful if it leads the patient to cooperate more fully with medical treatment. We should not expect the same factors always to predict disease and recovery from disease, although this error of inference is often made.

Spurious relations (falsely seen as causal) between psychological variables and heart disease may result from underlying third variables that produce both the psychological characteristics and the disease. A more complicated case involves various genetic patterns that affect both personality and health. For example, aspects of the same genetic predisposition may make one more susceptible to both anxiety or depression and heart disease. In such cases, interventions to change these aspects of personality would not necessarily lead to improvements in health, unless other mediating mechanisms are also affected.

A final type of noncausal association between psychological variables and heart disease results from methodological artifacts – errors in the design of the study. A common artifact in this field is a selection artifact or bias. For example, neurotic individuals are more likely to report symptoms and seek out medical care than nonneurotics, even when there is little or no discernable organic disease. In a study of personality and heart

disease, a large percentage of the patients may be neurotic, because those worriers are the individuals who are especially likely to visit the doctor and be included in the studies. Similarly, an interesting relation can emerge in which neuroticism appears to be inversely related to arterial blockage, as only the neurotics with clean or with damaged arteries, and the nonneurotics with true blockage-caused pain, are in the sample. The nonneurotics with clean arteries do not worry, and do not wind up in the doctor's office, so they are inadvertently omitted from the study. This artifact might obscure a true causal relation between neuroticism and the development of disease, and so such artifact-biased studies should never be undertaken.

Self-Healing Personalities

In the field of medicine, it is too often assumed that health is simply the absence of disease. A negative test result is good news – it means the disease is not there. Studies and theories tie stress and negative emotionality to illness, disease, and mortality. However, until relatively recently, little attention has been paid to the positive, proactive elements of good health.

What is a healthy psychological pattern? A self-healing personality can be characterized by enthusiasm for life and emotional balance, with good social relationships. Such people are curious, secure, constructive, responsive, and conscientious. They may be alert and energetic, or calm and self-assured. They are people one likes to be around, infecting others with their natural *joie de vie*. Self-healing individuals are hardy, feeling a sense of personal control in their lives, being committed to a higher ideal or cause, and interpreting stressful events in terms of meaningful challenge. They are inspired toward continual growth and resilience. These characteristics of the self-healing personality are not merely the opposite of disease-prone characteristics such as suspiciousness, bitter cynicism, despair and depression, loneliness, or repressed conflicts, but are positive, meaningful motives in their own right.

Positive emotionality and psychological maturity may protect one from illness and promote health through multiple pathways. Physiologically, positive emotions may buffer autonomic and hormonal responses to stress and restore parasympathetic processes sooner, essentially undoing the effect of CVR and physiological arousal. If there is less need to constantly reestablish homeostasis, there is less accumulated strain on the cardiovascular system over time. Socially, positive and mature individuals tend to have better relationships with others, and so will tend to have better individual and social coping resources. Behaviorally, positive and psychologically mature individuals tend to have healthier behavior patterns – more physical activity, better diet, and less smoking and substance abuse.

Dr. Walter Cannon, who developed the ideas of homeostasis upon which modern notions of self-healing are built, emphasized that the body has developed a margin of safety. By this, Cannon meant that the body has allowance for contingencies that we may count on in times of stress. The lungs, the blood, and the muscles have much greater capacity than is ordinarily needed. In other words, the body naturally prepares itself for the rare 'extra' challenge, and self-healing people do what they can to increase these margins of safety.

William James, who anticipated much of our modern scientific understanding of emotional responses, summed up this idea succinctly as he advised:

Keep the faculty of effort alive in you by a little gratuitous exercise every day. That is, be systematically ascetic or heroic in little unnecessary points, do every day or two something for no other reason that you would rather not do it, so that when the hour of dire need draws nigh, it may find you not unnerved and untrained to stand the test (*Principles of Psychology*, 1890, Chap. 4).

Like much of social and behavioral science, psychosocial prescriptions for good cardiovascular health often sound like 'common sense,' until the matter is examined more closely. In actual fact, it is very difficult to walk the fine line between narrow-minded biomedical views of the nature of health that exclude psychosocial factors, and the unscientific touchy-feely health gurus who proclaim oversimplified and overgeneralized prescriptions for good health.

Interventions

What psychosocial interventions can be made to prevent, reverse, or halt the progression of heart disease? Given that cardiovascular disease is by far the greatest cause of premature mortality in economically developed countries, and given that social and economic costs of heart disease are overwhelming for both families and society, what can be done? Because the various elements of a self-healing personality are usually inter-correlated, teasing out the causal pathways and the best interventions remains a major challenge.

There is good evidence that lifestyle changes affect the incidence of heart disease. Most of this evidence is epidemiological and anthropological, showing that when people move from one country or one cultural group to another, their heart disease rate can change dramatically. There is also some experimental evidence indicating that dramatic lifestyle changes can improve aspects or correlates of cardiovascular health. A serious problem with this work is that little is known about which components of the healthy, self-healing lifestyle are the necessary causal elements.

For example, consider Japanese immigrants entering America. They leave a close-knit, well-ordered society with an Asian diet and Asian recreation patterns, and they (or their children) enter an individualistic, heterogeneous American society with very different social and recreational patterns and a hamburger stand on every corner. If heart disease rates rise, what is to blame? Nutritionists might point to fish oils or fat intake; religionists may point to meditation patterns; sociologists may point to family structure; psychologists may point to stress reactions. We simply do not know for sure. There is evidence that some or all of these points may be valid.

What about specific recommendations that are often heard regarding individuals at risk for an initial or recurrent heart attack? For example, is it unhealthy to work long hours? There is no evidence at all that it is unhealthy to be a 'workaholic' if all the other elements of self-healing are in place. That is, hard work and long hours themselves have not been shown to be a risk factor. On the contrary, for example, many powerful or influential executives, leaders, artists, and scientists work

exceedingly long hours and live long and healthy lives. Instead, the individual's response to and success in the work environment are more important.

Is it healthy to retire and get away from the stresses of the workplace? In fact, retiring may be helpful or it may be very stressful and unhealthy, depending upon the particular individual and the particular situation. Retirement may be healthy if it reduces the psychosocial stress of the workplace and increases opportunities for healthy habits. Retiring has been shown to be unhealthy if it results in a diminution of social ties, inadequate financial resources, and psychological states of uselessness or boredom. In addition, changing societal reactions to retirement can be extremely important – in terms of social security programs, health insurance, laws that prohibit age discrimination, opportunities for educational and social activities, and so on.

Can heart disease be prevented or reversed by relaxation techniques? With the attention to the negative role of stress, some studies consider stress-reduction techniques, such as yoga and meditation. However, the general efficacy of these programs is still unknown. Is chronic stress a risk factor for heart disease? Yes. Has it been shown through controlled study that meditation is key to reducing the incidence of heart disease? No. Meditation is wonderful for some people, but others may find it stressful or impractical. It may be more important to match stress-amelioration techniques to individual preferences and situations.

Is it healthy to be optimistic and look on the bright side? Although it seems to be the case that a sense of willpower and positive hopes for the future can help us through difficulty, it is also true that optimism can lead us to be shocked by reality or to avoid taking necessary prophylactic measures. It makes sense, as has been found, that for a heart disease surgical patient, optimism is helpful. It does not, however, make sense to assume that optimism will prove helpful to a chain smoker or an ice cream addict. The emphasis on optimism without sufficient regard to context is an example of the futile search for the psychosocial equivalent of a 'miracle drug' that can cure all diseases.

Are societal pressures that encourage jogging the key to protecting one's heart? It is very clear that a cigarette-smoking obese person who cannot walk up a flight of stairs is at markedly increased risk of heart disease; and this often has led to the incorrect belief that being in shape means the ability to run 5 miles every morning. Moderate exercise, such as a brisk walk each day, may be sufficient to provide cardiovascular benefits. It is probably even better if the individual develops a more active daily lifestyle, even if it does not include any formal 'exercise.' Such lifestyle changes are more likely to be maintained. People who constantly struggle to 'get in shape' may be harming their health.

Few specific recommendations to make psychological changes to prevent heart disease are supported by strong, systematic, long-term human research. Further, most studies have focused on male participants or ignored possible gender differences, even though there is some indication that women experience different stressors and have different psychophysiological responses. Psychosocial factors do increase risk of the development and progression of heart disease. However, it remains unclear what interventions work, who should receive them,

and when we should intervene, beyond the encouragement of psychologically mature individuals who are well integrated in their communities.

Conclusion

Contrary to some common conceptions, most of the increase in life expectancy in the developed countries has come not from high-technology medicine but rather from improved sanitation, infection control techniques, low-cost inoculations, better nutrition, and other public health improvements. Antibiotics have also made a significant difference, but visits to super-specialized cardiac surgeons at university hospitals produce limited impact overall when the big picture is considered. This is not to say that a heart disease patient would not be wise to seek out a cardiac specialist, but only that the overall public health benefit of such high-cost cardiac surgery is relatively small. However, there is reason to suspect that dramatic (and lower-cost) improvements can be realized if we put our knowledge of self-healing to good use. Societal and lifestyle changes may be the psychosocial equivalents of improved sanitation, nutrition, and infection control.

Major reports are regularly published breaking the 'news' that some medical researchers are now urging that psychological and emotional reactions of patients be taken into account. Such considerations generally still lie outside the traditional medical model of disease that focuses primarily on pharmaceuticals and surgery. Individuals who learn their own psychosocial needs, expand their social ties, and develop appropriate techniques of self-regulation and better habits can maximize their potential for good health. Moreover, these psychological styles can be significantly complemented by societal structures that promote such healthy reaction patterns and behaviors.

See also: Anger; Behavioral Medicine; Behavioral Pharmacology; Depression; Homeostasis; Hormones and Behavior; Personality

Development and Aging; Self-Efficacy; Social Support; Stress and Blood Pressure Dysregulation; Stress and Illness.

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Psychology and Religion

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Glossary

Entheogens A term preferred by scholars of religion who believe that certain chemicals, formally called psychedelic, can facilitate religious or spiritual experiences.

Extrinsic religiosity Motivation for religion based upon utilitarian motives.

Fundamentalism Originally a Protestant movement affirming the Bible as God's revelation and rejecting hermeneutical based criticisms of the text. It is now controversially applied to any faith tradition that rejects modern and postmodern criticism of a sacred text or tradition.

Intrinsic religiosity Motivation for religion as an end in end in and of itself.

Parapsychology Refers to a range of experiences, such as telekinesis, clairvoyance, and channeling that may be seen as

embedded within religious traditions or as alternatives to them.

Postmodern A generic term that refers to a multiplicity of perspectives and methodologies none of which is viewed as privileged.

Quest religiosity Religious motivation primarily focused upon existential concerns.

Reductionism The claim that complex phenomena can be sufficiently explained by simpler phenomena upon which they are dependent.

Spirituality Refers to connection to the transcendent that may or may not be interpreted in religious terms.

Transcendent Refers to the ultimate object of interconnectedness, whether interpreted in religious or secular terms.

Psychology and Religion

Religion Defined

Religions have (1) a concern with transcendent reality (whether or not perceived in personal terms); (2) a sense of ultimate concern; (3) a consensus of belief concerning the nature of ultimate reality that is institutionally supported; and (4) imperatives to act according to beliefs regarding transcendence, often including specific rituals that affirm faith. Few would accept as religious any tradition that was devoid of all four criteria. Increasingly religion is seen as a pejorative term linked with a Eurocentric perspective.

Psychology Defined

Psychologies have (1) a concern with a specific method or range of methods to acquire knowledge; (2) a focus upon how it is that reality is constructed by mental processes; (3) the exploration of sequential changes that occur across the life span; and (4) treatments for psychopathologies. Few would identify as psychological any discipline devoid of all four criteria. It is the lack of consensual definitions of both religion and psychology that forces us to explore what particular psychologies have to say about particular religions.

History of Psychology and Religion

As a cultural phenomenon, religion is at least as old as recorded history. The roots of scientific psychology had been laid by philosophical developments that influenced the natural sciences, especially the union of empiricism and mathematics. By the middle of the nineteenth century, European and American scientists had begun to measure the speed of nervous

transmission and to conduct psychophysical experiments. Psychology had its uneasy origins in such activities as it attempted to emulate the natural sciences. Many date the origin of scientific psychology with the founding of a laboratory at Leipzig in 1879 by the German psychologist William Wundt. Psychological interest in cultural phenomena such as religion was seen as requiring methods other than those of the natural sciences. In American culture, psychology and religion were at odds and neither could be explained by the other. William James was most articulate in exposing this dilemma and argued that natural science assumptions were only a provisional beginning for psychology and need not exhaust the metaphysical options available. The debate over the natural science constraints on knowledge continues to characterize psychology today.

American Psychology and Religion

Interest in spiritualism was strong in nineteenth century America and associated in the popular mind with psychology, largely in opposition to mainstream religious denominations. In Europe, the Society for Psychical Research was founded in 1892 to investigate paranormal phenomena. In America, spiritualism was associated in popular culture with psychology and helped account for the establishment of psychology departments in American universities. William James founded the American Society for Psychical Research (ASPR) in 1894. Many members (who were also to become members of the American Psychological Association whose first annual meeting was held in 1892) assumed that a scientific psychology would dispel the reality of parapsychological phenomena in favor of reductionist explanations based upon natural science assumptions. Several of America's newly identified psychologists quit the ASPR when the organization was perceived to support the reality of spiritual claims. The rapid growth

of psychology in America was due to the paradoxical alliance of psychologists who took as their task the establishment of the validity of psychology by debunking paranormal and spiritualist claims and the common cultural view that the new science was providing support for the reality of paranormal phenomena. This uneasy alliance characterizes the study of psychology and religion in America today, especially in terms of large funding organizations that are perceived to encourage psychologists to support religious and spiritual claims.

Hall, Starbuck, and Leuba: The Clark school

G. Stanley Hall was the first president of the APA and one of those who quit the ASPR. He also founded the first American journal for the psychology of religion (*The American Journal of Religious Psychology and Education*) and established the only school of psychology of religion in America, the Clark school. Two members of that school illustrated the tensions between psychology and religion noted above that continues today.

Edwin Starbuck utilized questionnaires to study religious experience and development. He also employed simple quantitative methods to determine the age at which conversion was most common. His sympathy to religion, particularly evangelical Protestantism, accounted both for his interest in conversion and his avoidance of reductionist explanations. He was content in simply charting the path of religious development.

In contrast, the other most notable member of the Clark school, James Leuba, noted the clash between religious beliefs and advancement within the natural sciences. He used questionnaires to document the decline in belief in a personal God and personal immortality among the more accomplished natural scientists. He also provided reductionist assessments of mystical experience.

James and Pratt: The descriptive tradition

William James, a founding member of ASPR and twice president of APA, illustrates another uneasy alliance between psychology and religion. James' Guilford lectures, published as *The Varieties of Religious Experience*, have proven to be the one undisputed classic in the psychology of religion. It has been continuously in print since the first edition in 1902 and is the text most cited in the contemporary study of psychology and religion in America. In the *Varieties*, James painstakingly described extreme cases of religious experience in sympathetic fashion, and affirmed the pragmatic nature of their truth. James Pratt, a student of William James, extended his mentor's work by focusing upon less extreme and more common religious experiences. His *The Religious Consciousness* (1920) is second only to James' *Varieties* in the number of reprinting in America. Neither James nor Pratt relied heavily upon the emerging methods of scientific psychology. The popularity of their work rests largely upon rich descriptions of and sympathy for religious experience.

By the end of the 1920s American psychology was firmly established and, as it courted measurement and experimentation, the study of religion waned. The emergence of behaviorism left little room for the study of religion other than as a system of behavioral controls. Not until the early 1960s would the psychology of religion reemerge, largely linked to the

counter cultural revolution that arose on America's west coast. However, the focus was less upon denominational religion than new religious movements and the psychology of altered states of consciousness. The shift to spirituality as opposed religion had its roots here. Religiously affiliated schools offered APA accredited graduate psychology degrees assuring a sympathetic study of religion. Thus, the contemporary psychology of religion in America is following its early history, swerving between the Scylla of a religious apologetics and the Charybdis of a naturalistic reductionist interpretation of religion.

Classical psychoanalysis and religion: Freud

We have emphasized that there are varieties of psychologies associated with various schools based upon incommensurable assumptions. Psychoanalysis, founded by Sigmund Freud, emerged from the medical tradition and a concern with psychopathology. As with analytic and object relations theory to be discussed shortly, psychoanalysis was largely European but had an influential effect on American culture that only today is waning. No psychology has had as much influence on culture, arts, and literature as psychoanalysis. It also provided a powerful reductive explanation of religion. Critics of psychoanalysis note that it postulates its own myth of early childhood drama (the ontogenetic thesis) and of early humankind (the phylogenetic thesis) in what became the cornerstone of classical psychoanalysis. The Oedipal drama, especially for males, linked the desire for the mother with that of disposing of the father in a dynamic seen as thinly masked in both Judaism (a religion of the father) and Christianity (a religion of the son). Ultimately Freud saw religion as a falsification of reality. God was interpreted as a projected idealized father derived from the Oedipal drama. The decline of religion was predicated on Freud's assumption that it characterized the infantile stage of humankind. While American academic psychology largely ignored religion from 1930 through 1960, psychoanalysis in its classical Freudian variety produced literally thousand of articles and books providing a huge cultural impact on how Europeans and Americans viewed themselves. Efforts to test psychoanalytic theories by naturalistic scientific methods have, not surprisingly, found psychoanalytic theories largely deficient. However, whether theories based upon radically different assumptions can be tested by a single set of methodological criteria remains philosophically problematic. Furthermore, there are contemporary psychoanalysts who use Freud's theory to support traditional religious beliefs, especially by focusing upon the role of illusion (desire) in motivating belief while rejecting the claim that psychoanalysis can be provided criteria by which culturally shared beliefs can be proven delusional. Psychoanalysis is thus no longer interpreted as necessarily hostile to religion. This parallels the phenomena already noted with other American psychologies.

Analytic psychology: Jung

Among Freud's most famous early followers and one of the few non-Jewish psychoanalysts was Freud's hand-picked successor and eventually his greatest rival in the study of religion, Carl Jung. Jung quickly rebelled from the reductive explanation of religion proposed by Freud. He proposed a collective

unconscious centered upon the identification of archetypes seen as conscious manifestations of inherited instinctive tendencies. While academic psychology has largely ignored analytic psychology, Jung's theories continue to be influential in religious studies; they are seen by some as a spiritual alternative to traditional religion.

Object relations theories

Within the psychoanalytic tradition, continued interest in religious experience has been maintained by object relation theorists. The term comes from the focus upon objects confronted by infants' experience of the world. Obviously the earliest objects of experience include the primary caretaker, typically the mother. Characteristic of object relations are pre-Oedipal experiences, giving the mother (or parts of her body, such as breasts) a prominent role in theorizing. This has produced a variety of theories more sensitive to gender issues since many religious experiences are seen as rooted in infantile pre-Oedipal experiences with the mother and hence minimize the role of the father so prominent in classical psychoanalysis. While extremely diverse in their views, object relation theorists share a sympathetic view of religious experience, so much so that they have often been accused of being apologists for religion.

Transpersonal psychology

Interest in integrating spiritual phenomena directly into psychology has long been championed by transpersonal psychologists. Emerging out of the humanist psychology championed by Abraham Maslow, transpersonal psychology aims to explicitly provide an alternative to both the scientific psychology and the variations of dynamic psychologies discussed above. Transpersonal psychologists tend to integrate spirituality and science in what many see as a modern form of Gnosticism. Thus, few American universities have courses in transpersonal psychology. However, the influence on popular culture in Europe and America is great. While some free standing schools offer degrees in transpersonal psychology, most with a clinical focus, its influence remains largely associated with various forms of New Age Religion and popular culture, not academic psychology.

Cultural psychology

The mere fact of methodological pluralism and the inability of psychology to become a unified discipline contributes to its continued fragmentation such that histories of psychology often organize their texts around schools of psychology. Among the more recent schools is cultural psychology. Since religion is treated as a cultural product there can be no psychological explanation of religion per se. Cultural psychologists explore how individuals meaningfully appropriate religious beliefs. The focus for cultural psychologists is on religious diversity and not upon an overarching theory that explains something called 'religion' in the singular.

The Dominance of American Psychology

The success of psychology in America has always been associated with its rapid development as a profession, especially clinical psychology. Major journals published by the APA

assure the world dominance of American psychology and set what is the gold standard for publications. What emerged as a counter-organization to the APA focused more upon research that the clinical practice of psychology, the American Psychological Society (APS), has from its inception allowed identification of religion as a specialty.

However, it has not been able to make a serious challenge to the APA. In 2009, the division of the Psychology of Religion of the APA launched *Psychology of Religion and Spirituality*, beginning the first official APA journal dealing exclusively with religion. The inclusion of spirituality in the title indicates a broadening of the field that promises to be a permanent part of the religious landscape in American psychology discussed more fully below. The number of journals that deal with the psychology of religion continues to increase, indicating both the strength and fragmentation of the field. The Religious Research Association continues to sponsor a journal, *The Review of Religious Research*, favoring empirical studies of interest to churches and denominations. The Society for the Scientific Study of Religion has long sponsored the flagship journal in the scientific study of religion, *Journal for the Society for the Scientific Study of Religion*. More recent journals include *Research in the Social Scientific Study of Religion*, *Mental Health, Religion, and Culture*, *The International Journal for the Psychology of Religion*, and *Spirituality and Mental Health International*. Despite the tendency to include 'international' in many of the titles, research reported in journals devoted to the study of religion continues to be dominated by Americans or by researchers employing the methods championed by American psychologists. The longest continuous publication in the psychology of religion, *Archive for the psychology of Religion* (*Archiv für Religionspsychologie*) continues to be published in Germany and in 2009 switched from a yearly publication to three volumes per year. New journals devoted to the study of religion and spirituality compliment long standing journals with more explicit confessional concerns such as *The Journal of Psychology and Theology*, *The Journal of Psychology and Christianity*, and the *Journal of Psychology and Judaism*.

Psychology of Religion in Global Perspective

The emergence of journals devoted to the study of religion and spirituality with 'international' as noted above indicates that a distinctive American psychology of religion is becoming more global. While still primarily focused upon the Christian tradition and employing methodologies and statistical procedures championed by American psychology, the psychology of religion in Europe continues to be substantial. However, European psychology of religion remains more receptive to phenomenological, dynamic, and hermeneutical studies than does American psychology.

The psychology of religion in countries such as Australia, Canada, Israel, and the Scandinavian countries have only recent histories and thus do not reflect a reemergence that characterizes American psychology of religion. In contrast, Asian and Eastern cultures have been long histories of the psychology of religion minimally influenced by American psychology and have developed psychologies less distanced from philosophy and religion than American psychology.

Major Methodological Stances in the Psychology of Religion

Given that there is no unified science of psychology, one cannot expect consensus on either methods or procedures for the psychology of religion. Within American academic psychology in general, the emphasis has been on measurement and experimental studies. However, even among the most vocal proponents of this American style, psychology is the recognition that at best the psychology of religion can be approached by quasi-experimental studies in which true random assignment of participants to experimental and control groups and control over independent variables are impossible. Those not convinced that psychology can or should be a natural science employ methods uniquely adapted for humans, including a wide variety of phenomenological and hermeneutical studies. Below we shall explore some of these diverse methods.

Quasi-Experimental Studies

American psychology has long elevated the experimental method to the gold standard for empirical research. American psychologists of religion have thus striven to elevate the respect for their discipline by emulating this method. The experimental method requires that participants be randomly assigned to experimental and comparison groups so that true variation between groups can be assessed and attributed to a factor or factors manipulated by the experimenter. For a variety of reasons, this often cannot be done with studies in the psychology of religion. Studies of the efficacy of prayer are a notable exception. Hence, psychologists have turned to quasi-experimental methods as the closest approximation to the true experiment. Quasi-experimental designs are employed when randomization is impossible. They are often employed in natural settings where differences between groups can be assessed even though participants were not randomly assigned to these groups. Still differences between experimental and comparison groups can be measured. Three areas in which quasi-experimental studies by psychologists have been common are in isolating religious determinants of helping behavior, in conditions that facilitate the report of religious and mystical experiences, and in studies of the relationship between religion, spirituality, and health.

Measurement Studies

Many psychologists consider the ability to assign numbers to phenomena an essential characteristic of scientific psychology. Religious phenomena are no exception in this view insofar as their scientific study requires their ability to be measured. Questionnaires and scales have been developed for the widest possible range of religious phenomena, from beliefs about God, to reports of religious experience, to the motivational basis for religious involvements, to fears and anxieties about death. Most measurement studies are rooted in paper and pencil self-reports but increasingly psychologists of religion are relying upon implicit measures of religion using such indices as delayed response time.

Correlation Studies

Modern sophisticated statistical techniques allow for multivariate research in which several variables can be simultaneously related. Various types of factor analysis allow for the construction of scales with reliable subscales permitting more sophisticated assessments. Regression analyses and structural equation modeling allow for the prediction of religious variables suggesting but not confirming possible causal explanations. The fact that no matter how sophisticated the statistical technique, essentially correlational data cannot prove causation assures a range of disputes as to the causal meaning of any correlation data. This is especially common in studies exploring the relationship between religion, spirituality, and physical and mental health.

Phenomenological Studies

Phenomenological methods have not been widely accepted by American psychology despite the fact that such methods have produced many of the classic works in the psychology of religion. Phenomenological studies focus upon careful description of the content and structure of what appears to consciousness. An interface between phenomenological and measurement studies characterizes much of the contemporary study of mysticism with the use of scales to measure the report of mystical experience derived from phenomenological studies of mystical experience.

Hermeneutical Studies

Hermeneutical studies include a variety of methods that seek to interpret the meaning of phenomena. The psychoanalytic tradition and its off-shoots are viewed by many as hermeneutical rather than causal, and hence part of a distinctive human science. Typically, hermeneutical theories in the psychology of religion seek to understand religious claims in light of systems of meaning derived from more general psychological theories such as psychoanalysis.

Ethnography, participant observation, and field research

While there are various approaches to field and participant observation research in the psychology of religion, we can note one major distinction. Field research occurs in a natural as opposed to a laboratory setting. The difference does not, however, mean that measurement or quasi-experimental studies cannot occur in these settings. Ethnography overlaps considerably with participant observation research. Ethnographers are more committed to 'thick' descriptions of phenomena from many points of view of the various participants. Participant observation can include any study in which the researcher is present with and involved with the object of study. These types of research seek to understand religion from the believer's perspective. They essentially explore religion as a form of life.

Neurophysiological studies

Perhaps the most rapidly emerging method in the psychology of religion is due to advances in neurophysiological methods that allow for the noninvasive study of the brain during various

religious acts, such as prayer or meditation. Many neurophysiological studies correlate a given experiential state with ongoing neurological processes. Among the functional neuroimaging techniques are single-photon emission tomography (SPECT), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI). What is crucial is that these techniques are relatively noninvasive and can allow researchers to determine which areas of the brain are active when individuals are in various spiritual or religious states.

Major Content Areas in the Psychology of Religion

Since its reemergence in the 1960s, the psychology of religion in America has been characterized by a number of content areas that have been investigated by a variety of the methods discussed above. Investigators using some combination of measurement or quasi-experimental designs dominate the mainstream journals in the psychology of religion. Less common are phenomenological, hermeneutical, psychoanalytic, or object relations studies. This creates a series of discreet literatures that seldom dialogue with one another. Therefore, even within specific content areas it is difficult to find a consensus opinion and still be fair to the variety of methodologies and hence other psychologies that claim to possess insight of knowledge into religious phenomena.

Conversion and Deconversion

Conversion has been one consistent phenomena studied in all periods of the psychology of religion. Influenced by the history of Protestantism in America, psychologists since William James focused upon factors that produce sudden or gradual conversions. Recently, the same analyses and procedures have been used to study leaving religious groups, a process identified as deconversion. When either conversion or deconversion is sudden, psychoanalytic psychology has proven useful, focusing upon unconscious motivations that have erupted. Gradual conversion or deconversion is seen as more likely associated with conscious and intentional actions focused upon a search for meaning or involved in the maintenance of various social networks.

Religious Experience

Like conversion, since the time of William James, religious experience has been a continual focus of study. Included are any experiences perceived by the individual to be religious. Thus religious experiences need have no one common characteristic – almost anything can be religiously experienced, from a sense of a divine presence to the handling of serpents. Studies from a variety of methodological perspectives have shown that persons with intrinsic religious motivations derive special experiential awareness from their religious commitments. Particularly among those employing hermeneutical methodologies, religious experience has been found to identify a transcendent meaning that correlational and quasi-experimental studies can only identify in terms of proximate causes. The distinction between experience and its interpretation is heavily studied and debated. For some, all experience is interpreted

experience and hence linguistically and culturally constructed. For others, at least some experience is unmediated by language and culture. Mystical experience has been extensively studied and is perhaps the single experience most frequently cited as providing a transcendental unity to a variety of faith traditions based upon the distinction between experience and interpretation. Within the study of religious experience, the distinction between religion and spirituality noted above has become dominant. While most persons who identify themselves as religious also identify themselves as spiritual, a growing minority of persons identify themselves as spiritual but not religious. These persons often have similar experiences to religiously identified persons but refuse to accept either religious language or authority to interpret what otherwise might be identical experiences. Among the religiously devout, many have experiences that simply confirm their faith.

Religious Development

Theories of religious development are common in the psychology of religion. Classical Freudian theory saw religion as a stage in both individual and cultural development that is fated to be outgrown in the face of developed rational capabilities. Others have proposed that religion is a process that develops in stages, from more concrete acceptance of literal claims to more universal awareness of the symbolic meanings associated with mature faith commitments. Some have posited religious development as an endless quest for answers to existential concerns, including awareness of finitude. No stage theory has unequivocal support and all have been challenged as having implicit if not explicit value judgments as to what constitutes mature faith. Recently, empirically oriented psychologists have followed in the footsteps of object relation theorists and have focused upon early infant attachments to their primary caregivers. As with object relationship theorists, attachment theorists explore how images of God are related to early experiences, suggesting that one's image of God is a function of the nature of these earliest infant experiences. Efforts trace religious development across age groups in Western cultures tend to indicate that religious commitment of whatever form begins with childhood socialization, reaches a peak in adolescence, declines, then emerges strong again in late life. However, there are many exceptions to this generalization, including a general seeking for spirituality that continues unabated and without religious commitment across the life-span.

Psychopathology

From its origin, much of the psychology of religion has focused upon claims as to the psychopathology of particular religions or religion as a generic form. Most famous of these is Freud's final conclusion that religion is a mass delusion. However, contemporary psychoanalysts have used Freud's insights into the dynamics involved in religious belief to contrast pathological aspects of religious commitment from a mature and healthy religious commitment. Jung argued for the essential contribution of religion to psychological health, a tradition continued by analytical psychologists who continue to descriptively explore the range of spiritual experiences across the life span as do object relation theorists. Empirically,

measurement-oriented psychologists have focused upon relating various aspects of religion (belief, experience, and practice) to objective measure of psychopathology. No consistent pattern has emerged. Numerous factors interact to foster or mitigate psychopathology. The immense complexity of research in this area is exacerbated by the fact that neither mental health nor psychopathology are objective terms. While these states can be reliably measured they necessarily imply both normative and evaluative judgments. This is evident in research on fundamentalism which is seen by many psychologists across various schools as hindering or limiting psychological development as well as fostering prejudice and violence. Despite limited objective evidence that this characterizes all fundamentalists, it is clear that most psychologists are explicitly or implicitly satisfied with viewing fundamentalists as representing at best an immature stage of religious and psychological development.

Coping

Closely related to the study of psychopathology is the study of coping. By coping, psychologists refer to strategies by which individuals adjust or fail to adjust to difficult situations. Rather than attempting to judge the truth content of religious belief or the maturity of religious beliefs, psychologists focus upon how individuals use their faith. Thus, extrinsic motivation is involved in the use of a faith in the face of tragic circumstances. The literature on coping is largely empirically based, using measurement and correlational techniques. It tends to reveal that religion can provide a meaningful system of beliefs within which to frame even otherwise negative events as positive. Especially important in religious coping is how one images their God. Having a loving image of God is a powerful means to secure meaning and to provide a reservoir from which to draw comfort and solace in difficult times.

Religion and Social Psychology

Second only to clinical psychology among psychologists who study religion is social psychology. It is fair to say that the revival of interest in the psychology of religion in the 1960s in America had its roots in concern with the relationship between religion and prejudice.

Prejudice

American interest in the study of prejudice was an aftermath of WWII. Clinical and social psychologists united in an effort to understand anti-Semitism in particular and prejudice in general. Two strands of research began that continue to this day. One united psychoanalytic theory with measurement and correlational research to identify particular personality type attracted both to various forms of religious fundamentalism and to extreme political conservatism. This personality type came to be identified as an authoritarian personality, now identified by three characteristics: authoritarian submission, authoritarian aggression, and conservatism. These are persons likely to be prejudiced, especially when the target person has characteristics devalued by one's religion. The second strand of research was associated with Gordon W. Allport and the development of his widely influential *Religious Orientation Scale* that

empirically identified the dimension of intrinsic and extrinsic religion. Intrinsic religion or mature faith was rare but characterized by a lack of prejudice. Extrinsic religion, a less mature form of faith, was common and related to prejudice. Hence the apparent relationship of overall religion and prejudice masked a subtle distinction that mature faith actually unmakes prejudice. Research surrounding this claim still dominates the social psychology of religion with Allport's original findings challenged by claims that intrinsic religious persons seek to appear to be unprejudiced when in fact this is not the case. Confounding this research has been the debate concerning the evaluation of behaviors mandated by religious beliefs and whether such religiously sanctioned evaluations can meaningfully be defined as prejudice. The issue is far from settled and has been taken up fresh, especially by psychologists of religion in Eastern Europe, where religion and ethnic identity are confounded in complex ways that make it difficult to tease out how they determine prejudice. Thus, religion and prejudice promises to be a continued topic of interest in the future.

Altruism

It was a natural progression from the study of religion and prejudice to what for many is the opposite of prejudice, altruism. Just as many researchers have argued that intrinsic religious orientation is negatively related to prejudice, researchers have found that it is positively related to altruism. However, other researchers have challenged this claim, documenting that the intrinsically religious simply wish to appear unprejudiced and altruistic as part of presenting a desirable religious image to others. Researchers using a measure of quest, which focuses upon existential concerns, have marshaled evidence to show that a quest orientation is related to altruism. The debate continues and reflects a uniquely American psychology of religion focusing debates upon data derived from quasi-experimental studies. More recently, many social psychologists have adopted evolutionary psychology as a metapsychological frame and argued that altruism is only apparent and is based upon what are ultimately motivations that actually serve to enhance reproductive success. Included in the claim are debates concerning whether selective mechanisms for reproductive success operate for groups as well as individuals.

Sects and cults

Among the more sociological-oriented psychologists, extensive debate and research into religious groups have utilized a classification of sect, cult, and denomination. Denominations have little tension with their larger host culture. Sects are defined by tension with the larger culture. Often this tension is produced when the emerging sect breaks away from an established denomination either because the denomination refuses to accommodate cultural change (as with fundamentalists) or when the denomination endorses cultural change at a more rapid pace than the host culture supports (as with gay rights). Often sects are in tension because of rejection of all or aspects of secular medicine (as with Christian Scientists or Jehovah Witnesses). Cults are similar to sects but emerge de novo and are often led by a charismatic figure. Both sects and cults represent forms of cultural deviance and have been the targets of intense psychological investigation and of legal scrutiny. Issues have focused upon whether or not cults utilize

specific psychology techniques to coerce members to join. The metaphorical claim to 'brainwashing' is unsupported by empirical evidence. However, techniques of coercive persuasion, common to many groups, have been extensively studied. In cultures with religious freedom, noncoercive psychological process characterizes both entry into and exit from religious cults and sects. Most cults fail and most recruits leave cults within a year of joining. Those that succeed are often fundamentalist groups that provide a meaningful lifestyle lived in opposition to the large culture they oppose.

Atheism, agnosticism, and nontheism

A recent emerging area of study in the social psychology of religion is the study of atheism and nontheism. American psychologists have recognized that America is an outlier with respect to the importance both culturally and individually of religion compared to Europe. There are European cultures that are thoroughly secular, for instance, Sweden. Americans' participation in religious groups and belief in God are atypical and globalization referred to above has made psychologists aware that a psychology of religion based largely upon American studies results in a highly skewed view of religion. While rare, atheism (a denial that God exists) or agnosticism (the claim that one can have or have only uncertain knowledge about God) occurs only as secondary phenomena in reaction to religious socialization. One can deny that God exists for the same reasons that one affirms God, including conscious cognitive processes or more unconscious motives associated with psychoanalytic psychology. Having an absent father or an emotionally absent father in early childhood has been identified as a factor in atheism. Likewise, in purely secular cultures or among children raised in nonreligious families, religion and belief in God need not be rejected. Individuals are socialized without regard to religion or God and hence are simply nontheists. However, some atheists and nontheists identify themselves as spiritual (but not religious), accepting a sense of connectedness with nature that is expressed in purely secular language.

Controversial Issue in Psychology and Religion

Since little consensus exists either among various forms of psychologies or religions, one is tempted to define the entire area of psychology of religion as controversial by default, yet two areas are especially justified in being labeled controversial: entheogens and parapsychology.

Entheogens

Among psychologists of religion, entheogen has become the preferred term for chemicals such as psilocybin that are psychoactive drugs that have profound effects on consciousness. Researchers have long noted that naturally occurring entheogens have been used by religious groups such as the Native America peyote cults to facilitate religious and spiritual experiences. The use of entheogens to facilitate mystical experience or a sense of union with God or a larger reality have produced some of the most frequently cited textbook cases of true experimental research in the psychology of religion. Set and setting

have been documented to be important factors in facilitating positive experiences and a religious interpretation of them. Denominational opposition to chemically facilitated experiences is well documented, making research using religiously committed participants difficult. However, recent studies employing entheogens with religiously committed participants have suggested a bright future for this controversial research area. This is especially the case given that mystical experiences facilitated by entheogens have been documented to be identical on empirical measures of reported mystical experience to those occurring either spontaneously or facilitated by normative religious practices such as prayer.

Parapsychology

As noted above, the founding of psychology of religion in America was linked in the popular mind with parapsychological phenomena, especially those associated with spiritualism. William James believed that both religious experience and parapsychological phenomena would stand up to the empirical tests of science. Contemporary studies consistently find that those who report religious experiences also report paranormal experiences. Multidimensional measures of spirituality often find parapsychology phenomena to emerge as a separate factor. Psychological theories postulate that belief in parapsychology can be an alternative to religious commitment or an integral part of one's religious beliefs. Recent speculations about quantum effects in neurophysiology are leading to methods by which the existence of parapsychology effects can be documented, suggesting that the study of religion will continue to be linked with the study of parapsychology.

Future Prospects

The psychology of religion will continue to be filled with tensions only some of which can be empirically resolved. Yet since the first edition of this encyclopedia, psychology of religion has proven to be even more vigorous, especially as it has incorporated both religion and spirituality into its ever broadening vision. In a postmodern perspective, the claims of a narrowly conceived science that refuses to explore its foundational assumptions can do little to illuminate an equally narrowly conceived religion that refuses to do the same. There has been a widely accepted call for a paradigm for the psychology of religion that is multilevel, interdisciplinary, and nonreductive. Psychology will be unable to stand alone as an arbitrator of either the content of religious beliefs or the conditions that give rise to them. Efforts for a single overarching paradigm to explain religion such as evolutionary psychology will generate considerable research. New disciplines such as cognitive science in which psychology is only one voice have begun to focus on explanatory theories of the origins of religion often in cooperation with evolutionary views. However, for every effort to create a single, monolithic paradigm for psychology of religion, there will be resistance from what still amounts to schools of psychology, or simply psychologies. As for religion, history suggests there is little chance there might be a unified religion for humankind. Thus, pluralism in both psychology and religion will continue.

See also: Brainwashing and Totalitarian Influence; Prejudice, Discrimination, and Stereotypes (Racial Bias).

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Psychology of Reading

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Glossary

Dyslexia Literally, 'problems with words.' A specific reading problem, in a person with near-normal (or higher) intelligence, adequate instruction and motivation, and sufficient practice.

Grapheme The written symbols of a language.

Perceptual span The amount of material that can be detected by the eye in a single glance; in readers, estimated to be no more than 15–20 characters; furthermore, it is asymmetrical, extending about 12–15 characters to the right of the fixation and about four characters to the left (for English readers; the pattern is reversed in Hebrew readers, who read from right to left).

Phoneme Categories of speech sounds; the smallest unit of sound in a language.

Phonics Reading instruction emphasizing the mapping of visual symbols to auditory sounds.

Phonological recoding The process of converting the written symbols of a language into their sound-based components. In readers, especially skilled readers, this sound-based component may be internal.

Whole-language instruction A type of reading instruction that emphasizes 'natural' meaning and contexts in which reading and literacy takes place.

Whole-word instruction A type of reading instruction in which words are learned as entire units, rather than in individual, sound-based parts.

Introduction

Perhaps the most complex and important cognitive skill that humans acquire is language. Furthermore, we acquire language easily and with no special instruction, much as we master a skill like walking. As the cognitive scientist Steven Pinker puts it, "people know how to talk in more or less the sense that spiders know how to weave a web." Despite this complexity, a 5-year-old child has mastered most of the subtleties of language use. In addition, language appears to be as old as (anatomically modern) humans themselves. Every child, given a remotely normal environment, will acquire language. Similarities in children's developmental sequence hold true despite vast cultural and socioeconomic conditions.

This is true, however, only of spoken language. Acquiring written language, in contrast, is difficult and time consuming. Some individuals, even after considerable time and effort, will not learn to read, or will read poorly. In some very important ways, then, learning to read has more in common with learning calculus than it does with learning to speak. Written languages have been developed only in the past 5000 years or so. Therefore, it can be said that the use of written language is a skill which is not innate, nor is it a skill that all humans can or will acquire. In fact, literacy rates did not reach 50% worldwide until the twentieth century. Reading clearly hinges on the spoken language, but reading is not something we are innately predisposed to do.

Historical Review

The History of Written Language

True writing systems emerged about 5000 years ago, but other types of written communications were used long before

then. The earliest kinds of written communication employed 'logographs,' in which each symbol represents an object, with the symbol drawn to resemble that object. Although logographs have some advantages, such as relative transparency, they have some significant drawbacks. For example, symbols for some words would be difficult to draw. How would one draw a symbol for 'hope,' or 'integrity?' Many of the nouns might be able to be drawn, but verbs, adverbs, and adjectives would be considerably more difficult. Egyptian hieroglyphics, for example, used logographic representation for many words. 'Reading' these ancient hieroglyphs is anything but simple. Also, the absolute number of symbols needed in a logographic language would be overwhelming. In fact, Chinese is the only popular language today written with elements of a logography, although contemporary scholars consider modern Chinese to have 'morphosyllabic' mappings (i.e., characters map to syllables, and these are usually morphemes).

Languages such as Chinese are fundamentally different from English, which is known as an 'alphabetic' language. In an alphabetic language, each symbol stands for a sound, and reading is accomplished by decoding the letters into their corresponding sounds. Languages vary according to how 'good' this mapping is. Italian, for example, has a very good symbol-to-sound map, English somewhat less so. All alphabetic languages derive from Phoenician, which was developed a little more than 3000 years ago. The earliest Phoenician languages contained only consonants. While this may seem confusing, *n xmpl wll shw hw ths knđ f wrtng cn b ndrstd wth ltl trbl* (i.e., 'an example will show how this kind of writing can be understood with little trouble'). Later, the Greeks added vowels; in fact, all European written languages derive from the Greek alphabet, which remains relatively unchanged in the past 2000 years. (The other alphabetic systems, widely used in the Near and Middle East – Hebrew, Arabic, the languages of India – derive from the Aramaic alphabet.)

Early Reading Research

Research into the process of reading is among the oldest topics investigated by psychologists. Researchers in Wundt's laboratory, set up in Leipzig more than 125 years ago, addressed many of the same topics still being investigated by contemporary researchers. These studies, for example, focused on topics such as a reader's perceptual span – how much can readers perceive without moving their eyes – and eye movements associated with reading. Such early work culminated in Huey's classic text, *The Psychology and Pedagogy of Reading* in 1908. Although much of the work reviewed by Huey involved techniques that seem archaic compared to contemporary research, contemporary researchers have confirmed many, if not most, of Huey's central findings.

Relatively little research on the basic reading process occurred after the publication of Huey's text, most likely attributable to the rise of behaviorism in American psychology. Educators continued to debate about the appropriate methods of reading instruction, but this was generally applied (rather than laboratory) research. Furthermore, empirical findings played a less important role in such key issues as whether beginning reading instruction should focus on phonetic instruction or whole-word processing. Consider, for example, Flesch's influential book *Why Johnny Can't Read* in 1955: Flesch argued – correctly, as it turned out – that whole-word approaches to beginning reading instruction were seriously flawed, and he advocated a phonetics-based approach instead. While Flesch's argument was compelling, he had very few data to support his position. In large part due to the debates framed by Flesch and colleagues, reading research began to flourish in the 1960s. A number of specialized scientific journals specifically devoted to reading research were developed. In 1984, *The Handbook of Reading Research* was published, followed 6 years later by a second volume of the same name, and Vol. 3 was published in 2000. A number of textbooks on the psychology of reading were published in the late 1980s and early 1990s and in many ways those remain the best introduction to the field. (Several of those books are listed in the references.)

Perceptual Processes in Reading

The reading process is constrained by limitations of the perceptual human information processing system. For example, readers can move their eyes only as quickly and can see only as much as their eyes can in the periphery of their vision. Images that hit the retina last for only a fraction of a second before fading. Also, readers have a limited capacity short-term memory store that can easily get overloaded. Each of these stages introduces a 'bottleneck' into the reading process, limiting the speed with which the process can operate.

Eye Movements

Although early researchers like Javal observed (and crudely measured) eye movements of readers, recent and more sophisticated techniques allow a precise understanding of exactly how readers move their eyes. Casual observation gives readers the impression that their eyes are moving smoothly across the

page. This is not the case. Rather, readers' eyes are moving in a jerky, abrupt manner called 'saccades,' (from the French for 'jumps'). Saccades impose the first limitation on reading. Each eye movement in reading has two components: the actual movement of the eyes from one location to another (during which almost no information can be extracted) and the time when the eyes stop and focus on a word, called 'fixations.' While reading, the movement takes about 25–50 ms (a millisecond is one one-thousandth of a second; 50 ms, then, is one-twentieth of a second), while the fixations last considerably longer, from about 200 to 250 ms (about 1/5–1/4 of a second). When one is engaged in reading, rather than skimming, one is limited to a maximum of about five saccades per second.

Perceptual Span

The second determinant in reading rate involves the amount of information that can be derived from a single glance, without moving the eyes, what is called the 'perceptual span.' Visual acuity is best for information at the center of the retina, called the 'fovea.' The fovea is lined with cells (called 'cones') that perceive sharp detail. Farther out into the periphery, though, acuity fades. Again, you can demonstrate this for yourself. Hold a book a foot or so in front of you and focus on one word on the page. *Without moving your eyes*, try to recognize words on either side of where you are focusing (you'll probably have difficulty not moving your eyes, a demonstration of the automatic nature of eye movements in skilled readers). You can recognize some letters, perhaps, but you'll also see how rapidly the information becomes unusable.

McConkie, Rayner, and colleagues developed an extraordinarily useful technique for measuring perceptual span in reading, called the 'moving window.' Contemporary eye tracking equipment works by shining a harmless beam of light into the eye and measuring the angle of deflection from the eye. As the eyes move, the angle of reflection changes, and these changes can be mapped onto the visual field. Rayner and his colleagues took the output of the eye tracker and used it to control the nature of visual display. Imagine a computer screen displaying text, and then imagine that the text was covered up by a series of Xs. A sample display is shown in [Figure 1](#). As with any eye tracker, McConkie and Rayner could determine where the readers were looking. Next, they gradually removed the Xs that covered the text, displaying what was underneath. Each time the readers moved their eyes, the 'window' moved along with them. When this window was small, readers had to move their eyes many times to uncover even a single word.

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XXXXXXXXXXXXXXXXXXXX a XXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXte a wXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXicate a window XXXXXXXXXXXXXXXX
XXXXXXXXXXXXld indicate a window of sXXXXXXXXXXXXX
XXXX would indicate a window of size XXXXXXXXXXXX
This would indicate a window of size forty-eight
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Figure 1 An example of the Moving Window Procedure. Each line indicates a larger window.

Obviously, this greatly reduced the overall reading time. As the window increased in size, readers got faster, but only up to a point. Eventually, increasing the size of the window no longer increased the rate at which the text could be read. The point at which the reading rate levels off indicates the limits of the perceptual span. Adding more information outside that span had no effect because this additional information was presented outside the area where it could be perceived. Readers' maximum perceptual spans were about 20 characters and it was asymmetrical. Readers could make use of information about 15 characters to the right of the fixation and about four to the left. (The fact that the asymmetry is reversed in readers of Hebrew, for example, indicates that it is learned, rather than resulting from physiological factors.)

These numbers reflect reading under ideal circumstances. In typical reading situations, the movements are usually less than optimal. About 10–15% of the time, even in skilled readers, saccades are actually *backwards*. Furthermore, saccades of 20 characters are highly uncommon. Usually, saccades average about eight characters, or about one word. Though there is some evidence that readers do not focus on every word (readers are more likely to skip short and common words like 'the' and 'of,' for example), researchers now understand that readers do focus on the great majority of words in a passage. Therefore, typical reading rates for normal college readers average about 250 words per minute.

The Role of Phonology in Reading

The earlier sections described some of the perceptual limitations involved in reading. Readers cannot train themselves to see all 80 characters in the line of a text at a single glance, for example. The limitation is one that is perceptual in nature, resulting from the distribution of cones in the retina. Once information is extracted from the text, though, the bottleneck in the reading process lies with our limited-capacity working memory (WM) spans. WM can hold relatively few items (about 5–7, by most estimates); without constant rehearsal, this information lasts no more than a few seconds. Thus, efficient use of WM is critical for good reading.

Translating Visual Symbols into Sounds

For readers of an alphabetic language like English, the first task in reading is converting arbitrary visual symbols (letters) into the corresponding sounds (phonemes). Common wisdom is that English is a difficult language to learn because of the numerous inconsistencies in symbol-sound mapping. In truth, this is less of a problem than it first appears to be. Many such inconsistencies occur with high-frequency words like 'of' and 'was,' for example, and the exceptions are learned fairly rapidly. Furthermore, some of the inconsistencies in symbol-sound mapping preserve shared morphologies, such as in the words 'young' and 'youth.'

The process of converting visual symbols into sound is called 'phonological recoding,' and in many respects it is the central task of reading. This is obvious when watching a child learn to read (as they sound out letters and words), but adults do it as well (as shall be seen shortly). In fact, phonological

recoding appears to play a central role even in nonalphabetic languages like Chinese. Indeed, in recent decades, Chinese children who are learning to read are often taught an 'intermediate' alphabet called *pin yin*, which uses Western letters to represent Chinese words. Only after mastering this phonological recoding skill do Chinese readers move on to mastering more complicated symbols like radicals.

How Phonology Influences Reading

The progression of reading usually moves from oral reading, to reading while moving lips, to subvocalizing, and eventually to silent reading. The term 'silent reading,' however, is a bit of a misnomer. Recent studies indicate that even highly skilled readers read by means of recoding information into 'inner speech,' a voice (literally) inside the head. The relationship between inner speech and external speech is close; things that take longer to read out loud, like tongue twisters, take longer to read silently as well. To illustrate, read the following two sentences silently:

- a. Miss Jones' lobster sauce shop rarely sells halibut.
- b. Miss Smith's fish sauce shop seldom sells shellfish.

The two are roughly comparable in length, but most people find that the second sentence takes considerably longer to read. Why? Almost certainly because the printed words on the page are converted into inner speech, and things that take longer to speak externally also take longer to 'speak' internally. Importantly, this appears to be true of many profoundly deaf readers as well.

Note that 'inner speech' and 'subvocalization' are not necessarily the same thing. If readers are asked to eliminate subvocalization (by reciting 'la la la' while reading, for example), but inner speech is not disrupted, reading progresses fairly normally, particularly for simple material. But if inner speech is disrupted, reading is seriously impaired.

The importance of inner speech is demonstrated with profoundly deaf individuals. Only one-fourth of congenitally deaf individuals will learn to read at a level we would consider literate (roughly a fourth-grade level). Why? While the answer to this question is complex, the lack of external phonology certainly plays some role. The key task for beginning readers is to learn the mapping between a visual symbol and its corresponding sound. For hearing children, these external sounds are well learned before the symbol-sound mapping occurs. In contrast, the deaf child does not have this set of sounds on which to draw.

Further evidence of the importance of phonology in reading can be taken from those deaf readers who do learn to read. Interestingly, readers – despite never having 'heard' these words pronounced – make phonetic judgments similar to those of hearing readers. For example, they respond differently to rhyming words ('save' and 'wave') than the nonrhyming, but orthographically similar words ('have' and 'cave'). They can also name the real-world equivalents for nonwords that would be pronounced similar to real words in English ('cruise' for 'krews,' and 'broom' for 'brume'). Finally, as stated before, deaf readers exhibit tongue-twister effects. In short, though they have never heard external sounds, the inner speech of (at least some) congenitally deaf readers seems to parallel

that of hearing readers. It should be noted, however, that the precise nature and importance of phonological representation in deaf readers is far from settled. Some studies indicate internal visual representation, particularly in native signers. What is beyond question is that the lack of external phonology makes reading acquisition considerably more difficult for deaf children.

Developmental Aspects of Reading

As previously stated, reading is not merely a natural extension of speech. Rather, reading is a complex cognitive skill, and like all such skills, requires considerable time, effort, and practice. Furthermore, not all types of instruction are equally effective. Finally, the hundreds of hours of reading practice required for proficient reading are likely well beyond what a child will receive in school. Therefore, children who acquire critical pre-reading skills prior to formal instruction in a school setting have significant advantages.

Fluent Letter Identification

The first skill children must master is to be able to identify letters quickly and accurately. Many studies find that this ability is the best predictor of early reading success: prereaders who were fluent with the alphabet learned to read more easily and achieved a higher level of competence. Fluent letter identification does not mean memorizing the alphabet. Rather, the skill involves mastering basic orthographic skills: a rapid and automatic identification of a letter, given the visual representation. Although somewhat distinct from phonological skills, one can see the advantages of an alphabetic language in this situation. Fluent letter identification means that given the symbol 'B,' the child rapidly identifies not only the letter ('B') but also the underlying sound [bee]. Thus, identifying the letter also allows the child to access its phonology, at least in languages with clear symbol-sound mappings. For this reason, many early reading programs in English use limited alphabets, that is, use primarily those letters that have an unambiguous symbol-sound mapping. Once the letter identification process is automated, limited cognitive resources can be devoted to 'higher' reading processes, such as word recognition (and ultimately comprehension).

Phonetic Awareness

The second skill essential for beginning readers is what psychologists call 'phonetic awareness.' Earlier, reading was defined as the process of matching symbol to *sound*. A more accurate characterization would be to say that reading is a process of matching symbols to *phonemes*. While phonemes are often defined as "the smallest unit of sound in a language," a more accurate definition would be, "the categories of speech sounds in a language." When one examines different speakers trying to make the same sound, say "[bee]," there are some subtle differences across different speakers. Yet those sounds are heard as being the same because the categories important to speech have been learnt. Across languages, there are about 100 different phonemes. English uses about 44 of them

(scholars disagree about the precise number, but all agree that the number is between 40 and 45).

Phoneme acquisition by infants demonstrates the innateness of language in humans. A 9-month old, who has been raised in an exclusively Chinese-speaking environment, will respond to a change from [r] to [l], as in the words 'rah' and 'lah,' even though it is a phonemic distinction that the Chinese language does not make. (It is partly this lack of a distinction that gives natives of China their characteristic accent when speaking English.) Just a few months later, the same child, still being raised in a Chinese-speaking environment, will no longer differentiate those two sounds. This child has learned to ignore a phonemic distinction not used in the native language. This is all the more remarkable when one considers that this is done without any explicit instruction or feedback on the part of the parents. Children are genetically prepared to identify important categories of speech, those relevant to their native language.

Though speakers innately develop the categories necessary for phonemic detection, they are not innately *aware* of them. Prereaders who develop an awareness of these phonemes have greater advantage in reading, which hinges upon matching symbols with the appropriate phonemes. Early instruction clearly helps. An example of this instruction would be asking a child, "Take the word 'mop,' and replace the [m] with a [t]. What new word do you get?" As children develop phonemic awareness, they begin to appreciate things like alliteration or rhyme. Dr. Seuss, either by design or clever intuition (or very likely, both), uses rhyme and alliteration very effectively, which communicates phonemic awareness to children. 'Hop on Pop,' for example, is full of rhyming words that differ by a single phoneme. Very young readers, those just 2 or 3 years old, might enjoy Dr. Seuss for his clever stories and wonderful illustrations. Kindergarteners, however, will likely begin appreciating the rhymes, a demonstration of phonemic awareness.

Reading instruction on the PBS show 'Sesame Street' provides another example of how these two tasks can be combined in ways that children find interesting. Each episode of Sesame Street usually highlights a single letter ('Sesame Street was brought to you by the letter "s"'). The letter (say, 'S') is usually displayed by itself to allow the child to identify it prior to the name being read by the narrator. Then, the letter name is spoken while the letter is being displayed on the screen. Next, the letter is shown in ways that exploit the phonemic properties. For example, the 'S' turns into a snake, while the narrator might say, "Simon, the slippery snake, slides slowly." These lessons combine symbol-phoneme match and segmenting of phonemes in real words and give the child a concrete image (the picture of the snake, which looks like the letter) to aid learning.

Enhancing Children's Reading Readiness

What can parents do to enhance their child's reading potential? One of the most important is reading aloud to them. This serves several critical functions. Children practice their comprehension skills, especially if the parent asks the occasional questions while reading: "what else do you think the bunny could do to get the carrots?" Children practice matching letters to sounds, as they watch the letters on the page. In fact, most

children, as they get closer to school age, will ask if the parent can point to the letters they are reading. Equally important, though, the child sees that reading and literacy are valued, and reading is something that the parent does and enjoys. Given the hundreds of hours of practice that lies ahead for the child, anything that increases the intrinsic enjoyment of reading is a boon.

Some estimates indicate that children whose parents read to them each night enter school with some 1000 h of practice with print. In addition, children may spend nearly that much time watching *Sesame Street* or other educationally relevant programs. Other children, in contrast, have little or no print exposure before schooling. Schooling has little chance of making up these preexisting differences. In addition, remediation faces several enormous obstacles. First, reading instruction, like many areas of education, exhibits what Stanovich calls the 'Matthew Effect': those who have advanced reading skills are more likely to benefit from additional reading practice. In addition, they are also more likely to read outside of school. In other words, the 'cognitively rich' get richer. (The term is derived from the gospel of Matthew, Chapter 25: *For to all those who have, more will be given, and they will have an abundance; but from those who have nothing, even what they have will be taken away.*)

These differences are not trivial. A fifth-grade child in the 90th percentile of reading ability (meaning, one who reads better than 90% of his or her peers) reads *two hundred times* more text in a given year than does the child in the 10th percentile. Given the magnitude of these differences, any kind of remedial reading program faces significant challenges.

Phonetics, Whole-Word, or Whole Language?

During the middle part of the twentieth century, educators argued vehemently about the methods of reading instruction: should reading be taught using a 'whole-word' method, which focused on reading entire words without sounding them out? Followers of this approach believed that readers should experience 'authentic context' (meaning real books), and that at its core, reading was best viewed as a 'psycholinguistic guessing game,' in the memorable phrase of Kenneth Goodman. Others, perhaps best exemplified by Flesch in *Why Johnny Can't Read*, argued for a phonetic approach, teaching reading through explicit instruction via symbols-sound matches. Although some schools continue to teach 'whole words' to beginning readers, from the perspective of most reading researchers, the question is virtually settled: phonetic, code-based instruction is vital to learning to read any alphabetic language. 'Whole-word' approaches to beginning reading and abandoning the teaching of symbol-phoneme matches are misguided.

Most recently, an alternative approach, called 'whole language,' has emerged. In some respects, whole-language approaches differ from whole-word. For example, phonemic awareness is acknowledged as a skill to be acquired by readers. In addition, whole-language approaches stress the motivational aspects of reading instruction, using stories more likely to be interesting. However, most whole-language approaches share two flaws with whole-word methods. First, they share a disdain for explicit phonetic instruction, under the belief that such instruction is unnecessary (at best) and potentially

harmful because of the time it would waste and the frustration it may induce. If a child picks up phonetic skills during the course of learning to read (as did many of us who were taught using whole-word approaches in the 1950s and 1960s), that is fine. But there is no need for dedicated, isolated phonetic instruction. The second flaw is more philosophical: reading is viewed as a natural and logical extension of innate language mechanisms. As was discussed previously, most reading researchers no longer believe this to be true. Reading is a complex and difficult task, one that involves rapid identification of symbols, conversion of those symbols into sounds, and combining sounds to produce syllables and ultimately words and sentences. Nothing about these early, critical stages of reading is 'natural' in any sense of the word.

As reading skills develop, the educational emphasis shifts to the so-called 'higher' reading skills, like comprehension. No one denies that the final reading process involves recognizing realistic materials in a real-world context. But trying to teach a beginning reader this way would be like trying to teach someone to ski by placing them at the top of a steep mountain. A skilled skier could navigate that mountain because that skier has already learned the basic skills and has practiced for many hours. But that does not mean a beginning skier should learn to ski that way. A beginning skier would likely fall repeatedly, become frustrated, and eventually give up. The same occurs with beginning readers. We need not be concerned that beginning skiers on the shallow slopes do not look like expert skiers gracefully descending steep mountains. The skills developed on the bunny slope are a necessary prerequisite for expert skiing down steep Olympic courses.

The beginning reader, then, reads by matching symbol to phoneme, and then stringing the phonemes together to recognize words. This is a tedious process. As a result, the beginning reader will encounter the problems associated with the limited-capacity WM buffer. Readers may well forget the initial sounds of a word by the time they get to the end of the word. (Adult readers often have similar problems stringing together words when sentences are too long. Everyone is familiar with the experience of forgetting the beginning of a sentence by the time we get to the end of it.) Eventually, then, reading progresses beyond this 'sounding-out' stage.

Once basic phonetic skills are in place, the next task involves automating. Like any cognitive skill, highly skilled and fluent reading requires substantial practice. As with many cognitive skills, high-level performance requires hundreds, even thousands of hours of practice. (Anders Ericsson, a psychologist who has studied expert performance in domains from music to chess finds that between 1000 and 2000 h of practice are generally required to master a skill, five to ten times that much to become 'world class.' Those numbers are perfectly consistent with Stanovich's work on print exposure.) As the reading process develops, readers begin to recognize similarities among words. They use these regularities to allow them to recognize familiar words automatically, rather than having to sound out every word. With much practice they begin to recognize words directly. This additional way of accessing words has been incorporated into what has been called a 'dual-route' theory of reading. One of the routes, as we have already seen, involves phonological mediation – the words are accessed by their sounds. Skilled readers, though, begin to bypass the phonologically mediated

route (at least, most of the time). Skilled readers begin to access words directly.

That is not to say that the role of 'inner speech' becomes any less important. As has been stressed throughout, inner speech is crucial to reading. What happens as reading becomes more skilled is that words no longer require relatively slow letter-sound recoding and recombination. Instead, words become recognized as 'wholes.' When words are retrieved from the lexicon, it can be done without requiring the individual letter-to-phoneme mappings.

Does phonology play any role in skilled reading? Curiously, more than researchers once thought. Consider Chinese readers, who do not use an alphabetic language: although their language does not rely on a conversion of characters into sounds, phonology still plays a large role. Skilled readers of English are likely to be influenced by underlying phonology, even when a word is directly accessed: for example, if readers are asked, "is this something you would see in a garden?" they are significantly more likely to make an error if shown the word 'rows,' a homophone of 'rose.' Skilled readers may not need to access phonology when seeing the word 'rows,' but they still do.

There is an important lesson with respect to reading here. Skilled reading requires rapid, direct, and automatic access to words. As with any skill, much of reading also becomes automatic through practice. Grade school children vary dramatically in the level of print exposure they have, but it is not unreasonable to expect an above-average sixth-grade reader to read more than 1 million words a year. Even so, more practice provides the child with additional opportunities to develop fluent, automatic access to words. Therefore, children should be encouraged to read *anything*. Parents and teachers may shake their heads in disbelief when the child picks out another book about wizards and Hogwarts, or another mystery in the *Magic Tree House* series. Critics often bemoan the loss of cultural literacy when a child selects *Harry Potter* rather than *Moby Dick*. Should children be pushed away from reading these popular books, and into something that will be 'good for them?' Quite the contrary: developing these basic reading skills *is* good for them. A child is much better off, in terms of developing reading skills, reading 10 000 words of *Twilight* than 2500 words of James Joyce. Unless reading is considered pleasurable, few children will pursue it without being coerced. Children should be encouraged to read everything – magazines, newspaper, comic books, even cereal boxes! All of these provide important practice and hasten the development of skilled reading.

In summary, the most successful early reading instruction is provided by explicit instruction devised to develop phonetic skills. As readers become more skilled, phonological skills become less important. At the same time, some aspects of the whole language approach produce positive outcomes. For example, the emphasis on students reading meaningful and interesting material likely produces important motivational gains. Furthermore, these approaches may be more successful with more advanced students, those who have mastered basic phonetic skills.

Speed Reading

Advertisements for 'speed reading' courses are ubiquitous, especially on school campuses. Sometimes the claims are fairly

modest, for example, promising to double one's reading rate. Sometimes, the claims are extraordinary: "increase reading rates to 10 000 words per minute, *with no loss of comprehension!*" Such claims are impressive, and if they could work, would be a great benefit. The question, of course, is: do they work?

The answer is twofold, in some respects. First, it is impossible to increase true *reading* to 10 000 words per minute, for reasons discussed previously with respect to physiological limits on perceptual spans and saccade frequency. Readers may be developing a related, and also highly useful skill – skimming. During skimming, readers do not read every word, but when they finish can often tell the 'gist' of the passage. Skimming articles, for example, can allow a reader to make a useful assessment as to whether the article may be worth (genuinely) reading. Under the best possible circumstances, skimming rates might be a thousand words per minute.

That having been said, skimming is not the same as true reading. As mentioned earlier, the limitations on reading are physiological and perceptual, not purely cognitive. Readers are limited, by the physiological limitations of their neurons, to a maximum of about five saccades per second. Perceptual spans are similarly limited, but in this case by the resolution power of the retina outside of the fovea (essentially, the distribution of cones in the eye). The only way to increase saccade rate would be to increase the rate of firing of our neurons. The only way to increase the resolution power of the retina would be to add additional cones in the parafoveal regions. Neither, obviously, can be done. Programs that tell students to learn to move their eyes more rapidly or to attend to information in their distant peripheral vision are equivalent to a runner coach who tells a sprinter that she can sprint 100 m in 5 s by taking 12-foot strides or by doubling the rate at which she moves her legs.

Maximum Reading Rates

How fast can readers read, then? One can derive this using generous estimates of saccade frequency and perceptual span. First, assume that a reader makes five saccades per second and makes no backward saccades. Assume next that the reader can see three words with each saccade. Thus, the reader can see 15 words per second, and since there are 60 s in a minute, can read 900 words per minute. Few typically read half that fast. Using more realistic upper estimates (four saccades per second, 1.5 words per saccade) produces approximately 350 words per minute, a speed occasionally (though rarely) observed in skilled readers.

Dyslexia

Dyslexia is a specific reading problem. We might define dyslexia as a specific reading (not language) problem in individuals

1. with roughly normal (or above) intelligence
2. who have been provided adequate instruction
3. with sufficient practice
4. who are motivated to read
5. with no general neurological deficits that produce more global impairments.

Such a definition excludes many people – individuals who were never schooled, those with inadequate levels of intelligence to read, those with brain damage, etc. True, those individuals may well display poor reading skills, but they should not be confused with true dyslexics. The term ‘dyslexia’ has traditionally been reserved for those readers who, despite otherwise normal educational achievement, fail to read. Often, readers will be diagnosed as dyslexic if they read two grade levels below where they should be reading, or if they are 2 standard deviations below the mean reading ability for their peers (roughly, the bottom 2.5% of the distribution).

One important question, with respect to dyslexics, is whether they are *qualitatively* unlike normal readers. That is, do they read differently from normal readers, or are they simply readers at the bottom end of a normal distribution? (Recall that with any normally distributed population, 2.5% fall 2 standard deviations or more below the mean.) The answer to this question is more important than it may appear. If dyslexics read like normal readers, just less effectively, no specialized intervention would be necessary. If, however, dyslexics read *differently* (and not just worse) than normal readers, different types of instruction may be warranted.

Unfortunately, this is not easily answered. Although the term ‘dyslexia’ is often used as if it referred to a unitary phenomenon, this is wrong. Dyslexia is better understood as describing a family of reading problems. That is, any number of different underlying problems can lead to poor reading skills. Indeed, even when readers display the same symptoms, the underlying cause might be different. As a result, we should not expect to find ‘the’ cause of dyslexia, nor should we expect educators to develop a single treatment program. To say someone has dyslexia is in some ways no more informative than a physician telling someone they have a virus.

Acquired and Developmental Dyslexia

Dyslexics can be subclassified in several ways. First, researchers distinguish between *acquired dyslexia* and *developmental dyslexia*. Acquired dyslexia is dyslexia that can be attributed to known, identifiable brain damage – that’s what makes it ‘acquired.’ There are two particularly interesting subtypes of acquired dyslexia, surface dyslexia and deep dyslexia. Both result from brain damage, but the resulting reading problems are quite different. Surface dyslexics appear to read only by using the phonological route – they sound out every word. Not all words are equally accessible through the phonological route. English has a number of irregular words, those where the symbol–phoneme match is poor. Examples would be words like ‘island,’ ‘colonel,’ and ‘stomach.’ A surface dyslexic would read those words as ‘iz-land,’ ‘kol-o-nell,’ and ‘stow-match.’ However, surface dyslexics lose the direct-access route of reading. Deep dyslexics, in contrast, read only via the direct-access route – they have lost their ability to access words through phonology. They are most likely to make word substitution errors; shown the word ‘dresser,’ they may say ‘bureau.’ Given the word ‘car,’ they might say ‘automobile.’ Notice that the errors will often serve to preserve meaning, though the reader changes the exact wording. Finally (and importantly), deep dyslexics have extreme difficulty with pronounceable nonwords, like ‘blave.’ Even though ‘blave’ is not a word (fans of the movie ‘The Princess

Bride’ notwithstanding), it *could* be a word, as it conforms to the rules of English.

Although acquired dyslexia can be devastating, it is less of a puzzle for readers and educators. The cause is clear, and treatment options usually limited (or even nonexistent). The deficits seen in acquired dyslexics, though, provide powerful clues to the manner in which reading proceeds, as will be covered in the next section.

In developmental dyslexia, on the other hand, there is no identifiable brain damage. Rather, a child with developmental dyslexia has traditional learning experiences, adequate opportunity, yet still displays significant reading impairments. Developmental dyslexics account for the majority of the individuals diagnosed, and provide the greatest challenges for parents, educators, and researchers. Often, these are bright, motivated students, doing well in other subjects, who simply read poorly.

Individuals known as ‘backward readers’ provide an interesting comparison to developmental dyslexics. Backward readers may also read two grade levels below their age-appropriate peers, but they also have a level of intelligence 2 years below their peers. That is, they may be 10 years old, reading at an 8-year-old level, but have an IQ of 80 (which, roughly speaking, is a way of saying that they have the level of intelligence of an average 8-year-old). Several differences are striking and counterintuitive. Although backward readers are almost equally divided between males and females, about three-fourths of all dyslexics are males. Backward readers are more likely to display other signs of neurological impairment, such as problems with fine motor control. Perhaps most surprising is the outlook for the two groups. The prognosis for dyslexics is poor; currently, educators have a fairly low success rate with dyslexics. In contrast, the prognosis for backward readers is comparatively good. Backward-reading children may always read at a level below their age, but they will continue to make progress. Ironically, then, if two 10-year-olds – one a bright but dyslexic child, the other a less-intelligent backwards reader – are in the same remedial reading class, chances are very good that in 5 years, the less-intelligent child will be reading better.

What Acquired Dyslexia Says About Developmental Dyslexia

The two subtypes of acquired dyslexia, surface (all reading done via phonology) and deep (all reading done via direct access), suggest something important about the reading process in general, and about developmental dyslexia specifically. First, surface and deep dyslexia provide perhaps the strongest evidence for a dual-route model of reading. In acquired dyslexia, of course, loss of one of the routes results from neurological impairment. As is so often the case in psychology, researchers learn about normal functioning by looking at what is lost in abnormal cases.

Second, the nature of developmental dyslexia often mimics what is seen in acquired dyslexia: many developmental dyslexics have reading problems similar to those seen in (acquired) deep dyslexics. Many developmental dyslexics make word substitution errors, and almost all have problems with pronounceable nonwords (‘prume’ or ‘krell’). Given what is known about the impairment of the phonological route in deep dyslexics, it is not surprising that deficient phonological processing is suspected in developmental dyslexics as well.

Potential Causes of Developmental Dyslexia

When the general public first became aware of dyslexia, the problems were often assumed to be perceptual in nature. For example, it was believed that readers saw letters reversed or out of order. Now, researchers believe those kinds of perceptual problems to be relatively rare, and uncharacteristic of most dyslexics. When compared to normal children on perceptual/spatial tasks (which did not involve verbal materials), dyslexics typically perform as well as normal readers. Despite anecdotal evidence to the contrary, dyslexics do not consistently reverse letters or numbers.

Researchers have long known that the eye movements of dyslexics were abnormal. Dyslexics take longer to make saccades, their saccades tend to be shorter, and they make regressive saccades more frequently. In short, they move their eyes much less efficiently. However, the fact that dyslexics have faulty eye movements begs the question: are the faulty eye movement the *cause* of the dyslexia, or are they the *result* of poor reading behavior? After all, if an unfamiliar language was presented to readers of English (especially a language that was written from right to left), their eye movements would be considerably less efficient than those of skilled readers of that language. Recent evidence indicates that the faulty eye movements are the result of faulty reading, not the cause of it. If normal readers are given very difficult texts to read, their eye movements become more like those of dyslexics. If dyslexics are given easy material to read, their eye movements become much more like those of normal readers. Therefore, it seems unlikely that dyslexia is caused by faulty eye movements.

The central problem for developmental dyslexics appears to be related to poor phonological processing. One unresolved question is whether this reflects generalized deficits in processing sound-based information, or whether those deficits are language- and speech-specific. As is the case with most such questions regarding dyslexia, it is likely to be both: some will have a generalized auditory deficit, while others will have deficits only in speech-related areas.

Regardless of the precise nature of the phonological difficulties, genetic factors play a significant role. Concordance rates between monozygotic twins (the likelihood that one twin will be dyslexic given that the other is also dyslexic) are as high as 65% or 70%. Elevated rates are also seen between siblings, and between parents and children, although they are not as high as those between twins. Collectively, it appears that between 40 and 60% of the developmental dyslexia can be attributed to genetic factors. Researchers at the University of Colorado have been able to separate orthographic skills (reading letters) from phonological skills (turning symbols into sounds). The genetic contribution to phonological skills is significantly greater, as high as 90% in some studies. The genetic contribution to reading is much like genetic contributions to success playing basketball. There is no 'basketball gene,' but height has a significant genetic component, and height is certainly related to success in basketball. That is not to say that someone who is 5 ft 6 in. cannot be successful playing basketball (nor does it mean that a person 7 ft tall is automatically successful). But the shorter player is at a significant disadvantage. Likewise, having poorer phonological skills, whether generalized or language-specific, does not prevent one from reading, but it makes reading more difficult.

Educational Interventions for Dyslexia

Because of the serious and profound affect of dyslexia on academic performance, a number of interventions have been proposed over the past decade. Since early reading skills are cumulative, early intervention is critical: most successful interventions are initiated before the child ends the second grade. Some have focused on solving perceptual problems, perhaps by having readers read through colored lenses or through special glasses. Few, if any, of these have produced widespread or significant benefits.

The most promising programs are those that address phonological deficits directly, that recognize the importance of motivational factors, and that encourage the child to take advantage of accommodations such as extra time to complete exams. These programs are based on an understanding of the critical role of phonological processing in reading, and children with difficulty in this area require additional practice (perhaps significant additional practice). Early reading skills are stressed, and beginning readers are directed to books that emphasize phonology (like the Dr. Seuss books mentioned earlier). Early diagnosis and intervention are also encouraged.

Early intervention may well have effects above and beyond facilitating phonological skills – intervention is likely to prevent the student from perceiving reading as unpleasant and aversive. Reading problems often induce a vicious cycle: the child struggles in early reading exercises, reading skills develop slowly, and the child becomes frustrated. Because of the frustration, the child avoids reading, meaning that his skills do not improve as quickly as his classmates'. He reads poorly the next time in class; so his teacher assigns extra practice, which the student finds aversive and so avoids it, and so on. Developmental dyslexics need extended practice with precisely the same skills they lack, and few of us enjoy repeating things when we experience failure. Interventions that encourage the enjoyment of reading, while also affording the child extra practice on the skills they lack, are most likely to be successful.

Summary

Language is innate to humans, reading is not. Though its ties to speech are clear, reading involves different and highly specialized skills, combined with vast amounts of practice. Early reading instruction that stresses phonics has proven to be the most successful approach, and prereaders who have mastered the building blocks of reading – letter detection skills and phonemic awareness – are at a tremendous advantage. As reading becomes more skilled, the reliance on phonological mediation lessens but is never entirely eliminated. Words become directly accessible and the reading process becomes more efficient.

Skilled reading is the result of several factors. Readers must possess a nonintuitive grasp of their spoken language (phonemes). They must learn the symbols-to-phonemes match inherent in their alphabetic language. They must gradually learn to recognize patterns of letters (and eventually, words). All of these factors require many hundreds of hours of practice.

See also: [Eye Movements](#); [Memory](#).

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Psychology, Science, and Astrology

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Glossary

Astrology A belief system based on the view that strong correlations exist between the positions of constellations and planets and their relationships with human social affairs.

Birth chart A grouping on paper of information obtained from the heavens. These 'birth maps' are interpreted by astrologers as allegedly providing information about the subject (person, animal, country, company, etc.).

Pop psychology Popular psychology of the marketplace. It relies on testimonies and experiences of the writers rather than critical reflection and research. Testing of essential claims is not conducted. Negative cases and alternative conceptions are typically ignored or insufficiently considered.

Pseudoscience A theory or approach that portrays itself as a science, but at the present time, falls short in a number of essential aspects. It is usually not based on diverse supporting evidence from well-conducted studies, and the

conceptual structure of the theory has not been refined over time adequately in response to research findings. In addition, it has not contributed research suggestions to new areas, nor is it compatible with well-supported theories in related domains. The label 'pseudoscience' is not a permanent label as new discoveries or alternative conceptions of a discipline may require the rethinking of its status (or parts of it).

Psychology The scientific study of human behavior, including overt behavior, mental and neurological processes.

Science An approach to understanding the natural world using a diverse set of investigative methods. A central component of science is its reliance on public testing of claims rather than reflection alone or appeals to authority and intuitions. The results of well-conducted and replicated studies in science are, whenever possible, applied by practitioners at the applied level.

The main goal of psychological science is to fit our theories about ourselves to the social and physical world. Such knowledge can be used to explain, understand, under some circumstances predict, and even change human behavior. Unlike other disciplines or perspectives that also claim to contribute to our knowledge about ourselves and the world (e.g., religion, philosophy), science relies in a central way on the public testing and reliability of the very claims it makes. In contrast to commonsense, personal beliefs, or intuitions this is accomplished by the development of paradigms or research traditions that advocate ways of solving problems and what problems are solvable. Of course, the expression 'bad science' implies that there exists a contrast, namely, science proper. The distinction is not always clear and at times it is difficult to determine if some description of human behavior is scientific or not. However, there are approaches that *pretend* to be something they are not. They suffer from deficiencies both in quality of their research findings and in the rigor of the research methods employed that would allow them to claim to be a science.

Psychology: The Scientific Study of Behavior

Psychology is a science that studies and develops theories about behavior and mental processes such as thoughts, attitudes, feelings, personality, problem solving, and underlying neurological processes. As a science, psychology employs a variety of systematic procedures for obtaining and analyzing information. Attempts to organize the observations and findings often result in theories. While a theory attempts to explain

particular findings, it also generates new ideas or hypotheses that can be tested. Thus, a theory is not so much right or wrong as it is either more or less useful as a practical tool for studying human behavior.

Psychologists create hypothetical constructs to aid in discussing human behavior. Thus, concepts such as intelligence, extroversion, anxiety, achievement motivation, sensation seeking, and self-concept describe hypothesized internal conditions of the individual, while concepts such as social support and cultural climate refer to external features of the psychological environment. Many of these concepts are referred to as variables, since they are not static or fixed. For example, psychologists have demonstrated that the traditional notion of intelligence has a strong genetic basis.

The Role of Theory in Science

As research findings accumulate about concepts and principles, theories are created to attempt to pull them together into a more coherent, organized, and consistent system. In the process, these theories then allow for the generation of new hypotheses or predictions that may either be confirmed through rigorous testing or suggest that the theory is less useful for explaining the very phenomenon it was designed for. If the former holds true and consistently strong support emerges for these hypotheses, the theory, in turn, is supported. Alternatively, a lack of confirmation or support for the hypotheses generated by the theory requires that the theory be modified, restricted in application, or that it be abandoned in favor of alternative theories. Testability is of central concern.

For example, Hans Eysenck's original theory of extraversion relied very heavily on Pavlovian views of inhibition and excitation, but the results of various research investigations suggested that the initial theory was inadequate. Thus, Eysenck refined his theory so that introversion and extraversion were hypothesized to be related to differences in cortical arousal associated with the ascending reticular activating system (ARAS).

While scientists and research psychologists seem to be able to patiently test ideas and cope with the various different theories put forward to describe human behavior, this can be very confusing and irritating to the general public. Thus, while psychologists debate the intricacies of human memory or argue over reinforcement being, or not being, necessary in learning, the general public wants immediate answers. Parents who refer their child for learning problems are not interested in discussions about various hypothetical causes of learning disabilities, but rather in what can be done to improve their child's situation in school and future life in society. Of course, we all wish for a complete understanding of the cause(s) of cancer and heart disease, as well as autism and more importantly cures, but in the meantime we must continue to actively research the disease and use all of our current knowledge to assist those individuals with such conditions. Wishful thinking and pop remedies (some of which are fraudulent and only intended to benefit the seller) will not cure such diseases or psychological concerns. The same applies to the study of human behavior; pop psychology and pseudopsychologies may have great surface appeal to many people, but in the final analysis, they bring us no closer to a greater understanding about human behavior.

Scientific Method

Psychology's claim to being a science is grounded in the use of systematic observation and data collection with the attempt to minimize bias as the basis for gaining increased understanding about human behavior. Various quantitative and qualitative research methods are used to gather information and to test hypotheses and generate new findings. Correlational research is designed to explore the extent to which the two or more variables are related. Information is often carefully collected through questionnaires measuring particular psychological variables (e.g., IQ, anxiety, self-concept, attitudes), naturalistic observations (e.g., observing the frequency of occurrence of inattentive behaviors exhibited by an ADHD child), interviews (e.g., 'how do you most effectively cope with job stress?'), and other qualitative and narrative techniques. Through such research, it may be determined that, for example, school success of children is highly related with such home factors as parental encouragement to achieve and the opportunity for language development. While these specific findings are only correlational and therefore do not imply a causal relationship, they do describe and can be used to predict behavior. As always, the results need to be replicated, and the studies must be carefully conducted in the first place. The saying regarding computer data, 'garbage in-garbage out' also applies to psychological research. Like scientists from other disciplines such as physics and biology, psychologists are most interested in discovering causal or cause-and-effect relationships among variables. While the chemist knows that a mix of hydrogen

and oxygen produces water, the psychologist is interested in addressing questions such as 'Can intelligence be raised by creating more stimulating environments for children?' 'Does cognitive-behavioral therapy result in greater improvement in depressed patients than other therapies?' 'Does viewing TV violence result in increased aggression among children and adolescents?' Whenever possible, psychologists are interested in conducting *experimental* studies to investigate these questions.

Ideally, the focus of an experiment is to impose the necessary controls that will allow the researcher to determine what (causal) factors are responsible for any changes observed. Often there is one or more 'treatment' groups and even a control group that receives no treatment. Participants are carefully assigned to groups so as to ensure there are no pretreatment conditions or characteristics unique to one group that could affect the results. Once assignment to the experimental or control groups has occurred, the treatment(s) is administered and the effects are carefully observed, measured, and recorded. The treatment variable or the one believed to be responsible for any observed changes is called the independent variable. The dependent variable is the one that changes because of the treatment. A simple example should assist in clarifying the nature of a psychological experiment, although it should be remembered that most experiments are extremely complex.

Let us say that a university professor is concerned about the lack of participation and involvement by students registered in a first-year psychology course. Despite the professor's request for students to ask questions or respond to questions posed in class, there is very little student participation. Further, the professor is convinced that greater student interaction in class should have a positive effect on student grades. Since the professor teaches several sections of introductory psychology where students are randomly assigned to each given class, a study is created whereby group 1 is verbally reinforced ('thank you for such a good question, Cameron,' or 'that was a great answer, Genevieve; you have quite correctly outlined the purpose of the clinical interview') for questions asked and answered, or information sharing on an appropriate topic. Group 2 is told that a bonus mark of up to 5% will be awarded to students who volunteer to provide answers, ask questions, or share content-related information in class (average of one question/answer/comment per class = 1% up to five or more questions/answers/comments per class = 5%). Group 3 receives only the usual request to participate in class. A graduate student is asked to record the class participation on a specially designed data sheet. At the end of a 3-week unit on memory and forgetting, a carefully constructed objective test is administered to the three classes. The results suggested that the average participation rate per person and exam mark, respectively, for group 1 was 2.9 and 78%, for group 2 the results were 2.5 and 76%, while the results of the control group were 0.6 and 70%. Groups 1 and 2 were very similar in achievement and participation and certainly more active than group 3. Further, the results comparing the two treatment groups with the control group were found to be statistically significant ($p < .05$). Thus, the professor was able to conclude that even though these were all university students who were quite intelligent, their learning could be enhanced through the use of strategies designed to promote more active participation in the class.

A question that is often asked by psychologists is 'Are the groups really different, or did the differences between groups occur by chance?' The above example indicates that the probability that the differences between groups were due to chance is unlikely; if this study was repeated 100 times, such a difference among groups would occur less than five times if only chance was operating. If the differences between the groups are very unlikely due to chance, then the psychologist will conclude that there is likely a difference worthy of further investigation. Other psychologists will then try to successfully replicate the results and extend the study using other designs or variables to further increase our knowledge base.

Psychology is the scientific study of human behavior in a variety of contexts, but other scientific and nonscientific claimants also profess to further our understanding of humankind. For example, cultural anthropology, philosophy, history, and sociology, all contribute ways of conceptualizing human behaviors ranging from aggression to altruism. While these disciplines vary along the scientific continuum and may even, as in the case of philosophy, employ a more reflective and conceptual approach, they all employ critical analyses and/or rigorous testing procedures to validate their claims and applications. The results of inquiry in all these fields in turn modify the tenets of the discipline. In contrast, other efforts to characterize human behavior fall short with respect to a critical, reflective usage of their own tenets and findings and can in the extreme case be considered pseudoscience. Many of these approaches vary in their testability and plausibility. Some of these problematic approaches are acupuncture, faith healing, healing touch, tai chi (and similar 'energy treatments'), and much of the field of alternative and complementary medicine. A comprehensive consideration of all of these examples would require a large textbook. However, one popular problematic approach is astrology, which directly overlaps with and is often put forward as an alternative to personality theories and counseling techniques in psychology. We use popular astrology as an example of the problematic type of enterprise that shares many of the dubious underpinnings of the previously mentioned problematic areas.

Astrology: An Example of Bad Science

Astrology contends that there is a strong relationship between particular planetary and stellar configurations in the heavens and human personal and social affairs. More specifically, the birth time and place on earth of an entity (person, animal, country, company, etc.) allows the construction of an astrological chart for the frames of reference provided by the astrologically significant indicators such as signs, houses, and planetary aspects. On the basis of the symbolic interpretation of the birth chart, astrologers claim that they can obtain information about a particular individual's character and life (or prospects for a country or company). The astrological interpretations are not based on physical characteristics of the planets but mythological associations established by reading ancient traditions. In other words, the sizes and compositions of the planets do not play a role in their alleged astrological effects. The contrast with psychology is clear, given that astrology covers the same ground as psychology and other social sciences. Indeed, according to many astrologers, the planetary effects

are so strong on human behavior that psychology itself is seriously deficient in ignoring the most powerful relationships that allow understanding of human beings.

Astrology is based on several principles. One is 'as above, so below,' implying an association (not necessarily a causal relationship) between the lives of people, and institutions and heavenly configurations. Another principle is 'the stars incline, they do not compel.' This states that the relationship between the heavens and human behavior is one of tendency and is not simple cause and effect. A third principle is that 'the whole is more than the sum of its parts,' namely that the astrologically significant indicators such as signs, houses, and planetary aspects cannot be viewed in isolation. Rather, they interact and modify each other. These interactions are again based on mythological associations with the astrological symbols.

Many astrological practitioners (astrologers) contend that the tenets of astrology are based on 'practical' research or clinical observation, rather than on the findings of studies. In other words, these tenets have allegedly been arrived at by the 'critical' observation and discussion among astrologers of case studies of clients (including presumably, countries, companies, and pets).

Astrological Theory: A Critique

Theories can be evaluated according to their track record of past successes and their research potential. These involve an examination of a theory's empirical/conceptual performance over a specified interval of time. Some relevant considerations here are the success of the theory's problem-solving ability in its domain, and whether the theory has opened up new empirically investigable areas of investigation or extended fertile problem-solving resources without extensively resorting to 'face-saving' ad hoc hypotheses (face-saving hypotheses). The track record of a theory can also be evaluated on the elaboration and progress of its conceptual resources in helping us understand the social/natural world. The conceptual changes should direct and facilitate empirical research.

The conceptual/empirical performance of the field of astrology (as is the case of the other problematic approaches mentioned earlier such as acupuncture, healing touch, and energy treatments) is extremely unimpressive. There is little or no understanding or interest by astrologers of the kinds of biases and human deceptions in judgment that plague clinical observation in all areas of inquiry, including the social sciences and medicine. The reason careful studies and (whenever possible) experiments are used in psychology and other disciplines such as biology in the first place was to rule out as much as possible memory, perceptual, and reasoning biases and deceptions as well as alternative explanations. While case studies may play a role in generating hypotheses, they are too often fraught with error to be convincingly used as methods of confirmatory research.

If the basic claims of astrologers were based on observation, as many claim, then they would have been confirmed long ago by statistical tests, which basically do what any astrologer does (i.e., look for correspondences), only with a much greater sensitivity. But they have not. The claim that astrological interpretations developed as a result of clinical observation is like claiming to know the effect of each of 20 chemical elements on

every feature of every plant in your garden. Any reader who has tried to interpret a four-way interaction in an analysis of variance (ANOVA) will appreciate the problem if 15–20 or more factors are involved! The problem of examining the relationship between many variables has led to the development of sophisticated research tools in psychology such as LISREL, path analysis, and multivariate statistical models.

Astrology has an unimpressive scientific track record. Its problem-solving ability in the domain of understanding human behavior is noteworthy by its lack of success. Well over 100 controlled studies of signs, aspects, whole charts, and so on now exist, and indicate that overall the effect sizes (the impact of the variables in questions) are, at best, trivial. Moreover, there is nothing hinting at the sort of internal consistency that would arise if it was all real, like the effect size for whole charts being bigger than for parts. A meta-analysis (a statistical method of combining the results from many research investigations) on studies involving a number of prominent astrologers clearly showed that astrologers (even world famous ones) tend not to agree on an interpretation of birth charts.

The status of astrology as a science is therefore questionable. Further, studies on astrology play no serious role in theory development or astrological practice. Positive studies are given propaganda value, while negative findings are dismissed or ignored, and no scientific studies (positive or negative) have any influence on the daily practices of astrologers, as they do on the practices of practitioners of the physical and social sciences.

Many astrologers have responded to such criticisms and negative findings by claiming that astrology is an occult science, a divination approach or a philosophy. But in all such forms of unconstrained speculation, astrologers are not responsive to cogent criticism and have adopted varieties of postmodernism or relativism to avoid serious confrontation with their critics. In all its manifestations, astrology is made compatible with whatever happens or whatever studies show, and here lies one of its greatest present-day weaknesses.

The Scientific Research of Michel Gauquelin

A number of astrologers have made much propaganda over the research conducted by the late Michel Gauquelin of France and colleagues. His empirical research into astrology was conducted over a 40-year period in the second half of the twentieth century. Gauquelin's negative results regarding zodiac signs, planetary aspects, and tests of astrologers are seldom mentioned by astrologers or are explained away. Instead, astrologers have emphasized, and misinterpreted, Gauquelin's positive empirical findings as support for astrology.

Gauquelin forwarded three scientific findings that are relevant to a scientific evaluation of astrological theory. The first is that there is a relationship between planetary positions in the sky at the birth of *eminent* people in *some* occupations. For example, Mars tended to occur more often in certain sectors of the sky at the birth of outstanding athletes in some (but not all) sports. The planetary relationships did not hold with ordinary people or less eminent sportsmen. The effects were also very weak, generally needing large sample sizes for detection.

When astrologers cite Gauquelin research as supporting astrology, they neglect to inform people that Gauquelin only

found planetary relationships at the birth of *eminent* individuals and not the rest of us. Second, Gauquelin only found that *some* of the planets were associated with eminence, namely, the moon, Venus, Mars, Jupiter, and Saturn. He uncovered no relationship with the astrologically important sun, Mercury, Uranus, Neptune, and Pluto, and no relationship between zodiac signs or planetary aspects and the occupations of eminent or ordinary people. Third, the relationships uncovered by Gauquelin were very weak; there was little overall difference between effective and ineffective planets. Hence, while the results would have been of theoretical interest, they would have no practical benefit for astrological practice. Indeed, his negative findings, like the negative findings of other studies of astrology, were ignored or dismissed!

Gauquelin later offered two other claims, partly to explain the link between eminent individuals in some occupations and planetary positions at birth. One of these was to suggest a relationship between planetary position at birth and human temperament. The stronger the traits, as exhibited by top individuals in certain fields, the stronger the relationship uncovered. For example, Mars is, on Western myths, associated with strength and violence, and individuals outstanding in careers needing those traits should have, more often than those less eminent, Mars in certain sectors of the sky at their birth. However, Suitbert Ertel, a German psychologist, has found substantial biases on the part of Gauquelin's studies regarding the temperament (trait) hypothesis and has published a number of papers on this topic. Gauquelin's temperament research was based on trait extractions from the biographies of famous individuals. Ertel found that, using the same biographies as those of Gauquelin, the latter extracted more 'typical' traits for the relevant planets than did extractors who were 'blind' to planetary position. When coupled with other biases found by Ertel, it seems likely that Gauquelin's planetary-trait hypothesis will be, at best, severely weakened, and at worst, demolished.

The combination of an occupation/trait link to planetary position suggested a third hypothesis to Gauquelin, namely that the planetary relationships might be linked to hereditary factors. An initial study by Gauquelin with 24 961 parents and children showed that children tended to be born with the same particular planets in certain sectors of the sky as their parents. However, a replication by Gauquelin himself with 50 942 parents and children in 1988 found no relationship. This leaves the reality of the Gauquelin hereditary effects also in doubt.

The British astronomer Percy Seymour has written several books on astrology that have received media attention. Like Gauquelin, Seymour rejects much of astrology, including zodiac signs. Seymour's entire case for astrology rests on the Gauquelin data, which as we have seen, are now far less solid, at least in regard to his trait and heredity hypotheses, than it was two decades ago. Seymour has attempted to explain Gauquelin's findings in terms of geomagnetic activity, which induces currents in an individual's neural network by resonance. Seymour fails to answer the most important question of all: How does the fetus connect with the relevant planets in the first place? In addition, the planetary frequencies Seymour refers to are so microscopically weak that it seems doubtful to say the least that any organism could respond to them. Finally, Ertel in Germany found no evidence of geomagnetic influences in his reanalysis of Gauquelin's data, which in effect, nips

Seymour's theory in the bud. The reader should also notice that any *physical* explanation put forward for astrology creates other problems for astrologers. Astrologers will produce not only a birth chart for people and animals but anything that has a 'moment of birth,' including a company or a country. How could a physical force imprint itself on the nature of a company or country at its 'moment of birth?'

Astrological Practice: A Critique

Astrological *practice* has also not produced concrete evidence of its efficacy. When astrologers are asked to produce evidence of the validity of astrological practice, they usually cite testimonials, or case histories, or successful predictions by astrologers. Popular astrology books contain case studies involving the birth charts or horoscopes of famous individuals, which after the fact, invariably show a close connection between the interpretation of these individual's birth charts and their significant personality characteristics and life events. These case studies, however, should not be persuasive because of the large number of components in a birth chart that allow, by selection of factors, the chart to be made to fit almost any individual's life. As an example of this, at a British conference dealing with research into astrology, Australian ex-astrologer and critic of astrology, Geoffrey Dean, showed that British singer Petula Clark's horoscope matched her biographical details exactly; the horoscope was then revealed to be that of US murderer Charles Manson.

Counseling success with clients carries the most weight with astrologers. The assumption here is that a horoscope based on an individual's true birth date would be more accurate and informative than the one based on wrong birth dates or someone else's birth date. However, this assumption, which lies at the heart of astrology, is not supported by the evidence. Let us briefly consider reasons to support this skepticism. First of all, astrologers themselves do not seem to be able to distinguish between correct and incorrect horoscopes for well-known individuals most of the time. There are a number of published horoscopes that are based on incorrect birth data but purportedly describe the people involved perfectly. The German astrologer Peter Niehenke came across three different astrological publications, each containing a different horoscope of the late ex-Beatle John Lennon, each based on a different birth time, and each indicating 'definitely' the time of Lennon's tragic death. Second, most investigations of the validity of personality interpretations based on horoscopes have found that people or clients of astrologers were unable to distinguish between authentic interpretations and false interpretations at rates commiserate with astrological claims. In other words, wrong horoscopes are accepted as readily as right horoscopes.

The 'remarkable correspondences' that astrologers report between horoscopes and the lives of their clients are therefore unpersuasive. Every suspect system from phrenology to three-cycle biorhythms can produce similar 'remarkable correspondences.' One should also keep in mind that some startling coincidences should be expected to occur in such situations, given the length of the typical horoscope, the number of astrological elements involved, the leeway in interpretation of the statements contained in the horoscope, and the human tendency to concentrate on successes and ignore failures. Astrologers have failed to provide evidence that clients would

find more startling correspondences in birth charts based on an individual's correct birth data rather than incorrect birth data. In reference to Peter Niehenke again, he produced a horoscope for a client who was thrilled with its accuracy. The client told him that she had received horoscopes (based on accurate birth data) from several other astrologers and that this was the most thorough and accurate of them all. Niehenke's pride was diminished when he discovered that the horoscope he produced was based on incorrect birth data – 20 years earlier than the client's actual birth date!

Successful predictions similarly become suspect when the number of astrological predictions made are considerable and negative predictions are ignored or explained away. If astrology was a predictive discipline (as popular belief contends), one would expect large numbers of astrologers accurately predicting relevant important worldwide events, rather than the odd successful prediction made by one or a few astrologers. However, while making predictions is considered essential for popular astrology, it should be noted that the social sciences tend to be little better, in general, in their success rate in predictions of worldly affairs.

In a related vein, a number of studies have addressed the ability of astrologers using the complete horoscope to match individual horoscopes and various personal qualities, life events, handicaps, and so on. Some individual tests were made by the psychologist Vernon Clark in the later twentieth century. He carried out three tests, and each gave weak but positive results in favor of astrology. The studies by Clark are important because they have been widely cited as evidence for astrology. One problem with the studies is that no follow-up was conducted to measure the astrologers' skill again in a second test along the same lines or to extend the study in new areas. Also, equally competent astrologers from other countries (e.g., France) who tried Clark's tests failed and there was no evidence that the professional French astrologers had abilities inferior to those from other countries. In a later study conducted by Geoffrey Dean in Australia, individual's horoscopes were altered to make them as opposite in meaning to the authentic horoscopes (based on correct birth data) as possible: the extraverted indications were substituted for introverted, stable for unstable, tough for tender, ability for inability, and so on. It was found that reversed interpretations were accepted as accurate by clients just as readily as authentic interpretations. In another set of studies, Dean tested whether astrological theory or astrologers could predict two of the most important personality factors, namely, extraversion and emotionality in ordinary people. To this end, subjects with extreme scores on the Eysenck Personality Inventory were selected from over 1000 people. The average pair of opposite extremes used in the test was roughly equivalent to the two most extreme persons in a random sample of 15 adults. In the first experiment, Dean tested whether computer analyses of astrological factors such as tropical signs, elements, sidereal signs, aspects, Gauquelin plus zones, angularity, and so on, both individually and in combination, could predict extraversion and neuroticism (emotionality) in extreme subjects. None of the astrological factors, either singly or in combination, performed better than chance. In a second experiment, Dean tested whether 45 astrologers using the entire chart could predict extraversion and emotionality in ordinary people. He found that the

well-known astrologers did no better than chance. In addition, there was no relationship with the astrologer's experience, sex, confidence, personality, or technique. The cumulative verdict based on many such studies indicates that horoscopes are not useful in this regard.

Fourth, and most importantly, Dean found (as in other similar studies) there is poor agreement among astrologers regarding which astrological factors should predict various personality characteristics, and even astrologers using the same technique were found to show little agreement. This suggests that each astrologer's technique and interpretation are highly individual. In other words, the results of Dean's study showed that astrologers do not usually agree on what a chart (horoscope) indicates, even when using the same factors! In practice, this means that a client visiting equally competent astrologers is unlikely to get similar readings. Yet the client is likely to be satisfied with either horoscope. This is strong evidence that factors other than astrological ones are responsible for the perceived success of astrology.

Conclusion

Science and psychological science is characterized by an emphasis on the demonstration of its claims to the satisfaction of other scientists. To this end, theories are constructed, refined, tested against the alternatives, and reconstructed and refined, or rejected. Theories exist on a continuum regarding quality and usefulness. These attributes reflect the track record of past successes and the theory's research potential. A good theory has successes in its own domain, has opened up new areas of successful research, and has been conceptually modified in light of research findings. Theories can also be evaluated on the basis of their promise or research potential. While the past track record of a theory is relevant to the consideration of a theory's promise, other indices might be the production of analogies that direct researchers to examine problems in a new way, the introduction of new fruitful procedures for solving outstanding problems in an area, and the theory's consistency with well-established findings/theories in related domains.

As many of the expository articles in the *Encyclopedia of Human Behavior* show, psychology is a thriving, creative discipline. Many of the theories in psychology cannot yet duplicate the precision of those in the natural sciences – the sheer complexity, the newness of many areas of psychology, and conceptual problems in the field mitigate against this, yet the field has advanced both conceptually and empirically over the last 100 years.

The reader will be able to contrast the expositions given in other parts of the *Encyclopedia of Human Behavior* with the practices of astrology. If we appraise astrology's present status, we find a theory that has a very poor record of success in terms of studies obtaining positive evidence and, even less support once effect sizes are taken into account. Present-day astrology has not opened up new promising areas of research. While some astrologers have written books on the position of astrology in medicine, politics, crime, economics, and so on, the books are notable more for their authoritative postures than research studies and calculations of effect sizes.

Astrology does not appear to have any prospect in sight for providing a plausible mechanism that would explain human

behavior. While astrologers continually pose new models, they are not carefully examined or tested against each other in the astrological community. Instead, in response to criticism of claims, astrologers have resorted to many face-saving hypotheses; for example, that the relationship between an individual's planetary positions at birth exhibits patterns that are acausally related (synchronicity) to that individual's earthly activities, or that astrology is only involved in subjective human experiences that involve individual perceptions, or that astrology is a transcendent occult or divinatory discipline rather than a scientific one. These are precisely the situations where misinterpretation of data and biased evaluations of ambiguous data are most likely to occur.

Astrological claims (albeit not the Gauquelin effect) are readily explained by the perceptual, inferential, and small-sample biases to which people in general are quite prone. For example, knowing that Scorpios are supposed to be secretive, our observations will invariably confirm it, simply because everyone is secretive at time and we are disinclined to test non-Scorpios. Such findings underscore the importance of making sure those of us in the social sciences include both aspects of critical thinking along with readings on the extent of bias and deception in human life and investigations in our courses. The same lessons we can learn from our example of astrology are applicable to areas such as acupuncture, healing touch, and energy treatments.

Lest the reader come away with the impression that all that is put forward in the name of psychology is scientific, in contrast to other pretenders such as astrology, numerology, Tarot, past life regression therapy, and so on, we would caution the reader that there exists within psychology the same continuum. In psychology, there exist areas of developed theory, confirmed laws, well-conducted replicated studies, in contrast to areas that are on par with astrology. As an example of the latter, we would classify much of what could be termed pop psychology. Many pop-psychology books are bestsellers, selling millions of copies, and involve New Age (now misleadingly called 'New Science') psychobabble regarding 'co-dependency,' 'spirituality,' 'the adult child,' 'addictions,' 'psychological Laws of Attraction,' and a host of 'recovery programs.' These books and articles involve poorly articulated theory, the use of selected testimonials instead of clinical research, appeals to authority, the neglect of plausible scientific alternative explanations and cognitive biases, and contradictory assumptions. In the final analysis, a useful understanding of human behavior will be best achieved by the development of rigorous testable theories that can be improved upon by careful analysis and evaluation in both laboratory and real-world settings. Psychology is committed to this ideal.

See also: [Clinical Assessment](#); [Cognitive Behavior Therapy](#); [Evidence-Based Practice](#); [Extraversion–Introversion](#); [Personality Assessment](#); [Reasoning](#); [Violence](#).

Further Reading

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Psychopathology: Diagnosis, Assessment, and Classification

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Glossary

Abnormal behavior The behavioral component of dysfunction.

Functioning Behavioral, interpersonal, emotional, cognitive, and/or physiological patterns.

Insanity A legal term that addresses the question of whether a particular person can be held criminally responsible for his or her actions.

Mental disorder Descriptive term for psychopathology that does not connote an illness substrate.

Mental health The absence of psychopathology and positive characteristics such as subjective well-being, optimal development and use of mental abilities, social adaptation, and achievement of goals.

Mental health problems Synonymous with psychopathology or mental disorder.

Mental illness Similar to psychopathology, but implies that the dysfunction reflects disease or illness.

Psychopathology An aberrant or dysfunctional way of functioning.

Definitional Issues: Abnormalcy Versus Normalcy

The definition and conceptualization of psychopathology have long been subjects for discussion and debate. Psychiatric and psychological professionals have primarily led the dialogue and several related terms have held favor at different times within the discipline. In order to discuss the diagnosis, assessment, and classification of psychopathology, it is important to first define and distinguish some of the terms associated with the discipline. Psychopathology is a general term which refers to an aberrant or dysfunctional way of functioning, where functioning is defined in terms of behavioral, interpersonal, emotional, cognitive, and/or physiological patterns. Abnormal behavior is a similar term, but it focuses on the behavioral component of dysfunction. In contrast, although mental illness is largely synonymous with psychopathology, it is more closely aligned with a medical model as it carries the implication that the dysfunction reflects some form of disease or illness. Mental disorder, in contrast, is a more descriptive term, which does not connote a disease or illness substrate. Mental health is a term which is growing in popularity for its alternate focus on the positive attributes of human functioning. Mental health is not only defined as the absence of psychopathology, but also as positive characteristics such as subjective well-being, optimal development and use of mental abilities, social adaptation, and achievement of goals. Mental health is a term now often used to refer to the whole spectrum of mental experience from function to dysfunction. For example, mental health problems or issues are largely synonymous with psychopathology or mental disorders.

Insanity is a term that is sometimes confused with psychopathology. Although insanity and its derivatives, such as mad or lunatic, were used historically in much the same way modern society uses the terms psychopathology or mental illness, insanity is now a specific legal term that addresses the question of whether a particular person can be held criminally responsible for his or her actions. As such, whether or not a person is legally insane is determined by a judge or jury, not by a mental health professional. The tests necessary to inform the legal counsel are conducted by a mental health professional, who also provides

his or her expert opinion on the matter, but ultimately the decision is a legal one. Further, an individual, without a diagnosable form of psychopathology, may be deemed legally insane by the courts. In the same vein, many forms of psychopathology do not meet the criterion for insanity. In sum, while insanity and psychopathology have had similar definitions in the past, they are currently distinct concepts.

As exemplified above, different ways of conceptualizing psychopathology emerge as a result of different approaches to determining what is abnormal. One such method uses a statistical approach that conceptualizes function and dysfunction along a continuum. As such, the distribution of functioning in society can be conceived as forming a bell curve. Based on this model, statistical procedures can be used to determine at what distance a particular functional pattern falls from the norm, or the majority of the general population. If the functional pattern is determined to be statistically rare, then it is deemed dysfunctional. Alternatively, a deviance approach to abnormalcy may determine whether a behavioral pattern falls outside of current social norms or values and is thus considered a deviant pattern of behavior. Abnormalcy may also be determined by the level of distress experienced by the individual, or by the distress experienced by those in their environment. In contrast, the prototype approach provides a set of criteria for abnormalcy, a certain number of which must be met.

Theories of Cause

Beliefs regarding the cause of abnormal behavior have evolved over time. Historically, theories such as demonic possession predominated as an explanation for aberrant behavior. Contemporary explanations of psychopathology are based on scientific research and draw from at least one of three areas. Biological explanations of abnormal behavior view the cause of psychopathology in the individual's biological composition, specifically the brain. Some biological models focus on the location within the brain where problems may occur, while other models focus on biological processes such as neurotransmission to

explain abnormal behavior. Explanations for the cause of depression, for example, draw from evidence that individuals with depression have lower levels of the neurotransmitter serotonin in the brain. Psychological explanations of abnormal behavior are based on research on emotion, thinking, behavior, and personality, among other things. Using the example of depression once again, research has provided consistent evidence that certain patterns of thinking and certain personality styles increase one's vulnerability to depression. Third, social or environmental explanations view the individual's context as a causal factor in the development of abnormal behavior. For example, negative life events and harsh living conditions, trauma, and the loss of a loved one by death or separation, are viewed as playing a role in the possible genesis of depression. The most commonly accepted current conceptualization of the cause of psychopathology, however, is a combination of all three of these areas: termed the biopsychosocial model. The biopsychosocial model views each of the three areas as contributory to the development of psychopathology, in differing amounts depending on the disorder. Diathesis-stress models take this view one step further and typically suggest that biological and psychological factors constitute a vulnerability for psychopathology, and social factors trigger the expression of this vulnerability.

Classification and Diagnosis

The classification and diagnosis of abnormal behavior have also evolved over time. As early as in ancient Greece, there was a limited system for the classification of abnormal behavior. However, it was not until 1883 that the template for the majority of current diagnostic systems was developed by Emil Kraepelin. Similar to the medical model, his approach evaluated different symptoms that form cohesive patterns called syndromes. These syndromes, once identified, were then labeled. Following this general model, current diagnostic conceptions of psychopathology view abnormal behavior as discontinuous with normal behavior; as something that has a qualitatively different sense to it. Such conceptions often include ideas of illness or disease processes, as these processes are those that distinguish normal from abnormal functioning. The categorical approach to psychopathology is heavily subscribed to because diagnosis is often considered to be a necessary precursor to treatment in psychiatric settings. In contrast, dimensional approaches view functioning on a continuum, where some levels of functioning are more or less dysfunctional than others. Diagnosis and labeling are less accepted within a dimensional approach, except to the extent that labels are applied to individuals at agreed upon points along a continuum. For example, if a person bites his or her nails more than 3 times a week, we might label that as 'abnormal' and label such a person a 'nail biter.' Dimensional approaches are often used in combination with statistical conceptions of what is 'average' or normal, and abnormality is defined as being atypical or highly different from the 'average.'

The International Classification of Diseases

There are two predominant contemporary diagnostic nomenclatures used in the mental health professions. Both nomenclatures

adopted categorical approaches to diagnosis. In 1948, the World Health Organization (WHO) published the sixth edition of the *International Statistical Classification of Diseases, Injuries, and Causes of Death* (ICD-6) that included for the first time a section on mental disorders. Although ICD-6 was revised to ICD-7, the section on mental disorders was not modified. Efforts were made in the ICD-8 (1968) to improve the utility of the list of mental disorders across all member countries of the WHO. Further improvements to the system were made for ICD-9. Specifically, a descriptive glossary was provided for each disorder. ICD-10 was published in 1992 and is the version in current use. There are a total of 78 major categories of mental disorders in the ICD-10 (see [Table 1](#)), and many of these categories contain a number of more specific forms of psychopathology. ICD-10 is available in 42 world languages, and is the official coding system throughout much of the world.

The Diagnostic and Statistical Manual

Due to problems with earlier versions of the ICD, the American Psychiatric Association developed its own system for diagnosis. Referred to as the Diagnostic and Statistical Manual (DSM), the system was first published in 1952, and has since been updated and republished four times. The current DSM is the fourth edition with text revision (DSM-IV-TR), which was published in 2000, and a 5th edition is currently in development. Most versions of the DSM were coordinated with publication of each new revision of the ICD. Publication of DSM-I corresponded with ICD-6, DSM-II with ICD-8, DSM-III with ICD-9, and DSM-IV with ICD-10. However, the newest revision of DSM will not likely follow publication of ICD-11. Rather, if there is a revision of the mental disorders section, ICD-11 may be coordinated with the DSM-V.

The first two editions of the DSM had many similarities to the ICD. Distinctions were made between psychotic and non-psychotic disorders, for example, and the diagnostic system included many etiological terms in the diagnoses. The DSM-III made a major departure from this approach and deleted, as much as possible, references to putative causes of disorder and theory-based terminology. Instead, the DSM-III attempted to label disorders solely on their objective features, with as little inference about cause of the disorders as possible. In addition, more descriptive information for each disorder was provided, including criterion sets for each disorder, and an expanded discussion of each disorder (onset, course, gender differences, etc.) within the text. The DSM-III was also innovative in other ways, which garnered wide applause as a major step forward from earlier versions of the DSM. Notably, DSM-III incorporated a multiaxial diagnostic system, which was a way to examine different 'axes' or dimensions of functioning within the person being diagnosed, in order to achieve a more complete assessment (see [Table 2](#)). This multiaxial system was retained for subsequent versions of the DSM, and is expected to also be used in the DSM-V.

The success of DSM-III solidified the reputation of the DSM nosology and garnered significant investment in the system by mental health professionals. Publication of the DSM-III-R was largely propelled by changes in some of the diagnoses in the field, as well as a desire by the American Psychiatric Association to have a bridge between the DSM-III and DSM-IV.

Table 1 Major diagnostic categories from ICD-10

A. Organic, including symptomatic, mental disorders
1. Dementias in Alzheimer's disease
2. Vascular dementias
3. Dementias in other diseases classified elsewhere
4. Unspecified dementia
5. Organic amnesic syndrome, not induced by alcohol and other psychoactive substances
6. Delirium, not induced by alcohol and other psychoactive substances
7. Other mental disorders due to brain damage and dysfunction and to physical disease
8. Personality and behavioral disorders due to brain disease, damage and dysfunction
9. Unspecified organic or symptomatic mental disorder
B. Mental and behavioral disorders due to psychoactive substance use
10. Mental and behavioral disorders due to use of alcohol
11. Mental and behavioral disorders due to use of opioids
12. Mental and behavioral disorders due to use of cannabinoids
13. Mental and behavioral disorders due to use of sedatives or hypnotics
14. Mental and behavioral disorders due to use of cocaine
15. Mental and behavioral disorders due to use of other stimulants, including caffeine
16. Mental and behavioral disorders due to use of hallucinogens
17. Mental and behavioral disorders due to use of tobacco
18. Mental and behavioral disorders due to use of volatile solvents
19. Mental and behavioral disorders due to multiple drug use and use of other psychoactive substances
C. Schizophrenia, schizotypal and delusional disorders
20. Schizophrenia
21. Schizotypal disorder
22. Persistent delusional disorders
23. Acute and transient psychotic disorders
24. Induced delusional disorder
25. Schizoaffective disorders
26. Other nonorganic psychotic disorders
27. Unspecified nonorganic psychosis
D. Mood (affective) disorders
28. Manic episode
29. Bipolar affective disorder
30. Depressive episode
31. Recurrent depressive disorder
32. Persistent mood (affective) disorders
33. Other mood (affective) disorders
34. Unspecified mood (affective) disorder
E. Neurotic, stress-related and somatoform disorders
35. Phobic anxiety disorders
36. Other anxiety disorders
37. Obsessive-compulsive disorder
38. Reaction to severe stress, and other adjustment disorders
39. Dissociative (conversion) disorders
40. Somatoform disorders
41. Other neurotic disorders
F. Behavioral syndromes associated with physiological disturbances and physical factors
42. Eating disorders
43. Nonorganic sleep disorders
44. Sexual dysfunction, not caused by organic disorder or disease
45. Mental and behavioral disorders associated with the puerperium, not elsewhere classified
46. Psychological and behavioral factors associated with disorders or diseases classified elsewhere
47. Abuse of nondependence-producing substances

(Continued)

Table 1 (Continued)

48. Unspecified behavioral syndromes associated with physiological disturbances and physical factors
H. Disorders of adult personality and behavior
49. Specific personality disorders
50. Mixed and other personality disorders
51. Enduring personality changes, not attributable to brain damage and disease
52. Habit and impulse disorders
53. Gender identity disorders
54. Disorders of sexual preference
55. Psychological and behavioral disorders associated with sexual development and orientation
56. Other disorders of adult personality and behavior
57. Unspecified disorder of adult personality and behavior
I. Mental retardation
58. Mild mental retardation
59. Moderate mental retardation
60. Severe mental retardation
61. Profound mental retardation
62. Other mental retardation
63. Unspecified mental retardation
J. Disorders of psychological development
64. Specific developmental disorders of speech and language
65. Specific developmental disorders of scholastic skills
66. Specific developmental disorder of motor function
67. Mixed specific developmental disorders
68. Pervasive developmental disorders
69. Other disorders of psychological development
70. Unspecified disorder of psychological development
K. Behavioral and emotional disorders with onset usually occurring in childhood and adolescence
71. Hyperkinetic disorders
72. Conduct disorders
73. Mixed disorders of conduct and emotions
74. Emotional disorders with onset specific to childhood
75. Disorders of social functioning with onset specific to childhood and adolescence
76. Tic disorders
77. Other behavioral and emotional disorders with onset usually occurring in childhood and adolescence
L. Unspecified mental disorder
78. Mental disorder, not otherwise specified

The revision process for the DSM-IV also brought improvements to the nomenclature. Notably, the writers focused on the empirical literature to guide diagnoses, and they expanded the text for each disorder to include cultural, ethnic, and gender variations in presentation. The impetus for the publication of the DSM-IV-TR was thus to further update the text material.

The DSM-IV-TR multiaxial system comprises five major axes. Axis I contains the major psychopathology diagnoses, while Axis II is used to diagnose personality disorders and mental retardation. Axis III is used to diagnose general medical conditions. Some of these disorders or conditions may be relevant to the other psychopathology diagnoses, as malnutrition may be to anorexia, for example, whereas other medical disorders or conditions may simply help to round out a picture of the person's current problems. Axis IV is used to rate the severity of psychosocial and environmental stressors. Similar to reported general medical conditions, some stressors may be

Table 2 Major diagnostic categories from DSM-IV-TR*Axis I* – Clinical disorders/other conditions that may be a focus of clinical attention

1. Disorders first diagnosed in infancy, childhood, or adolescence (excluding mental retardation, which is diagnosed on Axis II)
2. Delirium, dementia, and amnesic and other cognitive disorders
3. Mental disorders due to a general medical condition
4. Substance-related disorders
5. Schizophrenia and other psychotic disorders
6. Mood disorders
7. Anxiety disorders
8. Somatoform disorders
9. Factitious disorders
10. Dissociative disorders
11. Sexual and gender identity disorders
12. Eating disorders
13. Sleep disorders
14. Impulse-control disorders not elsewhere classified
15. Adjustment disorders
16. Other conditions that may be a focus of clinical attention

Axis II – Personality disorders/mental retardation

- | | |
|---|---|
| <ol style="list-style-type: none"> 17. Paranoid personality disorder 18. Schizoid personality disorder 19. Schizotypal personality disorder 20. Antisocial personality disorder 21. Borderline personality disorder 22. Histrionic personality disorder | <ol style="list-style-type: none"> 23. Narcissistic personality disorder 24. Avoidant personality disorder 25. Dependent personality disorder 26. Obsessive–compulsive personality disorder 27. Personality disorder not otherwise specified 28. Mental retardation |
|---|---|

Axis III – General medical conditions

29. Infectious and parasitic diseases
30. Neoplasms
31. Endocrine, nutritional, and metabolic diseases and immunity disorders
32. Diseases of the blood and blood-forming organs
33. Diseases of the nervous system and sense organs
34. Diseases of the circulatory system
35. Diseases of the respiratory system
36. Diseases of the digestive system
37. Diseases of the genitourinary system
38. Complications of pregnancy, childbirth, and the puerperium
39. Diseases of the skin and subcutaneous tissue
40. Diseases of the musculoskeletal system and connective tissue
41. Congenital anomalies
42. Certain conditions originating in the perinatal period
43. Symptoms, signs, and ill-defined conditions
44. Injury and poisoning

Axis IV – Psychosocial and environmental problems

45. Problems with primary support group
46. Problems related to the social environment
47. Educational problems
48. Occupational problems
49. Housing problems
50. Economic problems
51. Problems with access to health care services
52. Problems related to interaction with the legal system/crime
53. Other psychosocial and environmental problems

Axis V – Global assessment of functioning

relevant to other psychopathology diagnoses, whereas others may simply provide a context for current functioning. Axis V consists of a global assessment rating of the individual's current overall functioning, ranging from 1 (worst possible functioning) to 100 (highest possible functioning). In order to diagnose a person using the DSM-IV-TR, information should be provided on each of the five axes. Thus, only Axes I and II are comparable to the ICD's diagnostic labels, the DSM is more comprehensive than the ICD, and the DSM provides

more of a complete context in terms of the patient's medical and psychosocial issues than the ICD.

Current Questions and Issues*Categorical versus dimensional models*

A significant amount of research has been conducted on issues of relevance to DSM that may be addressed in the DSM-V. A long-standing debate in the field is whether the choice of a

categorical approach to the classification of psychopathology is valid, and whether a dimensional approach might be more accurate. A large number of conceptual, research, and ethical issues regarding the categorical approach to psychopathology have been raised. At the conceptual level, issues of validity (i.e., accurate portrayal of reality) have taken a number of forms. For example, the fact that the total number of diagnoses has increased over time, and the fact that the ICD and DSM systems have different numbers and types of diagnoses, leads to the question about which system best reflects the 'real' range of psychopathology. Ideally, diagnostic systems should be both comprehensive (i.e., include all potential diagnoses), as well as distinctive (i.e., each diagnostic category should be distinct and minimally overlapping with other categories). It is not clear that either the DSM or ICD meets these criteria. Nor is it easy to imagine how they could demonstrate that they are both comprehensive and distinctive.

Another validity issue that has been raised is the extent to which a categorical system best represents psychopathology. This issue has been particularly raised in the case of the personality disorders, where it has been argued that rather than being discrete disorders they represent the extreme ends of personality dimensions. According to this view, rather than diagnosing personality disorders such as Dependent Personality Disorder, psychopathologists should speak about the relative strength or weakness of certain personality dimensions such as dependency.

Although the issue of whether disorders are dimensional or categorical in nature is most acute in the case of personality disorders, it is also clear that in other disorders, judgments must be made about when a given behavioral pattern or symptom falls outside the range of normal. Consider, for example, the diagnosis of anorexia nervosa. Within that diagnosis are a number of dimensional judgments that a diagnostician makes, including what is an 'expected' body weight, when a fear of being overweight is 'intense,' when thoughts about body size are 'disturbed,' and when body weight or shape has an 'undue influence' on self-evaluation. While at the extremes of such judgments there would likely be high agreement across diagnosticians, less extreme fears and disturbances are more difficult to judge with certainty. Put otherwise, some of the symptoms are themselves not dichotomous, but reflect dimensions of disturbance, which are identified only if they cross some imaginal 'line' of dysfunction. Decisions about how to recognize where that line has been crossed require some agreement among diagnosticians about what that line is, and how to recognize it is being breached.

Arguments about the dimensional nature of disorder have been made with respect to most forms of childhood disorders, as these disorders are typically conceptualized in terms of extreme forms of behavior (e.g., too much aggressive behavior). Determining when the 'line' of dysfunction has been crossed is even more difficult in the case of children, since development is not a uniform process in all children in any event. It is also often the case that the child him/herself does not have the insight to recognize that there is a problem and so adult caregivers (e.g., parents, teachers, extended family) in the child's life determine if behavior is abnormal. Aside from potential conflicts in the opinions of caregivers of what is normal or abnormal behavior, one must take into consideration the

developmental stage of the child. For example, while some behavior may be abnormal behavior for a preteen, it may be quite normal for a preschooler. Further, developmental stages only roughly correspond to age. Gender, culture, and other individual differences also affect the progression through developmental stages and so it is difficult to determine when each individual child should be at a particular developmental stage.

It has been suggested that diagnoses do not reflect the real world of psychopathology, but rather society's beliefs about and experience of abnormal behavior. Critics of diagnosis have pointed out that the 'emergence' of new disorders and deletion of others reflects changing societal values, rather than scientific advances that could validate such changes. For example, the diagnosis of homosexuality has had an interesting history within the DSM system. Homosexuality was defined as a psychopathology diagnosis in the DSM-II. By the time of the DSM-III in 1980, only 'ego-dystonic homosexuality' (i.e., sexual preference for a same-sex person, but where the individual felt that this preference was inconsistent with their own wishes) was a recognized disorder; instances where the homosexual patterns were 'ego-syntonic' (i.e., consistent with the person's wishes) was not considered abnormal. Homosexuality was totally deleted as a diagnostic label in the DSM-III-R. In contrast, the ICD-10 continues to include three related diagnostic labels: sexual maturation disorder (where an individual is confused about their gender identity or sexual orientation, resulting in anxiety or depression), ego-dystonic sexual orientation (similar to ego-dystonic homosexuality), and sexual relationship disorder (in which gender identity or sexual orientation is responsible for relationship difficulties with a sexual partner). It has been pointed out that this evolution of approaches to homosexuality mirrors a growing recognition and acceptance of homosexuality in Western society. It has been argued, therefore, that the changing diagnoses related to homosexuality do not reflect changes in the scientific basis of that diagnosis, but rather reflect changes in the attitudes and biases that the developers of diagnostic systems share with society at large.

At the scientific level, the major issues for categorical systems of psychopathology relate to the internal consistency and reliability of diagnostic categories. If a perfect diagnostic system existed, then every person with psychopathology should be captured in the system, and every trained diagnostician should recognize an individual's unique diagnoses in a manner consistent with other diagnosticians. Research on these issues suggests that our current systems, although better than their precursors, do not closely approximate these goals. Clearly, further research and development is needed to clarify why consistency and reliability have been elusive.

Finally, there have been ethical arguments raised about the practice of diagnosis. It has been argued that diagnosis is an artificial process of labeling people, and that labels are not taken as descriptions of the individual's current functioning, but rather become long-term crosses for the individual to bear. These abuses of the diagnostic process have been used by some to argue that the utility of diagnosis is more than offset by its costs, and should be abandoned.

Dimensional models view psychopathology as deriving from underlying dimensional constructs that explain both normal and abnormal functioning. For example, it is possible

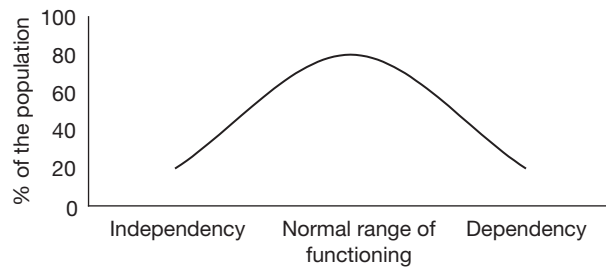


Figure 1 A dimensional approach to dependency.

to imagine a construct called interpersonal dependency. At one end of this construct is extreme dependency, as would be marked by such thoughts as being insufficient without others, having to have others around to feel comfortable, and marked by such behavior as seeking out others to be with, talking to others, etc. At the other end of this construct is interpersonal independency, which would be marked by such thoughts as never needing others, having to be alone to feel comfortable, and such behaviors as spending time alone, not starting conversations with others, etc. A person functioning at either end of this dimension would be considered dysfunctional, while a wide range of normal dependency–independency lies between these extremes.

Research has shown that most constructs are more common at their middle range, and less common at their extremes. As such, if the constructs that are related to psychopathology could be identified, it would be possible to identify those points along the continua where abnormal or extreme patterns could be identified. For example, using the dimension of interpersonal dependency–independency, it might be possible to identify a point along that continuum where the person is either so dependent or independent it causes distress and/or interpersonal problems for the person. It would be at those points we would talk about the person crossing an imaginary line from normal to psychopathological functioning (see [Figure 1](#)).

Trait versus symptom approaches

Dimensional models of psychopathology are often one of two types. Some dimensional models focus on underlying theoretical dimensions or traits that might explain abnormal behavior, while others focus more on the range of symptoms or descriptive features of the dysfunctional behaviors themselves. There are a number of trait approaches to psychopathology, and all cannot be described here. The work of Hans Eysenck is a good example of this approach. In Eysenck's earlier research, two basic trait dimensions were related to normal and abnormal behavior. One of these dimensions was introversion–extroversion, which had extremes of high introversion (shy, retiring, isolated) and high extroversion (outgoing, sociable). The other was neuroticism, which had two extremes of stable versus unstable patterns (where instability is marked by such attributes as anxiety, physical complaints, moodiness, etc.). According to Eysenck's research, these two personality dimensions were unique from each other, and an individual's placement on each dimension reflected a basic disposition, which likely could be seen in different situations, and across time.

Within Eysenck's model of functioning, psychopathology was identified at the extremes of each dimension. He developed questionnaires to measure these dimensions, and

established normative scores, to allow clinicians to assess if an individual was in the normal range of functioning or not. Later, Eysenck added a third dimension to this model, referred to as psychoticism. This dimension was theoretically distinct from the other two, and reflected an underlying tendency toward more extreme forms of abnormal behavior, including insensitivity toward and lack of caring about others, and opposition to accepted social customs. A mental health professional using Eysenck's system to describe psychopathology would not talk about a given individual as 'extroverted,' 'neurotic,' or 'psychotic,' but would rather talk about an individual as being low or high on these dimensions. The mental health professional would know that certain forms of thought, emotion, and behavior are related to these dimensions, and would explain psychopathology in terms of these underlying trait dimensions.

Contemporary developmental models also use a dimensional trait approach to the conceptualization of psychopathology. However, not only do they view abnormal behavior on a continuum from normal to abnormal, but they consider the development of psychopathology on a continuum across the lifespan. Research on behavioral inhibition versus behavioral disinhibition serves as a good example of the dimensional developmental model. Behavioral disinhibition is defined as the inability to restrict socially undesirable actions, whereas behavioral inhibition is defined as the restriction of socially undesirable actions. While the latter may seem to be a positive trait, at its extreme it can lead to over-inhibition of a wider range of emotions and behaviors, some of which may be socially desirable. Behavioral disinhibition at its negative extreme is exemplified by psychopathological diagnoses such as oppositional defiant disorder, conduct disorder, and attention deficit hyperactivity disorder in children, or by antisocial personality disorder and substance abuse in adults. In contrast, extreme behavioral inhibition is exemplified by psychopathological diagnoses such as social anxiety disorder, generalized anxiety disorder, and major depressive disorder. A well-adjusted, mentally healthy individual would be at the center of this continuum, able to strike a balance between restricting those behaviors that are socially undesirable without restricting prosocial behaviors or becoming worried and depressed. The behavioral disinhibition dimension is not unlike a composite of Eysenck's three dimensions: extroversion, neuroticism, and psychoticism.

Research on gender differences in brain development has examined the developmental trajectory of behavioral disinhibition due to the differential prevalence of externalizing disorders and internalizing disorders in girls and boys. The externalizing disorders are typically defined as problems directed toward the environment and others, whereas the internalizing disorders are typically defined as problems directed toward inner experience. These dimensions map loosely onto the behavioral inhibition/disinhibition dimensions mentioned above; the internalizing disorders correspond to those disorders listed at the extreme end of the behavioral inhibition dimension, and the externalizing disorders correspond to those disorders listed at the extreme end of the behavioral disinhibition dimension.

It has been found that boys have much higher rates of the externalizing disorders, and girls have much higher rates of the internalizing disorders. That said, the gender difference in

the prevalence of externalizing disorders is generally apparent from a young age, whereas the gender difference in the prevalence of internalizing disorders tends to emerge at puberty. The research on gender and brain development suggests that brain maturation tends to be delayed in boys relative to girls. Advanced brain maturation results in more rapid development of abilities such as the ability to read and follow social cues, empathy, and greater emotional expression and understanding. Once again, although these traits would appear to be positive, theories postulate that extreme traits predispose girls to behavioral inhibition and internalizing disorders. Delayed neural maturation would result in the opposite of advanced neural maturation (i.e., low prosocial behavior, etc.) which may predispose boys to behavioral disinhibition and externalizing disorders.

In contrast to trait models of psychopathology, there are symptom dimensional approaches. For example, there are 11 recognized personality disorder diagnoses within the DSM-IV-TR. As is true for other diagnostic categories, DSM-IV-TR lists the descriptive features of these disorders, and presents them as unique (although a given individual could have 'comorbidity,' in which the person qualifies for more than one diagnosis simultaneously). An alternative perspective is to conceptualize personality as having a number of dimensions, which at their extreme represent dysfunctional patterns of interpersonal relating. Such an alternative approach would view personality features in terms of their symptoms, as well as in terms of the severity of these symptoms. In recent years, there has been considerable discussion about a dimensional model referred to as the 'Big Five' or the 'five-factor' model of personality. This model was derived from research on normal personality and describes five personality dimensions on which people can be rated: extraversion (active, loquacious, and assertive, vs. reticent, silent, and passive); agreeableness (warm, kind, and trusting, vs. mistrustful, hostile, and egocentric); conscientiousness (dependable, organized, and thorough, vs. unreliable, imprudent, and negligent); neuroticism (nervous, irritable, and emotionally labile vs. even-tempered); and openness to experience (creative, imaginative, and inquisitive, vs. petty and imperceptive). While we will not discuss the adequacy of this model here, it is important to note that many theorists are beginning to converge on the importance of these five factors in personality. Further, one of these dimensions – neuroticism – is explicitly oriented toward identifying abnormal neurotic behavior (anxiety, physical complaints, nervousness, edginess).

Both the categorical and dimensional approaches to psychopathology face the issues of comprehensiveness and distinctiveness. How many diagnoses or dimensions, respectively, adequately account for the range of human dysfunction? Are these distinct diagnoses and dimensions, does their overlap call into question the theoretical basis for the approach to psychopathology? Despite the above issues, the Kraepelinian model of psychodiagnosis is dominant, and unlikely to be supplanted.

Assessment

The nature and severity of the problem must first be assessed, to proceed with the appropriate treatment. Assessment can be defined as the process of collecting information about an

individual in a systematic and objective way. There are several different kinds of information that can be collected, dependent on the purpose of the assessment and the hypothesized problem. Among the various pieces of information that may be of interest are the individual's intellectual functioning, behavior, cognition, personality, and emotions. Although the purpose of assessment is often seen as diagnosis, diagnosis is not always the end result. Assessment can also inform case planning, prediction, and prognosis, as well as provide descriptive information.

There are several assessment methods available to the psychodiagnostician. The three most commonly used methods are interviews, behavioral observation, and psychological testing. Other methods such as neuropsychological testing and collateral reports (i.e., information obtained from outside sources such as grades or hospital charts, or interviews with significant others in the individual's life) are also common, but used only in specific circumstances. For example, neuropsychological testing is typically only used when brain damage is suspected, and collateral reports are typically obtained when the information provided by the individual is not sufficient. While some diagnosticians use only one assessment method, comprehensive assessments that involve multiple methods are generally preferred. Such an assessment may include a clinical interview, review of the hospital chart, and a battery of psychological tests selected based on the reason for referral, the psychometric properties of the tests, and the practitioner's training, experience, and familiarity with the relevant literature. The psychometric properties of tests are the reliability and validity of the tests. Strong reliability and validity are determined by empirical assessment of the tests. While reliability and validity have diverse definitions, reliability can generally be defined as the degree of stability, consistency, predictability, and accuracy of the test. On the other hand, validity can be defined as how accurately the test measures the variable it was intended to measure.

Interviews

Clinical interviewing helps to both establish rapport and obtain information. There are three general types of clinical interviews: unstructured, semistructured, and structured interviews. Unstructured interviews are free-flowing, and are generally guided by the client. The interviewer does not prepare a list of set questions in advance, but rather begins with a general question and allows the client to determine the content of the interview, and then uses probes to gather more information on certain topics. Structured interviews consist of a precise set of questions, with specific wording. The interviewer follows a script and takes responsibility for guiding the interview in order to obtain the specific requested information.

Semistructured interviews are structured, in that they provide a set list of questions; however, the client's responses to the questions will lead the interview in different directions. For example, if a client responds 'no' to questions about the two key diagnostic criteria for depression, the interviewer may discontinue assessing for depression and proceed to ask questions about the next diagnosis under investigation. The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I), the Autism Diagnostic Interview Revised (ADI-R), and mental status exams are good examples of semistructured interviews.

There are advantages and disadvantages to each type of interview. The risk in conducting an unstructured interview is that interviewer biases may affect the direction of the interview and the interpretation of the results. For example, the interviewer may focus on one outstanding piece of information provided by the client and make global inferences from that piece of information, about the client, without adequate further inquiry. Alternatively, the interviewer may exercise a confirmatory bias, by making an inference about a certain topic and asking questions to confirm the inference. Last, the interviewer may infer certain personality traits in the client based on limited situational information. Unreliability in structured interviews can derive from an inappropriate choice of interview that does not target the real issues at hand, inaccurate observations on the part of the interviewer, differences in the criteria assessed by the interview and the diagnostic nomenclature, and inaccurate or selective information provided by the interviewee. Structured interviews pose less of a threat of lack of reliability, but they take longer to conduct. Further, unstructured interviews are superior to structured interviews because they permit the development of rapport between interviewer and interviewee. The choice of interview should be selected based on the purpose of the assessment and the training of the diagnostician.

Psychological Tests

Psychological tests vary widely in method and scope. There are psychological tests to assess intelligence, cognition, a range of symptoms for a particular diagnosis, emotion, personality, behavior, neuropsychology, etc. Psychological tests can be used for a variety of purposes, including treatment planning, informing diagnosis, case conceptualization, and determining treatment progress or current functioning. Appropriate test selection involves consideration of such factors as the theoretical construct the test is supposed to measure, the validity of the test, whether or not the test was appropriately standardized (i.e., Was the population the test was standardized on similar to the population being tested? How well do the instructions allow for standardized administration? Was the size of the standardization sample adequate?), the reliability of the test and practical considerations such as reading level, and the duration of the test (i.e., can the client sustain attention for long enough to complete the test).

A diagnosis is rarely made on the basis of psychological testing, as most tests do not assess all of the various symptoms of a particular disorder. Rather, they provide information on one or a few symptoms, or related traits. The Wechsler Intelligence Scales (adult and child versions) are a good example of well-used tests that provide one piece of information that may contribute to a diagnosis (e.g., autism) in conjunction with other information. The Minnesota Multiphasic Personality Inventory (MMPI), the Hamilton Rating Scale for Depression (HAM-D), and the Beck Depression Inventory (BDI) are other examples of tests that are frequently used in conjunction with other information to provide a diagnosis. In addition, the HAM-D and BDI are often used in both research and clinical practice to assess treatment progress. A listing and descriptive information for all published questionnaires and psychological tests can be gained by examining the *Mental Measurements Yearbook*, which is an annual publication of the Buros Institute.

Behavioral Observation

Behavioral observation is concerned with determining antecedents or determinants of behavior, as well as its consequences, in other words, the situational determinants of behavior. Behavioral observation is a functional, utilitarian approach in that it focuses on the clearly observable ways in which the client interacts with his or her environment. Behavioral observation may be used informally as part of an interview or in a testing session, or as a method in its own right. Behavioral observation may be the most informative type of assessment in certain cases, such as with very young children, the developmentally disabled, resistant clients, and clients lacking in insight. Behavioral observation may be conducted by the psychodiagnostician, by other individuals in the client's life (e.g., teachers, parents, spouses, other caregivers), or by the client themselves through self-monitoring.

The first step in behavioral observation is to select a target behavior, or set of target behaviors related to the problem behavior, for observation. There are then several recording methods from which to choose depending on the goal of assessment, the nature of the target behavior and the practicality of the method for the particular client. Narrative recording is what is frequently done during other psychological testing as an additional source of information. It involves simply taking note of any behaviors of interest. There is a lot of flexibility in terms of how descriptive or inferential the recording is, and little quantification is used. Interval recording, also referred to as time sampling, interval sampling, or interval time sampling, involves recording selected behaviors within a predetermined time interval (e.g., for 5–30 s every 5 min). Interval recording is used, for example, with behaviors such as walking, listening, or playing because they occur with moderate frequency and do not have a clear beginning or end. As opposed to using a predetermined time interval as a guide for recording, event recording relies instead on the occurrence of the behavior itself to record details of the behavior such as frequency, duration, and intensity. Behaviors of low frequency are best suited to event recording. Last, ratings recording is more general and global than the previously described methods; the evaluator provides a rating of a particular behavior, in terms of frequency or quality, after a defined period of observation. The advantages to ratings recording are that it can be applied to a wide variety of behaviors, it can be statistically analyzed, it is time-efficient, and the ratings can be made for individuals or groups.

Considerations for Assessment

The selection of an assessment strategy requires consideration of the needs of the client and the referral source. It would be inappropriate to ask that a client complete a number of superfluous questionnaires or undergo testing that is not directly relevant to the referral question. In addition, it is important that the diagnostician recognizes his/her role in the assessment process. Assessment goes beyond description into interpretation; put otherwise, assessment is not simply the accumulation of data, but rather includes the integration and interpretation of data to address specific questions for a specific purpose (e.g., case conceptualization, treatment planning, diagnosis, etc.). As such, psychodiagnosticians are intimately involved with

the data analysis process and outcome, and their own biases, strengths, and weaknesses are reflected in the assessment process and outcome.

Diagnosticians must recognize that their reports can have wide-ranging effects on their clients. In order to remain responsible to their clients, they must recognize their role, educate others, and stay within their limits of competence. They must also recognize and inform their clients that an assessment is one 'snapshot' of functioning, and cannot capture the person's lifetime functioning or the individual in their entirety. While clinical interviewing tends to be performed by a variety of mental health professionals (psychiatrists, psychologists, psychiatric nurses), psychological testing is almost exclusively administered and interpreted by clinical psychologists, sometimes with the assistance of a psychometrician.

See also: Big Five Model and Personality Disorders; Clinical Assessment; Test Behavior.

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Relevant Websites

- <http://www.psych.org/mainmenu/research/dsmiv/dsmivtr.aspx> – American Psychiatric Association website for the Diagnostic and Statistical Manual.
- <http://www.apa.org/science/testing.html> – American Psychiatric Association website for testing and assessment.
- <http://clinpsy.annualreviews.org> – Website for the Annual Review of Clinical Psychology Publication.
- <http://www.unl.edu/buros/> – Website for the Buros Institute.
- <http://www.who.int/classifications/icd/en/> – Website for the International Classification of Diseases.

Psychophysics

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Glossary

Absolute threshold Traditional term for the magnitude of a stimulus that is just discriminable from its null.

Accuracy Denotes how close a psychophysical measurement is to its physical representation.

Adaptive procedure Method for estimating the parameters of a psychometric function (PF) in which the stimulus magnitude on each trial is based on the observer's responses on previous trials, such that the amount of information gained from the trial is optimized.

d' (d -prime) A measurement of observer sensitivity or stimulus discriminability derived from Signal Detection Theory.

Difference threshold Traditional term for the magnitude of a stimulus difference that is just detectable when both stimuli are above detection threshold.

Discriminand One of the stimuli in a discrimination experiment.

Discrimination scale A perceptual scale derived by integrating JNDs. Also termed a Fechnerian scale.

Fechnerian scaling The method of deriving a perceptual scale by adding up or integrating discrimination thresholds (or JNDs).

Just-noticeable difference (JND) The smallest difference in stimulus magnitude that is just discriminable.

Perceptual scale The function describing the relationship between the perceived and physical magnitudes of a

stimulus dimension. Examples are perceived contrast as a function of contrast, perceived velocity as a function of velocity, perceived depth as a function of retinal disparity.

Point of subjective equality (PSE) The physical magnitude of a stimulus at which it appears perceptually equal to that of another stimulus. An example is a stimulus with, say, a contrast of 0.5 that appears to have the same contrast as a larger stimulus with, say, a contrast of 0.4.

Precision (of psychophysical measurement) The inverse of the variability of a psychophysical measurement. The measure of variability may be the slope of the psychometric function or the standard deviation of a set of measurements.

Psychometric function A function that describes the relationship between observer response and stimulus magnitude.

Signal detection theory A theory of how observers make perceptual decisions based on the premise that the internal representation of a stimulus magnitude is a sampling distribution with a mean and a variance.

Threshold The difference in magnitude between two stimuli or stimulus states needed to make them just discriminable. Examples are a contrast detection threshold, a contrast discrimination threshold, and the threshold for binocular rivalry.

Psychophysics is the primary scientific tool for determining how the physical world of colors, sounds, odors, movements, and shapes translates into the sensory world of sight, hearing, touch, taste, and smell. The advantages of psychophysics over other methods for studying sensory behavior are that it is non-invasive, is able to provide large amounts of data in a relatively short time, and measures behavior under relatively normal sensory conditions. Gustav Fechner (1801–1887) is widely credited with being the father of psychophysics, and his *Elements of Psychophysics* set out the principles behind the various procedures used to map the relationship between matter and mind. Fechner launched psychophysics not just as a methodology but as a research area in its own right, and new psychophysical procedures, new methods for running psychophysical experiments, and new methods for analyzing psychophysical data are in constant development. Although this article concentrates on psychophysics as applied to vision, the concepts and procedures described are applicable to all sensory modalities.

Components of a Psychophysical Experiment

A psychophysical experiment consists of the following components: *stimulus*, *task*, *method*, *analysis*, and *measure*. The stimulus

is the least generic component since it must be individually tailored to the specific question about sensory function being asked. Since the advent of digital computers, psychophysical stimuli are typically generated by a computer and presented on a device such as (in the case of vision experiments) a CRT (cathode-ray tube) monitor. The psychophysical *task* is the 'action' the observer must perform on each trial, for example selecting a stimulus from the two presented, pressing a button as soon as the stimulus is detected, or recognizing an object. The *method* refers to the way the stimuli are presented and the manner in which the observer's responses are recorded. For example, with the *method of adjustment* the stimulus is adjusted by the observer via a dial or keypad until a prespecified criterion is met, whereas with the *method of constants*, the stimuli are preselected by the experimenter and presented to the observer, typically in random order using a forced-choice paradigm (see section '[Varieties of Psychophysical Procedure](#)').

The term *analysis* refers to how the psychophysical data are converted into measurements. For example, with the method of adjustment, an observer's settings might be averaged to obtain an estimate of a threshold. On the other hand, using a forced-choice procedure in conjunction with the method of constants, the proportion of correct scores may be fitted with a function whose shape is chosen to approximately match the data.

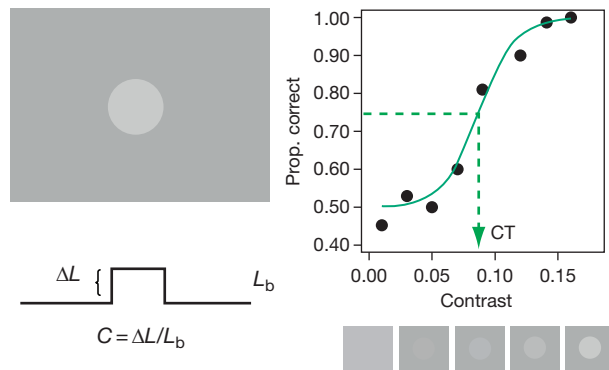


Figure 1 Example of psychophysical experiment to measure a visual contrast detection threshold. Top left: circular test patch on a uniform background. Bottom: luminance profile of patch and the definition of contrast C . Right: results of a standard two-interval forced-choice (2IFC) experiment. The various stimulus contrasts are illustrated on the abscissa. Black circles give the proportion of correct responses for each contrast. The green line is the best fit of a psychometric function, and the calculated contrast detection threshold (CT) is indicated by the arrow. See text for further details. L = luminance; L_b = luminance of background; ΔL = difference in luminance between patch and background; C = Weber definition of contrast. Reproduced with permission from Kingdom FAA and Prins N (2010) *Psychophysics: A Practical Introduction*. London: Academic Press.

The *measure* is the result of the analysis. Examples of measures are thresholds, reaction times, and proportion correct. The term *procedure* is used ubiquitously in psychophysics and can refer variously to the task, method, analysis, or some combination thereof.

Figure 1 illustrates some of these components for an experiment aimed at measuring a contrast detection threshold for a circular patch on a uniform background. The hypothetical data are obtained using a two-interval forced-choice (2IFC) procedure in conjunction with the method of constants. On each trial, two stimuli, one the patch the other a blank field, are presented in random order, and the observer chooses the interval containing the patch. Each point in the graph gives the proportion of correct responses for each patch contrast and the resulting psychometric function has been fitted with a logistic curve. The contrast threshold is estimated from the curve as the patch contrast producing 0.75% or 75% correct detections.

Classification of Psychophysical Experiments

This section considers the main ways in which psychophysical experiments have traditionally been classified.

Class A Versus Class B

An influential dichotomy introduced some years ago by Brindley is that between Class A and Class B psychophysical observations. Brindley used the term ‘observation’ to describe the perceptual state of the observer while executing a psychophysical task. The distinction between Class A and Class B attempted to identify how directly a psychophysical observation related to the underlying mental process involved.

For Brindley, a Class A observation refers to the situation in which two physically different stimuli are perceptually indistinguishable, while a Class B observation refers to all other situations. A prototypical Class A observation is the metameric match in color vision, in which the intensities of two colors in a mixture (say red and green) are adjusted until the mixture looks identical to a third test color (say yellow). The identification of an observation as Class A accords with the idea that when two stimuli look identical to the eye they presumably elicit identical neural responses in the brain. As the neural responses are identical, Brindley argues, it is a relatively straightforward matter to map the physical characteristics of the stimuli onto their internal neural representations. Other forms of Class A observations include thresholds, such as the contrast detection threshold (see **Figure 1**) and bisection acuity, in which a line must be bisected.

Class B psychophysical procedures include magnitude estimation, in which observers provide numerical estimates of perceived stimulus magnitude, and most types of matching experiment. For example, in an ‘asymmetric’ brightness match, the observer adjusts the luminance of a patch until it matches the brightness (perceived luminance) of another patch with a different surround. This is a Class B experiment because the two patches are always perceptibly different due to the fact that their patch surrounds are perceptibly different, even though the patches themselves are matched in brightness.

Type 1 Versus Type 2

An important distinction in psychophysics is between experiments for which there is a correct and an incorrect response on each trial, termed Type 1, and experiments for which there is no correct and incorrect response on each trial, termed Type 2. With Type 1 experiments, there is an external physical standard against which the observer’s response is judged; for example, the stimulus really was present, or the face was really was that of Abraham Lincoln. With Type 2 experiments, there is no such external physical standard, only an internal standard. For example, the color mixture only appeared to be identical to the single-color stimulus, or the face only appeared to look unhappy. In Type 1 experiments, observers may be provided with feedback during an experiment, such as a tone for a correct and/or a buzz for an incorrect response. Some researchers prefer Type 1 to Type 2 procedures because they regard them as more objective. However, a great deal about sensory function has been learnt from Type 2 experiments. For example, perceptual scales, which map the relationship between the perceived and physical magnitudes of a stimulus dimension, are primarily derived from Type 2 experiments (see section ‘Varieties of Psychophysical Procedure’).

Performance Versus Appearance

A distinction closely related to but not synonymous with Type 1 and Type 2 is performance versus appearance. Performance experiments measure *aptitude*, that is, ‘how good’ an observer is at a particular task. For example, if observer A’s threshold for discriminating two stimuli is lower than observer B’s threshold, one can say that observer A’s performance at the task is better than observer B’s. Examples of performance

experiments are those that measure detection thresholds, discrimination thresholds (or 'just-noticeable differences' (JNDs)), reaction times, proportion of correct responses, and precisions (the inverse of the amount of response variability). Appearance experiments on the other hand measure the *apparent magnitude* of some stimulus dimension, and appearance measures cannot meaningfully be judged as 'better' or 'worse' than any other measure. Examples of appearance experiments are matching the brightnesses of two patches with different surrounds, selecting the computer sketch of a stimulus that best matches its appearance, and labeling the most salient parts of an image of a natural scene. Two broad classes of appearance experiments are matching and scaling (see section '[Varieties of Psychophysical Procedure](#)'). Matching experiments measure points of subjective equality (PSEs) between physically different stimuli. Scaling experiments determine the relationship between the perceptual and physical magnitudes of a stimulus dimension, for example, that between perceived contrast and physical contrast, hue (or perceived chromaticity) and wavelength, perceived velocity and physical velocity, and perceived depth and physical depth. The relationship between performance and appearance measures of sensory function is a complex one but is critical to our understanding of the relationship between psychophysical measurement and sensory function.

Forced-Choice Versus Non-Forced-Choice

Forced-choice procedures are used extensively in psychophysics. The term 'forced-choice' as used here refers to any procedure in which the observer is required to choose from among two or more possible responses on each trial. It should be noted that in the literature on Signal Detection Theory, the term forced-choice tends to be restricted to procedures in which the observer chooses between two or more *stimuli* on each trial. Examples of forced-choice tasks are deciding whether a stimulus is in front or behind the background; deciding which of two stimuli, a blank field or patch, contains the patch; deciding which of two patches is brighter; deciding which of three lines, two oriented -5° and one oriented $+5^\circ$, is the -5° line. Typically at the end of a forced-choice experiment, the proportion of trials in which one response was given over the other(s) is recorded for each stimulus. These proportions may be used to derive performance measures such as proportion correct and thresholds, or appearance measures such as PSEs.

Criterion-Free Versus Criterion-Dependent

Some psychophysical procedures are prone to the effects of observer bias, and may entail the need for special measures. The best-known example of this is the yes/no task, in which a single stimulus is presented on each trial and the observer reports whether it contains the target. Different observer criteria lead to judgments being biased toward responding 'yes' or 'no' irrespective of the actual strength of the target signal. If a strict criterion is adopted, the signal must be relatively strong for the observer to respond 'yes,' whereas if a loose criterion is adopted, a weak signal is sufficient. The adoption of a particular criterion might result from an unconscious bias, or it might be part of a conscious strategy. For example, observers might

consciously bias their responses toward 'yes' because they want to maximize the number of correct target detections or 'hits,' even if this results in many false alarms, that is, 'yes' responses when the target is absent. On the other hand, observers might consciously adopt a strict criterion in order to minimize the number of false alarms, even if this means fewer hits. 2IFC tasks can also be prone to bias, but the bias is toward responding '1' (first interval) or toward '2' (second interval). This type of bias is less common than that observed in yes/no experiments, because with 2IFC, the two response choices are on an 'equal footing': the observer knows that on every trial the target will be present, so the option of consciously trading off hits and false alarms does not generally arise. The branch of psychophysics termed Signal Detection Theory has developed analytical tools for decoupling the effects of bias from the observer's actual sensitivity to the target in yes/no and other types of forced-choice experiment, and provides bias-free measures of performance such as d' (' d -prime').

Detection Versus Discrimination

The term detection is most commonly used to characterize experiments that measure thresholds for detecting the presence of a stimulus. For example, a contrast detection threshold is the minimum amount of contrast needed for a stimulus to be just visible, and a line curvature detection threshold is the smallest amount of curvature in a line required to make it just discriminable from a straight line. Discrimination on the other hand is generally used for experiments that measure the minimum perceptible difference between two stimuli that are both above their individual detection thresholds. Thus, in a curvature discrimination experiment, both stimuli in the forced-choice pair are curved and the observer decides which one is the more curved. However, the terms detection and discrimination are often interchangeable. Two terms closely related to detection and discrimination are 'recognition' and 'identification.' Both tend to be used to denote experiments involving relatively complex stimuli such as faces, animals, and household objects, where the task is to select from two or more objects, one either recently shown or previously memorized.

Threshold Versus Suprathreshold

A threshold is roughly defined as the stimulus magnitude that results in the perception of a new stimulus state. Traditionally, psychophysical thresholds have been divided into two categories: 'absolute' and 'difference.' An absolute threshold is the magnitude of a stimulus that enables it to be just discriminated from its null, as exemplified by a contrast detection threshold ([Figure 1](#)). A difference threshold on the other hand is the magnitude of stimulus difference needed to make two stimuli that are above their individual absolute thresholds just discriminable, as exemplified by a contrast discrimination threshold. These thresholds are performance measures. Not all thresholds are performance measures however. Binocular rivalry is said to occur when two stimuli presented separately to the two eyes are perceived to alternate in dominance. A threshold for binocular rivalry can be defined as the minimum physical difference between the stimuli needed to produce rivalry. This is an appearance measure.

The term suprathreshold has more than one meaning. Sometimes, it means any nonthreshold experiment, task, procedure, or measure. According to this usage, a simple matching experiment involving two visible stimuli is suprathreshold, but the curvature discrimination experiment described earlier is not because it measures a threshold. More often, however, the term suprathreshold refers to any experiment/task/procedure/measure that involves stimuli that are individually above their own detection threshold, irrespective of whether or not a threshold is being measured. According to this usage, the curvature discrimination experiment is also suprathreshold.

Varieties of Psychophysical Procedure

General Methods

The most basic method is the *method of adjustment*, in which the test observer adjusts the magnitude of a stimulus dimension, for example using a key-press, until some prespecified criterion is reached. The method of adjustment is most commonly used for appearance-based tasks, for example to measure PSEs. Although the method of adjustment is rarely used in performance-based experiments because forced-choice procedures are generally regarded as superior, the method of adjustment can be a useful way of obtaining a rough estimate of the measure in order to guide the choice of stimulus levels for a forced-choice procedure, a prudent strategy when there are a large number of different conditions.

A variation on the method of adjustment is the *method of limits*. Although rarely used these days, this procedure is a quick method of obtaining a rough estimate of a threshold and may be the most suitable method in situations where the experimenter needs to maintain close verbal contact with the observer. A verbal report, may be the only possible response with young children or clinically impaired persons, or indeed in any circumstance where it is difficult for the observer to be 'in the driving seat.' With the method of limits, the observer is presented with a series of temporally or spatially demarcated stimuli in increasing (ascending method of limits) or decreasing (descending method of limits) magnitude, including sometimes the null or baseline stimulus at one end of the stimulus continuum. On each presentation, the observer is required to report 'yes' or 'no' depending on whether the stimulus appears noticeably different from the null or baseline. The threshold in each case is measured as the stimulus magnitude at which the response switches from 'no' to 'yes' and/or vice versa. This is a Type 2 performance procedure because the observer's response cannot be evaluated in terms of whether it is correct or incorrect. Typically, the ascending and descending series are presented alternately and the thresholds from each averaged.

A potential disadvantage of the method of limits is that the observer may become accustomed to reporting that they perceive (or do not) a stimulus and as a result continue to give the same report even at stimulus magnitudes that are higher (or lower) than the 'real' threshold. This is termed the error of habituation. Conversely, the observer may anticipate that the stimulus is about to become detectable, or undetectable, and make a premature judgment. This is called the error of expectation. Errors due to habituation and expectation may

be minimized by averaging thresholds from ascending and descending series.

The standard method for presenting stimuli in forced-choice procedures is the *method of constant stimuli*, or simply 'method of constants.' In this method, the stimulus magnitude on each trial is selected, typically at random, from a predefined set. With a performance-based experiment, the set of stimulus magnitudes is typically chosen to straddle the expected threshold so that performance will range from near-chance to near-100% correct. This strategy generates data that, when fitted with the appropriate psychometric function, provides the most accurate estimates of the threshold as well as other parameters such as the slope of the psychometric function. The choice of stimulus set usually requires pilot work to obtain a rough estimate of the threshold, and the method of adjustment is sometimes useful for this purpose. The method of constant stimuli can also be used in conjunction with appearance-based procedures. For example, with forced-choice matching experiments aimed at measuring a PSE, all the above considerations equally apply, though the data here are not proportions correct but proportions of one stimulus being chosen over another.

To avoid the problem of selecting an inappropriate wrong range of stimuli when using the method of constants, an *adaptive (or staircase)* procedure is often employed instead. In an adaptive procedure, the stimulus magnitude on each trial is selected by an algorithm that analyzes the previous observer's responses, in order to 'zero in' on the threshold. Some adaptive procedures can be used in conjunction with conventional methods for fitting psychometric functions, enabling estimates of both the threshold and slope to be obtained. Adaptive methods can be used in conjunction with both performance-based and appearance-based tasks.

Forced-Choice Performance Procedures

Whether used in conjunction with the method of constant stimuli or an adaptive method, performance-based forced-choice tasks (all Type 1) come in different varieties. All forced-choice tasks may be termed by the generic acronym AFC (alternative forced-choice), or IFC (interval forced-choice), which is reserved for procedures in which the stimulus alternatives are presented in temporal order. The two acronyms are invariably prefixed by a number, usually the number of stimulus alternatives presented on each trial. The main varieties of performance-based forced-choice task are yes/no, symmetric 1AFC, 2AFC, MAFC, same-different, oddity, and match-to-sample. These are schematized in [Figure 2](#) for a task in which the observer is required to discriminate the orientation of a patch of grating (an arrangement of alternating dark and bright bars). In the yes/no task, termed here 1AFC, one of two stimulus states, 'target-present' or 'target-absent,' is presented on each trial, and the observer indicates whether the target is present. Symmetric 1IFC tasks are those in which the stimulus is selected from two that are in a metaphorical sense mirror-opposites, for example a left-oblique- and a right-oblique-oriented pattern.

2AFC procedures are the most popular procedure in psychophysics. In this procedure, two stimuli are presented on each trial, one of which is the target, and the observer must select the target. In an MAFC task, M stimuli are presented per trial, where $1 < M < \infty$, and with one stimulus being target,

and the observer must select the target. Same–different tasks come in two main varieties. In one variety, two stimuli are presented on a trial and the observer decides whether they are the ‘same’ or ‘different.’ In another variety of same–different, two *pairs* of stimuli are presented on each trial, one pair being the same, the other different, and the observer selects the pair that is different (or same). Oddity tasks involve three or more stimuli per trial, all but one of which are the same, and the observer chooses the ‘odd-one out.’ Match-to-sample tasks present a ‘sample’ stimulus, as well as two or more ‘match’ stimuli, one of which is the same as the sample, and the observer selects the match that is perceived to be the same as the sample. The same–different, oddity, and match-to-sample tasks offer an important advantage over other types of forced-choice tasks in that the observer does not need to know the basis on which the discriminands (the stimuli to be discriminated) differ.

Scaling Procedures

Perceptual scales describe the relationship between the perceived and physical magnitudes of a stimulus dimension. There are three types of perceptual scale relevant to psychophysics: ordinal, interval, and ratio. Ordinal perceptual scales rank-order stimulus magnitudes according to perceived


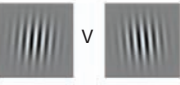
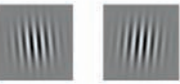

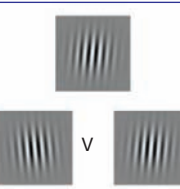
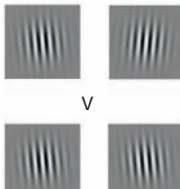
<i>N</i>	Task name	Stimuli presented during trial	Task
1	1AFC symmetric		Respond ‘left-oblique’ or ‘right-oblique’
2	Standard 2AFC		Select stimulus that is left-oblique
2	1AFC same–different		Respond ‘same’ or ‘different’
3	3AFC oddity		Select stimulus that is the oddity
3	2AFC match-to-sample		Select from the two bottom stimuli the one that is the same as the top stimulus
4	2AFC same–different		Select the pair (top or bottom) that is different (or same)

Figure 2 Varieties of forced-choice procedure for the task of discriminating the orientation of two grating patches. *N* = number of stimuli presented per trial. Reproduced with permission.

magnitude. Interval perceptual scales capture both the rank order *and* magnitudes of perceived difference between adjacent pairs of stimulus magnitude along the perceptual continuum. An interval scale can be transformed without loss of information by the equation $aX + b$, where X is the scale value and a and b are constants. Interval perceptual scales do not, however, capture the *relative* perceived magnitudes of the stimulus dimension. Perceptual scales that capture relative perceived magnitude are known as ratio scales and can be transformed only by the factor aX . Perceptual scales can be one or two dimensional. An example of a one-dimensional perceptual scale is the relationship between the brightness of a patch and its luminance. The best-known example of a two-dimensional perceptual scale is a color space, such as the CIE, in which each color is defined by a point on a plane with an X and a Y coordinate, and where the distance between points corresponds to the perceived distance in hue, or perceived chromaticity. Two-dimensional perceptual scales are invariably interval scales.

Figure 3 illustrates some of the types of procedure used to derive perceptual scales. Forced-choice scaling procedures are illustrated in the upper and non-forced-choice procedures in the lower half of the figure. With *paired comparisons*, two stimulus magnitudes are selected from a prespecified range, and the observer chooses the stimulus with the higher (or lower) perceived magnitude. With the *method of triads* (or ‘triples’), one of three stimuli is designated the target, the other two the comparisons, and the observer is required to compare the perceived


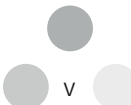

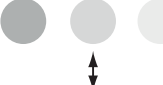

Forced-choice			
<i>N</i>	Task name	Stimuli	Task
2	Paired comparisons		Select the brighter stimulus
3	Method of triads		Select the stimulus from the bottom pair that is most similar (or most different) to the top stimulus
4	Method of quadruples		Select the pair (top or bottom) that is more similar (or more different)
Non-forced-choice			
<i>N</i>	Task name	Stimuli	Task
3	Partition scaling		Adjust middle stimulus until perceptually midway between the anchors either side
>3	Multipartition scaling		Adjust stimuli between the anchors at either end until all stimuli are at equal perceptual intervals

Figure 3 Varieties of procedure for measuring perceptual scales, illustrated for the scale of patch brightness. *N* = number of stimuli per trial. Reproduced with permission.

similarity (or difference) between the target and each of the two comparisons, and choose the pair that is the more (or less) similar. With the *method of quadruples* (or 'double pairs'), observers are presented with two pairs of stimuli on each trial, and the task is to decide which pair is the more (or less) similar. With the methods of triads or quadruples, the observer need not know the basis upon which the stimuli differ. With all these methods, the perceptual scale can be derived using statistical methods, for example maximum-likelihood fitting procedures, using the relative proportion of trials that one stimulus, or stimulus pair, is chosen over another stimulus, or another pair.

Turning to the non-forced-choice scaling procedures, a frequent method for deriving an ordinal perceptual scale is to present observers with the entire stimulus set together and to ask them to arrange the stimuli in rank order. The best-known example of this method is the Farnsworth–Munsell 100 hue test for color deficiency. Observers are presented with a randomly arranged series of disks that vary systematically along a particular color dimension (e.g., green to red) and are asked to arrange them in order according to hue (e.g., green, yellowish-green, more-yellowish-green, yellow, reddish-yellow, more-reddish-yellow, . . . , red). The resulting arrangement is compared to that typically made by a person with normal color vision. The pattern of errors made by observers with the Farnsworth–Munsell can be used to identify certain types of color deficiency. With *magnitude estimation*, the observer makes a direct numerical estimate of the perceived magnitude of the stimulus along the dimension of interest. Magnitude estimation produces a ratio scale if observers are instructed to allocate numbers that reflect the *relative* perceived magnitudes of the stimuli. In one form of magnitude estimation, the experimenter starts with a stimulus designated as an 'anchor' and asks the observer to suppose that it has a perceived magnitude of, say, 50. The other stimuli are then estimated relative to the anchor, that is, 25 (half-as-much), 100 (twice-as-much), 175 (3.5 times-as-much), etc. The scale values can then be normalized to the stimulus with lowest perceived magnitude by dividing all values by 50. Psychophysicists tend to regard magnitude estimation as a rather blunt tool because it requires observers to translate a perceptual experience into a numeric, that is, symbolic representation. Observers often find magnitude estimation difficult and unsatisfactory, and for this reason, other scaling methods are recommended wherever possible.

Partition scaling, sometimes termed '*equisection*' or '*bisection*' scaling, involves observers adjusting the magnitudes of stimuli until they appear to be at equal perceptual intervals. Partition scaling methods therefore generate interval scales. One variety of partition scaling method that is intuitively easy for the

observer but which has certain drawbacks is termed by Gescheider the '*progressive solution*.' The experimenter starts by providing the observer with two 'anchors' that define the start and end points of the stimulus continuum. The observer then divides the perceptual distance between the two anchors into two equal parts by adjusting a third stimulus to appear perceptually midway between the anchors. The resulting two intervals are then each bisected, resulting in four intervals, and so on. This method, however, suffers from the problem that errors will tend to accumulate as the intervals become smaller. Another version of partition scaling, termed by Gescheider as the '*simultaneous solution*,' presents observers with the full set of stimuli together on the display. Two stimuli at the ends of the continuum serve as anchors, and observers adjust the remaining stimuli until they appear to be at equal perceptual intervals. In general, this will not be an easy task, as adjustment to any one stimulus will tend to 'throw out' the previous adjustments, requiring a number of iterations to find the perceptually satisfactory solution.

Finally, *multidimensional scaling (MDS) procedures* are available for establishing whether two or more perceptual dimensions underlie a particular set of stimuli. The CIE color space is an example of a two-dimensional representation of perceived color similarities. MDS algorithms aim to provide an arrangement of the stimuli in which the distances between stimuli correlate with their perceived dissimilarity. The method of triads and quadruples can be used to generate the data for fitting with MDS.

See also: Depth Perception; Sense of Smell; Sense of Taste (Effect on Behavior); The Sense of Touch; Spatial Perception; Touch; Visual Motion Perception; Visual Perception.

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Psychotherapy

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Glossary

Corrective emotional experience The client is exposed, in the context of a nonjudgmental therapy relationship, to emotions and situations that they could not cope with in the past, in order to develop new perspectives and competence.

Eclecticism A recent therapeutic approach which involves integrating various elements of previously existing models of therapy.

Evidence-based practice The integration of research related to the results of specific intervention strategies with clinical expertise, in the context of a specific client's history and preferences.

Motivational interviewing An evidence-based approach to working with the person's ambivalence and facilitating change via a client-centered emphasis.

Postmodern A collaborative approach to therapy that emphasizes multiple perspectives and constantly evolving meanings (as opposed to traditional approaches that favor expert knowledge that resides with the therapist).

Psychotherapy The treatment of mental and emotional disorders by any of a variety of methods, which occurs in the context of a relationship between a trained professional and a client.

Resistance Conscious or unconscious efforts of the client to thwart the progress of therapy.

Self-actualization The lifelong process of fulfilling one's capabilities and achieving one's total potential.

Unconscious The sum of all thoughts, feelings, memories, and impulses of which an individual is not aware, but which influence emotions and behavior.

Introduction

One of the factors responsible for the rich diversity in the field of psychotherapy is the fact that therapists can receive their training in a variety of fields of study.

Such highly specialized training areas include:

- Clinical psychology
- Counseling psychology
- Psychiatry
- Educational and school psychology
- Marriage and family therapy
- Clinical social work
- Nursing
- Pastoral psychology
- Child and adolescent psychology
- Community mental health services

Therapists come to the profession with a variety of degrees, licenses, and credentials, as well as being trained in various therapeutic models. Despite the differences in emphasis and orientation among the various types of psychotherapists and psychotherapy, as well as differences in the treatment methods used, there are many areas of overlap between people trained in different fields. Regardless of background training, the common denominator between all psychotherapists is that they employ the relationship established between the client and the therapist to influence the client to modify maladaptive responses and to adopt healthier lifestyles.

The term 'psychotherapy' as used here reflects the diversity of disciplines that serve in the helping professions.

Recipients of Psychotherapy

During psychotherapy's formative years, ~1900–1950, the recipient of therapeutic intervention was typically an adult, treated in one-on-one sessions for a period of months or years. Although individual adult clients are still the most frequent recipients of psychotherapy, there has been a more recent movement toward offering therapy in other modalities, such as groups and families, and to children and adolescents.

Psychotherapy has become increasingly complex, due to the advent of new technologies such as the World Wide Web, the evolution of theory and information about specialized mental disorders, and the advances of specific treatment techniques.

Individuals

Many therapists conduct therapy with individual clients, which reflects the traditional and widespread belief that a one-on-one therapeutic relationship offers unique advantages over other types of therapy. Perhaps the strongest argument in favor of individual therapy is that it allows for an intensive focus on the subjective world of the client.

The development of a meaningful relationship with a therapist gives many clients a feeling of security which allows them to disclose material which they might be reluctant to reveal if other people were present. Therapy can offer a corrective emotional experience to address the emotional difficulties that lead to the recurrent and distressing patterns that the client suffers. In individual therapy, the client has the chance to consider issues of personal growth without outside distractions, and can

ideally experience being uniquely heard and understood in the therapeutic session.

Individual therapy is indicated for clients whose chief complaints are personal in nature, and whose complaints are such that the person has the power to do something to improve the situation. Individual therapy is also warranted for persons who wish to address distressing issues in the near or distant past, where the inclusion of other parties involved in the situation is either impossible or ill-advised (e.g., child abuse, death, or divorce). Individual therapy ideally presupposes a motivation on the part of the client to change, as well as a sufficient personal insight to make the therapeutic process useful.

Individual therapy may not be the optimal form of therapy in all cases. For example, some clients may derive greater benefit from involving family members or by participating in group therapy. Decisions about the most appropriate form of therapy are determined by a combination of the presenting problem, the therapist's experience, and the client's preference.

Families

Family therapy began to gain prominence as an alternative form of therapy to individual psychotherapy in the 1950s, essentially as an antiestablishment movement. The era was characterized by a growing dissatisfaction among some therapists with traditional forms of therapy, which tended to look at psychiatric symptoms in isolation, resulting in an emphasis on an individual's defects. The unique contribution of family therapists was their focus on understanding people's behavior in the light of their social context.

In the early stage of family therapy, perhaps borrowing from psychoanalytic/psychodynamic models, the individual's difficulties were seen as involving only that individual. A shift occurred in the second half of the twentieth century, as therapists focused on communication within the family. In the next phase, from the late 60s through mid-70s, there was a focus on the therapist as a skilled expert who strategically intervened to change the family system. Through each transition the therapist was an expert who could guide the family to adopt an appropriate model of family functioning.

In the last 20 years, there has been a strong influence of postmodern and social constructionist ideas in family therapy. The postmodern therapies challenge the idea of an independent, objective, and expert observer of the family reality. Issues of power and authority are also challenged, as the postmodern therapist encourages the recognition of multiple perspectives and multiple realities that contribute to the unfolding story of the family. The views of the client(s) and the therapist are viewed as equally valid, and it is in the constantly evolving dialog, with its emphasis on valuing the particular meanings that are attributed to the story being told, that treatment is focused.

The family has a critical role in offering support and an environment that will promote recovery and well-being. Hence, there can be particular value for all concerned if the family is involved in treatment, as all family members are affected by the illness or distress of one member.

Children and Adolescents

The specialized area of child and adolescent psychotherapy warrants a discussion of its own due to the unique

development, needs, and characteristics of children and adolescents. These needs have been highlighted by researchers, who have made important advances in the understanding of the nature and etiology of various forms of child psychopathology and healthy development. The challenge facing child therapists is to combine this growing knowledge base with the existing knowledge of developmental psychology in order to arrive at effective assessment and treatment methods for use with children and adolescents.

It is now clear that adverse outcomes in later life can often be attenuated or avoided by prompt and effective treatment of psychological difficulties detected in childhood. Trauma and abuse in the formative stages of a child or adolescent's development are especially important to consider. The provision of therapy to children and adolescents is also specialized according to the stage of development of the child or adolescent when treatment is sought. It is also important to consider the behavior, learning capacity, and social context of the child or adolescent, given that they are involved in a time of profound personal growth.

The techniques chosen for use in therapy with children take a number of forms, depending on the age and comprehension level of the child. Play therapy is often used with younger children, or older children who may have difficulty discussing troubling issues with an unknown adult. In play therapy, the therapist and the child spend time together in a play room, often moving from one activity to another (e.g., painting, puzzles, doll houses). The therapist usually makes inferences about the child's functioning on the basis of the child's play, and what the child says during the play time. The therapist also looks for 'teachable' moments which can facilitate therapeutic insight. Child therapists routinely treat children and adolescents who are depressed, have excessive fears, have been abused, have physical or mental handicaps, or have poor self-confidence. Specific problem behaviors, such as bed-wetting, biting, and temper tantrums, are also treated, and the therapist's role often involves teaching the child's caregivers how to administer a specially designed behavior modification program. 'Talking therapy' is generally more effective with older children and adolescents.

Therapists who work with children need to be mindful that children undergo developmental changes and that problem behaviors often wax and wane at different ages. The therapist must also be aware that many behaviors which may be indicative of severe maladjustment or emotional disturbance (e.g., lying, destructiveness) are also relatively common in most children. In general, the therapist needs to avoid a jump to conclusions on the basis of one or two pieces of behavioral evidence. Responsible therapy requires a thorough understanding of the child's situation, which implies a multimethod and developmental assessment approach. Such an assessment might include some or all of the following: child, parent, and/or teacher interviews; tests of cognition, personality, and academic achievement; and behavioral observation in the home, at school, and at play.

Groups

Group therapy has risen dramatically in popularity over the past 50 years, largely as the result of increasing pressure on

mental health professionals to treat growing numbers of clients. Therapists have found that group therapy can dramatically impact individual participants, yet therapists can provide service to more people than could reasonably be treated otherwise. However, the advantage of group therapy is not simply logistical. While it is true that members of a group usually do not have the luxury of exploring personal issues in the same depth that they would in individual therapy, they are rewarded in return with an expanded understanding of group dynamics and increased efficacy in interpersonal relationships.

Group therapy typically includes one therapist and six to eight clients. However, many variations of this model are offered, with common variants including multiple therapists and smaller or larger groups. Different types of clients can benefit from group therapy, and some heterogeneity among group members in terms of age, gender, and presenting problem is often considered desirable. At the same time, the group process is likely to be compromised if members represent too broad a range of functioning. The therapist must screen potential participants, with an eye to both the characteristics and needs of the individual, and the goals of the group. The therapist must also be prepared to modify the approaches and techniques normally used with groups of relatively healthy clients when forming groups consisting of clients with more severe challenges, as such groups are typically more modest in their goals.

It is advisable for the therapist to be aware of the developmental phases of a group, consideration of which will need adjustment according to whether or not it is a closed, open, or time-limited group process. A pregroup interview can be of benefit to participants to prepare for the group process and address expectations of membership. Attention to norms of group process, having a clear mandate as to the purpose and goals of the group, and ensuring that the group participants will have a sufficiently shared focus can also increase the likelihood that the membership will cohere and that a successful group experience will result. Successful group process will be realized if the experience allows participants to feel supported and accepted, less alone in their life, and that they can hope to enjoy a positive outcome.

Flexibility is required of therapists who become group leaders. The therapist with an advanced understanding of group dynamics will know that at times it is useful to be more or less active. An active therapist reduces the group's anxiety, which can be advantageous, especially in the early life of the group. However, too much activity on the part of the leader may promote the belief that the most important dynamics occur between individual members and the therapist, rather than among all the participants collectively. In contrast, a less active therapist may promote more group anxiety, but can also facilitate a group to develop a strength and identity of its own. The most effective group therapist is one who understands the changing needs of the group and is able to adapt his or her leadership style to meet those needs. Therapists must also be particularly aware of their own character traits and personal weaknesses, since it is not uncommon for therapists to adopt a leadership style based on their own needs at some point in the group process (e.g., the need to be in control or the need to appear perfect).

Basic Issues in Psychotherapy

Assessment and Therapy

Individuals who seek help from a therapist often have trouble pinpointing what is troubling them. To make the best use of the therapeutic time, the therapist conducts a thorough assessment of the client and the nature of their difficulty. The data gleaned from the assessment allows the clinician to arrive at a case formulation and provide specific directions for the therapy.

Although assessment is an ongoing aspect of therapy, the initial sessions with a new client will often focus on assessment. Adequate assessment at this stage includes the client's description of their chief complaint. The therapist should establish when the present problem began, previous occurrences of the problem, the duration of episodes, and specific symptoms. Any personal efforts to overcome the problems or prior treatment, including medications, should be investigated. Precipitating events that may have led to the current difficulties should be identified.

An assessment of the client's history often provides information to understand and help the client. The areas that are often discussed include birth history, early development, and attainment of milestones (e.g., walking, talking), relationships with parents and siblings, educational history, social contacts, and leisure activities, and occupational history and marital status.

As part of the assessment process, therapists often administer psychological tests or other assessment tools. These tests come in a variety of formats (e.g., verbal or nonverbal responses, fill-in-the-blank or complete sentences, timed or untimed) and are designed to measure a variety of aspects of psychological functioning (e.g., personality, intelligence, mood, aptitude). Established population norms are typically available for these tests, allowing the therapist to see how the client compares with his or her peers. Given the possibility of misinterpretation of statistically based data, therapists are ethically bound to administer and interpret only those tests for which they have received the requisite training.

The therapist may also seek additional data from outside sources. Potentially useful information can be provided by spouses, parents, teachers, physicians, or previous therapists. Of course, the release of such information requires the consent of the client or their legal guardian.

The Therapeutic Relationship

When one considers the strength of the arguments that are raised in favor of one theoretical orientation over another and the conviction with which they are raised, it would be easy to conclude that theoretical orientation is the most important variable affecting the outcome of psychotherapy. In contrast, one of the most important predictors of therapeutic outcome is the quality of the relationship between the therapist and the client. Good therapeutic rapport encourages clients to lower their defenses in the belief that they will not be judged or rejected, which may facilitate other therapy processes. It is unlikely that therapeutic goals will be met, even with a sound case formulation, if the quality of the relationship is poor.

The helping relationship is a unique relationship, which is not formed for social reasons, but rather to help clients achieve specific goals. The relationship is one-sided in that it is designed to meet the needs of the client, not those of the therapist. A successful therapist will do several things to establish a good relationship with a client. Most importantly, the therapist will communicate accurate empathy. Clients should feel that their concerns have been heard, clarified, and understood, and that they have been accepted despite any potential deficiencies. The therapist demonstrates care and respect through honesty with the client. An important part of honesty involves the ability to communicate feelings and intentions without distortion or facade. Such congruence between what the therapist feels, says, and does serves to establish trust and provides a model for the client to follow.

The therapist should be patient and not press for the exploration of difficult issues before the client is ready to discuss them. The relationship will also be facilitated if the therapist recognizes and acknowledges the client's strengths as well as weaknesses and works collaboratively with the client.

Resistance/Ambivalence

It is not uncommon for clients in therapy to hit roadblocks that impede their progress. Some of these roadblocks seem to be set by the clients themselves (e.g., being habitually late for appointments, missing appointments, not completing therapeutic assignments, resisting deeper levels of exploration by continually switching the discussion to trivial details or unrelated topics). The terms 'resistance' and 'ambivalence' have been used to describe these important parts of the therapeutic process, which often leave a therapist feeling confused or stymied.

In traditional psychotherapy, 'resistance' is usually seen as instinctive opposition displayed toward any attempt to expose a person's unconscious conflicts (i.e., conflicts that are so deeply rooted that the person is unaware that they even exist). Resistance is not viewed as an interpersonal problem between the patient and the therapist, but rather as a predictable demonstration of how invested the client is in trying to guard against the possibility of further pain or threat in a vulnerable area of his or her emotional life. From this view, resistance occurs when the probability of change becomes so real that the client's anxiety is aroused. Resistance thus serves as a natural signpost, telling the therapist that the material being mined is relevant. The therapist's job is not to address the resistance directly, but to use the quality of the therapeutic relationship to generate an imbalance that favors progress rather than maintenance of the status quo. The client will abandon resistant behavior when the perceived advantages of moving forward outweigh the normal anxiety associated with moving into uncharted territory.

Some therapists have argued that the concept of 'resistance' is better understood as an elaborate strategy which therapists use to explain their treatment failures (i.e., ineffective treatment is the client's responsibility, rather than a flaw in the therapist's interventions). If this view is accepted, it then becomes necessary for the therapist to move back to the assessment stage to ascertain if the correct target for intervention was originally identified. The therapist must also evaluate if

sufficient trust and rapport have developed with the client or if there is something about the client's social network which is serving as an impediment to change. The therapist should also question if incorrect techniques were used to combat the problem or if the correct techniques were incorrectly applied.

In recent years, clients who seem stuck in therapy are more likely to be conceptualized as expressing 'ambivalence' about change. This shift in terminology is deemed to be less blaming of both the client and the therapist, and reflects a growing awareness that weighing the costs and benefits of change is an important and ongoing part of the therapeutic process. Therapists who encounter ambivalence view it as a normal part of the change process that needs to be discussed, rather than pushing a client forward toward change precipitously. For example, if the client appears to be wrestling about whether or not to proceed with change, a discussion about the pros and cons of change may be indicated, with no discussion of specific action steps toward change until the client has articulated a clear desire to move in this direction.

Length of Therapy

The number of sessions devoted to a given client in a therapeutic relationship has undergone a substantial shift in recent years. Earlier therapeutic approaches, which were often largely based on the theoretical assumptions of Sigmund Freud, aimed at the resolution of unconscious conflict and the alteration of personality. Practitioners did not expect that these ambitious goals could be rapidly attained, and, as a result, patients often spent a number of years in therapy.

The current emphasis on therapy of shorter duration can be attributed to several factors. First, therapeutic approaches began to evolve after World War II to focus on specific problem behaviors or moods. Therapists who moved away from personality reconstruction as the fundamental goal of therapy found that positive changes could be realized in more limited areas of a client's functioning in much shorter time frames. This position was bolstered by research which validated the use of specific interventions to combat specific problems. Second, the advent of managed care has had profound implications for the practicalities involved in offering mental health treatment. These trends, coupled with ongoing refinements in the treatment of psychopathology, resulted in a realization that effective therapy could be accomplished more quickly than previously thought possible.

The move toward shorter therapy was also spurred on by the attitudes of the consumers of mental health services. Today's clients are often either unwilling or unable to devote several years and significant expense to psychotherapy. As the general population has become more sophisticated, their expectation of prompt, effective service has risen. This attitude is especially prevalent on the part of third-party payers (e.g., government agencies, the legal system, insurance companies), who have forced therapists to work within limited time frames as a cost-saving measure. Given the current cost of psychological care and the growing demand for mental health services, it is likely that the trend toward short-term therapy will continue.

Attention to relapse prevention can also affect the length of therapy or can lead to the conceptualization of therapy in episodic terms. Specific steps can be taken in treatment to

reduce the risk of relapse. This work can extend a course of therapy, but can also reduce the need for a new course of therapy resulting from relapse.

The length of therapy also depends on the nature and context of the presenting difficulties, the genetic vulnerability of the person, the possibly chaotic environment in which the illness incubated, the social supports available to the person over time, and the context in which the person presents for treatment.

Despite the movement toward brief therapy, a wide range of therapy durations still exist. The variables that are most likely to affect the eventual duration of therapy include the theoretical orientation of the therapist, the nature and severity of the presenting problem, the available funding for treatment, and the willingness/capacity of the client to engage in treatment.

Ethical Considerations

Ethical considerations play an important role in the way in which therapists conduct therapy. There is general agreement that therapists are in a position to wield considerable influence in their relationships with clients. A number of ethical codes have been evolved to protect against potential abuses of this power and to help clinicians make ethical decisions in specific situations.

The diverse educational backgrounds and current affiliations of therapists have made it impossible to develop one ethical code which is binding upon everyone who practices therapy. As a result, professional organizations have published their own ethical guidelines. While the details of the ethical codes vary among specializations, there are some almost universal aspects of the principles that should govern a therapist's conduct. First, therapists must be competent enough to practice by virtue of training and experience, and only provide services and use techniques for which they are qualified. Second, therapists must respect the confidentiality of all information obtained from others in the course of their work. Information may only be revealed with the consent of the client or their legal guardian, except in those unusual cases where failure to reveal information would result in a clear danger to the client or someone else (e.g., suicide, homicide, child abuse). Third, therapists must avoid any action that will violate or diminish the legal and civil rights of clients, and must adhere to government laws and institutional regulations. Fourth, therapists must make every effort to ensure that their services are used appropriately. It is considered unethical for clinicians to engage in professional relationships which limit their objectivity or create a conflict of interest. Fifth, therapists must not use their influence to exploit clients, especially in relation to sexual intimacies. Financial arrangements should be made with clients in advance of therapy, and therapy should be terminated when it is reasonably clear that the client has achieved the therapeutic goals established at the outset or when the client is no longer benefiting from therapy.

Apart from adherence to codes and laws, ethical practices are rooted in everyday relationships and interactions. Attention to how clinicians want to be with others (e.g., via ongoing examination of clinical interactions) can help therapists remain sensitive to the ethics inherent in all relationships.

Theoretical Orientations

As discussed earlier, therapists have adopted a wide variety of theoretical stances. There are dozens of separate approaches to psychotherapy today, and the techniques utilized by the advocates of these approaches number in the hundreds. For the sake of brevity and clarity, six influential approaches are presented here – psychoanalytic/psychodynamic, behavioral, cognitive, humanistic, postmodern, and eclectic.

Psychoanalytic/Psychodynamic

Psychoanalysis is the oldest recognized approach to explaining and treating psychological illness. The procedure, designed by Viennese neurologist Sigmund Freud, entails investigating mental processes by means of free association, dream interpretation, and other methods thought to provide the therapist with access to the client's unconscious mind. The client is encouraged to talk about whatever they wish and to associate thoughts, feelings, and fantasies with this material. It is expected that the client will exhibit defense mechanisms (e.g., denial, repression, projection) in the course of therapy, all of which serve to protect the client against the perceived danger associated with their long-hidden impulses and affects being brought to conscious awareness.

The role of the analyst is to interpret and point out the nature of the client's hidden, unconscious conflicts, in order to make the conflicts conscious. The client thus develops insight to 'work through' these conscious conflicts, culminating in the alteration of the client's inner psychological structure. Use is also made of the client's unconscious emotional responses to the therapist (transference). For example, the client may unconsciously respond to the therapist as a father or mother figure. It is the analyst's role to interpret and point out the nature of the transference and thereby facilitate understanding of the client's unconscious feelings toward their own father or mother. Psychoanalysis generally requires a commitment of several years before the process is considered complete.

Psychodynamic psychotherapy is a direct offspring of psychoanalysis. Most of the fundamental assumptions of psychoanalysts are shared by psychodynamic therapists (e.g., the importance of bringing unconscious conflicts to light). However, there are significant differences. For instance, while psychodynamic therapy emphasizes the past and its effect on the client, it is more concerned with the person's current personality dynamics and interpersonal functioning. Therapy aims at symptom reduction and the adaptive functioning of the client, and not necessarily core personality reconstruction. The therapist often takes a more active role than the psychoanalyst, and therapy is often completed in fewer sessions.

Behavioral

A dramatic shift in the theoretical underpinnings of psychotherapy began in the 1940s and 1950s. Based on emerging results of studies with animals, a view of neurosis developed which suggested that all maladaptive behavior is learned through normal learning processes. Behaviorists denied the concept of free will, suggesting instead that behavior consists of predictable responses which are contingent upon antecedent

events, with the likelihood of a given behavior being repeated being directly related to the reinforcement received by the person for performing the behavior. For example, a parent may learn to yell at a child at the slightest provocation if the yelling is quickly reinforced by the child's compliance. As behavior came to be understood in this way, the goal of behavior therapy became the modification of specific stimulus-response connections, which was often achieved via the alteration of the reinforcement schedule.

The role of the behavior therapist is to help the client modify maladaptive learning through the learning of new, appropriate responses. Behaviorists value the therapeutic relationship, but do not see it as a sufficient cause for change. More emphasis is placed on the therapist's role as a scientist and teacher. Part of that role involves very structured history-taking and behavioral assessment by the therapist in order to determine which of the client's behaviors are maladaptive, as well as the circumstances in which they occur. In addition to the specific behaviors and their antecedents, behaviorists scrutinize the real and perceived consequences of the behavior, since these are believed to maintain the problem. Interventions are designed to break these antecedent-behavior-consequence patterns, with the evaluation of therapeutic outcomes usually being characterized by a rigorous adherence to scientific method.

Among the more well-known behavior therapy techniques are systematic desensitization, assertiveness training, and aversive conditioning. Systematic desensitization is often used to help people overcome fears and phobias. The procedure involves relaxation training and a gradual exposure of the person to the feared situation, first in the person's mind and then in real life. By alternating between relaxation and approach toward the feared situation/object, the person learns that their worst fears are not confirmed, and the power of the pattern is broken. Assertiveness training has been used to help clients gain control over those social situations that tend to evoke their problematic behaviors. A given training program may include modeling, therapist coaching, group feedback, behavioral rehearsal, and repeated practice, which together teach patients a variety of skills for coping effectively with difficult situations. Aversive conditioning involves the pairing of a problem behavior with an unpleasant punishment, which is specifically designed to replace a positive reinforcement which maintained the behavior in the past. For example, chemical agents may be given to alcoholic clients to induce vomiting immediately after taking a drink. Before long, the very thought of taking a drink will make these clients feel sick to their stomachs. Although outcome data supports the use of aversive techniques, these methods are often seen as ethically less desirable and are generally used only after other attempts at intervention have failed.

Cognitive

As the applications of behavior therapy spread, it became evident that the behavioral model was unable to account for all psychological distress, and the therapeutic pendulum, which had swung away from Freud's heavy emphasis on internal processes, began to swing back. However, rather than relying again on unconscious conflicts, many theorists began to emphasize the way in which a person's conscious thoughts

contributed to their difficulties. Cognitive therapy, developed by the psychiatrist Aaron Beck, aimed to intervene in a person's life primarily at the level of thinking, developed as a natural by-product of the cognitive model of behavior. Research data emphasizes the immense benefit that effectively utilized cognitive therapy provides for people suffering from numerous disorders.

The main assumption of cognitive therapists is that a person's feelings or behavior in response to a given situation is not predicted by the situation itself, but rather by the person's interpretation of the situation. Thus, a person could feel either relieved or despondent in the face of the death of a loved one, depending on whether the accompanying thought was "I'm glad that his pain and suffering are finally over" or "I don't know how I can live without him."

Researchers have demonstrated convincingly that certain types of psychopathology (e.g., depression and anxiety) are associated with certain types of irrational thoughts and faulty interpretations. These cognitions, which seem to surface automatically in some people when faced with certain life events, are believed to reflect a person's core self-schema. The self-schema contains a person's basic beliefs about the self, which are usually based on childhood experiences. If the childhood experiences are sufficiently problematical, the self-schema may become negative, commonly containing ideas of defectiveness or inadequacy. The self-schema provides a filter through which events are interpreted throughout the course of a person's life. For example, a woman with a negative self-schema who is passed by a friend on the street without a wave or greeting may jump to the conclusion that the friend no longer likes her, which in turn strengthens the negative self-schema and results in subjective feelings of depression.

Cognitive therapy is a collaborative endeavor in which the therapist and the client join forces to investigate and challenge the thoughts that give rise to the client's actions and emotions in everyday life. Homework assignments are often used to help clients identify their negative thoughts and to test the assumptions on which they are based. Childhood issues are discussed to help clients gain insight into the source and content of their negative self-schema. This exploration can be a very painful process, but is usually seen as a necessary step toward the alteration of the self-schema. The ultimate goal of cognitive therapy is to help clients realize that the negative beliefs about the self which were formed in childhood are not valid, thus freeing them to respond to both good and bad life events in a healthy and realistic manner.

Humanistic

Humanistic therapies arose as a reaction to the determinism which is characteristic of both psychoanalysis and behaviorism. Rather than viewing behavior as primarily determined by childhood experiences or external rewards and punishments, humanistic therapists focus on the ultimate freedom with which people have to make choices which affect their lives. People are viewed as inherently good, and the therapist's role is to create a therapeutic environment that allows the client's innate tendency toward growth to surface. Although many humanistic approaches exist, only client-centered therapy and gestalt therapy are discussed here.

Carl Rogers' client-centered therapy is the best known of the humanistic therapies. Rogers' contributions to psychotherapy are immense. Surveys of the prominent figures in the field of psychotherapy consistently place Carl Rogers first (Smith, 1982; Cook et al., 2009). Rogers believed that individuals have problems in living because others impose conditions of worth on them. As people learn that they are expected to act, feel, or think in certain ways in order to be acceptable to others, they begin to conform to those expectations, at the expense of the person's own true feelings and impulses. This process results in an impediment in the individual's natural process of growth and self-actualization.

Key components of Rogers' contributions to client-centered therapy include unconditional positive regard, empathy, and genuineness. As the client experiences unconditional acceptance, they are freed to clarify their true feelings and come to value who they really are. The therapist maintains a nondirective stance throughout this process and strives to display empathy by accurately reflecting the client's thoughts and feelings, to ultimately result in the client's increased self-understanding and renewed growth as an individual.

Gestalt therapy, developed by Fritz Perls, is based on the idea that psychological problems arise from unresolved and repressed conflicts, and that these conflicts must be uncovered and worked through in order for a person's inherent potential for growth to be released. However, rather than dwelling on the past, emphasis is placed on the client's immediate thoughts and feelings (i.e., their experience in the 'here and now'). Clients are encouraged to express themselves openly and to take responsibility for their feelings and actions. Awareness of important psychological conflicts may be heightened by having a client stage a conversation between opposing parts of the self or by conversing with an emotionally significant person who is not actually present.

Postmodern Therapies

Recent years have seen the emergence of what are referred to as postmodern theories and therapies, also referred to commonly as social constructivism. These are exemplified by such developments as Solution-Focused and Narrative Therapy. These approaches emphasize the creation of meaning via evolving dialog in a collaborative therapeutic relationship. The idea of the therapist as an outside or objective observer and an expert on change for the client, with power and authority in the therapy resting with the therapist, is replaced by a collaborative search for meaning in the therapeutic dialog.

As a solution focus suggests, the principle orientation is on solutions to difficulties, rather than an exploration of the origins or maintenance of these difficulties. Exceptions to the problematic situation, drawing on the client's own resources and accomplishments, and a tendency for a shorter course of therapy sessions also characterize solution-focused therapy.

Narrative therapy emphasizes the significance of the meaning attached to experiences and stories that the individual holds about himself or herself. People's views of themselves and the world are shaped through these complex meanings. As well, the cultural context that contributes to human thought and actions is deserving of exploration, as these contribute to a person's story. Through therapy, the individual has an

opportunity to reexamine his or her story and to co-construct a different or preferred story that is more consistent with the individual's preferred values and purposes for that individual's life.

An appreciation of gender and culture can also be included under the rubric of postmodern therapies. Feminist theory and therapy attend to the broader social issues that the client must contend with, emphasizing collaboration, respect, a focus on strengths, and sensitivity to issues of power and control in the therapeutic relationship. The importance of nonsexist language and sensitivity to the implications of domestic violence are two additional contributions that have emerged since feminist theory and therapy became prominent in the 1980s. Feminist therapy articulates the long-held concern that traditionally accepted theories reflect patriarchy and male domination.

Eclectic

The majority of therapists today do not align themselves with one particular theoretical orientation, but prefer to think of themselves as eclectic in their practice. 'Eclectic' does not imply that therapists, overwhelmed by the diversity of the approaches available to them, resort to the random use of techniques in psychotherapy. Rather, eclectic therapists endeavor to include the specific models and techniques in their practice that have demonstrated efficacy in dealing with certain types of problems and populations. For example, therapists may develop skill in motivational interviewing for ambivalent clients, dialectical-behavioral therapy when treating individuals with traumatic backgrounds or difficulties in personality development, and transdiagnostic protocols when offering therapy for clients suffering with complex eating disorders. Additionally, techniques such as mindfulness meditation, which teaches clients to stay connected to the present moment in an open, nonjudgmental way, have been found to lead to numerous health benefits, and are finding increasing traction across a variety of therapeutic models.

Factors that Contribute to Therapeutic Success

New therapeutic approaches have often risen to challenge, augment, or supplant more established models, but this pattern of 'evolution' has led some critics to question the validity of the entire therapeutic enterprise. Unfortunately, determination of the factors that contribute to therapeutic success is not an easy task. The most accurate answer is that most therapies and modalities work for many people most of the time.

We have noted a number of factors that contribute to therapeutic success. These include fundamental attention to the development of a therapeutic relationship that can be experienced by the client as engaged, empathic, respectful, and collaborative. Matching a client and their concerns with a particular type of treatment, that is known to benefit that particular cohort of people, can increase the success of the therapeutic experience. Consistent foci on the goals of therapy and treatment expectations can set the stage for success.

Studies that compare the efficacy of different types of therapy have demonstrated that some types of therapy are better for treating specific problems than others. For example,

cognitive therapy has been shown to be especially effective in the treatment of major depression, while behavioral approaches have the best outcomes with phobias. These same studies have also consistently revealed that psychotherapy clients experience greater symptom reduction than control clients who receive no treatment. It should be noted, though, that these conclusions are based on statistical probability, and a minority of people who undergo therapy will not achieve their therapeutic goals. Given that therapy usually involves therapists who try to help clients whom they have never met with problems that they have never experienced, and given that clients come to therapy with widely ranging levels of motivation, insight, and commitment to change, it is unrealistic to expect that therapy will help everyone.

A recent focus on evidence-based practice has emerged in the field of psychotherapy. A 2005 American Psychological Association Presidential Task Force on Evidence-Based Practice has supported a prior evidence-based practice policy articulated by the Institute of Medicine (2001, p. 147 as adapted from Sackett et al.). Evidence-based practice involves the integration of research related to the results of specific intervention strategies with clinical expertise in the context of the client's history and preferences. Several treatment approaches are empirically supported and are designed for use with people suffering from distinct disorders or difficulties. One point of debate in this regard is how to ensure the validity of the interventions being studied, as it is difficult to guarantee the fidelity of each clinician's adherence to a specific training model. Evidence-based interventions are increasingly being offered in the form of specific treatment manuals in an effort to ensure that therapists deliver the interventions in the way they were intended to be delivered. There is also an ongoing debate about the dissimilarity between pure conditions of research and the circumstances that the clinician experiences when meeting with the client in the therapeutic process. Nonetheless, there is an emphasis on improving patient outcomes by integrating relevant research findings with continually evolving clinical practices and respect for the context and evolving story of the client.

Psychotherapists also need to be aware of other interventions that can be an important part of the change process. For example, specific medications used in the treatment of such illnesses as schizophrenia, bipolar disorder, major depression, and obsessive compulsive disorders (OCD) are continually being developed. There is considerable data in the literature that notes the positive outcome for the sufferer when psychotropic medication is combined with a course of psychotherapy. Where there is a role for psychotropic medication in the treatment, it is important for the therapist to be aware of the involvement of the prescribing physician, and ideally to consult with them about developing a coordinated treatment plan.

Future Directions

The current limitations of psychotherapy suggest some natural directions for therapists and theorists in the twenty-first

century. Further refinements of existing theories are necessary, and an increased emphasis on the integration of theories will likely prove to be fruitful. There is also a need for increased communication and research across disciplines. For example, the interaction between biological and psychological factors in the onset and maintenance of mental disorders requires further examination. Finally, as results in these areas of theory and research are reported, steps must be taken to ensure that the gap between research and practice is bridged. This connection can occur by encouraging more therapists who understand the unique demands of the therapeutic situation to become involved in theory construction and research. An insistence on continued education for all psychotherapists would also be beneficial, and efforts to disseminate current knowledge via academic journals, core textbooks, seminars, and workshops, both within and across disciplines, should continue. To the extent that these goals are met, the field will advance in its ability to match specific interventions to the needs of individual clients.

See also: Behavior Analysis; Clinical Assessment; Cognitive Behavior Therapy; Defense Mechanisms; Evidence-Based Practice; Gestalt Psychology and the Development of Perceptual Organization; Interpersonal Psychotherapy; Psychodynamic Psychotherapy: Theory and Practice; Psychopathology: Diagnosis, Assessment, and Classification.

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Reading and Phonological Processing

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Glossary

Alphabetic principle The concept that written symbols correspond to consonant and vowel segments (phonemes) of spoken words.

Dyslexia Unusual, persistent difficulty learning to read; genetically influenced, requiring special instruction.

Mapping Correspondence between two sets of entities that associates each member of the first set with a member of the second (as between letters and speech sounds, i.e., phonemes).

Orthography The set of letters or other symbols used in writing and their conventional arrangement in the spellings of words.

Particulate principle Natural hierarchical systems, such as chemistry, genetics, and language, conform to the particulate principle of self-diversifying systems (Ablar, 1989; Studdert-Kennedy, 2000) by which discrete units from a finite set of elements are repeatedly sampled, rearranged, and combined to yield larger units (e.g., molecules, genes, words) which are different and more diverse in function than their constituents.

Phoneme Smallest segments of speech that distinguish one word from another in a given language.

Phonemic awareness Awareness of the phonemic segmentation of spoken words and recognizing the identity of shared phonemes across words.

Phonological decoding Applying one's knowledge of the correspondences (mappings) between letters and phonemes to determine the identity of a word and its pronunciation.

Phonological processing The incorporation and reproduction of a language's sound structure in the course of learning to speak the language, in learning to read and write, and in using the language in spoken or written form.

Phonology Study of the sound patterns of language. Also the set of distinctive sounds of a specific language, their systematic patterning and organization into syllables and phrases.

Pictograph Ancient stylized picture symbolizing a word or meaning.

Protowriting Early, prealphabetic forms of writing (e.g., pictographs), lacking the scope of modern writing.

Pseudoword A letter sequence that is not a word, but conforms to the sound pattern and spelling rules of a language, hence a possible word (e.g., zaik).

Rebus Symbols or pictures that suggest the sound of the word they represent.

Syllable A unit of speech, usually consisting of a vowel and abutting consonants, if any.

Reading and Writing Exploit Distinctive Properties of Spoken Language

Although we may tend to think of our language as a unity that spans both spoken and written forms, we also appreciate that each form draws on separate abilities. There was a time when each of us could speak but not read or write, and for the human species, spoken language existed long before any form of writing that we would recognize as such. The development of writing is so large a step that it is impossible to exaggerate its importance for human cultural evolution. But writing as we know it did not appear all at once but is the cumulative result of a number of small steps.

The first step on the road to writing was the creation of visual signs, usually stylized pictures (pictographs). Unlike writing as we know it, protowriting conventions were used for signifying broad meanings, but not specific words other than names. Far from being the flexible vehicle that writing now is, the early forms were cultivated to serve narrow and specific purposes: keeping records of accounts, recording names of kings and their family trees, recording names of deities and sacred places, to name three. Although the origins of protowriting are buried in obscurity, the possibility of comprehensive, general-purpose writing seems to have been grasped comparatively recently, dating back only a few millennia at most. The several varieties of comprehensive writing were created by peoples from early

centers of civilization surrounding the Mediterranean, in Mesopotamia and the Nile Valley, in portions of east Asia, as well as sites in meso America.

We can think of the words of a language as a union of sound and meaning. Each aspect plays a role in writing. The history of writing shows a progressive trend toward innovations that gradually enabled protowriting to evolve into comprehensive writing, unlimited in scope with the potential to convey precise meanings by indicating specific words. Discovery of the rebus principle, a prealphabetic way to represent a word by using pictures or other signs to cue word sounds, was the breakthrough that opened the door to fully comprehensive writing. However, students of early writing were slow to recognize that pictographic symbols do not necessarily have a pictographic function. In a rebus, each symbol represents a syllable. The word sandwich, for example, could be cued by a picture of sand followed by a picture of a witch. Of course, the meaning of sandwich has nothing to do with either sand or witches. The word sounds that are prompted by the pictures, not their meanings, are what are being cued to convey the intended word. As a vehicle for writing, the rebus principle has limited scope. Many words in English, for example, would not lend themselves to this way of cueing. Yet, as I note in section 'A Role for Phonology in Semantically Based, Nonsegmental Writing,' the rebus principle is still used, in combination with other principles of representation, in some varieties of modern writing.

Fully expressive writing, the last stage in the evolution of writing, creates a visible, running record of speech, such that each word in a spoken message can be paired with its written word equivalent. As writing became comprehensive, capable of transcribing the full vocabulary of a language, it became an actual surrogate for speech. To achieve this, it had to become more abstract. One way writing became abstract was by moving away from iconic and pictorial representation to create pure symbols. Another way was to make the symbols represent discrete, meaningless segments of speech: syllables or their consonant and vowel constituents.

Alphabetic Writing and Syllabic Writing Convey Linguistic Messages Visually by Creating Symbols for the Meaningless Particles of Words

To gain an appreciation of how writing and reading are possible, we must first consider the role of phonology in enabling a language to convey an indeterminate variety of meanings by incorporating meaningless segments. Phonology refers to the distinctive patterning of sounds of a language and the gestures of tongue, lips, and vocal cords that produce them. In functional terms, phonology supplies the building blocks of words and also principles for binding them into syllables and larger metrical structures.

Words, from the standpoint of phonology, can be regarded as compounds, made up of ordered strings of individually meaningless particles, which are the familiar vowels and consonants (phonemes). Because a very large number of combinations are possible, phonology may be seen to incorporate a powerful principle for creating diversity: the phonology of a language supplies the resources for creating vast numbers of words. In this respect, language seems to mirror the make-up of the physical world. Much as all the material stuff of the world is composed of combinations drawn from a few dozen atomic elements, so the myriad words of a language are made up of combinations of a small number of phoneme particles, numbering <50 for most languages. The particulate principle and recombination of parts is also basic to the way genes mediate diversity in the world of living things. An analogy in this respect between language and genetics has repeatedly been noted.

Unlike protowriting, comprehensive writing is tied closely to speech, capable of creating an actual word-for-word record of speech. There are limited ways to achieve a word-for-word written record. Alphabetic writing, as one form of comprehensive writing, taps into the layer of meaningless particles at the base of the spoken language to create a visual surrogate for speech, one that mimics the productive potential of the phonological component of the spoken language. The innovation of alphabetic writing was therefore part discovery, part invention. The discovery was to recognize that spoken words can be divided into meaningless segments, phonemes. The invention was to map phoneme segments using made-up graphic symbols. These were the two ingredients that came together to make alphabetic writing possible. Since its first full flowering in the Mediterranean world about 3000 years ago, alphabetic writing was adopted by the ancient Greek and Roman civilizations and subsequently spread over much of the globe. Numerous specific alphabets employing a variety of graphic shapes

have been invented at different times and places, but the same general phonological principle of mapping the segments of the spoken word applies to all.

In English and most languages that employ alphabetic writing, each phoneme is symbolized by its own letter or group of letters, hence there are symbols for both vowels and consonants. Arabic and conventional modern Hebrew writing are exceptions. In these languages, there are letters for each of the consonants but not for some of the vowels. Given the consonantal frame, the appropriate vowel can be inferred from the context, so symbols would be redundant and unnecessary for experienced readers. But in Hebrew, and to a limited extent in Arabic, vowels are explicitly marked in texts intended for novice readers.

The existence of alphabetic writing and the obvious fact that it is capable of being passed on from person to person and capable of being read by most members of a language group is perhaps the strongest evidence for phonemic segmentation of language. However, examination of the actual physical record of speech, either as sound pattern or as the pattern of movements of structures in mouth, nose, and throat that produce the speech does not reveal separate segments that correspond neatly to consonants and vowels. The growth of speech science in recent decades has made this quite clear, serving to highlight the problem that particulate phonology lacks a clearly discernible foundation in the speech signal. As a result, the phoneme has at present an ambiguous status within the sciences of speech and language, a state of affairs that is unsatisfying to those who seek a theory capable of integrating what we know about the physics and physiology of speech with our practical capabilities to manipulate segments of language and with theoretical entities posited by linguists to account for these abilities. Ways to solve the problems surrounding phonological segments by exploring their gestural origin are being actively pursued, but are beyond the scope of this article.

The phoneme segments on which alphabets are based must in some sense be natural. A writing system probably could not be constructed based on purely arbitrary divisions of speech. Phoneme divisions are not the only natural units of speech. Speech can also be carved perceptually into coarser syllable segments, and, in fact, the syllable has served as the base for several writing systems. Examples of syllable-based systems are found in present-day Japan and in ancient Mayan writing. Syllabic writing is a practical option only for languages that have relatively small numbers of syllables. In the invention of writing, speakers may have been guided by such factors. Characteristics of a language may impose some constraints on the development of writing. Nevertheless, alphabets and syllabaries, though differing in the grain size of the base unit, are both grounded in phonological properties of spoken language.

A Role for Phonology in Semantically Based, Nonsegmental Writing

Alphabetic and syllabic writing do not exhaust the possibilities, however. Another kind of comprehensive writing, character writing, which is not segment based was developed in China and elsewhere in East Asia. It is important to appreciate that character writing also incorporates phonological information, although it does so indirectly. In Chinese writing, for example,

graphic characters, each consisting of a number of strokes, represent whole words or syllabic parts of words. By exploiting the rebus principle (see section 'Reading and Writing Exploit Distinctive Properties of Spoken Language'), phonological information relevant for pronunciation is coded within this predominantly semantic form of writing. A high proportion of Chinese characters (at least 70%) are actually compounds, in which one sector, the semantic radical, often represents a semantic root, and another sector, the phonetic radical, supplies clues for pronunciation. The illustration 鞍 shows how the word for saddle is written by a Chinese compound character. It consists of two simple characters, run together. Separating them, the left part is the semantic radical 革, which by itself means leather. Abutting it on the right is the phonological portion, the phonetic radical 安, also a simple character, which indicates how the word for saddle is pronounced by representing another word, or in this case a group of homophone words (different words that are pronounced the same) that are all written by this character. These words have various irrelevant meanings, but all are pronounced like saddle. Noting this pronunciation using English orthography, it would say approximately, 'ahn' in Mandarin Chinese. The rebus principle can work for Chinese writing because the language contains so many words that are homophones. English has homophones, too, of course, such as plane and date, but far fewer than Chinese. In the course of learning to read Chinese writing, learners become tuned both to the semantic and phonological portions which together provide clues to a word's identity, as in the example.

We learn from this example that Chinese writing can and often does provide information that links the written to the spoken form. Phonology is represented in this form of writing, although it does not adhere to the alphabetic principle by representing the individual consonant and vowel segments. Chinese writing is therefore consistent with the claim of some scholars that the incorporation of phonology into a comprehensive writing system is mandatory, and that each of the varieties of writing that has the potential to represent all the words of a language exploits the possibility inherent in all languages of separating phonological form from meaning content. Although this article focuses mainly on learning alphabetic writing and its relation to phonological processes, we should not lose sight of the fact that nonsegmental systems exist that also meet the tests of comprehensive writing. It is significant that these also supply phonological information, though in a quite different manner than alphabetic or syllable-based systems. The successful learning and use of Chinese writing (and related systems in Japan and elsewhere in Asia) by many millions of people testifies to its viability as a writing system. Obviously, there exists great variety in human possibilities for writing, but plausibly there are constraints based on the characteristics of particular languages. Finally there seems to be a universal constraint on a workable writing system: some way to incorporate phonology appears to be at the very heart of the possibility of writing.

Awareness of Phonemes, Key to Grasping the Alphabetic Principle

Alphabetic writing, as we noted, is distinguished by the fact that meaningless, particulate phonological segments, phonemes,

form the basis of the system (the orthography). From this point on the discussion will be about how would-be readers learn to read and write in an alphabetic system and how the system is used in practice by people at each level of skill. Two ideas, phonological processing and phonemic awareness, will be important to this discussion. Phonological processing is the more general idea: it refers to the incorporation and reproduction of a language's sound structure by a person in the course of learning to speak a language, in using speech in everyday life, and ultimately (for those who become literate) in learning to write and read. Because reading is parasitic on speech, it is appropriate to begin by briefly considering the place of phonology in acquiring speech.

In the course of learning to pronounce and comprehend utterances of her native language, a young child will gradually internalize its sound system, that is, its phonology. The phonology develops by successive approximations guided by feedback. Through experimentation with babbled syllables, while at the same time hearing speech in meaningful contexts from adults and older children, the learner discovers which sounds are used in the language, how they are combined in its words, and how to produce them well enough to be recognized by people who already know the language. Acquiring a vocabulary by ear and mouth is a matter of implicit learning that comes about spontaneously with normal exposure to speech in a normal environment.

Learning to read is altogether different. To become a competent reader of a language that uses an alphabetic script, such as English or Spanish or German, a learner needs phoneme awareness, the ability to explicitly segment spoken words by phoneme and to recognize recurrences of the same phoneme in different words (to appreciate, for example, that spoken words *sit* and *mat* have the final phoneme, /t/, in common). A child aged 5 or 6, when reading instruction ordinarily begins, has a working knowledge of the spoken language and already recognizes thousands of words, but ordinarily has little awareness of particulate sound structure needed for grasping the alphabetic principle on which word spellings are based. This knowledge does not develop hand in hand with ability to speak and understand the language.

Awareness of the larger segments of words, syllables, and demi-syllables emerges earlier than awareness of phonemes. Full phonemic awareness develops hand in hand with ability to decode words, not generally prior to it. The insight that words can come apart into segments and the ability to identify the same segment in different words does not come easily for many children. Perhaps we should not find this surprising. After all, the alphabetic principle was the late comer in the history of mankind's efforts to write. Indeed, experiments conducted with made-up, artificial writing systems show that even adults with much experience in reading do not often spontaneously infer the alphabetic principle in attempting to learn a new system for writing spoken words, even though they have been provided with examples of matching words and scripts that would logically permit them to make the inference. Similarly, there is abundant evidence that most child learners will not infer the alphabetic principle from experience with print alone. Most will need an adult's help to grasp the principle, to retain it, and use it as a basis for learning to recognize printed words.

But why should phonemic awareness be a barrier? For one thing, people as they listen to speech probably do not routinely

hear consonants and vowels as such, much as the casual music listener apprehends the melody but is unaware of specific pitches or chord progressions. Becoming aware of phonemic segments, the nuts and bolts of speech, requires a special kind of analytic listening that, as the author of this article noted, usually needs to be explicitly trained. Young children confronted with alphabetic writing may labor under an additional handicap: for them, words may be stored in only partially differentiated form in their memories. Full segmentation, particulate, phonemic organization, may require more extensive experience with the language. The English vocabulary includes many word pairs (such as map and nap) that are potentially confusable because they sound similar, differing in only a single, closely related phoneme. As growth in children's vocabularies accelerates during the preschool years, the gaps in phonetic space become filled with the inclusion of more and more similar sounding words. To accommodate this expansion of vocabulary without loss of discrimination, the representations of words in memory would need to become more detailed. The age at which a critical density is reached will vary, of course. Prior to that point in vocabulary development, a child would be ill-equipped to become aware of segments and would lack the basis for understanding how alphabetic writing works.

A further reason that awareness of segments may be expected to be at least somewhat difficult for children to acquire is that the phoneme segments are themselves meaningless. In her earlier experience with the spoken language, a child is naturally seeking to correlate chunks of sound with meanings, hence it would be entirely natural that she would approach reading in the same way with a bias to try to associate any visual segment, even single letters, with a meaning, not a sound. If not corrected promptly, this misapprehension would become a further barrier to grasping the alphabetic principle.

Whether or not a child attains phonemic awareness during the first year of school is a strong predictor of later success in reading in an alphabetic system. This insight alone, however, will not guarantee success nor inoculate children against the possibility of reading difficulty later on. A would-be reader must also learn the sounds (phonetic values) of the letters and combinations of letters. At the beginning of this process, letter names can usefully serve as reminders of their sounds. But in English, only certain letter names are helpful; others are actually confusing, such as the names for h, w, and y, which don't sound at all like the sounds they have in English words.

Necessary though it is to learn the sounds of the letters, reading is not a straightforward matter of pairing letters and phonemes. The stubborn fact that words as ordinarily heard are not discretely segmented into phonemes is an issue for the scientist, as we saw (see section '[Alphabetic Writing and Syllabic Writing Convey Linguistic Messages Visually by Creating Symbols for the Meaningless Particles of Words](#)'). It is also a potential source of difficulty for a would-be reader. A word in print is conveyed by a sequence of letters that taken collectively suggests its pronunciation. The letters stand for phonemes, but many phonemes, certainly most consonants, are not pronounceable in isolation but only in combination with a vowel. Accordingly, in reading a printed word, successive letter segments must be blended into syllables. As a consequence, knowing the letter sounds may not suffice for a child to identify

the word. For example, a child attempting to sound out the word brag may succeed in producing more or less appropriate sounds for each of the letters buh, ruh, ae, guh, yet not appreciate that they spell the monosyllabic word brag. Again, the difficulty is that the individual letters in brag do not represent separate syllables, as they would if we spelled the word aloud, where each letter in turn is named. But, of course, spelling is not reading. For the letter sequence to be read as a word, the four letter sounds must be fused into a single syllable; the word brag has one syllable, not four. Consequently, in a written word, the sequence of letters can only suggest a pronunciation. When written words are pronounced aloud or to oneself, the phonemes that the letters represent are encoded over syllable lengths of speech.

Children can be helped over this potential difficulty by the teacher showing them that words can be built starting from a vowel nucleus. The exercise begins by writing a vowel letter, saying its sound, and then adding a consonant letter, preferably one that can be prolonged. For example, writing first a, then an, am, as, and sounding out the resulting syllables. Then, when a consonant is made to precede the vowel, the wise teacher will choose a consonant that can be prolonged and exaggerated, such as s, to produce s-s-s-s am, sam. This is an effective exercise both because writing helps to make segments concrete and because it draws the child's attention to the significance of left-to-right sequencing of letters for word construction.

Not all languages have a mainly closed-syllable structure, as English does, with one or more consonants preceding and following a vowel nucleus in the most frequently occurring syllable type. Building syllables from phoneme components should be easier in languages, such as Italian and Spanish, with simpler, open-ended syllables. Research in recent years has shown, in fact, that phonemic awareness and word decoding are grasped earlier by children who are learning to read an open syllable language, in which most syllables lack a final consonant, than a closed-syllable language.

Because most children will not discover phonemic segmentation unaided, teachers of beginning reading have a vitally important role in promoting this awareness and in clarifying how the segmentation of spoken words relates to the spellings of those words. The evidence is strong that this kind of teaching works for most children. Despite the evidence, not all children presently receive instruction that promotes phonemic awareness. A novice reader who has failed to gain awareness will be unable to understand how the system works. As a consequence, all spellings will appear arbitrary and will have to be learned by rote, placing an unnecessary burden on memory. The stakes are high. Children who do not acquire basic word-reading skills in the first grade are likely still to be poor readers when they reach high school.

An alert teacher can do much to help children get off to a good start. She will detect the use of nonproductive strategies, and wean children away from them, such as the futile attempt to recognize words by their overall visual shapes, or wrongly trying to associate the individual letters of printed words with a meaning. Unfortunately, it is still not always appreciated that among the qualities of an effective teacher of reading is mastery of a definite body of knowledge pertaining to the structure of language and its varied reflections in the orthography.

English Spelling Is a Hybrid, Based Only Partly on Phonology

The peculiarities of specific languages and the conventions that have developed for writing them can have important consequences for the learner. As anyone knows who has struggled with English spelling, most letters in English have more than one pronunciation, and some English words are written in ways that do not match their pronunciations well. One reason that English has many spelling irregularities is that the language over the course of its history has frequently borrowed words from related and unrelated languages, which are sometimes written with anglicized spellings but often with imported spellings that are not English-like. This makes for a diverse, inhomogeneous set of spelling conventions. A further source of irregularity is the existence of spellings of some old English words that have not kept pace with changes in pronunciation. Some words in common use, such as *night* and *although* (with the silent *gh*), are familiar examples of frozen spellings.

These complexities have led some people to complain that it is confusing and futile to teach children the phonetic basis of regular spellings when many irregularities and exceptions exist. Critics of English spelling often fail to appreciate, however, that some of the apparent irregularities in the spelling of English words reflect a plurality of mapping principles such that shared meanings can in some related words take precedence over shared sound. For example, *health* and *heal* are pronounced differently in the vowel, but the similarity of their spelling underlines their shared root, linking them semantically in a way that would not be apparent if *health* were written as it is pronounced, *helth*. Another spelling pattern that follows meaning more closely than sound is in writing affixes such as the *s* or *es* at the ends of nouns that make the noun plural. Because the plural-*s*, while written as *s*, sometimes says *z* (compare *cats* and *dogs*), this regularity of spelling is not strictly based on pronunciation, but, instead, reflects a similarity in meaning (both plurals). Experience suggests that most learners readily grasp these hybrid features of English spelling when they are explained.

Nonetheless, the fact that English words are not spelled according to a simple one-letter, one-phoneme principle undoubtedly does complicate and prolong the task of the learner, both in reading and spelling. A number of other languages, Spanish and German among them, are more consistent than English in representing pronunciation by their written forms. Simplicity and consistency of sound-based coding seems to speed the development of reading and spelling skills in these orthographies relative to English. For example, there is evidence that German-speaking children acquire good printed word-recognition skills in their language about 2 years earlier than English-speaking children. (By the sixth year at school, the latter catch up and learners from the two language groups are on a par.)

Differences in dialect that affect word sounds are still fairly marked in the English-speaking world, but these differences are not reflected in conventional spellings. This fact underlines the principle that spelling represents the phonology of words at some abstract remove from speech, generalizing across differences in dialect (and, of course, differences in idiolect, since both physical and social differences between people will affect

the details of speech production). The obvious fact that English spelling can achieve this level of abstraction shows that readers and writers do not require a precise match between the way they talk and the way the language is written. As a representation of speech, spelling conventions are therefore something of a compromise. That said, conventional spellings are clearly a better match for some dialects than for others. Mismatch is especially great for minority dialects. Certainly, a high degree of mismatch between spoken dialect and written forms can be an obstacle for a learner. Sensitive teachers who are themselves bidialectal can help to mitigate this disadvantage.

Further Steps Toward Literacy

In English, especially, the complexities produced by many-to-one mapping of spellings to phonemes guarantees that there will be more to learning to recognize spelling patterns in reading (and generating them in writing) than a simple matching of letter and phoneme. Vowels, in particular, are often written with more than one letter, as in *seat* or *sleigh*. The position within a syllable at which a particular phoneme occurs is also a relevant factor in spelling. For example, the consonant phoneme /k/ is more often written with the letter *c* than the letter *k* in English, especially when it occurs at the beginnings of words, as in *card*. Moreover, /k/ is often written as *ck* but only when it occurs at the ends of syllables, as in *tack*. The prepared teacher will introduce the major spelling patterns, with examples from children's vocabularies, and opportunities to practice reading and writing them. However, there are far too many spelling patterns to teach them all, hence orthographic learning is largely implicit.

For older children and adults, who are past the beginning stages, reading and writing themselves serve to promote awareness of phonology and refine it. The activity of writing helps to make the segmental composition of words apparent, reinforcing phonological awareness. The relation between phonemic awareness and literacy abilities is, in fact, a reciprocal one. Phonemic awareness, which in rudimentary form helps beginning readers to grasp the alphabetic principle, becomes refined and sharpened with the development of literacy skills. Remembering spellings necessary for writing words is especially helpful in promoting and fixing awareness. But it has also been observed that ability to demonstrate phonological awareness is weak in some adults who are competent readers. After a person has become well-practiced in reading and writing, phonological segmentation abilities may become autonomous to such a degree as to no longer be readily accessible to consciousness. Adults and older children often seem more aware of how a word is spelled than of the phonological underpinnings of the spelling.

The effects of reading on spoken language abilities extend beyond phonological awareness, reflecting the pivotal role of literacy as a means for acquiring knowledge and culture. Once a reader has acquired fluency with print, the act of reading itself may become a major source of new vocabulary. In people who read a lot, vocabularies continue to expand in the mature years, well into old age. It may be surprising, however, to learn that ease of learning new spoken words can also be enhanced by reading experience. To add a new word to one's vocabulary,

whether spoken or written, the phonological form of the word must be apprehended and stored in memory. The quality of the representation in memory will vary with the individual, but if it is to suffice for vocabulary learning, it must be good enough to serve two purposes, the purpose of enabling the learner to identify further occurrences of the word in the speech around her, and good enough to guide the learner to produce the word well enough for others who know the word to recognize her attempts.

In fact, it has been discovered that even the most basic level of reading skill in an alphabetic orthography changes speech imitation abilities. In one study, totally unschooled adults from isolated villages in southern Europe were matched with others from the same villages with only a few years of schooling. The illiterate adults were inaccurate in repeating spoken pseudowords (phonetically possible, but not actual words in their language), differing sharply from the matched comparison group with only basic literacy. Both groups were highly successful in repeating actual words, but the illiterates were largely unable to treat the novel pseudowords as segmented phonetic strings. It appears that the ability to readily pick up a new word on a single hearing, and the changes in brain organization that support this ability, are telling examples of how the capacity to retain a novel phonological pattern can be profoundly influenced by even a modicum of reading experience. These are further examples of the reciprocal relations between language and literacy.

In reading words in context, can learners compensate for poorly developed phonological decoding skills? Novice readers already know from their experience with the spoken language many of the words they will eventually learn to read. That being so, will they not be able to use their vocabulary knowledge gained by experience with the spoken language to guess the identity of written words even though they are unable to decode the sound pattern independently? The answer seems to be yes, but that the benefits may easily be overestimated. Among adult readers with widely varying skill levels, it has been shown that the quality of a person's spoken vocabulary knowledge can facilitate printed word recognition. A well-functioning semantic knowledge of words and their interconnections may benefit reading by tipping the scales toward correct recognition of a partially decoded word. So two readers who are alike in having matched partial decoding skills, but differ in general vocabulary knowledge, may be expected also to differ in overall reading ability.

But we should be cautious about making the further inference that context can, in general, permit a reader to identify individual words that couldn't be read independently. True, a word can sometimes be inferred from context. But the practical usefulness of context for word recognition is limited. Here's why: It has been estimated that one word in four is predictable on average. However, the most predictable words are high-frequency function words, such as articles, pronouns, and conjunctions. If one considers only content words, predictability drops to one in eight. Yet it is content words that pose the challenge for comprehension. Context can supplement a word's spelling in reducing uncertainty, but it cannot substitute for phonologically driven, code-based processes of word identification. Struggling readers with weak phonological decoding skills are the ones most likely to attempt to rely on context, but

they do so ineffectively because they are required to rely on guessing the identity of too many words, yielding especially low odds on being correct. Skilled readers are better able, but less likely to need to rely on context. Skilled readers who have learned to sound out a new word do not ordinarily need the assistance of context in deciding what word it is they are reading because they have accurate context-independent word-recognition skills. These are the hallmarks of a mature, skilled reader. So, to sum up, context facilitation can benefit learners who are in midcourse, with partially developed decoding skill, but, for different reasons, context facilitation is of little benefit either to the weak or to the strong.

The larger point is that the skills that underlie word recognition are necessary, though not sufficient, for comprehension of connected material. Although the goal of reading is comprehension, the core of reading is word recognition. If the basic analytic skills that are built around phonology are deficient, a reader's general language ability and background knowledge cannot be brought to bear most effectively on reading performance.

In addition to the benefits conferred by attaining an early grasp of the alphabetic principle, learners need to invest much practice to become effective, mature readers. To promote development of a high degree of skill, novice readers need to experience the rewards of reading from the outset (initially by enjoyment of being read to), so as to be motivated to apply sufficient time and effort to activities that promote fluent reading. It is a long process; for most of those who succeed in becoming effective readers of English, it will require the entire span of elementary school years before they can recognize words and track sentences as well by eye as by ear. Only when that benchmark is reached is a learner well prepared to use the written language as a stepping stone to gain further knowledge of language and vocabulary, and to use the medium of print as a means, perhaps the primary means, of acquiring knowledge of the world. Unfortunately, for many children in our schools this benchmark will not have been reached by the time of school leaving. For these young people, reading remains labored, often inaccurate, and unrewarding. This avenue to the general culture is shut off and the door is also closed on opportunities to enter the ever-growing number of occupations that require more than basic reading skills.

Dyslexia: A Phonological Deficit Affecting the Decoding of Print

The existence of dyslexia, undue difficulty in reading and learning to read, has been recognized as a distinct condition for little more than a century, and has been in the public eye for a much briefer time. In the recent past, dyslexic children were frequently stigmatized as dull or mentally retarded. It is now recognized that dyslexia can occur across the spectrum of general cognitive ability. The diagnosis of dyslexia should not be attempted on the basis of a single testing, no matter how comprehensive. Failure to benefit from instruction that is normally effective for promoting learning is a sounder basis for making the diagnosis. This is not to say that tests have no place. They are appropriate to guide in planning treatment for an individual child, and they are useful for research purposes.

Test can contribute importantly, for example, to disentangling the relations among a variety of disorders of child development in which reading problems are often a prominent feature and which may be confused with dyslexia, such as specific language impairment (SLI) and attention deficit disorder (ADD).

Researchers have reached near consensus regarding some of the cognitive markers of individual differences in learning to read. Typically, dyslexic children and adults have greater difficulty than learners who are better endowed in gaining phonemic awareness, in developing accurate and rapid word-recognition skills, and in coping with spelling and its irregularities. Twin studies have shown that these differences are moderately heritable over the range of abilities, as is dyslexia itself. That is not to say, that environmental factors contribute less importantly to reading outcomes than genes do. As has often been noted, poverty is strongly correlated with several adverse educational factors, school crowding, poor facilities, poorly qualified and overworked teachers, frequent moves necessitating change of schools, lack of reading materials in the home, and lack of parental support for literacy activities.

Failure to develop serviceable basic skills for whatever reason leads to difficulties in comprehending written material and an understandable tendency to avoid reading, leading, in turn, to fewer opportunities for the many varieties of learning that are facilitated by reading. Avoidance of reading-related activities leads to a cascade of negative consequences which are progressively hard to overcome once children are beyond the first grade or two. Even so, with prolonged effort on the part of the learner, remedial teaching, emphasizing the phonological foundations of the orthography, even if long delayed, can usually achieve a degree of success, often sufficient to make a real difference to the quality of life of the dyslexic person. Certainly, the fact that reading difficulties are to a degree heritable does not preclude the benefits of remedial teaching and remedial treatment. In fact, it renders these interventions all the more important. Research indicates that children and adults who are not well-resourced for reading require a more intensive version of the phonologically based regimen that serves for those who are better resourced.

The considerable investment in recent decades that governments and foundations have made in interdisciplinary study of dyslexia and its treatment has led to benefits in the teaching of reading for children more generally. Furthermore, the needs of dyslexic children have spurred research to identify the sources of reading difficulties more broadly. In general, the factors that make reading hard for dyslexic children are also sources of some degree of difficulty for children who are better resourced. Of course, the range of individual differences spans both extremes. Precocious readers are to be found at the other end of the reading continuum. Some children who learned to read well prior to schooling were intensively coached by parents or older siblings. But apparently, others were autodidacts who early on managed to break the code with little explicit teaching. There have been only a few published studies of highly precocious readers. In the main, these are biographical, diary accounts that are not based on experiment. More study needs to be directed to this group of learners. They, too, undoubtedly have lessons to teach.

The biological underpinnings of dyslexia and related disorders of development have received much study in recent

years. I have alluded to contributions from genetic studies. In the final paragraphs, I will state some conclusions from brain research that are also relevant to the issues we have been examining. Techniques are available that enable a researcher to eavesdrop on brain activity cooccurring with cognitive performances such as reading. Functional measures, based on EEG and neuroimaging techniques, chiefly PET and fMRI, generate records based on brain activity during performance of reading-related tasks, such as judging whether pairs of printed words rhyme. Records of brain activity have shown that learning of reading-related skills by normally developing children gives rise to changes in activity within several left hemisphere zones. Dyslexics relative to nonimpaired readers typically underengage these structures on the left side, with abnormally high levels of activity in some corresponding regions of the right hemisphere. These developments have opened up new opportunities to sensitively assess the effects of remedial intervention on brain function. Changes in activity patterns in response to successful remediation based on phoneme awareness and decoding have been observed within broadly the same left-brain regions that show effects of learning during normal reading development. Like most other language functions, normal reading relies primarily on the left side of the brain.

As these examples show, progress in recording brain activity during cognitive performances has presented new opportunities to assess the role of phonological processing in reading skill and its development. Researchers have recently exploited these tools to compare patterns of brain activity in users of different languages and writing systems. Across-language comparisons have shown substantial commonality in reading circuits among learners from different language communities. For example, normal learners engage the left hemisphere predominantly and difficulties in learning to read are everywhere associated with abnormal reliance on the right cerebral hemisphere. As might be expected, some differences are also found in distribution of brain activity across languages and writing systems that reflect the level at which the orthography maps the phonology, as well as visual-graphic characteristics of the orthography.

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See also: [Dyslexia](#); [Phonetics](#); [Psychology of Reading](#); [Word Retrieval](#).

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Reasoning

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Glossary

Cognition Set of psychological processes that involves the construction, acquisition, maintenance, and utilization of knowledge.

Competence Abstract, universal idealization of a system of thought or reasoning. Regarding deductive reasoning, the competence system consists of a mental logic.

Conditional argument Four basic argument forms which include a conditional statement of the form “if p , then q ” as the major premise and affirmation or denial of the antecedent (p) or consequent (q) as the minor premise.

Two of these forms are determinate and valid while two are indeterminate and invalid.

Deductive inference Inference process that moves from the universal to the particular and where the premises provide absolute certainty for the conclusion.

Inductive inference Inference process where the premises provide probable or contingent evidence for the conclusion.

Logical necessity A relation holding among propositions where a conclusion follows with absolute certainty from the premises.

Mental model Presumed actual procedures and representations derived from the real world and that the individual employs when processing specific reasoning tasks in real-time.

Metalogic Conceptual knowledge of logic including the recognition that inference is a basis for knowledge, an understanding of key distinctions among types of inference, an appreciation that conclusions must be consistent with all possible states of affairs represented by the premises, and an understanding of logical indeterminacy, inconsistency, and necessity.

Procedure Actual or real-time strategy employed during thinking or reasoning. Provides access to, and implementation of, competence.

Reasoning The form of thinking that involves inference. Inference can be either inductive or deductive, hence, there is inductive reasoning and deductive reasoning.

The focus of this essay is on the nature and ontogenesis of reasoning. However, reasoning must be understood as one set of psychological processes that form part of a more general set of processes known as cognition. Cognitive processes are all those that involve the construction, acquisition, maintenance, and utilization of knowledge. Contemporary accounts of cognition often distinguish between heuristic cognition, involving relatively automatic, effortless, contextualized (domain-specific), and encapsulated processes, and analytic cognition, involving more deliberate, effortful, decontextualized (domain-general) processes that are accessible to consciousness. Perceptual processes and many aspects of language production or comprehension, memory encoding and retrieval, and even problem-solving are heuristic in nature. By contrast, reasoning falls squarely within analytic cognition. This is important to note because it distinguishes reasoning from associative, pragmatic, or highly schematized processes that may substitute for reasoning on any given task or occasion.

Reasoning involves ‘inference,’ which is the process where one proposition (i.e., knowledge claim) is arrived at and accepted on the basis of other propositions that were originally accepted. The originally accepted propositions are called premises and these provide the evidence from which inferences are made to the proposition called a conclusion. Reasoning, then, is distinguished from other types of relatively deliberate, effortful (i.e., analytic) processes such as fantasy thinking, creative thinking, and some kinds of decision-making that do not directly involve the inference process.

Reasoning is a specific type of cognitive process, but there are also several types of reasoning. Usually, these are divided

into inductive reasoning processes and deductive reasoning processes. Deductive reasoning is unique in several, interrelated respects. Most importantly, it is the only form of inference that can support judgments of necessity. In deduction, the premises, if true, provide absolutely certain evidence for the truth of the conclusion. This is because in a valid deduction, the conclusion is implicit within the premises. It is the form of a deductive inference, therefore, and not its content, that preserves the certainty of the premises in the conclusion. One important consequence of this is that deduction is monotonic. That is, the addition of new premises to a valid deductive argument cannot render the argument invalid. One last property of deductive inference worth noting here is that deduction proceeds exclusively from the general to the specific, thereby providing a basis for the application of general rules or categories to particular instances.

There are several forms of inductive reasoning including, for example, pragmatic reasoning (based on knowledge of the sociolinguistic context) and statistical reasoning (based on probability). These stand in sharp contrast to deduction as just described. Inductive inference cannot guarantee the truth of the conclusion and is nonmonotonic and defeasible. Although the truth of the premises may make the conclusion highly likely in inductive inference, there is always the potential for new information to render the conclusion false.

While the general focus of this essay is on reasoning, the specific focus involves the nature, origin, and development of logical or deductive reasoning. This is a domain that is central to scientific thinking and hypothesis testing, and central, as well, to the production of coherent arguments which can guide

a good deal of day-to-day life. Even if, as some claim, everyday reasoning involves more pragmatic and probabilistic inductive thought than deductive thought, an understanding of the nature of deductive reasoning forms a necessary foundation for considerations of when and under what conditions this type of reasoning is displaced by pragmatic reasoning and other types of cognition.

Reasoning and Logic

In order to clarify the specific nature of deductive reasoning and to clearly differentiate it from both inductive reasoning and logic, consider the following examples:

1. All trains from Philadelphia to Washington stop in Baltimore
The train on Track 6 goes from Philadelphia to Washington.
Therefore, the train on Track 6 stops in Baltimore.
2. All the trains I have ever seen that go from Philadelphia to Washington have stopped in Baltimore.
Therefore, all trains from Philadelphia to Washington stop in Baltimore.

Example (1) involves deductive inference, and example (2) involves an inductive inference. Here it is important to be clear that logic and deductive reasoning are not identical. Logic is a discipline of study that is not, in itself, interested in the reasoning processes (i.e., inductive reasoning and deductive reasoning) that produce these examples. The reasoning processes are the domain of cognitive and cognitive developmental psychology. Logicians are interested in the products of the reasoning processes which they term 'arguments.' From the perspective of psychology, examples (1) and (2) involve types of inferences – a deductive reasoning inference and an inductive reasoning inference respectively – but from the perspective of logic, example (1) is a deductive argument, and example (2) is an inductive argument. Logic identifies and analyzes arguments that are accepted as correct or incorrect. Logical reasoning concerns mental processes that are related to logical arguments.

For the logician, an argument is a sequence of sentences or propositions of which one (the conclusion) is said to follow from the others (premises), and the premises are said to provide evidence for the truth of the conclusion. Deductive arguments have the characteristic of being valid (correct) or invalid (incorrect). To say that a deductive argument is valid is to say that it is absolutely impossible to find situations in which the argument has true premises and a false conclusion. Thus, the conclusion necessarily or logically follows from the premises in a valid deductive argument. Inductive arguments cannot be valid/invalid because the premises provide only probable evidence for the truth of the conclusion. Regardless of how many trains to Washington that one sees stop in Baltimore, there may be some trains that go straight through.

The sentences that compose deductive arguments are true or false, but the argument itself is valid or invalid. Further, a valid argument may have true premises and a true conclusion (e.g., All parents have children; All fathers are parents; Therefore, All fathers have children); false premises and a false conclusion (e.g., All children have siblings; All fathers are children; Therefore, All fathers have siblings); or false premises and a true

conclusion (e.g., All children have siblings; All brothers are fathers; Therefore, All brothers have siblings). The validity of a deductive argument is relatively independent of the truth of its premises and conclusion. The only relation precluded by a valid deductive argument is true premises and a false conclusion.

The truth of a sentence or a proposition in a deductive argument is best understood through the concept 'possible worlds.' Roughly, a possible world is any situation that is conceivable or imaginable and can be described by a consistent story. This means there are many possible worlds (e.g., the worlds of novels, films, myths, etc.). The commonsense familiar world – called the 'actual world' – is one of these possible worlds. A sentence is true in a given possible world when the sentence correctly describes that possible world. Furthermore, a sentence is logically or necessarily true when it is true in all possible worlds.

Logic, then, is concerned with identifying the forms or patterns of valid arguments regardless of their specific content. Logicians begin this task from simple sentences and the sentential connectives that join them together (i.e., 'not,' called negation; 'and,' called conjunction; 'or,' called disjunction; 'if ... then,' called the conditional; 'if and only if,' called the biconditional) and demonstrate valid and invalid arguments related to these connectives. The elementary arguments that are established as valid constitute basic argument forms or rules of inference that are used to construct and to analyze more complex arguments. Three important conditional argument forms that involve reasoning with conditional statements are: Modus Ponens, Modus Tollens, and the Hypothetical Syllogism:

1. Modus Ponens (MP)	2. Modus Tollens (MT)
If p then q	If p then q
p	Not q
Therefore, q	Therefore, not p
3. Hypothetical Syllogism	
If p then q	
If q then r	
Therefore, If p then r	

In these and other valid argument forms, any content can be substituted for p , q , r and the argument remains valid (i.e., the argument remains valid in all possible worlds). By contrast, two argument forms that are invalid but are often mistaken for valid forms are Denying the Antecedent and Affirming the Consequent. In these forms, the conclusion (e.g., 'not q ' for DA) does not follow from the premises:

4. Denying the antecedent (DA)	5. Affirming the consequent (AC)
If p then q	If p then q
Not p	q
Therefore, not q	Therefore, p

The general deductive system that incorporates the connectives and inference rules is called a propositional or sentential logic. A more powerful system that includes the propositional logic but goes beyond it is variously called quantificational, predicate, or first-order logic. This system has features concerned with the internal structure of propositions and the

quantification of propositions (i.e., all, some, none) along with the features described by the propositional logic. The simplest kind of quantified arguments are the syllogisms. For example:

All *B* are *A*
Some *C* are *B*
Therefore, some *C* are *A*

Deductive propositional and predicate logics ultimately are formalizations of the commonsense correct deductive arguments that people engage in on a day-to-day basis. The logics are attempts to establish rules according to which such arguments proceed. A logic is a theory of the nature of arguments. By establishing the rules of valid deductive arguments, a logic also pinpoints the nature of error or incorrect arguments. When logic is seen in this fashion, it again helps to illustrate the distinction between logic and logical reasoning. If logic is composed of the rules of arguments, then logical reasoning concerns psychological processes that somehow reflect these rules. The major question then for psychology is: why and how do psychological processes come to reflect rules and operations within formal deductive systems? Among the various developmental theories of deductive reasoning, two very different answers to this question have been formulated, and yet, a kind of rapprochement among theories is possible.

Developmental Theories of Logical Reasoning

Even a cursory review of the empirical literature on deductive reasoning reveals some striking inconsistencies both within the developmental findings and between those findings and the results of adult research. Research with children has often been interpreted as indicating not only substantial innate deductive reasoning competence but also significant development from childhood to adolescence. The adult literature, by contrast, has generated considerable evidence of young adults failing to reason logically, even under reasonably favorable conditions. Resolving these inconsistencies represents a major challenge for any theory of deductive reasoning.

Overton's Competence-Procedural Theory

Competence-procedural theory claims that the rules of logic bear a nonarbitrary relation to the psychological processes involved in deductive reasoning. Therefore, the rules of logical arguments – as formalized in symbolic logic – can be understood as relatively adequate models of normative, idealized, abstract operations of mind in this domain. The individual in some sense acquires and has access to the operations characterized by these rules. The rules, thus described, constitute a 'competence,' and the competence is held to be a significant feature of the explanation for adequate performance on deductive reasoning tasks. It is important to note, however, that the competence is not to be thought of as mental representations used in actual reasoning. Competence is an idealization of the system of thought that the normal adult has access to. It constitutes an epistemic (i.e., universal) model. The actual individual mental representations used in accessing and implementing this competence constitute a procedural model.

There are numerous variations on the standard logical systems described previously in this article – some modest, and some substantially deviant – and, consequently, there are many candidates from which to choose in selecting a model for the competence system. The model favored by Overton's competence-procedural theory consists of a mental logic that resembles standard propositional logic, but is not isomorphic to it. Specifically, the combinatorial logic (INRC group) of Inhelder and Piaget revised as an entailment logic capturing the importance of relevance and meaningful implication to human reasoning has been proposed by the Overton group as a reasonable candidate for the competence model. For this reason, Overton's theory is Neo-Piagetian in nature. The propositional-entailment logic has a developmental precursor from which it can be formally derived. This precursor is a class and relational logic that represents the key competence system in middle childhood. Competence-procedural theory maintains that the logical competence systems emerge out of the general cognitive activity of the child interacting with her world. In particular, reflective-abstractive processes are stressed wherein logical organization implicit in embodied mental action is reflected onto more explicit, abstract levels of thinking.

Alternative mental logics have been proposed for the competence model within a competence-procedural account. The most influential in this regard has been the natural deduction system of Braine and O'Brien. This latter model differs from the Overton/Piagetian model in several key respects. The natural deduction system consists of relatively innate and heuristic core inference schemas and direct reasoning routines supplemented by a set of complex schemas and indirect reasoning strategies which are not innate or universal and which are particularly dependent upon formal tuition and related experiences. The primary or core schemas are employed automatically when the appropriate propositions are encountered. By contrast, the secondary or complex inference schemas are only employed under special conditions and are strategic, deliberative, and intentional. The Braine and O'Brien competence model resembles a production system more than a logic because the individual schemas and routines are not integrated into a recursive system the way logics are. The bulk of the theory's utility has been in explaining relatively automatic and isolated inferences such as might be involved in language comprehension. The theory has been less useful as an account of deductive reasoning as construed in this article and most other accounts, namely, deduction as deliberative, intentional, analytic cognition.

While competence systems function to promote understanding, procedural systems function to assure success on problems. They are composed of individuated real-time action systems that may be sequentially ordered but are not enduring in the way that the competence system endures. A procedure is an action means to an end or goal. It is context-dependent, and context includes both the available competence and information inputs (e.g., success at baking a cake requires stirring, mixing, and beating, but a recipe and ingredients form the necessary context for these procedures). A procedural system constitutes the psychological subject, and procedures are considered to be sufficient or insufficient, rather than complete or incomplete.

Because the kinds of procedures that can be used to account for the actual processing of deductive problems are limited

only by functional criteria – real-time processing and sensitivity to inputs, outputs, and internal states – the number of candidates for designation as procedures is large. For example, it could be the case that people process deductive problems by actually thinking in terms of truth tables, by actually thinking in terms of Venn diagrams, by actually thinking in terms of natural deductive procedures, by mental models, by pragmatic methods, or by various methods employing direct experience. Further, procedures may reflect individual differences or individual strategies. As a consequence, different people may – at different times and under different circumstances – use different procedures as they attempt to access and implement available competence in efforts directed at solving deductive reasoning problems.

Competence-procedural theory provides an account of the nature, origins, and development of procedural systems and their relation to competence. However, some of the most important empirical research on these systems and their relevance to performance on deductive reasoning tasks has been carried out within the frameworks of other, competing theories of reasoning. Nonetheless, with certain reconceptualizations, these theories are readily viewed as consistent with competence-procedural theory. This will be discussed below.

Competence-procedural theory has been successful in explaining a wide range of empirical findings on the development of deductive reasoning. The theory predicts, on an a priori basis, the various age-related effects that have been found for deductive reasoning along with a host of findings regarding key moderators of these age-related effects, including such factors as training, content, and SES. In general, research from within the theory indicates that deductive reasoning competence is lacking in fourth through sixth grades, coming on-line in eighth/ninth grade, and readily available in tenth to twelfth grades. This pattern has been confirmed through both cross-sectional and longitudinal research.

The theory is also able to reconcile the striking inconsistencies typically present when the adult and developmental literatures on deductive reasoning are compared. Evidence of early success on deductive reasoning problems is explained within the competence-procedural account in two ways. Some of this evidence appears to identify concrete precursors to formal deductive competence. These precursors are predicted by the theory on the basis of class and relational reasoning competencies present in middle childhood. Other evidence of early success consists of relatively isolated propositional inference forms such as MP or valid syllogisms and obtains in the absence of success on other, logically related inferences (e.g., AC or DA). In addition, children in these research settings generally fail to demonstrate an understanding of the deductive nature of the inferences they have made, suggesting that the cognitive processes involved are heuristic in nature and do not involve reasoning per se. Competence-procedural theory is able to explain apparent evidence of adult incompetence on deduction tasks as occasions where procedural obstacles to the accessing and implementation of a logical competence are present.

The competence-procedural account provides plausible explanations for a variety of content effects. Familiar content, meaningful content, and increased relevance of antecedent (p) to consequent (q) in conditional statements have been found to facilitate performance on deductive reasoning problems, but

only subsequent to the availability of the logical competence, and the greatest degree of variability in performance across content is found during periods of competence consolidation. Abstract content is problematic at all ages, but improvement is clearly evident from eighth through twelfth grades. Findings of this sort point to the importance of including a competence model in any viable theory of reasoning. Familiarity, relevance, and other aspects of content that would be expected to maximize the efficiency of processing in working memory support the application of an existing logical competence. Those same processes, however, are ineffective in the absence of that competence.

As noted previously, the Overton/Piagetian competence model for formal reasoning derives from a more fundamental logic of classes and relations and, as such, it comprises part of a theoretically viable and unique account of the emergence of deductive reasoning from earlier, more limited, logical competencies. Where children and preadolescents are still employing the precursor class logic, prior to consolidation of the propositional logic, they should be prone to conflate the two possibilities for the denial of the antecedent in a conditional statement (if p , then q), namely ($\neg p$ and q) and ($\neg p$ and $\neg q$). That is, they should fail to recognize that the truth of the conditional is consistent with both possibilities, and not merely with ($\neg p$ and $\neg q$). Such an error would be expected because class logic does not clearly distinguish between the two possibilities. This error amounts to interpreting the conditional as a biconditional (if p , then q AND if q , then p). For example, in evaluating the conditional statement, "If it is raining, then the street is wet," this conflation involves failing to distinguish between cases where "it is not raining and the street is dry," and "it is not raining and the street is wet." This kind of error is indeed significantly more common in childhood than in adolescence. In fact, it represents one of the most robust findings in the reasoning literature. The account of the emergence of conditional reasoning from class reasoning also predicts that this conflation should go hand in hand with a fundamental difficulty in generating alternative antecedents for the consequent q . That is, not only should children be more likely than adolescents to interpret conditionals as biconditionals, they should also be less likely to generate alternatives to p (e.g., a street cleaner is operating, a water main has broken, etc.) that could obtain along with q . Again, this prediction is substantially supported in the literature. For the competence-procedural account, then, the primary restriction on the range of possibilities that the child can generate in reasoning on deduction problems is a logical (competence-based) one – difficulty in appreciating that the truth of the conditional is consistent with situations where the consequent obtains despite the absence of the antecedent.

Alternative Accounts

Alternatives to competence-procedural theory generally reject the need for a competence model and make no explicit distinction between competence and performance. Their answer to the question of why psychological processes resemble the rules of argument is to claim that the resemblance is largely arbitrary. In this view, deductive reasoning per se plays only a limited role in human cognitive activity and does not reflect

operations within some kind of mental logic. Instead, deduction consists of psychological processes that are entirely shared with other forms of reasoning. From the standpoint of competence-procedural theory, these alternative accounts are essentially procedural theories that nonetheless maintain certain implicit, generally unacknowledged competence claims. Despite the seeming incompatibility, these alternative theories are potentially compatible with Overton's account if their implicit competence claims are acknowledged and the reduction of competence to procedure is avoided. From the standpoint of a rapprochement with competence-procedural theory, these alternative, essentially procedural, accounts accomplish one or both of the following: First, all of these theories serve to work out important components of the real-time processing involved in deductive reasoning and, in this capacity, are complementary to, and potentially compatible with, competence theories. Second, some of these theories include aspects of logical competence in a procedural form. As long as the reductionism is strictly avoided, research grounded in these theories could be interpreted as identifying important indicators, manifestations, or direct consequences of an emergent logical competence. The prime example here is research into the development of conceptual knowledge about logic (metalogical knowledge) in the metacognitive theories of Kuhn and Moshman.

The models employed as explanatory devices by the procedural group of theories are characterized as being attempts to imitate real or actual actions in real-time rather than being abstract idealizations of logical rule systems. Some, more narrowly applicable, models attempt to account for performance on deductive reasoning tasks strictly on the basis of domain-specific processes such as the application of pragmatic reasoning schemas induced from ubiquitous sociolinguistic activities including permissions, obligations, and causations. Other models are broader in the reasoning phenomena they propose to explain. In this vein, Johnson-Laird's work on mental models represents the most systematically developed procedural computational model of deductive reasoning. Johnson-Laird's mental models are presumed actual procedures and representations derived from the real world that the individual employs when processing specific reasoning tasks in real-time. Markovits and colleagues have extended mental models theory into a genuinely developmental account of deductive reasoning and this theory will be discussed at length here.

Markovits' mental models theory

Markovits' theory provides a thorough account of the encoding, retrieval, and inhibitory processes involved in deductive reasoning. Mental models theory maintains that the cognitive representations with which lay deductive reasoning proceeds are semantic, rather than syntactic, in nature. In this view, the cognitive processes employed by children and adults when engaged in deductive reasoning are not related to the rules of formal logic. A mental model is a real-time representation of possible states of affairs denoted by the premises of an argument. The theory focuses primarily on deduction problems that can be represented as conditional arguments. The particular mental model or models employed on a reasoning problem depends on which of three classes of objects/events happen to be activated.

One class consists of possibilities that are complementary to the conditional (if p , then q). These are cases where something other than p is combined with the denial of q . Using the previous example of a conditional – "If it is raining, then the street is wet" – the combination of "the sky is clear ($\neg p$)" and "the street is dry ($\neg q$)" would constitute a complementary case. A second class comprises alternatives to the antecedent. These are cases involving objects or events that are different from p and where q is affirmed. In other words, these are alternative ways in which q is realized, as in the case where "the street cleaner has passed ($\neg p$)" and "the street is wet (q)." The third class comprising this conceptual space consists of disablers of the conditional rule itself (if p , then q). Disablers represent conditions that, when paired with p , render the conditional false. Thus, cases where it is raining but something prevents the street from getting wet would represent disabling conditions or exceptions to the conditional. Disablers qualify the applicability of the conditional and must be suppressed or bracketed in order for the rule to hold.

Activation of the complementary class, solely, leads to the construction of a mental model featuring an interpretation of the conditional as a biconditional or equivalence relation ("The street is wet if and only if it is raining"). This model would represent the conditional as true when (p and q) or ($\neg p$ and $\neg q$) obtain and as otherwise false. Activation of the alternative antecedent class alerts the reasoner to the uncertain nature of the AC and DA argument forms. The resulting mental model represents (p and q), ($\neg p$ and q), and ($\neg p$ and $\neg q$) as each consistent with the truth of the conditional. Finally, activation of the disabler class leads to skepticism regarding the truth of the conditional rule itself and supports a tendency to represent MP and MT as indeterminate argument forms.

Whether or not a class is activated, and the degree of activation that potentially obtains, depends on a host of factors. The familiarity or novelty of the problem content, the availability of alternative antecedents or of disabling conditions, the degree of relatedness of antecedent and consequent, and constraints pertaining to speed of processing, amount of information to be retrieved, and the capacity of short-term store in working memory can all determine whether, and to what degree, a given class of object/event is activated. The resulting pattern of activation, in turn, determines the mental models that will be generated. At this point, various other considerations become relevant, including the number of models that can be accommodated by working memory and the availability of inhibitory processes that can block specific models in compliance with the demands of the task.

By situating performance on deductive reasoning tasks within a sophisticated model of the development of encoding processes, retrieval processes, and inhibitory mechanisms, mental models theory has been highly successful in predicting the extent to which indeterminate models will be generated on conditional reasoning problems leading to responses of uncertainty. For example, the likelihood of responding with uncertainty to AC and DA is associated with the number of alternative antecedents children and adolescents produce and the age of success on these indeterminate forms depends, at least partly, on the ease with which alternative antecedents can be generated. Similarly, the more readily disablers come to mind with regard to a particular conditional, the more likely a

participant is to indicate that MP and MT are uncertain or indeterminate and the greater the demand on inhibitory processes if the individual is to be required to accept the truth of the conditional.

It is clear from the available evidence that the Markovits model is able to account for a wide range of findings from both the developmental and adult literatures on conditional reasoning. At the same time, the theory seems best suited to explaining deductive reasoning with nonabstract, meaningful content problems. This is because concrete content allows, in principle, for activation of information in long-term memory and, therefore, construction of the three sets of potential models. Genuinely abstract content, that is, content whose semantic interpretation is wholly arbitrary ("If rems are full, then braks are soft," "If there is a vowel on one side, then there is an odd number on the other") is problematic for the theory because it provides no obvious basis for the activation of information in long-term memory. Yet, clearly, some individuals, including adolescents, can reason successfully with more abstract content. Further, success on abstract content problems increases across the adolescent years. Older adolescents are better at generating alternative antecedents under conditions of minimal support, that is, where there is less information in long-term memory or less real-world content that might yield concrete alternatives. Such findings seem to implicate an emerging competence system during adolescence.

By exclusively focusing on real-time psychological processes and their development, whether domain-general (improvements in retrieval, increases in working memory capacity and efficiency) or domain-specific (expansion of a knowledge base), mental models theory provides the best currently available account of the conditions under which an existent logical competence might be manifest on a deductive reasoning task. However, it provides little basis for explaining the development of that logical competence *per se*. The retrieval of alternative antecedents or of disabling conditions from long-term memory can prevent premature closure on a problem, but does it, in itself, amount to an understanding of logical indeterminacy or logical necessity?

Metacognitive theories

Metacognition is central to the developmental accounts of deductive reasoning offered by Kuhn and Moshman. Both theorists place significant emphasis on the basic notion of thought becoming an object for itself and, like Piaget, each maintains that the most powerful forms of reflexive thinking are largely an achievement of adolescence.

Kuhn's account of development across several areas of higher-order cognition, including deductive reasoning, scientific thinking, and argumentation, places particular emphasis on the progressive overcoming of belief-bias effects and other aspects of motivated reasoning. The belief-bias effect within a deductive reasoning paradigm refers to a tendency to accept or reject the conclusion of an argument on the basis of the believability of the premises and/or conclusion, rather than the logical form of the argument. Vulnerability to belief bias can be assessed by setting up a conflict between logic and belief. This can be accomplished by way of arguments that have an invalid form, but true premises and/or a true conclusion.

Alternatively, one could employ arguments with a valid form, but false premises and/or a false conclusion. Belief bias is evident when the former argument is judged to be valid and the latter invalid. When task instructions stress the importance of a logical or formal evaluation of the argument, susceptibility to belief bias tends to decrease across later childhood and adolescence, though it is substantially present even in adults.

Kuhn maintains that metacognition and executive functions are implicated in the ability to overcome belief bias in several respects. First, children and adolescents become less susceptible to belief bias as they develop knowledge of the formal properties of deductive inference and the advantages of using deductive strategies such as falsification. This is a kind of metalogical knowledge. Moshman, discussed next, provides a detailed account of what the development of knowledge about logic might involve. The second relevant aspect of metacognitive development concerns an increasing awareness of, and control over, beliefs. As with Markovits' mental models account, inhibitory capabilities are seen as key here. Where real-world knowledge and the rules of reasoning are in conflict on logic problems, that knowledge, which otherwise represents an aid and support to the application of inference rules, becomes a hindrance and must be suppressed. Overriding heuristic responses based in real-world knowledge and avoiding premature closure make it possible to consider alternatives and to recognize indeterminacy or invalidity despite believable content.

There are other metalevel elements of cognition that are both subject to development and potentially relevant to performance on deductive reasoning problems. In particular, the disposition to apply a competence is important in Kuhn's account. Dispositional factors provide favorable or unfavorable conditions for separating belief from evidence and for inhibiting more heuristic forms of processing. For Kuhn, disposition primarily involves intellectual values and level of epistemological understanding or awareness, where the latter concerns an appreciation of the nature of knowing and knowledge. Concerning intellectual values, deductive strategies are more likely to be invoked by individuals when the goal of arriving at veridical judgments and maximizing knowledge is given priority over the protection of existing beliefs and personal theories. Likewise, a personal epistemology in which knowing is understood to be a relatively transparent process that yields facts and opinions, rather than a theory-laden process yielding testable and falsifiable claims, is likely to favor inductive reasoning strategies over deductive strategies.

Moshman's theory of the development of deductive reasoning also places great emphasis on metacognition. In his view, reasoning involves explicit conceptual knowledge regarding inference (metalogical knowledge) and metacognitive awareness of, and control over, inference. Metalogical knowledge includes the recognition that inference is a basis for knowledge, an understanding of key distinctions among types of inference, an appreciation that conclusions must be consistent with all possible states of affairs represented by the premises, and an understanding of logical indeterminacy, inconsistency, and necessity.

The development of reasoning and rationality is viewed by Moshman as a process of reflection upon implicit metalogical

knowledge. This is essentially the developmental mechanism common to Piaget's notion of reflective abstraction and Karmiloff-Smith's representational redescription. Development involves a self-reflective process by which elements implicit in intellectual acts are rendered explicit and, as such, come under conscious, intentional control, thereby becoming applicable across a wider set of circumstances. This is an internal process, though it is supported by specific types of social interaction. It does not involve a process of transmission from external authorities to the child.

As noted previously, preschool and early school-age children are able to make various deductive inferences that comply with logical norms, but in Moshman's view these inferences do not represent reasoning because they are not consciously or purposefully constrained by particular inferential norms. Conclusions as the outcomes of inferential acts are not conclusions *per se* for the young child, but simply facts, in principle indistinguishable from observational facts. Moshman, however, considers some knowledge of inference and of inferential form and norms to be implicit in children's thinking at this stage. During the middle childhood years, these implicit elements become explicit. According to Moshman's account, we should see a developing awareness of inference as a source of knowledge across the elementary school years. This includes an appreciation of premises and conclusion as distinct components of inference and an increasing understanding of the premise-conclusion relation and of inference as a process which derives the conclusion specifically from the premises. However, still implicit during much of middle childhood are an appreciation of the different syntactic forms for premises (e.g., disjunction, conjunction, implication), and an understanding of key differences among types of inference, and between determinate (valid) and indeterminate (invalid) arguments. Explicit awareness of inferential validity as a function of argument form and independent of the truth and falsehood of the premises is alleged to emerge in adolescence, and this appreciation of logical truth as distinct from empirical truth enables success in reasoning with contrary-to-fact arguments.

Findings regarding child and adolescent metalogical knowledge provide a pattern of purely intuitive or implicit understandings of logical concepts preceding more explicit understandings. This pattern generally conforms to Moshman's predictions. There is also evidence of implicit understanding of more advanced concepts existing alongside explicit command of less advanced constructs.

Unlike mental models theory or domain-specific accounts, the theories of Kuhn and Moshman appear to include aspects of logical competence, but to represent these in procedural form. Logical competence becomes, in effect, conceptual knowledge about logic and about logical strategies along with adherence to intellectual values and personal epistemologies that entail a conscious conformity to logical norms in approaching certain problems. In this way, the theories attempt to avoid any notion of a mental logic. The claim here is that explicit conceptual knowledge about logical necessity and validity can obtain in the absence of an inherently logical-mathematical organization to thought itself. From within the metacognitive perspective, mature thinking is not inherently logical, but it can avail itself of different rule systems, including that of symbolic logic, in

order to accomplish specific goals. These theories also posit the development of metacognitive functioning as contributing in key ways to the controlled and strategic use of deductive inference.

Comparison and Conclusions Regarding the Theories

At this point in time, and despite considerable focus on deduction in developmental research, the available empirical evidence does not allow any decisive test of the competing theories of deductive reasoning because the majority of these findings are consistent with more than one theory. In the absence of decisive tests which might rule out particular theories, it may be profitable to seek some means of reconciling ostensibly competing claims. In this regard, a rapprochement afforded by competence-procedural theory offers a promising basis for resolving differences and preserving the obvious strengths of each theory.

The role of encoding, retrieval, executive, and pragmatic-interpretive processes in age, task, and content effects in deductive reasoning have been significantly clarified by research within domain-specific, mental models, and metacognitive theories. The proposed rapprochement requires interpreting the findings from research conducted within the procedural group of theories as providing important elaborations of the procedural component of a competence-procedural model while, at the same time, rejecting interpretations that blur distinctions between competence and performance or that reduce aspects of competence to procedural factors. The competence-procedural account also recognizes the findings of Kuhn and Moshman regarding metalogical development and some aspects of broader, metacognitive development as confirming the logical competence model of the theory and as identifying key indicators, manifestations, and consequences of an emergent logical competence. The course of development for conceptual knowledge about logic, documented by Moshman, is entirely consistent with the emergence of a class-based mental logic supporting concrete precursors to deductive competence followed by the emergence of a propositional mental logic supporting a mature formal competence. In addition, at least some aspects of metacognitive or executive functioning that have been linked to success on deductive reasoning problems by Kuhn, Moshman, and others could be seen as a manifestation or consequence of an emergent logical competence. For example, there are parallels both empirical and theoretical between the formal operational model of Inhelder and Piaget and certain metacognitive or executive functions such as planning, cognitive flexibility, and cognitive monitoring.

To many psychologists studying reasoning processes, the seeming choice among contemporary theories of deductive reasoning is between, on the one hand, a competence-based account that takes seriously the numerous parallels between rules and operations within formal systems of argument and the psychological processes involved in everyday argumentation, and, on the other hand, a group of what we have described as procedural accounts that deny these parallels or view them as arbitrary and coincidental. Rather than accepting this either/or option, however, a more profitable approach involves a partial division of labor among the theories with mental models and

domain-specific and metacognitive research programs providing key elaborations of procedural systems within an overarching competence–procedural account.

See also: [Adolescence](#); [Cognitive Bias](#); [Problem Solving](#).

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Retirement

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Glossary

Anticipatory socialization The process by which an individual adopts the values and behaviors of a specific group that she or he will incorporate into a new role(s).

Blurred retirement A gradual role transition marked by repeated reentries and exits from the workforce that may encompass months or years.

Bridge employment Employment that takes place between a long-term or career job and complete withdrawal from the workforce.

Career job The occupation which an individual is attached to for a substantial portion of his or her working life.

Crisp retirement A single transition that is a clear-cut exit from the labor force.

Retirement A process – influenced by the sociostructural, cultural, and political climate – that encompasses a worker's personal experience as she or he undergoes the change in balance of work and leisure. This usually includes the following phases: preretirement, the decision to retire, the act (or acts) of retirement, and the continual postretirement adjustment. Manifestation may include a permanent exit from the workforce, employment in a new arena (i.e., bridge jobs), and/or a decision to return to work full or part time.

Introduction

Retirement is often defined as a withdrawal from one's position or occupation, which usually entails giving up one's job. Retirement is not a sudden event; instead, it is a process by which people prepare for living in the later years. There is no one way to retire. Each individual needs to create a plan for himself or herself based on his or her needs and wants in later life. Preparation helps in the decisions about later life choices and facilitates a well-adjusted retirement.

There have been major changes in our understanding of the concepts of aging, work, and retirement. Beginning in December 2007, a change in the economic and social environment, described as a 'recession,' resulted in a clarion call to employees across the life span about the instability of one's work role and retirement. Past expectations and assumptions about retirement need to be carefully reviewed and revised to guide an individual's choices and timing of the transition from workforce participation to full- or part-time retirement.

As part of the decision-making involved with retirement, employees must carefully consider choices in health care coverage, use of retirement savings and pensions, and lifestyle (e.g., housing, travel, social milieu). Keeping these considerations in mind, individuals need to consider how long and under what conditions they will continue to work full- or part time. Many individuals say they want or need to stay in the workforce longer due to lack of resources and the scarcity of future employment opportunities. One of the strongest considerations held by employees is the desire to maintain health care and other benefits; without such benefits, many workers remain at or return to work, either full or part time. Similarly, those employees who have enough resources and are in good health may also choose to continue to remain in the workforce, or they make the transition to retirement. It is important to note that there are individuals who would like to work and cannot find employment either full or part time; considered as discouraged workers, these individuals eventually become retired as a result of the lack of employment opportunities.

As gerontological research indicates, there have been a number of continuing issues that are important to the understanding of work and retirement. Such issues include, but are not limited to: training; maintaining professional competence; job loss; retirement savings and pensions; housing choices; age discrimination in the workplace; and changes in the local, national, and global economy.

Over the last decade, some researchers have been suggesting that organizations need to prepare for the shortage of workforce due to the upcoming retirement wave of baby boomers. Others assert that there will not be shortages, or that predicted shortages will be industry-specific. In some cases, it may be important to retain or attract older workers.

History of Retirement

The evolution of retirement in the United States is a continuing saga. The workforce transitions from agriculture to industrial to the postindustrial technology boom were accompanied by changes in the attitudes, understanding, and policy proposals for retirement. Through the 1700s and mid-1800s, retirement was rather uncommon; about 70% of older men remained in the labor force. Many of these older workers held high-status and prestigious positions. The aged were valued for their wisdom and experience, and forced retirement was not supported by the social ideology of the time.

For those who did retire, it was commonplace to rely on the family for economic support during the retirement years. Almost one-fifth of the population of working-class held little to no financial savings, and in the mid-1920s, surveys of nondependent elderly showed that about 20% held assets or property worth less than one year of a retired couple's expenditures.

The growth in retirement was influenced by two trends in the early industrial era: the development of labor unions and mandatory retirement. In the agricultural era, society tended to value the elderly for their contributions and jobs

were typically flexible enough to allow changes in work demands for those with diminished capacities. The prevailing beliefs that older workers were worn out and useless reinforced the notion that older workers were unable to work. Thus, mandatory retirement emerged as a reflection of these beliefs and became a mechanism for removing older workers. Mandatory retirement served to insure companies against the high cost of continuing to employ older workers over the younger, cheaper, and believed-to-be more 'capable' workers.

The institutionalization of retirement – which gave employees the right to financial support in old age as a result of deferring income during one's years of employment – resulted from the establishment of Social Security Act of 1935 and employer pensions. The purpose of both Social Security and pension systems was to counteract the large population of elderly who were left in poverty due to the lack of private pensions at the time. Additionally, both were passed to protect individuals against the loss of income from unanticipated events such as retirement, disability, or death of the family breadwinner. Social Security payments began in 1940 and were based on careful analysis, considering cost and numbers of older workers. The US government selected 65 as the age for full retirement benefits.

Following the Great Depression and World War II, several improvements in retirement emerged: private pensions became more commonplace and Social Security coverage was extended to cover most workers. The minimum retirement age for Social Security was also lowered to 62 years of age for women in 1956 and men in 1961 for reduced benefit. Over time, the attitude toward retirement began to change from a negative standpoint to one where retirement was a right to those who earned it.

At mid-twentieth century, men aged 65 and older were close to 50% being employed; by the end of the century, fewer than one in five were in the labor force. Early retirement became usual for many. For individuals (aged 40–65) who wanted to continue to work, the 1967 Age Discrimination in Employment Act (ADEA) was passed to protect them from age discrimination. This act was revised in 1978 to prohibit mandatory retirement before the age of 70 years and no mandatory retirement for federal employees. It was amended in 1986 to prohibit mandatory retirement for workers aged 40 and older in most occupations.

By the early 1990s, private pension plans were commonplace, if not expected, by most employees and employers as a portion of income paid to workers. At peak, about 50% of the workforce was covered. Since that time, there has been a shift from defined benefit plans that guarantee a fixed retirement income to defined contribution plans, in which benefits depend on returns from invested funds. Defined benefit programs are subject to economic downturns, and thus make employees' financial future less certain.

The economic downturn starting in 2007 has made many workers aware that defined benefit programs can have a major loss of value. One way of dealing with this is for individuals to work longer, either in full- or part-time retirement. The result of this has been an increase in the average age of retirement, with workers choosing to work longer.

Definitions of Retirement

As stated earlier, retirement is often defined as a withdrawal from one's position or occupation, which usually entails an individual giving up his or her job. However, retirement is still evolving today as evidenced by changing transition patterns and ages of labor force exits. Retirement is not necessarily a complete withdrawal from the workforce and work activities. An estimated 20–30% of older workers continue to work or reenter the workforce, although the likelihood of reentry decreases with age. Postcareer bridge employment may involve changes in industry, occupation, hours, or salary. The multiple pathways from work to retirement highlight the importance of viewing retirement as a process and the need to study this process over time. A crisp retirement transition is a single, unreversed, and clear-cut exit from the labor force. A blurred retirement transition is a gradual role transition marked by more than one exit and reentry and may encompass months or years.

Crisp and blurred transitions are found to differ by age, financial resources, and health status. Individuals with poor health are more apt to demonstrate blurred transitions. Individuals with the poorest health are more likely to demonstrate a crisp exit pattern. It is clear that examining exit patterns is very important in understanding the retirement process: considering retirement as a single transition does not adequately capture the complexity and the dynamic nature of the retirement process.

Three retirement definitions found in the literature include self-definition of retirement, receipt of Social Security or pension income, and hours worked. Under current Social Security rules, people can work full time and receive the benefit with additional earnings, if above the full retirement age. If a worker uses Social Security benefits before his or her full retirement age, there may be an earning penalty. This is another example of the elusive nature of a definition of retirement.

The Retirement Process

Retirement is a process rather than a single event. The phases that have been identified as a normative experience include: preretirement, the decision to retire, and the continual postretirement adjustment. The initial stage, preretirement, deals with three major areas of concern: social, financial, and time management. Essentially, workers begin the contemplation of retirement and anticipatory socialization. Studies indicate that this stage can begin as early as young adulthood. During this phase, workers typically begin discussing retirement with loved ones, peers, and coworkers; engaging in retirement-oriented activities; and financially preparing for the life change.

The decision to retire, the second phase, addresses two major concerns: when and how to retire. The timing of retirement depends on whether or not retirement is voluntary or involuntary. If the decision is voluntary, it is likely that for many workers, the decision is considered over several years taking many elements into account such as health, finances, attitudes toward retirement, and family obligations. On the other hand, workers can be faced with involuntary retirement,

a result from employment constraints rather than a preference for leisure. Such constraints may include allowable mandatory retirement policies, organizational restructuring, a worker or loved one's ill health, or pressure from the employer. Additionally, an older worker may be forced to choose involuntary retirement because of the few choices he or she may have available. Overall, the decision to retire may or may not rest in the hands of individuals themselves, but they do have control over how they prepare for the transition.

Finally, retirees enter a period of postretirement adjustment, a continuous process that begins once a worker has determined when and how he or she will retire. The workers begin to discuss specific plans with others and enter a period where they experiment with and explore leisure activities. Individual differences exist in terms of available resources and also in what activities a retiree may find satisfying. Additional factors that affect a retiree's adjustment include preparation, socioeconomic status, health, marital status, and social support.

Self-Management

In response to changing social and organizational environments, self-management has emerged as a major theme. Individual responsibility is required for maintaining and updating knowledge, skills, and abilities when workers change employers, occupations, and/or jobs within their current company. Similar to work, retirement has moved into the realm of self-management. The individual has to take on the planning and decision-making of when and how to retire. Retirement is still evolving as can be seen by changing transition patterns and labor force exits. The transition from work to retirement can take many forms including bridge jobs, part-time work, or new careers.

Currently, the emphasis is on how individuals will be able to plan for future employment opportunities and retirement. Being creative in reshaping the later life period to fit continued work, retirement, and work in retirement is a challenge for many workers. The resolution to this dilemma is captured in discussions of the protean career.

The protean career concept stresses continuous learning and self-direction of both one's life and career, in that self-management of career and retirement entails taking personal control of decision-making. Not everyone has a career as such but may have a series of jobs that may be unrelated. Many individuals may have limited control of their employment situation. Some individuals may accept this responsibility and respond proactively with success. Others may respond ineffectively or may be immobilized by decision-making. These individuals may not have the needed skills, psychological resources, or may not know what their work future will be like. A major decision is whether a person will remain in the same career, change his or her career, or retire.

Career development training and retirement education need to be offered to workers of all ages in order to promote understanding and provide workers with important information about future planning which can include retirement. Employees cannot rely on their employer for career

development and/or retirement planning but need to make this a personal responsibility.

Along with the above issues, we need to consider the multidimensional aspects of decision-making in self-management of work and retirement. There are four dimensions that can influence self-management of career and retirement: self-concepts, work/employment environment, relationships with others, and community. Each dimension is influenced by many factors, which could affect the decision-making process of whether individuals would continue work or leave partially/entirely.

The first arena of self-management is a person's self-concept. Self-concept is influenced by many factors in consideration of retirement issues. One consideration is the need to understand one's past self and what values, preferences, and desires are based in the past. This is countered and complemented by one's future self. The possibility of new lifestyles, new living environments, new friends, and new actions are options. Three factors are important here: (a) the understanding of change and an awareness of the passage of time, (b) how an individual views change in others and oneself over time, and (c) how one sees and understands the implications of time into the future is a major aspect of personal cognitive integration leading to increased self-understanding.

Another consideration influencing self-concept is the perceived control that one has about his or her life at the personal level in relation to significant others as well as her or his work, career, business situations, etc. An individual may feel in control based on economic resources and position held, or may feel extremely vulnerable based on the current financial situations and business climate. During an earlier economic downturn in 2002, the United States went from the highest level of employment to a realization that many employment situations were vulnerable. The summer of 2002 made many potential early retirees come to terms with the fact that they would have to work longer based on the decline of their investments. In many cases, people in retirement have had to modify their daily choices or return to work in order to maintain their desired lifestyle.

A third factor impacting self-concept is personal insight, which takes into account how well an individual understands himself or herself with regard to motivations, personal desires, work approaches, and relations to family, friends, and organizations. Self-study, education, and counseling may aide this process. In addition, organizational based self esteem (OBSE) and perceived norms are important factors to consider. OBSE reflects how valued an individual feels in relation to one's fellow workers and the feeling of contribution that one gets from one's work. Perceived norms refer to how one perceives the work and retirement norms around one's self. It has been found that workers were more likely to retire early when they categorized themselves as older adults. Thus, one's personal social clock and one's understanding of social norms will influence self-perceptions and actions to be taken. The orchestration of all of these influences on the self is included in self-management capability.

The second arena of self-management of career and retirement focuses on the work environment. One is concerned here with one's self-evaluation of the employment situation. Part of

this relates to one's appraisal of the current employment situation. Beliefs regarding how one is viewed by supervisors, outcomes of performance appraisals, perceived growth opportunities within the organization, and observed treatment by others are of great influence. Also, it is important that individuals understand personal strengths and weaknesses in their working styles.

Employment-based appraisal refers to the formal and informal feedback that one receives from supervisors, which may result in various outcomes such as salary increases (or decreases), promotion (or demotion), and involvement in organization planning and policy. Work opportunities refer to future plans within the work context and potential opportunities over time. New work opportunities may be an important incentive to continue to work as a bridge to retirement. Other bridge opportunities may provide a gradual change in responsibilities to part-time employment. Another major factor is one's activities in continuous learning and maintaining professional competence. Remaining competitive with up-to-date skills may make one valuable to the organization.

Relationships to coworkers are also extremely important in continued employment. How an individual feels about his or her work situation is highly influenced by coworker interactions in many cases. Middle-aged and older workers value relationships on the job. A negative relationship with coworkers may lead a valuable older worker to take retirement. Supervisors may want employees to stay but may not be aware of interaction difficulties. On the other hand, an older employee who feels the need to work longer than he or she really wanted to for financial reasons may be a challenge for coworkers and supervisors.

Perceived organizational culture is another factor that provides important messages to current employees. Choices made by current organization leadership and how these are transmitted to current employees provide important general information that would shape retirement decision. Middle-aged and older employees are usually very aware of changing climate and how long service employees are being treated.

Another factor is possible new opportunities, namely looking for new employment opportunities within or outside of one's organization. This can be preplanned in terms of second or third career education and training or may be related to chance encounters or in response to a corporate recruiter. However, often middle-aged and older employees may not be in a position to choose when to retire as discussed elsewhere.

Self and work environment relationships with significant others and with community can be important dimensions to consider. These areas can have major influence on decisions regarding work and retirement. Considering important relationships and having spouses or significant others involved in retirement planning are essential for planning to be successful. Family relationships may become more important and become a major influence in self-management of retirement. Choosing to be near children, grandchildren, or other important family members may be a reason to retire from one's current job, move, and reestablish one's household in a new location. New part- or full-time employment may be a choice after such a move. Migration research tells us that ~80% of older adults choose to stay in their home communities to be near family and friends. This does not preclude new and

exciting choices as part of a new life period. In addition, caregiving responsibilities may be a major concern for many people. In many cases, an employee may choose or feel forced to retire in order to provide care to loved ones. Corporate eldercare services have been available for over two decades to assist employees who have care responsibilities. Such services may make it possible for employees to be able to continue to work.

What keeps people in their home communities or what aspects of community may be important in providing a meaningful context and sense of belonging? Much of the classical retirement literature has focused on these dimensions of community. What is important here is how these dimensions relate to one's self-concept and how this influences our decisions to continue to work or retire. Some individuals feel alienated by their community relationships and wish to reestablish themselves in a new community context. Others may have more than one residence and move back and forth between the new and the old locations, empowered by both, and others totally enjoy being a part of roles and involvements that are longstanding.

Self-concept is influenced in many of the above-described ways. What is critical is one's ability to bridge from the individual level to the broader work and societal context. Taken together, decisions regarding working longer, retiring, or finding a new job made by older workers can be influenced by many dimensions and factors in a dynamic way. Economic factors and business climate may limit opportunities for self-managements of retirement and work issues. Self-management entails greater resilience and flexibility and can be an important aspect for older workers to survive in changing work environments. In the following section, factors relating to retirement decisions, as well as retirement planning and process, will be discussed.

Retirement Planning

Retirement planning is one of the most important factors to facilitate later retirement satisfaction and adjustment. People need to consider financial aspects as primary. In addition, retirement education includes, but is not limited to, such aspects as the use of leisure time, where to live, health care and other benefits, wills and other legal documents, and the consideration of part- and full-time work in retirement. Those who have engaged in retirement planning have been more likely to retire earlier, and feel confident and satisfied with retirement decisions. However, retirement planning can also lead to other choices such as new full- or part-time employment, volunteer activities, later life learning, and other creative endeavors.

Due to the recent economic downturn, many people have been forced to take retirement before they had planned, which may make them feel more insecure and vulnerable. Thus, retirement planning should be started at an earlier career stage so that the worker is ready to confront unpredicted situations. Having financial resources can help to meet future needs and choices. Individuals who have higher internal locus of control and higher self-efficacy might feel that they have more control, resulting in better decision-making and adjustment. However,

the current sense of vulnerability shared by many middle-aged and older employees leaves a sense of little control. Unemployed individuals have to regain their self-efficacy and begin the process of seeking employment in a very difficult job market, which recently has included an unemployment rate as high as 10%.

Some researchers have suggested that the retirement process needs to be considered as a coupled process between husbands and wives, which indicates that retirement planning should include spouses or significant others. If husband and wife are retiring at different times, this may or may not create some marital strain. This may depend on the need for additional financial income and/or the sharing of leisure activities.

Another concern is caregiving, which is particularly relevant to women's experience of retirement. Women are traditionally the predominant caretakers in families for children and adults. The services that they provide to their loved ones are not compensated. Women's caretaking responsibilities are one of the factors that keep women out of workforce longer than their male counterparts. On average, women spend significantly more years out of the workforce than men, and while they are in the workforce they have interrupted careers. Because Social Security benefits are calculated based on an individual's average earnings over 35 years, many women are likely to have less money during their retirement. Unequal pay and systematic biases in policies also contribute to the economic constraint experienced by women. Women's jobs pay less than men's do, and women tend to work at jobs without pensions. It is also important to note that both men and women minorities also experience less lifetime pay and systematic bias, which results in lower pensions and retirement funds.

In retirement planning, it is suggested that one should examine at least four domains: financial planning, health planning, interpersonal/leisure planning, and postretirement employment plans. In sum, retirement planning should start from understanding one's own current situation, including health status, family responsibilities, financial status, and personal interests and desires. Considering recent economic developments, older workers may be even more interested in bridge employment than they were in the past. Individual differences are a key concept here. Some individuals will continue to have fairly traditional careers with job continuity and others may have interrupted and difficult job histories. Many middle-aged and older adults will continue to work longer out of choice or necessity. Others may experience layoffs and may need to find new employment. Older workers need to be resilient and have self-initiative.

Many older workers have strong skill levels, can successfully update their skills and abilities, and can be trained in new areas. They can also successfully make the transition to retirement. For many, there may be a need for more supportive job-finding situations such as employment coaching or job club. Additionally, they may need additional training to be competitive and may need assistance in planning for retirement.

Multiple pathways from work to retirement highlight retirement as a process. Changing economic environments have had a dramatic effect on individual financial well-being and have altered individual approaches to when and how individuals plan to retire. Another aspect is that workers may have to work longer than anticipated or may have to accept an early buyout

package rather than risk being laid off or fired at a later date. Individual characteristics, work-related, and other factors have an impact on work and retirement choices. These factors influence anticipatory retirement planning and decision processes.

The Changing Nature of Retirement

From 1969 to 1979, more than one-third of workers left their career employment before the age of 55, and half left before the age of 60. Improved health care and increased life expectancy have opened the door for significant shifts in the timing of retirement. Work life versus retirement length on average has changed from 46 years of work with one year in retirement in 1960 to 37 years of work with 12 years in retirement in 1995. Since that time, the trend toward early retirement has reversed with workers once again working longer. Change in the future may be related to Social Security moving to full benefit retirement at age 67. Recent data show many people taking Social Security at an earlier age especially if there is no earnings penalty.

How Do Future Generations View Retirement?

Many studies of retirement are cross-sectional and as such focus on age differences. Such studies may involve multiple generations at different points in the life span which may not represent what workers actually experience. Longitudinal studies, looking at individuals across time, may be generation-specific. Thus, retirement literature collected on earlier generations may not generalize to later generations. Different generations have had or are having different experiences at critical points in the life span that may lead to very different attitudes and values about retirement.

Upcoming generations are concerned about what their retirement period will be like. Will Social Security make the changes to meet the expected levels of benefit? Will people make the choice to build up defined benefit pensions that will provide the needed level of support? Will people be more conservative about their use of credit? And, will people plan to work longer to maintain their standard of living?

Many adult and older adult workers have made the voluntary/involuntary decision to work part time in retirement. Others are concerned that they may have to work full time to meet their needs in retirement. Many people today expect to have a lifestyle in retirement that is similar to their working years. Previous generations realized that the retirement period might require a more conservative and scaled down lifestyle. Future generations will need to come to terms with the realities of later life living.

New Concepts of Later Life

On a more positive note, a major issue is how to use extra decades of life and how to re-envision long life to include public engagement and personal growth. It is suggested that many people in their 50s and 60s should be considered in mid-career, rather than on the edge of retirement. Expectations

regarding working longer should become more normative. Many authors are suggesting that we redesign the later life period. This requires exploring new roles and activities. However, we must be aware that not everyone will be able to do this. Poor work histories, health problems and disability, and family caregiving responsibilities also need to be considered. Retirement policies need to include individuals who may need help and assistance in the 60s if not before. The challenge is to be able to accommodate a full spectrum of need and capability. Future public policy will play an important role in defining the retirement of the future.

See also: [Aging and Cognition](#); [Grandparenthood](#); [Work Efficiency and Motivation](#).

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Risk-Compensating Behavior

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Glossary

Exogenous Outside the control of the individual decision-maker.

Expected utility Satisfaction that one can reasonably expect to obtain in an uncertain situation; measured as the sum of the possible outcomes times their respective probabilities.

Probability Likelihood that an event will occur.

Risk Probability that an event with negative consequences will occur; the opposite of safety.

Utility Satisfaction one derives from an activity (e.g., consumption).

Background

The justification for legislation requiring safety belt use in automobiles is the reduced risk of death and/or injury, given the occurrence of an accident. Likewise, attempts to reduce risk in the home (e.g., tamper-proof packages and safer cigarette lighters), during recreation (e.g., sunscreens), and/or in the workplace (e.g., Occupational Safety and Health Administration (OSHA) regulations) are designed to create a safer local environment. However, the expected results from these risk reducing activities can be partially or fully offset if individuals behave in a risk-compensating manner. Risk compensation occurs when individuals, in response to an exogenous improvement in safety, voluntarily accept greater risk by reducing individual safety activities. The net effect is a reduction in the effectiveness of the safety-enhancing program. There exist numerous examples of risk-compensating behavior in home, recreation, and workplace situations.

Tamper-proof packages for household cleansers and prescription drugs were designed to reduce accidental household poisonings. However, the increased safety was largely offset by risk compensation, as these items were made more accessible to children through inadequate storage practices, which caused a documented increase in household poisonings after the adoption of tamper-proof packages. Likewise, individuals appear to have decided to spend more time in the sun in response to the availability and use of sunscreen products. Thus, increased sunscreen use has had little impact on the number of cases of melanoma and nonmelanoma (basal and squamous cell) skin cancer. In fact, the trend lines for these cancers of the skin are positively sloped over the period 1975–2006. The OSHA has been regulating health and safety conditions in the workplace for several decades. However, the policies of OSHA are less effective than expected, as workers compensate for safety regulation by behaving in a riskier manner; that is, workers reduce individual safety because of the perception that they are protected by government policy. Thus, while work-related death rates have been reduced over the past 35 years (from 18 to 3.6 deaths per 100 000 workers), ~5100 workers lost their lives in 2008. For the period 1988–97, the rate of cases with ‘days away from work’ declined 40%, but there was a 140% increase in the rate of cases with restricted work activity. Thus, while there exists information that points to the effectiveness of

OSHA regulations, there also exists countervailing evidence. A specific example of workplace risk compensation occurred in major league baseball. The number of batsmen who have been hit in major league baseball has increased markedly today when compared to the period before major league baseball mandated helmet use (mid-1950s). Specifically, the hit-by-pitch rate has increased from approximately one hit batsman for every 10 games in 1946 to one hit batsman for every 2.5 games in 2007. Thus, behavior of players has responded to safer batting situations by, for example, leaning over home plate because they feel safer.

Risk-compensating behavior is often described as an optimal response to a change in the existing situation. The individual decision-maker is confronted with new information and adjusts in an effort to increase utility or satisfaction-producing activities. An increase in exogenous safety can cause individuals to participate in activities that were formerly avoided because of their inherent negative consequences. For instance, the birth control pill, by reducing the probability of unwanted pregnancy, allows people to be more comfortable with increased sexual activity, which then may increase pregnancies. Helmets for bicycle riding and/or skiing permit faster speeds and more risk-taking behavior, resulting in more violent accidents and canceling the intended safety benefit. Improved automobile safety allows greater speed and driving under what were formerly hazardous road conditions.

Risk compensation is also applicable in converse conditions. An increase in exogenous risk often causes individuals to behave in a safer manner. Thus, as weather causes deterioration in road conditions, drivers generally compensate by driving slower. It has even been suggested, in jest, that mounting a dagger on the steering wheel pointed at the driver may incite safer driving.

In the next section, we describe in detail the decision process that underlies risk-compensating behavior. This is followed by a discussion of the empirical results concerning driving behavior, the most studied example of risk compensation.

Theoretical Construct

Risk compensation is derived from an economic model of behavior. In general, individuals possessed with full

knowledge are assumed to behave in an optimal manner and maximize utility or satisfaction, subject to an income constraint. In this context, safety (or risk reduction) is only one argument in the utility function. Note that the objective is to maximize overall utility, not minimize risk. The primary outcome of this model is that individuals will choose activity levels to the point where the incremental or marginal benefits equal the incremental or marginal costs of any specific action. As with other utility-producing goods, an optimal level of safety will be chosen by the utility maximizing individual.

In the real world, there exists considerable uncertainty concerning the effects (benefits and/or costs) of possible decisions. Thus, the standard utility maximizing model is not applicable to situations characterized by uncertainty. In these uncertain situations, individuals are assumed to maximize *expected* utility, which is the algebraic sum of outcomes multiplied by their respective probabilities. The optimal conditions for this model specify that individuals will undertake an action until the incremental expected benefits equal the incremental expected costs. This decision process can be seen in the following model, where subscripts refer to partial derivatives.

Let

- s = individual safety measures.
- e = exogenous safety measures beyond the control of the individual, such as required seat belt use laws.
- $P = P(s, e)$, the probability that an individual is involved in an accident where probability is influenced by individual actions ($P_s < 0$, $P_{ss} > 0$) and exogenous factors ($P_e < 0$, $P_{ee} > 0$); that is, as individual and exogenous safety measures increase, the probability of an accident declines with a declining rate because of diminishing returns.
- $L = L(s, e)$, the loss associated with an accident where loss is influenced by individual actions ($L_s < 0$, $L_{ss} > 0$) and exogenous safety measures ($L_e < 0$, $L_{ee} > 0$).
- $D = D(s, e)$, the disutility associated with practicing individual safety ($D_s > 0$, $D_{ss} > 0$) and from exogenous safety measures ($D_e > 0$, $D_{ee} > 0$). Disutility may also result from the interaction of individual and exogenous actions ($D_{se} > 0$).

Also, note that no assumption is made concerning the relationship between s and e in either the probability function P or the loss function L . If P_{se} and L_{se} are nonnegative, then individual and exogenous actions are substitutes in production. However, if these values are negative, then individuals perceive s and e as complementary goods, which are goods that make each other more valuable.

The individual is assumed to maximize expected utility (U), constrained by income. In the simplest case, there are only two states of the world: (1) the accident occurs with probability P and (2) the accident does not occur with probability $1 - P$. This simple optimization problem is written as follows:

$$\text{Maximize } U = P(s, e)[I - D(s, e) - L(s, e)] + [1 - P(s, e)][I - D(s, e)]$$

or

$$\text{Maximize } U = I - D(s, e) - P(s, e)L(s, e) \quad [1]$$

The individual will take safety measures until the benefits of additional action (benefits of reduction in expected loss) are just offset by the additional disutility. Thus, optimal individual

safety effort, determined by maximizing eqn [1] with respect to s , will conform to

$$-D_s = P_s L + P L_s \quad [2]$$

where the right-hand side is the extra benefits (change in probability times the loss function plus change in the loss times the probability) and the left hand side is the additional disutility.

The relationship between individual and exogenous safety measures can be determined by treating eqn [2] as an implicit function and using the implicit function rule to solve for ds/de .

$$ds/de = (D_{se} + P_{se}L + P_s L_s + P_e L_s + P L_{se}) / (-D_{ss} - P_{ss}L - 2P_s L_s - P L_{ss}) \quad [3]$$

The theoretical construct can be used to make a number of predictions concerning risk-compensating behavior. First, $ds/de < 0$ if individual and exogenous actions are assumed to be substitutes (see description above) in the probability and loss functions. This is the formula for compensating behavior. That is, increases in exogenous safety measures relax the constraint and allow the individual to substitute exogenous safety for individual safety. The individual reallocates scarce resources, purchasing less individual safety and more of other utility-producing goods. However, it should be noted that the sign of ds/de is indeterminate if s and e are assumed to be complementary in reducing risk and loss. In this case, risk-compensating behavior does not always occur and will depend on the extent that complementarity produces additional safety that offsets the extra disutility of any exogenous safety measure. The manner in which individuals treat individual and exogenous safety measures is, therefore, an empirical question. A priori one might expect that relatively risk-averse individuals would demonstrate the least amount of compensating behavior. Specifically, exogenous safety measures might not be offset by reductions in individual actions. Likewise, risk lovers may be relatively strong candidates for compensating behavior. In the next section, we present the relevant data concerning this hypothesis.

The second prediction of the model is that risk compensation will be heightened in situations in which there exist individual activities that substitute directly for the exogenous safety measures. If none exists, then there is no opportunity for risk-compensating behavior.

Third, risk compensation (ds/de) will be large when the probability change (P_e) corresponding to the change in exogenous risk is large. Thus, one can expect that policies that have a large (small) effect on perceived risk will (will not) produce compensating behavior, *ceteris paribus*.

Fourth, the benefits of risk-taking must be relatively large to induce risk-compensating behavior. If there is little to be gained in terms of utility from risk-taking, then the individual will lack the necessary incentive to alter behavior.

Finally, risk compensation will be larger for exogenous safety measures that affect the accident probability than for those measures that affect the severity of damage from the accident. For example, illegal immigration from Mexico is largely unaffected by a change in apprehension rates because deported illegal immigrants simply make more attempts to enter the United States. Thus, risk compensation offsets any increase in

apprehension rates. In this case, a change in the severity of punishment would likely have a greater impact because of the occurrence of less risk compensation.

Empirical Results: Driving Behavior

Automobile travel is risky business, with over 40 000 deaths and millions of injuries per year in the United States. Worldwide, these numbers are magnified considerably. The growth in deaths and injuries worldwide will likely increase substantially over the next two decades considering the rapid growth in vehicle ownership in China, India, and other countries. A recent study suggests a potential 66% increase in worldwide automobile-related fatalities over this period.

In the mid-1960s, Ralph Nader called into question the safety of automobiles and the complicity of automobile companies in producing a dangerous product. Regardless of the truth of the issue, the federal government responded with new regulations requiring installation of safety devices. This initially meant padded dashboards, collapsible steering wheels, and seat belts. Over time, the regulations became very extensive, leading to the basic redesign of the automobile to incorporate numerous safety factors. Individual states also became involved by passing laws requiring seat belt usage, changing speed limits, and setting lower limits on driving while drinking (including much higher penalties for violation of the law). Today, 30 states have primary seat belt laws (a person can be stopped for not wearing a seat belt) and 19 have secondary seat belt laws (a person must be stopped for another violation before the seat belt law can be enforced). The only state without a seat belt law is New Hampshire. Consequently, over the last 15 years, seat belt usage has increased in the United States from ~60 to 83%, and the vehicle occupant fatality death rate has declined from 1.4 deaths per 100 million vehicle miles traveled to 1.1 deaths per 100 million vehicle miles traveled.

Considering the above, it is clear that the magnitude of the potential cost of accidents and the associated response of the government through regulation presents an important and interesting area of study regarding offsetting behavior that perhaps allows for a natural experiment. Researchers in the early to mid-1970s first suggested the possibility that forcing drivers to consume more safety via regulation might lead drivers to offset the beneficial effects by driving more intensely. The first empirical study of this phenomenon was authored in 1975 and found that after the introduction of the initial federal safety regulations in the late 1960s no beneficial effect existed. The result was attributed to an increase in the deaths of nonoccupants who were involved in collisions with automobile drivers who were driving more intensely. This study came under heavy criticism with respect to the model setup, the empirical results, and their corresponding interpretation. The primary criticism focused on the highly correlated nature of the explanatory variables and the consequent inability to separate the independent impact of a specific variable. Some authors offered ad hoc models that found no offsetting effect. In general, the group most critical of this seminal research represented the public health community, which was outraged that an economist would be so bold as to invade their territory

and offer an alternative view on the impact of safety regulations. A similar reaction occurred among criminologists when an economist offered the economic concept that crime was subject to incentives (both positive and negative) and that new insights could be gained from such a view.

The initial empirical work on risk compensation led to a number of other studies using more sophisticated models and higher quality data. Some studies found offsetting behavior, and others did not. Work in the early 1990s in New Zealand using observational data on seat belt use, in the United States using Center for Disease Control data on self-proclaimed seat belt usage, and in the case of rear seat passengers being injured as a result of greater driving intensity of belted drivers, found offsetting behavior. Others researchers using pooled state data found no offsetting behavior. Probably the most significant work using a long, pooled, aggregated data set (state-level data across time) and the best econometric techniques was published in 2003. This study found a positive effect for seat belt usage (fewer deaths associated with seat belt usage) and no offsetting behavior. But the favorable effect was estimated to be only about a 13% improvement in lives saved, which is much below estimates from laboratory tests and the number cited by the National Highway Traffic Safety Administration, the main governmental regulatory agency.

Recent papers have developed another approach to testing for offsetting behavior. This work stresses the development of experimental data and/or the use of data gathered from individuals through some combination of surveys and established individual data sets. The only truly experimental study was completed in 1988. The authors of this study set up an experiment to gather data from a go-kart track that they built and operated solely for the purpose of the experiment. College students were given extra credit in a course for participating. Drivers were asked to drive the course a number of times with and without a seat belt. Speed and other measures of driving intensity were recorded. It was found that offsetting behavior was statistically significant for a group that first drove the course without the seat belt and then drove the course with a seat belt when compared with the group that drove the course both times using a seat belt. However, the reverse showed no statistically significant difference for those who drove the course with the seat belt and, then, without the seat belt.

In 1992, an attempt was made to develop a more detailed understanding of risk compensation by using individual-specific observations obtained from a regional survey (most previous authors used aggregate level data). The authors of this study also accounted for individual preferences toward relative risks and controlled for other individual-specific variables (besides seat belt use) that might affect driving performance. These confounding factors included the number of years individuals had worn seat belts, age, miles driven to work, education level, gender, and annual income. Finally, they used a more sensitive indicator of risk-compensating behavior. As discussed above, the aggregate studies have analyzed the impact of safety belts or safety belt laws on the number of fatalities and/or the number of accidents. However, these are rare events and much risk compensation may occur without the occurrence of an accident or a fatality. The 1992 study analyzed the impact of an individual's seat belt usage on the number of moving violations or tickets. The premise was that if

seat belt using drivers were practicing risk compensation by taking additional risks, then such behavior would result in a larger number of moving violations, *ceteris paribus*.

Econometric models based on individual-specific survey data were estimated to investigate the relationship between seat belt usage and the number of citations for moving violations. The analysis incorporated the risk preferences of individuals as revealed by the degree of precaution exhibited against everyday risk. The results indicated that risk-compensating behavior was undertaken only by those individuals who were not strongly risk-averse. Conversely, seat belt use was associated with relatively fewer moving violations for the individuals who exhibited risk aversion. Thus, individuals who had a relatively low regard for various risks practiced greater risk compensation. On the other hand, risk-averse individuals did not compensate (for the additional safety provided by a seat belt) by driving more recklessly. Clearly, tastes for risk are an important dimension of risk-compensating behavior.

A study in 2006 used individual data gathered through the Washington Department of Transportation. On the basis of this disaggregate data, the authors found that offsetting behavior existed with regard to the selection of vehicles equipped with airbags and/or antilock brakes. Specifically, they found that safety-conscious drivers were more likely to purchase automobiles outfitted with airbags and antilock brakes, but the safety benefits of these measures were offset by driving more intensely. The finding of offsetting behavior by risk-averse individuals is contrary to the results of the earlier 1992 study described above that found that offsetting behavior was concentrated among the less risk-averse. This additional evidence may imply that offsetting behavior is more widespread than previously believed, as it seems to extend even to the relatively risk-averse. These studies, taken together, suggest that individual risk preferences are an important dimension which should be considered when testing for risk-compensating behavior.

Finally, the most recent study (2007) of risk-compensating behavior using disaggregate data (individual driver information) is based on data from the National Association for Stock Car Auto Racing (NASCAR). These individuals, given their profession, are most likely characterized as 'less risk averse.' The estimated relationships, which include a set of rigorous control variables, strongly suggest that drivers practice risk compensation by driving more recklessly after safety regulations are instituted. However, the study also found that the impact of the offsetting behavior is relatively small. For a 10% increase in NASCAR safety measures, there is about a 1.8–2.8% increase in reckless driving. For a total offset to occur, it would be necessary to have a 10% increase in reckless driving.

Concluding Remarks

A commonly-used approach for assessing the effectiveness of an exogenous change in safety is to examine the technological aspects of the change. For example, if occupant movement can be restrained with a safety belt during the occurrence of an automobile accident, a prediction can be made regarding the number of injuries and lives saved by the given safety belt usage. However, this technological approach ignores any behavioral change that may accompany the technological

change. To the extent that behavioral change occurs, the estimate of injuries and lives saved will be in error. In general, if individuals tend to compensate for exogenous safety changes and thereby behave in a riskier manner, the effectiveness of the exogenous changes is reduced. Thus, a technological approach is incomplete and a more general model of behavior must be used to accurately assess exogenous safety changes. This is the objective of the economic model of behavior discussed above.

In the empirical research discussed herein, we find evidence that supports the existence of risk-compensating behavior for automobile safety measures. Of course, the nature of the risk, the age and gender groups the risk affects, and the culture could affect the relative magnitude of estimated risk compensation. That is why many of the confounding factors that could potentially influence the results are included in the econometric analysis. Thus, in the case of automobile safety, variables such as road quality, weather, driver age, miles driven, speed, race/ethnicity, gender, alcohol, automobile quality, time, space, education, income, and others have been included along with the variables related to automobile safety measures. The econometric models, most often regression models, are designed to allow for all these confounding variables to be held constant while determining the impact of the focus variables. Therefore, when a researcher suggests that automobile safety legislation might result in an offsetting effect, the researcher is stating this with the proviso that all reasonable factors have been included in the model and not allowed to change. Obviously, if everything were changing at once there would be no way to determine a suggested sequence of causation.

Risk compensation (or offsetting) has several important implications for the design of social policies that promote safety in the home, in the workplace, and during recreation. First, programs should be designed to achieve the largest direct impact on safety because offsetting behavior (an indirect effect) could reduce their effectiveness. For example, seat belt laws that are enforced as primary laws will provide greater overall risk reductions than those enforced as secondary laws; while risk compensation will occur in both situations, primary laws will provide greater direct risk reductions, which translates into greater overall risk reductions. Second, policies should be designed to reduce the expected loss from the event rather than the probability of the event. Policies that affect the probability of the event (e.g., better tires, shorter stopping distances and turning radii, and wider traffic lanes) provide direct feedback to the individual and heighten the potential for risk compensation. However, policies that reduce the loss given occurrence of the event (e.g., high penetration resistant windshields, breakaway sign posts, and seat belts) provide less direct feedback and reduce risk compensation.

There exist many policies that can be adopted to enhance safety and minimize the offset associated with risk compensation. However, the anticipation of risk-compensating behavior should be an inherent part of policy design.

See also: Behavioral Genetics; Behavior Analysis; Behavioral Economics; Expectation; Judgment; Reasoning; Risk-Taking Behavior (Young Male Syndrome).

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Relevant Website

<http://cdc.gov/niosh/> – Center for Disease Control/National Institute for Occupational Safety and Health.

Risk-Taking Behavior (Young Male Syndrome)

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Glossary

Environment of evolutionary adaptedness (EEA) The environment in which a behavior was selected for via the processes of natural selection.

Evolutionary psychology A perspective that emphasizes the importance of understanding both ultimate and proximate explanations of psychological mechanisms and behavior.

Intersexual competition Competition between members of the opposite sex.

Intrasexual competition Competition between members of the same sex.

Paternal uncertainty Whereas women who give birth can be completely certain that the infant shares their genes, men do not share this certainty. This biological fact is believed to produce differential investment in the child from

mothers and maternal relatives than from fathers and paternal relatives.

Proximate-level explanation An explanation of a mechanism or behavior that focuses on factors in an organism's immediate environment.

Risk-taking A specific type of decision-making and behavior in which the outcome of the decision is associated with a relatively great amount of variance in expected outcomes. By engaging in risky behaviors, individuals face consequences in which they have more to gain and more to lose compared to low-risk behaviors.

Ultimate-level explanation An explanation of a mechanism or behavior that focuses on the trait's adaptive evolutionary origins.

Young Male Syndrome

The increased tendency for young men to be more risk-oriented and aggressive than other demographic groups was first referred to as 'young male syndrome' by Martin Daly and Margo Wilson in a 1985 paper in which they elaborated upon a proposed ultimate explanation for this pattern and provided supporting data from a study of those who were convicted of homicide and their victims. This article explains the empirical finding that young men are more prone to take risks than members of other groups by addressing three fundamental questions: (1) What functions do risky and aggressive behaviors serve? (2) Why are men generally more likely to take risks and behave more aggressively than women? (3) Why do young men, in particular, tend to take more risks and act more aggressively than men of other ages or women?

Much like Wilson and Daly's original explanation of this phenomenon, the approach taken in this article relies heavily upon the perspective provided by evolutionary psychology. This perspective suggests that many of the behaviors and cognitive processes observed in animals evolved to perform specific adaptive functions. Contrary to perspectives that suggest that risky and aggressive behaviors are typically the symptom of some pathology, a functional perspective suggests that these patterns of behavior are, to some extent, typical of psychologically healthy individuals. In spite of this proposed normalcy of aggression, it cannot be denied that aggressive acts in the modern world frequently occur in such a way that they are maladaptive at the level of the individual. For example, a man who is convicted of homicide will lose his freedom, resources, and possibly, his life. For these reasons, it is easy to understand why someone might consider such behaviors to be maladaptive. The evolutionary perspective, however, requires taking into account the environment in which a behavior was selected for via the processes of natural selection. This environment is

typically referred to as the environment of evolutionary adaptedness (EEA). Anthropological evidence suggests that homo sapiens first emerged during the Pleistocene era, which began ~1.8 million years ago and ended about 12 000 years ago. Because evolutionary change occurs relatively slowly, it can be concluded that most human adaptations are tailored to a world which was fairly different from the world that we currently inhabit. Modern technological innovations in weaponry have enhanced the destructive potential of human aggressive behavior. Although ancient man possessed primitive weaponry that was capable of killing, such as stone spears and axes, these weapons still required a considerable amount of physical strength to produce lethal force. Mass-produced firearms, which have existed for fewer than 200 years, grant lethal force to any individual who is physically capable of pulling a trigger. In spite of the fact that most acts of human aggression remain nonlethal, the introduction of modern weaponry has produced an environment in which normal and functional aggressive responses that might have been nonlethal in the ancient world are somewhat more likely to produce more extreme and potentially lethal consequences. The extreme nature of homicidal incidents demands one's attention and may lead to a common-sense conclusion that human aggression is dysfunctional. However, an understanding of the self-presentational functions of risk-taking during the EEA reveals this conclusion to be somewhat misleading.

Sex Differences in Risk-Taking

As is the case in most animal species, constraints on human reproductive success differ between males and females. The number of offspring that a woman can produce is limited by physiological factors that determine her ability to carry and bear offspring. Given a 9-month gestation period and a period

of lactation following each birth that is typically associated with infertility, one can determine that the maximum number of children that the average woman can bear in her lifetime is ~15. Although physiological factors such as sperm count are important to male reproductive success, access to fecund mates is thought to explain more of the variance in male reproductive success than the reproductive success of females. Whereas a woman is physiologically limited to giving birth to ~15 children through the course of her entire life, a man could conceivably father 20 children in a matter of days assuming that he could gain sexual access to 20 fertile partners.

These biological facts lend themselves to an economic perspective of mating such that fertile women might be considered to be a 'resource' over which men compete for access. Although it is true that women also compete with one another for desirable mates, men tend to compete with greater intensity. Evolutionarily minded theorists typically attribute this increased intensity of male competition to the fact that there is greater reproductive variance among men than among women. In other words, women can give birth to between 0 and 15 children in a lifetime, whereas men can father between zero and several thousand children. This difference, compounded across the evolutionary history of our species, is thought to have resulted in a reproductive advantage for men who were willing and able to take risks and compete fiercely with competitors. Those men who were most fierce and dominant would have gained access to more mates than men who were submissive or noncompetitive. By comparison, traits associated with violent competitiveness had considerably less adaptive value for women.

Two basic biological realities can lead us to the conclusion that the reproductive resources desired by men are scarcer, and therefore likely to be perceived as more valuable, than those required by women. The first reality is the fact that women reach an age at which they become infertile far earlier than men typically do. Menopause typically occurs between the ages of 40 and 60. Although evidence suggests that sperm production can decrease with age, healthy men can continue to produce sperm into their 80s or longer. The second biological reality is that whereas men are biologically capable of becoming fathers at almost any given time throughout their postpubescent lives, women's fertility fluctuates during the menstrual cycle such that she cannot become pregnant unless inseminated at a time that is proximate to ovulation. Women are also incapable of conception from the beginning of a pregnancy until a period of time has passed after birth or the termination of pregnancy. Therefore, we can conclude that at any given time the number of potential fathers will always exceed the number of potential mothers in a human population with a gender ratio that is ~50% female. Although, this tendency may be compensated for the fact that men, cross-culturally, have higher mortality rates than women do. The basic economic principles stemming from differing ratios of supply and demand dictate that because the supply of potential mothers is far less than the supply of suitable fathers at any given time, men will value fertile women far more than women will value potential fathers.

Compounding the aforementioned issue of differential scarcity of reproductive resources is the fact that additional resources sought by women in potential mates can be

replaced by alternatives. Besides desiring a mate who has good genes, women tend to prefer men who are willing to make a commitment to them and who have resources that they are willing to devote to the care of a child. Although these characteristics are desirable, they are not essential to successful motherhood. Even in prehistoric times, women who faced a situation in which they were carrying the child of a man who was no longer present during the periods of pregnancy and child-rearing could presumably obtain support from family members. Inclusive fitness theory and the principle of paternal uncertainty (or maternal certainty) support the notion that maternal kin members should typically be willing to provide for a woman's child regardless of the status of the father. Furthermore, women who had maintained active sexual relationships with more than one man could potentially lead a man to believe that he is the biological father of her child regardless of the validity of this claim, therefore rendering the biological father unnecessary as a vehicle for parental support. The existence of potential alternatives to commitment and resources from biological fathers may explain the existence of cross-cultural variation in the extent to which women value these attributes in mates.

In summary, the reproductive resources sought by men tend to be scarce compared to those sought by women. Although it is doubtful that people consciously incorporate these facts into their mental calculus when it comes to mating-related behavior and decision-making, evidence suggests that these factors have shaped human nature and are ultimately responsible for the evolution of sex differences in aggression.

Intrasexual competition (competition between members of the same sex) over mates does not always take the prototypical form of two men fighting each other for direct access to a desirable female. Surveys of women's mate preferences typically reveal that women prefer men who possess resources and are therefore capable of providing for children. This is thought to be an important factor influencing male competitiveness for resources.

Although the modern world presents an environment in which wealth is durable and can be accumulated to the extent that a person can potentially support oneself using inherited stored wealth alone for an entire lifetime, this was not the case throughout much of human history. The earliest form of durable wealth is thought to have been agricultural resources such as harvested grain that could be securely stored for an extended period of time. Even this development can be considered to be relatively recent in terms of evolutionary time. Anthropological evidence suggests that for most of human history, people adhered to a hunter-gatherer lifestyle. This way of living is not amenable to the accumulation of wealth since it requires a degree of mobility. Therefore, it is likely that women evolved a preference not for modern accumulated wealth but for male displays of ability to obtain resources. Ancestral men who were more successful hunters would have been perceived as good providers. Although they could have also displayed skill in gathering, evidence regarding division of labor in modern hunter-gatherer societies in combination with anthropological studies suggests that male resource acquisition more typically took the form of hunting animals, whereas female resource acquisition centered around gathering roots, berries, and other resources.

Regardless of the nature of the resources, ancestral men likely competed with one another to display their ability to obtain these resources to potential mates. Those who possessed a stronger motivation, greater intellect, and greater physical prowess would have been more successful providers. Hunting success, however, tends to be highly variable such that individual hunting success is not a reliable source of food. A successful hunt will often yield a large quantity of meat that will only be preserved for a brief period of time without advanced preservation techniques. People living in hunter-gatherer tribes are, therefore, reliant on one another for shared meat. Contrary to the myth of the noble savage who shares equally among all members of the tribe, individuals with higher social status tend to get preferential treatment when resources are divided. Because higher status is associated with greater access to shared resources, men can be expected to compete for status as well as for resources.

Male intrasexual competition also serves a self-presentational function. In addition to placing a premium on mates who have access to resources, women have been shown to desire mates who possess physical strength and a degree of social dominance. A physical altercation with another male serves as an opportunity to display both of the aforementioned characteristics. This is a risky strategy because the possible outcomes include the potential for both significant benefits and substantial biological costs. A successful bout would result in a situation in which one's competitors have been bested and the perception of the victor as socially dominant and physically superior to his rival. Of course, violent altercations can also result in physical injury, death, or the appearance of physical inferiority upon suffering a defeat. Even if one emerges victorious following an altercation, the loser or his friends and family might seek vengeance for the initial offense at a later time. In modern times, physical fights carry the added risk of legal consequences, as individuals engaging in violent and aggressive behavior could be charged with assault, homicide, or other related offenses that could result in penalties ranging from minor fines to incarceration or even capital punishment.

Age Differences in Risk-Taking

Now that we have developed a satisfactory answer to the origins of sex differences in aggressive behavior, we must understand why young men in particular tend to favor risky strategies. Whereas the commonly accepted explanation of sex differences in risk proneness is relatively straightforward, explanations for age differences tend to be more diverse, incorporating ultimate explanations for the evolution of these differences with proximate causes of risky behavior that happen to be more common among young men than among young women or older individuals.

Upon reaching adolescence, young men become physically capable of reproduction. Although this involves tremendous changes in hormone levels in both young men and young women, men experience a drastic increase in testosterone levels that greatly exceeds testosterone levels in women. Testosterone levels have been shown to correlate with risky and aggressive behavior across a number of mammalian species such that higher levels of testosterone are associated with more risky

and aggressive behaviors. After men have children, they typically experience a decrease in testosterone levels and engage in fewer risky behaviors.

In addition to the aforementioned biological realities, young men typically possess few resources, and are still in the early stages of developing a social identity and reputation, and are frequently without a mate. This set of circumstances is neither novel nor unique to a particular culture. On the contrary, it is believed that young men have found themselves facing similar social challenges under similar circumstances throughout most of the history of the species. These situational forces have interacted with the aforementioned forces of sexual selection across evolutionary time to shape human nature. In other words, young men have evolved a set of psychological adaptations that help them to solve the adaptive problems of how to successfully compete with other young men in the domains of resource acquisition, impression management, and ultimately, mate acquisition. Because these selection pressures remain relevant in the modern world, one can also expect that they will have a proximate influence on behavior.

Evolutionary models of risk, based on optimization, as well as proximate utilitarian analyses of risk-taking suggest that individuals who have less to lose and more to gain should be more willing to take risks. Young people have typically not had time to amass much wealth or settle into a career and typically have less to lose compared to older individuals who have had more time and opportunities to develop these resources. Younger people should, therefore, be more willing to take risks. Although a youthful dearth of resources may contribute to risky decision-making on the level of the individual, this explanation fails to help us to understand why young men tend to take more risks than young women. After all, members of both sexes are likely to be relatively poor in youth. The aforementioned explanation of the origins of sex differences in risk-taking provides one piece of the puzzle. Evolutionary theorists have also suggested that women have evolved to be more risk-averse, particularly when pregnant. Physically risky female behavior during this period would be likely to damage a developing fetus and would therefore be selected against.

Recent empirical work has also revealed a positive relationship between mating motivation and risk-taking in young men when they believe that an available opposite-sex target is viewing their behavior. This suggests that risk-taking behavior, aside from serving as a directly competitive strategy, may serve a social function. By taking a risk in this context, men signal to potential mates that they possess qualities that are typically desired by women such as ambition, confidence in one's abilities, and social dominance. Indeed, single men, including those who have been widowed and divorced, tend to take more risks than men who are involved in a romantic relationship, which is consistent with the idea that single men have more to gain and less to lose via their risky actions. Although it has not yet been demonstrated by research, it is possible that this social function could generalize to members of the same sex, effectively communicating that one is a fierce competitor. In short, risk-taking may serve to help one develop a reputation. By engaging in behavioral displays of dominance, ambition, and skill, a young man can simultaneously garner admiration from potential mates and respect or fear from his competitors. Even if a young man has acquired a mate, a

reputation as a dominant individual with physical strength can serve functions helpful in relationship maintenance. Such a reputation might help a man to convince his current partner that alternatives to their relationship are not worth pursuing while simultaneously deterring potential mate poachers who might seek a romantic or sexual involvement with that partner.

Conclusion

Fundamental differences in reproductive biology have led men and women to evolve fairly different mating strategies. The relative scarcity of the reproductive resources sought by men compared to those sought by women has led to greater degree of intersexual competition (competition between members of the opposite sex) between men than between women. Men are believed to have evolved patterns of behavior that reflect the enhanced functional utility of aggressive and dominant behavior in solving male adaptive problems. Although these behaviors can be influenced by environmental factors as an individual develops, they are believed to have deep genetic roots and can therefore be expected to persist to some extent across human cultures.

See also: Aggression; Bullying; The Clinical and Cognitive Psychology of Conflict; Decision Making (Individuals); Evolutionary Psychology; Evolutionary Social Psychology; Homicide; Human Mating; Sex Differences.

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Savant Syndrome

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Glossary

Calendrical calculation Naming the day of the week on which a particular date will fall or fell without reference to a calendar.

Functional magnetic resonance imaging (fMRI) A type of MRI (noninvasive) scan that measures the flow of oxygenated blood throughout the brain in order to study brain function.

Mnemonist An expert memorizer capable of storing and recalling vast quantities of data.

Synaesthesia A condition in which experiencing one sensation (e.g., hearing) results in the involuntary experience of another stimulus modality (e.g., vision); such as 'hearing a color.'

Theory of mind The ability to recognize and represent other's mental states (e.g. beliefs) in order to predict and explain their behavior.

Transcranial magnetic stimulation (TMS) A noninvasive tool (using a strong magnet placed outside the head) used to study brain function by temporarily disabling brain activity in a specific region.

Introduction

A mute teenager who can complete a written sequence of prime numbers, a 4-year-old who spontaneously names the pitch of a door bell, a preschooler who draws realistic sketches of animals, using perspective and shading, an intellectually disabled adult who has memorized all the names in the local telephone directory, a blind pianist who can reproduce complex melodies after a single hearing, and improvise in the style of famous composers – these types of astonishing feats, often seen in the context of disability, capture public imagination and have made 'savants' popular elements of news and fiction.

What Is Savant Syndrome?

The term 'savant' comes from the early label 'idiot-savant,' a name first used by John Langdon Down in 1887 to refer to apparently paradoxical levels of expertise in a specific area ('savant,' from the French 'savoir,' to know) alongside intellectual disability ('idiot' was a technical term for those of IQ less than 20–25 in common use in the nineteenth century). Because of the pejorative connotations of this term, and identification of very similar astounding skills in individuals of near-average or superior intelligence, the terms 'savant skills' or 'savant syndrome' are now preferred. Nonetheless, most definitions of savant skills reflect the notion of a contrast between skills in the area of expertise and the level of general ability in other respects.

Treffert devised a three-tier system for describing savant skill levels. 'Splinter skills' are those that are considered remarkable given an individual's overall functioning level. Splinter skills could therefore be the result of an uneven cognitive profile, as typically seen in developmental disorders such as autism. Specific skills (e.g., puzzle completion) might be consistent with chronological age expectations but considerably exceed those based on mental age. The other two levels in the system are 'talented,' which indicates that a savant's skill is exceptional in comparison to other individuals with intellectual

impairments, and 'prodigious,' which describes a savant whose skill is remarkable in contrast to the general population. So-called prodigious savants are very uncommon, with Treffert suggesting that ~100 such cases might exist worldwide. In the largest study to date, Young applied Treffert's criteria to 51 potential savants she identified worldwide in the 1990s. Based on this study, she suggested that savant status should be reserved for those best described as talented or prodigious based on Treffert's system, validating the use of this and other systems that evaluate savant performance using comparison groups.

A striking aspect of the savant phenomenon is that skills are typically manifest in a relatively narrow range of areas: maths (calendar calculation, lightning mental calculation, prime number generation), memory (often for facts in a very specific area, sometimes for dates, events, routes), art (accurate 3D and perspective drawing without tuition), and music (perfect pitch, reproduction by ear, improvisation and even composition). Visuospatial skills (e.g., completing jigsaws picture-face down) and mechanical skills are also reported. Hyperlexia (perfect decoding in reading, well beyond comprehension, and sometimes acquiring reading before speaking) can occur, but its status as a true savant skill is debated because the absolute level of skill is notable for precocity but does not outstrip that eventually attained by the general population. In Treffert's classification, then, hyperlexia could be considered 'only' a splinter skill.

History of Savant Syndrome

Case reports of savant skills date back to more than 200 years. In what may be the first documentation of savant skills, a farmhand calculator and mnemonist, Jedediah Buxton (b. 1702), was described in the Gentleman's Magazine. A letter from George Saxe was published in February 1751 in which Saxe refers to "this surprising genius Jedidiah Buxton who could not even read or write and was indeed a farm laborer, yet he was able in his mind to multiply or divide large figures

sooner than the more precise of your arithmeticians pretend to." Perhaps the first case series of savants was presented by J. Langdon Down during his famous 1887 lecture to the Medical Society of London. He described individuals with remarkable skills and talents juxtaposed against a background of considerable disabilities. Down's work, along with that of Tredgold (in his 1914 book, *Mental Deficiency*), provided striking depictions of the range and variety of skills displayed by savants. Indeed, Tredgold's description of skill areas was remarkably prescient: the areas he highlighted (calendar calculation, lightning mental calculation, musical abilities, mechanical skills, and visual artistic abilities) remain the most frequently described in the modern scientific literature. As a method for quantifying talent level, he compared a savant's skill level to expectations based on the general population, which Treffert later expanded upon in his three-tiered talent description.

During these early times, there were several notable individuals designated as 'idiot-savants.' Thomas 'Blind Tom' Wiggins (1849–1908) was an African American pianist, apparently with autism, who began composing (on his slave-master's piano) at the age of 5, played for the president at the White House, and was chronicled by Mark Twain. Gottfried Mind (1768–1814) was known as 'The Cat's Raphael' because of his realistic depictions of cats. Over the ensuing decades, similar case studies appeared in the literature, largely echoing these earlier descriptions and findings. Modern examples include Nadia, who at the age of 4 drew beautiful sketches likened to Raphael's; the 'twins' described by Oliver Sacks, who, despite little functional spoken language, instantly saw the number of matches dropped from a box, and traded prime numbers. Other stunning modern savants include Stephen Wiltshire, an artist with autism whose amazingly accurate and detailed drawings of landscapes are astounding in quality and production: after only a brief helicopter ride above Tokyo, for example, he was able to complete a 360° cityscape with no memory aides. Derek Paravicini's skills as a pianist, his ear and memory for music and his precocious development in this area despite blindness and learning disability, are described by his musical mentor, Adam Ockelford, in his book *In the Key of Genius*. Daniel Tammet has written about his own synaesthesia, phenomenal memory (he holds the European record for reciting Pi from memory to 22 514 digits) and calculating skills, in his book *Born on a Blue Day*. Perhaps the most famous modern savant is Kim Peek (1951–2009), who was the model for the autistic savant, Raymond Babbitt, played by Dustin Hoffman in the 1988 film *Rainman*. Despite below average measured IQ, Kim Peek (who had agenesis of the corpus callosum) is described by his father (and life-long companion) as follows: "Known as 'Kimputer' to many, his knowledge-library includes World and American History, People and Leaders, Geography (roads and highways in the United States and Canada), Professional Sports (baseball, basketball, football, Kentucky Derby winners, etc.), the Space Program, Movies and movie themes, Actors and Actresses, the Bible, Mormon Church Doctrine and History, Calendar Calculations (including a person's day of birth, present year's birthday, and the year and the date the person will turn 65 years old so he or she can retire), Literature/Authors, Shakespeare, Telephone Area Codes, major ZIP Codes, all TV stations and their markets.

He can identify most classical music compositions and tell the date the music was written and the composer's birth date and place of birth and death. Kim has read (and can recall) some 7600 books."

Darold Treffert's seminal book, *Extraordinary People*, brought the savant phenomenon to a much wider audience, with numerous case descriptions and his own speculations regarding the mechanisms leading to savant skill expression. Treffert continues to be perhaps the world's leading expert on the savant phenomenon, and his website at the University of Wisconsin provides information about and links to dozens of savant individuals throughout the world.

How Common Are Savant Skills?

There are no systematic epidemiological studies of savant skills. Current estimates of prevalence are based on parent or carer surveys, often with selected samples. In the late 1970s, Bernard Rimland's postal survey of 5400 parents of children with autism yielded 531 cases of reported savant skills (9.8%), most commonly music (53%), memory (40%), maths/calculation (25%), and art (10%) – with 53% reporting more than one special ability. A more recent study by Bolte and Poustka, using standardized diagnostic interviews with parents, found 33 of 254 individuals with autism (13%) were said to have a special skill. The most thorough in-person study of savant skills to date, by Patricia Howlin and colleagues, found 39 of 93 (28%) adults with autism had a skill that was outstanding in relation to their own cognitive profile and/or in relation to the general population. Many more males than females in this sample showed a special skill (32 M:7 F): almost a third of males showed a special skill compared to 19% of females.

Savant skills are far more common amongst individuals on the autism spectrum than amongst other groups. Leo Kanner, who first described and named autism, noted the 'islets of ability' exhibited by many of these individuals, and found outstanding skills at follow-up in 6 of his 11 original cases, mainly in music and rote memory. Although data are scarce, estimates suggest that savant skills may be more than ten times more common in individuals with autism than in groups without, either with or without intellectual disability. For example, Hill's survey in the late 1970s of more than 100 institutions for individuals with intellectual disability suggested a prevalence of savant skills of ~0.06%. A population-based twin study in the United Kingdom asked parents of over 6000 8-year-olds if their children were unusually good at maths, music, art, or memory – better than children much older. In this study, parents identified 3–6% of children as unusually talented in each of these areas, with memory being the most, and art the least, commonly endorsed.

Splinter skills have also been reported in genetic conditions including Smith–Magenis syndrome (maths, memory), Prader–Willi syndrome (memory, visuospatial), and Williams syndrome (memory, music). Musical skills, and absolute pitch, may be more common in congenitally blind individuals. Savant skills have been speculatively linked to synaesthesia: Daniel Tammet reports that each positive integer up to 10 000 has its own unique shape, color, texture and feel for him, and that his synaesthesia allows him to 'see' the results of complex

calculations, and to sense whether a number is a prime, without conscious effort.

What Is the Source of Savant Talent?

The study of savant skills was transformed, from fascinating case studies to rigorous group studies, by London-based psychologists Neil O'Connor and Beate Hermelin in the 1980s. Some of their groundbreaking empirical work is discussed in Hermelin's book, *Bright Splinters of the Mind*. O'Connor and Hermelin showed that well-designed experiments were possible with individuals previously considered 'untestable,' and their studies of, for example, error patterns and reaction times in calendrical calculators showed that these skills were no mere trick of memory, and reflected (implicit) mastery of complex rules and regularities. These studies did not support early speculations that savant skills were rooted in, for example, eidetic imagery.

Because of the strong association between savant skills and autism, many theories of the former take as their starting point cognitive theories of autism. Indeed, 'islets of ability' and an uneven profile across the subtests of standard IQ assessments are very typical in autism. So what aspect of autism might explain this predisposition to narrow areas of talent?

Autism spectrum disorders (ASDs) are diagnosed on the basis of deficits in social interaction, communication and the presence of rigid and repetitive activities and interests. These different facets of ASD have aroused a number of explanatory theories. The social and communication difficulties, for example, have been hypothesized to result from problems representing the mental states (e.g., beliefs) of others and possibly of self – resulting in a sort of 'mindblindness.' Might mindblindness foster talent? Might time, or even brain capacity, normally spent on social interaction be rededicated in savants to the service of special skill? This notion has popular appeal, and indeed genius is often cited as an excuse for social gaucheness. Conversely, typically developing children and adults might be considered 'social savants,' remembering as they do, for example, thousands of faces without difficulty. There is, however, little evidence to support a causal link between mindblindness and savant skills – development of savant skills typically aids rather than compromises further social development, and neuroimaging studies to date have not found evidence for rededication of normally social brain systems for savant skill execution. While a certain social distance, and the pursuit of skill for own pleasure versus popular approval, may contribute to originality of vision, mindblindness appears unlikely to be the facet of ASD predisposing to savant skills.

Nonsocial difficulties in ASD appear to fit a pattern of 'executive dysfunction,' resembling in some ways the disorganization and lack of flexibility sometimes seen following acquired injury to the frontal lobes. Might this be the starting motor for talent? This appears, on the face of it, unlikely since difficulties in executive function are relatively nonspecific to ASD, and notable in a range of other conditions (e.g., ADHD) not associated with savant skills.

A third set of theories relate autism to superior featural processing, or 'eye for detail.' A tendency to notice and remember small details, often at the expense of the 'bigger picture,'

was first proposed by Uta Frith in her influential book *Autism: Explaining the Enigma*, in which she proposes that this 'weak central coherence' results in assets as well as deficits in autism. Superior featural processing is perhaps the best current cognitive explanation for the strong association between autism and savant skills. Laurent Mottron, has suggested that 'enhanced perceptual functioning' underlies savant skills, as reflected in perfect pitch, faultless drawing in perspective, and so on. Simon Baron-Cohen's 'hyper-systemizing' account takes as its starting point superior processing of detail. Francesca Happé has linked talent to detail-focus within and beyond autism; parent-reported talents were found to be more common in ordinary 8-year-olds with high levels of autistic-like eye for detail.

How Is the Savant Brain Different?

The scale and peculiarity of savant feats readily suggest a foundation in atypical brain function or structure. Somewhat surprisingly, studies utilizing neuroimaging as a window into the neural basis of savant skills are limited thus far. A case study by Boddaert and colleagues reported functional brain activity (using positron emission tomography (PET)) associated with calendar calculation in a relatively high functioning adult male with autism. During calendar calculation, as compared to rest, this savant activated the left hippocampus, left frontal cortex, and left middle temporal lobe, regions previously associated with memory – a key component to savant skill development. However, this study lacked a comparison group or even participant, partly due to the rarity of calendar calculation. This prevented conclusions regarding atypicality, in terms of both localization and degree, of the activation pattern during calendar calculation. A more recent study by Cowan and Frith used functional magnetic resonance imaging (fMRI) to investigate activation patterns during calendar calculation and mental calculation tasks for two higher functioning adult male calendar calculating savants with ASD. During the mental calculation task, these savants did not demonstrate atypical activation patterns. The calendar savants utilized the same regions as used by neurotypical adults when completing this task. Moreover, the savants activated overlapping parietal regions during both calendar calculation and mental calculation tasks, suggesting similar neural underpinnings for these tasks. These findings indicate that calendar savants do not rely on different networks to perform calculations; however, the use of functional neuroimaging to study the neural basis of savant skills has only just begun. The two studies completed thus far have studied calendar calculation only, making it hard to obtain a comparably skilled control group. Similarly proficient controls, or even participants who can perform better than chance when asked to give the day on which a certain date falls, are extremely rare, preventing direct comparisons of savants and controls on a calendar task. Future work is needed to extend this line of inquiry to include other skill domains.

To date, one study has utilized magnetoencephalography (MEG) to study neural correlates of savant skills in individuals with high functioning ASD. Within a group of seven savants with memory skills (mostly for time tables and maps), basic memory was assessed in the MEG environment using an

old-new paradigm for both novel shapes and pseudowords. Though the mnemonist savants did not outperform controls on these tasks, and in fact were outperformed by controls on the pseudoword task, there was some indication that savants used occipital regions (i.e., the visual system) instead of parietal regions, as controls did, during early components of the pseudoword task. These findings are reminiscent of earlier fMRI studies showing what amounts to inefficient reliance on visual regions during verbal tasks by (nonsavant) individuals with autism. Unfortunately, because this MEG study did not compare savants and nonsavants with autism, it is unclear whether the findings reflect autism, savant skills, or both. Moreover, localization of MEG signal was hampered by the lack of structural MRI scans for the savants.

Structural neuroimaging, including quantification of brain volumes, cortical thickness, and/or white matter tractography, has been used to assess the impact of expertise on the brain, such as short-term training to learn to juggle. The most robust effects have been demonstrated among London cab drivers, who undergo extensive training to learn the intricate and irregular layout of London's streets (the 'Knowledge'). Widely reported research by Eleanor McGuire and colleagues found that cab drivers who successfully completed this 3-year training had larger posterior hippocampi than did controls, and a driver's years of experience were positively correlated with posterior hippocampus size. Finally, retired taxi drivers exhibited hippocampus size more similar to controls, suggesting that brain changes underlying this expertise were maintained by ongoing practice.

Only one published study thus far has sought to apply these techniques to study the structural brain correlates of savant skills. Wallace and colleagues compared cortical thickness between a multiply talented (in art, calendar calculation, and memory) adult male savant with Asperger's syndrome and age- and verbal ability-matched neurotypical males. The savant volunteer demonstrated generally thinner cortex in frontal, temporal, and parietal regions, consistent with other studies of adults with ASD, and with the social and nonsocial deficits characteristic of these disorders. However, a small region of bilateral superior parietal cortex was thicker for the savant as compared to control males, intriguing given that this region has been implicated in visual-spatial functions, including drawing and calculation, two of his areas of expertise.

Though savant skills occur predominantly in the context of ASD, savant-like skills are also found in non-ASD populations, which may inform their neural foundations. For example, Brink described a case of left-sided brain injury from a gunshot wound after which mechanical skills emerged, despite persistent difficulties in relearning language and academic skills in reading, writing, and arithmetic. Kim Peek had agenesis of the corpus callosum as well as other brain abnormalities. While the disconnection of his left and right hemispheres may have played some part in his uncanny ability to read simultaneously two pages from an open book, what contribution, if any, it made to his mnemonic abilities is unclear. There are also suggestions that frontotemporal dementia (FTD) is associated with later onset of savant-like skills. Miller described five individuals who developed artistic skills, some of which were previously undocumented, concurrent with the onset and progression of FTD. Similar to savant artists with ASD, the images

produced tended to be detailed and realistic copies rather than abstract renderings. Consistent with savants more generally, these patients exhibited an intense focus and preoccupation with their skill domain; art, in this case. 'Paradoxical functional facilitation,' Kapur's term for enhanced behavioral functioning resulting from a neural insult, has been invoked to explain these findings. Miller speculates that increased interest and skill in art was the result of diminished inhibition of visual systems due to degeneration of anterior temporal and orbitofrontal cortices.

In a provocative account of the neural origins of savant skills, Snyder has suggested that each of us is capable of savant skills, but our complex conceptual cognition overwhelms and suppresses these skills. Savants with ASD, on the other hand, are suggested to have 'privileged access' to raw, unprocessed information that is not usually available to neurotypical individuals. Snyder and colleagues tested this model by applying transcranial magnetic stimulation (TMS) to the left frontotemporal cortex (based in part on the studies of FTD discussed above) on two drawing tests. Though the use of TMS did not result in systematic improvement of drawing ability, stylistic changes were noted for 4 of the 11 participants. Using a similar approach, Morrell and colleagues did not find skill enhancement on a wide variety of savant-related tasks after TMS. Based on these results, they suggest that instead of savant abilities lying dormant in us all, they are likely to be possible for a small segment of the neurotypical population, just as they are for individuals with developmental disabilities. Though TMS is a useful tool in the search for the neural underpinnings of savant skills, it has limitations. Interfering with key brain regions using TMS in adults to study savant skill ontogeny is not equivalent to the early development (often emerging during early to middle childhood) of these skills. Therefore, TMS studies of this sort may more closely approximate the cases of later savant skill onset, not the more predominant early onset cases, which invoke notions of experience-dependent plasticity of cortex given the continual learning and honing of skills during development.

Where Do Savant Skills Come From?

When considering talent development, genetic (e.g., heritability of skills) and environmental (e.g., practice) influences are often at the forefront of discussion. These issues have also been debated vigorously as they apply to savant skills; however, they have rarely undergone rigorous empirical scrutiny. One recent population-based twin study of over 6000 8-year-olds demonstrated that (parental) skill ratings in savant domains are highly heritable and are associated with nonsocial autistic traits, such as being detail focused, having special interests, or exhibiting an 'insistence on sameness.' Complementing these quantitative genetic findings is at least one molecular genetic study in which regions of chromosome 15 were associated with ratings on autism diagnostic inventory (a gold-standard parent interview measure of autism symptoms often used for diagnosis) items that assess savant skills, although an attempted replication of these findings failed. Surprisingly good skills in isolated domains have also been reported in genetic disorders, which may also inform genetic etiology. For example, there are reports

that people with Williams syndrome (deletion of a portion of chromosome 7) exhibit strong interest and abilities in music, while individuals Prader–Willi syndrome (disorder of chromosome 15) perform well on jigsaw puzzles and similar tasks.

There are an increasing number of studies addressing the heritability of savant-related skills; for example, family and twin studies converge in demonstrating the heritability of absolute pitch, a skill nearly universal among savant musicians. Moreover, the largest savant study to date found that relatives of savants were more likely than relatives of nonsavant individuals to exhibit talents and extreme narrow interests.

Recent advances in understanding the interplay between genes and environment render a simple nature–nurture dichotomy obsolete. Environmental factors, particularly education, training, and practice, are of enormous importance. However, whether practice alone can account for savant feats remains highly debated: many such skills seem to appear more or less out of the blue, with at least little overt rehearsal or preparation. While the now famous ‘10 000 h of practice’ may be sufficient for talent, it remains a key question why only some few individuals are motivated to develop such savant skills as calendrical calculation. Notably, in the study of London cab drivers, only around a third of those beginning their training in the knowledge completed the course – suggesting that practice interacts with preexisting individual differences in ability, personality or motivation.

In spite of our impressive and rapid technological advances in neuroscience and genetics, we have only begun to scratch the surface in better understanding the biological basis of savant skills.

Conclusions

Savants are common figures in popular fiction, fascinating for their extraordinary feats and helpful plot-devices in Hollywood. There can be a downside to such ‘positive’ publicity, with parents of children with autism being asked eagerly what

their child’s talent is, and the implicit suggestion that the value of the individual comes from his or her skill rather than being inherent to their status as a person. However, further research into the basis for savant skills may teach us much about how to appreciate a different mind in autism and other neurodevelopmental conditions. Recognizing potential, encouraging interests and passions, and raising awareness of the mysteries of the human mind may all be fostered by future studies of savant skills.

See also: [Human Intelligence](#); [Memory](#).

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Schizoid and Schizotypal Personality Disorder

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Glossary

Atypical or second-generation antipsychotics A more recently developed class of antipsychotic drugs that act as antagonists at both serotonin 5-HT_{2A} and dopamine D₂ receptors and carry a lower risk of motor side effects than the conventional antipsychotics.

Conventional, or typical, antipsychotics A class of antipsychotic medications first developed in the 1950s with high affinity for D₂ receptor that carry a high risk for sedation, motor and anticholinergic side effects, such as blurry vision and dry mouth.

Dopamine hypothesis of psychosis A model that attributes the psychotic symptoms of schizophrenia to a disturbed and hyperactive dopaminergic signal transduction in the mesolimbic pathway.

Endophenotypes Heritable intermediate phenotypes (neurophysiological, biochemical, endocrinological,

neuroanatomical, cognitive, or neuropsychological) associated with an illness but with a simpler genetic architecture than the illness phenotype.

Executive functions A defined collection cognitive functions involving higher order brain processes such as abstract thinking, planning, problem solving, and initiation/inhibition of appropriate/inappropriate actions.

Negative symptoms A group of symptoms observed in patients with schizophrenia that include social withdrawal, apathy (decreased motivation), poverty of speech, inability to experience pleasure (anhedonia), limited emotional expression, and attentional deficits.

Positive symptoms A group of symptoms present in patients with schizophrenia such as delusions, hallucinations, and disorganized thought and behavior.

Introduction

Personality disorders are pervasive chronic psychological disorders involving several areas of the personality. Patients suffering from these disorders experience severe disturbances to their characterological constitution and exhibit behavioral tendencies leading to considerable personal and social disruption in their lives. When the Axis II personality disorders were included in the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III), they were grouped into three clusters. The first cluster (cluster A) includes the paranoid, schizoid, and schizotypal personality disorders. Features such as eccentricity and odd appearance are common among individuals suffering from this cluster. Before the inclusion of schizoid and schizotypal personality disorders in DSM-III, schizoid abnormalities were understood as attenuated manifestations of schizophrenia.

Schizoid Personality Disorder

The term schizoid was first introduced by Eugen Bleuler in 1908 to describe the concept of introversion, that is, the tendency to direct attention toward one's inner life and away from the external world. An extreme version of introversion is one of the main characteristics of schizoid personality disorder (SZPD). SZPD was initially considered the prototypic schizophrenia-related personality disorder, a role now largely assumed by schizotypal personality disorder (STPD). SZPD was broadly defined in the first two versions of the DSM, but was then divided in the DSM-III (APA, 1980) into the schizoid, avoidant, and schizotypal types of personality disorder.

Epidemiology and Genetic studies

Incidence and prevalence

SZPD is believed to be one of the rarest personality disorders because its prevalence in the general population is <1%. However, other studies have found its prevalence to be as high as 3.1% in the US population and even higher in substance-abusing and primary-care samples. Epidemiological studies of personality disorders suggest that SZPD is more prevalent among men than women, with a two-to-one sex ratio.

Genetic studies (twin and adoption studies/familial aggregation)

SZPD is more frequently observed in first-degree relatives of patients with schizophrenia, further supporting the notion of a shared genetic liability among individuals with SZPD and other schizophrenia-spectrum disorders. The heritability of SZPD has been estimated to be in the range of 28–29%, as revealed by twin studies in two independent Norwegian epidemiologic studies. However, a follow-up study that included more reliable measurements for the diagnosis of SZPD found higher heritability rates, ranging from 55 to 59%. In addition, environmental factors can influence very early neurodevelopmental processes. For example, prenatal exposure to famine has been associated with a twofold increase in the relative risk for SZPD.

Clinical Features and Diagnosis

SZPD patients have prominent defects in the ability to relate to others in a meaningful way. The first symptoms of SZPD,

Table 1 DSM-IV-TR diagnostic criteria for schizoid personality disorder

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- (A) A pervasive pattern of detachment from social relationships and a restricted range of expression of emotions in interpersonal settings, beginning by early adulthood and present in a variety of contexts, as indicated by four (or more) of the following:
- (1) neither desires nor enjoys close relationships, including being part of a family
 - (2) almost always chooses solitary activities
 - (3) has little, if any, interest in having sexual experiences with another person
 - (4) takes pleasure in few, if any, activities
 - (5) lacks close friends or confidants other than first-degree relatives
 - (6) appears indifferent to the praise or criticism of others
 - (7) shows emotional coldness, detachment, or flattened affectivity.
- (B) Does not occur exclusively during the course of schizophrenia, a mood disorder with psychotic features, another psychotic disorder, or a pervasive developmental disorder and is not due to the direct physiological effects of a general medical condition.
-

manifested as early as childhood and adolescence, include underachievement in school, social isolation, and poor peer relationships, which mark them as 'different' and make them targets for teasing and bullying. [Table 1](#) summarizes the DSM-IV-TR criteria for the diagnosis of SZPD. The main characteristic of this personality disorder is the attenuated desire for relationships or the absence of it. This is manifested by extreme social isolation and limited interactions with peers, mostly first-degree relatives, which provide them with a sense of security and stability. In addition, the limited social interaction is typically characterized by emotional coldness and reduced expression of affect. SZPD individuals demonstrate a limited capacity to express either positive or negative emotions, manifested by an indifference to praise or criticism from others.

Patients with SZPD may display characteristics of apathy and amotivation, such as lack of goals and passive reaction to adverse circumstances, as well as inappropriate response to important life events. The lack of interest in social relations and extreme introversion often lead to engagement in solitary intellectual activities, such as computer games or puzzles. However, the pleasure experienced in these activities lasts only for a brief period, typically followed by a more pervasive period of anhedonia. For SZPD patients, modulating their emotional interaction with others is important and, when their personal space is violated, they experience emotional distress and an increased need to remain isolated and independent. In addition, these patients are usually sexually apathetic, although the majority of such individuals have a normal sex drive. Occupational functioning may be impaired, especially in cases where interpersonal involvement is required. However, SZPD individuals may do well when they work under conditions of social isolation.

Course and Prognosis

The onset of SZPD usually occurs in early childhood. While there are no well-established clinical data about the prognosis, SZPD individuals are believed to remain functional in the context of a restricted, well-defined environment. On the other hand, lifestyle changes in social settings, living arrangements,

or work environment can create additional stress that can complicate their prognosis. Like many of the personality disorders, SZPD is a long-lasting, but not necessarily lifelong, condition. Progression to schizophrenia might occur, usually in the second or third decade. However, the proportion of SZPD individuals who later develop schizophrenia is unknown. Furthermore, some investigators have found that premorbid SZPD is associated with specific dimensions of schizophrenic symptomatology, especially negative symptoms.

Differential Diagnosis and Comorbidity

SZPD shares common phenomenological features with other schizophrenia-spectrum disorders, such as reduced expression of affect and negative symptoms. However, in comparison with schizophrenia patients, schizoid individuals do not present with prominent psychotic symptoms. Another caveat is the difficulty, particularly in the early stages of the illness, in differentiating individuals with SZPD from those with pervasive developmental disorders, such as mild forms of autism. In contrast to these disorders, SZPD does not involve impairment in nonverbal communication or patterns of restricted interests and repetitive behaviors. However, the relationship between SZPD and autism, more particularly Asperger's syndrome, is a complex one and, as is the case with schizophrenia, it is likely that SZPD has been diagnosed in place of autistic spectrum disorder, rather than vice versa. Furthermore, although SZPD patients may suffer from associated depression, this personality disorder is not usually associated with guilt, hopelessness, helplessness, or low self-esteem.

SZPD also has certain features commonly observed in other personality disorders, occasionally making it difficult to distinguish it from these disorders. Phenomenological characteristics such as social isolation and constricted expression of affect are present in cluster A personality disorders. However, SZPD is distinguished from STPD by the lack of cognitive dysfunction and perceptual distortions; and from paranoid personality disorder by the lack of exaggerated suspiciousness and paranoid ideation. Individuals with SZPD and avoidant personality disorder share the characteristic of social isolation. However, the social avoidance in SZPD does not stem from fear of rejection but from genuine indifference to social relationships, pervasive detachment, and limited desire for social intimacy.

The diagnosis of SZPD should be made only when the traits exhibited by an individual are maladaptive and inflexible, and cause significant subjective distress or functional impairment. Moreover, it is crucial to explore the individual's cultural background as the interpersonal style of certain cultures may be erroneously labeled as schizoid. Additionally, immigrants from other countries or those who have moved from rural to metropolitan areas may initially react with emotional coldness, constricted affect, and limited interactions with their peers and be mistakenly perceived as cold, hostile, or indifferent.

SZPD and the Brain

Psychological test data

A study of 314 twins revealed that executive function deficits and personality disorders are significantly heritable. This study also found a 27% correlation attributable to heritable factors

between executive function deficits and schizoid characteristics, the lowest among the personality disorders that were tested. Executive functions were assessed in this study with the use of the Coolidge Personality and Neuropsychological Inventory, which contains items measuring decision-making difficulties, organizational impairments, poor planning, perseveration, and sequencing difficulties. The findings from this study provide some insight into why individuals diagnosed with SZPD frequently exhibit chronic difficulties with everyday decision making and selective attention, as well as deficits in inhibition, judgment, planning, and flexibility.

Biological test data

Psychophysiological studies

Eye movements In a recent study that examined the association between smooth pursuit eye-movement (SPEM) score and schizophrenia-spectrum personality symptoms, relatives of schizophrenic patients who experienced schizoid symptoms were compared to community-recruited subjects without family history of psychosis but with comparable schizoid scores. Eye tracking was significantly worse in those subjects with spectrum personality symptoms who had a biological relative with schizophrenia. Furthermore, schizoid symptoms explained 20% of the variance in the eye-tracking measure in relatives of schizophrenia patients.

P300 event-related potential Multiple studies have reported P300 amplitude reduction in schizophrenia and STPD. However, only one study assessed the P300 event-related potential in SZPD. This study did not find P300 to be reduced in individuals who had been diagnosed as schizoid in childhood.

Genetic risk factors

The *NcoI* restriction fragment length polymorphism (RFLP) (C to T transition) in exon 6 of the dopamine (DA) D₂ receptor gene has been associated with SZPD. The C allele predicts low density of the DA D₂ receptor; this variant is more prevalent in SZPD individuals. In addition, the A1 allele of the *TaqI* A1–A2 RFLP of the DA D₂ receptor gene has also been significantly associated with SZPD, predicting higher schizoid behavior. Interestingly, both the *TaqI* A1 and *NcoI* C alleles, which are present with increased frequency in SZPD patients, correlate with lower DA D₂ receptor density. A weak association between the variable number tandem repeat 10/10 genotype of the DA transporter gene and schizoid/avoidant behavior has been identified. Moreover, a functional deletion/insertion allelic variation associated with decreased expression of the serotonin transporter gene SLC6A4 was also found to restrict expression of schizoid traits in normal subjects and patients with affective disorders.

Treatment (Biological and Psychological)

In keeping with their excessive isolation and social withdrawal, individuals with SZPD rarely seek treatment. Such patients do not perceive the establishment of a therapeutic relationship with the treatment team as potentially beneficial. Thus, they are brought for treatment by others or may occasionally seek treatment for an associated problem, such as depression. As such, treatment reports of patients with SZPD have been

rare, and obtaining a substantial number of SZPD patients for a treatment study is a challenge in itself.

Psychological

Psychotherapy is the treatment of choice for personality disorders, and this is mainly concluded from two formal meta-analyses. The most recent meta-analysis reported a large to very large overall effect size for both psychodynamic treatments and cognitive-behavioral therapies. However, this meta-analysis included 22 studies of which 19 had patients exclusively from cluster B and/or C. The other three studies recruited patients from all three clusters and had a naturalistic design. Thus, clinical descriptions and research reports in psychotherapeutic treatment of SZPD patients are limited. Based as it is on expert advice, individual psychotherapy is the initial treatment of choice. The primary aim of the therapy should be the development of a strong therapeutic alliance. This might be facilitated by the avoidance of early interpretation or confrontation and by showing an interested and caring attitude toward addressing the possibility of underlying needs. The primary goal of therapy should be to increase the coping and interpersonal relationship skills of SZPD individuals and to make them more comfortable in social settings. Psychotherapy should also be focused on alleviating current pressing concerns or stressors in the individual's life.

Another beneficial approach in the psychotherapeutic treatment of SZPD is the incorporation of cognitive-behavioral techniques that encourage patients to gradually increase their social involvement. In addition, cognitive-restructuring exercises may be appropriate for those irrational thoughts that negatively influence the patient's behavior. Furthermore, SZPD patients who are able to complete individual therapy may have adequate minimal social skills and abilities to tolerate group therapy. In this alternative treatment modality, SZPD patients develop social and interpersonal skills, and improve their capability to relate and interact appropriately and meaningfully with other individuals.

Biological

The pharmacotherapy in SZPD is understudied, as there have been no long-term controlled clinical trials. In view of the limited clinical data, long-term psychopharmacological treatment should be avoided in SZPD patients without other comorbid conditions. Medication is generally useful only as a temporary aid for the relief of specific acute symptoms such as overwhelming anxiety, or as an effective treatment in SZPD individuals with comorbid conditions such as major depression. Many experts in the field recommend the use of atypical antipsychotics in SZPD, based on the fact that schizoid traits are similar to the negative symptoms of schizophrenia. More specifically, there are anecdotal reports that low doses of risperidone or olanzapine might constitute effective therapeutic options in the treatment of social deficits and blunted affect. Additionally, antidepressant medications might be effective in treating the rejection sensitivity and social anxiety of SZPD patients. Bupropion, an atypical antidepressant that inhibits norepinephrine and DA reuptake, has been reported to be effective for the anhedonia commonly experienced by these patients. Other available options include the selective serotonin reuptake inhibitors, tricyclic antidepressants, and monoamine oxidase

inhibitors. However, sufficient evidence is lacking to support the use of a specific antidepressant medication in SZPD. The administration of benzodiazepines for short periods might diminish the interpersonal and social anxiety of these patients.

Schizotypal Personality Disorder

STPD was first introduced in DSM-III (APA, 1980) as part of the 'odd, eccentric' cluster A along with schizoid and paranoid personality disorders. This disorder is characterized by eccentricities of behavior, cognitive, or perceptual distortions, as well as acute discomfort with, and reduced capacity for, close relationships. STPD is considered the prototypic schizophrenia-related personality disorder, sharing genetic, neurophysiological, structural, and functional neuroanatomic features with schizophrenia. Interestingly, in the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) by the World Health Organization, STPD is classified as a mental disorder associated with schizophrenia rather than as a personality disorder, in contrast to the DSM-IV classification.

Epidemiology and Genetic Studies

Incidence and prevalence

The prevalence of STPD is approximately 3% of the general population. However, this prevalence differs across different cultures, ranging from 0.6% in a Norwegian sample to 4.6% in a US sample population. Results from a recent large epidemiological survey in the United States showed a 3.9% lifetime prevalence of SZPD. Men (4.2%) have significantly higher prevalence rates than women (3.7%). Moreover, the phenomenology of STPD is gender dependent: male STPD individuals exhibit higher scores on measures of negative schizotypy compared to female STPD individuals. Conversely, female STPD individuals exhibit higher positive schizotypy scores than their male counterparts. Higher prevalence of STPD was present among individuals with lower incomes, as well as those who were separated, divorced, or widowed. Odds for SZPD are significantly higher among black women and lower among Asian men, but it still remains unclear if this is due to culture-specific environmental stressor/genotype interaction or to a relative lack of cultural sensitivity in the DSM diagnostic manual. Furthermore, STPD is associated with higher co-occurrence rates of Axis I and other Axis II disorders, including bipolar I and II disorders, social and specific phobias, lifetime generalized anxiety disorder, and posttraumatic stress disorder, as well as borderline and narcissistic personality disorders.

Genetic studies (twin and adoption studies/familial aggregation)

STPD is more frequently observed in first-degree siblings of patients with schizophrenia, further supporting the hypothesis of a genetic basis for STPD and a strong shared genetic liability with schizophrenia and other schizophrenia-spectrum diagnoses. The notion of a common genetic substrate for these disorders is further supported by findings of adoption, family, and linkage studies. Findings from a twin study suggest that positive-like and negative-like symptoms might represent two relatively independent heritable dimensions in STPD

patients. This study also showed that in STPD, and in other schizophrenia-spectrum disorders, genetic factors are responsible for the social and cognitive deficits (i.e., spectrum phenotype), as well as for the psychotic symptoms (i.e., psychotic phenotype), and might be transmitted independently. Additionally, the spectrum phenotype of STPD shares a stronger genetic liability with schizophrenia in comparison to the psychotic phenotype, further supporting the notion that specific dimensions of the STPD phenomenology might share a closer genetic relationship to schizophrenia and other schizophrenia-spectrum diagnoses.

Clinical Features and Diagnosis

The diagnosis of STPD is based on a constellation of signs and symptoms, as there is no laboratory test that can definitively indicate the presence of the disorder. STPD individuals have a pervasive pattern of deficits marked by discomfort with, and reduced capacity for, close relationships, as well as cognitive or perceptual distortions and eccentricities of behavior. The DSM-IV-TR criteria (Table 2) include odd beliefs or belief in magic that diverge from the social norms of the subjects' culture and usually exert a significant impact on their speech and appearance. Speech in this disorder is characterized by unusual or idiosyncratic phrasing as well as loose and vague construction, but without the more severe deficits, such as derailment or loosening of associations, observed in schizophrenia. A main clinical manifestation observed in STPD individuals is the idea of reference, where patients develop a belief or perception that irrelevant, unrelated, or innocuous phenomena in the world refer to them directly or have special personal significance. This should not be confused with delusions of reference, where the beliefs are held with significantly more conviction. Additionally, it is common for patients with STPD to experience perceptual alterations, such as hearing a voice whispering their name.

Table 2 DSM-IV-TR diagnostic criteria for schizotypal personality disorder

- (A) A pervasive pattern of social and interpersonal deficits marked by acute discomfort with, and reduced capacity for, close relationships as well as by cognitive or perceptual distortions and eccentricities of behavior, beginning by early adulthood and present in a variety of contexts, as indicated by five (or more) of the following:
 - (1) ideas of reference (excluding delusions of reference)
 - (2) odd beliefs or magical thinking that influences behavior and is inconsistent with subcultural norms (e.g., superstitiousness, belief in clairvoyance, telepathy, or 'sixth sense'; in children and adolescents, bizarre fantasies or preoccupations)
 - (3) unusual perceptual experiences, including bodily illusions
 - (4) odd thinking and speech (e.g., vague, circumstantial, metaphorical, overelaborate, or stereotyped)
 - (5) suspiciousness or paranoid ideation
 - (6) inappropriate or constricted affect
 - (7) behavior or appearance that is odd, eccentric, or peculiar
 - (8) lack of close friends or confidants other than first-degree relatives
 - (9) excessive social anxiety that does not diminish with familiarity and tends to be associated with paranoid fears rather than negative judgments about self
- (B) Does not occur exclusively during the course of schizophrenia, a mood disorder with psychotic features, another psychotic disorder, or a pervasive developmental disorder.

STPD individuals exhibit suspiciousness, which makes them extremely cautious about others' motives and intent. These individuals may also suffer from paranoid ideation, believing that they are being harassed or persecuted. Thus, their interaction with others is usually characterized as inappropriate, rigid, or constricted. This could also be related to their inability to express a full range of affects and interpersonal cuing or to relate appropriately to other people. While these patients often complain of a lack of relationships or of being isolated, their behavior suggests an attenuated desire and drive for intimate contacts. Their social relationship is usually restricted to their first-degree relatives as interaction with unfamiliar people or social situations leads to exaggerated levels of anxiety. This excessive social anxiety may not diminish with familiarity as it is usually associated with suspiciousness about others' motives. STPD individuals commonly demonstrate odd speech, excessive social anxiety, and suspiciousness, as well as the lack of empathy and pleasant emotions. These characteristics lead to prominent social deficits affecting the potential to interact with and relate to other people. A recent study found that young STPD subjects use the Internet for social interaction more frequently than normal controls. It could be further speculated that these youths might utilize the Internet for social interaction, as an environment that attenuates the interpersonal deficits in communication skills.

The first symptoms of STPD may be evident as early as childhood or adolescence. These symptoms differ from the typical clinical picture found in adults. Children or adolescents demonstrate poor peer relationships, pronounced social anxiety, underachievement in school, and a tendency toward solitary pursuit of activities. Additionally, symptoms that may be present during the developmental stages of childhood include bizarre fantasies, unusual use of language, odd thoughts, or hypersensitivity to criticism and correction. Children with these tendencies present with prominent social isolation and poor or disrupted interpersonal relations, which increase their risk for future development of more severe STPD psychopathology.

The clinical presentation and symptomatology of STPD can sometimes be confused with the abnormalities seen in patients with schizophrenia. However, the psychotic and cognitive-like symptoms observed in STPD, while pervasive and disturbing to the patient, almost never lead to prolonged functional impairment with multiple hospitalizations or long-term exposure to psychotropic medications, as in schizophrenia. Moreover, the cognitive deficits of STPD are usually milder and more circumscribed than those of schizophrenia. Occasionally, STPD individuals can develop transient psychotic episodes. These episodes are characterized as less pronounced or frequent than in schizophrenia. However, there are limited data to support the notion that STPD individuals develop brief psychosis. Additionally, experts in the field suggest that such individuals might be misdiagnosed as schizotypals though, in actuality, they meet the criteria for schizophrenia.

Course and Prognosis

The prognosis of STPD is variable and significantly related to the patient's maturity and to the integrity of his/her coping mechanisms. STPD is thought to be a premorbid personality of schizophrenia. Thus, a large proportion of young individuals,

ranging from 17 to 40%, meeting the criteria for the STPD diagnosis in cross-sectional studies, later develop the full spectrum of schizophrenia. Moreover, retrospective studies have demonstrated that a significant number of patients with schizophrenia exhibit schizoid and schizotypal traits before the onset of their illness. However, other authors have shown that patients who were diagnosed with schizophrenia actually met DSM criteria for STPD. Additionally, preliminary findings from ongoing studies show that subjects with more 'typical' STPD symptomatology rarely develop schizophrenia. Furthermore, published data suggest that the childhood personality of individuals who later develop STPD is totally distinct from those with schizophrenia. Interestingly, longitudinal studies have reported attenuation in the STPD symptomatology, or even significant remission rates with age. Currently, no conclusive evidence exists as to whether STPD is a necessary transitional stage of schizophrenia.

Differential Diagnosis and Comorbidity

STPD is the prototypic schizophrenia-spectrum disorder, which shares with schizophrenia common phenomenological features emerging from common spectrum-related risk factors. It has been speculated that STPD subjects have more developed compensatory mechanisms such as preservation of frontal integrity and function, as well as the capacity to recruit other related brain regions to compensate for dysfunctional areas during cognitive demands. Therefore, STPD individuals are more protected from the severe cognitive deterioration and social deficits of schizophrenia. Moreover, STPD lacks the severity of psychosis seen in patients with schizophrenia, and they are thus spared from multiple hospitalizations and long-term exposure to psychotropic medication. The differentiation between STPD, schizoid, and paranoid personality disorders is complicated by their shared phenomenological features. For example, both schizoid and STPD are characterized by a lack of close friendships. However, in SZPD this results from diminished pleasure or absence of pleasure from casual or intimate relationships. In contrast, the asociality observed in STPD individuals is secondary to suspiciousness, odd, bizarre behavior, and excessive social anxiety.

STPD and the Brain

Abnormalities in specific structural, psychophysiological, and neurocognitive tasks have been suggested as candidate biomarkers of STPD. These abnormalities are hypothesized as arising from alterations in brain frontal and fronto-parietal-temporal circuitry. Unfortunately, none of these abnormalities has yet proven sensitive or specific enough to implicate a clear etiology of STPD.

Psychological test data

STPD and schizophrenia patients exhibit similar neurocognitive impairments hypothesized as secondary to shared neurodevelopmental pathway abnormalities. However, the deficits in STPD are less severe and more circumscribed to specific cognitive areas compared with the more severe and diffuse ones observed in schizophrenia. For example, STPD individuals have been found to perform poorly on tests measuring

abstraction and executive function tasks such as the Wisconsin Card Sorting Test, Stroop Color Word Interference Test, and Trail Making Test B. A common component of all the above tasks is the engagement of working memory, a short-term type of memory that stores and manipulates information required to perform specific tasks. Multiple studies have demonstrated that working memory is subserved by the dorsolateral prefrontal cortex (DLPFC) dopaminergic system. Dysfunction in the DLPFC has been implicated in the neuropathology of clinical STPD populations, and working memory is believed to represent a core deficit in these populations. In a recent study, STPD patients performed significantly worse than healthy volunteers and patients with personality disorders unrelated to psychosis on tasks of working memory, episodic memory, and delayed recall. Working memory differences were the most significant determinants of differences in cognitive performance in the aforementioned comparison groups. Similarly, deficits in working memory have been demonstrated in nonclinical populations with high scores of negative or positive schizotypy scales.

Other cognitive domains in which STPD subjects show poor performance include selective attention and verbal learning, believed to be modulated by the fronto-striatal circuits and temporal cortex, respectively. Schizophrenic patients and individuals with high schizotypal personality features, as revealed by the schizotypal personality questionnaire, perform worse on attentive tasks, namely the sustained attention response to task. Furthermore, studies have also shown that STPD patients suffer from impairments in initial word list learning and multitrial memory learning tasks.

Biological test data

Neurochemical, functional, and structural studies

STPD subjects show neurochemical alterations similar to those observed in schizophrenia patients. In schizophrenia, augmented levels of homovanillic acid (HVA), a DA metabolite, correlated with severity of psychotic symptoms. Similarly, the plasma and cerebrospinal fluid (CSF) concentration of HVA is significantly increased in STPD individuals compared with healthy controls or patients with other personality disorders. Conversely, STPD patients with poor performance on neurocognitive tasks and/or deficit-like symptoms have low levels of plasma and CSF HVA concentration. Augmentation of DA neurotransmission by the administration of the indirect DA agonist amphetamine in STPD subjects improves their cognitive functions. However, this improvement is not accompanied in these patients by the appearance or exacerbation of psychotic-like symptoms, as observed in patients with schizophrenia. A possible explanation for this is that the amphetamine-induced increase of striatal dopaminergic neurotransmission observed in STPD is significantly lower compared to that in schizophrenia during illness exacerbation. This is consistent with reports of reduced striatal volume, especially in the caudate and putamen in STPD, when compared to patients with schizophrenia. Moreover, STPD patients do not suffer from the significant volume reductions in the medial dorsal nucleus of the thalamus found in schizophrenia patients. The medial dorsal nucleus receives its main input from the prefrontal cortex (PFC) and limbic system and then projects to the prefrontal association cortex. Thus, it has a crucial role in attention, planning, organization, abstract

thinking, multitasking, and active memory. Importantly, reductions in the medial dorsal nucleus of the thalamus in schizophrenia are accompanied by smaller volumes in the PFC, a finding not observed in STPD. Other brain areas with consistently attenuated volumes in schizophrenia but not in STPD include middle temporal regions such as the amygdala and the hippocampus.

The reduction of the frontal lobe gray matter is less prominent in STPD than in schizophrenia, leading to significantly less cognitive and social deterioration in STPD subjects compared to schizophrenic patients. A recent study that assessed the cortical gray/white matter volumes in a large sample of unmedicated schizophrenia-spectrum patients and healthy controls showed that the observed frontal reduction in STPD was only about 50% of that found in schizophrenia and did not differ statistically from the healthy control group. Additionally, there is evidence to support the notion that STPD individuals are capable of recruiting different PFC areas as a compensatory mechanism during cognitive tasks, a finding not observed in schizophrenia.

Psychophysiological studies

Subjects with schizophrenia-spectrum personality disorder exhibit deficits in information processing. This could be secondary to an inability to filter out irrelevant information in the early stages of processing so that attention can be focused on the more salient features of the environment. It is possible to examine this inhibitory phenomenon by using psychophysiological paradigms.

Prepulse inhibition Prepulse inhibition (PPI) of the acoustic startle response refers to a reduction in the magnitude of the blink reflex component of the startle response to a strong auditory stimulus if this is preceded by a weak stimulus. PPI is considered a measure of 'sensorimotor gating,' whereby prepulses reduce the effect of subsequent sensory stimuli to protect the brain from sensory overload. Deficient PPI is a reliable feature of neuropsychiatric disorders such as schizophrenia, where reduced gating is thought to be one possible neurobiological mechanism underlying some basic cognitive abnormalities associated with this disorder. Reduced PPI was also found to be present in asymptomatic first-degree siblings of schizophrenic individuals, as well as in schizophrenia-spectrum personality disorder patients. Moreover, PPI levels are significantly correlated in STPD subjects with a general schizotypy score, reflecting a general proneness or vulnerability to psychosis.

Smooth pursuit eye movement SPEM measures visual tracking of smoothly moving targets, such as a pendulum. The psychophysiological study of eye movements, particularly the antisaccade task, has been proposed as a candidate endophenotype for schizophrenia. This is a result of SPEM deficits being evident in the majority of patients with chronic schizophrenia when compared with controls. Additionally, SPEM impairment is also significantly more marked in relatives of probands with schizophrenia and STPD individuals. Volunteers who were selected on the basis of poor eye-tracking accuracy had a greater prevalence of STPD diagnosis than the control group with high eye-tracking accuracy. In addition, deficits during the eye-movements task have been observed in

nonclinical populations such as adult, healthy volunteers with a high degree of schizotypy. STPD patients with positive-like symptoms are likely to show elevated error rates on standard antisaccade tasks in comparison to healthy normal controls. Additionally, a recent study showed that SPEM deficits were predicted solely by the criterion of social isolation, with low accuracy trackers also reporting reduced desire for social contact. These findings support the notion of impaired SPEM in relation to negative-symptom schizotypy. However, other studies have failed to demonstrate differences in antisaccade error rates between STPD with predominantly negative-like symptoms and normal individuals. Based on this, it remains unclear whether impaired SPEM is specific to negative versus positive symptoms or instead reflects the entire schizotypal syndrome. Nevertheless, SPEM deficits are found in both STPD and schizophrenia patients, further supporting the notion of impaired SPEM as an endophenotype for schizophrenia-spectrum disorders.

P300 event-related potential P300 amplitude has been proposed as an endophenotype for the study of psychosis as multiple publications have reported P300 amplitude reductions in patients with schizophrenia. STPD individuals demonstrate similar deficits; however, these findings are less consistent than in schizophrenics. Similar reductions in auditory P300 amplitudes and delayed P300 latencies are exhibited by nonclinical populations scoring high in schizotypy as measured by the Schizotypal Personality Questionnaire.

P50 event-related potential P50 is another type of event-related potential task that assesses attention and early information processing. Impairments in P50 wave suppression have been identified as vulnerability markers for the sensory gating deficits observed not only in patients with schizophrenia, but also in their first-degree relatives, further supporting the notion of P50 as a candidate endophenotype for schizophrenia-spectrum disorders. Compared with healthy volunteers, STPD subjects show less suppression of the P50 event-related potential to the second of a pair of click stimuli, indicating a failure of sensory gating at a relatively early stage of information processing. Healthy volunteers with higher schizotypal characteristics, as assessed by the schizotypal personality questionnaire, had lower P50 suppression than subjects with a low schizotypal score.

Genetic risk factors

There is now abundant evidence that catechol-O-methyltransferase (COMT) has a critical impact on dopaminergic transmission. Certain variations of COMT, a candidate gene for the modulation of performance in PFC-mediated cognitive tasks, have been hypothesized as playing a role in the phenomenology of STPD. A polymorphism in the COMT gene, leading to an amino acid substitution valine (Val) to methionine (Met), results in the Met/Met variant. Patients with this variant exhibit 40% less enzymatic activity than Val/Val individuals. There is an extended literature on recent functional magnetic resonance imaging (fMRI) findings showing that, relative to Met-loading subjects, Val homozygotes underperform in PFC-related tasks and/or have prefrontal hyperactivation. Recent studies have shown that these subjects have deficient gating and early information processing as evidenced by deficient PPI. Consequently, it has been suggested that the Val allele is

associated with less efficient information processing and increased prefrontal neuronal 'noise.' Recent studies have shown that STPD subjects with the Val/Val genotype exhibited worse performance on executive functioning and PFC-dependent memory tasks independent of clinical status. These findings were replicated in a recent study in which the STPD subjects with higher Val loading showed not only worse cognitive performance, but also more severe negative schizotypy. These Val-dependent cognitive and early information processing deficits were found to be improved by compounds such as tolcapone, a selective inhibitor of the brain COMT enzyme, resulting in DA neurotransmission enhancement in the PFC and simultaneous improvement in gating and working memory deficits. Another recent study has pointed to other genes, such as the proline dehydrogenase (PRODH), which might be an important determinant of the continuum from normality to psychosis and the genetics of schizophrenia-related traits. Healthy individuals who displayed the markers for the psychosis variant risk factor presented with gating and verbal memory deficits, as well as higher anxiety and schizotypal personality traits.

Treatment (Biological and Psychological)

In STPD, treatment could be beneficial, leading to measurable gains, especially in mildly affected individuals. However, the majority of these individuals are not able to alter their ingrained ways of perceiving or interpreting reality. The lack of a social support structure might prevent most STPD subjects from initiating any type of treatment. Notably, compared to schizophrenia, the severity of psychopathology is milder in STPD patients and a significant portion will maintain, despite their oddities, an adequate functioning level in occupational, social, and interpersonal environments.

Psychological

As with SZPD, only a limited number of studies have assessed the psychotherapeutic treatment of SZPD patients, and most of the evidence is based on expert opinion. The principles of therapy in STPD patients do not differ from those in patients with SZPD. However, individuals with STPD distort reality to a more significant degree and usually demonstrate peculiar patterns of thinking and behavior, such as involvement in cults and strange religious practices. Therapists must keep a neutral position and should not be judgmental about these beliefs or activities. In addition, STPD patients often report feelings of being 'different,' usually because of their belief in magic or delusional thinking. A warm, supportive, and client-centered environment should be established with initial rapport, as these individuals lack an adequate social support system and usually avoid most social interactions due to extreme social anxiety. Significant emphasis should be given to the acquisition of social skills, as competence in the fundamentals of social interactions may be beneficial. While individual therapy is the preferred modality at the onset of therapy in these patients, it may be appropriate to consider group therapy as treatment advances in order to enhance social and interpersonal skills.

Biological

The number of pharmacological treatment trials in STPD is significantly higher in comparison to SZPD. However, all the

clinical trials of STPD have to date typically included subjects with borderline or mixed personality disorders. The phenomenological similarity of the psychotic-like symptoms (e.g., magical thinking, suspiciousness, and ideas of reference) of STPD individuals with the psychosis of chronic schizophrenia has led to the notion that treatment with antipsychotic medications will ameliorate and improve these symptoms. The first studies that examined the beneficial effect of antipsychotic medications suffered from design flaws such as lack of homogeneity (i.e., inclusion of patients with other personality disorders besides STPD) and lack of randomization. Despite these drawbacks, these studies have been able to demonstrate a reduction of psychotic-like symptoms in STPD patients following administration of first-generation antipsychotics. For example, in a mixed sample of patients with schizotypal and borderline personality disorders, thiothixene led to a more prominent improvement of psychotic symptoms in STPD patients compared to those with borderline diagnosis. Additionally, compared with placebo, haloperidol has been shown to improve positive-like STPD symptoms. However, these findings were not replicated in subsequent trials of haloperidol in STPD.

More recently, the effectiveness of second-generation antipsychotic treatment has also been demonstrated in STPD. More specifically, a randomized, small-scale study showed that, compared to placebo, risperidone reduced the positive, negative and general score of the positive and negative syndrome scale (PANSS) in these patients. Interestingly, this effect was more significant for doses in the range of 1 mg day^{-1} or even smaller. The authors concluded that this might be secondary to better tolerability and less exacerbation of somatization-like symptoms in treated patients. This success in the improvement of psychotic-like symptoms is not observed in the case of depressive symptoms, where there is poor effectiveness of medications. For example, risperidone failed to demonstrate a reduction of depressive symptoms in STPD patients. However, a recent open-label study with a flexible olanzapine dose demonstrated significant improvement in psychotic-like symptoms, depression, and overall functioning scores in a small group of patients, most of whom had STPD that was comorbid with borderline personality disorder.

Also, the use of antidepressant medications has failed to show a significant improvement of mood or psychoticism in STPD patients without comorbid borderline personality disorder. More specifically, an open trial of fluoxetine in patients with borderline personality disorders and STPD showed significant improvement in psychotic symptoms; however, the results were not analyzed with respect to diagnosis. Another clinical trial of fluoxetine demonstrated improvement in impulsive aggression in a mixed sample of patients with personality disorders. However, these results were not presented separately by cluster.

Early phenomenological studies have reported that STPD shares similar cognitive deficits with other schizophrenia-spectrum disorders. Studies have shown that amphetamine reduces these cognitive deficits. Specifically, the use of this drug leads to attenuation of errors on working memory and verbal learning tasks in STPD subjects. This is attributed to the enhancement of the dopaminergic system by amphetamine, as hypodopaminergic neurotransmission is an important determinant of the cognitive deficits in schizophrenia-spectrum

illnesses. More specifically, amphetamine indirectly activates the D_1 receptors in the frontal cortex, which are known to modulate visuospatial working memory performance. The use of escalating doses of another DA agonist, pergolide, with preferential activity at D_1 receptors for 2 weeks has shown to improve working memory performance in STPD subjects, without any clinical worsening. The increased risk for valvular heart disease induced by pergolide has restricted the use of this agent in the management of STPD patients. Another pharmacologic compound with a high ratio of D_1/D_2 activity is dihydrexidine. In a recent study, the administration of this agent failed to improve cognitive deficits of patients with schizophrenia; however, the beneficial effect of this compound on cognition may be detected with more sensitivity in STPD patients whose deficits are usually less severe and more readily reversible than in patients with schizophrenia. Additionally, compared to schizophrenia patients, STPD individuals do not experience worsening of psychotic-like symptoms after the administration of dopaminergic agonists. It has been speculated that STPD patients share with schizophrenia patients the cortical hypodopaminergic, but not the subcortical hyperdopaminergic neurotransmission.

Norepinephrine has also been found to play a significant role in cognitive functions such as working memory and attention. More specifically, norepinephrine increases the signal-to-noise ratio in the PFC during the processing of sensory stimuli, enhances long-term memory consolidation in the amygdala and hippocampus, and modulates cognitive flexibility for insight-based problem solving. Guanfacine is an agonist that acts on the norepinephrine α -2a postsynaptic receptors of the PFC. This compound has the potential to be an effective treatment for the cognitive deficits in the schizophrenia-spectrum disorders. Indeed, a recent, placebo-controlled, double-blind study showed that guanfacine improved performance in context processing (though not in verbal or visuospatial episodic memory tasks) in STPD individuals, but not in patients with other personality disorders. This selective enhancement of context processing but not episodic memory further suggests that working memory deficits may in fact underlie the range of cognitive deficits within the schizophrenia-spectrum disorders.

Summary

Schizoid and schizotypal personality disorders are included in the odd and eccentric cluster A personality disorders. SZPD is characterized by a restricted range of emotional expression in interpersonal settings and excessive detachment from social relationships, while STPD is characterized by pervasive patterns of social and interpersonal deficits marked by a reduced capacity for close relationships as well as by cognitive or perceptual distortions and eccentricities of behavior. Research has supported heritability for both disorders and higher prevalence in biological relatives of schizophrenics. STPD is highly prevalent in the general population and is associated with the co-occurrence of Axis I and other Axis II disorders. SZPD is less common than STPD or other personality disorders. It is still unclear whether a proportion of SZPD individuals progress to schizophrenia or whether STPD is the premorbid personality of

schizophrenia or a necessary transitional stage of schizophrenia. Cognitive deficits in schizotypal individuals are similar to those for patients with schizophrenia, but less severe and more circumscribed to specific cognitive areas. Thus, STPD is considered the prototypic schizophrenia-related personality disorder, sharing genetic, neurophysiological, structural, and functional neuroanatomic features with schizophrenia. Moreover, schizotypal features can be quantitatively measured at the general population level by using self-rated schizotypal personality traits. Thus, both schizotypy and STPD might serve as promising endophenotypes for schizophrenia. Schizoid and schizotypal individuals usually seek treatment for a concomitant Axis I disorder. Psychotherapy is the initial treatment of choice for SZPD, and the primary goal of therapy is to increase coping and interpersonal relationship skills. Limited clinical trials in STPD support the notion that these patients might benefit from the addition of antipsychotic medication. However, pharmacotherapy in both personality disorders is understudied, and additional long-term controlled clinical trials are needed.

See also: Avoidant Personality Disorder; Behavior Genetics of Personality; Behavior Measurement in Psychobiological Research; Cognition and Personality; Event-Related Potentials (ERPs); Molecular Genetics and Human Behavior; Neuroexecutive Function; Neurotechnologies; Paranoia; Personality Assessment; Personality Development; Personality Disorders; Schizophrenia.

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Schizophrenia

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Glossary

Delusion A strongly held erroneous belief that does not change in the face of contradictory evidence or information.

Hallucination A sensation without an external object or precept. Hallucinations can be in any sensory modality.

Negative symptoms The absence or diminution of cognitions, feelings, or behaviors.

Paranoia The belief that others are currently planning to harm, injure, or mistreat the person usually without evidence.

Positive symptoms Thoughts, sensory experiences, and behaviors that are usually in excess of normality and not found in persons without the disorder.

Prognosis The outcome or conclusion of the disorder; future direction and course.

Psychosis A loss of contact with reality.

Recovery A broad concept that implies that the person has achieved some degree of improvement in symptoms and community and social functioning.

Social cognition The way a person thinks about, perceives, and interprets social events and others.

Introduction

Schizophrenia is considered one of the most severe and debilitating psychiatric disorders. Persons with schizophrenia report symptoms that include delusional beliefs, unusual sensory experiences, disorganized speech and behaviors, and apathy, emotional flattening, and indifference. Schizophrenia is also characterized by impairments in social functioning, including difficulty establishing and maintaining interpersonal relationships, problems working or fulfilling other instrumental roles (e.g., student, homemaker, employee), and difficulties caring for oneself (e.g., poor grooming and hygiene). Many individuals with the illness depend on others to meet their daily living needs. For example, estimates from studies in Europe and the United States suggest that between 25% and 60% of persons with schizophrenia live with relatives, and an even higher percentage rely heavily on relatives for daily care. Individuals without family support typically rely on mental health, residential, and case management services to get their basic needs met. In the worst case scenario, persons with schizophrenia who have insufficient contact with relatives and who fall between the cracks of the social service delivery system end up in hospitals, jail, or become victimized or homeless. About 25% of all inpatient hospital beds are for the treatment of schizophrenia and it has been estimated that the cost of treating schizophrenia is over 63 billion per year in the United States. The burden of schizophrenia places the disorder as one of the top ten most disabling conditions in the world in terms of illness-adjusted life years. One of the largest costs is the lack of productivity over the lifetime, as unemployment rates are near 75%. Sadly, even with optimal treatment, many continue to experience substantial impairments throughout most of their lives.

Brief History of Schizophrenia

The exact origins of schizophrenia are difficult to determine, but it is believed schizophrenia has been present in various

forms for centuries, with historical reports going back to Ancient Egypt. Many persons with psychosis were believed to be possessed or acting under the influence of malevolent gods or spirits. John Haslam, the resident apothecary at Bedlam Hospital (London, UK), offered the first detailed description of schizophrenia on a patient named James Tilley Matthews, who developed paranoid delusions around 1810. Matthews believed that a gang of London area criminals skilled in 'pneumatic chemistry' were torturing and manipulating him using a device called an air loom. In the 1880s, the German Psychiatrist Emil Kraepelin suggested that schizophrenia, or what he called 'dementia praecox,' was a distinct mental disorder, not a form of manic depression, thus solidifying its place as a formal mental condition. In 1911, the Swiss psychiatrist Eugen Bleuler first coined the term 'schizophrenia' which means split mind. Bleuler believed that schizophrenia was a group of different disorders, thus referring to them as 'the schizophrenias.'

Prevalence and Gender Differences

Worldwide, schizophrenia affects more than 50 million persons. In the United States, it is estimated that 2.2 million persons have schizophrenia. The lifetime prevalence rate for developing schizophrenia is about 1% for the general population. The prevalence rate of schizophrenia is believed to be remarkably stable (ranging between 0.5% and 1.0%) across a wide range of different populations and cultures. There has been little difference in the rates of schizophrenia according to gender, race, religion, or level of industrialization. However, there is evidence that schizophrenia is more heavily concentrated in urban areas of industrialized countries, and in fact persons from developing or third world countries may have a better prognosis and course of illness.

Schizophrenia can develop at any age, but is most common between the ages of 16 and 30. The peak age of onset is 20 for men and 24 for women. Childhood-onset schizophrenia (in children <10 years old) is considered rare and

controversial at present. There are persons, most often women, who show signs of schizophrenia after the age of 40, which is believed to be exacerbated by falling estrogen levels in menopause (schizophrenia after the age of 40 is often called late-onset schizophrenia). There are about 1.5–2 times as many men with schizophrenia than women and men tend to have more severe cases and less functional recovery over time. Women tend to spend less time in hospitals, have fewer negative symptoms, demonstrate less cognitive impairment, and have better social competence and social functioning than men with the illness.

Onset, Course, and Prognosis

In general, the onset of schizophrenia can be described as either gradual or acute. The gradual onset of schizophrenia can take place over many months or years, and it may be difficult for family members and others to clearly distinguish onset of the illness. Many persons enter a prodromal phase in which symptoms become increasingly apparent and more severe over time. As persons develop the condition, they may lose interest in friends, jobs, and school. Other common prodromal symptoms include odd beliefs, magical thinking, and paranoia. The prodromal phase then evolves into the active phase of the disorder, and for persons who are experiencing their first break this can be a frightening and confusing time. In other cases, the symptoms develop acutely over a period of a few weeks with dramatic and easily observed changes occurring over this time. Generally, though, once schizophrenia has developed, the illness usually continues to be present at varying degrees of severity throughout most of the person's life. Over the lifetime, schizophrenia is usually an episodic illness with periods of acute symptom exacerbation (i.e., relapse) requiring more intensive, often inpatient, treatment interspersed by periods of higher functioning between episodes (i.e., remission). Prognosis is better for persons with primarily positive symptoms, females, and persons with a later onset of symptoms. A poorer prognosis is found for males, persons with early onset of symptoms, and persons with persistent negative and cognitive symptoms. Recently, there has been an emphasis on recovery which consists of a reduction in symptoms, subjective improvement in quality of life, and improved social, community, and interpersonal functioning. In fact, longitudinal studies which follow clients for over 20 years have reported that between 21% and 57% of persons with schizophrenia showed periodic episodes of recovery.

Clinical Symptoms and Diagnosis

The formal diagnostic criteria for schizophrenia can be found in the *Diagnostic and Statistical Manual for Mental Disorders*, 4th edn., text revision (DSM-IV-TR). The criteria for schizophrenia are as follows (Table 1).

In recent research, the individual symptoms of schizophrenia are generally classified as either positive or negative. *Positive symptoms* refer to thoughts, sensory experiences, and behaviors that are usually in excess of normality and not found in persons without the disorder. Positive symptoms include

Table 1 Summary of DSM-IV-TR criteria for the diagnosis of schizophrenia

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- | | |
|----|---|
| A. | Presence of at least two or the following characteristic symptoms in the active phase for at least 1 month: |
| 1. | Delusions |
| 2. | Hallucinations |
| 3. | Disorganized speech (e.g., frequent derailment or incoherence) |
| 4. | Grossly disorganized or catatonic behavior |
| 5. | Negative symptoms (i.e., affect flattening, alogia, or avolition) |
| B. | <i>Social/occupational dysfunction</i> : For a significant proportion of the time from the onset of the disturbance, one or more areas of functioning, such as work, interpersonal relations, or self-care, is markedly below the level achieved prior to the onset |
| C. | <i>Duration</i> : Continuous signs of the disturbance persist for at least 6 months. This 6-month period must include at least 1 month of symptoms that meet criterion A |
| D. | <i>Schizoaffective and mood disorders exclusion</i> : Schizoaffective disorder and mood disorder with psychotic features have been ruled out |
| E. | <i>Substance/general medical condition exclusion</i> : The disturbance is not due to the direct effects of a substance or a general medical condition |
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hallucinations (e.g., hearing voices, seeing visions), delusions (e.g., a strongly held belief that is maintained despite contradictory evidence), and bizarre, disorganized behavior (e.g., maintaining a peculiar posture for no apparent reason, wearing multiple layers of clothes, mumbling or talking to oneself). Persecutory delusions (i.e., belief that some entity, group, or person has clear on-going or future intentions to harm the person) or grandiose delusions (i.e., belief that the person is very important, famous, or has special powers or abilities) are the most common types of delusion found in schizophrenia. More bizarre delusions include thought stealing, thought broadcasting, and thought insertion. About 75% of persons with schizophrenia report hallucinations. Auditory hallucinations are the most common form of hallucinations and are frequently derogatory, negative, or abusive although some can be benevolent, comforting, and kind. Many persons with schizophrenia develop a close relationship with their voices. Auditory hallucinations can range from inaudible sounds (buzzing sounds, noises, muffled speech) or clearly perceived voices of either gender and can occur intermittently or on a continuous basis. Visual hallucinations are less common and are found in about 10–15% of persons with schizophrenia. Olfactory and tactile hallucinations can be present, but are considered rare. Disorganization includes problems in language, emotion, and behavior that are perceived as strange and bizarre by others. Persons with the disorder may display emotional expressions that are either too intense or out of context for the situation (e.g., laughing at a funeral). Their speech may be incoherent, tangential, or circumstantial (e.g., speech that is difficult to follow or understand), and their behavior may be strange or bizarre (e.g., wearing multiple layers of clothing, yelling at others on the street, mumbling, or talking to oneself). *Negative symptoms*, on the other hand, refer to the absence or diminution of cognitions, feelings, or behaviors which are ordinarily present in persons without the illness. Common negative symptoms include blunted or flattened affect (e.g., diminished facial expressiveness), poverty of speech (i.e., diminished verbal communication), anhedonia (i.e., inability to experience

pleasure), apathy, psychomotor retardation (e.g., slow rate of speech), and physical inertia. Long-term, persistent negative symptoms (e.g., deficit syndrome) are considered a poor prognostic indicator and are linked to impaired social functioning, poorer clinical outcomes, and greater brain and cognitive impairments. Once a diagnosis of schizophrenia is made, it is often useful to determine if a particular subtype of the disorder is present. Common subtypes include paranoid, disorganized, catatonic, undifferentiated, or residual schizophrenia.

Associated Symptoms

Although neurocognitive deficits are not part of the diagnostic criteria for schizophrenia, they are regarded by many researchers and clinicians to be a core feature of the disorder. Research in this area has consistently documented stable, often severe neurocognitive deficits across multiple domains, including verbal memory, visual memory, working memory, executive function, attention, verbal fluency, processing speed, and motor speed. Individuals with schizophrenia often perform below the 5th percentile compared to the normal population on neuropsychological tasks. While a small percentage of individuals (about 10%) with schizophrenia do not display these impairments (e.g., normal functioning schizophrenia), it is likely that these individuals still show significant impairment relative to their premorbid cognitive abilities. High-risk children who have a parent with schizophrenia tend to show attentional, language, and motor abnormalities early in development (around the age of 2 at the earliest), and these deficits may predict the development of schizophrenia as adults. Finally, first-degree, unaffected relatives of a person with schizophrenia tend to show problems in smooth pursuit eye tracking (tracking a moving object with their eyes) and other cognitive abilities, reflecting the genetic aspects of the condition.

In addition to cognitive deficits, it has become apparent that impairments in social cognition (defined as the way we perceive, interpret, and understand social information) are also found in schizophrenia. Deficits in emotion and social cue perception, problems inferring the intentions and motivations of others (theory of mind), and impairments in social knowledge and schemata have all been found in schizophrenia. Persons with schizophrenia have severe problems recognizing facial expression of emotion, and this deficit is more pronounced than in any other psychiatric disorder. Persons with persecutory delusions tend to exhibit an attributional style in which they tend to blame others rather than situations for negative events (personalizing attributional style).

Other symptoms associated with schizophrenia include high rates of substance abuse, medication noncompliance, and emotional distress. Substance abuse is problematic as many drugs of abuse can mimic or produce psychosis. Amphetamines, marijuana, LSD, and alcohol are the most commonly used substances, and about 70% or more of persons with schizophrenia smoke cigarettes. Approximately 50% of all persons with schizophrenia have a lifetime history of substance use disorder. Persons with schizophrenia have a two to three times higher rate of cannabis abuse, and a heavy use of marijuana in adolescence (before the age of 18) can increase risk of schizophrenia by as much as six times. Medication noncompliance is also a problem in schizophrenia. Studies estimate that about 75% of persons with schizophrenia do not take their medication

as prescribed. Persons may discontinue medications due to the presence of side effects, cost, a lack of insight into their condition, daily hassle, or stigma from others. Recent research has found that persons with schizophrenia report higher levels of depression, anxiety, and suicidal ideation. It is estimated that 40–50% of persons with schizophrenia report significant levels of depression or anxiety in addition to schizophrenia. Sadly, about 10% of these persons commit suicide, and suicide risk is 10–50 times higher if depression is present, if there is a history of prior suicide attempts, and in the weeks immediately preceding and/or following hospitalization.

Etiological Theories

Genetics

Schizophrenia is a complex disorder with a number of interrelated causes, with many stemming back to prenatal development. There are hundreds of theories about the causes and potential mechanisms of schizophrenia, each with varied levels of research support. There has been considerable interest in genetic factors involved in schizophrenia due to findings that a person's risk for developing schizophrenia is higher if a first-degree relative (parents, siblings, and children) has the condition. Children born from two parents with schizophrenia have an estimated 46% greater risk for developing the disorder themselves (1% lifetime risk in the general population). Twin studies have proven useful in understanding genetic factors in schizophrenia. Studies examining rates of schizophrenia among monozygotic (MZ; 100% genetic similarity) and dizygotic (DZ; 50% genetic similarity) twins show pairwise concordance rates of 28% and 6%, respectively. In MZ twins, the one who is discordant (i.e., does not have the disorder) for schizophrenia has a 17% chance of having children who develop the disorder even though they themselves are healthy. Twins who are reared apart still have an elevated risk for developing schizophrenia above that accounted for shared environmental factors. Adoption studies conducted in Scandinavia show a rate of schizophrenia of about 16% if one of the biological parents has schizophrenia. Environmental factors such as communication deviance (i.e., incomprehensible speech) and stressful family events in combination with a genetic predisposition led to the highest risk for developing schizophrenia in adoption studies. Despite the clear role of genetics and family history in schizophrenia, the genetic relationship is modest at best and schizophrenia is considered a polygenetic construct. In fact, it is possible that there may be different types of schizophrenia each with their own profile of genetic abnormalities. Current research has focused on several chromosomes such as 6, 8, 13, and 22, but research to identify a specific genetic locus has proved largely disappointing. Chromosome 22 is of particular interest as it contains the COMT (catechol-*o*-methyltransferase) gene that metabolizes dopamine. Persons with a particular type of COMT genetic profile (valine/valine allele type) are at an increased risk for developing schizophrenia.

Brain Pathology and Impairments

Schizophrenia is largely considered a brain disorder, so it is not surprising to find a number of cerebral impairments in persons

with the disorder (see associated symptoms above). The brain pathology found in schizophrenia appears to predate the condition and represents a developmental process subject to genetic and environmental triggers. In terms of brain structure, people with schizophrenia are apt to have abnormally reduced cortical gray matter (3% smaller brain volume on average) and larger cerebral ventricles. The frontal lobes seem to be implicated in schizophrenia with a reduction in both total gray and white matter volume in this area. Notably, the frontal lobes are presumed to be the neural substrate of planning, motivation, working memory, goal-directed activities, and the capacity to inhibit impulses. Coincidentally, schizophrenia is characterized by poor problem-solving, apathy, and disorganized behavior. Thus, these frontal lobe anomalies may underlie some aspects of schizophrenic symptomatology. Researchers have also found abnormalities in the temporal lobe, parietal lobe, thalamus, amygdala, basal ganglia, and hippocampus. Functions attributed to the temporal lobes are varied, and include auditory processing, language, and memory. Schizophrenia is often characterized by auditory hallucinations, disorganized language, and impaired memory, which reflect temporal lobe function. This suggestion is supported, albeit weakly, with some research revealing an association between temporal lobe volumes and severity of positive symptoms.

Although the etiology of structural brain impairments has not been clearly determined, they appear to be present at the time of initial symptom onset. The combination of brain pathology and cognitive deficits in high-risk children and the lack of glial scarring in the brain itself might suggest that cerebral anomalies precede symptom onset. Thus, schizophrenia may be a neurodevelopmental process. However, it is still possible that over time some further deterioration in cerebral integrity may occur, implying a progressive etiology.

Regarding functional abnormalities, many of the same regions implicated in structural imaging studies appear to manifest abnormal activation patterns. In particular, the prefrontal lobe structures demonstrate considerable hypoactivation in people with schizophrenia, especially when they perform tasks requiring working memory, vigilance, or concentration. This 'hypofrontality' is one of the most consistent findings in schizophrenia.

These structural and functional anomalies seem to correspond with abnormalities at the cellular level. In particular, schizophrenia is associated with disordered arrangements of neurons, and this ultimately is reflected by abnormal distribution and orientation of neurons within the six cortical layers. This is found most consistently in the hippocampus. Research has also suggested that there are fewer neurons in the thalamus, which may lead to sensory overload and the inability to screen out irrelevant information. Problems in cellular organization may suggest some problem in neuron migration, synaptic pruning, or preprogrammed cell death. Taken together, these findings imply that frontal and temporal lobe regions possess abnormal interconnectivity, as evidenced by anomalous neuronal branching and distribution during the second trimester and first few years of life. This type of disorganization again suggests a developmental process.

Neurochemical Deficits

Dysfunction in neurotransmitters, in particular, dopamine, has been important in both the etiology and treatment of

schizophrenia. In fact, the dopamine hypothesis of schizophrenia was promulgated over 50 years ago based on the effect of early antipsychotic medications, such as chlorpromazine, which block dopamine receptors (dopamine antagonists). According to this model, excessive levels of dopamine activity yielded positive symptoms given that dopamine affects how much salience we give to internal and external stimuli. Further support for the role of dopamine in psychosis comes from evidence that amphetamines can induce a psychotic state, and if dopamine agonists are given to a person with schizophrenia, psychosis will ensue. Over the years, a modified dopamine hypothesis has been proposed based on inconsistent evidence for dopamine abnormalities in schizophrenia. In this model, subcortical dopamine (mesolimbic and nigrostriatal; primarily D2, D3, and D4 receptors) circuits interact synergistically with frontal cortical dopamine systems (mesocortical; primarily D1 and D5 receptors) to yield excessive subcortical dopamine activity and insufficient dopamine activation in the frontal cortex. The nature of this abnormal activation seems broad, as presynaptic storage, release, and reuptake of dopamine, but current research suggests that the dopamine receptors are supersensitive. In fact, higher numbers of D2 dopamine receptors have been found in medication naïve patients before taking antipsychotic medications. Notably, excess subcortical dopamine activity corresponds with severity of positive symptoms while a lack of dopamine activity is believed to correspond to deficits in working memory, impaired cognition, and negative symptoms.

The second major neurotransmitter of interest is glutamate. Glutamate is a diffusely distributed neurotransmitter which generally acts to increase arousal, and is localized in the prefrontal cortex and hippocampus. In schizophrenia, however, glutamate tends to have a diminished presence (reduced NMDA receptor activity), and this correlates with severity of negative symptoms and is affected by excess dopamine activity. Moreover, glutamate antagonists, such as ketamine and PCP, tend to exacerbate psychotic symptoms.

Environmental and Life Events

Given the brain impairments found in schizophrenia, it has been argued that certain prenatal, perinatal, and postnatal events could trigger the condition. Research conducted in Finland in the 1950s noted a slightly higher risk (8%) for developing schizophrenia among mothers who were infected with the influenza virus in the second trimester. The second trimester (around the 5 month of gestation in particular) is considered a crucial time period for brain development and maturation, and influenza might lead to some type of abnormal autoimmune response that impairs brain development. Since this early finding it has been shown that a number of other infections or obstetrical problems enhance risk, albeit slightly, for schizophrenia. Diabetes, *rh* incompatibility, placental or uterine abnormalities, low birth weight, advanced parental age at conception (fathers greater than 45 years of age) and hypoxia during delivery have been associated with schizophrenia.

Although stressful life events alone are not the 'cause' of schizophrenia, some theories hypothesize that negative life events may play an important role in the course of schizophrenia. The stress-vulnerability model assumes that stressors can impinge on the biological vulnerability of schizophrenia to

exacerbate symptoms. *Stressors* include traumatic events such as being the victim of violence and assault, poor family interactions, poverty, and being a member of a minority group.

Schizophrenia can be affected by stressful events and interactions between the individual and family. Although families do not cause schizophrenia, it has repeatedly been found that critical attitudes and high levels of emotional over-involvement (expressed emotion, EE) on the part of the relatives toward the individual with schizophrenia are strong predictors of the likelihood that persons with schizophrenia will relapse and be rehospitalized. Family EE seems to act as a stressor, increasing the vulnerability of persons with schizophrenia to relapse.

Due to the severity of the disorder, many persons with schizophrenia live in poverty (schizophrenia is often more concentrated in urban areas). Persons with schizophrenia might gradually drift into lower socioeconomic classes (SES) as symptom severity and functional impairment increases, but this has not been consistently supported. However, it is also possible that persons with schizophrenia are born into poverty and get worse due to their lack of resources and care. Being a member of a minority/immigrant group may also increase the risk for developing schizophrenia or being hospitalized. Minority individuals may experience high levels of racism and discrimination, which can lead to higher levels of stress and physiological arousal. In terms of psychosis, there has been a link between the amount of perceived racism and paranoid ideation among African-Americans. In addition, certain ethnic and migratory groups such as second-generation Afro-Caribbeans living in the United Kingdom, Dutch Antillean and Surinamese immigrants in Holland, Finnish, Eastern and Southern European first- and second-generation immigrants in Sweden, and African-Americans in the United States have shown higher rates of schizophrenia.

Finally, people with schizophrenia are much more likely to be the victims of violence, criminal acts, and sexual/physical abuse. Rates of childhood sexual or physical abuse range from 30 to 50% (based on self-reports) and similar rates have been reported for criminal victimization. Exposure to traumatic events may lead to the development of posttraumatic stress disorder (PTSD) in persons with schizophrenia. The presence of PTSD in persons with schizophrenia has been found to worsen the course of the disorder and complicate treatment. The prevalence of PTSD among people with schizophrenia and other severe mental illnesses ranges from 29% to 43%, which are greater than the general population rate of about 10%.

Treatment of Schizophrenia

The treatment of schizophrenia is complex and requires a multidisciplinary team of psychiatrists, psychologists, social workers, and case managers. Due to the many problems (symptoms, medication issues, social functioning) associated with the condition, the ideal treatment is multifaceted. In general, the most common avenue of treatment is the use of antipsychotic medications, but there are also a number of psychological approaches that are of benefit. Even with optimal medication management, a person with schizophrenia often has reduced social and occupational functioning and residual symptoms. No treatment is considered 100% effective. Treatment can be

offered in inpatient or outpatient settings depending on the severity of symptoms. Psychological approaches are best when the person has been stabilized on medications.

Medical Treatment

Antipsychotic medications are the first line of treatment for schizophrenia in order to reduce the active symptoms of the disorder. There are two main classifications of antipsychotic medications: (1) first-generation (typicals) or (2) second-generation (atypicals). First-generation medications, such as Haldol, have been shown to be efficacious in reducing the positive symptoms of the disorder and have a long history of clinical use. The first antipsychotic used en masse for schizophrenia was chlorpromazine (Thorazine), which was developed in the 1950s and was largely responsible for the deinstitutionalization movement in the 1960s. However, effectiveness of chlorpromazine and other first-generation drugs is tempered by the side-effect profiles of these medications (sedation, fatigue, dry mouth, motor side effects, memory impairment), which are largely responsible for their waning use in current treatment. These side effects also lead to high rates of noncompliance, and some clients receive injectable medications which last longer than traditional pills. First-generation antipsychotics block D2 dopamine receptors (dopamine receptor antagonists) in the temporal and frontal lobe dopamine circuits, and this mechanism of action is believed to lead to their antipsychotic effect. Since the blockade of dopamine receptors also occurs in the nigrostriatal pathway, these medications also lead to an array of extrapyramidal symptoms (EPS). EPS symptoms include motor abnormalities such as dystonia (painful muscle contractions/spasms), akathisia (restlessness, pacing, inability to sit still), and medication-induced Parkinson symptoms (fine tremors, rigidity, gait problems, slowed cognition). Long-term administration of these first-generation medications can lead to the development of a serious medical condition called tardive dyskinesia (TD). TD consists of involuntary hyperkinetic movements of the face, tongue, limbs, fingers, and trunk. TD is considered irreversible and cannot be accurately predicted, but can be reduced by switching to an atypical antipsychotic medication with less dopamine D2 receptor antagonism or using the minimal effective dosage.

In the 1990s, atypical antipsychotics such as Clozaril were developed with promise of improved treatment for schizophrenia with greater efficacy and fewer side effects. As a general rule, atypical medications such as risperidol, ziprasidone, and aripiprazole are less potent antagonists of the D2 receptor system (less potential for EPS) and affect several neurotransmitter systems such as serotonin (5-HT_{2A/2C}), norepinephrine, acetylcholine, and glutamate (NMDA receptors). These medications tend to activate other dopamine receptors such as the D1, D3, D4, and D5 receptors in the brain as compared to a nonspecific blockage of D2 receptors found in first-generation medications. Thus, these drugs are more specific in terms of their effect on the dopamine system. It is now recommended that atypical medications be considered the first line of treatment for schizophrenia due to a lower risk for EPS in these medications. However, atypicals do have their share of potential side effects such as sedation, weight gain, abnormal heart activity (QT interval slowing),

and diabetes. It was hoped that atypical medications, due to their impact on different neurotransmitters, would also improve cognition, but results have been generally disappointing in recent years.

Psychological Treatments

There are a number of psychological treatments for schizophrenia, but only those that have some degree of research support (e.g., evidence-based treatments) are considered appropriate. Behavioral treatments have fared well in research; many efficacious treatments involve behavioral or modeling components. Some of the more common therapies will be presented here.

Behavioral interventions using reinforcement and punishment to reduce hallucinations and delusions have the longest history, but the use of a token economy system has shown the most effectiveness. Token economies are program or hospital level treatments based on the reinforcement of adaptive behaviors using tokens (most often points, checks, etc.) that can be cashed in for privileges or tangible items. For example, if a person attends group therapy they earn ten points. Points are accumulated to obtain some item or goal that is desirable for the client. When implemented correctly, these are very effective. However, these programs are costly and require substantial training and fidelity along with administrative support to work in real-world settings.

Social skills training (SST) is aimed at improving the social functioning and competence of persons with schizophrenia. Persons with schizophrenia have consistently been found to have poorer social skills than persons with other psychiatric disorders. SST provides instruction on conversation skills such as how to begin, maintain, and end conversations, express emotions appropriately, and resolve interpersonal conflict. Each social skill is broken down into different units such as verbal, paralinguistic, and nonverbal components. To facilitate learning, SST involves didactic teaching, rehearsal, role-playing, corrective feedback, and modeling of appropriate social and communication skills, usually in a group setting. To reinforce gains made in the group session, participants are asked to continue to develop and practice these skills outside of the group sessions, which may improve the generalization of new skills into the real world. SST does improve specific social skills, but evidence for improved symptoms and community functioning or preventing relapse is less consistent.

Behavioral family therapy (BFT) is based on teaching adaptive coping skills to ameliorate the deleterious effects of stress on schizophrenia (i.e., EE). The treatment works to reduce negative, hostile, and overly critical communication patterns found in families. There is a clear link between EE and higher rates of relapse. BFT emphasizes psychoeducation about the symptoms and causes of schizophrenia, communication exercises, and group problem-solving activities. BFT can be conducted with a single family unit or with multiple families. BFT has shown to lower relapse rates from about 60% to 30%.

Cognitive-behavioral therapy (CBT) has seen a tremendous increase in popularity since the 1990s as a treatment for schizophrenia, and it can be argued that CBT has the most research support of any treatment. The most common applications of CBT are in the treatment of delusions, hallucinations, and negative symptoms, which allows a very specific treatment

focus. CBT assumes that psychotic symptoms develop from information processing biases in attention, appraisal, attribution, and belief formation. CBT for schizophrenia grew out of the work of Aaron Beck in his seminal work on depression. Delusions and hallucinations are modified by challenging the evidence for a person's beliefs. Cognitive restructuring, behavioral experimentation, teaching and practicing coping skills, generating alternative attributions for events, and behavioral activation are common techniques. Although CBT has tremendous promise, there remains a lack of dissemination and implementation in the United States. However, in the United Kingdom, CBT is considered a front-line treatment offered to all persons with schizophrenia.

Other treatments of note include: (1) assertive case management (ACT), (2) cognitive remediation, and (3) supported employment. ACT teams provide intensive support and medication services to clients in their homes, and the idea is to meet the clients where they are, whether in the home or on the street. Medications are delivered and administered to clients to increase compliance rates. Cognitive remediation targets the neuropsychological and cognitive impairments found in schizophrenia. Repeated cognitive exercises and computer games are used to improve attention, memory, visual processing, and problem solving. It is believed that improving basic cognitive ability will lead to better social and community functioning. Given the high rates of unemployed in schizophrenia, supported employment programs provide training to clients prior to and during employment. Clients are taught the basics of their job, how to interact with others, and how to manage stress and symptoms. Supported employment works best when the client is placed in a job and then trained (rather than trained and then placed later).

Conclusions

Schizophrenia is a chronic psychiatric condition that affects over 50 million persons worldwide and is characterized by positive symptoms (hallucinations, delusions), negative symptoms (social withdrawal, flat affect, apathy), and impairments in cognitive (executive functioning, memory) social-cognitive (emotion perception), and social functioning. There is no consensus on the etiology of schizophrenia, but there appear to be both biological and environmental factors involved in the development, course, and outcome of the disorder. In terms of treatment, antipsychotic medications are considered the first line of treatment and show efficacy in reducing symptoms, especially positive symptoms. However, adherence rates to medications are low, even with the widespread use of newer atypical medications. Psychosocial treatments such as CBT have led to further improvement in functioning or a reduction in symptoms that do not respond to medication therapy. The combination of medication and psychosocial treatments leads to the best outcome and has provided a renewed hope for recovery for those persons with the condition.

See also: Delusions; Hallucinations; Social Cognition; Schizoid and Schizotypal Personality Disorder.

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Selective Mutism

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Glossary

Contingency management Behavioral intervention that involves the structured provision of rewards for certain behaviors. The value of performing each behavior is clearly specified in advance.

Exposure Exposure is a procedure used in behavior therapy than involves, under therapist-controlled conditions, placing individuals in contact with an object, event, or situation that they fear.

Selective mutism A consistent failure to speak in specific social situations (in which there is an expectation for speaking, e.g., at school) despite speaking in other situations.

Shaping Shaping is a process by which an individual's behavior is reinforced to achieve a predetermined status.

Systematic desensitization A form of behavior therapy that combines the use of gradual exposure and relaxation skills to approach more anxiety-provoking situations.

The term selective mutism (SM) used to describe the failure to speak in social settings has undergone an evolution over the past 130 years. The condition was first described by Adolf Kussmaul in 1877, who labeled it *aphasia voluntaria*. The use of this term conceptualized this disorder as one in which children *voluntarily* withheld speech. This label was later changed (in 1934), when the term *elective mutism* was proposed by Swiss child psychiatrist Moritz Tramer. Still, the term implied that children with SM elected or chose to remain quiet in social settings. Whereas the current *International Classification of Diseases – Tenth Edition* has retained the term *elective mutism*, other diagnostic schemas such as the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition Text Revision (DSM-IV-TR) changed the term from *elective* to *selective* in an effort to avoid previous conceptualizations of the behavior as inherently volitional (i.e., the child actively refusing to talk). Thus, whereas the ICD-10 continues to conceptualize SM as a withholding of speech in social settings, the change in wording from 'elective' (voluntarily deciding not to speak) to 'selective' was an effort to remove the connotation that children with this disorder were deliberately oppositional and replace it with the connotation that it was the situation, and not the child, that was responsible for the lack of speech. Despite the change in term in the DSM, the controversy regarding the presence of oppositional behavior in at least a subgroup of children with SM remains.

Diagnosis

According to the DSM-IV-TR, SM is defined "as consistent failure to speak in specific social situations (in which speech is expected, e.g., at school) despite speaking in other situations" (p. 125). The most common presentation of SM is a child who speaks freely (and often loudly) when at home in the company of parents or siblings. However, when other individuals (often including grandparents) come to the home, the child 'clams up' refusing to speak, often refusing to make eye contact and sometimes hiding in another part of the house. Similarly, a child with SM who speaks at home will refuse to speak in any environment outside of the home, even if in the

presence of parents, if there are other people who might overhear the conversation. At these times, parents often report personal frustration or embarrassment because adults are speaking to their child and the child stares back but does not respond. Parents fear that this refusal to speak will be perceived as 'rude' by other adults and parents quickly respond for the child. Although this negates parental distress, it also allows children to escape from what is perceived to be an uncomfortable situation, and perhaps sets up a pattern of continued avoidance of verbal communication (see section 'Etiology'). In school, when parents might not be available, children will often turn to a classmate to verbally communicate their needs to a teacher.

The use of the phrase 'verbal communication' in the above paragraph is a deliberate choice on our part. Often, nonmental health professionals interpret a 'failure to speak' as a failure to communicate. In fact, children with SM are often able to communicate quite effectively through nonverbal means. Gestures, pointing, nodding, writing, and even using email are some the means that children with SM use to communicate their needs. Therefore, these children can express themselves even without the use of verbal communication.

Simple failure to speak in situations where speech is accepted is not sufficient for a diagnosis of SM. This failure to speak must interfere with educational/academic achievement or with social communication. In many instances, children with SM do have difficulty in school. Although most children with SM appear to learn, it is often difficult for teachers to determine the child's academic achievement. Children refuse to read aloud making it difficult to assess their reading skill. Similarly, because they refuse to speak, they do not answer questions in class or ask the teacher for help, leading to distress on the part of the child and frustration on the part of school personnel.

In addition to the need for SM to result in distress or functional impairment, the diagnostic criteria require that the duration of the disturbance must be at least 1 month and not limited to the first month of school. Indeed, social reticence in novel situations is common and often occurs, even among children who do not have SM. Therefore, it is important to allow children to become familiar and comfortable in new situations before raising concern about limited speech in

these settings. Even if children remain in the same school, the start of a new school year, with a new teacher, a new classroom, new school subjects, and perhaps even new classmates, may create sufficient novelty and elicit temporary distress. Thus, there is a need to allow any child to adjust to new surroundings prior to determining the existence of SM.

Interestingly, the refusal to speak does not always interfere with the children's ability to establish friendships. Following the diagnostic subgrouping used for social phobia, Cunningham, McHolm, and Boyle examined the social skills and social relationships of children with either specific SM (e.g., did not speak to teachers but spoke to friends at school) or generalized SM (e.g., spoke only to parents at home). Despite their subtype designation, children with SM had similar scores on parent-rated measures of social phobia, generalized anxiety, and obsessive-compulsive disorder (OCD) symptoms. Furthermore, parental and teacher reports revealed that children in both SM groups had significantly poorer verbal and nonverbal social skills when compared to controls. Despite this, children with SM did not see themselves as less accepted by peers. Therefore, even though adults perceive significant psychopathology among children with SM, this condition may not always seriously impact children's ability to interact with peers.

The diagnostic criteria require that the failure to speak is not due to a lack of knowledge of, or comfort with, the spoken language required in the social situation. Therefore, a diagnosis of SM must be cautiously applied when evaluating children who have recently moved from another country, and/or for whom the language spoken at school (or in other settings) is not their first language. In such cases, it is important to determine if the same pattern of behavior existed prior to the move to a new country or culture. Similarly, SM is not diagnosed if the lack of speech is part of a larger communication disorder such as stuttering or only occurs as part of other disorders such as pervasive developmental disorder, schizophrenia, or another psychotic disorder.

Epidemiology

SM typically begins between 3 and 5 years of age. Yet, even though refusal to speak occurs at such a young age, the determination that the child has a psychological disorder does not necessarily occur until the child enters situations where failure to speak is problematic – such as formal schooling. Since children speak at home, parents may not initially view the behavior as problematic. Thus, there is often a considerable lag between initial failure to speak and referral to a mental health specialist. The delay from onset to identification and diagnosis holds out the possibility of entrenchment of the mutism behavior and has implications for treatment and service delivery. Specifically, intervention for children with SM is intensive and extensive. Therefore, earlier identification could lead to earlier intervention thereby shortening intervention length and perhaps preventing or limiting functional impairment.

Relationship to Social Anxiety Disorder and Shyness

Although it is possible that SM could exist in conjunction with many other disorders, children with SM most often exhibit an

anxious affect, show social avoidance, and are very often comorbid with social phobia, with rates ranging from 61 to 97% of children with SM also meeting criteria for social phobia, depending on the particular characteristics of the sample, leading some researchers to propose that SM may not be a separate disorder but a severe and developmentally appropriate variant of social phobia.

By conceptualizing failure to speak as a behavioral avoidance strategy designed to eliminate distress, it is possible to examine the idea that SM represents a developmentally appropriate and/or severe variant of social phobia. To date, most of the research has addressed the issue of severity and has compared children with SM and comorbid social phobia to children with social phobia alone. In the following review, we will refer to children with SM and comorbid social phobia simply as children with SM. In one of the initial investigations, Manassis and her colleagues found that children with social phobia and children with SM scored similarly on a number of standardized measures of general anxiety and social anxiety. In our research clinic, children with SM were rated by parents and observers as more socially distressed than children with social phobia alone. However, in our clinic, the groups were indistinguishable in terms of self-report measures assessing social anxiety, trait anxiety, and general fears.

Furthermore, research data suggests that children with SM are not anxious in general. Rather, their anxiety is restricted to social situations and social conversation. For example, children with SM self-reported significantly higher social anxiety than children with other anxiety disorders and controls. However, children with other anxiety disorders reported greater overall anxiety than children with SM and controls. Thus, children with SM are not just overly anxious – rather their anxiety appears to be specific to social situations. Overall, the data suggest that there may be a special relationship between social phobia and SM, although not all researchers are in full agreement. Alternatively, it may be that as a result of their behavioral avoidance, children with SM may underreport anxiety symptoms.

Oppositionality

As noted above, a number of children with severe social phobia symptoms do respond to verbal communication by others. In an effort to identify factors that might differentiate children with SM from other children who have social phobia, a number of clinicians have pointed to refusal to speak as evidence of an oppositional behavior style. Overall, there is minimal evidence for the presence of significant externalizing disorders, such as conduct disorder or oppositional defiant disorder in children with SM although they sometimes display oppositional symptoms/behaviors. However, this type of behavior (e.g., refusing to engage with an anxious object, situation, or event) also exists among children, and even adults, with other types of anxiety disorders. Thus, the presence of oppositional behavior, whether it is refusal to leave a parent (as in the case of separation anxiety disorder) or refusal to speak (as in the case of SM), may indicate the presence of severe anxiety and not oppositional defiant disorder. The distinction between the presence of oppositional behaviors and oppositional defiant

disorder is important to emphasize, as many parents often hear the work 'oppositional' and conclude that the therapist is labeling their child as being deliberately oppositional rather than understanding anxious emotionality as the probable basis for the behavior.

Etiology

There is no single identified etiology for SM. As with many other conditions, it is likely that biological, psychological, and environmental factors play a role either singularly or in various combinations. There is a strong family history of social phobia, avoidant personality disorder, taciturnity (minimal speech), shyness, and SM among the first-degree relatives of children with SM. These results, further supported by numerous clinical observations, indicate that a genetic predisposition must be considered. However, it is important to note that when disorders 'run in families,' mechanisms such as vicarious conditioning and information transfer may be as important as genetics.

A number of investigations have examined the presence of neurological deficits, neurodevelopmental delays, language abilities, and auditory processing deficits among children with SM. In many instances, research data suggest a significantly higher presence of speech/language abnormalities among children with SM when compared to children with no disorder. There are two important caveats to keep in mind. First, even though much of the research finds a significantly higher rate of speech/language deficits among children with SM, the rates of abnormalities do not exceed 50% of the sample, suggesting that the deficits that might exist do not account for a substantial number of cases of SM. Second, there are different abnormalities reported in different studies and the findings are not consistent, discounting the idea that there is a consistent abnormality that accounts for a substantial number of cases of SM.

Traumatic experiences have been suggested as an etiological factor, but data from controlled empirical trials do not support this hypothesis. However, as noted above, parents may be deliberately or inadvertently contributing to the onset and/or maintenance of this disorder in one of two ways. First, as noted above, a number of parents of children with SM also have social phobia, avoidant personality disorder, SM or exhibit minimal speech in social encounters. Thus, these parents may model anxious behaviors and/or limited speech in social encounters and children may learn to imitate this pattern of behavior.

Parents and teachers, among others, often reinforce nonresponse to social overtures by (1) continuously asking the child to 'please answer,' setting up a contest of wills (which the child will always win) or (2) answering for the child. Behaviors such as these often have the opposite effect on children with SM. That is, parental attention to 'not talking' often strengthens the child's lack of speech. For example, clinically, it has been our experience that when the child will not answer an adult, the child is encouraged to whisper the response to the parent, who will respond for the child. This strategy allows the child to get what he or she might need but also the attention that the child receives sets up a pattern of reinforcement for not speaking. Teachers and classmates often participate in

reinforcing silent behavior. In particular, classmates are often used by the child to request permission to go to the bathroom, ask a question, etc. In such cases, there is little motivation for the child to speak, as there are alternative ways of getting what the child needs/desires. In order for therapy to be efficacious, all relevant parties must be trained to discontinue reinforcement of nonspeaking and reinforce the child for any attempts at speaking (see section 'Treatment').

Assessment

Exemplary assessment of SM requires that clinicians draw information from various sources. Given the clinical symptomatology of the disorder, the child is often unable to provide an adequate description of their experiences. Therefore, information shared by the parent is essential to the assessment of SM. The Anxiety Disorders Interview Schedule for Children and Parents is a semistructured clinical interview that gathers information pertaining to SM, as well as other anxiety and psychiatric disorders. Items of the ADIS-C/P assess DSM-IV diagnostic criteria as well as vital features such as symptom history, age of onset, and situations in which the child displays mutism. Furthermore, the ADIS-C/P allows for severity ratings to be assigned to each diagnosis. Although it is unlikely that children will verbally respond to the interview questions, we have found that oftentimes, they respond in nonverbal fashion, giving a 'thumbs up or thumbs down' for 'yes' or 'no' and using the feelings thermometer included in the ADIS-C/P to allow children to point to their estimated level of distress.

Another method through which a parent may relay information is the SM Questionnaire (SMQ), a 17-item parent report measure. The SMQ consists of items that assess for speaking behavior in three general situations: at school, at home or with family, and in public. Parents rate each behavior on a 4-point Likert-type scale that ranges from 0 (never) to 3 (always); thus, lower scores on the SMQ represent fewer instances of speech from the child. The SMQ has demonstrated excellent internal reliability and consistency and convergent validity with the ADIS-C/P clinical severity ratings. Additional studies replicate the strong psychometric properties of the SMQ and support its incremental validity when used with other measures of child anxiety.

Although it is difficult to interact directly due to the mutism, behavioral observation remains a useful approach to examining first-hand the nature of impairment (i.e., whether or not the child engages in nonverbal communication). Moreover, examining the specific situations, people, and events that are associated with each child's specific refusal/inability to speak will allow parents and therapists to identify characteristics that elicit or maintain the lack of speech in certain settings.

The developmental history is a critical consideration when evaluating SM. Potential neurological deficits should be considered to rule out other conditions that may better explain language difficulties and delay. Additionally, a thorough speech and language assessment could identify potential speech problems that may be contributing to SM. This may be particularly important if parents report articulation or fluency difficulties that are observed when the child is at home. Audio-taped samples of 'normal' speech with family members

may be used to determine fluency, semantics, phonetics, and expressive syntax. By identifying potential difficulties in the child's speech, assessors may begin to ascertain and address the factors influencing mutism across other situations.

Because schoolteachers typically have extensive interactions with their students, they are important sources of information in the assessment of SM. Schoolteachers may provide descriptions of verbal and other communicative behaviors in school settings. They furthermore may identify peers/classmates to whom the child speaks and who may assist at later points of the intervention. Schoolteachers may also provide descriptions of the situations in which the child is most or least likely to verbalize and may report on the success of previous intervention attempts.

Treatment

Within the past 15 years, several reviews have summarized the efficacy of psychosocial and pharmacological interventions to treat SM. The treatment literature for SM is relatively small, with many studies having methodological weaknesses (i.e., lack of comparison groups). Currently, most investigations consist of single case studies. Thus, the need for larger randomized controlled trials is evident but may be limited by the relatively rare nature of this disorder. The literature on treatment includes a broad range of modalities, including play therapy, family therapy, behavior therapy, cognitive-behavior therapy (CBT), and multimodal interventions. However, critical reviews of the extant literature conclude that behavioral interventions offer the most robust evidence for efficacy. Newer CBT approaches also have support for their effectiveness, including a web-based CBT program for children with SM.

Behavioral interventions for SM include exposure-based practices such as systematic desensitization, shaping and stimulus fading, self-modeling, social skills training, and parent-based contingency management. Systematic desensitization traditionally involves the use of gradual exposure and relaxation skills to approach more anxiety-provoking situations. The therapist also assists the child in developing a fear hierarchy so that the feared speaking situations are targeted in order of difficulty. There is evidence that systematic desensitization is effective in increasing speech with peers and teachers and reducing anxiety related to speaking. However, systematic desensitization and relaxation techniques may work better for older youth, with younger children benefitting more from *in vivo* exposure, due to difficulty with imaginal exercises. Similarly, cognitive techniques used in CBT (i.e., cognitive restructuring, coping plans) may be more effective for older youth with SM relative to younger children.

Contingency management techniques involve positive reinforcement for nonverbal communication (i.e., pointing, nodding) and eventually verbal communication through shaping, where approximations of the target behavior (i.e., mouth-ing words, whispering) are reinforced. Once contingency management is implemented successfully, stimulus fading interventions can be used by rewarding speech after gradually increasing (i.e., fading in) the number of people and places to which the child is exposed. It can be helpful to begin shaping and fading procedures with a friend or family member to

whom the child already speaks before adding unfamiliar people to the group. With parent-focused techniques, therapists can also train parents to continue with contingency management in scenarios encountered regularly (i.e., restaurants). Although there is support in the literature for both contingency management and stimulus fading, follow-up studies are needed to confirm if gains made in treatment are sustained after the reinforcement is ceased.

Self-modeling is an effective and convenient technique to increase speech. Self-modeling involves creating and playing video and/or audiotapes repeatedly of the child speaking. It is expected that the child habituates to hearing their voice in settings where they previously remained silent. It is important to note that sometimes children refuse to record their own voices. In addition, if not done correctly, listening to a recording of their voice could make the child's anxiety worse. Thus, this procedure should be done under the guidance of a mental health clinician.

Since children with SM may begin to avoid social interaction with peers at an early age, positive interactions may be thwarted by the lack of appropriate skills to initiate and maintain friendships. Social skills training may be used to facilitate speech in instances when the child has anxiety related to peer interaction. In a randomized trial comparing children with social phobia (without SM) who received fluoxetine alone and those who received a combination of medication and social skills training, deficits in social skill remained for children who received the medication alone, despite reporting a decrease in anxiety related to social situations. Because children with SM most likely suffer from social phobia, these data suggest that children with SM may have similar positive outcomes with the inclusion of social skill training.

Many approaches in treating youth with SM combine behavioral procedures, thus limiting the ability to identify the efficacy of any one treatment component. When exposure-based practices and parental contingency management practices were compared, exposure-based practices were superior at increasing words spoken audibly and daily in public situations. Empirical support for differential effects of behavioral techniques may lead to increased gains and cost-effectiveness in treatment.

For more than a decade, researchers have been concerned about the considerable gap existing between the frequency with which physicians prescribe pharmacological treatments to children with SM and the limited empirical data supporting the prescribed medications. Currently, the majority of studies examining the efficacy of medication are single case studies, which limit the external validity of the findings. A review of the literature has examined the effectiveness of selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors, and depressants (i.e., nitrous oxide). Although there is some support for all three forms of medications mentioned, SSRIs (i.e., fluoxetine, paroxetine, sertraline, fluvoxamine, citalopram) appear most promising for youth diagnosed with SM. Medication is recommended only for those children who have a chronic condition and are unresponsive to other forms of treatment (i.e., psychosocial and behavioral). Researchers also note that youth treated with fluoxetine remain highly symptomatic once treatment ends and that side effects are common. Since the United States Food and Drug Administration placed 'black box' warnings on these medications to alert consumers

of the risk of suicidal thoughts or self-harm, clinicians and physicians must carefully monitor youth on SSRIs. Future research is needed to assess how youth with SM function once medication is discontinued.

Since SM may otherwise have an extensive treatment course, increasing awareness of SM to target school teachers, physicians, and parents, may increase the early identification and possibly improve treatment outcome. Since maintenance of the disorder may be highly influenced by the child's environment, a collaboration of efforts with parents, teachers, and the child's friends proves promising in reducing the cycle of reinforcement the child receives for not speaking. Overall, much more research is needed in many areas (i.e., longitudinal studies) to better conceptualize SM and identify the best modes of treatment.

See also: [Anxiety Disorders](#); [Social Anxiety Disorder](#).

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Self-Defeating Behaviors

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Glossary

Learned helplessness A failure to exert behaviors to avoid negative consequences when such behavior would be effective after experiencing uncontrollable outcomes.

Procrastination Procrastination is knowing that one needs to perform a task, but not motivating oneself to do it within a defined period of time.

Self-defeating behaviors Self-defeating behaviors are those that make more likely a consequence that the person tried to avoid. They lead to a lower reward/cost ratio than available through alternative behaviors.

Self-fulfilling prophecies Self-fulfilling prophecies are beliefs that individuals make happen by their actions, sometimes enlisting others to aid in making the predicted events come to pass.

Self-handicapping behavior The process whereby a person creates or chooses obstacles to behavior or a performance setting, for the purpose of protecting self-esteem in response to an esteem-threatening situation.

Self-regulatory behavior Self-regulatory behavior involves setting different goals, assessing progress toward goals, emotional reaction to progress or the lack thereof, and shifting resources toward either attaining or giving up goals.

Self-defeating behaviors are generally viewed as behaviors that enable people to maintain a particular view about themselves, but which lead to certain consequences the individuals would have preferred to avoid. Any behavior if overused can become self-defeating when people do not have a wide and flexible repertoire of responses to differing situations. A self-defeating behavior is any deliberate behavior that will likely have a negative effect on oneself or one's goals. Specifically, however, a self-defeating behavior is any behavior that leads to a lower reward/cost ratio than was available through an alternative behavior or behaviors. Self-defeating behaviors include choosing to suffer, self-handicapping, failure to achieve potential, fear of success, learned helplessness, procrastination, and impulsivity. A person may procrastinate in handing in an assignment, for example, in order to try and do a better job, but get a lower work evaluation due to the delay. Or a person may avoid a social situation out of fear of rejection when the primary motive is to make more friends.

Self-defeating behaviors are learned in a variety of ways, but usually they are initially adaptive in preventing greater suffering or in obtaining rewards in the situations in which they are originally learned. For example, parents may be less punitive if children are self-critical after doing something the parents do not like than if children do not derogate and punish themselves. Such self-critical behavior can subsequently become a self-defeating pattern. Self-defeating behaviors often occur as a consequence of situations that are uncontrollable. For example, if children are punished even when they believe they have behaved well, or if they are rewarded even when they have behaved poorly, they may gain the impression that their behavior does not matter. Then 'learned helplessness' is said to occur because the child feels that he or she is not in control of what is happening. On the other hand, persistence at tasks can become counterproductive when it prevents people from engaging in more valuable experiences or when it leads people to exhaust their resources in futile endeavors.

Baumeister and Scher (1988) identified three potential types of self-defeating behaviors: (1) primary self-destructiveness,

(2) trade-offs, and (3) counterproductive strategies. They found no evidence for primary or deliberate self-destructiveness among normal individuals. Trade-offs occur when people act to gain short-term benefits despite long-term costs – behaviors especially likely to occur when people are emotionally aroused and/or highly self-aware. For example, shy people may avoid social situations out of a fear of making a bad impression. Their avoidance of people may lead to a greater social exclusion in the future, resulting in their becoming even less confident. They trade the possibility of intimacy to avoid short-term rejection. Or, the cost of medical treatment may lead people to discontinue it when they do not perceive symptom relief. Failure to comply may exacerbate their condition in the long run. Counterproductive strategies involve misjudging one's capabilities or the realities of the situation. An example is choking under pressure. Here, one may carefully monitor performance in order to do one's best, but the monitoring itself may lead to more anxiety and a poorer performance.

Self-defeating behaviors may follow from rejection and exclusion. Although prosocial acts would help individuals to be accepted by a group, several studies have shown that the rejection leads people to be less prosocial and more aggressive, further reducing their chances of acceptance. Narcissistic people also engage in more self-defeating behaviors, but this relationship is often mediated by impulsivity and lack of self-control. Sometimes, it is also related to grandiosity, as in the case of gambling.

Maladaptive Cognitive Schemas

'Maladaptive cognitive schemas' are considered by many psychotherapists to be related to all self-defeating behaviors. Maladaptive schemas may be that others are not reliably available to provide support or protection, that one will inevitably fail or be inferior to one's peers, that something bad will happen at any moment, and that one should surrender one's needs or emotions to avoid anger or rejection from others.

Maladaptive beliefs are more likely to persist if people provide explanations for them. Some maladaptive thinking patterns are selective abstraction, overgeneralization, dichotomous or black-white thinking, maximization and minimization, and personalization.

Self-Fulfilling Prophecies

In many situations, people use their preconceived beliefs to guide their behavior. These behaviors may in turn influence others to act in ways that confirm the initial beliefs. This phenomenon, in which belief creates reality, is known by several names such as self-fulfilling prophecy, expectancy confirmation, and behavioral confirmation. Teachers who were led to expect that certain students (actually selected randomly) would 'spurt' during the school year acted in ways that created a self-fulfilling prophecy so that the actual performance of these students improved as measured eight months later.

Self-defeating behaviors often simply reflect these self-fulfilling prophecies or expectancy-confirmation processes. If we think that we are not good at a particular task, we do not try our best, and then we perform more poorly than if we had thought that we could excel. People also often internalize the expectations held by others as to their gender, race, or social class and then engage in behaviors to confirm others' prophecies. If such expectations are negative, then they are self-defeating. For example, when people were led to believe, through deception, that another person disliked them, they sat further away, engaged in less eye contact, and disagreed more than people who were led to believe that the other person liked them. Research has also investigated people who are 'rejection sensitive,' people who expect others to reject them. Women who are rejection sensitive are more hostile to their partners and thus elicit the rejection they expect. They do not simply choose partners who are more rejecting.

People who expect something bad to happen may not only make it more likely to happen, but may also do something else that is unpleasant to themselves, or they may choose to suffer. Sometimes people appear to 'choose to suffer' in an effort to improve (magically) their outcomes in some other situation. Such behavior may stem from an unrealistic extension of the work ethic. Research has shown that people expecting an unpleasant event are more likely to choose to engage in another unpleasant activity during the waiting period if they change their beliefs about themselves, such as thinking either that they are brave or that they deserve to suffer. If they change their beliefs about the situation, such as thinking it would not be so bad after all, they are less likely to engage in an unpleasant activity during the waiting period. People who 'choose to suffer' also expect to score higher on a subsequent task. They appear to believe that if they chose to suffer, they were likely to be rewarded. People have also been found to choose to suffer after failing tests. In one experiment, participants who were led to fail five tests shocked themselves more than participants who were led to fail only two tests.

Studies of masochistic-like behavior have been conducted mostly with animals. Dogs that were given a mild shock before feeding eventually gave indications of welcoming the unpleasant experience. Human infants who were given a needle prick

followed by feeding also appeared to show a pleasurable anticipation. Cats that learned to depress a switch for shock and food continued to press the switch when the food was no longer forthcoming. These studies suggest that pain accompanied by pleasure might be sought after for itself. In other research, rats learned to escape shock in a starting box. Then the shocks in the starting box were extinguished, but some rats got shocks in the alleyway. These rats continued to run to the alleyway, whereas rats that did not receive shocks there did not. These and other studies demonstrated that if there was an expectation of something unpleasant, animals and humans appeared to prefer having control over the advent of the unpleasant experience.

Self-fulfilling prophecies have also been referred to as 'vicious circles.' For example, if one feels unloved, unsafe, and unvalued, one develops a basic anxiety that inhibits spontaneity and leads one to adopt defensive strategies, such as avoiding other people or close relationships. This, in turn, leads to feelings of being unloved.

Fear of Success

Fear of success was an idea essential to Freud's concept of the Oedipal conflict. Freud noticed that some people appeared to have difficulty in achieving more success than their parents. He hypothesized that these parents were competitive with their children and that the children failed to achieve their potential in order to protect the parents' fragile ego, although both parties were usually unaware of these feelings and behaviors. Other psychoanalysts and clinical psychologists have noted the difficulty that children, including grown children, experience when leaving their parents. For example, a child may develop a school phobia. Something bad may have happened at school or the child may have a fear about what might happen to the parent, such as anxiety or alcohol abuse, if the child is not at home. A grown child may also worry about what will happen to a parent, for example depression, if he or she is not around to take care of the parent. This sort of fear of success has been called 'neurotic fear of success' and deals with a personality characteristic.

Research from a social-psychological perspective examines the conditions under which most people will act in ways to avoid success. Research in the 1960s and 1970s in the United States examined stories about what men and women who were first in their classes at medical and law school might have experienced. Although people wrote about positive consequences for men, the consequences for the women were often disastrous. These results were interpreted as reflecting social views about what happens to women who outperform men in areas where men have traditionally achieved greater success. This type of fear of success is known as 'feminine fear of success.' Subsequent research demonstrated that people avoid success, not surprisingly, in areas where success might indicate to themselves or others an undesirable personality characteristic.

Experimental research indicated that when participants achieved greater success than they had expected, and were then given a chance to change some answers, they changed right answers to wrong ones, appearing to make their

performance, although not necessarily consciously, more consistent with their previous expectations. Such research appears to confirm the notion that people often prefer consistency in expectations over unexpected success. When women were tested in the presence of men and blacks in the presence of whites, it was found that they had lower expectations of their performance than when tested in the presence of others of their own group. As discussed earlier, when people have low expectations regarding their performance, their performance is poorer than when they hold high expectations. Therefore, the performance of women was poorer in the presence of men than when they were alone or when they were in the presence of other women, and the performance of blacks was poorer in the presence of whites or even when they thought that their scores were to be compared with those of whites.

The personality trait of fear of success is called 'neurotic fear of success.' Parents of children who are high in fear of success intrude more in their children's activities – preempting, criticizing, and preventing independence. Success fearers are characterized by low or unstable self-esteem, and a preoccupation with evaluation and competition. Fear of success is also highly correlated with a fear of failure. In research regarding achievement motivation, these motives have been referred to as motives to avoid success and motives to avoid failure. Individual success in work or athletic achievement situations can have negative consequences for achievement in affiliation situations. For people who are motivated to avoid both types of experiences, achievement may be most sought after when it will provide the group with success. Success fearers can tolerate success when it contributes to the success of others and they need not fear retaliation or rejection. In athletics, this is sometimes the position of the 'choke' player. Here, the person avoids failure, but also avoids the anxiety of other people for whom his or her being more successful than they were might present a problem – real or imagined. At one college, all the best 'choke' players identified by three coaches were found to be high in fear of success.

Learned Helplessness

The learned helplessness hypotheses evolved from work in animal laboratories, where it was observed that dogs that were first subjected to inescapable shock did not attempt to escape shock when they were given the opportunity in a later condition. When outcomes are not related to behaviors but are independent, this sense of helplessness apparently develops. This can occur with unavoidable punishment or when rewards are given regardless of actions. This may, at times, occur with people who are very smart or attractive. Further research revealed that punishment contingent on responses also produced helplessness. A later distinction was made between personal and universal helplessness. Personal helplessness refers to the perception that events can be controlled by the actions of others but not by one's own. Universal helplessness refers to the perception of events as being beyond anyone's control. Personal helplessness occurs when a person has a low sense of self-efficacy, while universal helplessness occurs when a person has low outcome expectancies. When people feel helpless, they start to believe that nothing they do will improve their situation and so they do not try.

Learned helplessness is related to people's beliefs about control over life events, known as 'locus of control.' Some people feel personally responsible for the things that happen to them. These people are labeled 'internals.' Others feel that their outcomes in life are determined by forces that are beyond their control (e.g., fate, luck, and other people). These people are labeled 'externals.' People who are internally controlled are more likely to attribute their failures to a lack of effort and their successes to effort and ability. Obviously, most people fall between the two extremes, forming a continuous distribution of locus of control beliefs. Externals tend to exhibit less persistence at tasks. They are less likely to seek feedback and thus they may have more inaccurate self-assessments. Internality is positively related to a willingness to delay rewards in order to maximize them. Internals, especially if they are male, have a greater likelihood of achievement.

Self-Handicapping Behaviors

Self-handicapping behavior refers to the process whereby a person creates or chooses obstacles to behavior or a performance setting, for the purpose of protecting self-esteem in an esteem-threatening situation. In other words, the choice enhances the opportunity to excuse failure while accepting credit for success. Self-handicapping can occur when people receive positive information that they feel may be unwarranted. In order to protect a positive view of themselves, people may engage in some sort of excuse-making in advance in order to protect a positive, but precarious, self-view or self-esteem. Self-handicapping involves engaging in a behavior that is known to hurt performance, such as getting too little sleep, using a harmful substance, not studying, or not working hard. A person may choose a task so easy that success is meaningless or so difficult that success is unlikely. Success and failure in such situations do not provide information about one's comparative ability.

In the original research regarding self-handicapping, Berglas and Jones students were told they had performed exceedingly well on a test made up of questions that were impossible to answer questions, in one of the experimental conditions. They had 'succeeded' without knowing why or how. In the other condition, the problems had been soluble. The students were all expected to take a parallel form of the test after they took either a performance-inhibiting or performance-enhancing drug. The students who had been in the condition where the problems were insoluble were more likely to take the performance-inhibiting drug. The authors reasoned that if the students performed poorly, they could maintain their precarious view that they were brilliant and that the drug lowered their performance the second time. Subsequent work showed that the text-anxious and hypochondrical participants reported more symptoms during an evaluative task than did similar participants who informed that symptoms could not serve as an excuse for poor performance. Type A personality types were more likely to choose an inhibiting drug after receiving failure feedback on a task that was unrelated to their performance in comparison with Type As, who received the contingent success feedback and Type Bs who received either contingent success or noncontingent failure feedback. More

self-handicapping occurs in public conditions where others will also know what has happened, unlike in private conditions, but the phenomenon is not limited to conditions where others' views are a concern. The conditions that lead to self-handicapping also lead to the avoidance of evaluative information that is highly diagnostic of abilities. Self-handicapping appears to occur mostly among depressed individuals with an exaggerated perception of control.

Self-handicapping is correlated with low self-esteem, neuroticism, narcissism, perfectionism, elevated evaluative concerns, lower grade-point averages, increased substance abuse, and depression among depressed people who have exaggerated perceptions of control. Self-handicappers are high in public self-consciousness, social anxiety, other-directedness, depression, and are less agreeable, conscientious, extraverted and less open to experience. Although anxiety is a factor related to self-handicapping, anxiety can have additional effects. Self-handicapping appears to be related to a self-aggrandizing attribution style more than to self-presentational concerns. Those who are afraid of being seen as impostors also handicap more. Men are more likely to engage in active behavioral forms of self-handicapping, such as withdrawal of effort, taking drugs or alcohol, or listening to distracting music than women. Research regarding self-handicapping has been conducted cross-culturally with diverse groups, including Asians and Lebanese.

Excuse-making is related to self-handicapping. Excuses will protect one's image if certain principles are followed: First, excuses must be consistent with social conventions. For example, blaming others has significant social costs. Second, excuse-making should be ambiguous. Excuses do not work if they are found to be inconsistent with certain facts. Third, an excuse should not be used often enough for a personality label to apply such as alcoholic, depressed, or procrastinator. Fourth, an excuse maker may have to choose between negating responsibility for an act and negating the wrongfulness of an act. The excuse maker may take responsibility but provide a justification for the act, to reduce the perception of wrongfulness.

Taking responsibility for a failure or for a negative event, including self-blame, can have obvious benefits. The person can then assess how to handle situations differently in the future. For example, it can be adaptive for victims to blame their behaviors for their experience, although it is not adaptive to blame personality traits that are not modifiable.

Procrastination

Procrastination is knowing that one needs to perform a task, but not motivating oneself to do it within the defined period of time. People who procrastinate have a more diffuse sense of identity than people who begin and complete tasks promptly. The beginning of difficult and unpleasant tasks is delayed. Anxiety from fear of failure or fear of success affects the beginning of a project, whereas perfectionism affects the completion of a task. Once procrastinators begin a task, they make more errors. Those who procrastinate in making decisions are systematic in requiring more information about choices and have not been found to be more distracted. However, they

are less tolerant of uncertainty. Overall, procrastination has been found to be positively correlated with a large number of variables: fear of failure, depression, guilt, anxiety, evening proneness, rebelliousness, indecision, irrational cognitions, public self-consciousness, perfectionism, parental criticism, and parental performance expectations. Not surprisingly, procrastination is also related to cheating and plagiarism. It is negatively correlated with optimism, confident feelings of control over one's life, dominance, self-esteem, global life satisfaction, and intrinsic motivation. Putting off a task can engender a self-destructive cycle. Although putting off the task enables people to avoid anxiety temporarily, by delaying they set themselves up for even stronger negative emotions when forced to confront the task, and for self-blame afterwards.

Low conscientiousness is related to procrastination and ability to delay gratification. High conscientiousness, however, can lead to persistence and irrational commitment in order to save face. High achievement strivers who are high in conscientiousness may escalate commitment to a losing proposition.

Perfectionism

The most common definition used for perfectionism is the tendency to establish excessively high personal standards of performance. Maladaptive perfectionism is associated with depression, stress, obsessive-compulsive disorder, eating disorders, and suicide. Research has shown that perfectionism itself is multifaceted and requires distinctions to be made between self-oriented perfectionism (i.e., high self-standards and motivation), and two interpersonal dimensions described as other-oriented perfectionism and socially prescribed perfectionism. Other-oriented perfectionists tend to have unrealistically high standards for others, whereas socially prescribed perfectionists believe that others are imposing perfectionistic demands on the self (i.e., my family expects me to be perfect). A distinction must also be made between people who need to be perfect and people who need to appear perfect. People who wish to appear perfect engage in self-promotion and do not display or disclose imperfections.

The avoidance of verbal disclosures of any perceived personal imperfections can lead to an avoidant interpersonal style. Perfectionists who are concerned about negative evaluation are less verbally expressive in social situations. This is in keeping with research that suggests that perfectionists who are concerned about social evaluation tend to be anxious. Social perfectionists demonstrate high levels of emotional control and social sensitivity. Emotional control is the ability to regulate displays of emotionality, and social sensitivity involves the skill to understand verbal messages from others. Maladaptive perfectionism is related to parents who are psychologically controlling, harsh, or critical.

Failures in Self-Regulation

Many behaviors are failures to self-regulate, such as overeating and other substance abuse, gambling, impulsive behaviors, and physical aggression. There appear to be limits to the extent to which people can expend energy to engage in self-control.

Self-regulatory behavior includes setting different goals, assessing progress toward goals, emotional reaction to progress or the lack thereof, and shifting resources toward either attaining or giving up goals. People appear to be able to tolerate failures to the extent that goals do not threaten survival or survival of the meaning system including their theories of themselves, others, and the world. When failure has a larger meaning, depression and/or anxiety often result. For others, attempts to control the uncontrollable can lead to high blood pressure and coronary illness.

The inability to delay gratification is one type of regulation failure. Delaying gratification requires sacrificing immediate rewards for distant but greater ones in the future. To delay gratification, a person must direct his or her attention away from the immediate lure and focus on the positive consequences of the distal pursuit. Too much self-control, however, can lead to problems in experiencing pleasure, depression, or anorexia. The self-control needed to overcome impulses and operate successfully may well be a limited resource, like energy. People who exert self-control over a variety of impulse-related behaviors, such as dieting and quitting smoking, subsequently have impairment of self-control. Self-control may get depleted.

One type of regulation failure is emotional self-absorption or excessive self-focus. Self-focus can be beneficial to self-regulation when the comparison to a standard is temporary and accompanied by high expectations. When this happens, people bring their behavior in line with the high standard. However, prolonged self-focus is self-defeating. It is counter-productive when people allocate limited conscious attention to their emotions, and leads to impairment of performance. Poor performers have more frequent 'off-task' thinking and misdirect attention toward emotional control rather than motivational control. Choking under pressure is an example of a behavior when people give too much attention to internal processes. If people are too self-focused, they may also fail to assess others' emotions accurately. They may fail to help others out or may actually hurt others.

Self-regulation requires ways of coping with threat and anxiety. Defenses can lessen the perception of threat and its ensuing emotional impact. Defenses include rationalization, intellectualization, humor, sublimation, projection, repression, idealization/devaluation of others, dissociation, and denial. Defenses that distort reality, such as projection and denial, are more self-defeating in the long run than those that do not, such as rationalization and sublimation.

As there are limits to how much information people can keep in consciousness at any given moment, people in threatening situations often cope by focusing on details and not seeing the larger picture or by concentrating on the whole situation without sufficient attention to particular details. Although this type of regulation has the advantage of maintaining conscious functioning and control without paralysis, information that is not attended to may be crucial. Memory is also limited and people may tend to forget unpleasant memories ('repressors') or to forget pleasant experiences (depressives). When people are not aware of their emotions, physical symptoms, and illness may result. Cognitions that are emotionally informed are preferable to cognitions that are disconnected from feelings. Awareness of emotions, even unpleasant ones, has advantages. College freshmen who write down their

feelings, for example, make fewer visits to the doctor. People who felt ill after listening to others speak of their experiences in a concentration camp had fewer physical symptoms and visits to a physician in the next year than people who reported not feeling that bad during and after the experience.

Self-Defeating Personality

A scale to measure self-defeating personality has been developed. Those who score high on this scale identify with a victim position. Self-defeating personality has been found to be related to memories of rejecting and nonsupportive parents and to a memory of an over-involved parent in men. Those with this personality style report their families to have been less cohesive. They report more ambivalent and avoidant histories of their mothers and men report more histories of avoidant fathers. The men say that their home environment discouraged expressiveness, lacked achievement orientation, and provided no moral or religious emphasis. People who score high on this scale are more depressed and have more suicidal ideation, especially females. They score lower in self-esteem and have more negative views of themselves, the world, and the future. With lower ego strength and more of an external locus of control, they have less adaptive coping strategies and engage in more denial, mental disengagement, alcohol, and drug use. They also have greater career indecisiveness, and self-defeating women have greater choice anxiety and less need for self-knowledge. These women are less argumentative and less assertive, with thoughts that inhibit them from making assertive statements. Those with self-defeating personalities score higher on social dependence, but the women also score higher on autonomy, suggesting that threats to their independence may be a source of depression as well. In relationships, women who have self-defeating personality describe their style of loving as game playing and being less romantically involved. Once in a relationship, both men and women with self-defeating personalities feel more dependent, jealous and more desperate to maintain the relationship. Women report more difficulty in dating. Those with self-defeating personalities report less self-reinforcement, and less pleasure and enjoyment from individual and social activities. Sexually abused persons are more likely to have self-defeating personalities but people in physically abusive relationships are no more likely to have this personality style.

Scores on the self-defeating personality scale are correlated with scores on a self-handicapping scale. A scale to measure chronic self-destructiveness was also developed. However, it is not a good measure of self-defeating behaviors, and is most useful as a measure of impulsive and self-centered behavior. Those high in chronic self-destructiveness feel more hopeless and are more involved in risky behaviors, such as cheating, aggressive and illegal behaviors, alcohol, and drug use. The self-destructive men, however, are less likely to engage in high risk sports.

Insecure Attachment Styles

Most of the behaviors studied by psychologists under the rubric of 'self-defeating behaviors' are related to achievement

situations. Self-defeating interpersonal behaviors are often more elusive and harder to investigate, unless they have reached the degree of severity to be labeled as a 'Psychiatric Disorder or Personality Disorder.' Recently, however, many psychologists have investigated the role of attachment styles that affect friendship formation and romantic relationships. Individuals who are confident that others will befriend them are considered 'secure' in their attachment style, while those who expect rejection are labeled 'fearful,' those who devalue others and relationships with them are considered to be 'dismissive.' Those who value relationships with others highly and tend to idealize others, and depend on them for their self-esteem are referred to as 'preoccupied.' Such attachment styles are measured in numerous ways, but these styles are predictive of many variables in life, with secure individuals engaging in fewer behaviors that are considered self-defeating and less likely to score high on the self-defeating personality scale. They are less likely to be rejected by others, to engage in infidelity, etc. These attachment styles begin as ways of coping with early relationships in life and often persist throughout the lifespan, although they can be altered by positive relationships, including psychotherapy.

Selective Attention and Memory

Considerable knowledge in psychology and psychiatry are needed to fully understand self-defeating behaviors. An examination of defensive styles and ways of coping is necessary in order to understand the ways in which people deal with threatening situations – and then repeat these successful responses in situations where these responses are no longer the most advantageous ones required. Self-defeating behaviors often involve self-deception. People tend to defend themselves against threats by focusing on the whole picture at the expense of details or on details at the expense of the whole picture. In other words, they selectively attend and inattend, and selectively remember and forget, experiences. Much perception and forgetting is thus self-defeating to some extent, although perhaps allowing a titration of information into consciousness, so that conscious decision-making and processing can continue to occur and prevent deterioration into paralysis or insanity. What might appear to be self-defeating may actually serve to preserve life itself or preserve the meaning-making system. Although not feeling emotions is self-defeating in many regards, it is helpful in other ways. Without understanding a human being as a whole, it is difficult to say with certainty what defeats the self.

Difference from Psychiatric Disorders

All clinical disorders could be considered as forms of self-defeating behaviors. The term 'self-defeating behaviors' is a more general term, however, that could apply to people who would not be considered as having a psychiatric disorder or a personality disorder. They may simply talk too much or too little, disclose too much or too little, or behave in numerous other ways that other people do not like. Many psychologists object to a disease model being applied to behaviors and

prefer terms such as 'problems in living,' 'maladaptive behaviors,' or even 'self-defeating behaviors' to all such difficulties. Most psychologists and psychiatrists consider psychiatric and personality disorders as more serious in nature, however, than the behaviors referred to here as self-defeating, unless such actions become chronic. These more serious disturbances are measured by such tests as the Minnesota Multiphasic Personality Inventory (MMPI) and the Millon Multiaxial Clinical Inventory (MMCI). Self-defeating behaviors can also be distinguished from self-destructive, self-injurious behaviors, and physical self-harm, which refer to cutting, burning, or mutilating oneself. They are also distinguished from substance abuse.

A specific category, 'self-defeating personality disorder,' was considered briefly by the American Psychiatric Association, drawn largely from characteristics that had been noted as masochistic by clinicians since the time of Freud. The criteria for the proposed self-defeating personality disorder, however, overlapped too much with those for dysthymic disorder (depression) and other personality disorders, such as dependent personality, borderline personality, and avoidant personality. Furthermore, feminists were concerned that women who were abused might get labeled as having a personality disorder that brought on abuse, thus leading to victims of abuse being blamed. Therefore, such a personality disorder was only included provisionally in the Diagnostic and Statistical Manual of the American Psychiatric Association and then deleted. This category was described as a pervasive pattern of self-defeating behavior, which begins by early adulthood and presents in a variety of contexts. The person may often avoid or undermine pleasurable experiences, be drawn to situations or relationships, in which he or she will suffer, and prevent others from helping him or her, as indicated by at least five of the following: (1) chooses people and situations that lead to failure, disappointment, or mistreatment when better options are available; (2) rejects or renders ineffective the attempts of others to help him or her; (3) responds with depression, guilt, or a behavior that produces pain, following positive personal events; (4) incites angry or rejecting responses from others and then feels hurt, defeated, or humiliated; (5) rejects opportunities for pleasure, or is reluctant to acknowledge enjoying himself or herself; (6) fails to accomplish tasks crucial to his or her personal objectives despite demonstrated ability to do so; (7) is uninterested in or rejects people who consistently treat him or her well; (8) engages in excessive self-sacrifice that is unsolicited by the intended recipients of the sacrifice.

Treatment

All forms of psychotherapy are designed to treat some form of what might be called self-defeating behavior. The major theoretical orientations of psychotherapy are cognitive-behavioral, psychoanalytic, and experiential or affect-focused. When people are frightened of situations, that is, when they are phobic or have panic attacks, behavioral treatments are usually the most effective. When people have unrealistic thoughts, cognitive treatments have been shown to help with catastrophization, discounting, and exaggeration of beliefs. When people are not clear as to what the problem entails, a treatment involving talking and ascertaining feelings that are not necessarily

conscious may be appropriate. For example, psychoanalysis has been oriented especially toward understanding if fears of hurting parents or other loved ones interfere with achieving personal goals, such as the fear of leaving a loved one all alone, being more successful than a parent, or not fulfilling loved ones' desires to impress other people. At some level, self-defeating behaviors avoid aversive affects such as anxiety, grief, or anger, hence the effectiveness of affect-focused treatments. Lack of motivation, anxiety, mood disorders, and unrealistic thinking are also treated with medication in combination with psychotherapy. Personality disorders, including the following types – obsessive-compulsive, schizoid, paranoid, histrionic, borderline, dependent, and narcissistic – often take longer to treat than problems such as depression and anxiety not accompanied by a personality disorder.

The Challenge of Treatment

Self-defeating behaviors often represent behaviors learned in one situation that are repeated in a new situation where they do not work. It is possible, however, that what may appear to be self-defeating to an observer may in fact act to avoid a further deterioration in a person vulnerable to extreme depression, paralysis, or a loss of sanity. Given the complexity of human beings, there are ways in which what appears to be self-defeating undoubtedly feels self-enhancing – if we are able to enter the other person's subjective experience. The reader is referred to the broader topic of the self. Herein lies the challenge of the treatment.

See also: Expectation; Perceived Control; Personality Disorders; Psychotherapy; Self-Efficacy; Self-Esteem; Self-Fulfilling Prophecy.

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Relevant Websites

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- www.psychologicalscience.org – Association for Psychological Science.
- www.isspd.com – International Society for the Study of Personality Disorders.
- www.authenticchappiness.sas.upenn.edu – Positive Psychology.
- www.spsp.org – Society for Personality and Social Psychology.
- www.personality.org – Society for Personality Assessment.
- www.berglas.com – Steven Berglas.
- www.millon.net – Theodore Millon.

Self-Efficacy

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Glossary

Agency A broader term that encompasses multiple psychological theories that emphasize the role of the individual in determining outcomes.

Mastery experiences The achievement of valued goals, which are proposed to be the most effective means of developing self-efficacy beliefs.

Mediator The mechanism by which an intervention or psychological factor influences an outcome.

Self-efficacy is proposed to be a crucial mediator of clinical interventions.

Meta-analysis A method of reviewing research literature that allows for the systematic integration of the results of numerous studies.

Optimism The generalized belief that positive outcomes will occur frequently in the future.

Self-efficacy The belief that an individual can execute the actions necessary to achieve a valued goal.

Introduction

Self-efficacy is defined as people's domain-specific perceptions of their ability to perform the actions necessary to achieve desired outcomes. The concept of self-efficacy was first proposed by Albert Bandura in 1977 in an attempt to provide a unified theory of behavior change. Bandura suggested that the effects of psychological treatments on behavioral change are mediated by self-efficacy beliefs. Importantly, the mediation of treatment outcomes via changes in the level and strength of self-efficacy beliefs is proposed to be universal across treatment modalities. The development of self-efficacy theory was therefore a critical development in the field of psychology because, to the extent that empirical evidence supports Bandura's hypotheses, self-efficacy theory provides a compelling and parsimonious explanation of how and why behavior can change. The lasting impact of self-efficacy is clearly demonstrated by the extraordinary amount of citations that the original 1977 manuscript has accumulated (more than 10 000 as of December, 2009), and the broad impact that self-efficacy theory has had on the various subdisciplines of psychology.

Defining Self-Efficacy

Self-efficacy has been a vibrant area of research for more than three decades, but there has often been confusion about exactly what self-efficacy beliefs are and what they are not. Before discussing the benefits of self-efficacy beliefs, it is therefore important to clearly identify what self-efficacy beliefs are and to clearly distinguish between how self-efficacy and similar theories describe human behavior.

Self-efficacy beliefs are defined as people's perceptions of their capability to execute the actions necessary to achieve a desired goal. Self-efficacy is not a perception of whether one *will* perform these actions or whether one *will* necessarily achieve the desired outcomes, but an evaluation of whether one *can* perform the necessary actions.

Self-efficacy beliefs are not a stable personality trait, but rather represent an evaluation of perceived capacity in relation to specific contexts or goals. Some researchers have proposed

using measures of generalized self-efficacy, but the extent to which these measures demonstrate incremental utility beyond the domain-specific measures has been inconsistent, and Bandura has consistently argued for the focus of research to be on domain-specific evaluations of self-efficacy.

Self-efficacy beliefs do not necessarily reflect an individual's intention or motivation to pursue a particular goal. It is possible to feel extremely efficacious for a goal or task that one cares little about or to feel ineffective about extremely important goals. It is in the pursuit of the most valued goals, however, that self-efficacy beliefs become the most important and have the most impact on eventual outcomes.

Finally, self-efficacy beliefs are not merely the evaluations of fine motor abilities, but are the evaluations of whether people believe they can execute behaviors when necessary. It is clear from this discussion of the form and function of self-efficacy beliefs that self-efficacy theory shares much with other popular psychological theories.

Control

One of the theories most often discussed in relation to self-efficacy theory is Julian Rotter's Locus of Control theory. The primary theoretical distinction between Locus of Control theory and self-efficacy theory is that Locus of Control theory focuses on perceptions of whether responses are contingent upon personal behavior or external circumstances whereas Bandura's theory focuses on perceptions of whether individuals can execute the actions necessary to produce successful outcomes. Self-efficacy beliefs therefore presume some degree of internal locus of control for particular tasks/outcomes.

Optimism

Another relevant theory of positive expectancies is the optimism model developed by Charles Carver and Michael Scheier. Their theory defines optimism as a generalized expectation that positive outcomes in the future will be common and undesired outcomes will be rare. They have found optimism to be a stable trait that is consistently associated with improved psychological and physical well-being. Optimism is measured in global

terms and is posited to produce effects by impacting the way in which individuals think about and pursue goals, and how they react to adversity when pursuing their goals. The two primary distinctions between the optimism and self-efficacy theories are that (1) optimism is conceptualized as a global evaluation of outcome expectancies, and (2) self-efficacy explicitly focuses on the individual as the agent of action whereas optimism is more ambiguous about how or why necessary actions may be accomplished.

Trait Agency

Another important distinction is between Bandura's theory of self-efficacy and other theories of human agency that focus on more global or generalized perceptions of agency. Numerous theories (e.g., Rick Snyder's theory of hope) have articulated alternative theories of human agency that focus on more generalized perceptions of human agency. As previously mentioned, Bandura has always focused on domain and state-specific evaluations of agency in the form of self-efficacy beliefs and has consistently argued that these more global assessments are not as useful. Nevertheless, there is extensive research examining Snyder's hope theory and other theories of agency that suggest that dispositional agency beliefs may also be important predictors of behavior and outcomes. The relative utility of trait agency beliefs and state/domain-specific self-efficacy beliefs in predicting human behavior and outcomes remains unclear.

Self-Efficacy and Social Cognitive Theory

An improved understanding of self-efficacy theory can be obtained by considering the broader social cognitive theory developed by Bandura. Social cognitive theory provides a model of understanding human emotion, behavior, cognition, and motivation that emphasizes how as humans we actively interact with and help shape our environment, rather than be passively controlled by it. Briefly stated, the basic premises of social cognitive theory are as follows.

Our environment, our behavior, and personal factors such as cognitive (i.e., self-efficacy beliefs) or emotional/biological events interact with and jointly determine one another in what is referred to as 'triadic reciprocal determinism.' Social cognitive theory therefore suggests that each of these three areas is shaped by and helps shape the other two. The relative influence of these factors is thought to vary according to the situation, and the relative speed with which these three factors may influence one another can also vary.

Our perceptions of ourselves and our personalities are social constructions that are constantly revised as a result of our interactions with others. These perceptions are therefore never static and can often vary depending upon the context in which we are in.

Humans have evolved to have the cognitive capacity to develop internal models of our experiences that allow us to visualize potential courses of action and to communicate these possibilities to others. We are also capable of reflecting upon our own thought, feelings, and actions, and these self-referential abilities provide the foundation for self-regulation.

We are capable of regulating our behavior in the pursuit of goals. The attainment of goals is a fundamental motivator for human behavior and our expectations regarding our ability to achieve our goals are crucial determinants of our behavior.

Social cognitive theory also provides the foundation for understanding how self-efficacy beliefs are developed over the course of a lifetime. As children, we develop the capacity to understand cause and effect relationships, which provide the foundation for understanding how our actions can influence our environment. Families play a crucial role in fostering this sense of agency by providing an environment that is responsive to the child's actions and needs. The development of self-efficacy beliefs is further cultivated as children enter school and are presented with new opportunities to explore their environment and to develop an improved understanding of their capacities. Peer relationships gradually become more and more important determinants of efficacy beliefs as children develop relationships that help form their identity. Our self-efficacy beliefs then continue to evolve with age as we incorporate information from the various sources of self-efficacy beliefs.

Sources of Self-Efficacy

Research has identified five mechanisms by which self-efficacy beliefs can be developed: mastery experiences, modeling/vicarious experiences, imagined experiences, social persuasion, and somatic/emotional cues. These five mechanisms vary in terms of their effectiveness, and individuals tend to use a combination of the various methods as they pursue their goals.

Mastery experiences are the most effective method of developing self-efficacy beliefs. The successful attainment of meaningful goals has a powerful effect on self-efficacy beliefs if people attribute the success to their own actions. This is particularly true when individuals are required to persevere despite serious obstacle as the experience of success following adversity can have a profound effect on individuals' confidence. For example, if an employee receives positive evaluations from her/his boss and believes those positive evaluations reflect her/his actions at work, then she/he is likely to develop stronger self-efficacy beliefs regarding her/his job performance. Similarly, experiences of failure that are attributed to personal actions can have negative effects of self-efficacy beliefs.

Modeling, or witnessing the mastery experiences of others, is another effective way of developing self-efficacy beliefs. Although it is generally not as effective at developing self-efficacy beliefs as achieving personal success, witnessing other people achieve success and persevere despite obstacles can help inspire people to believe more in their own capabilities and to maintain a strong sense of self-efficacy when faced with difficult circumstances. Modeling can be especially effective when individuals share an identification with an individual or group that embodies success (e.g., having a Nobel Prize winning mother). Vicarious experiences of success can also be particularly powerful when we encounter a task that we are unfamiliar with as we often develop our performance expectations on the basis of observing the successes and failures of other individuals.

Imagined experiences are another effective way of developing self-efficacy beliefs. By visualizing ourselves or others

performing successfully, we can gradually influence our expectations for our own behavior and ultimately help determine the likelihood of successfully obtaining our goals. This process is perhaps most commonly discussed in the context of athletic performances (e.g., golfers visualizing themselves sinking an important putt or basketball players visualizing themselves hitting a crucial free throw) but is also commonly used in clinical interventions that target self-efficacy beliefs (e.g., exposure treatments for specific phobias), and this process can be applied to any domain of performance. Although these imagined successes can often increase self-efficacy beliefs, they are rarely as effective as actual experiences of success.

Social persuasion is a fourth mechanism by which self-efficacy beliefs can be developed. Just as witnessing or imagining the success or failure of others can influence self-efficacy beliefs, the encouragement or discouragement of others can help shape our beliefs about our capabilities. The extent to which social persuasion is effective varies according to numerous social factors such as the closeness of the relationship and the perceived trustworthiness of the source. Although not necessary to develop self-efficacy beliefs, the presence of a trusted friend or family member providing encouragement can often be a crucial factor in helping people to develop and maintain self-efficacy beliefs in the face of obstacles.

The last method of influencing self-efficacy beliefs is on the basis of somatic/emotional cues. This is the least effective method of promoting self-efficacy beliefs, but can still play an important role in many situations. The extent to which individuals are emotionally/physiologically aroused can have minor effects on the level and strength of self-efficacy beliefs. When people are experiencing pain, fatigue, or unpleasant levels of physiological arousal, they are more likely to question their abilities than when they are in a rested or relaxed state. Interestingly, by helping to shape our perceptions of perceived threats, self-efficacy beliefs can help promote more adaptive levels of physiological arousal, which can in turn serve to help improve or maintain higher levels of self-efficacy beliefs.

The core idea running through each of these five methods is that success, particularly when it occurs after overcoming obstacles, promotes further success. This is true both for personal success and the success of other individuals. Although self-efficacy theory is primarily focused on perceptions of personal agency, the theory does not suggest that we operate in a vacuum. Rather, the success, failures, and encouragements of those around us are proposed to be crucial mechanisms in the development of adaptive levels of self-efficacy. In this way, self-efficacy theory suggests that the promotion of individual's success can have a cascade of positive effects both for that individual and those around them.

Mechanisms of Self-Efficacy

Bandura has also identified four mechanisms by which self-efficacy beliefs exert their influence. As with the sources of self-efficacy beliefs, these mechanisms work in concert to help people more effectively pursue their goals.

First, self-efficacy beliefs determine cognition by helping to shape the goals that individuals identify, the strategies individuals identify to pursue their goals, and the thoughts they

experience as they pursue these goals. Individuals with higher levels of self-efficacy beliefs are more likely to seek out challenges that allow them to continue to develop their skills and are more likely to believe that they are capable of overcoming these challenges.

Self-efficacy beliefs also help determine individual's motivation and willingness to persevere in the face of obstacles. Affirming thoughts can be a crucial factor in determining whether individuals persevere when the going gets tough.

Self-efficacy beliefs are a crucial determinant of behavior. For example, phobic individuals are more likely to physically approach feared stimuli if they perceive themselves to be capable of managing the potential threat.

Finally, self-efficacy influences the experience of emotion directly by shaping how we appraise events and indirectly by facilitating the achievement of valued goals, which in turn promotes a positive effect. Individuals with higher levels of self-efficacy are less likely to experience anxiety as a result of perceiving uncertain situations as threatening and are more likely to experience relaxation as a result of their confidence in their ability to cope with difficult situations.

Adaptive Benefits of Self-Efficacy Beliefs

As previously mentioned, the benefits of self-efficacy have been extensively studied in a variety of contexts over the past three decades. The rationale for why self-efficacy beliefs promote positive outcomes is perfectly captured in the classic children's story *The Little Engine That Could*. In this story, the little engine is able to succeed where all other engines have failed by resolutely maintaining a strong sense of efficacy. This confidence is exemplified by the 'I think I can, I think I can' mantra that the engine repeats to help motivate himself to persevere despite all the obstacles that he encounters.

Self-efficacy theory suggests that this confidence in one's abilities is one of the most crucial determinants of success. People inevitably encounter obstacles when pursuing goals and these obstacles provide crucial junctures at which people can become discouraged and give up on their goals or remain motivated, persist despite the obstacles, and ultimately achieve the desired outcomes. Self-efficacy beliefs are proposed to be the crucial psychological characteristic that allows people to persevere in such situations. Furthermore, individuals with higher levels of self-efficacy perceive these challenges as exciting opportunities to test and improve their abilities rather than frightening situations that need to be avoided. Self-efficacy beliefs therefore provide individuals with the motivation to continually challenge themselves, develop new skills, and further solidify their confidence in the ability to perform the actions necessary to achieve their goals.

Classic Self-Efficacy Anecdotes

The value of a persistent sense of self-efficacy has been famously demonstrated by many of the most accomplished artists, musicians, authors, scientists, and inventors. Many of the most famous and successful members of various professions did not achieve instant fame or success, but rather persisted through years of rejection, failure, or uncertain outcomes. The ability to persist

through these setbacks is often what distinguishes these elite performers from individuals who do not achieve such success.

The following are examples.

The Beatles were arguably the most successful rock band of all time, but their initial efforts to obtain a recording contract met with little success. Following their initial audition with Decca Records, the Beatles were told that 'guitar groups are on their way out' and that 'the Beatles have no future in show business.' The Beatles are now estimated to have sold more than 1 billion records since their inception.

Michael Jordan is now widely considered to be the best basketball player of all time, yet he failed to make the cut when he first tried out for the varsity basketball team during his sophomore year of high school. Rather than giving up, Jordan practiced even harder, made the varsity squad the following year, and eventually won six NBA championships.

Despite painting nearly 900 paintings during his lifetime, Vincent van Gogh sold only one of his paintings during his life. He is now widely considered to be one of the greatest painters in history and had a remarkable impact on the development of modern art.

J. K. Rowling's Harry Potter series of children's novels is one of the most successful book franchises of all time, with more than 400 million copies sold in more than 60 languages. Yet when J. K. Rowling submitted her first Harry Potter manuscript she was rejected by a dozen publishing houses before finding a small London publishing house that was willing to take a chance on her. Despite living in poverty at the time, Rowling stuck with her dream of becoming a successful writer and is now one of the most successful writers in history.

Lance Armstrong is one of the most successful cyclists of all time. With seven consecutive Tour de France victories, he has had one of the most distinguished careers in the history of the sport. Yet when Lance Armstrong began his career, he did not meet with immediate success. In Lance's first race, the San Sebastian Classic, he not only did not win the race, but he finished dead last in the field of 111 cyclists. He persevered despite this setback and is now considered to be one of the greatest cyclists of all time.

Thomas Edison was told by his teachers that he was 'addled' and not smart enough to learn anything. Edison famously made 1000 unsuccessful attempts before successfully inventing the light bulb. When Edison was famously asked by a reporter "How did it feel to fail 1,000 times?," Edison is said to have replied, "I didn't fail 1,000 times. The light bulb was an invention with 1,000 steps."

Robert Sternberg received a C in his introduction to psychology class in college. He was told by his psychology professor that "there was a famous Sternberg in psychology and it was obvious there would not be another." Decades later, he became a tenured professor at Yale University and was elected President of the American Psychological Association.

These stories share a common theme. In various fields, many of the most successful individuals do not succeed immediately. Rather, what has defined the careers of many icons is an extraordinary willingness to fail and ability to persevere through the early setbacks. Self-efficacy theory suggests that it is these individuals' unwavering belief in their abilities to perform the actions necessary to achieve their goals (i.e., self-efficacy) that confers this resilience and ultimately determines their success.

Empirical Evidence

In addition to these fascinating stories demonstrating the immense value of a resolute sense of self-efficacy, there is now more than three decades of empirical research demonstrating the adaptive benefits of self-efficacy beliefs in a wide variety of contexts.

Some of the earliest research examining the benefits of high levels of self-efficacy was in relation to mental health and mental illness and this remains a vibrant area of research today. In particular, the benefits of self-efficacy beliefs have been extensively studied in relation to the development and treatment of anxiety disorders. Self-efficacy beliefs are thought to be critical factors in determining how individuals exercise control, appraise threats, manage feelings of anxiety, and whether individuals engage in avoidant behavior. Specifically, when people believe they can manage threatening situations, they do not fear those situations and do not resort to maladaptive coping techniques. Evidence of the importance of self-efficacy beliefs comes from studies indicating that self-efficacy beliefs are negatively correlated with anxiety in children and adults, and studies suggesting that self-efficacy beliefs are a better predictor than anticipatory anxiety of avoidant behavior in individuals suffering from anxiety disorders.

The benefits of self-efficacy beliefs in academic contexts have also been examined extensively. Academic self-efficacy beliefs are proposed to influence academic success by helping students to more effectively identify academic and career options, to more efficiently harness their natural talents, and to persevere through academic setbacks. Meta-analytic reviews of the academic self-efficacy literature have supported these hypotheses and have demonstrated that academic self-efficacy beliefs are crucial determinants of who excels in academic contexts. What is particularly interesting about this research is that the effects of positive evaluations of personal agency have been shown to predict academic performance many years later. This research suggests that instilling high levels of self-efficacy beliefs in young children could have profound effects on the course of their education.

A third area in which the benefits of self-efficacy beliefs are often examined is in work contexts. Self-efficacy beliefs have been proposed to influence the performance of individual workers and the success of the companies in which they work by helping workers to more effectively and efficiently complete their required tasks. A meta-analytic review of more than 100 studies in the self-efficacy and work literature has been conducted and the results of this review have demonstrated that self-efficacy beliefs predict superior performance in professional contexts. These results suggest that by developing supportive environments that promote early successes and the development of professional self-efficacy beliefs, companies could improve not only the job satisfaction of their employees but also their own overall performance.

These are just a few of the many areas in which self-efficacy beliefs have been evaluated and demonstrated to promote positive outcomes. The common thread throughout all of this research is that self-efficacy beliefs appear to be an importance predictor of behavior and performance, regardless of the specific context. What is perhaps most remarkable is that empirical research has demonstrated that self-efficacy beliefs

are sometimes better predictors of future behavior than past behavior. There are few other psychological theories or constructs of which that same claim can be made.

Self-Efficacy Interventions

In the original 1977 publication that provided the first overview of self-efficacy theory, self-efficacy beliefs were proposed to be crucial mechanisms or mediators of behavior change in the treatment of psychological disorders. Early self-efficacy research tested this idea within the context of the treatment of anxiety disorders and found promising support. Specifically, Bandura and colleagues demonstrated that changes in self-efficacy beliefs over the course of treatment predicted individuals' willingness to confront the objects of their phobias, which in turn predicted symptom improvement. These early studies provide promising evidence that interventions designed to target self-efficacy beliefs may provide an effective means of treating various psychological disorders. Subsequent research has examined the utility of self-efficacy focused interventions for the treatment of obesity, substance abuse, depression, and many other conditions. This research has consistently demonstrated that targeting self-efficacy beliefs can often provide clinicians with an effective means of promoting behavior change, even in cases when previous treatments have failed.

Perhaps, the most striking example of an intervention that was developed on the basis of self-efficacy theory comes from recent self-efficacy based interventions that were delivered via television in Mexico and other countries. These interventions targeted crucial issues such as condom use, literacy rates, and women's rights in many communities in which these issues are not often given much attention. Bandura consulted with the producers of telenovelas (i.e., soap operas) to adapt the scripts in order to boost self-efficacy levels of viewers by providing positive models of agentic action. Follow-up studies demonstrated that individuals in communities in which these self-efficacy telenovelas were shown were significantly more likely to enroll in literacy programs and to practice safer sex practices after watching these videos. These interventions provide compelling evidence that the benefits of self-efficacy beliefs are universal and are not just limited to laboratory settings. This process also perfectly captures the worldview of self-efficacy theory in that the empirically supported practices of developing self-efficacy beliefs were applied to empower individuals across the world by elevating their levels of self-efficacy.

The Agentic Worldview of Self-Efficacy Theory

Self-efficacy theory emphasizes the importance of the individual and the individual's perceptions of his/her personal capabilities as key determinants of successful outcomes. Self-efficacy theory, and the broader social cognitive theory in which self-efficacy is encompassed, therefore clearly endorses a democratic ideal that suggests that all individuals are competent and capable of being successful, provided they have the opportunities and self-efficacy necessary to pursue their goals. Self-efficacy theory explicitly focuses on how individuals and communities can be empowered with a sense of agency that

will facilitate goal attainment. This is important as self-efficacy theory does not presume that individuals who are currently successful are inherently better than those who are not as successful. Rather, self-efficacy theory would suggest that individuals who are currently struggling may not have been provided with opportunities to obtain mastery experiences or modeling necessary to develop high levels of self-efficacy. Self-efficacy theory therefore suggests that it is the responsibility of the government and society to provide everyone with sufficient opportunities to engage in mastery experiences, receive positive social persuasion, and witness positively reinforcing models that will engender a strong sense of self-efficacy.

It is worth noting, however, that self-efficacy theory does not suggest that positive self-efficacy beliefs are the only causes of important outcomes. Rather, as previously discussed, self-efficacy theory is rooted in a theory of triadic reciprocal determinism in which there is a constant interplay between personal factors (i.e., self-efficacy beliefs), behavior, and environmental factors. Self-efficacy theory emphasizes the relative importance of personal factors, but acknowledges that behavioral and environmental factors have profound effects on outcomes. This theory of triadic reciprocal determinism therefore further reinforces the idea that if the effects of the environment are consistent (i.e., an even playing field for all), then self-efficacy beliefs will take on an even greater role in determining human behavior, and ultimately shaping outcomes.

It is also important to note that self-efficacy theory does not advocate a Pollyannaish world view in which positive expectancies for the future are the sole determinant of future outcomes. There has been a recent backlash against positive thinking among many members of the popular press. Books such as Barbara Ehrenreich's *Bright-Sided: How the Relentless Promotion of Positive Thinking Has Undermined America* have argued that an excessive emphasis on and belief in the benefits of positive thinking has had a detrimental effect on the lives of many individuals and the society as a whole. There is much to be said about identifying the potential pitfalls of naively optimistic worldviews or self-help programs that suggest that positive thinking provides almost magical benefits. However, it is important for researchers, clinicians, and the public to recognize the distinction between these less scientific theories of positive thinking and empirically based theories such as self-efficacy. Self-efficacy beliefs are in no way proposed to be a panacea for all of the ills of the world nor are self-efficacy beliefs proposed to be the only psychological factor that may determine important life outcomes. Rather, self-efficacy theory proposes a more measured worldview in which opportunities to experience or witness success may promote positive evaluations of one's capacities to succeed in the future which in turn increases the likelihood of subsequent positive outcomes.

Impact of Self-Efficacy Theory on Psychology

The agentic worldview of self-efficacy theory is particularly interesting when considering the historical context in which self-efficacy theory was developed. Bandura received his doctorate from Iowa University in the early 1950s, a time in which psychoanalytic and behavioral perspectives still dominated much of psychology. Bandura's theory of self-efficacy provided

an important contrast to these models that emphasized how external forces or intrapsychic forces that individuals were unaware of ultimately shaped behavior. Bandura's theory and research on self-efficacy helped to shift the course of psychology by emphasizing two factors that had previously been minimized. First, he emphasized the role of personal agency in opposition to deterministic behaviorist theories espoused by psychologists such as John Watson and B. F. Skinner. Second, he emphasized the role of cognition as a vital mediator in treatments that produced behavioral change. By emphasizing how cognition moderated the influence of external events, and mediated the effects of interventions, Bandura helped to usher in the cognitive revolution that followed under the leadership of Aaron Beck, Albert Ellis, and many others. Self-efficacy theory therefore played an important role in the history of psychology as it helped to shape the trajectory of the field by assigning agency to the individual and emphasizing the importance of cognition.

Future Directions

Research to date has clearly demonstrated the adaptive benefits of self-efficacy beliefs in numerous contexts. Self-efficacy theory nevertheless remains a vibrant area of psychological research as researchers are now attempting to develop a more sophisticated understanding of exactly how positive evaluations of personal agency may promote positive outcomes. In particular, three areas of self-efficacy research appear to be particularly promising areas for future research.

The first promising area for future research is the exploration of self-efficacy as a mechanism or mediator of change in psychotherapy. In Bandura's original 1977 article, self-efficacy beliefs were proposed as a crucial mechanism of change. Early self-efficacy research provided promising support for this hypothesis. In particular, research examining the treatment of anxiety disorders, specifically phobias, provided promising evidence that self-efficacy beliefs were in fact a crucial mechanism of psychotherapy. Unfortunately, subsequent research has failed to adequately build on these early promising findings and the extent to which self-efficacy beliefs fully or partially mediate the effects of psychotherapy remains unclear. There has been a recent resurgence in interest, however, in the mechanisms of change of empirically supported treatments, and researchers are once again proposing self-efficacy as a crucial mechanism of change in the treatment of psychological disorders, particularly anxiety disorders. What is now needed is more sophisticated longitudinal research using the recently developed and improved quantitative methods of examining mechanisms of change. This research will be difficult to conduct, but is crucial for advancing our understanding of the function self-efficacy beliefs play in empirically supported treatments of psychological disorders.

A second promising area for future research is the examination of the concept of collective efficacy. As the name obviously implies, self-efficacy research has traditionally focused on the adaptive benefits of a personal sense of agency. More recently, however, Bandura and other self-efficacy researchers have begun to explore the potential utility of extending the individual focus of self-efficacy to the level of groups or

communities in order to evaluate collective efficacy. Collective efficacy is defined as the perception of a group that they can successfully work together to accomplish valued goals. Initial research examining the construct of collective efficacy has demonstrated that the construct may have promise. Higher levels of collective efficacy have been shown to predict satisfaction in marriages, academic achievement in kids, and team athletic performance. Nevertheless, more research is needed to determine exactly how collective efficacy should be defined, how it should be measured, and whether it consistently promotes superior performance.

A third important area for future research will be examining the incremental validity of trait theories of agency in relation to traditional, domain-specific self-efficacy constructs. As previously mentioned, despite the initial focus on domain-specific measurement, numerous researchers have expanded upon the agentic core of self-efficacy theory in order to examine the utility of global or trait levels of agency/self-efficacy. As expected, this research has generally demonstrated that trait self-efficacy is an important predictor of behavior and positive outcomes. The problem with much of this research, however, is that traditional measures of domain-specific self-efficacy beliefs have rarely been measured in conjunction with trait measures of self-efficacy. The extent to which the global self-efficacy construct/scales help improve our understanding or prediction of human behavior beyond the predictions of traditional self-efficacy measures is therefore unclear.

Summary

Self-efficacy theory was presented in 1977 as an ambitious attempt to provide a unifying theory of behavior change. Although the extent to which the theory is truly unifying and comprehensive remains open to debate, there can be no doubt that the development of self-efficacy theory has had an extraordinary effect on the course of psychology. In fact, it could be argued that few psychological theories have had more of an impact worldwide than self-efficacy theory.

See also: Academic Achievement; Anxiety Disorders; Coping; Hope and Optimism; Motivation; Positive Psychology.

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Relevant Website

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Self-Esteem

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Glossary

Domain-specific self-esteem Self-regard referring to a particular area of one's life (e.g., athletic self-esteem).

Implicit self-esteem A relatively automatic, nonconscious, self-evaluation. This term is also used to refer to measures of self-esteem that do not require self-report and whose purpose is not transparent.

Self-esteem A person's global evaluation of the self.

State self-esteem Transient assessment of self-worth that is relatively malleable.

Trait self-esteem One's dispositional, overall evaluation of the self that is fairly stable across situations.

Self-Esteem Defined

Self-esteem refers to one's overall evaluation of oneself – the extent to which one values and prizes the self. Self-esteem need not reflect objective reality. Instead, self-esteem is one's subjective evaluation of the self. A person who is overly critical of himself or herself may have a more negative self-evaluation (and thus lower self-esteem) than someone else who, by objective standards, is less competent. Although people with high self-esteem (HSEs) have more favorable self-views than their low self-esteem (LSE) counterparts, LSEs do not necessarily view themselves negatively. Most LSEs evaluate themselves positively, just less positively than do HSEs, or have ambivalent attitudes toward the self. Relatively few LSEs actually dislike themselves.

Self-esteem can refer to either trait or state self-esteem. Trait self-esteem refers to global evaluations about the self that are relatively stable and enduring. This type of self-esteem is highly resistant to change, with test–retest correlations over a 16-year period reaching as high as 0.72 in one investigation. Stability of this construct is comparable to other personality traits, and is particularly stable in later adulthood. State self-esteem, in contrast, refers to self-evaluations that occur on a moment-to-moment basis. Such temporary evaluations are more fragile and malleable than trait self-esteem. For example, a person whose trait self-esteem is high may have low state self-esteem after being refused for a date. Self-esteem also can be conceptualized as global or domain-specific, with the former referring to one's overall self-view and the latter referring to one's self-view in a specific domain, such as academics or appearance. As an example, whereas one's global self-esteem might not decrease after losing a tennis match, one's athletic self-esteem would likely suffer.

People differ not only in terms of their levels of trait self-esteem (e.g., high vs. low), but also in terms of how much their self-esteem varies around their own average level. Kernis and his colleagues demonstrated the importance of such within-person fluctuations of self-esteem. People whose self-esteem is relatively stable enjoy better mental health outcomes, such as less depression, than people whose self-esteem is unstable, even when their initial levels of self-esteem are controlled. It seems that it is beneficial not to simply have a positive self-evaluation, but to have a consistent self-evaluation.

Within the last two decades, self-esteem has also been examined as an implicit evaluation of the self. Implicit self-esteem is usually assessed by social-cognitive measures such as the implicit association task (IAT), whose purpose is not transparent to respondents. Such measures are thought to tap into evaluations of the self that the individual may not be aware of or be able to articulate, and are less vulnerable to social desirability concerns than self-report measures. Research shows that implicit self-esteem can predict a variety of behaviors, particularly when explicit self-esteem is incongruent with implicit. For example, participants with high explicit, but low implicit, self-esteem have been shown to act more defensively (e.g., derogating an outgroup member) than participants high in both implicit and explicit self-esteem. The remainder of this entry will concern explicit self-esteem at the conscious level.

Perspectives on Self-Esteem

As Jonathon Brown has noted, researchers have traditionally emphasized one of two self-esteem models. The cognitive perspective emphasizes the judgmental and 'bottom up' component of self-appraisals. Cognitive models stress that domain-specific self-evaluations (e.g., "I am a good chess player") combine to produce either high or low global self-esteem. Several positive self-evaluations in specific domains lead to high global self-esteem. In contrast, affective models emphasize the 'feelings' part of self-regard (e.g., "I feel happy with myself generally") – feelings that are thought to develop early in life from general perceptions of others' acceptance and love. How we feel about ourselves can then influence in a 'top down' fashion how we evaluate our specific qualities. For example, if we have mixed or negative feelings about ourselves, we are more likely to evaluate our competence in a given domain unfavorably. It seems likely that both the affective and cognitive models have merit – that overall feelings about the self influence specific evaluations (the affective view) and that domain-specific evaluations influence global feelings of self-worth (i.e., the cognitive view) – especially when those specific evaluations are highly personally relevant.

Why does self-esteem exist? Several theories have emerged regarding the function of self-esteem. From the perspective of Mark Leary's sociometer theory, self-esteem is a barometer

of one's relational value to others. When a person feels that she is valued by others, her self-esteem is high. Taking quite a different view of self-esteem, theorists associated with Terror Management Theory hypothesize that self-esteem develops to ward off the fear and anxiety that arises due to people's knowledge of their own mortality (for a discussion on this view of self-esteem, see Pyszczynski et al., 2004). Another view of self-esteem, outlined in self-determination theory, makes a distinction between true and contingent self-esteem. Whereas contingent self-esteem is reliant on meeting external standards, true self-esteem is noncontingent on achievement or on reaching others' standards, resulting in a genuine, more stable sense of self-worth. True self-esteem, from this perspective, is thought to arise from pursuing the three fundamental needs of autonomy, relatedness, and competence.

Cultural differences have been observed in the self-esteem literature, with East Asian participants typically reporting lower levels of global self-esteem than their Western counterparts. Some researchers have argued that cultural values in the East, such as modesty, constrain responses on explicit self-esteem scales. Indeed, implicit measures of self-regard reveal fewer cultural differences than do explicit measures. However, when participants complete anonymous measures of self-regard, which presumably reduce modesty concerns, East Asian participants again rate themselves less positively than Western participants. The exact nature of the cultural differences in self-esteem continues to be debated.

Measurement

Given that self-esteem has been defined in various ways – trait versus state, global versus domain-specific – it is not surprising that there exist multiple measures of self-esteem. For instance, researchers who conceptualize self-esteem as a global self-evaluation would see little utility in asking domain-specific questions. On the other hand, researchers who are interested in increasing academic self-esteem through an intervention would be wise to use a domain-specific measure of self-esteem because it is unlikely that a short intervention would boost one's global feelings about the self.

By far, the most commonly used scale is the Rosenberg Self-Esteem Scale (1965). This ten-item scale assesses participants' overall impression of the self and contains items such as, "On the whole I am satisfied with myself" and "I feel I do not have much to be proud of" (reverse scored). The scale has been shown to have high internal consistency, high test-retest reliability, as well as convergent and discriminant validity. However, it is likely that the Rosenberg, like all self-report measures of self-esteem, is contaminated to some extent by social desirability concerns, inasmuch as it is socially desirable to have HSE. Another frequently used measure of self-esteem is the Fleming and Courtney Self-Esteem Scale (1984), a revision of the Janis-Field Feelings of Inadequacy Scale (1959). This scale has 33 items that tap into global feelings of self-adequacy, as well as self-esteem in the domains of social confidence, school abilities, physical appearance, and physical ability. As with the Rosenberg, participants respond on a Likert scale, answering questions such as "How often do you dislike yourself?" Other commonly used scales include the Texas Social Behavior

Inventory and the Coopersmith Self-Esteem Inventory (for a detailed review, see Blascovich and Tomaka 1991).

Each scale reflects a different theoretical conceptualization of self-esteem. The Rosenberg taps into general feelings of self-regard rather than self-esteem in specific domains. Hence, it captures the 'affective' view of self-esteem identified by Brown better than the cognitive or 'bottom up' view. In multidimensional scales, such as the Fleming and Courtney scale discussed above, researchers are more interested in a 'self-esteem profile' rather than a single global self-esteem score. Multidimensional scales, which measure self-evaluations in several domains, are more appropriate than global scales when investigators are interested in specific components of the self-concept. For example, researchers who are interested in increasing academic self-esteem through an intervention would be wise to use a domain-specific measure of self-esteem, because it is unlikely that a targeted, short intervention would boost one's global feelings about the self. Conceptualizing self-esteem as unidimensional, in contrast, the Coopersmith assesses self-esteem in various domains and then sums across domains to form a single measure of self-worth. This practice has been criticized, because it fails to acknowledge that people differ in the importance they place on different domains. As William James recognized long ago, proficiency in some domains matter a great deal to one's self-esteem, whereas proficiency in others matter not at all. For example, athletics are more important to an athlete's overall self-esteem than to a statistician's. Harter and her colleagues advocated assessing self-esteem in line with James' observation – namely by asking questions about self-regard in a variety of domains as well as the perceived importance of success in each domain. Most self-esteem research conducted by social psychologists assesses general feelings of self-worth, rather than unweighted summed scores of domain-specific regard.

Several scales have been developed specifically for use with children. The most commonly used is the Piers-Harris Children's Self-Concept Scale (1984). Children respond 'yes' or 'no' as to whether various statements apply to them (e.g., "I am dumb at most things"). The scale contains subscales to assess domains such as popularity, happiness, and intelligence. Another measure, the Self-Perception Profile for Children (Harter 1985), uses pictorial representations and is therefore less dependent on children's verbal abilities.

Although most self-esteem scales have focused on trait self-esteem, some measures tap into how participants feel about themselves at the moment of measurement. Heatherton and Polivy's (1991) scale was developed specifically to assess state self-esteem, and taps into the domains of performance, social, and appearance self-esteem (e.g., "I am pleased with my appearance right now."). McFarland and Ross (1982) developed a measure that is often adapted to assess current feelings of self-worth, using bipolar adjectives such as 'accepted-rejected.'

Self-Esteem and Responses to Failure

By far, the topic that has received the most attention by self-esteem researchers within social psychology has been self-esteem differences in response to failure. In the typical experiment, HSEs and LSEs (often selected from the top third and bottom third, respectively, of the distribution of

self-esteem scores) engage in some task purportedly measuring an intellectual or social skill. Participants are randomly assigned to receive bogus failure feedback, or, in a comparison condition, either neutral, success, or no feedback. Then measures are administered that typically tap into one or more of the following: affective reactions, 'cognitive' reactions, or the use of 'self-enhancement' strategies.

On measures of affect, results consistently indicate that LSEs are more devastated than HSEs by failure. LSEs report more anxiety and distress than HSEs, and more than LSEs in neutral or success conditions. In success conditions, LSEs and HSEs appear to be equally happy after succeeding. For a long time, such results led self-esteem researchers to believe that the key to understanding how self-esteem is maintained lies in LSEs' and HSEs' different reactions to negative events. Recent research, however, suggests that LSEs and HSEs *do* differ after success (albeit less than they do after failure): LSEs are more anxious than HSEs after succeeding, and LSEs can even be more anxious after success than in neutral conditions. These results, as well as evidence that LSEs savor positive moods less than HSEs, suggest that self-esteem differences in reactions to positive events may, like reactions to negative events, serve to perpetuate self-esteem differences.

'Cognitive' measures inquire about reactions such as participants' attributions for the feedback and their judgments of the validity of the (bogus) test they completed. HSEs, to a greater extent than LSEs, tend to make self-serving attributions – blaming failure on an invalid test, for example, and success on their skills. HSEs also tend to believe that failure feedback is less valid than LSEs do. Such results have been interpreted as evidence for 'self-verification' motives. According to Swann's self-verification theory, people are motivated to maintain their self-views because stable self-views make the world more orderly and predictable. When HSEs encounter negative feedback, they may dismiss it, so as to preserve their HSE. Likewise, LSEs may doubt or minimize success feedback to preserve their LSE.

Alternatively, such cognitive measures may be interpreted as a means of self-enhancement for HSEs; attributing failure to an invalid test may help them restore their wounded pride. Some measures are designed to capture precisely such tendencies. 'Self-enhancement' measures afford participants an opportunity to 'self-enhance' – to maintain or boost their self-esteem in some way. For example, participants may be presented with a measure that asks them to rate themselves relative to someone else, to seek positive or negative information about other people, to stereotype others, to focus on their own favorable attributes, and the like. Over and over again, HSEs have been found to engage in more self-enhancing strategies than LSEs. After failure, HSEs self-aggrandize, derogate others, choose to see negative information about others, engage in stereotyping, and so forth. It is widely believed that such strategies help HSEs to maintain their HSE.

Self-Esteem-Related Motives: Self-Enhancement, Self-Verification, and Self-Protection

Why do LSEs and HSEs differ in their reactions to failure? For some time it was believed that LSEs may simply lack the motive to self-enhance. Now the consensus seems to be that both LSEs

and HSEs are motivated to feel good about themselves, but that LSEs are constrained by their self-beliefs; they cannot as readily claim or defend a positive view of themselves, so are wary of entertaining overly positive self-views. Also constraining LSEs may be self-verification motives; their motives to feel good about themselves are opposed by motives to maintain a stable self-view.

In addition, the motive to feel good about oneself may differ somewhat between LSEs and HSEs. A useful distinction has been offered between self-enhancement and self-protection: Whereas self-enhancement involves striving for or enhancing positive self-views, self-protection involves avoiding or minimizing negative self-views. Baumeister et al. (1989) proposed that HSEs focus on self-enhancement – taking risks to draw attention to their skills and talents – whereas LSEs focus on self-protection – seeking to *avoid* drawing attention to their deficiencies. This view of HSEs as risk-taking and self-enhancing, and of LSEs as cautious and self-protective, is supported by research on decision making, achievement, social comparison, and interpersonal behaviors, as will be described later.

Extensive debate has surrounded the question of whether self-verification or self-enhancement/self-protection motives are more important determinants of human behavior. Many social psychologists regard the motive to self-enhance as paramount, and as guiding almost all facets of life. Yet self-verification researchers have amassed substantial evidence that, contrary to the view that people engage in unbridled self-enhancement, LSE people do resist overly positive information about themselves and even seek information that confirms their relatively negative self-views. Probably the safest conclusion is that both self-verification and self-enhancement/self-protection motives operate for most people, with the predominance of each motive varying with person and situation.

Development Across the Lifespan

There is a growing consensus as to how self-esteem develops and evolves throughout the life span. Using meta-analytic techniques to analyze a large number of self-esteem studies, Trzesniewski, Robins, and their colleagues have determined that although self-esteem, on average, may wax and wane across the life-span, rank-ordered self-esteem remains fairly stable. For example, individuals who have LSE compared to their peers during adolescence are likely to have relatively LSE in later adulthood, even though their personal self-esteem may have increased.

During early childhood, self-esteem tends to be quite high, perhaps due to children's egocentric style of thinking. As childhood continues, self-esteem gradually decreases – a decrease that corresponds to developments in the cognitive system. Children begin to represent the self in a more complex fashion as they start to incorporate external feedback and information about their standing relative to their peers. Self-esteem continues to diminish through adolescence, which likely reflects the myriad of biopsychosocial changes in the adolescent's life. Concerns about 'fitting in,' hormonal changes, as well as further cognitive development (e.g., thinking about the self abstractly) all contribute to relative uncertainty about the self's worth during adolescence.

With adulthood, increases in self-esteem are evident. During this stage of life, several important milestones occur, such as forming and maintaining stable long-term relationships, becoming a parent, and attaining and establishing career goals. Self-esteem tends to slowly increase across adulthood until the mid to late sixties, at which point it reaches its apogee. Although less data exist on self-esteem in old age, the available evidence points to marked declines in self-esteem. This decline has been attributed to the many changes that are inevitable in older age, such as the loss of mobility, autonomy, cognitive ability, close friends, and spouses.

Finally, gender differences in self-esteem are small but consistently reported. Namely, although both males and females follow a similar developmental pattern, during early adulthood, boys tend to report having higher self-esteem than girls. This gap remains until old age, at which point it is reduced or erased.

Some of the predictable changes in self-esteem over the life span are likely due to changes in reference groups. For example, although self-esteem tends to be relatively low around the ages of 12–13, an important predictor of self-esteem at this age is whether or not the adolescent attends a new school – and thus encounters a new group of peers. When Grade Seven is marked by a transition to a new school, self-esteem in seventh-grade students is lower than that of seventh-grade students who attend a K-8 school. Also highlighting the importance of reference group for self-esteem, when children with learning disabilities are mainstreamed, and hence have nonlearning-disabled classmates more available as comparison targets, they report lower self-competence than when they attend classes only with others who have learning disabilities. Experimental studies have also underscored the importance of social comparisons on self-regard. For example, in one study, the self-esteem of job applicants was lower when a competing applicant was unkempt and disorganized than when the other applicant appeared tidy and orderly.

Self-Esteem and Other Personality Dimensions

Studies that have examined self-esteem in relation to other personality variables have consistently found that self-esteem is negatively correlated with neuroticism, which is viewed as one of the five basic personality traits (the 'Big Five'). This association is not surprising, given that LSE is associated with general negative affectivity, which is a central component of the neurotic personality trait. Extraversion, another Big Five personality trait, is associated with HSE. This association is less robust than that of LSE and neuroticism. More specifically, correlations of -0.50 or stronger are typically reported between neuroticism and self-esteem, whereas correlations between self-esteem and extraversion tend to fall within the 0.30 – 0.50 range. A weaker, but significant correlation is typically found between self-esteem and conscientiousness (e.g., $r = 0.20$ – 0.43). The other two personality traits of the Big Five, openness and agreeableness, are only weakly associated with self-esteem (e.g., typical r s = 0.19 and 0.16 , respectively). Attachment style is also reliably correlated with self-esteem, such that people with a secure style of adult attachment tend to have HSE. Conversely, insecure attachment styles are associated with LSE. The association between self-esteem and attachment style (as well as

neuroticism and extraversion) has been replicated across a diverse range of cultures.

Another facet of the self that is linked to self-esteem is self-concept clarity. HSEs' self-views are more internally consistent, stable, and confidently held than those of LSEs. Perhaps due to deficient self-concept clarity, research suggests that LSEs' self-views are more susceptible than HSEs' to external self-relevant feedback, which may, for example, encourage conformity.

Why are several personality traits linked with self-esteem? From the perspective of sociometer theory, the self-esteem – personality links do not imply that self-esteem causes the observed differences between HSEs and LSEs. Instead, the underlying cause of both LSE and associated personality variables may be low perceived relational value. When people feel that their relational capital is low, self-esteem will also be low; in addition to experiencing LSE, feeling relationally undervalued may also cause a person to develop an insecure style of attachment, or a neurotic personality (for a review, see [Leary and MacDonald, 2003](#)). This argument is buttressed by evidence linking LSE with rejection sensitivity and fear of negative evaluation.

Emotions and Psychopathology

Self-esteem is associated not only with certain personality traits, but also with emotional disposition, as well as some forms of psychopathology. When self-reported mood has been factor analyzed, two independent factors consistently emerge. Positive affect reflects a tendency to experience enjoyable mood states (e.g., pride, joy), whereas negative affect reflects a tendency to experience undesirable mood states (e.g., shame, sadness). These two factors, positive and negative affect, are highly associated with HSE and LSE, respectively. In one study, the strength of the association between self-esteem and positive affect was 0.47 , whereas the strength of the association between self-esteem and negative affect was -0.54 . Compared to HSEs, LSEs report more guilt, hostility, anger, proneness to embarrassment, and jealousy. Further, LSEs are less motivated to repair negative moods than HSEs, despite being equally knowledgeable about mood-enhancing strategies. And whereas HSEs tend to actively savor positive mood states, LSEs are less likely to do so.

LSE is often linked with depressive symptoms, and in fact, some theorists believe that unfavorable self-evaluations are the root cause of depression. More specifically, certain theories of depression place LSE as a primary etiological factor, and in the Diagnostic and Statistical Manual of Mental Disorders, 'feelings of worthlessness' is a symptom of a major depressive episode. Correlations between self-esteem and depressive symptoms have been reported to range from -0.53 to -0.74 . In a recently reported longitudinal study that included participants of diverse ages, LSE at Time One was associated with higher levels of depressive symptoms across a 9-year period. This association was found at all ages, and the reverse association was not found; depressive symptoms did not predict future (low) self-esteem (see Orth et al., 2009, for more detail). Anxiety disorders are also (negatively) associated with self-esteem, but to a lesser degree than is depression (with correlations between -0.31 and -0.45 reported in the literature).

Eating disorders are thought to be influenced by self-esteem as well. This association is not surprising, given that eating disorders involve an unrealistically negative view of the self. Bulimia Nervosa in particular seems to afflict LSE women to a greater degree than HSE women. A study of adolescent patients found that the association between LSE and eating disorders was mediated by depressive symptoms. That is, LSE was related to depressive symptoms, which in turn predicted maladaptive eating patterns (see Courtney et al., 2008, for full details).

Links have been reported between LSE and substance use and abuse, although there is substantial disagreement regarding this link. Whereas women alcoholics have lower self-esteem than nonalcoholic women (and alcoholic men), alcohol consumption in men is more complex. Some studies show positive, negative, or no link between alcohol consumption and self-esteem for male participants. In terms of drug use, the results are also varied. Initial drug use has been found to negatively correlate with self-esteem, although other evidence points to HSE leading to risky behavior in adolescence, including activities such as drug use. Further, longitudinal evidence reveals that although LSE may be associated with initial drug experimentation, continued use may actually boost self-esteem. Thus, although there may be an association between self-esteem and substance use, this association is complex and additional factors need to be considered.

Self-Esteem and Other Real Life Outcomes

Humanist theories, talk shows, and popular wisdom alike have long held that LSE is at the root of many social problems. From substance abuse to poor school achievement, LSE has been viewed as causing several deleterious outcomes. Indeed, the California Task Force to Promote Self-Esteem and Social Responsibility was initiated in the belief that boosting self-esteem would remedy societal ills of all kinds. However, increasing self-esteem may not be the cure-all for social ailments. Roy Baumeister and his associates reviewed evidence concerning self-esteem and real-life outcomes, including academic achievement, professional success, delinquency, and substance abuse. They drew two main conclusions. First, the associations between self-esteem and many outcomes are weak or nonexistent. For example, these authors concluded that academic achievement, success in the workplace, and leadership quality were virtually uncorrelated with self-esteem (although some weak positive associations were reported). Further, Baumeister and colleagues' review made clear that certain links between self-esteem and outcomes such as smoking, engaging in early sexual activity, and antisocial behavior, previously thought to be associated with LSE, have mixed empirical support (at best). Only a few differences between HSEs and LSEs seem to exist beyond the laboratory. For example, HSEs appear to show a stronger tendency toward in-group favoritism, and persist longer in the face of failure.

Baumeister and colleagues' second main conclusion is that, where associations involving self-esteem do exist, HSE does not necessarily cause such outcomes, so boosting self-esteem may not help. It may be just as likely that the causal direction is reversed – that some positive outcomes, such as overall happiness, cause increases in self-esteem. Additionally, both

self-esteem and positive outcomes may be caused by a third variable, such as strong interpersonal bonds producing both HSE and happiness, for example.

The 'Dark Side' of HSE

One ongoing debate in the literature surrounds the 'dark side' of HSE. Jean Twenge and colleagues have argued that attempts to increase self-esteem, such as the California Task Force mentioned above, alongside greater emphasis on individualism, may be leading toward more narcissism in Western society. These researchers argue that the rates of narcissism, or the tendency to aggrandize one's self-worth, have steadily increased since the 1980s – thus leading Twenge to dub recent generations as 'Generation Me.' Other researchers have questioned whether narcissism has actually increased, and contradictory findings exist (e.g., see Trzesniewski et al., 2008; but also Twenge and Foster, 2010).

Another potential harm linked to HSE involves aggression. According to popular wisdom, delinquency and aggression are associated with LSE. Contrary to this view, Baumeister and colleagues reviewed considerable evidence that people with LSE are *not* especially prone to aggression. In fact, these authors linked aggressive behaviors with high, not low, self-esteem. They reviewed evidence that people who have "favorable self-appraisals that may be inflated or ill-founded" (p. 5) are prone to aggression when anyone or anything calls into question their positive self-evaluations. Some self-esteem researchers may take issue, however, with how Baumeister et al. included in the HSE category those who are arrogant, conceited, or whose self-views may be 'inflated or ill-founded.' Thus, Baumeister et al.'s review of the 'dark side' of HSE may depict a construct closer to narcissism than to self-esteem. Indeed, in one study by Baumeister and colleagues, the combination of HSE and high narcissism produced the highest levels of aggression toward a confederate who provided a negative evaluation of the participant. HSE with low levels of narcissism did not produce the same degree of aggressive behavior.

Relationship Functioning and Self-Esteem

HSEs report themselves as being higher in popularity, more socially skilled, and as having larger networks of friends than LSEs. Although HSEs may inflate self-reports of social capital due to self-enhancement motives, empirical evidence suggests that HSEs generally do make better relationship partners. This evidence concerns all relationship phases, from relationship initiation to established unions.

In terms of relationship formation, HSEs' tendencies to self-enhance and LSEs' tendency to self-protect are evident in their initiation strategies. One study found that HSE men were more likely than LSE men to make direct overtures to potential romantic partners. Whereas HSE participants introduced themselves, for example, LSE participants reported more passive strategies, such as waiting for the other person to approach them.

In a related vein, it has been shown that LSEs are highly vigilant to rejection cues when interacting with a new person. This focus on rejection may overshadow positive overtures, and

in fact, LSEs tend to underestimate how much a new acquaintance likes them. Interestingly, LSEs are not ill-equipped to detect acceptance cues. Instead, Stinson and Cameron and their colleagues have found that although LSEs do not seem to notice or report acceptance cues when the overtures are directed at themselves, they do detect such cues if directed toward another person.

Another way that self-esteem can influence relationship initiation is through self-disclosure. We tend to like those who disclose information to us, and we tend to disclose information to those we like. This association holds because self-disclosure acts as a sign of intimacy, a necessary ingredient for developing (and established) relationships. In general, LSEs report that they disclose less information than HSE individuals, a finding confirmed by studies that use objective judges to rate self-disclosure. When one interaction partner is concerned with self-protection, as LSEs tend to be, they reveal little about their opinions or feelings. LSEs' interaction partners are then apt to report that they found the interaction awkward and boring, and that they like the LSE person less. Self-protectively refraining from self-disclosure, then, can bring about precisely the reaction LSEs fear: rejection.

In developed relationships, compared to HSEs, LSEs tend to experience more ups and downs, and less relational satisfaction. Longitudinal studies of relationship partners have revealed that HSEs start out with higher levels of relational satisfaction than LSEs, and experience increases in satisfaction over time. LSEs, in contrast, are more likely to show decrements in satisfaction as relationships go on.

According to the 'risk regulation model' of interpersonal functioning put forth by Sandra Murray and John Holmes, relationship partners must balance the goal of connecting with their partner against the goal of protecting the self from the sting of rejection. Connection can bring joy, increase intimacy, and heighten commitment, but it also increases the pain that rejection would bring. How do people decide, then, whether to seek connection or to protect themselves against possible rejection? According to the risk regulation model, perceived regard, or the extent to which people feel that their partners value them, is an important determinant of whether people pursue connection or protection goals. That is, the more people think their partners value them, the more likely they are to let go of self-protection goals and to pursue connection goals. As detailed above, LSEs are concerned with self-protection during initial social interactions, and perhaps unsurprisingly, this concern extends to long-term relationships as well.

Through multiple studies, the risk regulation model has garnered empirical support, often underscoring undesirable outcomes for LSEs and their partners. LSEs typically underestimate how much their partners love them, and instead, seem to assume that their partners question their worth in the same way they themselves do. Another problematic tendency for LSEs is that, as in relationship initiation, they interpret neutral or ambiguous cues in a less than benign manner. LSEs are quick to infer personal rejection when their partner is in a bad mood. HSEs, in contrast, are more likely to make favorable attributions for ambiguous partner behaviors, which can increase trust and relationship quality.

Inevitably, though, all relationships face threats or setbacks. Differences in how HSEs and LSEs deal with such threats has

proven informative. When the fear of rejection is warranted, LSEs self-protect by defensively drawing away from the partner. Intuitively, this may seem like a smart strategy; after all, it hurts much more to be rejected by a close other than by a distant other. However, when they are concerned about rejection, LSEs not only draw away from the partner, they also derogate their partners' value and behave less positively toward the partner. How do HSEs respond to potential rejection? Instead of creating distance between the self and partner, HSEs attach greater value to the partner, and feel more loved – a response that leads to positive interpersonal outcomes.

Summary

Self-esteem has received an abundance of research attention, both in pursuit of understanding the nature of self-esteem per se, and in relation to other variables that are important in life. Indeed, at the time of publication, a search of 'self-esteem' in the database PsychINFO reveals well over 65 000 results! Self-esteem refers to an evaluation of the self and has been conceptualized as a stable trait and as a state – a moment-to-moment evaluation. A large body of evidence makes clear that LSEs (at the trait level) respond less adaptively than HSEs when faced with failure and that LSEs behave in a more self-protective manner than HSEs, who are more likely to self-enhance. Several lines of research suggest that LSE is associated with undesirable personality traits, such as neuroticism, and proneness to guilt and shame, as well as with certain types of psychopathology, such as depression and anxiety. Also reviewed was evidence that HSE is not highly associated with positive outcomes such as superior academic performance, or successful task performance in the lab or workplace. Aggression in response to 'wounded pride' might be specific to HSEs (particularly those with high levels of narcissism). Research has made clear that interpersonal relationships of HSEs and LSEs differ in meaningful ways. Whereas HSEs draw closer to their partners in response to relational threat, LSEs distance the self from the partner. Although it is tempting to conclude that LSE causes negative outcomes and HSE causes positive outcomes, it is important to recall that most studies of self-esteem simply measure this construct. Thus, causal conclusions cannot be drawn. One prominent theory of self-esteem has proposed that both self-esteem and related outcomes are both caused by perceived relational value. Although much is already known about self-esteem, many questions remain unanswered. Self-esteem will undoubtedly continue to hold the imagination of researchers, the popular press, and the general public.

See also: Big Five Model and Personality Disorders; Body Image; Depression; Extraversion–Introversion; Peer Relationships and Influence in Childhood.

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Self-Fulfilling Prophecy

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Glossary

Binomial effect size display (BESD) A standardized procedure for the display of an effect size correlation of any magnitude, where row and column totals are set at 100; its purpose is to clarify the practical importance of the obtained correlation.

Correlation (r) An index of the closeness of a relationship between variables.

Effect size The magnitude of the research results, such as the size of the relationship between an independent variable (e.g., treatment vs. placebo) and a dependent variable (e.g., degree of improvement).

Experimenter expectancy effect An experimenter-related artifact that results when the hypothesis held by the experimenter leads unintentionally to behavior toward the participants that, in turn, increases the likelihood that the hypothesis will be confirmed.

Meta-analysis The use of quantitative and graphical methods to summarize the results of a group of similar studies.

Placebo A substance without any pharmacological benefit given as a pseudomedicine to a control group.

Introduction

Self-fulfilling prophecy is a concept used in the social and behavioral sciences to refer to the idea that one person's or one group's expectations for the behavior of others can quite unintentionally help to bring about the behavior expected of those others. The sociologist, Robert K. Merton, helped to bring this concept into the mainstream of the social sciences and gave it a now classic example from the discipline of economics. If, for some reason, people who have deposited their money in a particular bank come to believe that the bank will fail, they may well rush out to withdraw their money from that bank, thereby causing the up-until-now solvent bank to fail. In the area of international relations, social psychologist Gordon Allport believed that a self-fulfilling prophecy can be the cause of war. If one nation (A) believes that another nation (B) is arming itself in anticipation of going to war against nation A, then nation A will arm itself in self-defense, signaling hostile intent to nation B, which will then arm itself in self-defense, and so on until an actual war may occur based on initially unfounded observations. The expectation of the need for war may have contributed to the onset of that war.

In the medical sciences, Henry K. Beecher compared the effects of morphine to the effects of placebo. The beneficial effects of morphine in reducing pain were greater when investigators were aware of whether they were administering the morphine or the placebo. When the investigator did not know when was the morphine or when was the placebo being administered, then the morphine was no more effective than the placebo. Apparently, the knowledge that they were getting the real thing was somehow communicated to the participants who were administered the morphine, leading to their deriving greater benefits from it than were obtained by morphine-receiving participants whose investigators did not know whether the real thing had been administered to the participant.

Perhaps the most famous example of a self-fulfilling prophecy in the early days of modern experimental psychology is the

case of Clever Hans. Hans was a well-known horse who, in the early years of the twentieth century, amazed even sophisticated scientific observers by multiplying and dividing numbers in his head, and tapping out the answers with his hoof. Hans could do a great deal more including spelling, reading, and solving problems of musical harmony. Hans's owner, Mr. von Osten, a German mathematics teacher, unlike the owners of other clever animals of the time, did not profit financially from his horse's talents, and it seemed unlikely that he had any fraudulent intent. He was quite willing to let others question Hans even in his absence so that cues from the owner could be ruled out as the reason for the horse's abilities. In a brilliant series of experiments, Oskar Pfungst discovered that Hans could answer questions accurately only if the questioners themselves knew the answer and were visible to the horse during his foot-tapping of the answer. Finally, it was discovered that whenever people asked Hans a question, they leaned forward very slightly, the better to see Hans's hoof. That, it turned out, was the unintentional signal for Hans to begin tapping. Then, as Hans approached the number of hoof-taps representing the correct answer, the questioners would typically show a tiny head movement. That almost imperceptible cue was the signal for Hans to stop tapping, and Hans was right again. The questioner, by expecting Hans to stop at the right answer, was actually 'telling' Hans the right answer and thereby fulfilling his own prophecy. Pfungst did not learn all of this so easily. It took a long and elegant series of experiments to learn the secret of Hans's success. Pfungst summarized eloquently the difficulties in discovering Hans's talents. He and others had been misled too long by, to paraphrase, 'looking for, in the pupil, what should have been sought in the teacher.'

The four important examples of self-fulfilling prophecies drawn from the domains of economics, international relations, medicine, and experimental psychology, help us define and clarify the concept, but they do not by themselves establish the generality or the replicability of the effects of a self-fulfilling prophecy. To establish that generality and that replicability requires a series of randomized experiments, that is, a series

of studies in which the causal nature of the prophecy, or interpersonal expectancy, can be firmly established. In what follows, the evidence from a few of these randomized experiments is reported.

Some Early Experiments

Human Research Participants

In the first of the studies using human subjects, ten students of psychology, both undergraduate and graduate, served as the experimenters. All were enrolled in an advanced course in experimental psychology and were already involved in conducting research. Each student-experimenter was assigned as his or her research participants about 20 students of introductory psychology. The procedure was for the experimenters to show a series of ten photographs of people's faces to each of their participants individually. Participants were to rate the degree of success or failure shown in the face of each person pictured in the photos. Each face could be rated as any value from -10 to $+10$, with -10 meaning extreme failure and $+10$ meaning extreme success. The ten photos had been selected so that, on the average, they would be seen as neither successful nor unsuccessful, but quite neutral, with an average numerical score of zero.

All ten experimenters were given identical instructions on how to administer the task to their participants and were given identical instructions to read to them. They were cautioned not to deviate from these instructions. The purpose of their participation, it was explained to all experimenters, was to see how well they could duplicate experimental results which were already well established. Half of the experimenters, who had been randomly selected, were told that the 'well-established' finding was such that their participants should rate the photos as of successful people (ratings of $+5$), and half of the experimenters, who had been randomly selected, were told that their participants should rate the photos as being of unsuccessful people (ratings of -5). Results showed that experimenters who had been led to expect higher photo ratings obtained higher photo ratings than did experimenters who had been led to expect lower photo ratings. Subsequent studies tended to obtain generally similar results.

Animal Research Subjects

Pfungst's work with Clever Hans had suggested the possibility of experimenter expectancy effects with animal subjects. In addition, Bertrand Russell, in 1927, had noted this possibility, adding that animal subjects take on the national character of the experimenter. As he put it: "Animals studied by Americans rush about frantically, with an incredible display of hustle and pep, and at last achieve the desired result by chance. Animals observed by Germans sit still and think, and at last evolve the solution out of their inner consciousness."

But it was not only the work of Pfungst and Russell that led to the test of the generality of experimenter expectancy effects by working with animal subjects. It was also the reaction of researchers who themselves worked with animal subjects. That reaction was: "Well of course you'd find expectancy effects and other artifacts when you work with humans; that's why we work with rats."

A class in experimental psychology had been performing experiments with human participants for most of a semester. Now they were asked to perform one more experiment, the last in the course, and the first using animal subjects. The experimenters were told of studies that had shown that maze-brightness and maze-dullness could be developed in strains of rats by successive inbreeding of the well and the poorly performing maze-runners. Sixty laboratory rats were equally divided among the 12 experimenters. Half of the experimenters, chosen at random, were told that their rats were maze-bright, while the other half, chosen at random, were told that their rats were maze-dull. The animal's task was to learn to run to the darker of the two arms of an elevated T maze. The two arms of the maze, one white and one gray, were interchangeable; and the 'correct' or rewarded arm was equally often on the right as on the left. Whenever animals ran to the correct side, they obtained a food reward. Each rat was given ten trials each day for 5 days to learn that the darker side of the maze was the one that led to the food.

Beginning with the first day and continuing on through the experiment, animals that were believed to be better performers became better performers. Animals that were believed to be bright showed a daily improvement in their performance, while those believed to be dull improved only on the third day and then showed a worsening of performance. Sometimes, an animal refused to budge from the starting position. This happened 11% of the time among the allegedly bright rats, but among the allegedly dull rats, it happened 29% of the time. When animals did respond and correctly so, those believed to be brighter ran faster to the rewarded side of the maze than did even the correctly responding rats that were believed to be dull.

When the experiment was over, all experimenters made ratings of their rats and of their own attitudes and behavior vis-à-vis their animals. Those experimenters who had been led to expect better performance viewed their animals as brighter, more pleasant, and more likable. These same experimenters felt more relaxed in their contacts with the animals and described their behavior toward them as more pleasant, friendly, enthusiastic, and less talkative. They also stated that they handled their rats more and also more gently than did the experimenters who were expecting poor performance.

The next experiment with animal subjects also used rats, this time using not mazes but Skinner boxes in which there was a food dispenser and a small bar that could be depressed by the rat and would sometimes lead to a bit of food from the food dispenser. Because the experimenters (39) outnumbered the subjects (14), experimenters worked in teams of two or three. Once again, about half of the experimenters, selected at random, were led to believe that their subjects had been specially bred for excellence of performance. The experimenters who had been randomly assigned the remaining rats were led to believe that their animals were genetically inferior.

The learning required of the animals in this experiment was more complex than that required in the maze learning study. This time the rats had to learn in sequence and over a period of a full academic quarter the following behaviors: to run to the food dispenser whenever a clicking sound occurred; to press the bar for a food reward; to learn that the feeder could be turned off and that sometimes it did not pay to press the bar; to learn new responses with only the clicking sound as a

reinforcer (rather than the food); to bar-press only in the presence of a light and not in the absence of the light; and, finally, to pull on a loop which was followed by a light which informed the animal that a bar-press would be followed by a bit of food.

At the end of the experiment, the performance of the animals that were believed to be superior *was* superior to that of the animals that were believed to be inferior, and the difference in learning favored the allegedly brighter rats in all five of the laboratory sections in which the experiment was conducted.

Just as in the maze learning experiment, the experimenters of this study were asked to rate their animals and their own attitudes and behaviors toward them. Once again those experimenters who had expected excellence of performance judged their animals to be brighter, more pleasant, and more likable. They also described their own behavior as more pleasant, friendly, enthusiastic, and less talkative, and they felt that they tended to watch their animals more closely, to handle them more, and to talk to them less.

The absolute amount of handling of animals in this Skinner box experiment was considerably less than the handling of animals in the maze learning experiment. Nonetheless, those experimenters who believed their animals to be Skinner box bright handled them relatively more, or said they did, than did experimenters who believed their animals to be dull. The extra handling of animals believed to be brighter may have contributed in both experiments to the superior learning shown by these animals.

In addition to the differences in handling reported by the experimenters of the Skinner Box study as a function of their beliefs about their subjects, there were differences in the reported intentness of their observation of their animals. Animals believed to be brighter were watched more carefully, and a more careful observation of the rat's Skinner box behavior may very well have led to more rapid and appropriate reinforcement of the desired response. Thus, a closer observation, perhaps due to the belief that there would be more promising responses to be seen, may have made more effective teachers of the experimenters who had been led to expect good performance.

Teacher Expectation Effects

If rats became brighter when expected to, then it would not be far-fetched to think that children might become brighter when expected to by their teachers. Indeed, psychologist Kenneth Clark had for years been saying that teachers' expectations could be very important determinants of their students' intellectual performance.

The Pygmalion Experiment

All of the children in the study were administered a nonverbal test of intelligence, which was disguised as a test that would predict intellectual 'blooming.' The test was labeled as 'The Harvard Test of Inflected Acquisition.' There were 18 classrooms in the school, 3 at each of the 6 grade levels. Within each grade level, the three classrooms were composed of children with above average ability, average ability, and below

average ability, respectively. Within each of the 18 classrooms, ~20% of the children were chosen at random to form the experimental group. Each teacher was given the names of the children from his or her class who were in the experimental condition. The teacher was told that these children had scored on the 'Test of Inflected Acquisition' such that they would show surprising gains in intellectual competence during the next 8 months of school. The only difference between the experimental group children and the control group children, then, was in the mind of the teacher.

At the end of the school year, 8 months later, all the children were retested with the same test of intelligence. Considering the school as a whole, the children from whom the teachers had been led to expect greater intellectual gain showed a greater intellectual gain than did the children of the control group.

An Unexpected Finding

At the time the Pygmalion experiment was conducted, there was already considerable evidence that interpersonal self-fulfilling prophecies could occur, at least in laboratory settings. It should not then have come as such a great surprise that teachers' expectations might affect pupils' intellectual development. For those well acquainted with the prior research, the surprise value was, in fact, not all so great. There was, however, a surprise in the Pygmalion research. For this surprise, there was no great prior probability, at least not in terms of many formal research studies.

At the end of the school year of the Pygmalion study, all teachers were asked to describe the classroom behavior of their pupils. Those children in whom intellectual growth was expected were described as having a better chance of becoming successful in the future and as more interesting, curious, and happy. There was a tendency, too, for these children to be seen as more appealing, adjusted, and affectionate and as less in need of social approval. In short, the children in whom intellectual growth was expected became more intellectually alive and autonomous, or at least were so perceived by their teachers.

But we already know that the children of the experimental group gained more intellectually, so that perhaps it was the fact of such gaining that accounted for the more favorable ratings of these children's behavior and aptitude. But a great many of the control group children also gained in IQ during the course of the year. We might expect that those who gained more intellectually among these undesignated children would also be rated more favorably by their teachers. Such was not the case. The more the control group children gained in IQ, the more they were regarded as *less* well-adjusted, as *less* interesting, and as *less* affectionate.

From these results it would seem that when children who are expected to grow intellectually do so, they are benefited in other ways as well. When children who are not specifically expected to develop intellectually do so, they seem either to show accompanying undesirable behavior or at least are perceived by their teachers as showing such undesirable behavior. If children are to show intellectual gain, it seems to be better for their real or perceived intellectual vitality, and for their real or perceived mental health, if their teacher has been expecting

them to grow intellectually. It appears worthwhile to investigate further the proposition that there may be hazards to unpredicted intellectual growth.

The Meta-Analytic Evidence for the Self-Fulfilling Prophecy

Meta-analysis is the rapidly developing area of data analysis in which the entire body of research literature on a given question is summarized quantitatively.

Table 1 summarizes eight meta-analyses of the literature on interpersonal expectancy effects (self-fulfilling prophecies), with each meta-analysis conducted on a different domain of the research. For each domain, the table shows the mean effect size (r) and gives an example of the type of study included in each domain. The effect size r can be interpreted as the correlation, r , between (a) experimental versus control group status (e.g., coded 1 or 0) and (b) the outcome score (say, gain in performance). In an updated meta-analysis of 479 studies conducted nearly 20 years later, the average effect size r was 0.30. The correlation r indicates the strength of the relationship between two variables, for example, (a) the randomly assigned expectation for another's behavior and (b) the subsequent occurrence of that behavior. A correlation (r) of 0.00 indicates no relationship at all between the two variables (a) and (b); an r of +1.00 means a perfect positive correlation between (a) and (b) (the higher the score on (a), the higher the score on (b)); an r of -1.00 means a perfect negative correlation between (a) and (b) (the higher the score on (a), the lower the score on (b)). More on the interpretation of the correlation, r , of any particular magnitude, is discussed shortly.

Meta-analyses are also available for just the effects of interpersonal expectations on pupils' IQ test performance. Both

Stephen Raudenbush and Mary Lee Smith each found significant overall effects of interpersonal expectations on students' IQ. The mean effect size reported by Mary Lee Smith in units of r was 0.08. (The term 'significant' in referring to the results of these meta-analyses is a technical term meaning approximately that there is less than a 1-in-20 chance (i.e., a probability (p) of 1/20 or 0.05) that the results would have been obtained if the true size of the effect had really been an r of 0.00. The statistical significance of a particular correlation depends on the size of r and the size of the sample being studied. The larger the r and the larger the sample on which it is based, the more 'significant' is the result. There are many ways to compute the statistical significance of any effect size (e.g., r), and one of the most common is called the t test.)

Stephen Raudenbush's more recent meta-analysis was designed to investigate the relationship between the credibility of the expectancy induction and the magnitude of the teacher expectancy effect on pupil IQ. He reasoned that inductions of expectations in teachers would be credible only to the extent that teachers did not already know the children and, thus, had not already established expectations on the basis of their direct experience. As he had predicted, he found dramatic differences in effect sizes as a function of how long teachers had known pupils before the induction of the expectation.

Table 2 shows the magnitude of teacher expectancy effects on their pupils' intellectual performance for four levels of prior acquaintance: <1 week, 1 week, 2 weeks, and 3 or more weeks. There was a very strong linear trend such that the longer teachers were acquainted with their pupils before the induction of the expectation for superior performance, the smaller was the effect of teachers' expectations, exactly as Raudenbush had predicted.

It seems clear, then, based on the meta-analytic evidence, as well as on the evidence provided by the original *Pygmalion* experiment, that the educational self-fulfilling prophecy has now been well established – and as Merton noted some 40 years later – that is the first step in the scientific study of any phenomenon.

Table 1 Magnitude of interpersonal expectancy (self-fulfilling prophecy) effects in eight research domains

Domain	Mean effect size r	Example of type of study
Laboratory interviews	0.07	Effects of sensory restriction
Reaction time	0.08	Latency of word association
Learning and ability	0.26	IQ test scores; verbal conditioning
Person perception	0.27	Perception of others' success
Inkblot tests	0.39	Ratio of animal to human Rorschach responses
Everyday situations	0.40	Symbol learning; athletic performance
Psychophysical judgments	0.46	Ability to discriminate tones
Animal learning	0.65	Learning in mazes and Skinner boxes
Weighted mean ^a	0.33	
Unweighted mean	0.35	
Median	0.33	

Source: Rosenthal R and Rubin DB (1978) Interpersonal expectancy effects: The first 345 studies. *The Behavioral and Brain Sciences* 3: 377–386.

^aWeighting is by the number of studies in each domain.

The Practical Importance of Experimental Effects

For the eight experiments in **Table 2** in which teachers' expectations could most credibly be created, those in which teachers

Table 2 Stephen Raudenbush's meta-analysis showing teacher expectancy effects as a function of length of prior teacher–pupil acquaintance

	Number of weeks of prior acquaintance			
	0	1	2	3(+)
Mean r	0.24	0.18	0.05	-0.05
k of studies	5	3	3	8
Contrast weights (λ)	+3	+1	-1	-3

$t_{\text{contrast}}^a = 3.77$, $df = 15$, $p = 0.00093$, $r_{\text{contrast}} = 0.70$

$t_{\text{grand mean}}^b = 3.39$, $df = 15$, $p = 0.0020$, $r = 0.66$

$t_{\text{alerting}}^c = 10.53$, $df = 2$, $p = 0.0045$, $r_{\text{alerting}} = 0.99$

^aTests linear trend of 19 effect sizes over length of acquaintance.

^bTests mean of four effect sizes for overall effect of teacher expectancy.

^cTests linear trend of four mean r s over length of acquaintance.

knew their pupils 1 week or less, the median effect size was an r of 0.14, or $r^2 = 0.02$. These effect size estimates of r , and, especially, r^2 (called the proportion of variance accounted for), suffer from a common problem, the tendency to underestimate the practical importance of the effects of behavioral or biomedical interventions. This tendency to underestimate the importance of effects occurs not only among experienced behavioral researchers but among experienced statisticians as well. Accordingly, an intuitively appealing general purpose effect size display was proposed, the interpretation of which is far more transparent: the binomial effect size display (BESD). The question addressed by the BESD is: What is the effect on the success rate (e.g., survival rate, cure rate, improvement rate, selection rate, etc.) of the institution of a new treatment procedure? It, therefore, displays the change in outcome attributable to the new treatment procedure. Table 3 illustrates the BESD for the median effect size under discussion ($r = 0.14$) and for the median effect size for just those studies that Raudenbush reported in which teachers had already known their pupils for 2 weeks ($r = 0.04$).

It seems clear from Table 3 that a treatment that changes success rates (e.g., survival) from 43% to 57% or even from 48% to 52% is of substantial practical importance. Death rates are dramatic but so are failure rates, rejection rates, and error rates. To use the BESD, we compute the effect size r for our experimental effect. Adding the quantity $r/2$ to 0.50 gives the experimental group's success rate. Subtracting the quantity $r/2$ from 0.50 gives the control group's success rate. When effect sizes are displayed as a BESD, there emerges a better picture of the real-world importance of any treatment effect. Even so 'small' an effect as one accounting for nearly 0% of the variance, the BESD shows, has practical implications to a degree that most behavioral researchers and most statisticians find surprising. If it seems far-fetched to consider important those effects improving the rate of favorable outcomes from 48% to 52%, it should be noted that major drug studies have been interrupted and discontinued because the effect size, which was of just that magnitude, was regarded as so important that it seemed unethical to deprive the placebo control patients of the benefits of the drugs in preventing heart attacks. The drugs were propranolol in one case and aspirin in another.

The 10-Arrow Model

For many years, the central question in the study of interpersonal expectancy effects was whether there was any such thing.

Table 3 Binomial effect size displays (BESD) for r s of 0.14 and 0.04 that account for 'only' 2% and '0%' of the variance, respectively

Example of a treatment result				
Effect size	Condition	Alive	Dead	Σ
$r = 0.14$ ($r^2 = 0.02$)	Treatment	57	43	100
	Control	43	57	100
	Σ	100	100	200
$r = 0.04$ ($r^2 = 0.00$)	Treatment	52	48	100
	Control	48	52	100
	Σ	100	100	200

The meta-analytic evidence has answered that question sufficiently (e.g., $p < 1/10^{175}$, (i.e., 1 chance in 1 followed by 175 zeros), mean $r = 0.30$, based on the full number of 479 studies) so that simple additional replications will add little new knowledge. The central questions in the study of interpersonal expectancy effects have changed so that now the more interesting questions include the specification of the variables that (a) moderate expectancy effects and (b) mediate expectancy effects. Moderator variables are preexisting variables such as sex, age, and personality that are associated with the magnitude of interpersonal expectancy effects; mediating variables refer to the behaviors by which expectations are communicated. The basic elements of the 10-arrow model designed to clarify the study of interpersonal expectancy effects are (a) distal independent variables (e.g., stable attributes of the expecter and the expectee), (b) proximal independent variables (the expectancy), (c) mediating variables, (d) proximal dependent variables (e.g., outcome measures such as achievement on tests, etc.), and (e) distal-dependent variables (longer-term outcome variables). A useful feature of this model is that the ten arrows of the model represent the types of relationships that can be examined in research on interpersonal expectancy effects (see Figure 1).

For our purpose here, it will be enough to mention only the two links relevant to the topic of mediation: the B-C and C-D arrows. B-C relationships describe the effect the expectancy has on the expecter's behavior, the relationships most often investigated in research on mediation. Equally important to understanding mediation, however, are the C-D relationships between the expecter's behavior and outcome variables. Research bearing on the B-C link tells us which behaviors are induced by a given expectancy, but research bearing on the C-D link assures us that these behaviors affect the expectee so as to create a self-fulfilling prophecy. As is evident, the two types of relationships address different questions, making the B-C/C-D distinction critical.

The Four-Factor 'Theory'

On the basis of the first 30 or so published studies relevant to mediation, a four-factor 'theory' of the mediation of teacher expectancy effects was proposed. The 'theory' describes four major groupings of teacher behaviors hypothesized to be involved in mediation. The first factor, *climate*, refers to the warmer socioemotional climate that teachers tend to create for high-expectancy students, a warmth that can be communicated both verbally and nonverbally. The *input* factor refers to the tendency for teachers to teach more material to their 'special' students. The *output* factor refers to the tendency for teachers to give their 'special' students greater opportunities for responding. Finally, the *feedback* factor refers to the tendency for teachers to give more differentiated feedback to their 'special,' high-expectancy students. By differentiated, we mean that the feedback will be contingent on the correctness or incorrectness of the student's response and that the content of the feedback will tend to be directly related to what the student has said.

Subsequent meta-analyses were designed to summarize the many studies examining either the B-C or C-D links (or both) and to come up with a quantitative estimate of the importance

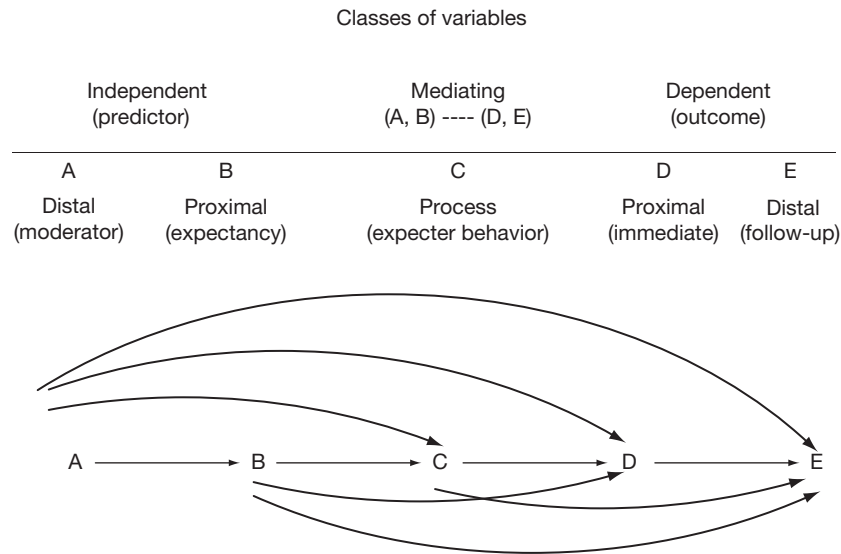


Figure 1 Model for the study of interpersonal expectancy effects.

Table 4 Summary of four factors in the mediation of teacher expectancy effects

Factor	Brief summary of the evidence
<i>Central factors</i>	
1. Climate (affect)	Teachers appear to create a warmer socioemotional climate for their 'special' students. This warmth appears to be at least partially communicated by nonverbal cues
2. Input (effort)	Teachers appear to teach more material and more difficult material to their 'special' students
<i>Additional factors</i>	
3. Output	Teachers appear to give their 'special' students greater opportunities for responding. These opportunities are offered both verbally and nonverbally (e.g., giving a student more time in which to answer a teacher's question)
4. Feedback	Teachers appear to give their 'special' students more differentiated feedback, both verbal and nonverbal, as to how these students have been performing

of each of the four factors in the mediation of interpersonal expectancy effects.

Table 4 summarizes the qualitative evidence for each of the four factors based on the meta-analyses, and **Table 5** gives the average magnitude of the role of each factor separately for the B–C and C–D links. While all four factors received ample support in terms of statistical significance, the magnitudes of the effects for the *climate* and *input* factors were especially impressive. Teachers appear to teach more and to teach it more warmly to students for whom they have more favorable expectations.

From these results, one cannot infer that if one selects warmer and more material-presenting teachers, school children will learn more. One also cannot infer from these results that training teachers to be warmer and more material-presenting

will lead to improved learning on the part of their students. The results do suggest, however, that conducting the research required to determine the benefits of selection and training for *climate* (or affect), *input* (or effort), *output*, and *feedback* may well yield substantial benefits both for science and for society.

Beyond Classrooms and Laboratories

The covert communication mediating one person's expectation for the behavior of another occurs well beyond the confines of the classroom or the cubicles of our laboratories. A meta-analysis of 13 Pygmalion studies conducted in work organizations found a mean overall effect size r of 0.38. In terms of the BESD, a mean effect size r of that magnitude is associated with improving a success rate from 31% to 69%. Larger effects of interpersonal expectations were found when workers' initial levels of performance were low. Larger effects were also found when the experiments were conducted in military rather than in business settings.

Several studies have investigated the effects of judges' beliefs about the guilt of the defendant on the way in which judges deliver their instructions to jurors (i.e., the B–C links described earlier), and the way in which these instructions influence jurors in how they decide on the defendant's guilt (i.e., the C–D link described earlier). In a meta-analysis of four studies, the median effect size r was 0.14, combined $p = 0.0006$, (i.e., 6 in 10 000). In terms of the BESD, the obtained median effect size r is associated with a change in the rate of findings of guilty from 43% to 57% as a function of being instructed by a judge who believes a defendant to be guilty rather than not guilty. It should be added as a methodological note that the defendant the judge believed to be guilty versus not guilty was not the same defendant whose case the jurors were trying to decide. Jurors saw a videotaped trial with defendant A but were given their instructions via videotape by a judge who was actually instructing a different jury with a different defendant, B.

Table 5 Meta-analytically derived average correlations indexing the effect sizes of the four-factor theory

Factor	Correlation between expectation and expecter's behavior (B–C link)	Correlation between behavior of expecter and response of expectee (C–D link)	Mean correlation
1. Climate (affect)	0.23	0.36	0.30
2. Input (effort)	0.26	0.28	0.27
3. Output	0.18	0.16	0.17
4. Feedback	0.13	0.08	0.10

Source: Harris MJ and Rosenthal R (1986) Four factors in the mediation of teacher expectancy effects. In: Feldman RS (ed.) *The Social Psychology of Education*, pp. 91–114. New York, NY: Cambridge University Press.

Note: All correlations are significantly greater than zero at $p < 0.002$, that is, <2 times in a thousand.

The correlation between the magnitudes of the average B–C and C–D links is 0.88.

There have been few randomized experiments in which health care workers' expectations have been raised for the health outcomes of their patients. One such study was conducted in a nursing home context; it was found that raising caretakers' expectations led to a reduction in the depression levels of the residents.

Not all of the relevant research on covert communication has been directly in the context of the mediation of interpersonal expectancy effects. For example, some recent work on what has been called 'thin slices of nonverbal behavior' has dealt with the tone of voice that primary care physicians and surgeons use when talking with their patients. Clinicians who had never been sued were compared with those who had been sued at least twice. Surgeons who were more bossy in tone of voice, and primary care physicians who seemed to care less about their patients, judging from their tone of voice, were those more likely to be sued. A good deal earlier it had been found that physicians' tone of voice in talking about patients was substantially correlated with physicians' success rates in getting alcoholic patients to enter treatment.

Of special interest to those who teach and are evaluated at the end of the term by their students is the research showing just how easy it is to predict how students will evaluate their instructor's overall effectiveness at the end of the term. All it takes is showing 30 s of a videotape of instructors' teaching behavior, with the sound turned off, to undergraduate raters of nonverbal behavior. Nonverbal warmth, enthusiasm, likability, etc. as rated by these undergraduate raters predicts the subsequent overall effectiveness ratings made by our students with $r = 0.76$; a replication study in a high school rather than a college setting yielded $r = 0.68$. In further studies, when the 30 s of silent videotape was reduced to 6 s, predictive accuracy decreased but remained remarkably high: $r = 0.71$ for college teachers, $r = 0.31$ for high school teachers.

These studies turned out not to be aberrant. In a meta-analysis of 38 independent studies using thin slices of behavior (5 min or less), considerable accuracy of predictions of various objective outcomes were found in the areas of social and clinical psychology, with an overall mean effect size r of about 0.40. Perhaps most surprising was the result that accuracy did not increase as exposure length was increased from 30 s to 5 min; nor did it increase for a series of studies based on quite thick slices of behavior covering spans of hours and even days.

Conclusion

Some processes of covert communication in classrooms, clinics, and courtrooms, and in the cubicles of corporations and of laboratories have been described. The primary emphasis has been on processes in which the expectation of one person (a teacher, a health care provider, a judge, an executive, or an experimenter), for the behavior of another person (a pupil, a patient, a juror, an employee, or a research participant), has come to serve as a self-fulfilling prophecy. The behavior expected actually came to pass *because* the expecter expected it.

That causal conclusion can be drawn because of the hundreds of randomized experiments that have been conducted, reported, and summarized quantitatively. However, there is still much that is not known. It is not known precisely what changes in the expecter's verbal and nonverbal behavior are brought about by changed expectations nor is it known precisely what elements of these changes are causal in bringing about the behavior changes seen in expectees.

As more is learned about various processes of covert communication, more is learned about what it is we do *not* yet know. But that should not be discouraging; it just shows the normal progress of the science of human behavior.

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Self-Regulatory Skills and Behavior Change

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Glossary

Action plans The 'if-then' links between environmental stimuli and the desired behavioral outcome. Action plans specify when, where, and how one will strive to obtain that chosen goal.

Behavior change processes Processes including motivational stages (strengthening motivation and developing new behavioral goals), action stages (adoption and maintenance of the new behavior), and relapse stages (returning to old behavioral habits). Transition from stage to stage is a function of self-regulatory processes.

Behavioral intention or goal Intentions are self-instructions to perform particular behaviors

or to obtain a certain outcome. Proximal goals (or intentions) indicate how hard an individual is willing to try to perform the target behavior or pursue the outcome. Goal setting includes processes of selecting behaviors, capturing the motivational factors.

Self-efficacy Beliefs about the ability to attain goals regardless of challenges, and internal or external barriers, arising during the goal pursuit.

Self-regulation Processes of management of thoughts, attention, emotion, and impulses. Self-regulation has an ultimate aim of reaching goals in an efficient way.

Introduction

Self-regulation is a volitional process of managing one's own thoughts, feelings, impulses, and reactions aiming at goal attainment. Simple and direct processes translate into a complex function, regulating intentional behavior. Self-regulation takes place when information about the current state is used to manage this state. According to major theoretical models of self-regulation, achieving self-regulatory efficiency is a function of balance between planning, initiating, and maintaining behavior patterns oriented toward achieving realistic goals. The withdrawal of engagement should follow if the goal becomes unattainable. Self-regulation is a cyclical process. Thus, monitoring and memory processes are crucial to the efficiency of self-regulation. Fixed patterns of behavior are ineffective as people need to constantly adjust to changing conditions.

As a result of natural selection, self-regulation in humans appears to be greater than among other species. It may be assumed that self-regulation is one of the qualities specific to the human species. Self-regulation research derives from several competing areas. Most of the conceptualizations, however, share the same basic assumptions. For example, theory and research clearly point to the fact that most of the behavior is goal-oriented. In this context, self-regulation is understood as a process of controlling responses in order to achieve a desired end state.

Self-regulation skills may have a function of attention and emotion control. Attention regulation deals with the ability to organize incoming stimuli in order to maintain a calm state of mind, delay gratification, tolerate change, and create the cognitive and behavioral response to selected stimuli exclusively. Processes of attention regulation depend on central nervous system characteristics and abilities of the brain to transform sensory data into organized neural impulses, which also suggests that attention regulation might be a relatively stable

characteristic of an individual. Attention self-regulation enables the individual to attend to relevant (voluntarily selected) environmental stimuli and to reduce the interference by irrelevant stimuli. Another aspect of regulatory skills portrays the ability to regulate and selectively attend to information that originates from within, for example negative emotions. Self-regulation of emotions is defined as modification of subjective experience of emotions in such a way as to optimize some personal goals. Thus, low self-regulation of negative emotions results in inability to stop experiencing negative emotions, rumination, preoccupation with current emotions, and difficulties with disengagement from their current emotional state.

In adopting a desired behavior, individuals first form a goal and then attempt to execute the action. Goals serve as self-incentives and guides to behaviors. A distinction can be made between distal goals and proximal goals. The latter regulate the amount of invested effort and guide action. Intentions, as defined in other social cognitive theories, are more similar to proximal goals than to distal goals. Terms such as 'I intend to' or 'I aim to' reflect goals, with all major theories agreeing that goals or intentions should be as specific as possible in order to facilitate subsequent action. In any case, goals (or intentions) are seen as direct and sometimes sufficient predictors of behavior. People tend to focus on multiple goals. These goals may compete or produce synergistic effects. Either achieving or failure in achieving a goal results in emotional and motivational consequences. Thus, attention and emotion self-regulation, goal setting, goal attainment, and affect are closely related to each other.

The science of intentional behavior and self-regulation often accentuates processes of planning. People formulate conditional plans of taking specific action in response to particular circumstances. Contrary to unconditional goals, conditional planning assumes that behavior is triggered with regard to specific conditions. In general, action planning is an extension

of an intention as it includes specific situation parameters and a sequence of action. Action plans specify when, where, and how the intention will be implemented. A different way of planning is the anticipation of barriers and generation of strategies to overcome them. This has been called coping planning. People may imagine scenarios that hinder them in performing their intended behavior, and they develop one or more plans to cope with such a challenging situation. Coping planning might be a self-regulatory strategy which augments the effects of action planning, partly because it implies action planning. After people contemplate the when, where, and how of an action, they imagine possible barriers and generate coping strategies.

Self-monitoring is an umbrella term for the self-regulatory processes enabling an individual to detect the discrepancies between the goals and actual behaviors. Self-regulation systems should allow for detecting discrepancies, varying in terms of the size and relevance. In general, the sensitivity to errors varies intra- and interindividually. The self-monitoring processes of high sensitivity promote fast response to discrepancies, prompt action before the discrepancies are too large, and precisely detect even small differences between the goals and behaviors.

One of the fundamental concepts connected to research on self-regulation is metacognition. Metacognition is known as the 'cognition of cognition,' a process in which an individual consciously monitors and controls their cognitive functions. Metacognition processes derive information about the cognition through the monitoring process. At the same time, metacognition informs cognition with the control process. We are thus able to reflect on our own cognitive processes and exert conscious control upon them. One of the facets of metacognition is the metacognitive knowledge, a construct strictly related to the monitoring function. Metacognitive knowledge is organized in a declarative belief system including models for cognitive processes such as language or memory. Metacognitive knowledge includes information regarding ongoing tasks, applied strategies, and selected goals, in the context of the environmental changes. This type of knowledge develops continually, through conscious observations on outcomes of our own actions, undertaken in different situations.

Leading Theories of Self-Regulation

There have been many conceptualizations modeling the underlying mechanisms of self-regulatory processes. Five major theories are discussed in this section. We start with the model of self-regulation by Carver and Scheier, and briefly summarize Baumeister's strength model, social cognitive theory by Bandura, Kuhl's theory of personality systems interaction, and Strack and Deutsch's reflective-impulsive model of self-regulation.

Carver's and Scheier's Self-Regulation Model

According to Carver and Scheier's model of self-regulation, human behavior is oriented toward reducing the perceived difference between the desired end state and the current situation. The process begins with a comparison between the desired state and the perceived present state. If the desired

standard is not met, an individual begins to take action in order to change the current situation to the point when subsequent 'adequacy tests' eventually show that the desired goal has been reached.

The perception of a goal being distant intensifies efforts undertaken in order to reach it. Consequently, when the perceived discrepancy between the current situation and one's goals is a continuing state, a modification of the desired end result may be initiated as a function of time and experience. That is to say, failure in achieving success results in the restriction of a person's goal. The process of abandoning a goal or developing a new one is referred to as limited disengagement.

According to Carver and Scheier, self-regulation acts as a negative feedback system reducing the discrepancies between current and desired states. The person's assessment of the current situation is the input and the person's behavior the output of the feedback system. One of the core ideas of the model is that the perceived pace at which a person approaches his or her goals has affective consequences. When the rate of progress toward the desired end state is greater than expected, positive affect is induced. A slower pace results in negative affective reactions. Emotional changes result from a variable rate of progress while constant rate does not evoke emotional changes.

Carver and Scheier assumed that both our goals and behavior are organized hierarchically. At lower levels, our goals are concrete and practical and they gradually become more abstract and conceptual toward the higher levels. People focus on an ideal self which then translates to corresponding principles. As a response, adequate behavior is being triggered. According to this theory, the attainment of high-level goals is only possible when the lower level behaviors are performed antecedently. Moreover, the success in reaching high-level goals is a function of the consistency between goals at antecedent levels. Emmons performed a rather sensible summary of the concept stating that "The most adaptive form of self-regulatory behavior may be to select concrete, manageable goals that are linked to personally meaningful, higher order representations."

Some critique of the model states that Carver and Scheier's theory is limited solely to mechanisms of either maintaining or withdrawing efforts concerning selected goals. The theory doesn't account for the nuances of the initial process of goal setting; hence, to some degree it omits individual differences in the perceived importance attached to different goals. The process of goal attainment requires a broader theoretical perspective.

Personality Systems Interactions Approach to Self-Regulation

The core idea of Kuhl's personality systems interactions theory states that human motivation is controlled by regulatory systems organized in a hierarchical manner. Similar to other conceptualizations, Kuhl postulated the existence of specific processes that manage the initiation and maintenance of goal-oriented behavior. The processes are triggered in cases where automatic behavioral responses prove to be inadequate. One of the crucial self-regulatory processes is self-discrimination. It refers to the ability to distinguish one's own conceptions from other's beliefs, desires, and expectations. Self-regulation processes are present and effective when the intentional behavior

is self-related. Intentional behavior should at all times conform to current circumstances in order to adapt to changing situations. Using an internal-control pattern enables an individual to flexibly choose between maintaining a behavioral pattern and disengaging from his or her initial intentions. According to Kuhl's theory, adapting to ever changing demands is the very essence of self-regulation processes.

The model assumes that several regulatory systems work with each other to perform self-regulatory functions. Seven levels of regulation can be roughly divided into three basic categories from elementary sensations and intuitive behavior, through affective control, to sophisticated cognitive processes. Self-regulation is a product of an interaction between goal enactment and self-development. Goal enactment processes consist of abstract goal representations put into concrete actions by intuitive behavior. Self-development functions by way of including new experiences in a person's network of accumulated experience. Both systems are strongly related to a person's affect. In states of low positive affect, goal representations become accentuated while high positive affect puts emphasis on intuitive behavior. States of high negative affect elicit increased object recognition at the expense of extension memory. The opposite happens when negative affect is low; in those cases, the process focuses on extension memory.

Social Cognitive Theory

According to social cognitive theory (SCT), human motivation and action are extensively regulated by forethought. This anticipatory control mechanism involves expectations that might refer to outcomes of undertaking a specific action. The theory outlines a number of crucial factors that influence behavior. The crucial factors are perceived self-efficacy beliefs and outcome expectancies, which promote behavior change and behavior maintenance. Besides these two cognitions, SCT also includes goals, perceived impediments, and opportunity structures in the environment of the individual.

Outcome expectancies are the other core construct of SCT which are concerned with people's beliefs about the possible consequences of their actions. Outcome expectancies can be organized along 3D: (a) area of consequences, (b) positive or negative consequences, and (c) short-term or long-term consequences. The area may refer to physical (e.g., health-related), social (e.g., social response to behavior change, such as disapproval or acceptance), or self-evaluative consequences (e.g., such as being ashamed, being proud of oneself, or satisfied with oneself).

Perceived self-efficacy represents the confidence that one can employ the skills necessary to resist temptation, cope with stress, and mobilize one's resources required to meet the situational demands. Self-efficacious individuals believe in their own capabilities to perform specific actions required to attain a desired outcome. Self-efficacy beliefs represent self-regulatory cognitions that determine whether instrumental actions will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and failures. Persons with low self-efficacy harbor pessimistic thoughts about their likely accomplishments and personal development. Self-efficacy beliefs affect the amount of effort to change undesired behavior and the persistence to continue

striving in the face of barriers and setbacks. Self-efficacy may be of a general character (i.e., generalized beliefs about ability to cope with various barriers arising during the processes of goal pursuit) and behavior- or domain-specific (i.e., referring to condom use, physical activity, and academic achievements). Further, efficacy beliefs may be specific for stages of behavior change, that is, they may refer to barriers specific for forming intention, processes of initiation of behavior change, maintenance of desired behavior, and relapse prevention (or a reduction of the scale of relapse). Self-efficacy is based on different sources, such as an experience of personal mastery, observing a model who is successfully acting upon his or her intention, verbal persuasion by others (e.g., role models), and positive emotions.

Baumeister's Strength Model of Self-Regulation

In Roy Baumeister's strength model, self-control is regarded in analogy to a working muscle. According to the theory, self-regulation derives from a global resource which, when depleted, disenables an individual from continuing the self-regulation process. Just as a muscle requires energy in order to retain effort through a period of time, the self-regulatory processes draw strength from a specific supply that is limited in its nature. When facing demanding circumstances for the self-regulatory processes over a prolonged period of time, people develop a growing level of fatigue which leads to self-regulatory failure. In accordance to Baumeister's findings, performing continuing acts of self-control leads to a dropdown in performance of the subsequent self-control responses. Baumeister refers to this state of energy exhaustion as ego depletion. The model expands on the muscle analogy and claims that the self-control reservoir can be replenished through rest and relaxation.

The theory further suggests that the mentioned strength supply is used for various volitional processes, be it controlled processing, active choice, initiating behavior, or overriding automatic responses. A substantial part of self-regulation deals with resisting impulses, and thus it should be regarded within the same categories as motivation. One of the obvious dimensions of motivation is the strength aspect. According to the theory, if motivation can be placed on the strong-weak continuum, then self-regulation should also be regarded as operating in the same plane.

Reflective-Impulsive Model

Strack and Deutsch's model suggests a system of two parallel processes – the impulsive and reflective system – that regulate social behavior. The impulsive system is interpreted as a parallel, fast-paced, and partially automatic activation spread along content associations. Essentially, the impulsive system may be regarded as a basic memory system. Environmental circumstances are associated with corresponding activation patterns. The emergence of subsequent stimuli in spatial and temporal proximity forms stronger links. Such associations may also include behavioral and affective responses.

On the other hand, the reflective system is responsible for rule-based reasoning and symbol manipulation and is the primary resource for self-regulation. The reflective system is a

sophisticated process enabling the use of more complex and flexible relations which at the same time contribute to a decreased rate of processing and reduced stability.

According to RIM, in the process of managing our behavior, the two systems may interact, using different procedures. The reflective system drives behavior by conscious decisions based on probabilistic assumptions. The impulsive system administers behavior according to activation patterns, formed automatically on the basis of previous stimuli and associations. According to the reflective-impulsive model, self-regulation is a process of restraining impulses and changing behavioral responses with the impulsive and reflective systems working antagonistically. The reflective system's ability to influence impulsive reactions is a trait specific to the human species. Similar to Baumeister's theory, it is assumed that people have a limited supply of reflective energy and recurring acts of self-regulation lead to the depletion of the person's resources.

Measurement of Self-Regulation in the Context of Behavior

Assessment of self-regulation mirrors the underlying theory and the conceptualization of self-regulation constructs. For the models applying the approach favoring conscious self-regulation processes, the measurement covers cognitive strategies (specific for the theory), metacognitive strategies (if included in the theory), and respective cognitive and behavioral outcomes. The measurement may range from more global to domain- and situation-specific, referring to motivational and volitional components of self-regulation. Further, the measures cover environmental factors which may interfere or contribute to the pursuit of behavioral goals.

Usually, self-report questionnaires with standardized instructions and response forms are used. This form of assessment is a typical way of evaluating self-regulation in the context of health behaviors, academic achievements, or sport performance. Self-regulation in the context of academic achievements is also evaluated by means of observations of overt behaviors, think-aloud protocols, or interviews.

The example of measurement of self-regulation processes may be derived from recent developments in SCT. This theory suggests that the measurement of the key cognitions should refer to the particular task at hand, specific behavior, and barriers relevant for the target population. For example, if we want to explain adolescents' tobacco use, we should apply self-efficacy referring to refraining from smoking in those situations which increase the risk for obtaining a cigarette. If the aim is to predict diabetes management and the control over diabetes symptoms, then diabetes self-efficacy beliefs should be evaluated. The measure would cover the ability to deal with diabetes-related self-care in the context of the typical barriers that arise when an adolescent tries to integrate diabetes self-care into his or her daily routines. In general, self-efficacy is measured with items referring to respective behavior and expected barriers "I am confident that I can ... (perform an action) even if ... (a barrier)." Intentions are usually measured with items such as "I intend to do X within the next week (day, month, etc.)." In line with other theories, the level of specificity is adjustable. One could say "I intend to swim twice a week,

starting from tomorrow," or one could say "I intend to exercise more in the near future." The semantic structure of outcome expectancies is: "If ... (a behavior), then ... (consequences)." An example of a positive outcome expectancy is "If I exercise more frequently, I will become slim." An example of a negative one is "If I exercise more frequently, I will have less time for my favorite social activities."

As indicated above, researchers have also proposed that self-regulatory cognitions may be measured as more general, or that they should be measured as tailored to particular stages of behavior change. Applying general measures of self-regulatory cognitions may be particularly useful if the investigation aims at predicting a broad range of behavioral outcomes. Measuring stage-tailored behavior may be particularly useful if a target population is in a particular stage of behavior change (e.g., the intervention is applied to adolescents who have not initiated sex life, therefore they are in motivational stage in terms of condom use).

Self-Regulation in the Context of Academic Performance

Self-regulation is frequently applied to explain academic achievements from kindergarten to university education. Regardless of a myriad of research, so far, randomized controlled trials were very rarely conducted in the area of self-regulation and academic achievement; thus, any conclusions should be drawn with caution.

Self-regulated learning is considered one of the key outcomes of the educational process, besides the instruction of factual knowledge. The process of self-regulated learning includes the preaction phase, when a learner sets his or her goals. Applying self-motivation strategies facilitates goal achievement and accentuates personal responsibility. In the action phase, the learner may acquire control over internal resources (e.g., concentration) and master several self-regulatory strategies, including metacognitive strategies (planning and monitoring), resource management strategies (time and attention management) or external regulation strategies, such as support-seeking. Finally, the learner acquires strategies allowing him or her for the evaluation of his or her efforts and strategies enabling dealing with mistakes. Thus, goal attainment should be accompanied by self-reflection processes. Besides learning outcome (i.e., the acquired knowledge), the learning process always results in affective response.

Experimental studies indicate that teaching such self-regulation strategies during regular math classes resulted in a significant increase of motivation, higher overall use of self-regulation strategies, setting higher goals, and an increase of global self-regulation. Although the direct effects on math tests results are only marginally significant, those who participate in such training and show an improvement in their self-regulation skills have significantly better results of math tests at follow-ups. Studies using randomization and experimental design indicated that the type of teaching strategy (i.e., an instruction method) may influence not only students' achievements but also their use of self-regulation strategies such as self-monitoring and knowledge acquisition strategies, as well as their self-efficacy beliefs. When prompting self-regulation

development is considered as the main outcome, concept mapping strategy turns out to be significantly more effective than individual study methods.

Recent experimental research also indicated that using computer programs fostering self-regulation skills during mathematics learning may affect the results of learning. In particular, programs training metacognitive control (planning and monitoring) enhance use of control strategies. Such programs also lead to better knowledge acquisition. Further, experimental studies show that metacognitive prompting interventions for science, which include metacognitive skills training during the phases of forethought, performance, and self-reflection, resulted in higher academic achievements. Encouraging students to reflect on their observations and conclusions and prompting them to compare their results with the expectations of the scientific community promotes progress in students' content knowledge. Further, participating in metacognitive prompting interventions resulted in a reduction of making decisions based on authority. By contrast, an increase of the frequency of making decision based on evidence was observed.

As indicated, models of self-regulatory learning assume that the main results of self-regulatory learning include both learning outcomes (academic achievements) and affect or well-being outcomes. Theory of self-regulation assumes that intrinsic self-regulation is the most autonomous form of self-regulation (people freely chose an activity out of a sense of interest). It is assumed that intrinsic self-regulation is superior to the identified regulatory style (the individual recognizes and accepts the value and importance of a behavior and integrates the behavior into the self). Experimental research supports this hypothesis, showing that intrinsic self-regulation is related to children's well-being at school, and also to better academic performance over longer periods. Identified regulation is also a good predictor of academic achievements, but only a combination of high school grades and high identified self-regulation was predictive of better well-being.

Self-Regulation in the Context of Health Behavior Change

Self-regulatory cognitions influence behaviors in different health domains, such as adherence to medication, recovery from disease, and dealing with pain. Further, the role of self-regulation is frequently analyzed in the context of initiating health-promoting behaviors, such as physical activity and healthy nutrition, and ceasing health-compromising actions, such as cigarette smoking, illicit drug use, and unsafe sex practices.

Researchers analyzing the role of the self-regulation strategies in health behavior change frequently apply SCT, Carver and Scheier's control model, information-motivation-behavioral skill model by Fisher and Fisher, and theory of planned behavior. Recent taxonomy of health behavior change interventions assumes that conscious self-regulatory processes form the backbone of the behavior change. Abraham and Michie proposed a list of 26 theory-based health behavior change techniques, which are most frequently applied in the health behavior change intervention. The taxonomy includes such self-regulatory strategies as prompting self-monitoring of behavior, specific goal setting, using feedback on performance,

planning social support or social change, prompting self-talk, task grading, barrier identification, intention formation, analysis of behavior consequences, and analysis of behavior-health link.

Recent systematic reviews allow for a synthesis of the accumulating research evidence in the area of self-regulation and health behavior change. For example, an increase of physical activity is likely to be obtained if the interventions apply self-regulatory techniques focusing on strengthening self-efficacy beliefs and focus the participants on positive expected outcomes. Other systematic reviews suggest significant relationships between goal formation (and intention strength) and health behavior (such as physical activity) as well as significant associations between forming actions/coping plans and nutrition (in particular, moderate effects were observed for adoption of healthy diet, smaller effects are observed for a reduction of unhealthy nutrition habits).

The number of experimental studies on the effects of self-regulatory interventions on health behavior and health-related outcomes is impressive. There are, however, some serious limitations. Research rarely showed that behavior change is mediated by the change in self-regulation. Only a few studies indicated that the change in health behavior or health-related outcomes is indeed a function of a change in an application of self-regulation. For example, our study suggested that overweight and obese women who participate in a training prompting their abilities of planning significantly reduced their body weight, compared to controls who received a standard care. The effect of the intervention was completely mediated by an increase of the use of physical activity and nutrition planning. However, a vast majority of experimental research has not shown the mediating effect of a shift in self-regulation. Such a mediation effect is required if one wants to assume that the effects of self-regulation-enhancing interventions are indeed due to changes in self-regulation processes. A recent systematic review conducted in the context of addition behaviors points out that although self-regulatory interventions promoting behavior change result in a change of behavior or self-regulatory beliefs (such as self-efficacy), the evidence that the behavior change is actually mediated by a change in self-regulation is actually very weak. In sum, further research is pending, before stronger conclusions about the role of self-regulation may be drawn.

Experimental and longitudinal research explaining health behavior change also showed that the self-regulatory cognitions may operate in a specific order, or acquiring higher self-regulatory skills in one area may be a condition for the effective use of other self-regulatory skills. There is sufficient evidence to assume that strong intentions (proximal goals) are prerequisites for obtaining beneficial effects of planning strategy. Thus, self-regulatory training may first focus on forming realistic goals and strengthening the willingness to engage in those goals and then teach participants how to form effective action plans. Further, the effects of a prompting action planning intervention are moderated by the self-efficacy beliefs. For example, our studies indicated that participants of nutrition planning intervention who have strong baseline nutrition self-efficacy are able to change their nutrition more effectively than participants of the planning intervention who have weak baseline self-efficacy or suffer a decline in nutrition efficacy beliefs.

Thus, teaching planning self-regulatory skills should follow after the training which enhances self-efficacy. Systematic reviews suggest that the largest effects on self-efficacy may be expected, if the intervention includes feedback on past or other's performance.

Self-Regulation in the Context of Sport Performance

Basic rules of interventions aiming at the performance enhancement in sports are drawn from self-regulation theories. Professional and elite sport players are constantly confronted with strenuous training, competition, and evaluation, as well as a need to balance personal life and sport career demands. Thus, self-regulation may be considered a prerequisite to achieve progress in physical skills and in achieving elite status. Self-regulation strategies are usually acquired in the process called mental skills training. Mental skills training aims at helping athletes to attain optimal personal development, management of one's own psychological and physical states, achieving optimum of psychological functioning, and enhancing learning (of physical and mental skills) by means of activating self-regulatory processes.

It is assumed that the acquisition of four groups of mental skills by athletes and their coaches affects sport performance and athlete well-being. The first group, called foundation skills, includes: (1) training of productive thinking (management of thoughts in order to effectively prepare and respond to life events, training, and competition), (2) building up self-confidence (or self-efficacy), (3) increasing self-awareness of physical processes in athlete's body, (4) introspective and retrospective analysis and understanding of the interactions between thoughts, feelings, and behaviors. Performance self-regulatory skills refer to attentional focus and energy management. Personal development skills refer to regulatory abilities aiming at developing interpersonal competences. Finally, team skills deal with all self-regulation skills, which are used to building the leadership competencies, effective team communication, fostering team cohesion, and confidence.

There is a variety of mental skills-training components, but only four sets of self-regulatory techniques were investigated more thoroughly. The studies applied experimental design and focused on adolescents involved in sport training and on adult elite and nonelite athletes.

First technique refers to use of imagery or visuomotor behavioral representation. Imagery technique develops 'mental blueprints,' representing perfect behavioral responses in a specific situation. Imagery may include both physical and visual representation of a sequence of actions which will be implemented in a training situation or during a competition. An application of such technique aims at boosting self-confidence, attention control, reducing harmful effects of sub-optimal activation, and promoting visual search abilities. It also improves performance satisfaction and cohesion of sport performance.

Goal setting represents second crucial self-regulatory technique. This technique promotes speedy progress in physical skills training and thus prompts performance improvement. Athletes are taught to plan, set, focus on, evaluate, and manage their behavior in the perspective of the self-selected goals.

It is suggested to use goal setting systematically, as systematic use promotes better attention focus and results in increased efforts. Sport psychologists differentiate between outcome (e.g., winning the competition, not really controllable), performance (flexible, allowing to raise the levels of specific skills continually), and process goals (enabling athletes to focus on specific demands created by the current situation, the promotion of coping with the situation in a most effective way). Goal setting techniques are moderately related to the sport performance. Training goal setting (including individual and team goals) may be more useful in earlier stages of sport career.

Next self-regulatory technique, called self-talk, encompasses a range of self-regulatory skills of using verbal dialogue and evaluations in order to interpret and manage emotional states and perceptions. Self-talk also aims at giving oneself instructions or reinforcements. Self-talk may include positive thinking and positive reinterpretation, blocking distractions, and perspective talking. This technique is used more consistently and for longer time periods by elite athletes, compared to those in earlier stages of their career. It enhances skill acquisition and performance (e.g., precision of shooting). One of the main consequences of using self-talk is a reduction of anxiety and arousal during the competition, psyching oneself up during training or while competing in endurance sports, relaxing and calming down, managing confidence, and reinforcing oneself after an effortful trial.

The final component of mental training in sport refers to the relaxation techniques. These techniques are used to manage physical energy levels. Applying physical relaxation helps athletes to reduce somatic aspects of anxiety. Relaxation may include restricted emotional stimulation, inducing deep relaxation state prior to the competition. Such self-regulation strategies may enhance performance of fine motor tasks, requiring high precision. Cognitive relaxation techniques may help athletes to reach their individual optimal zones of arousal and mobilization, which in turn may affect sport performance.

Recent research indicated that the effective mental skill training should include a combination of self-regulatory skills. Randomized controlled trials showed that visuomotor behavior rehearsal combined with self-talk or a combination of goal setting with activation regulation techniques (relaxation) and self-talk may result in performance improvement in sports.

Self-Regulation and Coping Behaviors

Self-regulatory cognitions determine the ways individuals perceive and cope with stress and therefore they influence mental and physical health, as well as any behaviors at stress. According to Carver and Scheier's approach to self-regulation, coping behaviors reflect the self-regulatory efforts at the time of stress. The commonsense model of self-regulation, developed in the context of illness, assumes that perceptions related to illness may influence coping responses (i.e., coping aiming at emotion regulation and problem-solving coping). In turn, coping efforts predict emotional response and such behaviors as the use of external resources, management of one's own symptoms, and adherence to recommended behavior change.

A large body of evidence on the role of self-regulatory beliefs in predicting coping with stress refers to the effects of

self-efficacy. For example, self-efficacious individuals perceive stressful situations as challenging and controllable, which may reduce the negative impact of stress on health. SCT suggests that self-efficacy is a resource determining the way individuals cope with stress. In particular, efficacy beliefs facilitate the selection of active coping strategies, increase coping effectiveness, affect mental health directly, and buffer stress indirectly (reducing negative affect). Self-regulatory beliefs, such as self-efficacy are seen as a proximal determinant of physiological stress response, affecting levels of cortisol, catecholamines secretion, and immune system response. It is assumed that because self-regulatory cognitions determine that a stressful situation is perceived as manageable, the neuroendocrine and immune response to stress is reduced, and therefore a stressful situation becomes less harmful to physical and mental health. Systematic reviews indicate that a combination of specific coping strategies (low passive coping, such as wishful thinking, self-criticism, and social withdrawal), accompanied by high self-efficacy, is an important predictor of well-being among people with diseases inflicting chronic pain. Similar conclusions may be drawn from systematic reviews of research in the area of adaptation among patients with cancer. Those patients who use problem-focus coping and harbor high self-efficacy beliefs have better emotional adjustment.

Another construct which has been developed in the context of self-regulation theories and theories of coping with stress refers to proactive coping. This construct refers to processes of anticipation or detection of potential stressors and acting before the situation arises in order to reduce its negative impact. Aspinwall and Taylor suggested that proactive coping develops in several stages, such as resource accumulation (e.g., social support-seeking), recognition of potential stressors, initial appraisal, preliminary efforts to cope, and the use of feedback regarding the effects of one's own coping efforts.

Conclusions and Outlook

Self-regulation science of the last two decades offered a major development in self-regulation theories. Models assuming conscious self-regulation evolved into models encompassing both conscious and impulsive (automatic) processes. Although the area of self-regulation had drawn major attention and resulted in a large body of empirical evidence, the quality of this evidence varies, depending on the area of studies or a target behavior. Our review indicates that although thousands of studies analyzed the use of self-regulatory strategies in the context of behavior at school, students' well-being, and their academic achievement, the list of randomized controlled trials is very short. Thus, there is a need of high-quality trials showing the effectiveness and superiority of self-regulated

learning over standard treatment/control condition. The role of self-regulation in predicting health behavior change has been studied more thoroughly, applying lines of experimental trials. The research, however, provides a limited experimental evidence for the assumption that the change in specific self-regulatory skills (trained in the intervention) mediates the change of health behavior. Recent years brought major developments in the area of sport-related behaviors and interventions addressing self-regulatory skills, aiming at optimal behavior in training and competition. Although sport psychologists provided detailed self-regulation intervention protocols (which are pretty detailed, as compared to descriptions of health behavior change interventions), the effects of these protocols were rarely evaluated in randomized controlled trials. In sum, across analyzed domains, the evidence for the effectiveness of the interventions promoting self-regulation is weak. Longitudinal and experimental trials, accounting for mediating processes of change in self-regulatory skills, are necessary to advance science of self-regulation.

See also: [Intention](#); [Planning](#); [Self-Efficacy](#); [Self-Fulfilling Prophecy](#).

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Self-Relaxation

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Glossary

Autogenic training A suggestion-based approach to relaxation and 'self-healing.' Beginning exercises focus on passively thinking physical relaxation-related phrases such as 'hands warm and heavy.'

Breathing exercises Relaxation exercises targeted to enhance deep, even, and slow breathing with enhanced use of the diaphragm.

Imagery Relaxation exercises that focus on passively engaging in nongoal directed fantasy involving a relaxing setting or activity.

Meditation Relaxation and focusing exercise that involves passively directing attention to a simple stimulus.

Mindfulness Relaxation and focusing exercise that involves passively attending to spontaneously emerging stimuli while avoiding judgment, analysis, or effortful mental processing.

Progressive muscle relaxation Relaxation exercise that involves tensing up and letting go of targeted skeletal muscle groups.

Relaxation response Diffuse nonspecific reduction in physiological arousal that is generally the opposite of the stress arousal response.

R-state Relaxation state, or empirically defined psychological states, associated with the practice of various approaches to relaxation.

Self-stressing The voluntary triggering or maintaining of stress arousal through stressed posture or position, tensing skeletal muscles, stressed breathing, stressed body focus, stressed emotion, or stressed attention.

Stretching Relaxation strategy central to Hatha yoga that involves slowly, smoothly, and gently engaging stretching and maintaining balanced stretched positions.

Yoga General term for a cluster of ancient religious, philosophical, and relaxation disciplines, most often associated with stretching and maintaining special postures and positions.

Relaxation is perhaps the most widely applied tool in stress management as well as in complementary and alternative medicine. Thousands of techniques have evolved over the millennia from religion, philosophy, medicine, and psychology. Controversies exist concerning whether all techniques have the same effect or whether different approaches work for different individuals and goals.

Relaxation as Reduced Arousal: The Relaxation Response

Walter Cannon and Hans Selye helped popularize the notion of stress as increased physiological arousal. Mediated largely by the brain's hypothalamus and the sympathetic nervous system, the stress arousal response automatically awakens and energizes the body for emergency action in what is traditionally termed the 'fight or flight response.' The fight or flight response is automatically integrative, adaptive, and helps us respond to emergencies. Its effect can be immediate and prolonged. However, prolonged activation has its costs, contributing to an increased propensity to display high levels of chronic stress arousal.

Stress arousal can make one more vulnerable to, less likely to recover quickly from, and more likely to suffer complications from a wide range of diseases. Put simply, intense and chronic activation of the stress response subjects the body to measurable wear and tear. Our organs were not meant to continue in a state of emergency readiness for long periods of

time without showing some wear and tear. Second, although brief stress can boost the body's immune system, too much stress interferes with immune functioning, making one more vulnerable to illness and less likely to heal and recover quickly. Wear and tear as well as impaired immune functioning are two important reasons why stress can be unhealthy.

Severe and prolonged stress can also have a detrimental effect on how well one performs the tasks of living. Eventually attention is reduced and one is likely to let important stimuli go unnoticed. Behavior is more rigid and less flexible; creativity is impaired (one can get 'stuck in a rut,' trying over and over the same unsuccessful coping strategies). Memory is impaired. Energy reserves are depleted and one is more likely to experience fatigue.

In the early 1970s, Harvard cardiologist Herbert Benson found that practitioners of transcendental meditation show a constellation of physiological changes suggesting deepened relaxation. These include the mirror opposite of the stress response – reduced heart rate, blood pressure, respiration rate, brain wave activity, and so on. Benson's research was not only partly responsible for increasing public and scientific interest in meditation, but he popularized a definition of relaxation as generalized reduced arousal, the 'relaxation response.' Any approach to relaxation, not just meditation, evokes the relaxation response and has the potential for protecting against over-stress and promoting stress recovery. Activity of the sympathetic nervous system, dominant during stress arousal, lessens whereas the parasympathetic nervous system (responsible for recovery and rest) becomes more dominant.

Neuropsychological Conceptualizations of Relaxation

Relaxation response definitions state that all approaches to relaxation should be equally effective as long as they evoke the relaxation response. Indeed, this is one reason why most stress clinics rely on one or two approaches. However, contemporary neurophysiological views of relaxation suggest that different approaches have quite different relaxation effects and work for different people. Self-stressing models (see below) place a bit more emphasis on neurophysiological variables whereas other models focus more on psychological states of mind, or 'R-States,' associated with relaxation (such as mindfulness, feeling rested). The author's research itself (Smith, 2006) suggests a surprising cornucopia of such psychological states, each reported during practice of relaxation. It is beyond the scope of this article to elaborate on these R-States. Briefly, they seem to sort into five categories: Withdrawal and Release (sleep, reported physical relaxation such as feeling heavy or warm, feeling far away); Basic Renewal (feeling peaceful, at ease, refreshed); Positive Energy (feeling energized, happy, love, optimism); Mindfulness (quiet mind aware, focused); and Transcendence (reverence, awe and wonder). When people practice a relaxation technique, they often experience many things (Figure 1).

Self-stressing and Relaxation

Today, most presentations of relaxation consider a variety of approaches, typically variations of yoga stretching, progressive muscle relaxation, breathing exercises, autogenic training, imagery/positive self-statements, and meditation/mindfulness. Such differentiation is no accident but an inevitable consequence of the very nature of psychological and physiological processes that underlie stress arousal (Smith, 2005). According to self-stressing theory, there are six ways by which we can trigger and sustain physiological stress arousal. Each form of 'self-stressing' suggests a corresponding family of relaxation technique (Smith, 2005).

Stressed posture and position: When confronted with stress, people often assume a variety of defensive or aggressive postures or positions (standing, crouching, bending over a

desk) for an extended time. This, combined with sustained immobility, can evoke skeletal muscle tension, joint stress, and reduced blood flow and contribute to tension, fatigue, and decreased energy. *Stretching approaches to relaxation such as hatha yoga are most associated with stressed posture and position.*

Stressed skeletal muscles: When threatened, one clenches, grips, and tightens skeletal muscles to prepare for attack or escape. When chronic, such tension can contribute to pain and fatigue. *Approaches involving tensing and letting go (progressive muscle relaxation) directly target stressed skeletal muscles.*

Stressed breathing: Under stress, one is more likely to breathe in a way that is shallow, uneven, and rapid, deploying greater use of the intercostal (ribcage) and trapezius (shoulder) muscles and less use of the diaphragm. *Breathing relaxation exercises, woven into many systems especially yoga, target relaxed breathing.*

Stressed body focus: Simply attending to and evoking thoughts and images about a specific body part or process can evoke related neurophysiological changes. An individual facing a threat may notice her rapidly beating heart or churning stomach. Attending to and thinking about these somatic reactions can aggravate them. *Autogenic suggestion approaches involve evoking thoughts and images about specific types of somatic relaxation ('Hands warm and heavy').*

Stressed emotion: We often motivate and energize ourselves for a stressful encounter with affect-arousing cognitions. We entertain fantasies and repeat words and self-statements that can evoke anxiety, anger, or depression. *Imagery and visualization approaches to relaxation involved evoking images and words associated with affective states conducive to relaxation.*

Stressed attention: When dealing with a threat, we actively and effortfully concentrate on attacking, defending, or running. In addition, we often direct our attention to multiple targets, including competing tasks (as in multitasking), a targeted task versus worried preoccupation, or self-stressing efforts (thinking how one is breathing, maintaining a stressed posture or position, thinking about relaxed fantasies or negative emotions, etc.) rather than the task at hand. *Meditation and mindfulness approaches involve calmly and simply attending to a single target stimulus, or the moment-to-moment flow of stimuli.*

In sum, self-stressing theory suggests that the world's diverse rainbow of relaxation strategies can be sorted into six universal family groups, stretching, tensing and letting go (progressive muscle relaxation), breathing exercises, autogenic exercises, imagery, and meditation/mindfulness. Approaches that do not fit neatly in one of these categories are combinations of approaches; for example, the graceful movements of tai-chi blend stretching, breathing, imagery, and meditation.

Self-stressing theory does not claim that one universal family group works only for one type of symptom, for example that progressive muscle relaxation works only for skeletal muscle tension. Instead, the associated self-stressing effect is an *initial effect*, part of the initial core rationale given to practitioners, and an initial procedural self-unstressing strategy. So a client may read that 'progressive muscle relaxation targets the

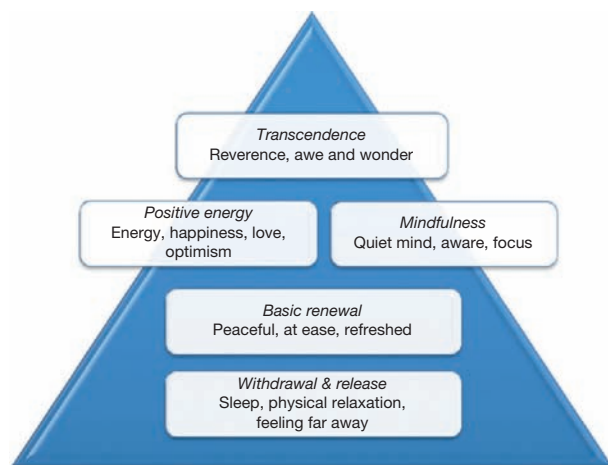


Figure 1 The dynamic pyramid of R-states.

muscles' (a typical rationale) and in the first session be instructed to 'focus on your shoulder muscles and let go' (a beginning procedural instruction focusing on skeletal muscles). Quickly, clients and practitioners discover that eventually *all universal family groups of relaxation can eventually address all components of self-stressing.*

Types of Relaxation

The relaxation practitioner has available thousands of techniques that evolved over several millennia. We have seen that according to the relaxation response perspective, all are interchangeable, as long as they evoke a general relaxation response. Contemporary theories of relaxation, organized under the rubrics of self-stressing and R-State theory, suggest that most approaches fall into one of six universal family groups. This is most clear for self-stressing theories of relaxation. Primarily physical family groups of stretching, progressive relaxation, and breathing exercises, initially targeted to stressed posture and position, muscle tension, and stressed tension. Cognitive family groups of autogenic self-suggestion, imagery and positive self-talk, and meditation/mindfulness target stressed body focus, stressed emotion, and stressed attention. Here we consider each universal family group. It is instructive to note that prior to the advent of relaxation science, advocates of each family group tended to view their approach as the only way to relax. Note that because breathing and stretching exercises share historical roots, we will consider them together.

Illustration of Yoga Stretching Exercise

Let both arms hang to each side. Slowly swing your right hand and arm up tracing a circle in the air to your side. Do this very slowly, smoothly, and gently, as if you were balancing a feather on your fingertips. Let your arm and hand move higher until it is pointing straight up into the sky. Continue attending to your hand and arm and you slowly, smoothly, and gently return it to your side.

Breathing and Yoga Stretching

The histories of breathing and yoga stretching (as well as meditation) are intertwined. Hinduism, one of the ancient religions of India, has incorporated a diverse assortment of yoga stretching, breathing, and meditation exercises for thousands of years. In the second century BC, such exercises were codified in the yoga aphorisms of Patanjali. Patanjali emphasized an eight-step path for cultivating a meditative state of mind conducive to spiritual insight. The steps included various initial ascetic practices, yoga postures and stretches, breathing relaxation exercises, and finally meditation. The easiest of meditative practices, often called concentrative meditation, involved withdrawing the senses from the troubling and distracting influence of external stimuli, memories, and so on, and concentrating on a single point.

Through the centuries, numerous divisions of Hindu thinking appeared, some emphasizing devotion to a theistic God and others an impersonal nontheistic absolute (the 'flow of energy everywhere,' 'consciousness and being'). This latter position, associated with the eighth century Indian philosopher Shankara, was eventually to form the basis of most Western

forms of Hinduism, yoga, and meditation, including transcendental meditation.

Many yogas

Yoga is primarily associated with exercises involving stretching and maintaining various postures (Smith, 2006). However, there are many approaches. There is no single yoga tradition. Over the past 5000 years, thousands of exercises and hundreds of systems have evolved. Indeed, someone who claims to 'practice yoga' has said very little about what she actually does; she might as well claim to 'practice fitness,' 'do holistic health,' or 'believe in moral living.' Some of the specific systems include hatha yoga, prana yoga, kundalini yoga, bhakti yoga, raja yoga, kriya yoga, and tantra yoga. Every year, a new yoga system emerges.

Some preliminary distinctions can be made. Hatha yoga focuses on stretching and maintaining specific postures (such as the famous 'lotus' cross-legged sitting position) and to some extent developing muscles; prana yoga focuses on breathing; kundalini yoga emphasizes chakra energy centers in the body, bhakti emphasizes prayer and worship, raja yoga focuses more on philosophical inquiry, kriya yoga tends to consider sources of energy, and tantra yoga is often associated with sexuality.

It should be noted that in the West simple stretching exercises can be traced back to Olympic athletes in ancient Greece. Such exercises, although sometimes similar to hatha yoga, have primarily been used to prepare for and recover from athletic activity. Other contemporary fitness routines, ranging from the Alexander technique to Pilates, incorporate some form of stretching.

Many breathing exercises

As we have noted, prana yoga focuses primarily on breathing exercises. It is an approach over 5000 years old and has generated thousands of specific breathing exercises.

Breathing exercises are almost always deployed as a part of another technique. One popular Western approach is Lamaze, a natural childbirth method. Breathing exercises vary considerably, and include active yoga stretches, active diaphragmatic breathing, and passive approaches. Generally, the goal of breathing exercises is to foster diaphragmatic breathing and a pace that is slow and even. One initially learns to breathe deeply, then breathing becomes effortless and shallow as training progresses and relaxation deepens throughout weeks and months of practice.

Illustration of Breathing Exercise

Gently take a deep breath. Pause. And slowly exhale, slowly letting the air flow through your lips, as if you were blowing on a candle flame. Attend to the flow of breath. Notice how it quietly moves in through your nostrils, and down into your lungs. Follow the flow of breath in and out.

Tense-Let Go Exercises (Progressive Muscle Relaxation or PMR)

Variations of Edmund Jacobson's progressive muscle relaxation is perhaps the most widely used professional approach to relaxation in America. For years it has dominated textbooks

and relaxation research and, even now we see the term 'progressive relaxation' used interchangeably (and incorrectly) with relaxation.

Jacobson's approach involved training subjects to detect and recognize increasingly subtle levels of muscle tension and remain relaxed throughout the day. In each session, a client would focus on a body part, for example, the hand, generate as small an amount of tension as possible and let go. Jacobson felt it was very important to avoid suggestive patter, fearing it might introduce what he felt were the confounding effects of hypnotic suggestion (ironically, some hypnosis scholars consider Jacobson's approach to be a form of hypnosis). Clients would be taught to relax two or three muscle groups per 60-min session, eventually covering 50 groups for the entire body. Training required 50 or more sessions that could last from 3 months to a year.

Overt PMR

Jacobson's minimal method was cumbersome and not widely used. In 1958, Joseph Wolpe introduced the first abbreviated version of progressive relaxation. Earlier, Wolpe had found that a conditioned fear reaction in cats could be eliminated by evoking a response incompatible with fear concurrently with a feared stimulus. Progressive relaxation could work as such a 'reciprocal inhibitor' and became a part of Wolpe's well-known desensitization treatments.

The abbreviated approach of Wolpe and others involves overtly creating a considerable level of relaxation starting in the first session. One effortfully 'tenses up' for about 5–10 s and then 'lets go' attending to the release of tension for 30 or so seconds. Often up to 16 muscle groups, rather than one to three, are separately targeted in each session. As training progresses, muscle groups are combined until eventually one can simply detect and relax tension without first overtly creating tension.

Covert PMR

Covert PMR involves letting go of muscle tension without first tensing up. Often it is presented as an advanced lesson, after weeks of training in overt PMR. Occasionally, covert PMR is introduced alone, without prior practice in overt PMR, and often combined with autogenic training. One focuses on letting go.

In the most abbreviated format, termed conditioned relaxation and cue-controlled relaxation, one simply thinks a relaxing cue word, such as 'relaxed' or 'calm,' immediately after practicing progressive relaxation. In time, thinking the cue itself is sufficient to evoke relaxation.

Illustration of Overt Progressive Muscle Relaxation

Quietly attend to your right hand. Tense up the muscles in your right hand now. Keep the rest of your body relaxed. Notice the tension grow in your right hand. And let go. Let the tension flow away. Notice the sensations of relaxation. Can you tell the difference between how your hand feels now and how it felt when you were tensing it?

Autogenic Training

Autogenic training is a popular European approach to relaxation, one that has had modest impact in North America. Its roots can be traced to hypnosis of nearly a century ago. At the

onset of the twentieth century, Johannes Schultz made use of the notion that hypnotic suggestions involving physical sensations related to relaxation can often evoke relaxation, for example, by simply and calmly stating 'your hands are warm.' Importantly, he was convinced that hypnosis was not something imposed upon a patient by a domineering hypnotist, but an inner ability patients permitted to unfold.

In the 1920s and 1930s, Schultz introduced autogenic training, a relaxation-based system of therapy based a somewhat overstated notion of 'self-generated' (autogenic) healing. This version has been popularized by Linden. Central to this idea is that the brain has powerful self-healing potential.

Standard and organ-specific exercises

Traditional autogenic training is a highly structured sequential program. It begins with six 'standard exercises' that involve mentally repeating verbal formulae or suggestive phrases targeted to the following somatic sensations:

- Heaviness,
- Warmth,
- Cardiac regulation (slowly, evenly beating heart),
- Respiration (relaxed breathing),
- Abdominal warmth, and
- Cooling of the forehead.

Autogenic training places considerable emphasis on 'passive volition,' that is, repeating formulae passively, while maintaining complete indifference about the result. A beginning client might be instructed to let the phrase 'hands are warm ... hands are warm' repeat in his or her mind, quietly attending to the repeating words much as one might attend to the slow repetition of an echo. After mastering beginning warmth and heaviness exercises, a client progresses to phrases targeted to the heart ('heartbeat strong and even'), respiration ('it breathes me'), abdominal warmth ('warmth radiates from my stomach'), and forehead ('forehead cool and calm').

Many traditional relaxation traditions have elements that resemble autogenic suggestion. One type of zen meditation involves focusing on abdominal warmth. Kundalini yoga involves meditating on presumed chakra 'energy centers,' which loosely correspond to autogenic standard exercises. Some forms of Christian prayer involve attending to feelings of loving warmth radiating from the heart.

Once the standard exercises are mastered, a variety of special exercises may be introduced. 'Organ-specific formulae' tailor the standard exercises to the particular needs of the patient. For example, a backache patient may use the phrase 'My back is warm,' a headache patient, 'My forehead is cool,' and so on. 'Intentional formulae' are phrases targeted to behavioral change objectives ('I will study more, drink less.')

Illustration of Autogenic Standard Exercise

Gently let these words float through your mind: 'Hand and arms, warm and heavy. Hand and arms, warm and heavy.' There is no need to deliberately try to conjure up these feelings. Just let the words float through your mind.

Autogenic 'meditation'

More advanced exercises incorporate various forms of 'meditative' imagery. One begins with an imagery preparation exercise that involves attending to vague retinal sensations that spontaneously occur with eyes closed in relaxation. Such sensations might include faint and formless clouds of light, spots, and so on. Once a trainee can sustain attention on such phenomena, he or she graduates to increasingly challenging images, including colors, then simple shapes (square, circle) and concrete objects (chairs, vases) until they can be produced and modulated on demand. The most advanced images include abstract constructs (truth, justice, friendship), emotional states, and other people. Eventually, exercises are directed toward seeking 'answers from the unconscious,' that is, asking questions ('What is the source of my frustration') and passively waiting for a spontaneous answer to emerge in the form of a change in image (an answer spontaneously appearing on an imagined blackboard or TV screen).

Today, autogenic training more or less in full form is popular in Europe and Canada whereas highly abbreviated forms (usually targeting 'warmth and heaviness') prevail in the United States. In addition, abbreviated variations have emerged with highly specific suggestions targeted, for example, to individual cancer tumors, the immune system, and so on.

Imagery and Relaxing Self-talk

Imagery involves creating in one's mind a passive relaxing setting or activity, often accompanied by the repetition of relaxing words or self-statements. Imagery has scientific roots in both hypnosis and autogenic training, and antecedents in nineteenth century religious and self-help cults and in many Eastern and Western religious traditions. Images often form an important part of hypnotic induction. Advanced autogenic exercises incorporate a graduated series of simple and complex images. It should be noted that yoga and meditation traditions have their own imagery exercises, although these are rarely employed in the West.

Many forms of imagery do not have relaxation as a goal. Active and discursive imagery is often used in psychotherapeutic traditions as diverse as psychoanalysis and behavior therapy. For example, a psychodynamic therapist might instruct a client to engage in 'free association.' Here, a word or topic ('Your dream about a domineering old bear') is selected that is salient to a therapy session. Then the client, with eyes closed, lets thoughts and images spontaneously emerge without any censorship, modification, or selection. During this activity, he or she shares to the therapist whatever thoughts arise.

Behavior therapists might use a different type of 'coping imagery.' Here imagery is a mental rehearsal of confronting and coping with a stressor, including possible setbacks. A client suffering fear of public speaking might visualize approaching a podium, taking a few deep breaths, opening lecture notes, repeating the supporting phrase 'one step at a time, I can do it,' beginning the speech, perhaps forgetting a point, coping by successfully checking notes, resuming, and successfully completing the speech. It should be emphasized, that coping imagery does not involve visualizing just the successful outcome. Although self-help books and programs often offer a

strategy of visualizing success ('Imagine yourself rich ... successful ... in love ... powerful ... etc.'), such imagery simply does not work.

Relaxation imagery involves creating a cognitive or mental representation of a real or hypothetical relaxing setting or activity, perhaps supplemented by relaxing self-statements. Unlike therapeutic imagery, it involves a minimum of thought activity and effort, greater sustained focus, and some indirect intention to evoke positive states of mind. Most forms of relaxation imagery can be divided into three categories: sense, narrative, and insight imagery. This text emphasizes sense and insight imagery.

Sense imagery involves passively attending to sense stimulation without engaging in an activity. One might imagine a beach and attend to the waves, sky, sounds of birds, and so on. Again, all senses are involved. Narrative imagery involves attending to a simple and somewhat plotless relaxing story, for example, walking through the woods, floating through the air, riding a horse, and so on. One attends to simple relaxing sensations (sights, sounds, feelings, smells) that arise while completing a relaxing activity. Insight imagery has as its objective evoking deeper understanding or appreciation of a topic or question.

Illustration of an Imagery Exercise (Sense Imagery)

Enjoy a fantasy about a pleasing vacation spot on the beach. Involve all of your senses. What do you see? The blue sky above? The green trees? The clear blue water? What do you hear? Perhaps the gentle rustle of trees, or the splashing of waves. What do you feel touching your skin? Perhaps the warm sun or cool breeze. And what relaxing fragrances are there? The clean scent of water? Flowers?

Meditation and Mindfulness

Health professionals who use meditation teach either concentrative meditation (sometimes termed focused attention meditation), which involves restricting attention to a simple stimulus, or mindfulness (open monitoring) meditation which involves nonjudgementally attending to all stimuli.

Concentrative meditation

Concentrative meditation is most often traced to ancient Hinduism and Tibetan Buddhism. Three general types of concentrative meditation that have appeared through the years: meditations of the body (focusing on relaxing body feelings, rocking, breathing), meditations of the mind (meditation on a thought syllable or mantra, meditation on an internal visual image), and meditation on an external stimulus (a repetitive sound or continuous visual image).

Mindfulness meditation

Mindfulness meditation (also called Zazen, just sitting, or Vipassana) traces its roots to Buddhism. Buddhism gave birth to Zen, one of the most popular approaches to meditation in Japan, and to some extent the West. Around 500 BC, Buddhism emerged as a reform offshoot of Hinduism. Buddha taught that existence is permeated with suffering caused by self-centered thought. Selfish thought can be destroyed by following an 'eightfold path' of right motivation and conduct eventually culminating in a passive focusing exercise, meditation.

In the sixth century, Buddhism was carried to China and appeared 600 years later in Japan as Zen. Unlike concentrative meditation, Zen involves calmly attending to the flow of all stimuli, not a continuous single stimulus. One does so without thought, judgment, or analysis. This is typically called mindfulness meditation. Today health professionals outside of the Buddhist tradition teach simple mindfulness awareness techniques, often in combination with stretching, breathing, and other concentrative meditation techniques.

Historically, at least seven methods have been used to teach meditation: (1) meditation (concentrative or mindfulness) alone, without pre-session warmup; (2) meditation (concentrative or mindfulness) with either yoga stretching or breathing or both as warmup; (3) meditation (concentrative or mindfulness; with or without breathing or stretching warmup) gradually increasing in length (over the course of several weeks) from 10 to 25 min; (4) graduated mindfulness, beginning with simple physical sensations, progressing to awareness of other sensory input, and ending with awareness of all sense input; (5) mindfulness with concentrative meditation as warmup; (6) mindfulness after several weeks of training in concentrative meditation; and (7) multi-technique concentrative/mindfulness meditation in which several approaches are taught and the client selects which works best. Trainers of mindfulness and meditation rarely mention (and may not be aware) of such diversity of approaches.

Illustration of a Meditation Exercise

Let the word 'one' easily float through your mind, over and over. There is no need to force it to repeat at any speed or volume. Just let the word gently repeat again and again. All you need to do is attend to the word 'one.' Whenever your mind wanders, gently return to attending to the word 'one' as it repeats over and over.

The Uses of Relaxation

Self-relaxation (as well as casual and assisted approaches) has been applied in a variety of goals, including enhancing sleep, alleviating unwanted states, achieving states that may be desired, and exploring the possibilities beyond everyday frustrations and joys. In more formal terms, these are the sleep-related, negative, positive, and transcendent goals of relaxation.

Sleep-Related Goals of Relaxation

People untrained in professional deep relaxation often think relaxation is sleep. Indeed, combating insomnia as well as enhancing sleep and mastering the skill of 'catnapping' or 'power napping' can be important preliminary goals of relaxation. Treatments that incorporate relaxation are used as a way of preparing for sleep.

The Negative Goals of Relaxation: Stress Management/Healing

Chronic stress arousal can contribute to a wide range of physical disorders as well as psychological distress. Traditionally, relaxation has been used in stress management and healing. Both are

negative goals in that they involve reducing or minimizing something one does not want, a negative. To summarize:

1. Relaxation has demonstrated potential for relieving the destructive wear and tear of severe and chronic stress arousal on specific body systems and organs as well as on the immune system.
2. Relaxation has demonstrated potential for speeding healing and recovery from nonchronic conditions. For example, the wounds of relaxed people heal more quickly.
3. Relaxation has demonstrated potential for reducing serious complications of chronic conditions. For example, individuals with AIDS or diabetes do better.
4. Relaxation has demonstrated potential for reducing the destructive impact of stress on functioning (attention, flexibility, memory, energy).

The Positive Practical Goals of Relaxation: Health and Energy/Calm Control

The negative goals of relaxation involve getting rid of something one does not want. The positive goals involving getting what one wants. The goal of health and energy seeks to maintain health and resistance to disease, and increase energy reserves and stamina. Those who use relaxation as a tool for enhancing health and energy have acquired a healthy habit, not unlike good diet, exercise, sleep, and proper hygiene. For them, the practice of relaxation limits extremes of stress arousal, enhances routine recovery from the stressors of daily living, and helps support a positive frame of mind. Energy is enhanced by limiting unnecessarily draining stress and worry, enabling the body to recover from sustained discursive effort, and opening sources of energy by enhancing breathing and cardiac functions.

The goal of calm control involves sustaining attention on a chosen task, ignoring external distraction, and coping with diverting impulses and desires to do something else. Calm control is required to finish one's homework, resist the craving to smoke a cigarette (or eat an extra cookie), or stay on a job in spite of boredom or fatigue. This can be differentiated from self-control, the management of internal emotions and desires; calm control has the additional feature of sustaining attention on a desired course of action, and returning to this course of action after internal or external distraction.

The Positive Expressive Goals of Relaxation: Spontaneous Enjoyment/Creativity and Insight

Relaxation becomes an expressive activity when it is done because it is fun or meaningful, and does not necessarily have any immediate pragmatic use. The simplest expressive goal is spontaneous enjoyment, practicing a relaxation exercise because it is fun or because it contributes to the unstructured, unplanned, and spontaneous enjoyment of another fun activity. Any of the six families can be presented in the spirit of play and pleasure. PMR and yoga become dance. Imagery becomes storytelling. Meditation becomes an adventure, and so on. Furthermore, one can deliberately introduce relaxation before a pleasurable activity, for example, by practicing breathing exercises before dancing, or meditating before a concert.

The goal of creativity and insight involves nurturing an expressive source of ideas. Of course, creativity and insight may be required for highly pragmatic goals, for example, deciding on a job, a term paper topic, a new business strategy, a course of action in a crisis, or even a proper gift for a friend. However, the act of brainstorming, of actually generating potential ideas, involves temporarily putting aside pragmatic concerns and freely entertaining all ideas, good and bad, sane and silly. To this end, relaxation can very much enhance creativity and insight.

The Transcendent Goals of Relaxation: God-Based Spirituality/Meditation and Mindfulness

Transcendent goals involve going beyond one's everyday wants, both negative and positive. Self-directed concerns are minimized. God-based or theistic spirituality focuses on celebrating and relating to a theistic entity, one's God or Higher Power. This may or may not be in the context of organized religion. The goal of transcendent meditation/mindfulness is the cultivation of calm and focused awareness and action in the world as it is, undistracted by irrelevant personal

concerns or biases. For God-based spirituality, one transcends self-centered negative and positive motivations and expectations in service of God or one's Higher Powers; for meditation/mindfulness, one transcends such distracting personal motivations and expectations in order to see and act in the world as it really is.

See also: [Meditation: The Science and the Art](#); [Stress and Illness](#).

Further Reading

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Relevant Website

www.lulu.com/stress – Dr. Smith's webpage.

Semantic Memory

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Glossary

Amygdala It is responsible for processing of emotion (e.g., fear, disgust, happiness).

Association areas These are regions of the neocortex beyond the primary sensory processing cortex and cortical areas processing information before the primary motor cortex. Unimodal association areas surround primary sensory and primary motor areas, and multimodal association areas lie beyond these, that is, in between unimodal sensorimotor association areas.

Cingulate cortex It lies immediately superior to the corpus callosum, which is the white matter axonal fiber bundle that connects the cerebral hemispheres. Cingulate cortex is included in the limbic system implicated in emotion and motivation and continues posteriorly as the parahippocampal gyrus in the temporal lobe, which provides input to the hippocampus, consistent with a role in episodic memory.

Embodied (grounded) cognition This is a long-standing framework for cognitive science that proposes that processing of modal information (i.e., sensory, motor action, and mental state) has a necessary role in cognition, including semantic memory. Largely neglected until recently, this framework opposes the standard framework of cognition that states that an amodal symbol system exists apart from the modal systems and represents meaning in semantic memory. Embodied (grounded) cognition accounts vary according to whether embodied (grounded) cognition alone can explain all knowledge or embodied knowledge represents concepts alongside an amodal system. The latter hybrid frameworks vary further according to how much embodied and amodal systems each contribute to cognition.

Frontal lobe It extends from the anterior-most part of the brain to the central sulcus where the primary motor cortex ends. The frontal lobe contains motor areas and lateral and medial prefrontal regions and anterior cingulate regions implicated in cognitive control, working memory, and selective attention.

Lexicon This is the set of all words and expressions in a language (i.e., the vocabulary).

Linguistic This refers to perceptual cues (i.e., words) and actions involved in natural language, including semantics, grammar, and phonetics.

Mental state This is a state of brain activity related to introspection, that is, a state accompanied by a subjective quality of conscious experience (or qualia, e.g., feeling a headache, taste of food, your experience of the colors in a rainbow). Mirror neuron circuits, in which neurons involved in manipulating objects are also involved in perceiving another animate agent perform that action, may underlie social simulations for embodied cognition.

Occipital lobe It is the most posterior part of the neocortex. It includes the primary visual area (V1) in striate cortex and

extrastriate visual cortex that lies anterior to V1, as well as association areas that are object-sensitive, responding more strongly to intact images of objects than scrambled versions with no coherent object structure. This lobe is retinotopically organized such that adjacent neurons receive input from nearby parts of the visual field (and corresponding retinal location). Neurons adjacent but displaced laterally from each other across the cortex represent adjacent but likewise displaced visual field (and retinal) locations. Consequently, this cortex effectively represents an orderly image of light hitting the retina, though distorted to magnify central over peripheral retina. Extrastriate visual areas contribute to semantic memory based on an embodied cognition account.

Parietal lobe This lies in the dorsal posterior part of the cerebral cortex. It includes the angular gyrus region in the lateral inferior part (Brodmann's area [BA] 39; areas PGa and PGp) and the supramarginal gyrus (BA 40) that have been implicated in semantic processing in response to written and spoken words. This angular gyrus region extends posteriorly into the anterior occipital lobe.

Priming This refers to a phenomenon in which experience with a stimulus (referred to as the prime) affects the response to another stimulus (referred to as the target). Priming is typically attributed to implicit (nonconscious) memory. The relationship between the prime and target can be perceptual (i.e., both have the same or similar sensory features or properties, e.g., the words 'dog' and 'dog'), conceptual (i.e., both have the same meaning, e.g., the word 'dog' and a picture of a dog, or hearing and reading the word 'dog'), or semantic (i.e., both have associatively or categorically related meanings, e.g., the words 'nurse' and 'doctor' are associated concepts). Priming usually facilitates processing of the target, making task performance faster and more accurate but can be detrimental in some cases.

Semantic memory Semantic memory or knowledge refers to conceptual information about the meaning of words, objects, people, scenes, and facts. This meaningful information is not consciously related to specific, personally experienced events of episodes. However, concepts are formed by abstracting or generalizing across multiple individual experiences. For example, the meaning of a dog is not about a single personal event with a dog but rather the meaning of the dog category (dog-ness) is generalized across features common to many instances of dogs.

Spreading activation The process of how activation can move from one concept (or node) to another in a semantic (or associative or neural or connectionist) network. Each link between two concepts has a weight that determines how much a concept can activate the other linked concept. Concepts can be directly linked to each other and indirectly linked to each other through one or more other concepts. The combination of weights

and how directly linked concepts are determines how far activation of one concept spreads to other linked concepts. Through this process, activation spreads to related concepts in the network.

Temporal lobe It is a ventrally located region of the neocortex that includes association areas for visual processing, primary and association areas for auditory

processing, and multimodal association areas. The anterior temporal lobe has been proposed to be an amodal hub for semantic memory. The medial temporal lobe includes the hippocampus and the surrounding cortex of the parahippocampal region, which is composed of perirhinal cortex, parahippocampal gyrus, and entorhinal cortex, and may also represent semantic memory.

Semantic Memory Is One Type of Memory

Semantic memory is conscious long-term memory for meaning, understanding, and conceptual facts about the world. Semantic memory is one of the two main varieties of explicit, conscious, long-term memory, which is memory that can be retrieved into conscious awareness after a long delay (from several seconds to years). Endel Tulving in 1972 (building upon a distinction between two primary forms of memory by Reiff and Scheers in 1959) distinguished between semantic and episodic memory. Episodic memory refers to stored representations for personally experienced episodes from one's life within a particular spatiotemporal context (e.g., dinner in Berkeley in January this year). Semantic memory refers to stored representations for meaningful facts or world knowledge, regardless of the spatiotemporal context in which the information was acquired and without information about personal experiences surrounding learning of the information (e.g., the concept 'dinner' but not a particular dining experience), and is necessary for language. Crucially, while episodic memory involves awareness of a feeling of having personally experienced an event or item, regardless of meaning (i.e., an item could be a nonsensical figure like abstract art and so has no meaning but has been experienced before as on multiple museum visits), semantic memory involves awareness of meaning unaccompanied by a feeling of familiarity of having previously experienced the event or item or remembering the place and time of the personal learning experience(s). For example, using semantic memory, you know what a dog is and can read the word 'dog' and be aware of the meaning of this concept, but you do not remember where and when you first learned about a dog or even necessarily subsequent personal experiences with dogs that went into building your concept of what a dog is. Even without a feeling of personal experience, you know what a dog is when you see, hear, or read about a dog. Thus, you have semantic memory for meaning, regardless of a feeling of familiarity or recollection of the personal experiences that had originated from the concept.

Language, Concepts, Categories, and Semantic Networks

Hierarchical Model

Ideas about semantic memory developed from attempts to explain how human language communicates concepts. While computer scientists proposed semantic nets for translating natural language as early as 1956, the term 'semantic memory' emerged in psychology in early models of human knowledge about word

concepts circa 1969. Collins and Quillian viewed semantic memory as a hierarchical network of relations among concepts. A concept refers to meaning, which is stored in semantic memory. Language enables an arbitrary symbol, such as a stream of sounds comprising a word (e.g., 'dog'), to be associated with the memory representation of the meaning of the symbol (i.e., the semantic memory of a dog). As described in concept learning research, a concept is a mental representation that places an object, event, or idea into a category. Semantic memory can thus be said to be the store of mental representations of categories. In their original formulation of the organization of semantic memory, Collins and Quillian assumed that categories are organized hierarchically, and defining features compose each category. For example, an animal has skin, moves, eats, and breathes. In 1976, Eleanor Rosch proposed different levels of categories. For example, song and field sparrows are subordinate categories of the more general category of sparrow, which is a basic-level category, along with eagle and cardinal of the superordinate-level category of birds, and, at a still more general level, birds and fish are animals. Collins and Quillian's theory predicts that the response time to classify whether a feature belongs to a category depends upon how many nodes or levels of the hierarchy must be traversed to do the task, which was confirmed experimentally.

Feature Overlap

Smith and colleagues modified this basic framework to suggest that the meaning of a concept is a set of features, as opposed to a single node. Further, defining features are essential (e.g., robins have red breasts), whereas characteristic features are merely typical of a concept (e.g., robins are wild, bipedal, have wings, perch in trees). Consistent with this feature overlap model, people rate robins and sparrows as more typical birds than ducks and geese, and robins and sparrow are rated as more similar to each other than the other birds. However, there may be no defining features; as noted by the philosopher Wittgenstein in 1953, there is no feature that all games share. Also, feature overlap models compare features to decide the concept, but evidence indicates that other kinds of knowledge are relevant. For example, while a butterfly is readily categorized as an insect, subjects instructed to generate members of the insect category infrequently mention a butterfly. Such problems motivated alternative theories that continue to be debated and tested. The main competing theories can be grouped into those that propose that categories depend upon a prototype representation, which is an average of all examples, or many representations composed of each of the exemplars (or instances) of the category (e.g., each example of a dog experienced), referred to as prototype versus exemplar theories, respectively.

Spreading Activation

Most current theories organize concepts and categories as nodes in a network. Nodes connect to one another via a semantic link, thereby associating together related concepts or categories. The length of the link in a semantic network model varies with the relatedness and associations between concepts. For example, car, truck, and bus may be connected directly via short links, and each of these connects to fire engine via a longer link. Nodes can be connected directly or indirectly via links to other nodes. For example, apple may connect directly to red and connect indirectly to fire engine through the red node. As in the earlier Collins and Quillian model, the properties of a concept/category can be connected to its node. Semantic network theories propose that activation spreads from one node to another along the links between them, allowing for even indirectly linked concepts to activate one another. Semantic networks can easily explain retrieval of meaning. For example, when thinking about apples, one might activate the concept of red, which might trigger one to think about fire engines, stoplights, or bricks.

The semantic network approach has the advantages over other theories of predictive power (perhaps too much so that it becomes unfalsifiable, according to some critics) and being readily modeled using neurocomputational methods (i.e., connectionist or parallel distributed processing models, as described by Rumelhart and McClelland). A node can be modeled as a neuronal cell, and the dendrites (input) and axons (output) that interconnect neurons to each other are modeled as links between nodes. Neural network models incorporate recurrent and feedback connections that are well-known principles of neocortical organization. A node in a semantic network has a level of activation representing the probability that the neuron will fire, thereby potentially activating a connected neuron sufficiently that it also fires. Activation in one node could thereby spread to other nodes connected to it directly or eventually indirectly. Semantic memory is acquired using learning rules (e.g., hebbian plasticity) that determine network connectivity by modifying how strongly neurons connect to each other based on experience. Contemporary neural network models have more biological realism.

Compound Cue

Compound cue models propose that semantic memory operates like other types of memory. For example, in the case of episodic recognition, memory is an interconnected feature set representing the item (i.e., its meaning), its learning context, and its relation with other such feature sets. Recognition cues are held in mind briefly to probe the feature sets, producing a familiarity signal sent to a decision process, enabling a decision that the stimulus is old or new. Likewise, in the types of priming (implicit memory) tasks used to assess semantic memory, additional cues are relevant beyond those used for recognition. For example, in the lexical decision task people decide faster whether a letter string is a real word (or not, e.g., xutkifq) when the target word (e.g., doctor) is preceded by a word that is related (e.g., nurse) than unrelated (e.g., butter). Prime and target are both cues that together constitute a third type of association besides the associations between target and context

plus target and other feature sets, which are available for recognition. Compound cue theory attributes faster performance for prime and target pairs that are related to the greater number of shared associates between them than for unrelated pairs.

Knowledge and Generic Memory Encompass Semantic and Nonsemantic Memory

The common label, semantic memory, may not be the most appropriate but rather the term generic memory (suggested by D. L. Hintzman) or knowledge (suggested here) can include nonsemantic information about perceptual form and motor action-related processing. Consider that, in general, knowledge is what you know (e.g., that dogs bark, your house number, the capital of France, the color of spinach, the shape of a cat, as well as their meanings). Linguistic stimuli (i.e., words) activate meaning, but objects, scenes, and people are also meaningful. To activate meaning, the perceptual features of the stimulus must be matched to stored memory of these sensory-based features. For example, to categorize a dog, its perceived shape or other identifying perceptual attribute(s) (e.g., a bark) must match successfully to memory for the perceptual form associated with the dog category. Likewise, to activate the meaning of a word, the word form being currently perceived must match memory for the perceptual form of that word. Thus, semantic memory depends upon nonsemantic memory for perceptual form to mediate between the perceived cue and its meaning. In addition, activation of nonsemantic memory can also activate associated nonsemantic information about the stimulus, as when observing a dog and becoming aware of its meaning and associated perceptual (e.g., its color, sound, smell), motor (e.g., its movements), emotional (e.g., fear), or mental state information.

Like semantic memory, nonsemantic knowledge is distinct from episodic memory. For example, patients with visual object agnosia are slow and make errors categorizing common objects when visually presented (e.g., seeing a dog but being unable to name or describe it meaningfully as a dog). However, these patients can tell that they saw the object before, demonstrating episodic memory. Moreover, all forms of visual object agnosia involve some impaired perceptual processing, even associative (i.e., semantic) subtypes; a knowledge system for the perceptual form of an object is required in order to know also about its meaning. In most theories, this perceptual matching stage must, to some extent, succeed in order for semantic memory to become active. Substantial parallel and interactive processing between perceptual form and meaning can occur. Thus, activating meaning always requires matching memory to the perceptual form of the referent, be it a word, object, face, or place.

Knowledge, Priming, and Awareness

Semantic memory and nonsemantic (perceptual and motor) knowledge are nonepisodic, and aspects of these memories may be conscious, while others lie outside of awareness. Conscious semantic memory is primarily the variety of explicit memory that has been distinguished from episodic memory.

After all, clearly, one can become aware of a concept in a semantic network, as when you are aware that you know what a word means. However, one is not necessarily conscious of activating the nodes or links in the network itself that lead to awareness of meaning or aware of the processes that match a perceptual form to its nonsemantic memory. Nonetheless, these nonconscious processes can lead ultimately to awareness of the shape, color, category, and meaning of the object.

By contrast, nonconscious implicit memory is thought to include nonsemantic memory as well as situations in which semantic memory activates nonconsciously. Implicit memory is typically probed by repeating information. In such priming paradigms, the item (e.g., doctor) or a version of it (a picture of a doctor) or a related item (e.g., nurse) is presented for study, as in the lexical decision task used commonly to assess semantic memory. Then, following a delay, the target item (doctor) is presented again in the memory test phase. Relative to unrepeated (i.e., new) items, repeated items exhibit faster and more accurate performance, as well as different brain response characteristics. Repetition priming (i.e., doctor–doctor), conceptual priming (i.e., a picture of, and then the word for, doctor), and semantic priming (i.e., nurse–doctor) are varieties of implicit (nonconscious) memory. It is important to note, however, that evidence is accumulating that consciousness is not the critical factor distinguishing varieties of learning and memory. Instead, the computational and decision demands of the task, and how these recruit different brain structures, are primary.

Standard Theory of the Semantic Memory System

Research has focused on how meaningful (semantic) representations are organized, leaving nonsemantic knowledge organization relatively less understood. Multiple memory systems theory distinguishes between a semantic memory system and a nonsemantic perceptual representation system that can be matched to a currently perceived stimulus, for example, to determine what an object is, such as a dog, based on its perceived shape. This distinction of memory systems theory essentially reflects its adoption of the standard theory of meaning that proposes that conceptual knowledge resides in a single amodal system with a uniform architecture and exists separate from modal sensorimotor systems.

Anterior Temporal Lobe Stores Amodal Meaning

Multiple memory systems theory (e.g., Elizabeth Warrington in 1979) adopted the distinction between semantic and episodic memory and added the proposal that different brain systems support each type. In particular, while episodic memory depends upon the medial temporal lobe (MTL), semantic memory depends upon association areas of neocortex that lie outside primary sensorimotor areas and outside the MTL. Studies of patients with semantic memory problems indicate that an amodal system may reside in the anterior temporal lobe (ATL). The ATL is considered to be the best candidate for an amodal hub for meaning based on convergent evidence from patients with semantic memory problems and its anatomical connectivity. The ATL lies next to limbic system structures, including the amygdala and the orbitofrontal cortex, which

have been implicated in emotion, reward, and motivation processing, thereby enabling associations among these abilities and sensorimotor and linguistic aspects of concepts. Further, the ATL lies next to the anterior MTL system for episodic memory, which is thought to contribute to learning conceptual knowledge gradually over multiple experiences, as when many personal experiences with a variety of dogs gradually result in a concept of the dog category. Hub theories do not equate amodal with cross-modal (i.e., picture and word modalities), emphasizing that a cross-modal (or multimodal) region that integrates information from multiple sensory and/or motor regions may not perform the true amodal function required of a semantic hub. For example, the angular gyrus performs multimodal sensory integration but may not function as a semantic system for linguistic purposes.

However, it is unclear what exactly is the difference between amodal and cross-modal/multimodal, and this distinction will be critical for determining the anatomical locus of an amodal hub for meaning that abstracts across stimulus form. Consider that any region that integrates information, (a) across sensory modalities, (b) multiple sensory plus motor or linguistic information, or (c) any of these plus emotion or mental state information, would meet the definitions of multimodal, cross-modal, and amodal (i.e., a similar pattern of neural activity is activated by more than one type of physical stimulus or type of response in the case of motor output). Moreover, alternative views about the organization of semantic memory, including those that posit no amodal hub, can accommodate the anatomical definition offered for the amodal semantic hub (i.e., integrates sensorimotor and emotion/reward information).

Further, anatomical evidence suggests that the ATL may not be amodal (or fully multimodal) or a domain-general semantic hub. Some evidence suggests that the ATL stores knowledge about a unique item (e.g., an individual person, a famous landmark). This may be particularly necessary for socially relevant knowledge, as social information necessarily involves two or more unique persons. Consider also that the hippocampus receives nonspatial (or object) information computed along the ventral visual pathway from the perirhinal cortex in the MTL and spatial information from the dorsal visual pathway via the parahippocampal gyrus in the MTL, and both perirhinal and parahippocampal areas lie adjacent to and receive input from the associative cortex in the ATL. It is unclear why information in the MTL would be modal (e.g., spatial vs. object), whereas the adjacent ATL that feeds into it would be amodal, as the standard theory of semantic memory suggests. If the ATL is amodal, then why would segregated, modal nonspatial, and spatial inputs be sent into the MTL, which lies at a more advanced stage of hierarchical processing from the ATL? Modal segregation is difficult to reconcile with a definition of semantic memory organization that requires an amodal semantic hub where both spatial and nonspatial (object) information must be combined. Further, other types of sensorimotor, emotion, and reward inputs also send segregated inputs into the MTL via the ATL.

Medial Temporal Lobe, Episodic Memory, and Meaning

Perhaps the brain structure that shows the most amodal (or multimodal) properties is the MTL. The MTL shows highly sensory-invariant response properties. For example, MTL

neurons respond to single individuals (e.g., Jennifer Aniston), regardless of the form of the stimulus (i.e., varieties of pictures, names), showing seemingly complete invariance, and have been suggested to represent meaning in long-term semantic memory. Further, MTL structures have been proposed to construct representations of integrated multimodal percepts that are sensitive to semantic variables.

Spared new learning of knowledge in amnesia suggests that the MTL is necessary not only for episodic memory but also for semantic memory. However, this idea is hard to reconcile with the substantial evidence dissociating episodic and semantic memory. For example, patients with developmental amnesia in which the MTL is dysfunctional from childhood have impaired episodic memory but remarkably spared semantic memory. Some evidence suggests that MTL amnesics can acquire some new explicit knowledge, but this is limited in amount and generalization and attributable to the remaining spared MTL structures, clearly so in some cases and possibly in others. Whether new explicit knowledge learning is spared in amnesia remains controversial in part due to the inherent difficulties of the lesion approach involving human patients; controlled, targeted lesions cannot be done in humans and so residual sparing of critical structures is hard to rule out. Overall, the evidence suggests that knowledge can be acquired using primarily cortical mechanisms but only through substantial repeated exposure. Episodic encoding processes of the MTL accelerate knowledge learning by integrating across multiple episodes in a way that also facilitates generalization and abstraction of knowledge. This is consistent with evidence that episodic and semantic memory are interlinked. Episodic and semantic memory systems have substantial mutual interdependence during encoding and retrieval.

Semantic Memory Includes Embodied (Grounded) Knowledge

Neuroscience largely invalidates the strong form of the standard theory. All current views about the organization of knowledge incorporate an embodied (or grounded) cognition framework that says that knowledge depends upon multiple modality-specific systems, including those for sensorimotor properties in perceptual systems based on the senses (e.g., vision) and action systems for motor planning as well as emotion and mental states. For example, different modal knowledge systems in the extrastriate occipitotemporal cortex support face, word, and object knowledge. Different parts of each system can vary in the perceptual-specificity of the representation. Some knowledge is more specific for the shape, orientation, or other physical property (e.g., visually specific object knowledge) and others less so. The latter knowledge is more abstract from perceptual form) showing, for example, more invariance across changes in physical properties between experiences (e.g., an object from different viewpoints) or cross-/multi-modal activation patterns as when stimuli with the same associated meaning (i.e., a picture, sound, and word for dog) produce similar patterns of performance or brain activity. By an embodied account, a brain area can be both nonsemantic (e.g., sensorimotor), supporting, for example, both perceptual processing and perceptual memory, and semantic, supporting human symbolic abilities. Hybrid

theories suggest that one or more separate amodal system(s) act as hub(s) or convergence zone(s) that interact reciprocally with embodied knowledge systems.

A key argument against embodied cognition is that so-called abstract words, such as truth and freedom, are unrelated to sensorimotor processes. The main counterargument is that internal states, such as metacognition and emotion, are also stored as knowledge, and introspective states provide information that is central to representing abstract concepts. Unfortunately, relatively little is known about abstract concepts even though they play central roles in human cognition, as most research has focused on concrete concepts.

Brain Basis of Knowledge

Word Meaning

Mental lexicon

How words activate meaning has been a central question in language and semantic memory studies. The mental lexicon stores word information, including meanings (i.e., semantic memory for words), syntax, and perceptual word forms. Most studies focused on speech comprehension, with early accounts (e.g., by Levelt) positing a processing sequence from word sounds to syntax and finally to concepts in semantic memory. Due to the importance of sequential processing for language theory and the fact that language comprehension is rapid, with all word identification achieved even before sentences end, the timing of semantic activation with words has been of greater interest than anatomy. Consequently, most neuroscience studies of semantics from words measured electromagnetic potentials that have high temporal resolution that is lacking in anatomical methods like functional magnetic resonance imaging (fMRI), which instead has been used to locate the brain regions.

Linguistic N400 to words

Most studies of language and semantic memory focus on the linguistic N400, which is a scalp-recorded, negative electrical potential, peaking around 400 ms, that varies with semantic processing between 300 and 500 ms in response to written words and spoken words for which the onset is slightly earlier. The N400 indexes a multimodal, relatively abstract knowledge system for word meaning. This system is sensitive to ongoing context, constructive, and processes semantic information over an extended time period and across multiple brain regions. Thus, the meaning of a word is extracted within about 300 ms of processing. However, some lexical processing, including semantics, has been argued recently to occur before the N400 since ERPs to words between 200 and 300 ms seem sensitive to lexical processes.

Anatomy of word concepts

The N400 in response to words indexes activity in the ATL and the superior temporal gyrus, which are considered storage sites, and the ventrolateral prefrontal cortex (VLPFC), which supports efficient retrieval and encoding of this semantic knowledge. Electromagnetic potential and fMRI findings were combined to infer these neural generators. However, fMRI findings alone suggest that a more extensive, left-lateralized network (i.e., more activity in the left cerebral hemisphere) activates semantic memory in response to written and spoken words. The temporal lobe

regions recruited extend (a) posteriorly into the modal visual association cortex implicated in category-specific semantic deficits and semantic dementia and may store object knowledge specifying perceptual and conceptual attributes and support multimodal integration, and (b) medially into the parahippocampal region of the MTL, implicating it as an interfacing region between the more lateral temporal cortex and the episodic memory system in the hippocampus of the MTL. Notably, the left superior temporal gyrus region implicated in language comprehension problems of Wernicke's aphasia is mainly the modal auditory cortex for speech perception and has not been implicated in word meaning, though the most ventral part may contribute to processing abstract concepts. Nearby, in the lateral inferior parietal lobe, an angular gyrus region is greatly expanded in humans, receives multimodal inputs, and may support the conceptual retrieval, integration, and fluent combination processes critical for understanding discourse. While these regions are on the lateral surface, other regions lie medially. Specifically, the posterior cingulate region includes the retrosplenial cortex, which connects directly and bidirectionally with the MTL system for episodic memory and may promote episodic and semantic memory interactions. This cingulate region has been implicated in visuospatial, mental imagery, and simulation functions of both memory systems. In the frontal lobe, dorsomedial parts (BA 8) may support internally guiding semantic memory retrieval, while ventromedial parts support the emotional significance of concepts.

Semantic (default mode) network for words

Intriguingly, the lateral temporal lobe regions, the angular gyrus, posterior cingulate, and medial prefrontal regions of this proposed semantic memory network for words (i.e., all word meaning regions except VLPFC) are all key components of the default mode network (Figure 1(a) and 1(b)). This network activates in an anticorrelated manner with an active task network, which essentially includes the rest of the neocortex (Figure 1(c)). The active task network activates more than the default mode network during tasks demanding greater selective attention, working memory, and executive functions. By contrast, the default mode network activates more than the active task network in many language studies, episodic memory tasks (for which the MTL also activates), and rest (i.e., when minimally engaged with a task). The default mode network is affected earlier and more than other brain systems in Alzheimer's disease patients who develop progressively severe problems encoding new long-term episodic memory and retrieving knowledge. The default mode network may thus have a greater role in semantic memory, consistent with proposals that this network supports mental imagery or simulation processes that creatively synthesize, integrate, and associate multimodal information, especially episodic memory from the MTL, across past experiences. These functions would be crucial for constructing sequential, higher-order concepts from multiple life episodes, such as generalizing across numerous restaurant visit to construct a framework to comprehend the next such visit. Such a knowledge representation is known as a schema. Multiple schemas can combine to predict and anticipate how the next such visit will unfold over time. Such a sequential knowledge representation is known as a script. However, it is unclear whether default mode network regions are sufficient to support all aspects of meaning, as such studies

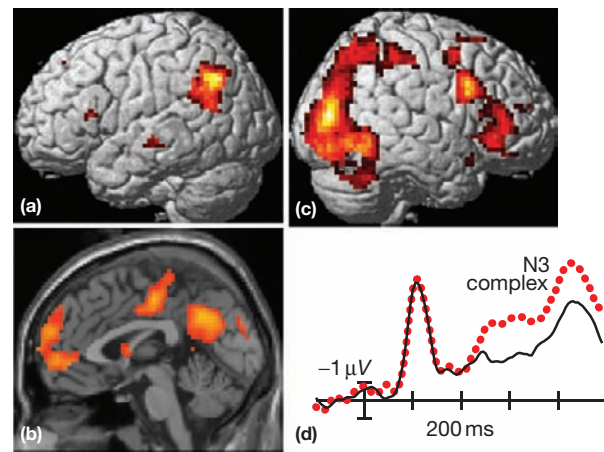


Figure 1 Brain systems for knowledge. (a) Rendering of the left lateral neocortex (Montreal Neurological Institute individual canonical brain, SPM99) showing the lateral inferior posterior parietal regions, including the angular gyrus, and superior temporal gyrus parts of the default state network implicated in semantic memory for words. (b) Sagittal slice through the medial cortex showing the medial areas that form most of the default state network implicated in semantic memory for words. (c) Rendering as in a, except showing the right lateral neocortex and parts of the active task network implicated in knowledge about visually presented objects during a categorization task. (d) The negative event-related potential called the N3 complex in response to visually presented known objects (from an experiment like that in c). *Note*, a and c were computed based on data from an experiment described in Schendan and Stern (2008), results in a are from the contrast of old > new objects (uncorrected $p < 0.001$) on an episodic recognition task; results in c are from the contrast of unusual > canonical views of known visual objects (e.g., dog) on a categorization task (uncorrected $p < 0.05$). Results in b were computed from the contrast of control > mental rotation (uncorrected $p < 0.05$) based on data from Schendan and Stern (2007). Results in d are based on an ERP version of that used for fMRI in c; the N3 is more negative for unusual than canonical views of known visual objects for which knowledge is more challenging to activate.

focused on words. After all, other regions in the active task network as well as the VLPFC are implicated in semantic memory and contribute important processes to knowledge encoding and retrieval and to mental imagery. For example, script knowledge evoked by linguistic and nonlinguistic (e.g., picture) sequences involves active task network regions that interact with basal ganglia structures implicated in sequential processing and implicit learning more than the default mode network.

Multiple Knowledge Systems

Nonlinguistic knowledge

The focus on semantic memory to words has left meaning in response to nonlinguistic stimuli relatively less well understood. Most work with nonlinguistic stimuli used pictures, revealing visual object knowledge. This knowledge is the most important to study in order to explain human cognition. After all, vision is our dominant sensory modality, and objects are the focus of visual processing and attention. Research on visual object knowledge is also necessary to define the neural underpinnings of semantic memory from neural circuits to systems. Such research enables direct links between human

and nonhuman animals not afforded by word studies. After all, nonhuman animals have at best only very limited linguistic capacity, precluding studies with words. Further, nonhuman animal work must be incorporated into semantic memory theory because most neuroscience questions cannot be addressed in humans for ethical reasons.

Object N3 complex

In response to a visually presented object, an N400-like scalp electrical potential, the N3 complex (aka N300, N350, N390), indexes neurophysiological processes between 200 and 500 ms involved in acquiring categorical knowledge, retrieving knowledge and implicit memory about objects, and making cognitive decisions based on object knowledge (Figure 1(d)). The N3 complex peaks around 350 ms, differs in scalp distribution from the N400 (i.e., the N3 has a frontal maximum and can become positive over occipitotemporal locations, whereas the N400 is centroparietal), and cognitive manipulations affect it earlier, around 200 ms, than the N400. The earlier time course of the N3 relative to the N400 suggests that the arbitrary relationship between a word and its meaning takes longer to activate than the (nonarbitrary) association between a perceived object and its meaning; note, the shape and other physical properties are part of its meaning by an embodied cognition account. The N3 complex indexes a modal knowledge system from more visually specific to more abstract or invariant representations stored in extrastriate occipital and ventral temporal cortex. Crucial evidence that the processes underlying the N3 complex are part of a semantic memory system is that the N3 is sensitive to similar contextual, memory, and conceptual manipulations as the linguistic N400. For example, semantic priming, that is, preceding an item by a semantically related item (e.g., doctor preceded by nurse), reduces both brain potentials and response time. The different scalp distributions of the N3 and N400 indicate multiple, modality-specific knowledge systems. This is due to recruitment of the occipitotemporal cortex involved in storing object knowledge (N3) versus anterior and superior temporal regions involved in storing word knowledge (N400). The VLPFC has a general role in semantic memory, however, controlling posterior cortical processes for both object and word knowledge to accomplish task-relevant goals and for decision-making (e.g., categorization). Notably, faces also evoke a functionally similar frontal N400-like potential. In sum, functionally similar but somewhat anatomically distinct semantic memory systems support knowledge about words, faces, and other objects.

Anatomy of object knowledge

Multiple knowledge systems are consistent with the functionally localized, hierarchical organization of the neocortex. From posterior to anterior areas along the ventral stream, stimulus selectivity becomes increasingly complex from more elementary, local features and greater visual-specificity to higher-order global shapes and combinations of features and increasing visual object constancy (i.e., similar responses despite changes in orientation, size, or other visual properties). Human occipitotemporal cortex is necessary for normal behavior on wide-ranging object cognition tasks. Patients with occipitotemporal damage have visual object agnosia: impaired perceiving, categorizing, and recognizing of visual objects with the pattern of deficits varying with

the locus of damage. Occipitotemporal areas are retinotopic (adjacent) and object-sensitive (i.e., responding more strongly to intact images of objects than scrambled versions with no coherent object structure). However, recent evidence suggests that object-sensitivity, object perception, and invariant object knowledge continue into the MTL, including the hippocampus. Extended object processing and memory from the occipital into the MTL accords with embodied cognition but not the standard theory of an amodal system.

Domains of knowledge

Multiple knowledge systems are consistent with embodied cognition and an alternative, but not incompatible, idea that object domain primarily constrains conceptual knowledge organization. Distributed domain-specific theories propose that evolutionary history influences development, which thereby determines object domain. Convergent findings suggest that the domains are living animate (e.g., mammals), living inanimate (e.g., trees), conspecifics (e.g., humans), and tools. For example, a brain-damaged patient can display category-specific semantic problems with multimodal input, implicating abstract representations of conceptual knowledge. Both picture-naming and verbal questions about objects can be impaired for living animate objects (e.g., animals) but spared for nonanimals. Even so, the patients can also have problems with nonsemantic, visual structural processing and knowledge. These and other findings motivated other multiple semantic system accounts to distinguish instead between nonliving things, animals, and fruits/vegetables. They propose that visual motion and functional information are more important for knowing about nonliving things, and other kinds of sensory information are more important for knowing about living things, of which fruits/vegetables depend more on color and taste information (than animals do). Notably, a domain account need not imply that semantic memory is modular. Instead, current ideas emphasize that domain-specific neural networks are distributed across multiple cortical regions. Each domain of knowledge can be further subdivided according to the sensorimotor, affect, and mental state processes posited in embodied cognition theories, enabling a rapprochement between theories. A central idea in hybrid accounts is that sensory processing within a specific domain (e.g., how a conspecific human looks based on visual processing) will be connected (e.g., via links in the semantic network) to other processes (e.g., how a conspecific human also sounds, emotes, or acts based on auditory, affective, or motor processing, respectively). Overall, findings converge on the idea that knowledge is organized across multiple cortical systems, contrary to the standard theory of meaning incorporated in multiple memory systems theory, but debates continue over the organizational principles governing the divisions (embodiment, domains, sensory-functional).

Frontal Lobe Controls Knowledge Encoding and Retrieval

The VLPFC controls encoding of mappings between knowledge stored in posterior areas and decision processes in frontal areas and subsequent retrieval. The human lateral prefrontal cortex (PFC) is organized functionally along a gradient from abstract decision and action planning processes in more rostral

parts (e.g., VLPFC) to increasingly more concrete response-related processes in more caudal parts (e.g., premotor cortex (PM)). This prefrontal system maintains patterns of activity for various types of information (e.g., linguistic, visuospatial, object, rules) in functionally distinct neural populations. Each influences (controls) other areas to accomplish a mental or overt action. For example, to decide the category of a visual object, dorsolateral PFC (DLPFC) and PM accumulate and compare visual evidence obtained from the occipitotemporal cortex to compute a decision according to a rule that determines the choice, which involves more rostral frontopolar (BA 10) areas. In the parietal lobe, the intraparietal sulcus (IPS) also accumulates evidence, consistent with its strong bidirectional connections with some decision-making regions. The VLPFC has an important role in disambiguating knowledge, as when multiple interpretations of the input result from initial processing (e.g., ambiguous figures, impoverished percepts, multiple alternative meanings or knowledge types are competing), and it interacts reciprocally with DLPFC and PM to recruit working memory resources to resolve uncertainty.

Simulation, Mental Imagery, and Semantic Memory

Embodied cognition theories propose mental imagery, particularly automatic simulation varieties, as a core mechanism for deep conceptual processing, rather than language with which semantic memory has been commonly allied. For example, hearing the word dog automatically simulates the sensorimotor, affect, and/or mental state associated with experiences of dogs (e.g., what they look like, how they move, feel, etc.). The idea is that embodied processes encoded into the knowledge system during the initial experience are later recapitulated via cortical network simulation mechanisms in response to the original stimulus (e.g., seeing a dog) or associated stimuli (e.g., the word, dog). The human capacity for symbolic cognition arises from interactions between simulation in the cortical knowledge network and linguistic processing. By this view, nonhumans lack symbolic cognition insofar as they lack linguistic processes, even though nonhuman animals have simulation abilities like those in humans by virtue of common cortical architectures for sensorimotor, emotion, and mental state processes.

However, mental imagery research has primarily investigated not automatic imagery but rather strategic mental imagery. Such studies, moreover, mainly use recently trained stimuli for which episodic memory (not semantic memory) likely dominates processing. For example, people are trained to memorize a few pictures until they can visualize them mentally with clear vivid detail. Later, while trying to visualize these pictures (i.e., strategically), they answer questions about them that require accurate mental images, such as whether a specific object part falls within a location of a grid on a computer screen. Consequently, little is known about mental imagery that is evoked automatically when semantic memory is activated. What is known comes mostly from studies of embodied cognition and two neuroimaging studies comparing episodic and semantic memory sources. The latter evidence implicates similar structures for imagery from episodic and semantic memory, including visual association areas, the amygdala,

which supports emotional processing, the MTL, and parts of the active task and default mode networks. Notably, the right VLPFC is activated more during mental imagery based on episodic than semantic memory. This is consistent with the possibility that most prior mental imagery studies reveal how strategic mental imagery from episodic memory works, which depends more on the frontal lobe, but not necessarily automatic mental simulation (imagery) from semantic memory.

Summary

Semantic and nonsemantic perceptual and motor memory systems store knowledge based on experience with the world independent from episodic memory about the originating personal experiences. Initial studies aimed to solve how language communicates concepts, inspiring cognitive models describing hierarchies of concepts composed of sets of overlapping features, semantic networks that operate by activation spreading along links between concepts, or memory decisions based on cues to conceptual associations. Meaning may be embodied in sensorimotor, emotion, and mental state information processing but also may be organized by domain in multiple semantic systems and may include an amodal hub in the anterior temporal lobe. While words activate meaning between 300 and 500 ms, knowledge evoked by nonlinguistic objects (for which the perceptual form may convey aspects of meaning, according to embodied cognition theory) starts earlier by 200 ms. Anticorrelated active task and default mode networks may support different aspects of meaning, while the lateral prefrontal cortex controls semantic memory retrieval and encoding. Conceptual processing depends critically upon automatic mental imagery simulating information processing in these brain networks, which, in humans, interacts with language to accomplish symbolic reasoning functions.

See also: Alzheimer's Disease; Amnesia and the Brain; Associative Learning; Electroencephalography; Empirical Challenges to Conventional Mind–Brain Theory; Episodic Memory; Event-Related Potentials (ERPs); Memory; Memory, Neural Substrates; Mental Imagery; The Mirror Mechanism; Our Cognitive Map; Psychology of Reading; Visual Motion Perception; Visual Perception; Word Retrieval.

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Sensation Seeking

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Glossary

Boredom susceptibility An aversion to repetitive experience, routine work, or predictable people with a reaction of restless discontent when unavoidably exposed to such experience.

Disinhibition The need to seek release in uninhibited social activities with or without the aid of alcohol or other drugs.

Experience seeking Seeking of novel experiences through travel, music, art, and a spontaneous, nonconforming lifestyle with similarly inclined persons.

Impulsivity A personality trait characterized by a tendency to act quickly and without sufficient forethought or planning regarding the consequences of the action.

Sensation seeking A trait defined by the seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience.

Thrill and adventure seeking A desire to engage in physical activities involving elements of speed, danger, novelty, and defiance of gravity (e.g., parachuting, scuba diving).

The trait of sensation seeking (SS), as measured by the sensation seeking scale (SSS), a self-report questionnaire, takes its definition from more than 40 years of research conducted by Marvin Zuckerman and his colleagues in the area of extroversion and optimal arousal or stimulation level. SS, as originally conceptualized by Professor Zuckerman, described only the 'sheer quantity and intensity' of external stimulation sought by an individual. Subsequent factor analytical work revealed that a more precise definition of SS would include the need for varied, novel, and complex stimulation as well as respect for the domains in which the stimulation was sought: socially acceptable or unacceptable venues. Therefore, a more contemporary definition of SS is that 'Sensation seeking is a trait defined by the *seeking* of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, *legal*, and *financial* risks for the sake of such experience.' According to Zuckerman, activities such as skydiving, scuba diving, and driving fast, as well as being more likely to drink ethanol, try recreational drugs, and perhaps sleep with strangers and gamble are common among sensation seekers. The main focus of sensation seeking is not merely the risk per se but the quest for novelty, change, and excitement. As we shall see, the drive to seek sensation is fundamental, but the venue for seeking stimulation can be very plastic and environmentally dependent.

believes that SS is related to reproductive success. He reasons that in order for animals to survive they must command enough territory to sustain them and engage in mate selection and reproduction. When resources become scarce in one area, animals must have the willingness to explore new territories in search of new sources of sustenance. Indeed, the animal that may have explored novel territory before resources became scarce would have a selective advantage since more resources would be available in times of stress. The same logic applies when it comes to mating; those animals most willing to explore the possibilities of finding new and different mates would more likely succeed in producing more offspring. However, those animals that expose themselves to excessive risk in search of resources or potential mates would be more likely to meet with misfortune and therefore are likely to pass fewer copies of their genes into future generations. Therefore, it is always a tradeoff between SS in the service of reproductive success and danger to the individual organism which might reduce his or her fitness or remove him or her from the gene pool altogether. In Zuckerman's view, SS is an instinctive drive in the service of reproductive success. Zuckerman sees humans, given their history of dispersal throughout the world, as a species who are aggressive sensation seekers. If we had not been willing to move into new territory and to seek mates outside our family groupings, we would simply not have come to dominate the earth in such a short time span.

Theoretical and Historical Background for SS

Evolutionary Underpinnings of SS

Zuckerman's early work draws heavily on evolutionary theory and comparative psychology to reach the conclusion that there is considerable variation in animals' levels of exploration, approaching novel stimuli, and levels of risky play. Zuckerman asserts that the tendency to engage in these activities is, to a large extent, biologically determined for any one individual. There is now confirming evidence that SS is a stable heritable personality trait with an h^2 of ~ 0.60 . Given the range of heritability of personality traits from somewhere in the 0.30 range to a high of near 0.80, SS is one of the traits that is most heavily influenced by inheritance, genetics. Zuckerman

Inhibition and Arousal

Zuckerman's theory depends heavily upon Pavlov's work. Pavlov claimed that organisms differ in terms of the type of nervous system they possess. He conceived of two nervous system types, one, a weak nervous system, prone to nervousness and shyness, while the other was a strong, gregarious type. For Pavlov, seeking environmental stimulation is to overcome inhibitions to the contrary. Seeking out stimulation in the face of physical or social danger requires disinhibition of protective tendencies. Some organisms seem to find it very difficult to overcome the anxiety barriers generated by social or physical danger. Other organisms seem willing to 'tread where angels

fear to go.' Cattell and Hans Eysenck have termed the tendency toward being disinhibited in social situations as 'extroversion,' one pole of the continuum of an introversion-extroversion personality dimension. Introverts are individuals who shy away from environmental interaction, while extroverts do exactly the opposite. Eysenck has repeatedly noted the relatedness of his theory of extroversion to theories of arousal and the physiological underpinnings thereof. Research indicates that SS is very probably a major component or corollary of Eysenck's extroversion.

Another corollary of SS relates to the level of arousal. Since the end of the nineteenth century, investigators and theorists have been interested in what constitutes an optimal level of stimulation for individuals. Each of us can recall situations from our own experience where a stimulus at a certain level may be pleasurable, yet when experienced at a different, often more intense level, the stimulus becomes aversive or even painful. Think of music. When your favorite music is experienced through headphones at 50–60 dB, it may be stimulating or soothing depending on the character of the music. Additionally, one's attention to the music at this level may drift away to other topics or issues. One can either focus on the music or let it drift in and out of the background while one accomplishes another task. However, when the volume begins to increase, attention shifts exclusively to the music and it produces higher levels of arousal until around 80–90 dB the music is most difficult to ignore and is quite arousing. At this level, for some people, the music may begin to resemble noise and at higher levels it becomes aversive and at still higher levels certainly painful. Organisms exposed to high levels of noise may appear very aroused and motivated as they attempt to avoid the aversive nature of the stimulus. Freud observed that stimulus intensity can drive internal 'cerebral excitement' or arousal.

Citing the work of Wundt, Freud, Yerkes & Dodson, Hebb, and Duffy as background, Zuckerman reached the conclusion that there is for each individual an optimal range of stimulus contact, intensity, and novelty that is most pleasurable or most conducive to better learning or performance. In this view, individuals seek stimulation to maintain an optimal level of arousal so as to maximize their comfort and pleasure. It is also clear that different levels of arousal may affect performance such as learning efficiency and motor performance. Interestingly, the level of arousal necessary for optimal learning and performance may vary as a function of the difficulty of the task to be learned or performed. As task difficulty escalates, less-intense stimulation is necessary for optimal learning and performance. Duffy studied several indices of physiological arousal, including EEG, as measures of mental effort. She observed that individuals vary in task arousal due to either genetic or environmental factors and that these differences reflect their personality or temperament.

Over the last quarter of the twentieth century and into the first decade of this century, personality theorists have come to understand that the well-defined personality traits are heavily influenced by heredity and genetics. The study of personality theory has become known as evolutionary psychology for just this reason. One early advocate of biologically based temperament, in the 1940s, was Hans Eysenck. He defined personality along three dimensions: introversion versus extroversion, neuroticism or emotional instability versus stability, and psychoticism or

tough-mindedness and antisocial tendencies versus socialized humaneness. The first two dimensions have been much better investigated than the third. In the 1960s, Eysenck proposed that extroverts have a higher optimal level of stimulation than do introverts. Capitalizing on an increased understanding of how cortical arousal is achieved, Eysenck linked his theorizing to differential levels of sensitivity of the brainstem reticular activating system (RAS). The RAS is responsible for modulating the level of cortical arousal, among other things, through a feedback loop system. Stimulation can impact the system from the senses or from the 'emotional brain' or limbic system. We now know that this system also includes the frontal cortex and that input from brainstem loci near the pons influences frontal lobe function via dopamine (DA) and serotonin inputs. There is also reciprocal looping between the frontal cortex and the amygdale that enhances our ability to modulate our arousal. Our ability to make decisions, or favor different levels of stimulatory activity, we now understand, is largely controlled by this complex system.

In the late 1960s, Eysenck began to increasingly emphasize the role of genetics for personality theory. Taking the animal literature as a point of departure, Eysenck observed that selective breeding could produce individuals of very different temperaments. He reasoned that human personality traits such as extroversion, and perhaps more narrow traits such as impulsivity or SS, might have a common or correlated genetic underpinning. Eysenck had a significant influence on Zuckerman who studied with Eysenck during an early period in his career when he was moving away from research on sensory deprivation and beginning to consider temperaments as a field of inquiry. The fact that genetics makes a significant contribution to personality development is a view shared by many psychologists today, and also researchers such as David Buss, who have come to provide significant research support for the position that both genetics and environmental influences are important, and in many cases at least equal, contributors to the stable patterns of behavioral tendency we call personality traits.

SS is clearly related to Eysenck's extroversion variable in his global theory of personality. It is also related to the surgency factor of the popular 'Big Five' global personality theory. Researchers such as Barratt, Revelle, and others have also found it related to more specific subfactor personality traits such as impulsivity, and it has also been linked to certain forms of psychopathology such as alcoholism and attention deficit disorder.

Measuring SS and Characterizing Sensation Seekers

The Sensation-Seeking Scale

Zuckerman's theory postulates that there are individuals in our midst who differ in terms of the stimulation they need to effectively negotiate the environment. In order to categorize individuals, Zuckerman developed the SSS. Form V, the latest version of the SSS, is a 40-item paper-and-pencil forced-choice questionnaire (more recently, a true-false version is also available and is often used). Items on the SSS separate into four factors:

1. *Thrill and adventure seeking (TAS)*. Items reflecting a desire to engage in physical activities involving elements of speed, danger, novelty, and defiance of gravity (e.g., parachuting, scuba diving).

2. *Experience seeking* (ES). Items reflecting seeking novel experiences through travel, music, art, and a spontaneous nonconforming lifestyle with similarly inclined persons.
3. *Disinhibition* (Dis). Items describing the need to seek release in uninhibited social activities with or without the aid of alcohol.
4. *Boredom susceptibility* (BS). Items reflecting an aversion to repetitive experience, routine work, or predictable people with a reaction of restless discontent when unavoidably exposed to such experience.

The SSS provides an overall score and subscores for each of the factors. Factor, internal and retest reliability data indicate that the SSS is psychometrically sound, and it continues to be refined and used in research and clinical settings (a more recent version, VI, was developed for more specific uses). Form V scales are moderately intercorrelated, suggesting that they all tap different aspects of a more global factor. Three of the four scales show good cross-gender and cross-cultural replicability (TAS, ES, and Dis).

Because of its cross-cultural validity, the SSS has been translated from English into more than 15 other languages and special forms have been developed for children in several languages. The fact that the subscales intercorrelate and that they seem to hold up psychometrically and cross-culturally supports the assertion that there is very likely a biological underpinning to SS. It is important to recognize, however, that the SSS is a paper-and-pencil assessment rather than a behavioral test. Although scale scores correlate highly with SS behaviors, it is clear that individuals may not be honest on self-report assessments. The degree that respondents are not honest affects the test's reliability and validity. Additionally, and even though the SSS has been translated into a fair number of languages for use outside the United States, culture is an important determiner of what constitutes SS behaviors. Zuckerman himself, as his work progressed, attempted to discriminate between culturally acceptable and unacceptable SS behaviors. The definition of what ultimately is acceptable and unacceptable is a cultural assessment. Even within the United States, there are differences in acceptability of specific behaviors based on race, culture, religion, social class, gender, geography, and many other demographic variables. Zuckerman himself recognizes and writes about the fact that young males who have a high imperative for SS may not have the diversity of avenues of expression available that would allow the most healthy choices or perhaps choices most valued by a different or dominant culture. Attitudes concerning particular high-risk behaviors change over time as well. A classic example is the changing attitude toward smoking where early in the last century no 'proper' woman would have smoked in public. While these issues do not render the SSS any less valuable in most contexts, recognition of these issues should provoke careful consideration of the use and interpretation of the assessment in any one case or study.

Characteristics of Sensation Seekers

Using data from self-report inventories of drug use along with SSS scores, researchers have found significant relationships between high scores on the SSS and drug use, including smoking (nicotine), ethanol, marijuana (hashish), amphetamines,

opiates, and psychedelic drugs. For many, tobacco is the first drug of abuse, and there has been a strong relationship between SSS scores and early smoking, one that has continued to remain strong in studies from the 1970s until today. More individuals with high SSS scores, members of both sexes, smoke and smoke earlier, and this relationship is found in data from many countries.

SS is also related to drinking ethanol in preadolescence and adolescence, and early high scores predict later ethanol use. Youngsters who use alcohol have higher SSS scores on average than those who do not but not as high as those who use other drugs, especially those who use drugs considered more harmful than marijuana. SS is correlated with early onset alcoholism which is defined by early onset and the presence of antisocial behavior combined with less anxiety. This is a difficult area because those who go on to be chronic alcohol and drug abusers have a tendency to display both anxiety and depression. SS may lead many youngsters to initially experiment with alcohol and drugs, and those who have issues with anxiety and depression seem more prone to adopt a longer lasting lifestyle choice to use these substances chronically and therefore become dependent. While drug use is related to all subscales and the total score, it is most clearly related to the Dis subscale.

Sensation seekers are also different in terms of their sexual experience, thrill seeking, and preference for complexity. Sexual experience in college students and sexual responsiveness, arousability, and frequency in young married women are related to the broad SS trait as measured by the SSS. Sensation seekers participate in a greater variety of heterosexual activities, with more partners. When it comes to thrill seeking, driving habits are a readily recognized outlet for thrill seeking expression. There is a very strong linear relationship between the speeds at which survey respondents reportedly drive on highways and all of the SSS scales. Sensation seekers have strong preferences for particular types of stimulation. High SS prefer complex as opposed to simple graphic designs when asked to rate designs. High SS people prefer spicy or sour foods and even prefer novel smiles versus familiar mundane ones.

High sensation seekers are more prone to volunteer for various types of unusual experiments and activities, including experiments in sensory deprivation, hypnosis, drug effects, encounter groups, and gambling instruction. Sensation seekers seem to have a continuing taste for novelty as well as intensity. Interestingly, in experiments that are boring or monotonous (e.g., sensory deprivation, meditation), sensation seekers are more likely to drop out early or seek additional stimulation. Notably, in experiments involving social interaction, sensation seekers seem to enjoy themselves, while low sensation seekers seem to experience anxiety, often withdraw, and report not liking the experience. Sensation seekers who volunteer for gambling experiments tend to bet more and at higher odds. Finally, sensation seekers who take scuba lessons tend to stay under longer and dive deeper on their first free dive than others. Groups such as volunteer salvage divers and volunteer fire fighters have even higher SS scores. The TAS subscale was predictive of how far female subjects would go in looking over an exposed parapet 16 stories high and has also predicted fear reactions in other phobia-evoking situations such as exposure to snakes. It is important to keep in mind that risk taking is not the end determinate of behavior in Zuckerman's system,

rather it is the need for stimulation. High sensation seekers generally tend to underestimate the risk in a situation compared to low sensation seekers as they seek stimulation. Given equal levels of risk appraisal, high sensation seekers anticipate more positive arousal, whereas low sensation seekers anticipate feelings of fear and/or anxiety.

SS has been correlated with other personality variables. Those who score high on the SSS also tend to score high on Eysenck's extroversion scale, although the correlation is modest and not all extroverts score high on SS. In fact, high SSS scores are more reflective of the 'impulsive' component of extroversion than the 'sociable' component. Sensation seekers tend to be nonconformists and risk takers guided more by their selfish interests than by societal convention or the needs and opinions of others. In persons with low SS scores, as activities get more risky, anxiety increases, while in high SS individuals, as risk increases, anxiety or fearfulness decreases. SS increases as a function of age until adolescence and then declines from the early 20s onward. Older persons tend to score lower on TAS and Dis. Males generally score higher than females especially on the Dis scale but also on TAS subscales, while scores on ES are similar.

The Place of SS in a Global Theory of Personality

The 'Big Five' personality structure has enjoyed decades of empirical support in the evolutionary psychology literature. It provides a structure for describing the most basic major (superfactor) dimensions of personality. The Big Five are (i) Extroversion or Surgency, (ii) Agreeableness, (iii) Conscientiousness, (iv) Emotional Stability, and (v) Culture or Intellect or Openness to Experience. Researchers such as Tupes, Christal, Catell, Costa, McCrae, Goldberg, and Hough have been major contributors to the initial elucidation of a set of stable primary temperaments and their subsequent combination into the five superfactors we now recognize as the Big Five. Evolutionary psychologists have found over decades of study that the Big Five model has held up across language domains, using both adjectival and questionnaire-type assessments, and across methods of analysis. Clearly, the Big Five structure is our most robust molar global description of personality. However, as Hough observes, on a more practical scale, while the Big Five may represent the superstructure of personality, it does not have the fine grain detail to adequately predict variation in constructs such as job success. Some evolutionary psychologists have criticized the Big Five noting that the combination of subfactorial traits underlying the five superfactors is sizable and complex. In any case, the first three factors of the Big Five seem the most stable. SS fits into Factor I (FI): Extroversion or Surgency. Some facets of FI include: talkative, extroverted, assertive, forward, daring, flamboyant, sociable, zestful, dominant, active, persistent, mischievous, confident, bold, uninhibited, flirtatious, explosive, adventurous, spontaneous, opportunistic, and exhibitionistic. These are easily recognizable correlates of SS.

Clearly, SS attributes load heavily on FI and this factor is one of the major descriptors of both human and likely nonhuman-animal personality. This is consistent with Zuckerman's assertion that SS is an important biologically relevant and determined personality trait or temperament. While SS and Extroversion or Surgency (FI) are not identical,

SS is a major component of FI and therefore important for inclusion in any dimensional theory of personality, no matter what the name a particular theorist assigns this factor. The factor, FI, is also stable across a number of investigational domains mentioned earlier. If this were not so, there would be considerable reason to doubt claims made for the biological relevance and determinism of this factor.

Biological Correlates of Sensation Seeking

Orienting Responses and Stimulus Seeking

As we navigate our environments on a daily basis, we are exposed to a stimulus array of great complexity. Some of these stimuli we recognize, in fact some we know quite well, and we may either choose to respond to them or ignore them depending on their meaning, context, and the situational demands. Others may be new and novel to us, and we have no experience with their meaning or predictive capabilities. These novel stimuli generate interest, and we attend to them, orient to them, producing what is called an orienting response (OR). If the initial stimulus is aversive, with greater than moderate intensity so as to be aversive or very intense, then organisms may wish to avoid that stimulus, the definition of a defensive reaction (DR).

The assumption is that sensation seekers have a higher drive, willingness, or curiosity to investigate moderately intense, novel, or complex stimuli. Therefore, sensation seekers should have stronger ORs to these stimuli. This is in fact what Zuckerman and others found when they compared subjects with various scores on the SSS for the strength of their OR. High SS subjects had larger galvanic skin responses in response to novel visual and auditory stimuli. Both high and low SS subjects habituated at the same rate to repeated stimuli, however. In fact, when several levels of sensory intensity are included in an experiment, the high SS subjects respond with a stronger OR to the moderately intense stimuli and with a DR to very intense stimuli, while low SS respond with DRs to both the moderate and highly intense stimuli. Further confirmation that OR is reflective of SS is the fact that young subjects have stronger ORs than older subjects, especially to moderately intense stimuli. OR strength has been related to psychopathology. Schizophrenics who are behaviorally inactive tend to display weak ORs. Stimuli in their environments do not seem to interest them while they are quiescent. These same schizophrenics typically score low on the SSS. However, schizophrenics who are more actively psychotic, as well as psychopaths, tend to display strong ORs. Additionally, extreme psychopaths have a tendency to give strong ORs to stimuli such as needle puncture and strong skin shock. These same stimuli would elicit strong DRs in normal people. Display of a strong OR to an intense stimulus is also a characteristic of high sensation seekers.

The definition of OR includes a component of physiological response in addition to a behavioral component. One type of physiological response can be recorded from ongoing brain, EEG activity, using scalp electrodes. When the brain perceives an external stimulus, it orchestrates the OR. In other words, any response to a stimulus is initially brain activity that may ultimately be manifested, or not, as overt behavior, an OR.

The brain's response, as elaborated in a disturbance of ongoing electrical activity, to an external stimulus is termed an average evoked response or evoked potential (AER). Monte Buchsbaum measured the amplitude of a certain component of the AER and plotted that amplitude as a function of the stimulus intensity that produced it. If increasing levels of stimulus intensity produce increasing amplitude of AER in an individual, then that individual is termed an 'augmentor.' This is similar to an increasingly intense OR to escalating stimulus intensity. Conversely, if increasing levels of stimulus intensity produce a reduction in AER amplitude, then the person is termed a 'reducer.' Again, obviously, this is similar to a DR. These differences are often most apparent at higher stimulus magnitudes. Augmentors are thought to be involved in stimulus intake, and stimulus seeking, while reducers are engaged in stimulus rejection. As you can see, there is a close parallel between augmenting and reducing and the OR versus DR continuum.

Buchsbaum and a number of colleagues, including Zuckerman, began to relate SS to the AER in the 1970s. In general, these studies have found that normal people who are augmentors tend to be high scorers on the SSS, that augmenting decreases with age, and that augmentors have low endorphin levels. Psychiatric patients who are augmentors tend to be manics (and their relatives), delinquents, heroin users, psychopaths, alcoholics, process schizophrenics, and to have low levels of the neurochemically important oxidative enzyme monoamine oxidase (MAO). Normal people who display a tendency to be reducers score low on the SSS and have higher levels of endorphins. Psychiatric patients who are reducers tend to be stimulant users, hospitalized reactive schizophrenics, insomniacs, and have high MAO levels. Of special note is the fact that manic patients are most often augmentors. Lithium, a standard treatment for bipolar affective disorder, prevents mania in many patients and may also reduce the number and severity of depressive swings common in this disorder. Lithium also has a tendency to reduce the augmenting pattern and seems most effective in those patients who are the most significant augmentors. Augmenting of the cortical evoked response seems to involve another postulated aspect of the biological makeup of sensation seekers: the capacity to seek stimuli and react to stimuli of high intensity without displaying a DR.

Neurobiology of SS

Catecholamine neurotransmitters, DA, and norepinephrine are long-recognized key regulators of important survival behaviors such as arousal, determining which stimuli are reinforcing control of movement and allocation of attention. MAO is a degrading enzyme in catecholamine systems that helps keep these neurotransmitters functioning within narrow limits, closely controlled by neuronal mechanisms, presumably because their particular functional levels are so important in regulating survival behavior. MAO assays have been instrumental in research in a number of fields searching for etiology of mental disorders including affective disorders and impulse control disorders. Over the last two decades, researchers have found MAO levels to be a reliable biological marker for a number of behavioral and personality traits.

Across a number of studies, from a diverse set of laboratories involving thousands of subjects, normal subjects who

score highly on the SSS tend to have lower levels of platelet MAO than low sensation seekers. For instance, low MAO subjects had a tendency to be heavy drinkers and more likely to be alcohol-dependent. In fact in males, low MAO is associated with type II alcoholism, which is defined as having an earlier age of onset and is associated with more antisocial behavior when intoxicated and a family history of alcoholism. In addition, people with low MAO were more likely to smoke tobacco and use marijuana. Recall the use of these three drugs, alcohol, tobacco, and marijuana, is heavily correlated with high scores on the SSS. Individuals with bipolar disorder tend to have lower levels of MAO, and these levels do not change in concert with their clinical state. In fact, their relatives have been found to have lower levels of MAO as well, a result many believe is indicative of a general predisposition for the disorder rather than a highly specific predictor of this particular disorder. The types of patients here described as having low MAO are also more likely to be augmentors. Not surprisingly, MAO research has not been confined to human subjects but has also been conducted in other primate species. Tested in a natural setting, rhesus macaques having low MAO were more active, social, and spent more time in play than those monkeys having higher levels of MAO regardless of sex. Those males with the lowest MAO were also the most aggressive, dominant, and sexually active. The parallel between the behavior of these macaques and extroversion and sociability in humans is unmistakable.

Recent research, in the last decade of the twentieth century and the first decade of the twenty-first century, indicates that perhaps the influence of MAO in SS is in DA pathways, both the striatal system and medial forebrain bundle system that projects from the nucleus accumbens to the ventral tegmental area and then to the frontal cortex. Evidence indicates that availability of DA D₂, ₃, & ₄ receptors in this system may be negatively correlated with SS. DA receptor genetics have now been firmly linked to SS as well as behaviors such as gambling, excessive drinking, and drug abuse, as well as personality traits such as impulsivity.

Numbers and characteristics of receptors as well as the functional capability of enzymes such as MAO are under both genetic and environmental influence in any one individual. A moderately low level of MAO, or reduced functional capacity of DA receptors, might occur in a person who is a sensation seeker, gregarious, an augmentor, and a social drinker who likes to party. However, this individual may live a relatively normal life if he or she has appropriate outlets for his or her SS behavior. Yet, a person with an even lower level of MAO or DA receptors, or one not having acceptable outlets for their SS behavior, may fall into a high-risk category, perhaps drinking to excess, using other drugs, and having a habit of driving while intoxicated and perhaps drug-related convictions along with a court-ordered psychiatric referral. Still lower levels of MAO, or decreased DA receptor availability, or more adverse life circumstances, might predispose one to become an outright alcoholic, drug addict, or have an incapacitating bipolar disorder. As MAO and/or DA receptor availability decreases behavior related to SS, more extreme SS increases in frequency. Clearly, SS seems related to neurochemical variables that are heavily influenced by genetics and also by early environmental experience.

Social Influences on the Expression of SS

We are all sensation seekers to some degree. However, most of us tend to express our SS tendencies through socially acceptable avenues. Many of the behaviors indicative of SS canvassed on Zuckerman's SSS on the TAS and the ES scales are reflective of the kinds of risk taking common to middle- and upper-class American people. Those two subscales, the TAS and ES, also show the greatest differences between British and American samples, indicating some cultural difference between the two populations. Cultural influences obviously have a heavy impact on the types of behaviors individuals choose to use as outlets to express the trait of SS.

Zuckerman feels that the more deviate the form of SS activity, vis-a-vis cultural norms, the more likely the behavior is the result of a biological imperative, driven by an extreme genetic component in that individual. Bungee jumping might be a good example as it is a culturally acceptable expression of SS that requires people of above average SS tendency to participate, but it is not deviate nor is it illegal. It is frightening as one is required to jump off some high object and no reasonable sober person would be without fear in such a circumstance. However, peer pressure or some other mechanism might be necessary to get some people who might not be such active sensation seekers to give it a try. In the last 10 years, 'reality' television programs have become very popular. One of the most challenging for participants is a program called 'Fear Factor.' On this program, participants are asked to do things that are known to produce fear or disgust, such as being placed in a clear plastic coffin for a brief period of time, a coffin filled with nonvenomous snakes, spiders, or large hissing cockroaches, allowing these animals to crawl all over them. The motivation to endure this frightening treatment is a substantive amount of money, tens of thousands of dollars. Yet, even for the promise of \$40 000 or \$50 000, many people simply cannot force themselves to complete some of the tasks. Their optimum level of arousal is exceeded, and many simply panic and decompose when pressured by a cocompetitor – which is obviously a great source of popularity among viewers who undoubtedly experience some level of vicarious excitement and arousal themselves from seeing others very excited or disintegrating into uncontrollable panic. Participating on 'Fear Factor' is a socially acceptable form of SS. Some other forms of SS that are culturally acceptable are sports such as mountain bike racing, rodeo, rock climbing, mountaineering, scuba diving, automobile or motorbike racing, and water skiing among others. Activities such as these might be termed forms of 'healthy' risk taking. They are risky, arousing, but not deviate or illegal.

In one of his most recent books, Zuckerman has an article entitled 'Prevention and Treatment of Unhealthy Risk-Taking Behavior.' We have already discussed multiple forms of unhealthy SS behavior from smoking to risky sexual behavior and polydrug use involving needles. How do people choose between healthy and unhealthy patterns of SS? This is especially critical if that person is not affluent and has limited or no avenue for socially acceptable but expensive forms of outlet for their drive to increase arousal. As Zuckerman states: "It is difficult to change a basic personality trait like sensation seeking." Zuckerman quickly thereafter asserts that it is entirely

possible to channel SS tendencies into risky sports or vocations such as fire fighting or police work. In fact, he provides the insight that while society condemns some forms of SS, it affirms other equally extreme forms practiced by public servants such as those who went into the Twin Towers or their rubble at considerable risk to save or recover others. These folks we anoint as heroes.

How do people get down these different paths? One simple answer is that availability and exposure are very important. Clinical experience tells us that it is very difficult to extinguish an SS behavior once it is established. Information, reasoning, and appeals to the imminence of negative consequences are almost always insufficient. Prevention is much preferred to treatment after a destructive pattern is established. Research shows that the full range of therapeutic interventions from pharmacological to established psychological methods such as cognitive-behavioral therapy must be applied to have any impact at all. Many who enter these programs drop out before completion and those who do complete may have changed their behavior for a while, but often relapse is very common, perhaps most common. The higher the indications are that an individual has a personality characterized by high SS and high impulsivity, the more dim the prognosis. One important covariate is testosterone level. As individuals age, testosterone levels often drop off to some degree. There is firm evidence, clinical and experimental, that testosterone levels interact with other biological determinants to produce higher levels of SS behavior. Prevention is key to avoiding maladaptive SS. Socializing at church or volunteer organizations, working a boring 9–5 job, and settling into a long-term monogamous relationship are not likely to work well after an individual has experienced the intense arousal of cocaine, gambling, or varied sexual experiences. Shifting to other societally acceptable risky behaviors such as extreme sports may or may not be within the grasp of individuals, and they may pose their own risk of dependency or injury.

What can be concluded from the research on prevention and treatment? The fact remains that it is difficult to modify to a great degree the genotypic influence and while we may understand some of the factors involved in the acquisition of SS preferences from within a range of environmental options, there is precious little practical advice for parents. It seems clear that one important way to deal with a child who might be a high sensation seeker is to channel that drive into socially acceptable methods of satisfaction where possible. In that regard, vigilance regarding what the child is doing and choice of peer groups is critical. Society clearly admires sensation seekers who advance the goals of society: fire fighters, astronauts, military jet pilots, explorers, and college and professional athletes, among others. Sadly, either because of personality structure, physical attributes, or opportunity, not everyone can channel their SS drive into one of these socially acceptable venues.

As we become more urban and civilized, we seem to have less tolerance for antisocial forms of SS. Until we find some accessible, affordable, alternatives for folks who crave stimulation, we are likely to have continued problems with the most extreme of sensation seekers among us who have not, by good fortune of early experience, affluence, and family circumstance, found acceptable outlets for their urgent drive to seek higher

levels of arousal. And even for those among us who by good fortune can live socially acceptable, even heroic, risk-taking lives, injury and death are constant shadows.

Conclusion: A Biosocial Model of SS

Zuckerman and his colleagues and collaborators have done a masterful job of outlining the parameters of a very important, impactful, personality trait – sensation seeking. As with many traits, the extremes would represent maladaptive behavior in most social contexts, and some middle point in the range would confer an evolutionary advantage for most of us, although points on either extreme might be more adaptive in selected circumstances. A genetic predisposition toward the extremes would be, predictably, fairly resistant to environmental modification, while those in the middle might come to be able to exercise their prerogative for SS with some flexibility and discernment. Those in the middle range would also find their expression more plastic to the environment both in terms of level and venues of expression. The malleability of this trait for those in the middle range of the distribution would only serve to make the trait more adaptive by allowing some modification to suit both the individual and the circumstances at hand.

Zuckerman and his colleagues then have compiled a sizable and remarkable literature outlining the nature of SS and its expression across a number of species, Zuckerman having published two books himself in the first decade of the twenty-first century. They have also made noteworthy progress in identifying physiological and neurochemical markers for this trait. They have firmly placed the trait into the general framework of personality trait structure accepted by most evolutionary psychologists and personality theorists. There is still work to be done regarding the specific nature of relationships with other traits, but the place of SS in empirically derived trait theory in personality is firmly established. Two major research issues remain. One would have the goal of understanding what environmental influences may most effectively modify the genotype one inherits for SS. A corollary topic would be what can be done therapeutically to redirect unhealthy SS behavior to more healthy alternatives and sustain those shifts over a

lifetime. Much work remains to be done here. A second research imperative is to more fully understand the neurobiology and genetics of this trait. This research is assured to continue with urgency as SS is so closely tied to both instances of heroism and tragedy of the human condition. Zuckerman, now Professor Emeritus, has stimulated two generations of behavioral and neural scientists with his keenly insightful outline of what has proved to be a key personality characteristic with a profound impact on both our daily individual happiness and our long-term species survival.

See also: Alcohol: Psychosocial Effects; Drugs, the Brain, and Behavior; Evolutionary Psychology; Psychopathology: Diagnosis, Assessment, and Classification.

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Sense of Smell

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Glossary

Allocortex Regions of the cerebral cortex that have fewer cell layers than the neocortex, especially the olfactory cortex and the hippocampus. Also called *heterotypic cortex*. The phylogenetically older part of the cerebral cortex.

Amygdala An almond-shaped nucleus located deep within the medial temporal lobes of each side of the brain. This nucleus, which is part of the limbic system, plays a critical role in the processing and memory of emotional reactions.

Anterior olfactory nucleus A nucleus found behind the olfactory bulb and in front of the lateral piriform cortex and medial olfactory tubercle in a region known as the olfactory peduncle or retrobulbar area. The deep part of a sector of this nucleus comprises a thick ring of cells that surround the anterior limb of the anterior commissure.

Cortex A thin layer of gray matter on the surface of the cerebral hemisphere, folded into gyri with about two thirds of its area buried in fissures. It integrates higher mental functions, general movement, visceral functions, perception, and behavioral reactions.

Dynein arms Large multimeric proteins (600–800 kD) that comprise the outer microtubule doublets in the ciliary axoneme. These proteins are involved in ciliary activity that is dependent upon the decomposition of ATP into ADP and a free phosphate ion, thereby releasing energy.

Entorhinal cortex The entorhinal cortex is located at the rostral end of the temporal lobe and stretches dorsolaterally. It is usually divided into medial and lateral regions with three bands with distinct properties and connectivity running perpendicular across the whole area. A distinguishing characteristic of this cortex is the lack of cell bodies where layer IV should be; this layer is called the *lamina dissecans*. This cortex is important for memory and forms the main input into the hippocampus.

G-protein Any of a class of cell membrane proteins that function as intermediaries or transducers between receptors and intracellular elements such as enzymes (e.g., cyclic adenosine monophosphate or cAMP) or ion channels.

Mitral cell The major projection neuron of the olfactory bulb. The shape of its cell body resembles the head dress – mitre – of bishops in the Catholic church; hence its name. This cell sends primary dendrites into the olfactory bulb glomeruli, and axons to the primary olfactory cortex.

Secondary dendrites are found in the external plexiform layer of the bulb, where they receive inputs from a range of cells, including inhibitory inputs from granule cells.

Nasopharynx (also termed epipharynx) That part of the space behind the mouth (pharynx) located above the soft palate that is continuous with the nasal passages. The pharynx proper serves as a passage for food from the mouth to the esophagus and for air from the nose and mouth to the larynx.

Neocortex The outer layer of the brain of mammals. Also termed the neopallium or isocortex, the neocortex is made up of six layers, with layer VI being the innermost layer and layer I the outermost layer. It is involved in sensory, cognitive, and motor processes, including conscious thought and language.

Periglomerular cell The generic term for interneurons within the olfactory bulb that are located near olfactory bulb glomeruli, where the first synapses occur between the axons of incoming olfactory receptors and the dendrites of the major output neurons of the olfactory bulb, the mitral and tufted cells. Such cells modulate activity among glomeruli, with a number having processes that enter into glomeruli.

Pheromone A biological agent made up of one or at most a few chemicals said to uniquely and specifically elicit behavioral or endocrine responses among conspecifics. While such agents have been identified in insects and some other life forms, their existence in mammals is highly questionable.

Rostral migratory stream Also known as the rostral migratory pathway, this brain pathway is the route along which neuronal precursors that originate in the subventricular zone of the brain reach the olfactory bulb, where they differentiate into interneurons: namely, periglomerular and granule cells. Such neurogenesis continues into adulthood along this pathway.

Introduction

The sense of smell, termed olfaction, is ubiquitous in nature, being found in one form or another in nearly all air-, water-, and land-dwelling animals. Even bacteria and single cell organisms have mechanisms for sensing environmental chemicals. In our own species, this sense largely determines the flavor of foods and beverages and provides a means for detecting such environmental hazards as spoiled food, leaking natural gas, fire, toxic fumes, and polluted environments. Smell plays a significant role in social and sexual behavior, as evidenced by its role in the multi-billion dollar perfume and personal care products industries.

In this article, I review the anatomy and physiology of the human olfactory system, its presence in early life, and factors that alter its function in adulthood.

The Olfactory Receptors

An estimated 10–15% of the air that enters the human nose during inhalation reaches the olfactory epithelium, a pseudostriated neuroepithelium lining the roof of the nasal cavity. During chewing and swallowing, volatiles reach this epithelium from the rear of the mouth via the nasopharynx, a process

called retronasal olfactory stimulation. This epithelium contains 6–10 million receptor cells capable of detecting thousands of chemicals by G-protein-mediated receptors located on their thread-like cilia. Each cell extends 10–30 cilia up to one eighth of a millimeter in length. This results in an enormous surface area. In the human, for example, the surface area of the cilia is around 16 cm²; in the German shepherd dog, this surface area is ~5 times the surface area of the dog's body! A scanning electron photomicrograph of the surface of the olfactory epithelium with bordering respiratory epithelium is shown in **Figure 1**.

In 2004, the Nobel Prize in Physiology or Medicine was awarded to two scientists who identified the gene family responsible for the expression of the olfactory receptor proteins (hereafter termed simply olfactory receptors). In the human, around 450 types of functional receptors are expressed, in contrast to over a thousand in the mouse. This stands in stark contrast to the number of receptor types found in vision, that is, three types of cones and one type of rod. Interestingly, each of the 6–10 million human receptor cells expresses only one type of the ~450 receptors. However, a given receptor type responds to more than one odorant. The peripheral 'olfactory code' comprises set combinations of activity among receptors. For example, receptors a, b, c, d, g, k, n, w, r, and z may be

activated by odorant A, whereas receptors c, d, j, n, q, and r may be activated by odorant B. Note that receptors c, d, r, and n in this example are activated by both odorants, illustrating the concept that most receptor cells are 'generalists.'

The olfactory receptor cells are unique in a number of ways. First, they serve as both the receptor cell and the first order neuron, that is, first neuron in the chain of neurons that sends signals to the brain. Second, unlike the cilia in the surrounding respiratory epithelium, their cilia do not beat in unison and more or less waft in the mucus. This is because they lack the biochemical machinery, termed dynein arms, necessary for synchronized beating. Third, when damaged, the receptor cells can be replaced by stem cells located near the basement membrane, although such replacement is rarely perfect and damaged regions previously occupied by receptor cells are often replaced by other forms of epithelia. Fourth, these cells can be a direct conduit for the passage of viruses, bacteria, toxins and other exogenous agents from the nasal cavity into the brain. Indeed, it was discovered in the first half of the twentieth century that polio virus readily entered the brain via the olfactory receptor cells. This led to public health initiatives in Canada and elsewhere to chemically cauterize the olfactory region of school children in attempts to prevent contraction of polio.

When a sufficient number of odorant molecules bind to the receptors of a given receptor cell, an ion flux occurs across the cell membrane, generating an action potential that propagates along the length of the cell's axon. The long axon extends from the nasal cavity into the brain and, when depolarized, releases a chemical agent or neurotransmitter into the space between adjacent neurons, termed the synaptic cleft. The neurotransmitter release, if of sufficient magnitude, alters the activity of the cell or cells to which it is connected on the other side of the synaptic cleft, resulting in alterations in their ion flux and, in most cases, producing depolarization and an action potential.



Figure 1 A transition region between the human olfactory epithelium (bottom half) and the respiratory epithelium (top half). Arrows signify two examples of olfactory receptor neuron dendritic knobs with truncated cilia. Bar = 5 μm. Reproduced from Menco BPM and Morrison EE (2003) Morphology of the mammalian olfactory epithelium: Form, fine structure, function, and pathology. In: Doty RL (ed.) *Handbook of Olfaction and Gustation*, pp. 17–49. New York: Marcel Dekker, with permission from Marcel Dekker.

The Olfactory Bulbs

The olfactory bulbs are paired elongated structures found at the base of the brain. In humans, they are located roughly between the eyes. These structures are the sole recipients of the olfactory receptor axons, which first collect into bundles, termed 'fila,' before passing from the nasal cavity into the brain via small holes (foramina) in the cribriform plate of the ethmoid bone. The axons of the olfactory receptors ultimately make up the outermost layer of the olfactory bulb, the olfactory nerve layer. Each olfactory receptor cell axon then diverges from the bulb's olfactory nerve layer to penetrate a single olfactory glomerulus, a 50–200-μm spherical structure found in the second layer of the bulb, the glomerular layer. In young persons, the glomerular layer comprises thousands of glomeruli arranged in single or double layers. In older persons, this layer becomes less well defined, largely reflecting disappearance of glomeruli subsequent to death of the olfactory receptor neurons. The next layers of the bulb, in order, are the external plexiform layer, the mitral cell layer, the internal plexiform layer, and the granule cell layer (**Figure 2**).

A key element for understanding olfactory transduction is that each glomerulus receives axons only from olfactory

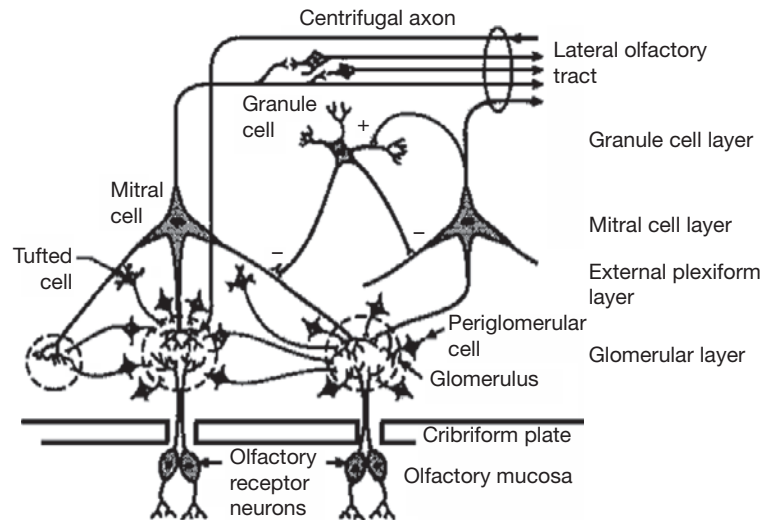


Figure 2 Schematic of the major cell types, layers, and interrelation of cells within the human olfactory bulb. Note excitatory influence of mitral cell axons on granule cell processes (+) and inhibitory influences of granule cell processes on secondary mitral cell dendrites (–). Modified from Alloway KD and Pritchard TC (2007) *Medical Neuroscience*, 2nd edn. Raleigh, NC: Hays Barton.

receptor cells that express the same type of receptor. Since these receptors are tuned to specific molecular features of odorants, the glomeruli are, in effect, functional units. The glomeruli are analogous, in principle, to other brain modules in which neurons with a similar function are grouped together, such as the 'barrels' of the somatosensory cortex or the 'columns' of the visual cortex. The information they receive, however, is complicated by the fact that, as noted earlier, a given olfactory receptor type can bind a range of molecules which share similar elements and a given odorant typically activates a number of receptors. Thus, the pattern of activation across receptors from information related to odor quality must be extracted by higher brain regions.

The main secondary neurons, the mitral and tufted cells, send their axons via the lateral olfactory tract to the olfactory cortex (see next section), whereas the periglomerular cells have localized projections confined to the bulb. The latter cells, along with the axonless granule cells found within the core of the bulb (Figure 2), serve to modulate the neural activity of the mitral and tufted cells. Periglomerular cell modulation presumably sharpens contrasts between adjacent glomerular modules, depending upon the nature of the stimuli. Granule cell modulation often reflects influences of centrifugal fibers from the hypothalamus and other brain structures, increasing or decreasing the sensitivity or gain control of the mitral and tufted cells, depending upon the biological needs of the organism. Like the receptor cells within the olfactory epithelium, granule cells and periglomerular cells are capable of being regenerated. Thus, subsets of these cells are continuously replaced by primordial cells that migrate along the rostral migratory stream from the subventricular region of the brain. Factors that alter this migration can influence the ability to smell.

There is evidence that the size of the olfactory bulbs relative to that of the brain correlates with how important olfaction is to the organism, although this relationship is not invariant. As a general rule, nocturnal and ground-dwelling species have

relatively larger olfactory bulbs than their diurnal and tree-living counterparts. The olfactory bulbs of bats that use echolocation to catch flying prey are typically smaller than the bulbs of fruit-eating bats.

The Olfactory Cortex

The primary olfactory cortex has been defined as cortical brain regions which receive the mitral and tufted cell axon projections. This includes the anterior olfactory nucleus, the piriform cortex, regions of the amygdala and periamygdaloid complex, and the rostral entorhinal cortex (Figure 3). The axonal projections from the bulb are primarily ipsilateral. Unlike other sensory systems, the output neurons project directly to cortex, albeit a simpler three-layered allocortex, without first synapsing in the thalamus. It has been suggested that this may help to explain strong associations between odors and memory, emotion, and endocrine function. The secondary olfactory cortex is defined as cortical regions receiving projections from the primary olfactory cortex. The structure most commonly termed secondary olfactory cortex in humans is the orbitofrontal cortex.

In humans, the *anterior olfactory nucleus* is a predominantly two-layered cortical-like structure with connections to the olfactory tract. It has an anterior segment located posterior to the olfactory bulb and a posterior segment within the anterior temporal lobe. Its functions are multiple, including reciprocal transfer of information from the bulb to the piriform cortex and relaying information between the left and right olfactory bulbs, as well as the left and right piriform cortices, largely via the anterior commissure.

The large three-layered *piriform cortex*, named for its pear-like shape, has frontal ('prepiriform') and posterior (temporal) components. This cortex reciprocally connects with a number of brain regions involved with behavior and emotion and is critical for processing basic olfactory information. It is involved

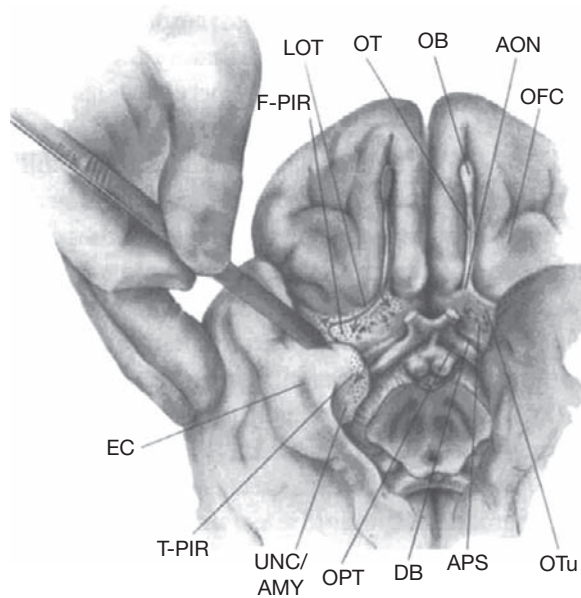


Figure 3 The anatomy of the human basal forebrain and medial temporal lobes, including the olfactory bulb, tract, and surrounding nonolfactory structures. DB, diagonal band; EC, entorhinal cortex; F-PIR, frontal piriform cortex; OB, olfactory bulb; OPT, optic tract; OT, olfactory tract; OTu, olfactory tubercle; T-PIR, temporal piriform cortex; UNC/AMY, uncus with amygdala situated beneath. Reproduced and modified from Heimer L (1983) *The Human Brain and Spinal Cord: Functional Neuroanatomy and Dissection Guide*. New York: Springer, with permission from Springer.

with the learning and memory of odors, and encodes representations of odor quality, identity, familiarity, and hedonics. Another function of this brain region is that of multisensory integration. For example, piriform activity becomes elicited by visual stimuli after they are paired with a pleasant food odor. When food associated with the odor is eaten to satiety, this response is attenuated.

The almond-shaped *amygdala* is positioned deep within the medial temporal lobe. It is closely and reciprocally related to the hypothalamus, and is intimately associated with sympathetic nervous system activity and emotion, such as fear. Its connections with the ventral tegmental area, locus coeruleus, and laterodorsal tegmental nucleus influence the release of such neurotransmitters as dopamine, norepinephrine, and epinephrine. Recent neuroimaging studies suggest that the amygdala responds to the intensity of emotionally significant, that is, pleasant or unpleasant, odors.

The most caudal temporal lobe region that receives axonal projections from the olfactory bulb is the lateral entorhinal cortex. This six-layered cortex is a transitional cortex between the three-layered allocortex and the six-layered neocortex. This brain region has strong reciprocal connections with the piriform cortex. It preprocesses information entering the hippocampus and is intimately involved in learning and memory. In animals, conditioned odor-aversion learning is disrupted by lesions of the medial or lateral entorhinal cortex.

The *orbitofrontal cortex* is located in the posterior ventral region of the frontal cortex. This five-layered agranular neocortex receives projections from, and sends projections to, all

primary olfactory regions, including the amygdala, piriform cortex, and entorhinal cortex. In addition to these direct connections, the orbitofrontal cortex also reciprocally connects to a number of these structures via the dorsomedial nucleus of the thalamus. This cortical region has extensive connections with brain regions associated with vision, touch, taste, and visceral sensations, providing cross-modal integration and associative learning. In addition to integrating food-related and odor-guided behaviors, the orbitofrontal cortex is intimately associated with judgments of odor familiarity, intensity, hedonicity, and quality, and facilitates the perception of flavor sensations.

Development of Olfactory Perception

Both developmental and functional studies suggest that human and other mammalian fetuses can respond to odors in utero. In humans, the receptor cell axons are observed at 7 weeks gestation and cilia appear around 9 weeks, when the fetus weighs <3 g. Cilia numbers dramatically increase during weeks 10 and 11, along with G-proteins involved in stimulus transduction. By 11 weeks, mature looking ciliated receptors are observed at a time when the fetus weighs around 7 g. By 19 weeks, adult-like lamination of the olfactory bulb is apparent, including the presence of periglomerular cells. Olfactory marker protein, an index of functionality, is detected in human olfactory receptor neurons at 25–28 weeks. This protein is found in receptor neuron cell bodies and dendrites at 29–32 weeks and soon thereafter in the glomerular layer of the bulb.

The olfactory receptors develop in an intrauterine liquid environment rich with chemosensory stimuli. Such stimuli enter the amniotic fluid by means of the excreted urine, gut wastes, the mother's diet, and other constitutional sources. Much more fluid is inhaled than swallowed, implying receptor exposure to a wealth of odorous materials during later fetal life, particularly as the placental barrier becomes more permeable. Given that diffusion rates for odorants in amniotic fluid are similar to those in olfactory mucus, odor detection may actually be facilitated in the intrauterine environment.

Premature human infants reliably detect and discriminate among odorants by 29 weeks, and exhibit odor preferences by 31 weeks. Human newborns preferentially turn their head toward the odor of their mother's amniotic fluid when given a choice between that smell, the smell of amniotic fluid from an unfamiliar mother, and distilled water. Offspring of mothers exposed during pregnancy to anise in their diet are attracted to anise-spiked amniotic fluid, implying transfer of the flavor from the mother's diet into the amniotic fluid. The offspring of mothers who drank ethanol during pregnancy exhibit postnatal responses to ethanol odor, independent of whether abnormal development of the brain has occurred (e.g., Fetal Alcohol Syndrome). Prenatal ethanol exposure can influence odor preferences for alcohol years later and may, in some instances, increase the likelihood of alcohol abuse.

Conditioned aversive responses to odorants can also be learned in utero, although studies demonstrating this phenomenon have largely been performed in animals. Thus, offspring of pregnant mother rats who have been intentionally made sick following infusion of an odorant into the amniotic fluid show postnatal aversions to that specific odor.

Postnatally, olfaction is involved in the earliest infant–mother interactions. The mother’s nipple and surrounding areola area provide a rich assortment of maternal odors to the infant during lactation. In addition to secreting colostrum and milk from the lactiferous ducts (whose constituents are influenced by the mother’s diet, genetic constitution, and metabolism), the nipple is densely supplied with apocrine and sebaceous glands. The areola contains eccrine glands and enlarged sebaceous glands, including secretory prominences or protuberances that contain miniature mammary acini. Suckling babies rapidly learn to recognize their own mother’s odors and respond preferentially to them. This preference is learned within the first few days of the mother–child interaction, and increases as a function of the time the mother breastfeeds the infant.

Mammalian Pheromones

In the early 1930s, a German entomologist made the distinction, in insects, between hormones secreted within the body (‘endohormones’) and hormones excreted outside of the body (‘ectohormones’). The latter were divided into those agents acting within the species, such as sex attractants (termed homoiohormones) and those acting on other species, such as defense chemicals (termed alloiohormones). In the late 1950s, two investigators changed the term homoiohormone to that of pheromone, defining the latter as “substances which are secreted to the outside by an individual and received by a second individual of the same species, in which they release a specific reaction, for example, a definite behavior or a developmental process.” Soon thereafter a number of insect pheromones were chemically identified, most notably the primary sex attractant of the female silkworm moth, *Bombyx mori*.

In the 1960s and early 1970s, several prominent scientists suggested that pheromones are also present in mammals, including monkeys and humans. Claims were made that such agents mediated a host of behaviors and changes in endocrine state, such as territorial behaviors, sexual attraction, aggression, and acceleration of puberty. Although many studies have reported such pheromone-related effects, few such substances have been chemically identified and, even in these cases, the isolated agent or agents fall far short from being anything like an insect pheromone. Learning, novelty, bodily state, and other factors have been shown to be important in establishing the influences of most socially related chemicals on the behavior and physiology of mammals.

The most widely publicized claim for a human pheromone is the purported synchronization of the menstrual cycles of women who are close friends or roommates. The studies upon which this claim is based, however, have been thoroughly discredited on methodological and statistical grounds. Importantly, an evolutionary basis for such a phenomenon has been questioned. In most preindustrialized societies (which presumably are similar to societies associated with much of human evolution), pregnancy occurs in the early teenage years and there is little attempt to control fertility. Menstrual cycling, as seen in modern societies, was the exception rather than the rule. In an extensive study of the Dogon of Mali, a society where menstruating women are segregated at night in special

huts, no evidence for synchrony was found among those who habitually ate and worked together or who lived with a particular lineage of related males. Moreover, synchrony was not observed in any of the remaining cycling women, suggesting to the author of the study, Beverly Strassmann, that the “Popular belief in menstrual synchrony stems from a misperception about how far apart menstrual onsets should be for two women whose onsets are independent. Given a cycle length of 28 days (not the rule – but an example), the maximum that two women can be out of phase is 14 days. On average, the onsets will be 7 days apart. Fully half the time they should be even closer. Given that menstruation often lasts 5 days, it is not surprising that friends commonly experience overlapping menses, which is taken as personal confirmation of menstrual synchrony” (Strassmann, 1999: 128).

Another widely publicized claim for a human pheromone is that of 5 α -androst-16-en-3 α -one (androstenone), a steroid found in the blood, testes, seminal fluid, and fat of primarily male pigs. This agent, which purportedly influences sexual attraction and other social behaviors of humans, is the major cause of ‘boar taint,’ the bad taste of meat from boars who have not been castrated. Androstenone is found in human axillary secretions, as well as in the roots of numerous plants and vegetables such as parsnip and celery. While this agent has commercial value since it aids in the induction of lordosis – the mating stance of estrous sows – this effect is not invariant, does not occur in all sows, and is likely a result of conditioning, as numerous other sensory stimuli can similarly produce this phenomenon in sexually experienced sows.

Factors That Influence the Ability to Smell in Adulthood

The ability to smell in adulthood is influenced by age, sex, nutrition, health, smoking habits, air pollution, reproductive state, and a range of diseases and other factors. Olfactory sensitivity for some odorants, for example, is greater before than after a meal.

In general, women outperform men on a range of olfactory tests and retain normal smell function to a later age than do men (Figure 4). Decreased smell function is common in later life, with measurable decrements occurring in about half of those between 65 and 80 years of age and three quarters of those 80 years of age and older. Smell loss explains, in part, the disproportionate number of elderly persons who die in accidental natural gas poisonings and the reports of many elderly that food has little or no flavor. Decreased smell function can result in nutritional disturbances and, in rare instances, even death. Most food flavors, for example, chocolate, pizza, lime, meat sauce, strawberry, etc., depend upon stimulation of the olfactory receptors from the rear of the nasopharynx during deglutition. Taste buds mediate such sensations as sweet, sour, bitter, and salty.

The most common cause of smell loss seen in the clinic results from an upper respiratory infection. Usually, the infection is more severe than usual and damages the olfactory epithelium. Once the common symptoms of the cold, such as stuffiness and running nose, resolve, the individual discovers that food does not taste right and the smells are gone or diminished. Other common causes of smell loss seen in the

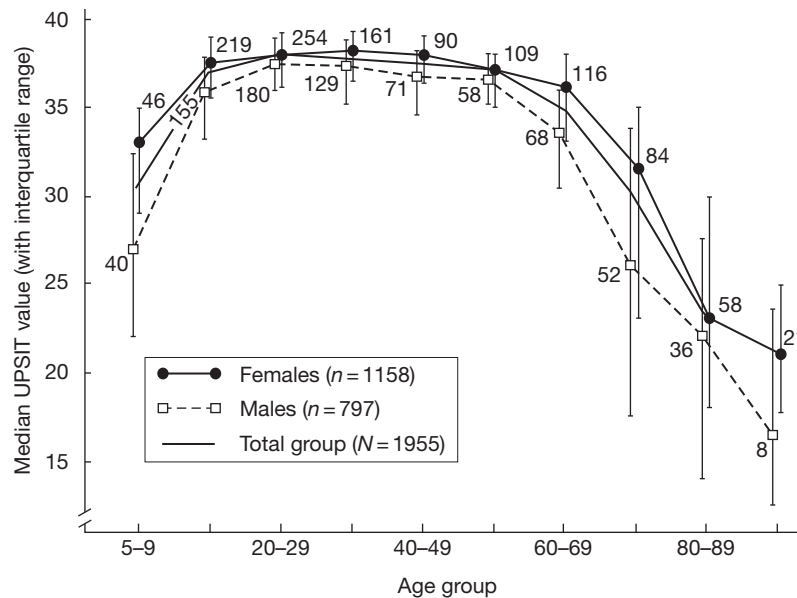


Figure 4 University of Pennsylvania Smell Identification Test (UPSIT) scores as a function of age and sex. Reproduced from Doty RL, Shaman P, Applebaum SL, Giberson R, Sikorsky L, and Rosenberg L (1984) Smell identification ability: Changes with age. *Science* 226: 1441–1443, with permission. Copyright © 2004, American Association for the Advancement of Science.

clinic are chronic rhinosinusitis, which can lead to permanent neural damage of the olfactory epithelium, and head trauma. Blows to the head that result in rapid acceleration or deceleration of the brain relative to the skull can sever or damage the very thin olfactory fila as they course through the cribriform plate. A strange odor, likely representing either degeneration or attempts at regeneration of the receptor neurons, may be noticed for a few weeks or months after such an injury. Interestingly, olfactory dysfunction occurs more frequently from blows to the back of the head than to the front of the head, in part because frontal blows are cushioned to some degree by the collapse of the softer facial structures (e.g., the nose and sinuses).

Of particular interest to the clinician is the fact that olfactory dysfunction is among the first signs of Alzheimer's and Parkinson's disease. Indeed, in these disorders smell loss typically occurs several years before the onset of the classical disease signs. Such findings have led to the use of olfactory tests in helping to identify persons at the earliest disease stages and to differentiate between neurodegenerative diseases often confused with one another. For example, Alzheimer's disease is consistently associated with smell loss, whereas the major affective disorder, that is, depression, is not. Similarly, Parkinson's disease is associated with smell loss, whereas progressive supranuclear palsy and essential tremor disorders which are sometimes misdiagnosed as Parkinson's disease, have normal smell function.

Summary

The perception of odors begins when volatile molecules bind to specialized receptor proteins located high in the nose. Each of ~450 such receptors, expressed individually on

6–10 million receptor cells, respond to a range of odorant molecules. Activation of these receptors in combination encodes the initial information which is subsequently transformed in higher brain centers, beginning with the olfactory bulb, to produce the sensation of odor.

Multiple brain regions are involved in this process. The piriform cortex encodes higher-order representations of odor quality, identity, and familiarity, and is intimately associated with the learning and remembering of odors. The amygdala and entorhinal areas are thought to mediate the affective aspects of olfactory perception, and play an important role in olfactory learning and memory. The orbitofrontal cortex is involved in facilitating the appreciation of flavor sensations as well as other feeding-related and odor-guided behaviors.

Interestingly, the olfactory system is functional prior to birth, and neonates exhibit the ability to smell a wide range of environmental stimuli. In utero learning of the meaning of odors has been demonstrated in humans and other species, and such learning can influence behaviors directed toward odors after birth. In adulthood, a range of factors influence the ability to smell, including sex, age, and a wide range of medical conditions, including head trauma, upper respiratory infections, chronic rhinosinusitis, and such neurodegenerative diseases as Alzheimer's disease and Parkinson's disease. Olfactory testing is now employed to detect such disorders early in their development, as well as to differentiate between such diseases as (1) Alzheimer's disease and major affective disorder and (2) Parkinson's disease and progressive supranuclear palsy.

See also: Alzheimer's Disease; The Brain; Central Nervous System; Sense of Taste (Effect on Behavior).

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Sense of Taste (Effect on Behavior)

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Glossary

Ageusia The complete loss of taste.

Dysgeusia An alteration or distortion in the perception of taste.

Hypogeusia A diminished sense of taste.

Mastication The process by which humans mechanically separate food molecules that dissociate in the presence of saliva and digestive enzymes.

Palatability The hedonic reward provided by foods or fluids that are agreeable to the 'palate' in regard to the homeostatic satisfaction of nutritional, water, or energy needs.

Taste buds Also referred to as taste receptors; any one of many peripheral taste organs distributed over the tongue and the roof of the oral cavity.

Taste, also known as gustation, is one of the five traditional senses and is a chemical sense by which the qualities and flavor of a substance are distinguished by the taste buds. Taste stimuli are detected by taste receptors, which are located on the tongue, mouth, and pharynx. In humans, five taste qualities have been identified, including sweet, salty, sour, bitter, and umami. Taste is different from flavor, which includes the olfactory, tactile, and thermal attributes of food in addition to taste. First, we review the significance of taste for humans and the five primary taste categories. Next, we examine the anatomical and physiological substrates in taste receptors. Then we describe the lifespan development of taste from *in utero* to elderly. Finally, we discuss common taste disorders and their effect on behavior.

Concepts of Taste

Significance of Taste

Why are humans equipped with the advanced capability of taste discrimination? The answer to this question is thought to lie in the evolutionary force of nature. The physiological mechanism of taste reception enables an organism to decipher different tastes, including those considered to be desirable, mediocre, or repulsive. Each flavor has a distinct taste and elicits a different response from the palate to the nervous system, which proves advantageous to the organism. For example, salty foods are useful in water retention, sweet flavors indicate a food source high in carbohydrates and calories, umami suggests protein-rich foods, while bitter flavors often are associated with food sources containing toxins that may prove poisonous to the organisms. Thus, it appears that taste reception was, at one point, important for the survival of an individual.

The idea that taste perception and discrimination is essential for energetic enrichment and nutritional preservation stems from the simplest of all organisms, the single-celled bacterium *Escherichia coli*. For example, if *E. coli* sense a baneful chemical, their whip-like appendages rotate and propel them away from such a stimulus, whereas the sensation of an advantageous chemical stimulus will prompt their movement toward the chemical. In regard to human behavior, our ability to

differentiate among various tastes permits individuals to digest the appropriate food source necessary for the required energy in active and dynamic organisms.

A combination of genetic inheritance and an individual's lifetime experiences and culture also contribute to taste perception and specific food preferences. For example, findings from a recent study revealed that variation in a taste receptor gene influences taste sensitivity of children and adults that can explain individual differences in taste preferences and food selection. In this study, researchers compared taste sensitivity and food-related behaviors across three genotypes of the TAS2R38 gene, which encodes a taste receptor responsive to bitter taste. Groups were classified according to the following genotypes: type AA had two bitter-insensitive sites (alleles), type PP had two bitter-sensitive alleles, and type AP had one of each. Findings indicate that children and mothers with a bitter-sensitive allele (type AP) on the TAS2R38 receptor gene were more sensitive to propylthiouracil as compared to children and mothers with two bitter-insensitive alleles or two bitter-sensitive alleles, suggesting some genetic influence on bitter taste sensitivity. In a study that examined the contributions of individual difference and culture, results demonstrated that infants and teenagers of African descent preferred significantly higher levels of sucrose when compared to similar aged Caucasians.

Four (or Five) Basic Tastes

Tastes are organized into five different categories; salty, sour, sweet, bitter, and the newly found umami which is a savory or meaty flavor. Enjoying different tastes has become a recreational activity for the average person such that eating foods pleasant to the palate is considered delectable. But on a more instinctual level, taste enables an individual to desire and enjoy the consumption of material that is in fact beneficial for life. The enjoyment or unpleasantness people experience when eating food differs between individuals and cultures; in other words, there is great variation between individuals, families, and cultures along the hedonic dimension. An individual's food preference may stem from multiple facets such as innate taste preference, acquired or learned food preference, or association of a specific taste to a certain memory.

Sodium is a necessary component for the maintenance of adequate electrolyte and water balance. Researchers believe that the perception of salty foods is derived from an ancestral need to maintain homeostatic equilibrium. The literature is decidedly mixed on the notion of salt acuity. Prior studies suggested that there were age-related changes in taste and odor sensitivity and/or preferences, yielding a more pronounced liking of salty foods in the elderly as compared to younger people. However, more recent experiments reveal that no differences exist between age groups in ratings of saltiness in chicken broth. Moreover, some research findings indicate that older individuals actually prefer less salty broth than do young adults.

Sour tastants are acids, often found in spoiled or unripe food. Infants make facial grimaces when sour tastants are ingested. Furthermore, one study found that infants ingested a smaller amount of mixed sour and sweet solution in comparison to a uniform sweet solution.

The hedonic 'sweet' taste signals high-calorie carbohydrates such as sugars, as well as nonnutritive synthetic sweeteners such as saccharin, which bind to the specific sweet taste receptors. Perhaps universally instilled in humans is the feeling of pleasure when eating something sweet. Many studies have shown that infants readily accept sweet tastes.

In contrast to a sweet taste, which evolved to detect a limited subset of nutrients, a bitter taste helps prevent the ingestion of numerous structurally distinct toxic compounds. The bitter taste is perceived by many to be unpleasant and sharp. Evolutionary biologists theorize that the bitter taste evolved in humans as a defense mechanism against toxins and poisons. This holds true regarding the taste of alkaloids, bitter almonds, and the like. Without prior repeated exposure to a bitter taste such as beer, coffee, or cabbage, most people regard these tastes as undesirable.

In humans, two L-amino acids known as monosodium glutamate (MSG) and aspartate generate the unique savory sensation known as umami. The relatively new umami taste was derived from Japanese soup. Generally, this taste triggers a pleasurable response in humans and thus encourages the intake of peptides and proteins. Proteins derived from food sources yielding a umami taste help to build muscle and organs, antibodies, and enzymes. Few studies have shown that human infants, when fed Japanese soup broth, regard umami taste in a similar manner to that of a sweet taste. In a cross-cultural study that compared hedonics of taste in the Japanese to that of Australians, findings revealed that the Japanese group demonstrated greater preferences for umami tastes. The Japanese people frequently cook with many foods containing the umami taste such as seaweed and nombu. As such, this difference can perhaps be attributed to a learned preference for umami tastes in the Japanese since they are far more accustomed to these tastes than Australians.

Anatomical and Physiological Substrates in Taste Receptors

Gustatory Receptors

Taste buds are clusters of taste receptor cells and are located in various places throughout the oral cavity, including the tongue,

palate, pharynx, and epiglottis. These taste receptors are specialized cells surrounded by nerve endings. The taste receptor cells within a bud are arranged such that their tips form a small taste pore, and through this pore microvilli from the taste cells extend. A single taste bud contains 50–100 taste cells. The number of taste buds varies (2000–10 000) from one individual to another, with the average human possessing approximately 5000–7500 taste buds. Distribution of the taste buds across the oral structures is uneven, with the largest concentration and density being located on the posterior tongue.

Taste buds tend to reside in clusters within the bumps of the tongue, called papillae. There are four types of papillae: (1) Filiform papillae are cone shaped and found all over the tongue. These papillae are mechanical and nongustatory and account for the tongue's rough and uneven surface – in their absence the tongue is pale and smooth. (2) Fungiform papillae are mushroom shaped and are located on the most anterior part of the tongue and generally contain one to several taste buds per papilla. These papillae appear as red spots on the tongue because they are richly supplied with blood vessels. (3) Foliate papillae are a series of folds along the sides of the tongue and are predominantly sensitive to sour tastes. (4) Circumvallate papillae are shaped like flat mounds surrounded by a trench and are found at the back of the tongue. Taste buds and papillae are more numerous in infants than adults. With advancing age, there is a gradual reduction in the number of papillae and the number of taste buds, at a rate of about 1% per year.

The lifespan of the taste cells within the taste buds is relatively short, approximately 10–14 days, although some cells have a much shorter and others a much longer life span. During this process, dying cells are continuously being replaced by new taste cells, such that cells at a variety of different developmental stages are present within a single taste bud. The lifespan of the cells is short due principally to the damaging effects of temperatures, textures, and size of foods; however, the taste bud itself will not die unless significantly damaged. If it is damaged, however, it will have to wait for a nerve to innervate the tissue.

Pathways to the Brain

Taste cells contain gustducin, or receptor molecules, which convert taste stimuli into nerve impulses. Three nerves are responsible for transmitting information from these impulses: nervus intermedius, part of the facial nerve (chorda tympani branch) which innervates the receptors of the anterior two-thirds of the tongue; the glossopharyngeal nerve which innervates the posterior one-third and part of the pharynx; and, the vagus nerve for the remaining taste buds in the posterior oral cavity that includes the pharynx and epiglottis.

When the impulses reach the ganglion associated with their nerve, they project to the solitary tract, which ends in the nucleus of the solitary tract in the medulla oblongata. The solitary tract and nucleus are structures in the brainstem that carry and receive visceral information from the cranial nerves. The pathway for the second-order taste relay neurons projects to the pontine taste areas, which in turn project to the thalamus, lateral hypothalamic area, and amygdala. From the thalamus, the pathway continues to the lowermost part of the postcentral gyrus and limen insulae of the insula.

The somatosensory cortex is responsible for the conscious perception of taste. The hypothalamus, amygdala, and insula are responsible for the so-called 'affective' component of taste, which in turn is responsible for the behavioral response (e.g., aversion, gastric secretion, feeding behavior).

The Taste Map and Taste Stimuli

Through the process of mastication, humans mechanically separate food molecules that dissociate in the presence of saliva and digestive enzymes. These separated molecules are detected by chemoreceptors within the mouth. Chemoreceptors are specialized cell groups responsible for acquiring information about the chemical environment and subsequently conveying the information to neurons. Specifically, taste receptors respond to the dissolved molecules of the masticated food. Groups of receptor cells are formed and surrounded by support cells and basal cells.

Individual taste buds form within the tough, waterproof epithelium of the gustatory region. This region is capable of perceiving taste through use of a group of receptor, support, and basal cells. The microvilli on the apical membranes of the receptor cells project into the gustatory space to detect incoming food sources. The interaction of molecules with these membranes generates distinct tastes. Each receptor cell is formed to be more sensitive to a certain stimulus or tastant over another. Taste buds typically form in specific factions, allotting certain parts of the tongue to be slightly more sensitive to certain tastes or flavors.

Popular belief is that the human papillae are more sensitive to one taste quality than another such that the tongue can be divided into different receptor areas by taste sensitivities. For example, the tip of the tongue best detects sweet substances, the sides of the tongue demonstrate the most sensitivity for salty and sour tastes, and the back of the tongue is most sensitive at detecting bitter taste. The soft palate is sensitive to sour and bitter tastes. Contrary to popular belief, the current scientific view suggests that papillae possess multiple sensitivity to compounds representative of the four primary taste qualities. As such, all taste qualities are found on all regions of the tongue, as long as taste receptor cells are stimulated.

Even though each type of receptor cell is activated differently, the general pathway is comparable. First, the receptor cell is stimulated by the tastant, typically an ion, a sugar, an alkaloid, or an amino acid associated with a particular taste. A conformational change occurs within a taste receptor protein that results in depolarizing the receptor cell. Depolarization leads to release of neurotransmitter at the chemical synapse connecting the taste receptor cell with the next cells in the pathway to the brain. Information sent from the receptor cells in taste buds is transmitted to taste nerves by neurotransmitters. A number of probable neurotransmitters in taste buds have been proposed including serotonin, enkephalin, adenosine triphosphate (ATP), aspartate, and glutamate. Among these, glutamate is the prominent excitatory neurotransmitter involved in this taste signaling. These neurotransmitters bind to postsynaptic receptors, resulting in the quick opening of ligand-gated ion channels. Neurotransmitters can be short term or long term such that some neurotransmitters stay in the synaptic cleft and produce a neural signal for an extended

period of time, while other specified neurotransmitters involved in taste are only short term in nature.

Since foods have different physicochemical properties, the electric potential of the nerve (nerve excitation) and the membrane potential of the taste cell depend on the type of food consumed. In regard to salty perception, the taste cell only needs to detect simple ions. Salt, composed of sodium and chloride, readily dissociates in water yielding sodium cations. One way the taste cell detects the salt is through a particular type of sodium ion channel that spans the apical membrane of the salty receptor cells. Ion channels are proteins that form a channel through a membrane, allowing specific inorganic compounds to diffuse. The sodium ion channel that responds to NaCl is known as the amiloride-sensitive channel. The amiloride-sensitive channels are different from voltage-gated sodium ion in that they are constitutively open. As Na⁺ ions come across the amiloride-sensitive channel, the receptor cell is depolarized. The influx of Na⁺ ions creates a change or gradient in cellular ion concentrations, which in turn generates the action potential needed to enable the associated neuron to fire.

Sour tastants are prevalent in sour stimuli. Hydrogen ion channels have the capacity to detect H₃O⁺ ions that have dissociated from an acid. The ions enter the taste cells through a proton channel or act by blocking an apical potassium channel. Hydrogen ion flow can induce substantial transmembrane currents through amiloride-sensitive sodium channels. Hydrogen ions also inhibit the potassium channel that normally functions to hyperpolarize the cell. The combination of these mechanisms incurs changes in membrane polarization in sensory neurons that produce the sensation of sour taste.

Utilizing cell-based assay, genetics, and bioinformatics, discoveries of the sweet taste receptors have been made, namely T1R2 and T1R3 members of G-protein linked receptors. GPCRs are integral membrane proteins that span certain areas of the apical membranes of taste receptors. Together, T1R2 and T1R3 form the G-coupled receptor. Via activation of these G-protein-coupled receptors, sweet compounds have been shown to lead to the intracellular synthesis of cyclic adenosine monophosphate (cAMP). cAMP is an intracellular messenger and leads through several steps to the closing of potassium (K⁺) channels on the basolateral membrane of the receptor, ultimately depolarizing the receptor through the small resting influx of Na⁺. Once the receptor cell is depolarized, ion-gated channels open eliciting repetitive action potentials.

In contrast to a sweet taste, which evolved to detect a limited subset of nutrients, a bitter taste has the onerous task of preventing the ingestion of numerous structurally distinct toxic compounds. Despite the vastness of this repertoire, these compounds all evoke such a similar sensation that humans simply know them as 'bitter.' Approximately 30 different GPCR bitter taste receptors have been identified, accounting for the large variety of molecules that are associated with bitter taste.

At the molecular level, umami taste detection is mediated by GPCR receptors sensitive to glutamate and perhaps other amino acids.

Importantly, human perception of taste is significantly influenced by other sensory inputs such as olfactory and visual, as well as experiences such as satiety and hunger. Indeed, much of what we perceive as flavor is actually olfactory.

Lifespan Development of Taste (In Utero to Elderly)

Perceiving taste first occurs in the womb and continues throughout the entire lifespan. Taste sensitivity and food preferences change across the lifespan.

Before Birth

At the 7–8 weeks' gestation, taste buds start emerging, and by the 14th week the taste sensation is formed. By 13–15 weeks a fetus' taste buds already look like a mature adult's and are already communicating with their invading nerves. As early as the 6th month of gestation, observations have confirmed that the fetus will engage in behavioral responses to the presence of taste compounds. Specifically, the fetus will increase its swallowing in response to sweet tastes while also decreasing its swallowing in response to bitter and sour tastes. In addition, the fetus will display sensitivities to different chemicals in the amniotic fluid. As gestation progresses, the fetus will develop a similar number and distribution of papillae as those found in children and adolescents. Similar to prenatal smell, a fetus's taste experience in the womb may bias food preferences.

Newborn and Infant

Taste sensations become heightened in newborns as they are able to perceive the basic tastes of sweet, sour, salty, bitter, and umami compounds. Infants are capable of expressing positive and aversive facial responses to tastes. Although newborns can discern different tastes, it is clear that they prefer sweet tastes. For example, newborns and infants show a positive preference for sweet tastes such that a combination of sugar with a pacifier has a calming effect on newborns. In contrast, newborns and infants may demonstrate a negative reaction to sour tastes, usually signaled with a frown on the newborn's face. Newborns can even tell the difference between different types of sugar and concentrations of the same type of sugar. Newborns seem to prefer sucrose (table sugar) over fructose (found in fruit). Reactions to salty food are more variable with responses ranging from positive to negative, but with the majority of newborns reacting in a neutral manner. Taste abilities continue to evolve during early childhood such that after 4–6 months of age, infants start developing a taste for salty food. Several lines of research indicate that the delay in development of salt sensitivity is associated with the development of the kidney.

Children and Adolescents

Around the age of 2, response to salty food will again change. In addition, children's taste preferences and perception of bitterness also will evolve over time. While it is clear that children like the basic taste of sweet and salt, all other food preferences are due to acquired tastes. Results from a recent study of 8900 school-aged children in Denmark revealed that girls are generally better at recognizing tastes as compared to boys, including all concentrations of both sweet and sour tastes. Furthermore, boys have a sweeter tooth than girls and tend to like the more extreme flavors. Finally, findings indicated that the ability to recognize tastes increases gradually with age, with the greatest

shift occurring at 13–14 years of age when children become markedly more sensitive to sour tastes. In another study that involved youth, young male subjects between the ages of 8 and 10 were compared to adult males, with findings revealing that adolescents had a higher anterior papillae density than the adults, making them more sensitive to sucrose or sweet flavors.

Marketing and expectation also play a primary role in taste preference for children and adolescents. In a study conducted by Stanford University, two identical meals, one in a plain wrapper and one in a package from a popular fast food chain were offered to a group of children. Even young children associated a better taste experience with the name-brand selection.

Adults

Although there are approximately 10 000 taste buds in an adult's mouth, the number of these taste buds will decrease beginning between the ages of 40 and 50 in women and 50 and 60 in men. In addition, each remaining taste bud atrophies with age. However, the decline in taste sensitivity with aging is worsened by smoking, chewing tobacco, and poor oral care.

Advancing Age

An estimated one-third of all older adults report dissatisfaction with their sense of taste. This loss of taste sensitivity is common in the elderly and often results from normal aging in which the number of taste buds gradually decreases with age because the receptor cells are replaced less often. Additional causes beyond normal aging include (1) adverse side effects from medications, (2) surgical interventions, (3) certain disease states (especially Alzheimer disease), and (4) environmental exposure.

As the loss of taste progresses, sometimes from the loss of saliva due to aging, there may be concomitant reductions in the pleasure and comfort from food. This loss of pleasure and enjoyment of food is an important risk factor for decreased adherence to specific dietary regimens as well as nutritional and immune deficiencies such as malnutrition and weight loss. There are some gender differences as men tend to lose taste earlier than women.

Taste Disorders

Taste disorders fall under three broad descriptors: *hypogeusia* is a diminished sense of taste, *ageusia* is the complete loss of taste, and *dysgeusia* is an alteration or distortion in the perception of taste. Ageusia is relatively rare; more commonly, individuals will complain of diminished ability to perceive or distinguish taste quality, which can occur as a general loss across all taste qualities or reduced perception of specific taste qualities such as salty, sweet, or bitter. Total loss of isolated taste modalities (such as an inability to perceive sweet) also is rare but has been described in the literature. Many patients who complain of dysgeusia will report that food is perceived as sour, bitter, or metallic. *Phantogeusia* ('taste phantoms'), often a bitter or metallic taste when no gustatory stimulus is present, has been reported in certain disorders (e.g., schizophrenia) or as a seizure aura in epilepsy. Complaints of taste loss or reduction in taste quality should be thoroughly assessed, as individuals will

often report a taste disorder when the primary dysfunction is olfactory, as smell is contributory to flavor. Although gustatory dysfunction or loss does not typically result in serious disability, it can have adverse consequences if one is unable to detect tainted or spoiled food. Specifically, gustatory dysfunction can signify a number of systemic or neurological disorders, which increases the clinical significance and underscores the need for psychophysical taste and smell testing. For example, loss of taste can be psychologically distressing and lead to anorexia or depression. Nutritional deficits or excesses are notable sequelae of taste disorders and can put a patient at risk for additional health problems, such as hypertension, heart disease, or diabetes resulting from modifications to diet (e.g., increased sugar or salt intake to compensate for decreased taste perception).

Taste disorders are generally the result of certain medical conditions, pharmacologic or surgical interventions, environmental exposure to toxic chemicals, head injury, or advanced age. Poor oral hygiene is a common cause of taste reduction and *cacogeusia* (a foul or unpleasant taste). Brushing the tongue is associated with *hypogeusia*. Dentures or other palatal prostheses can result in a deficit in sour or bitter perception, although, in at least 10% of cases, this deficit is caused by an allergic reaction to the prosthetic material. Smoking, particularly pipe smoking, can impair taste perception. Upper respiratory infections also affect both taste and smell, thereby decreasing taste appreciation. Influenza-like infections or viral hepatitis can cause taste disorders. Dryness of the mouth from inadequate saliva can result in *hypogeusia* or *ageusia*, as occurs in Sjögren syndrome. Deficiencies in certain nutrients such as zinc, B12, niacin, or copper can result in changes in taste. Finally, endocrine disorders such as Cushing's syndrome, hypogonadism, diabetes mellitus, pseudohypoparathyroidism, and adrenal cortical insufficiency can result in aberrant taste function.

Burning mouth syndrome (BMS) is characterized as a taste disorder. BMS (also known as *glossodynia* or *glossalgia*) is characterized by persistent, severe intraoral pain generally described as a burning or scalding sensation, usually occurring on the tongue. BMS is accompanied by complaints of *dysgeusia* and dry mouth. The etiology of BMS is not well understood, but some evidence indicates that it can be idiopathic or secondary to another pathological condition such as mucosal disease, hormonal disturbances, nutritional deficiencies, medication side effects, or psychosocial stressors. In addition, the epidemiology and pathophysiology are not well defined, suggesting that more research is needed to clarify these issues.

There are a number of neurological syndromes and diseases in which taste disorders manifest as part of the clinical presentation. Central nervous system disorders such as Alzheimer's disease, Bell's palsy, Parkinson's disease, multiple sclerosis, and epilepsy can produce deficits or dysfunction of taste. Familial dysautonomia has a reduced number of circumvallate and fungiform papillae, leading to deficits in sweet and salty perception. Taste disorders also have been described as a prominent early feature in Creutzfeldt-Jakob disease and speculated to occur in early rabies infection.

Another cause of taste disorders are various surgical and treatment procedures. Taste loss resulting from otologic surgery is rare, but occurs most often following middle ear surgery due to manipulation and stretch, dryness, or injury of the

chorda tympani, which carries gustatory fibers and parasympathetic fibers for the salivary glands. Damage to these fibers can result in taste distortion, reduction, or loss. These taste changes are often unnoticed by patients and are temporary; however, those individuals whose chorda tympani have been severed during surgery have the worst prognosis for recovery and may experience a permanent sensory loss. Very rarely, transitory taste problems are reported following tonsillectomy. Cancer and its associated treatments are common causes of taste disorders. For example, oropharyngeal tumors can invade the chorda tympani or lingual nerves and the resectioning of oral or cervical structures can result in damage to taste fibers. In terms of cancer treatment, chemotherapy and radiation treatment to the oral cavity and neck can cause damage of the salivary glands and taste buds. Salivary gland necrosis and mouth dryness can persist after radiotherapy, while taste bud regeneration typically resumes.

A prevalent cause of taste disorders is drug-induced taste alterations, and up to 33% of older adults will experience taste distortion or deficit as a result of medications. Popular pharmacological culprits include antihistamines, antibiotics, antineoplastics, anticholesteremics, antidepressants, antipsychotics, bronchodilators, diuretics, and anticonvulsant medications. Taste dysfunction can be induced by a single medication or by drug interactions between two or more medications. Typical medication-induced taste complaints include 'metallic taste,' *hypogeusia*, and *dysgeusia*.

Lesions occurring along the central taste pathway, including select areas of the brainstem, thalamus, cranial nerves, or cerebral cortex can result in gustatory dysfunction. Lesions or traumatic injury to cranial nerves VII, IX, or X also can result in taste loss. Taste disorders caused by brainstem lesions generally occur as a result of ischemia or hemorrhage, or a demyelinating process at the level of the solitary tract or pons. Thalamic or corona radiata infarcts can result in *dysgeusia*. Contributors to cortical taste disorders include neoplasm, epilepsy, or cerebrovascular disease. Head trauma can also result in posttraumatic taste dysfunction, although gustatory dysfunction in isolation is relatively rare (<1% of cases) without a concomitant loss of olfaction. Damage to the tongue can occur from self-inflicted bites, facial fractures, or foreign-body-induced lacerations following a trauma, although gustatory dysfunction is typically transitory. Cranial nerve injury can occur from head trauma in which there are temporal bone or skull base fractures, leading to deficits in taste.

See also: Central Nervous System; Evolutionary Developmental Psychology; Evolutionary Psychology; Facial Expression of Emotion; Perceptual Development; Sense of Smell; Touch.

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The Sense of Touch

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Glossary

Afferent fiber Neural fiber that carries information from the receptors to the brain.

Cutaneous Of or relating to the skin.

Glabrous skin Hairless skin; for instance, on the palmar surface of the hand.

Mechanoreceptor A neuron that is activated by mechanical deformation of the skin.

Primary somatosensory cortex Located just posterior to the central sulcus, the primary somatosensory

cortex comprises four areas, each containing a full body map.

Receptive field A patch of skin which, when stimulated, results in the activation of a receptor or neuron.

Secondary somatosensory cortex Located in the parietal operculum, the secondary somatosensory cortex contains neurons with large receptive fields and complex response properties.

Somatotopic organization Adjacent neurons in the brain have adjacent receptive fields on the body.

We are capable of using our hands to produce remarkably fine and precise movements, such as those involved in writing with a pen or playing a musical instrument. Our ability to interact seemingly effortlessly with objects is mediated not only by a sophisticated motor system – comprising both muscles and brain structures specialized for controlling these muscles – but also by a complex sensory system, which informs us of the consequences of our actions. The sense of touch forms a critical component of this sensory system, playing a key part in mediating our ability to explore and dexterously manipulate tools and act upon our environment. Indeed, for individuals with impaired touch, the activities of daily living are slow, clumsy, and require great concentration. The sense of touch also plays a powerful role in social communication, as evidenced by the fact, for example, that deprivation of parental touch in infants severely impedes emotional development.

Sensors in the Skin

Deformations of the skin or changes in skin temperature activate receptors in the skin, and different types of receptors are sensitive to different types of skin stimulation. In glabrous skin (for instance, on the fingertips or on the palm), four types of receptors signal mechanical deformations of the skin: Merkel cells, Ruffini organs, Meissner corpuscles, and Pacinian corpuscles (Figure 1). An individual Merkel cell is activated when light pressure is applied to a small patch of skin (the diameter of the receptive field of a typical Merkel cell is about 5 mm) and will not respond when other parts of the hand are touched. These receptors play a key role, for example, in signaling how much force is applied on a grasped object. Without these receptors, we would either routinely drop objects or crush them. Ruffini organs have large receptive fields, are sensitive to skin stretch, and, in the glabrous skin, are concentrated around the nail. In hairy skin, these receptors may convey information about movement of the joints. Like Merkel cells, Meissner corpuscles have small receptive fields. However, Meissner corpuscles do not respond to steady pressure applied to the skin but to changes in pressure or to movement across

the skin. These receptors are thought to play a critical role in signaling a slip between the skin and an object, which in turn signals to our muscles to increase our grip. Pacinian corpuscles have very large receptive fields and are exquisitely sensitive to small vibrations applied to the skin, the types of vibrations we experience when a breeze is blowing across our skin or when we scan our hand across a finely textured surface. In hairy skin (of the arms and legs, for example), other types of receptors are closely bound with each hair and are activated when the hair is deflected (Figure 2). In addition, two populations of receptors in the skin respond to changes in skin temperature – one responds to cooling of the skin (aptly named cool fibers) and the other responds to warming of the skin (warm fibers). If the skin is cooled or warmed a lot, to the point where it may become damaged, other populations of receptors become activated. The activation of these receptors (nociceptors) is associated with sensations of pain. Other nociceptors become activated when the skin is deformed violently (and in a potentially damaging way), such as when one stubs one's toe. In this article, we focus on the so-called discriminative touch – our ability to perceive shape, texture, vibration, and motion – which is mediated primarily by Merkel, Meissner, and Pacinian receptors.

Signals from the receptors are carried to the spinal cord, and ultimately to the brain, by afferent fibers. Receptors send signals to neurons in the spinal cord when action is required at a short latency. Indeed, sending signals up to the brain and back down to the muscles takes time, and, under certain circumstances, too much time, for example, when we touch a burning object or when a tool is slipping from our grip. Neurons in the spinal cord directly activate muscles that trigger a withdrawal reflex or an increase in grip force. Ultimately, however, signals from the receptors, carried by afferent fibers, are conveyed to the brain.

The afferent fibers that carry information from Merkel, Ruffini, Meissner, and Pacinian receptors have relatively large diameters (on the order of 10 μm) and thus conduct signals very fast (up to 70 m s^{-1}). The afferent fibers that carry signals from Merkel cells are called slowly adapting type 1 (SA1) fibers because, when steady pressure is applied to their receptive field, they produce a response that fades (adapts) slowly.

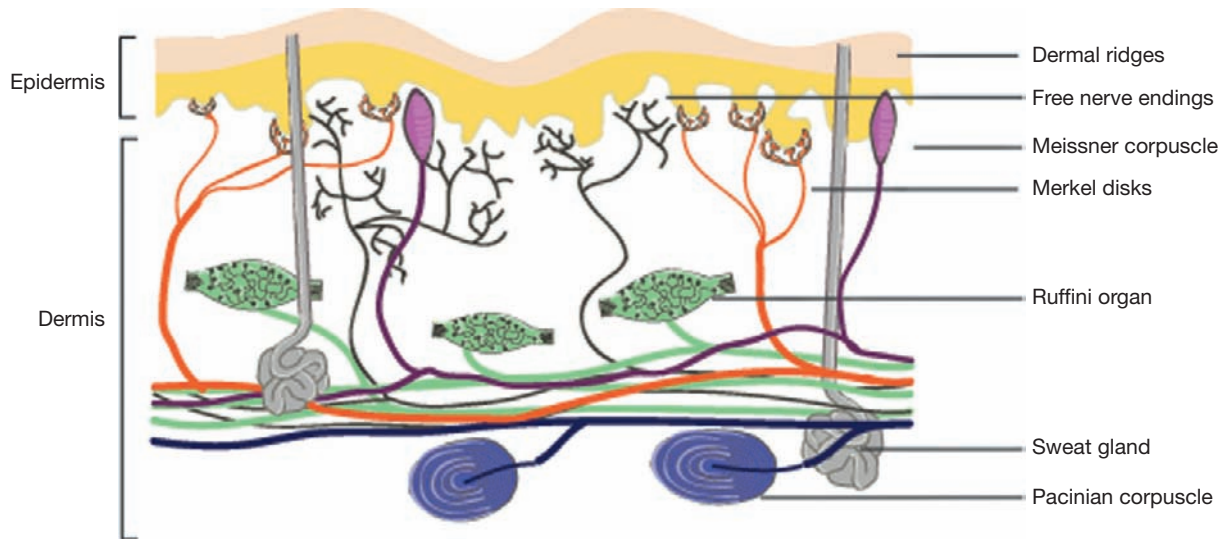


Figure 1 Cross section of the glabrous skin illustrating its innervation and principal structures.

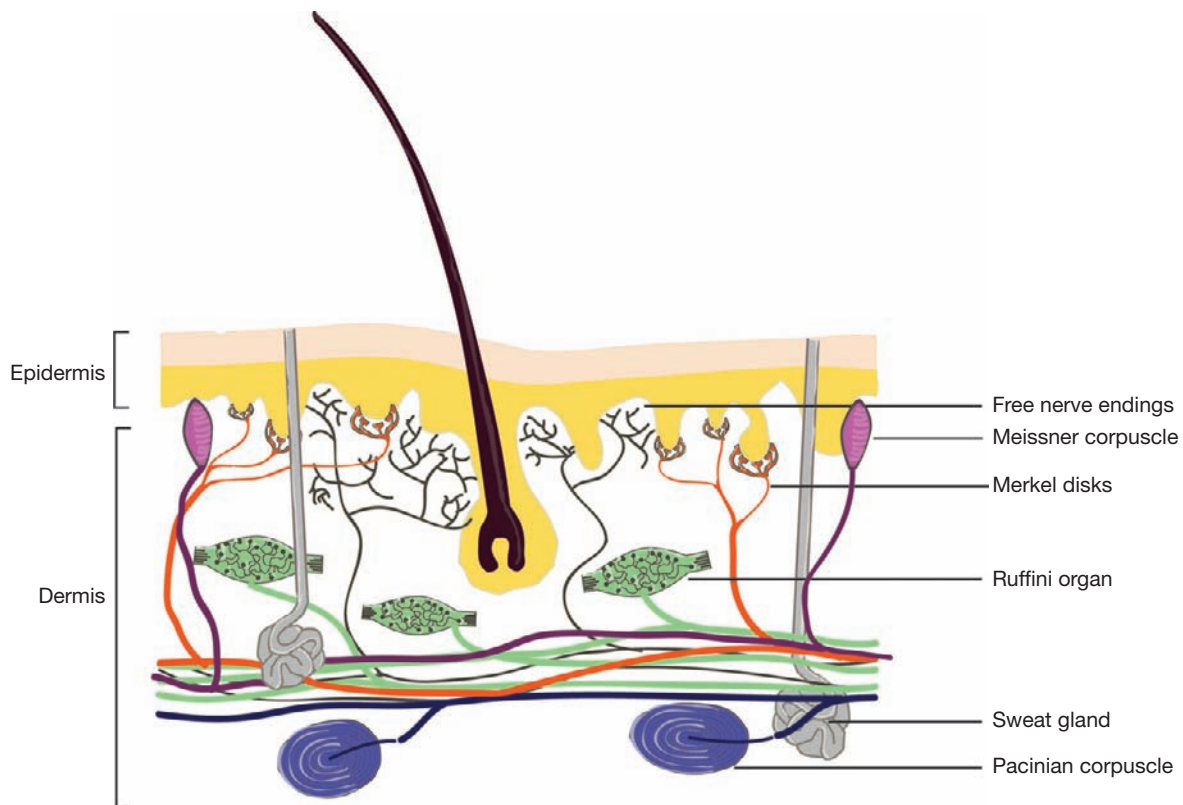


Figure 2 Cross section of hairy skin illustrating its innervations and principal structures.

Similarly, afferents that carry signals from Ruffini organs are called slowly adapting type 2 (SA2) fibers. In contrast, rapidly adapting (RA) fibers, which innervate Meissner corpuscles, produce a response only at the onset and offset of the pressure stimulus (and are thus said to adapt rapidly). Signals from Pacinian corpuscles are carried by PC fibers, which also exhibit RA properties.

Touch in the Brain

Signals from Merkel, Ruffini, Meissner, and Pacinian corpuscles – carried by SA1, SA2, RA, and PC fibers, respectively – ascend the spinal cord and terminate in neurons in the dorsal column nuclei, located in the brainstem. Neurons in the dorsal column nuclei in turn send signals to neurons in

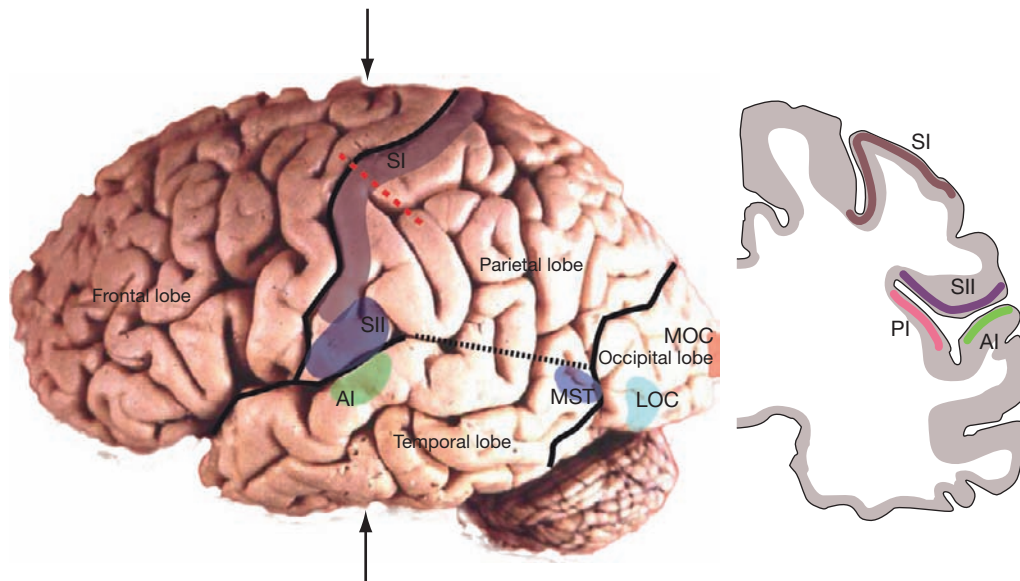


Figure 3 The human brain. Regions involved in somatosensory processing are highlighted, as are various landmarks. SI, primary somatosensory cortex; SII, secondary somatosensory cortex; PI, posterior insula; AI, primary auditory cortex; MOC, medial occipital cortex; MST, medial superior temporal; LOC, lateral occipital complex. Left panel: view of the brain from the left side; right panel: coronal slice of a cortical hemisphere, taken approximately at the location of the black arrows. The red dashed line denotes where the somatosensory cross section in **Figure 4** was taken from.

the ventral posterolateral nucleus of the thalamus, which then send projections to the primary somatosensory cortex. Tactile signals in the brainstem and in the thalamus essentially mirror those from afferent fibers, that is, there is very little transformation of the sensory information until it arrives at the primary somatosensory cortex. The primary somatosensory cortex is located just posterior (toward the back of the head) of the central sulcus, which separates the frontal and parietal lobes (see **Figure 3**).

The primary somatosensory cortex consists of three areas, demarcated according to the organization of the neurons they contain (cytoarchitecture) and the response properties of these neurons (**Figure 4**). According to the nomenclature established by the German neurologist Korbinian Brodmann, the primary somatosensory cortex comprises areas 3, 1, and 2, and area 3 can be further subdivided into two areas: area 3a, which contains neurons that respond primarily to joint movements, and area 3b, which contains neurons that respond primarily to stimulation of the skin. Like their counterparts in area 3b, neurons in area 1 also respond almost exclusively to skin stimulation, whereas neurons in area 2 respond to both stimulation of the skin and movement of the joints. Importantly, each area of the somatosensory cortex contains a full representation of the body, that is, the receptive fields of neurons in each area of the primary somatosensory cortex tile the entire body. Furthermore, the three areas of the somatosensory cortex are organized somatotopically, which means that adjacent neurons tend to have adjacent receptive fields on the body. The somatotopic organization of the somatosensory cortex is illustrated in the famous cortical homunculus (**Figure 5**), which shows the location of the receptive fields on the body surface of neurons as a function of their location on the cortical surface. As can be seen from the cortical homunculus, different amounts of brain volume are dedicated to different parts of

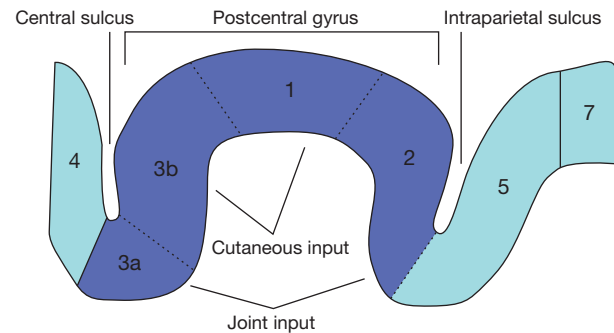


Figure 4 Primary somatosensory cortex (areas 3, 1, and 2) and adjacent cortical areas.

the body. For instance, the hand and lip representations span a wide swath of cortex, whereas the back and leg representation are relatively diminutive (**Figure 5**). The amount of cortex dedicated to a body region is related to how important the sensory information from that body region is. For instance, we use our hands to manipulate objects and to explore our environment. Sensory feedback from our hands is thus critical and this region is thus overrepresented in the brain (a phenomenon called 'cortical magnification'). Similarly, as we use our lips to speak, to eat, and to kiss, tactile sensations from these are also important. In contrast, we do not require fine sensory feedback from our back or from our forearm, as reflected in the smaller cortical volume dedicated to these regions.

The somatosensory cortex is organized hierarchically such that the first stage of processing of cutaneous information is area 3b, the second is area 1, and the third is area 2. This hierarchical structure is reflected in the fact that neurons in area 3b have small receptive fields (with diameters less than about 1 cm), whereas the receptive fields of neurons in areas



Figure 5 Cortical homunculus. This coronal view of the brain shows a cross section of the somatosensory cortex, along with the location of the associated neuronal receptive fields.

1 and 2 can span multiple digits. Also, neurons in the primary somatosensory cortex tend to be selective for certain aspects of the stimulus but not others. For instance, some neurons respond when a bar at a specific orientation is indented into the skin. Those neurons respond less or not at all when something other than a bar is indented into the skin or when the bar is not at their preferred orientation. The degree to which neurons selectively respond to specific stimulus features increases as one ascends the perceptual pathway from area 3b, through area 1, to area 2. Thus, neurons in area 3b will respond at least somewhat to just about any stimulus applied to their receptive field on the skin, whereas neurons in area 2 might respond only when a bar at a specific orientation is pressed into the skin. This hierarchical organization is characteristic of all sensory systems.

The next stage in the processing hierarchy is the secondary somatosensory cortex, located in the parietal operculum (Figure 3). Neurons in this brain area have very large receptive fields, sometimes covering the entire body, and more complex response properties than their counterparts in the primary somatosensory cortex.

Brain activity during tactile manipulation is not restricted to regions traditionally considered to be somatosensory, however. In the visual processing region of the brain, two distinct areas receive tactile input. The first is an area that has been implicated in the processing of visual motion (the medial superior temporal area). This area is activated not only when motion is presented visually but also when mechanical vibrations are applied to the skin of the hands or feet. When this region is temporarily inactivated, smooth hand movements are not possible, suggesting that this brain area may integrate tactile and visual information necessary for tasks such as tracking and grasping objects, playing video games, and writing.

The second visual area that is activated during tactile manipulation (the lateral occipital complex) seems to be involved in processing the geometrical shape of objects, whether these are explored visually or tactually. That is, similar activity

is observed whether the object is seen or felt and seems to be sensitive to the shape of the object. One possibility is that the activity observed in this area during tactile manipulation is due to mental imagery. In other words, when we manipulate an unseen object, we may form a mental image of the object. The alternative interpretation is that this area is involved in the processing of shape, regardless of modality. Ultimately, we can identify an object both visually and by exploring it tactually, and perhaps the lateral occipital complex is a brain area where visual and tactile information about objects converge.

In addition to cross talk between vision and touch, there is an intimate relationship between touch and audition. Indeed, certain brain areas that typically process auditory stimuli are activated when vibrations are delivered to the skin of the hand, specifically the belt areas of the auditory cortex, buried in the superior temporal sulcus (Figure 3). As will be discussed later, skin vibrations may play an important role in the perception of texture, and, while we rely more heavily on touch to acquire information about texture, acoustic signals produced when we rub our skin across a surface also convey a lot of information about its texture.

Tactile Acuity

As mentioned earlier, cutaneous information from certain body regions plays a greater role in our interactions with the environment than that from other regions. This disparity in the importance of sensory feedback across the body surface is reflected in the deformity of the so-called homunculus, which shows that the cortical volume dedicated to some areas (hands, lips) is much greater than that dedicated to others (back, legs). This increase in cortical volume is also associated with a greater spatial acuity in those magnified regions relative to the mini-fied regions.

In vision, spatial acuity is typically measured using a Snellen chart (eye chart). The patient's or subject's task is to read successive lines of increasingly small letters until he or she can no longer make out the letters. In effect, this tests the ability of the subject to discern small spatial details, those that distinguish one letter from another. Typically, visual acuity is constrained by the ability of the lens and cornea to focus light on the back of the eye (or the retina), and the purpose of the Snellen chart is to determine whether a given patient requires a correction on the optics of the eye.

While object (and thus spatial) perception is the principal purview of the visual system, we can also distinguish spatial form tactually. In fact, we can even distinguish embossed letters of the alphabet through tactile exploration. The ability of the somatosensory system to convey spatial information is best illustrated in the ability, after extensive training, to read Braille characters – letters optimized for touch rather than vision – rapidly and effortlessly. However, to measure tactile acuity, an eye chart, such as that used in vision, cannot be used because most people have little to no experience in identifying letters through touch. As mentioned earlier, subjects can be taught to discern letters by exploring them tactually, and their performance increases as the letters get bigger (such as is observed in vision), but letter identification is impractical as a test of tactile acuity because of the extensive training it requires.

For a long time, the standard test of tactile acuity was the two-point threshold. The task consists of indenting two fine probes on a subject's skin, using an instrument akin to a compass, and having the subject judge whether the two points are perceptually distinguishable. In other words, do they feel like a single poke or two spatially distinct pokes? If the two points are very close together, they feel like a single point; if they are far away, they feel like two distinct points. The two-point threshold is the shortest distance between the two indentations at which they feel distinct. The problem with the two-point threshold is that there is perceptual continuum between the two points feeling completely distinct and the two pokes perceptually merging into a single one. Because of the subjective nature of the judgments involved in the two-point threshold, it has been replaced with a more objective test of acuity, the grating orientation discrimination task. In this task, a grating is pressed in the skin of the finger at one of two orientations (perpendicular to one another) and the subject's task is to judge the orientation of the grating (Figure 6). When the grooves of the grating are wide enough, the task is trivial. As they get narrower, the task becomes more difficult because the ridges and grooves become increasingly indistinct. The grating orientation threshold is the narrowest groove width at which subjects can still distinguish the orientation of the grating.

Tactile spatial acuity has been shown to vary widely across the body surface, being most sensitive on the fingertips and lips, and least sensitive on the back. Two-point thresholds are around 1 mm on the fingertips and lips, and 4 cm or more on the calf, thigh, back, shoulder, and upper arm. Spatial acuity decreases rapidly even as one progresses from the fingertips (1 mm), to the palm (12 mm), and the forearm (35 mm). Such a progressive decrease in spatial acuity is also observed in



Figure 6 Johnson-Van Boven-Phillips domes. These gratings are used to measure tactile acuity. They vary in the width of their ridges and grooves. The subject's task is to determine the orientation of the groove. As the grooves get smaller, the task becomes increasingly difficult.

vision, if one measures acuity in different parts of the visual field. Indeed, peripheral vision is far less acute than vision at the center of our visual field. In both vision and touch, the acuity is ultimately limited by the density at which receptors innervate the sensory sheet (the retina or the skin). Indeed, at the fingertips, Merkel receptors, which mediate fine spatial form, are spaced on average 1 mm apart, so that the spatial resolution of the hand is approximately 1 mm. In the palm, Merkel receptors are about ten times sparser, which leads to a 10-fold decrement in acuity. Note that the increased density of receptors in the fingertips and lips would not lead to an increase in acuity if it were not accompanied by the increased cortical volume dedicated to those body regions. Indeed, many cortical neurons are required to interpret the signals from the large number of receptors innervating the skin of the fingertips and the lips.

Form Perception

When we reach into our pockets for loose change, we can distinguish it from other items such as keys, a cell phone, etc. This ability is mediated by information about object shape conveyed by cutaneous mechanoreceptors in the skin and their associated afferents. The afferents that primarily mediate this ability are SA1 afferents as these are highly sensitive to the spatial configuration of the stimulus and densely innervate the skin. At the fingertips, RA afferents innervate the skin even more densely than do their SA1 counterparts (the spacing between adjacent receptive fields is about 0.7 mm), but signals from multiple Meissner corpuscles converge onto individual RA afferent fibers, which serves to blur the spatial image these afferents convey. Information about the shape of an object is thus primarily represented in the spatial profile of the activity of SA1 afferents. The spatial profile of the activity of populations of SA1 fibers matches the spatial profile of the stimulus. In other words, if a grating is pressed into the skin, the spatial profile of SA1 afferent activity will consist of alternating bands of active and inactive fibers, reflecting the alternations of ridges and grooves of the grating. More complex spatial stimuli (such as keys) will evoke more complex spatial patterns of activation in SA1 afferent populations. Our ability to distinguish the shape of an object is mediated by the spatial patterning in SA1 afferent activity. Populations of neurons in the primary somatosensory cortex then interpret these spatially patterned signals emanating from these afferents (transmitted via the dorsal column nuclei and the thalamus) to infer the shape of the object that produced them.

In the primary visual cortex (the visual equivalent of the primary somatosensory cortex), the visual scene is first parsed as a set of oriented contours. In other words, neurons in the primary visual cortex are feature detectors that respond if a bar at a specific orientation is present in their receptive field. Similarly, a large proportion of neurons in the primary somatosensory cortex respond if a bar at a specific orientation is indented into their receptive fields but not otherwise. Our ability to perceive the orientation of objects grasped in our hand is mediated by this population of neurons. The tactile perception of orientation is important in tool use because it is critical to monitor the orientation of the tool relative to our hand.

When we write with a pen, for example, we do not have to visually monitor the orientation of the pen in our hand because signals from our skin provide constant feedback about its orientation.

In the visual system, information about objects, represented initially as sets of oriented contours, is elaborated into more complex representations. Some neurons higher up in the visual processing hierarchy, for example, respond to simple geometrical shapes that comprise multiple contours at different orientations. Some of these neurons respond to curved contours, whose orientation changes more or less gradually. Similarly, neurons higher up in the somatosensory processing hierarchy (in area 2 and in the secondary somatosensory cortex) also selectively respond to curved contours, with each neuron preferring a specific curvature and orientation. For instance, some neurons might respond when a U-shaped curvature is pressed against their receptive field, whereas other neurons may prefer a V-shape, oriented leftward ($<$). In both systems, then, neurons become increasingly complex feature detectors, responding to increasingly complex combinations of object features. Ultimately, visual and tactile representations of objects may converge onto a single area, possibly in the lateral occipital complex (see section 'Touch in the Brain'), which would serve to bind object representations emanating from the two senses.

Texture Perception

Texture refers to the perception of surface material and microgeometry. Though textural information can be obtained both visually and auditorily, touch yields much finer and more complex textural information than do the other sensory modalities. When we run our fingers across a surface, we may perceive the surface as being rough, like sandpaper, or smooth, like glass; the surface may also vary along other sensory continua, such as hardness (e.g., stone) versus softness (e.g., moist sponge), and stickiness (e.g., tape) versus slipperiness (e.g., wet soap). Also, whether a texture is thermally isolating (e.g., leather) or thermally conductive (like metal) contributes to the textural percept. Texture is represented at the somatosensory periphery in the spatiotemporal pattern of activity in populations of afferents innervating the skin. Different aspects of texture are encoded by different populations of afferents.

The tactile exploration of a surface has been shown to yield a multidimensional textural percept that includes sensations of roughness/smoothness, hardness/softness, stickiness/slipperiness, and warmth/coolness. The overall textural percept of a surface is strongly determined by three of these texture properties, namely roughness, hardness, and stickiness. Of all textural continua, the study of roughness has been the most extensive, whereas much is unknown about how information about hardness and stickiness is processed by the nervous system.

The subjective sense of roughness seems to vary along a single dimension and has been shown to vary predictably with surface properties. In psychophysical studies, the perceived roughness of sandpapers increases with particle size, the roughness of gratings increases with spatial period, and that of embossed dots increases monotonically with interdot spacings up to about 2–3 mm, then decreases with further increases. For gratings, however, the spatial period does not seem to be

the relevant stimulus property since changing the width of their grooves and changing the width of their ridges have opposite effects on perceived roughness. The main determinant of perceived roughness seems, at a first approximation, to be the extent to which the skin is deformed when in contact with the surface. However, surface roughness varies over a wide range, and many discriminable surfaces essentially do not deform the skin at all when we press our finger against them. To distinguish the microgeometry of these surfaces, we scan them with our fingers. In the absence of such movement, they feel almost completely smooth. Note that, for coarser surfaces, such as embossed dots or gratings, movement between skin and surface is not necessary to discern their surface properties. The basis for this dichotomy is that roughness perception relies on two distinct neural mechanisms.

For coarse textures, the perceived roughness is determined by the spatial pattern of activation in SA1 afferent fibers. Specifically, neurons in the primary somatosensory cortex compute the degree to which the activation of SA1 afferents varies across the skin. For a completely smooth surface, all SA1 afferents will be activated approximately equally, so there is no variation in the activity of these neurons. The roughness of a grating, embossed dot pattern, or coarse sandpaper can be predicted from the degree to which the activation produced in SA1 afferents varies across the sensory sheet.

For fine textures, movement between the skin and the surface is necessary to acquire a percept of roughness. Indeed, when we run our fingers across a finely textured surface, small vibrations are produced in the skin. These vibrations activate PC fibers, which, as mentioned earlier, are highly sensitive to skin vibrations. As surfaces get coarser, the strength of these vibrations increases and the strength of the response of PC fibers increases. The perceived roughness of fine textures, then, is determined by the degree to which the texture-elicited vibrations excite PC afferents. This Pacinian-mediated mechanism operates over a range of surface microgeometries. If the surface texture is coarse enough, the SA1-mediated mechanism dominates.

Information about roughness is encoded in the primary somatosensory cortex as evidenced by the fact that the responses of neurons in this brain area are sensitive to changes in surface properties that determine perceived roughness, namely, the spatial period of embossed dot patterns and the groove width of tactile gratings. Lesions in the primary somatosensory cortex, particularly in areas 3b and 1, lead to severe impairments in roughness discrimination. The second somatosensory cortex has also been implicated in the processing of surface roughness as it contains neurons that are sensitive to the relevant surface properties, and lesions in the secondary somatosensory cortex also cause impairments in roughness discrimination. Finally, the posterior insula and the medial occipital cortex are selectively activated when human subjects perform a roughness discrimination task, indicating that they too are involved in the cortical processing of roughness information.

Hardness/softness is the subjective continuum associated with the compliance of an object. Hardness ratings have been shown to be inversely proportional to softness ratings; these ratings are, in turn, related to surface compliance. Softness perception has been shown to rely primarily on cutaneous

cues: as an object is pressed against the hand, it conforms to the contour of the hand in proportion to the contact force. The compliance (and the softness) of the object may be signaled by the growth of the area over which the skin contacts the object as the contact force increases, as well as the increase in the force exerted by the object on the skin across the contact area. Softness perception likely relies on signals from SA1 fibers: First, PC fibers are too sparse and their receptive fields too large to play a significant role in softness perception. Second, the response of RA fibers to a surface indented into the skin is not modulated by the compliance of the surface whereas the response of SA1 fibers is. One possibility is that the average pressure exerted across the contact area is predictive of compliance and that this quantity is signaled by populations of SA1 afferents.

Stickiness/slipperiness is the sensory continuum associated with the friction between skin and surface. Indeed, magnitude estimates of stickiness have been shown to closely match the measured kinetic friction between skin and surface, that is, the ratio between the force exerted normal to the surface and that exerted parallel to the plane of the surface. Furthermore, when judging stickiness, subjects do not substantially vary the normal forces they apply on the surface, but the applied tangential forces tend to vary across surfaces, suggesting that tangential forces are critical in the perception of stickiness. The neural mechanisms that mediate stickiness perception are yet to be conclusively identified but SA2 fibers are likely to be involved, given their sensitivity to skin stretch.

Motion Perception

When an object brushes against our skin, we acquire information about its direction and speed of motion. Information about tactile motion is important in at least two respects. First, a hallmark of tactile exploration is that it involves movement between skin and object. A blind or blindfolded individual asked to recognize an object by touch will scan the object with both hands. Without this exploratory strategy, we would only gather information about part of the object, the part that contacts our fingers at any given time. Instead, we integrate information about the object over time as we explore it with our hands. Information about the motion of the skin relative to the object is necessary to reconstruct the relative positions of successively touched object features. Second, detecting when an object begins to slip from our grasp triggers adjustments in grip force, critical in object manipulation.

Motion between skin and object consistently evokes activity in RA and PC fibers. These two populations of afferent fibers, particularly the former, play an important role in slip (and thus motion) detection. While activation of these afferent populations often triggers a motion percept, our ability to perceive the direction in which an object moves is mediated primarily by SA1 afferents. Motion can be inferred from the spatiotemporal sequence in which these afferents are activated. A moving object will successively contact adjacent patches of skin, and thus successively activate small populations of SA1 fibers with adjacent receptive fields. Furthermore, many SA1 afferents respond anisotropically to skin movement, that is, they respond

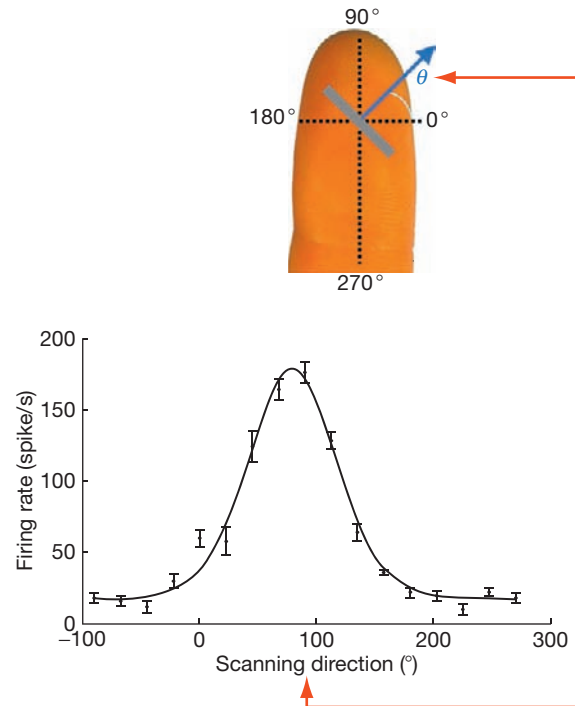


Figure 7 Responses of a neuron in area 1 to bars scanned across the finger in different directions. This neuron responds most strongly when a neuron is scanned up and to the right across the (right) index finger. As the direction of motion diverges from this preferred direction, the neuron's response decreases. This neuron was recorded from a Rhesus macaque, but the same principle is thought to apply to human somatosensory cortex.

more strongly when the skin is pushed in one direction than when it is pushed in another, thereby conveying information about the direction in which the object is moving across the skin. Thus, while motion detection is mediated by RA and PC afferents, information about motion direction is conveyed by SA1 afferents.

In the primary somatosensory cortex, many neurons respond selectively to stimuli moving in a particular direction (see Figure 7). These neurons thus convey information, not about the properties of the object that is contacting the skin, but rather about the motion of this object across the skin. Analogous neurons, selective for the direction of visual motion, are found in the primary visual cortex and in the middle temporal area, a visual area dedicated for motion processing.

The Role of Touch in Object Manipulation and Tool Use

Cutaneous cues play a critical role in the dexterous manipulation of objects. First, signals from mechanoreceptive afferent fibers innervating the glabrous skin of the hand convey information about the location of contact between the skin and the object and about the forces that are exerted on the skin when the object is grasped statically. As discussed earlier, mechanoreceptive afferents also signal when our grip on an object is slipping. Without these fibers, then, we would routinely

crush or drop grasped objects. Second, cutaneous afferents convey information about object properties that are useful for manipulation. For instance, information about the orientation of a writing utensil in the hand plays an important role in our ability to maintain the proper grasp on the utensil while writing. Information about the slipperiness of a surface helps to determine how much force will be needed to grasp it. Third, cutaneous signals play an important role in guiding the dexterous manipulation of objects in that they signal contact events. For instance, establishment of contact with an object signals the end of the reach phase and the beginning of the grasp phase. Although this information is sometimes (though not always) available visually, visual signals are slower, less reliable, and require greater concentration to guide movements.

Pleasant Touch

The importance of touch in emotional development was illustrated in a well-known series of experiments conducted by Harry Harlow, in which he showed that surrogate mothers made out of terrycloth (and thus tactually more similar to real mothers) were more attractive to infant monkeys than surrogates made from wire. The tactile experience provided by the two surrogates was the determinant of the infants' choice. The infants with the terrycloth surrogates developed relatively normally, while those with the wire surrogates did not. This controversial series of studies was interpreted as providing support for a critical role of contact comfort in development.

The importance of touch in social and emotional communication is illustrated in the ubiquity of tactile contact in interpersonal relationships, ranging from handshakes to kissing. Much less is known about the neural mechanisms of pleasant touch than about other aspects of tactile processing. However, some evidence suggests that activation of a subpopulation of receptors in the hairy skin (C-tactile receptors) may elicit pleasant sensations. Furthermore, pleasant touch is known to cause activity in an area of the brain (the left anterior insular cortex),

that receives information from C-tactile receptors and processes positive emotional feelings.

See also: Spatial Perception; Visual Motion Perception; Visual Perception.

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- http://en.wikipedia.org/wiki/Somatosensory_system – Wikipedia definition for Somatosensory system.
- http://www.scholarpedia.org/article/Texture_from_touch – Scholarpedia definition of Texture from touch.

Sentence Processing

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Glossary

Garden-path sentence A sentence that ends with an interpretation that differs from the interpretation that the reader or the listener initially expected.

Incremental processing The integration of incoming words into a linguistic structure immediately at the moment at which they are encountered.

Locality A theory of sentence processing in which integrating words that are far apart creates a higher processing cost than integrating words that are close together.

Prosody The acoustic–phonetic properties of speech that are independent of the sounds of the actual words being produced. This can include pitch, loudness, tempo, rhythm, and pausing.

Reanalysis The process of reanalyzing a sentence's meaning and structure when the reader or the listener's initial interpretation turns out to be incorrect.

Sentence processing The cognitive process of understanding the structure and meaning of a sentence.

Surprisal A theory of sentence processing that predicts a higher processing cost when the predictability of a word or a syntactic structure is low.

Syntactic processing (or parsing) The process of analyzing the relationship between words and phrases in a sentence to recover a sentence's syntactic structure.

Syntax A level of linguistic structure that specifies how words are combined with other words or phrases to create a well-formed sentence.

We produce or encounter a tremendous number of sentences throughout our life. The productive nature of human language means that an infinite number of sentences are possible, yet we have little difficulty understanding these sentences, even when they are completely novel. We understand what a speaker or a writer intends to convey quickly and reliably even though everyday language is riddled with ambiguity and has the potential for confusion. Even though this process may seem effortless, a wide array of psychological processes are deployed to make sentence processing possible. In this article, we discuss how people comprehend sentences, what kinds of processes are involved, what kinds of information sources are used, and what factors lead to processing difficulty.

Sentence Structure

Sentences consist of a sequence of words. Native speakers of a language share intuitions about how words should be ordered to construct a well-formed sentence. Consider (1).

- (1) a. The boy saw the girl.
b. The girl saw the boy.
c. *The boy the girl saw.

The basic or canonical word order in English is subject (S), followed by a verb (V), followed by the direct object (O). Although there are many variations of this basic word order that might include things like indirect objects, prepositional phrases, adjectives, and many other grammatical categories, SVO is the basic word order in English. English speakers agree that (1a) and (1b) are grammatical, and (1c) is ungrammatical (as indicated by an asterisk). The linear order of words in English is important not just because it determines the grammaticality of a sentence but also because it contributes to the meaning of a sentence. Sentences (1a) and (1b) consist

of the same words and both sentences are grammatical. However, these sentences convey different meanings about who did what to whom because their words are arranged in different orders. In (1a), the boy is doing the seeing, while in (1b), it is the girl who is doing the seeing.

Sentences are also not just a sequence of linearly ordered words. The elements in a sentence are hierarchically organized: Words are organized into larger units such as phrases and clauses, which serve as subunits of a sentence. A phrase structure tree in [Figure 1](#) illustrates the structure of sentence (1a) graphically.

The node 'S' at the top of the tree diagram stands for 'sentence.' The nodes at the bottom indicate the parts of speech of the words (Det: determiner, N: noun, V: verb). The other nodes represent phrasal categories, subunits that are smaller than a sentence but larger than words (NP: noun phrase, VP: verb phrase).

This linear and hierarchical relationship between words in a sentence is called a language's syntactic structure. Sentence comprehension requires a process called syntactic parsing or processing, a process by which readers or listeners recover the grammatical structure of the sentence with the goal of recovering the sentence's meaning. Syntactic parsing involves identifying the linguistic categories of each word and recognizing how these words and phrases are linearly and hierarchically organized relative to one another. For example, in (1a), our knowledge of syntax allows us to identify 'the' as a determiner and 'boy' as a noun and to build a NP by combining them. The syntactic parser also identifies 'saw' as a verb and combines it with the following NP 'the girl' to form a VP.

Psychologists and linguists are generally interested in understanding the cognitive mechanisms that underlie syntactic parsing. One way to study parsing has been to investigate how the parsing system handles syntactic ambiguity, that is, instances in which the parser must decide among more than

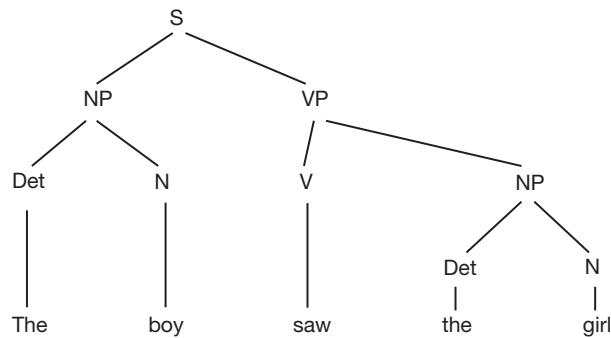


Figure 1 Tree diagram for the sentence 'The boy saw the girl.'

one potential syntactic structure for a given sentence. The types of decisions made by the parser under these circumstances can reveal how the mechanisms of sentence processing operate more generally.

Structural Ambiguity

Language is riddled with ambiguity, that is, instances in which there is more than one interpretation of a sentence, phrase, or word. A type of ambiguity that is of particular interest to psycholinguists who study sentence processing is syntactic, or structural, ambiguity. In this type of ambiguity, there is more than one potential syntactic structure for a given string of words. Consider (2).

- (2) The boy saw the girl with the binoculars.

Sentence (2) can be interpreted in more than one way. One possible interpretation is that the boy used binoculars to see the girl. The other possible interpretation is that the boy saw the girl who was holding binoculars. The ambiguity arises because more than one syntactic structure can be associated with this sentence, which is illustrated in [Figure 2](#).

The structures illustrated in [Figure 2\(a\)](#) and [2\(b\)](#) differ in how the prepositional phrase 'with the binoculars' is structured with other words and phrases in the sentence. In [Figure 2\(a\)](#), the prepositional phrase directly attaches to the VP node, which leads to a reading in which the prepositional phrase is interpreted as an instrument of the action denoted by the verb (i.e., The boy used binoculars to see the girl). In contrast, in [Figure 2\(b\)](#), the prepositional phrase is structured as part of the NP, which leads to an interpretation in which the prepositional phrase modifies the preceding noun 'girl' (i.e., The boy saw the girl who was holding binoculars).

Ambiguous sentences can be either globally or temporarily ambiguous depending on whether the ambiguity is resolved later in the sentence or not. Sentences like (2), which contain an ambiguity that is never resolved, are called globally ambiguous. In contrast, sentences like (3) are temporarily ambiguous. In these sentences, an ambiguity arises during the processing of the sentence, but later information eventually rules out one of the interpretations.

- (3) The boy saw the brothers of the girl who was holding the binoculars.

The modifying clause (i.e., the relative clause) 'who was holding the binoculars' is ambiguous because it can potentially modify either of the preceding nouns. This ambiguity arises when the onset of the relative clause is encountered (at 'who'), but it is resolved upon encountering the auxiliary verb 'was.' This is because 'was' is singular and must agree with a singular noun. Because 'girl' is singular and 'brothers' is not, the relative clause must be associated with 'girl.' Another example of a temporarily ambiguous sentence is shown in (4a).

- (4) a. The horse raced past the barn fell.
 b. The horse raced past the barn.
 c. The horse that was raced past the barn fell.

In sentence (4a), the tense of the verb 'raced' is ambiguous. It is either a past tense verb as in (4b) or a past participle as in (4c). How this ambiguity is resolved has consequences for which grammatical interpretation is chosen. If the verb has a past tense, then it must be the main verb of the sentence. If it is a past participle, it is a verb of a relative clause that modifies the subject of the sentence. The ambiguity arises because in English, the full relative clause 'that was raced past the barn' in (4c) can be reduced to 'raced past the barn' by deleting the relative pronoun and the following auxiliary verb (i.e., 'that was') as in (4a). When this verb is encountered, the processor immediately determines whether it is a past tense verb or a past participle without waiting until all the words in the sentence become available. Individuals tend to preferentially interpret the verb as a past tense verb, processing 'the horse raced past the barn' as a main clause. When the verb 'fell' is encountered at the end of the sentence, however, the reader either judges the sentence to be ungrammatical because there is an extra verb or the reader reanalyzes the sentence after realizing that 'raced' cannot be a main verb. Studies that have measured the amount of time taken to read each word in a sentence observe a noticeable slowdown at the point of 'fell' in (4a). The slowdown is taken to be an indicator of the difficulty that the processing system undergoes in recovering from incorrectly analyzing 'raced' as a main verb when it turns out to be a past participle. The main verb 'fell' would be read more quickly if it was preceded by a full relative clause in which a temporary ambiguity does not arise as in (4c). Sentences that end with an interpretation that differs from the interpretation that the reader initially expected are called garden-path sentences. The garden-path effect comes about when the processor encounters a temporarily ambiguous sentence that is eventually disambiguated toward a less preferred interpretation (such as the reduced relative clause interpretation in (4a)).

Incremental Processing

What does the garden-path effect discussed earlier reveal about the human sentence processor? It suggests that sentence comprehension is highly incremental. The human processor does not wait until the entire sentence becomes available to start building syntactic structure. As sentences are heard or read, the processor incorporates each incoming word into the syntactic structure being currently constructed. Expectations about what is coming next are continuously updated as is the syntactic representation.

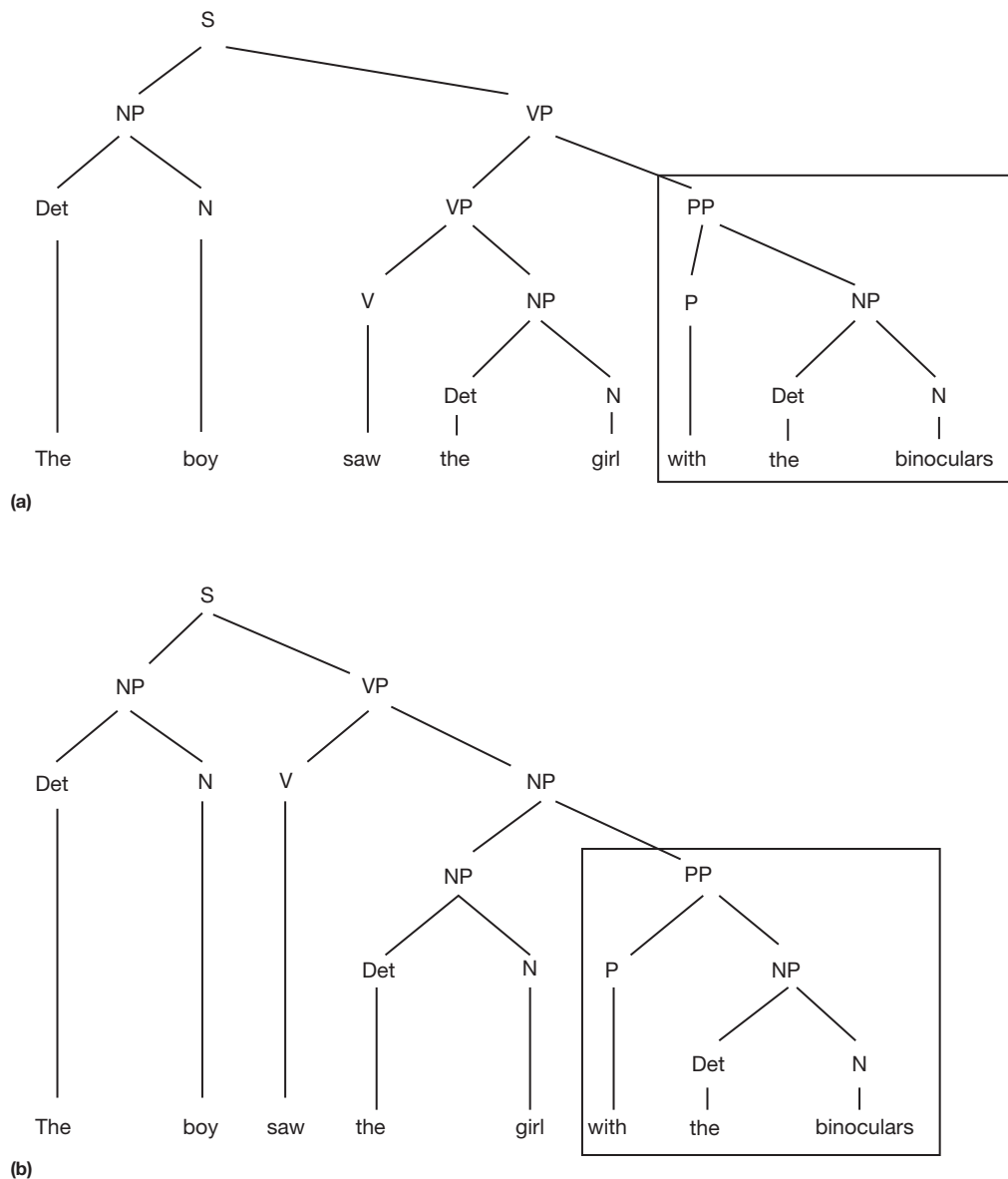


Figure 2 Tree diagrams for (a) an interpretation in which the boy used binoculars to see the girl and (b) an interpretation in which the boy saw the girl who was holding binoculars.

In an unambiguous sentence like (1a), there is only one way to integrate each incoming word into the syntactic representation. However, in globally or temporarily ambiguous sentences like (2) and (4a), it is not always clear how to incorporate new words into the structure being built. For example, the processor is required to determine whether to attach the prepositional phrase to the NP or to the VP in (2), or whether to identify the verb 'raced' as a main verb or as part of a reduced relative clause in (4a).

One solution would be to wait until the end of the sentence to compute a syntactic structure. If we postpone determining which interpretation to take until the end of the sentence, a penalty need not be paid for guessing incorrectly. However, this strategy would require holding all the words in the sentence in memory until the end of the sentence, increasing the burden on memory systems. An incremental

parser reduces memory load but at the expense of potentially being garden-pathed.

How does the processor determine which structure to commit to when there is ambiguity? Comprehension of sentences is not just based on syntactic knowledge. The human sentence processor relies on various sources of information to recover the message intended by the speaker or the writer. First, sentence comprehension requires access to semantic information that encodes how meaning is mapped onto syntactic structure. Second, written or spoken communication is typically composed of a set of connected sentences in a conversation or discourse, and thus, the processor also uses context to make parsing decisions. The sentence processor also uses frequency information, which can include the probability of a given structure or a word, to make syntactic decisions. Prosodic information, which includes the rhythm,

tune, and grouping of words in an utterance, also contributes to the meaning of a sentence.

There is a general agreement among researchers that humans use multiple information sources to determine linguistic structure when they comprehend a sentence. However, there is controversy surrounding when each of these information sources is used: whether all relevant information sources are used at one time or whether syntactic information takes precedence over other information sources. In the next two sections, we outline two major models of sentence processing that provide differing views regarding this question.

Models of Sentence Processing

Garden-Path Model

The garden-path model assumes that only syntactic information is used to construct an initial interpretation. Other non-syntactic knowledge sources such as semantics, discourse contexts, and frequency are used only if a problem occurs at the initial syntactic stage. If the initial analysis is deemed to be implausible or ungrammatical, a structural reanalysis occurs.

The garden-path account posits that two universal syntactic principles guide initial parsing by directing the processor toward a syntactic analysis that creates the simplest possible structure. One of those principles is minimal attachment. Under minimal attachment, the processing system prefers a structure that contains as few nodes as possible in

incorporating a new item into the existing structure. This is motivated by a desire by the processing system to reduce memory load. Consider Figure 3 to see how the minimal attachment principle accounts for a preference for the main clause analysis in sentence (4a).

As illustrated in Figure 3, the main clause analysis (Figure 3(a)) is simpler than the relative clause analysis (Figure 3(b)) in integrating the verb into the existing structure. While the main verb analysis requires no intervening node between the VP node and the S node, the reduced relative clause analysis requires postulating two additional nodes, NP and S. This leads the processor to initially adopt the structurally simpler main clause analysis over the reduced relative clause analysis.

Another strategy proposed under the garden-path model is *late closure*. The late closure principle refers to a general preference for listeners to attach new inputs to the phrase that is currently being constructed over other potential locations. Consider the following example:

- (5) The boy saw the brother of the girl who was holding the binoculars.

Sentence (5) is ambiguous because the relative clause 'who was holding the binoculars' can attach to more than one NP. It can attach either to the NP 'the brother of the girl' as in Figure 4(a) or to the NP 'the girl' as in Figure 4(b). According to minimal attachment, these two structures are equally preferred because the relative clause directly attaches to the NP in both cases, and there are no differences between

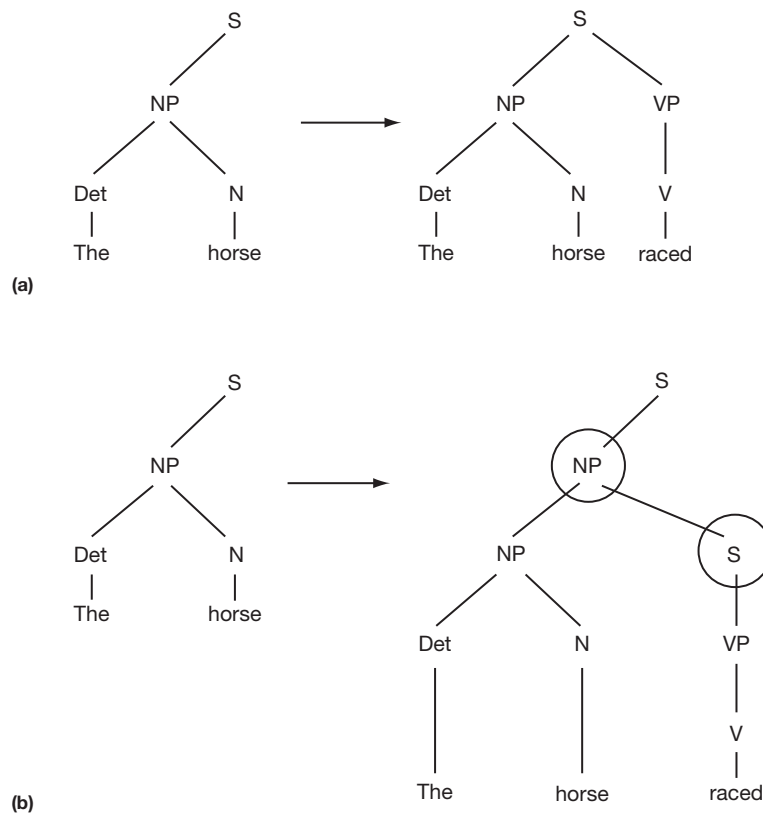


Figure 3 Tree diagrams for (a) an analysis in which 'raced' is a main verb and (b) an analysis in which 'raced' is part of a reduced relative clause.

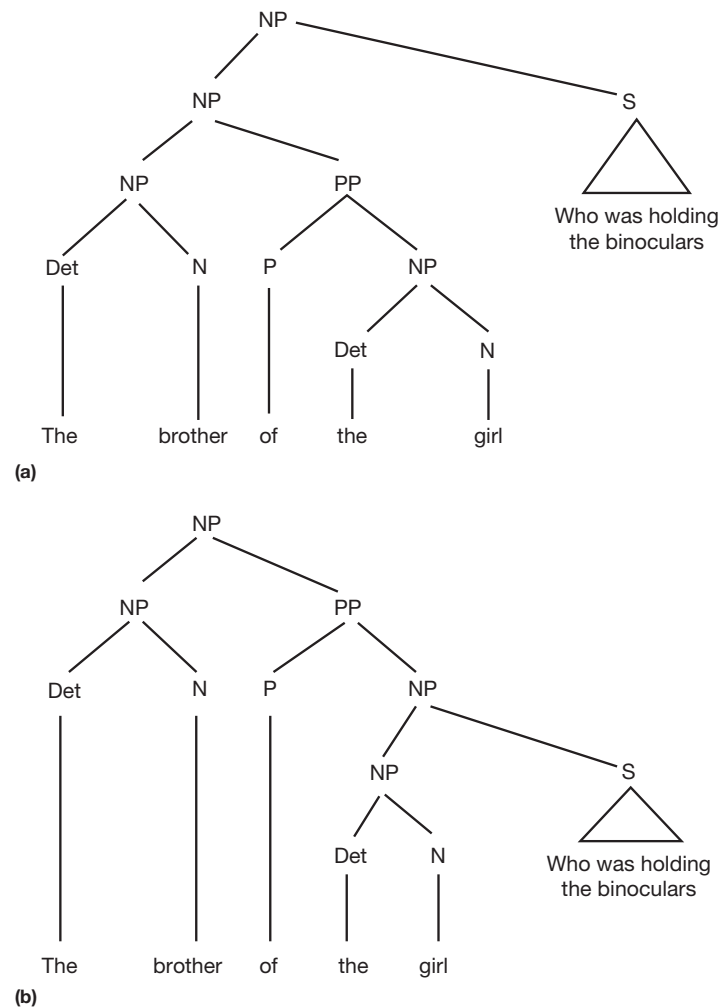


Figure 4 Tree diagrams for (a) an interpretation in which the relative clause is associated with the phrase 'the brother of the girl' and (b) an interpretation in which the relative clause is associated with the phrase 'the girl.'

the structures in terms of the number of nodes. Thus, attachment falls under the late closure principle and there is a preference to attach the relative clause to the NP 'the girl' because it is the most recently constructed phrase.

Under the garden-path model, when minimal attachment or late closure yields a sentence that is ungrammatical or semantically anomalous, the parser must go back and reevaluate the structure it has chosen. This process is called reanalysis. While in sentence (5), there is no conflict between the initially committed analysis and the interpretation forced by the auxiliary verb 'was' in the relative clause, in sentence (4a), the initially preferred main clause analysis is not consistent with a correct analysis of the sentence. During the process of reanalysis, other sources of information like semantics, plausibility, frequency, context, and prosody can influence the corrected interpretation.

Constraint-Based Models

The other dominant class of sentence processing models is constraint-based models. According to these theories, multiple

sources of information guide initial processing in parallel. Nonsyntactic information sources such as semantics, referential context, frequency, and prosody are used with syntactic information to resolve ambiguity in the very earliest stages of parsing. Unlike the garden-path model, which assumes a serial processing mechanism by which only a single analysis is activated at a time, the constraint-based account assumes that processing occurs in parallel with all possible syntactic analyses activated simultaneously.

In constraint-based models, all possible syntactic analyses are ranked in terms of activation level. Initial processing is guided by the syntactic analysis that is most highly activated by virtue of receiving the greatest support from relevant sources of information. The relative ranking of possible syntactic analyses is continuously reordered depending on the most current information. Processing difficulty arises when more than one syntactic analysis is activated to a similar degree, resulting in competition, or when the most activated analysis is not the analysis that must eventually be chosen.

In the following sections, we discuss how various nonsyntactic sources of information influence initial parsing decisions.

Animacy

Lexical semantics concerns how words in a sentence are related to an event denoted by the verb. These relationships can affect sentence processing decisions. For example, animate nouns, like animals or people, are more likely to serve as the 'doers' of the action denoted by the verb. These nouns are called agents. Inanimate nouns are more likely to be the 'undergoers' of the action denoted by the verb. These are called patients. Consider (6).

- (6) a. The researcher examined...
b. The data examined...

Like the verb 'raced' in (4a), 'examined' can be a past tense verb or a past participle. The verb serves as a main verb if it continues with a patient (e.g., *the question*), that is, the entity that is being examined by the researcher or the data. If the sentence continues with a 'by-phrase' that includes an agent (e.g., *by the lawyer*), that is, the entity that examines the researcher or the data, the verb is a past participle that is part of a reduced relative clause (e.g., *The data that was examined by the lawyer was important*).

According to the garden-path model, the main verb analysis is preferred in both (6a) and (6b) because of minimal attachment's requirement that the parser choose the simplest structure. Even though 'data' is unlikely to examine something, the parser under the garden-path theory is blind to animacy information until ungrammaticality is detected later downstream in the sentence.

Empirical studies have shown that the animacy of the main subject NP can influence processing. When reduced relative clause sentences are followed by a disambiguating by-phrase like 'by the lawyer', readers experience less difficulty in processing this phrase in (6b) than in (6a), suggesting that initial processing is guided by subject NP animacy information. An animate subject is more likely to be initially recognized as the agent of the main verb, while an inanimate noun is more likely to be identified as the patient of the verb, that is, the thing to be examined. Thus, when the sentence is disambiguated toward a reduced relative clause analysis, the processor encounters greater difficulty at the disambiguating by-phrase when the subject noun is animate than when it is inanimate.

Plausibility

Plausibility information that reflects real-world knowledge may also guide initial parsing decisions. Consider (7).

- (7) a. The doctor examined...
b. The patient examined...

In (7a) and (7b), both 'doctor' and 'patient' are animate nouns, but they differ in the plausibility of their being the agent of the verb 'examined'. For the verb 'examined', the 'doctor' is more plausible as an agent, that is, the person examining someone, while the 'patient' is more plausible as the person who plays a patient role, that is, the person being examined. Studies have shown that readers use plausibility information in sentence processing and preferentially interpret the verb as a past tense verb in (7a) and as a past participle in (7b).

Lexical frequency

Example sentences (6) and (7) show that animacy and plausibility information associated with the NP is rapidly used by the

processor to resolve ambiguity. Another factor that influences ambiguity resolution is the frequency with which a verb co-occurs with different types of syntactic constituents. Information about how often verbs are used in particular sentence structures may influence initial parsing decisions. Consider the following examples:

- (8) a. The journalist confirmed the rumor...
b. The journalist believed the rumor...

The sentences in (8) are temporarily ambiguous because the NP 'the rumor' can be the direct object of the verb (e.g., *The journalist confirmed the rumor about his death*) or the subject of an embedded clause (also called a sentential complement) as in (9).

- (9) a. The journalist confirmed the rumor was true.
b. The journalist believed the rumor was true.

The frequency with which a verb has occurred with a direct object or a sentential complement in the language can lead the processor to develop expectations about what will follow the verb. The verb 'confirm' occurs more often with a direct object, while the verb 'believe' is more likely to occur with an embedded complement clause. Thus, the processing system is more likely to assume that the NP following the verb is a direct object in (8a) and a subject of the complement clause in (8b). Experimental studies have shown that readers tend to spend more time reading at the disambiguating auxiliary verb 'was' in (9a) than in (9b), suggesting that the frequency bias of the verb leads readers toward the direct object interpretation in (8a).

Referential context

The interpretation of an ambiguous sentence may also be influenced by the context in which it occurs. Suppose that the sentence 'The boy saw the girl with the binoculars' that we discussed earlier could be preceded by two different context sentences as shown subsequently.

- (10) a. There was a boy and a girl in the park. The boy saw the girl with the binoculars.
b. There was a boy and two girls in the park. The boy saw the girl with the binoculars.

The sentence 'The boy saw the girl with the binoculars' is ambiguous because the prepositional phrase can be a modifier of the preceding noun or an instrument of the verb. According to Minimal Attachment, the instrument interpretation is preferred over the modifier interpretation. However, the modifier interpretation is often necessary to point out which referent (i.e., the entity being referred to) is being mentioned when more than one potential referent of the noun has been established in the discourse. In (10a), the discourse establishes only one girl. In (10b), two girls have been mentioned. While in (10a), it is obvious which girl the boy was looking at (as there is only one), in (10b), the reader expects the writer to indicate which one.

Studies have found that in sentences like (10b), a reader is more likely to interpret the prepositional phrase as a modifier. The prepositional phrase indicates which girl is being referred to so that the reader knows that it is the girl who was holding binoculars and not, for example, the girl who was holding a telescope.

These effects have also been found in visually presented referential contexts and this information seems to be used very rapidly. Researchers have used the visual world eye-tracking paradigm to examine how referential contexts influence the online processing of ambiguous sentences. In this paradigm, listeners hear auditory instructions that include ambiguous sentences like (11). Researchers monitor the listener's eye movements to real objects in a visual display using an eye-monitoring system. Listener's fixations provide researchers with hints about how the listener is interpreting the sentence as they hear it.

(11) Put the apple on the towel in the box.

Sentence (11) is temporarily ambiguous because the prepositional phrase 'on the towel' can be interpreted either as a goal of the event denoted by the verb 'put' (i.e., where the apple is to be put) or as a modifier of the preceding noun. It is only clear that the prepositional phrase 'on the towel' has to be a modifier once the second prepositional phrase 'in the box' is encountered. Because the verb 'put' requires a patient and a goal, listeners tend to initially interpret 'on the towel' as a goal, increasing fixations to the incorrect location in the referential context, that is, an empty towel. When the display contains two apples (e.g., one apple on a towel and the other apple on a napkin) and thus, requires a modifier for listeners to know which apple is being referred to, listeners are more likely to interpret 'on the towel' as a modifier, reducing fixations to the incorrect goal. This early effect of the referential context on ambiguity resolution suggests that the referential context is rapidly integrated with unfolding linguistic information, guiding initial processing.

Prosody

Prosody refers to a variety of phenomena that encode the acoustic-phonetic properties of spoken sentences. It includes pitch, loudness, tempo, rhythm, and pausing. In spoken communication, these factors can affect how a sentence is interpreted. One aspect of prosody that has been observed to influence initial syntactic processing is pausing. These rhythmic pauses are called 'prosodic boundaries.' Prosodic boundaries roughly correspond to a comma in written sentences. When there is a prosodic boundary, the word preceding it tends to be lengthened and followed by a pause (though not always). Prosodic boundaries also tend to co-occur with either a drop or rise in pitch.

Prosodic boundaries can guide the analysis of ambiguous sentences like (12) by signaling the location of major syntactic boundaries.

- (12) a. The journalist confirmed // the rumor was true.
b. The journalist confirmed the rumor was true.

As discussed earlier, a direct object-bias verb 'confirm' tends to lead the processor to be garden-pathed at the disambiguating verb 'was.' When there is a prosodic boundary (which is marked by the double slash marks) after the verb as in (12), listeners are less likely to be misled toward a direct object interpretation because the boundary signals that there is a clause boundary.

Researchers have also demonstrated that prosodic boundaries may guide initial processing using paradigms like the

cross-modal naming paradigm. In this task, listeners hear sentence fragments like 'The journalist confirmed the rumor' and are visually presented with a disambiguating word like 'was' that continues the sentence. The time taken to name the visual probe is used as an index of how the listener initially thought the sentence fragment would continue. In (12), naming times are shorter when there is a prosodic boundary after the verb than when there is not. Many studies have found that prosodic boundaries are used in the earliest stages of parsing.

Garden-Path versus Constraint-Based Model

Under both the garden-path and constraint-based models, nonsyntactic sources of information influence syntactic processing. However, these theories differ with respect to when these sources of information are thought to come into play. Experimental evidence from the psycholinguistic literature has shown very early effects of these nonsyntactic sources of information during syntactic processing, suggesting that the processing system is interactive. Proponents of the garden-path model, however, interpret these early effects as reflecting the process of reanalysis, arguing that they do not necessarily rule out the garden-path model. For the garden-path model to account for these data, reanalysis must occur very rapidly, and thus the outstanding differences between the garden-path and constraint-based models are now fairly minimal. Thus, consistent with both models, we can conclude that a wide array of information sources are used very rapidly to determine the most likely structure of a sentence.

Incomplete Processing

The processing system constructs syntactic and semantic representations to reach the meaning of the sentence intended by the speaker or the writer. Both the garden-path and constraint-based models predict that the processing system eventually reaches a single correct interpretation even if reanalysis or re-ranking is necessary. However, some recent evidence suggests that the processing system sometimes constructs an incomplete representation of a sentence's meaning by failing to eliminate initial misinterpretations from memory. This phenomenon is claimed to be an example of good-enough processing, the idea being that the processing system computes a representation that is good enough. Consider (13).

- (13) While the mother washed the baby cried.

When sentence (13) is presented without a comma after the verb 'washed,' readers are frequently garden-pathed toward an interpretation in which the mother washed the baby. Once the verb 'cried' is encountered, it becomes clear that the mother washed herself and that 'the baby' is the subject of the upcoming clause, not the direct object of the verb 'washed.' While the processing system eventually comes to the correct reading, it sometimes fails to completely rule out the incorrect interpretation. As a consequence of good-enough processing, the incorrect interpretation 'the mother washed the baby' remains activated in memory, possibly affecting the representation of the sentence's meaning.

Sentence Complexity

In temporarily or globally ambiguous sentences, processing difficulty arises when the processor is led to recover from an initial incorrect analysis. However, even unambiguous sentences can lead to processing difficulty. Consider (14).

- (14) a. The lady who helped the florist took care of the child.
b. The lady who the florist helped took care of the child.

In (14a) and (14b), the relative pronoun 'who' refers to the same entity as the 'lady.' We call relative clauses like the one in (14a) subject-extracted relative clauses because 'who' is a pronoun that refers to the subject of the relative clause (i.e., 'who helped the florist'). We call relative clauses like the one in (14b) object-extracted relative clauses because 'who' refers to the object of the relative clause (i.e., 'who the florist helped'). To process the relative pronoun 'who,' the pronoun must be linked with the empty subject or empty object position in the relative clause. In English, object-extracted relative clauses have been found to be more difficult to process than subject-relative clauses.

Why are object relative clauses more difficult than subject relative clauses? One theory is that the distance between two related words affects processing difficulty, an idea that has been formalized in the dependency locality theory (DLT). Central to the DLT is the notion of integration cost. These costs reflect the amount of memory resources that are required to integrate incoming elements into the existing structure. Integration costs increase as the number of intervening new referents increases between two elements in a dependency relationship. For example, while in (14a), the subject position in the relative clause (i.e., where the subject is typically located) is locally integrated with the relative pronoun 'who' with no intervening new referents, in (14b), integration between the typical object position in the relative clause (i.e., after the verb) and the relative pronoun 'who' occurs over two new discourse referents, 'florist' and 'helped'. According to the DLT, object-relative clauses are more difficult because they involve more long-distance integrations than subject-relative clauses.

The DLT also accounts for parsing decisions in ambiguous sentences. Under this theory, listeners prefer to choose syntactic structures with the shortest dependencies between words. Consider (15).

- (15) The lady said that the florist helped the child yesterday.

In (15), the adverb 'yesterday' can be associated either with the verb 'said' in the main clause, resulting in an interpretation in which the lady spoke yesterday, or with the verb 'helped' in the subordinate clause, resulting in an interpretation in which the florist helped the child yesterday. English speakers prefer attaching 'yesterday' to 'helped' rather than 'said.' This parsing preference is consistent with the prediction of the DLT. Attaching 'yesterday' to the main verb 'said' is less preferred because it is farther away, requiring a longer integration distance.

While the DLT attributes sentence complexity to integration costs and memory, other theories attribute sentence complexity to predictability, and these are called surprisal theories. Surprisal is estimated from the negative log probability of a word or a syntactic structure in a sentence where the

probability is estimated by various information sources such as syntax and semantics. The lower the predictability of a word or structure given its semantic and syntactic context, the more difficult it will be to process. According to surprisal, (14b) is more difficult than (14a) because object-extracted relative clauses are less common and thus less probable than subject-extracted relative clauses.

Under surprisal, the processing system incrementally updates its expectations about upcoming words as each new word is encountered. Consider (16).

- (16) a. The lady who helped the florist took care of the child.
b. The lady who helped the florist in the park took care of the child.
c. The lady who helped the florist in the park yesterday took care of the child.

In (16b) and (16c), a reader encounters additional information (i.e., 'in the park' in (16b) and 'in the park yesterday' in (16c)) before he or she reaches the main verb 'took', compared to (16a). Surprisal predicts that as listeners encounter words in the relative clause, their expectation of encountering the main verb should increase. The longer the relative clause is, the higher is the probability of the main verb when the main verb is finally encountered. Thus, in (16c), expectation for the main verb at the end of the relative clause is higher than in (16a) and (16b) because expectations for the main verb are higher after a long relative clause. Consequently, processing the main verb in (16c) should be easier.

Thus, surprisal and the DLT make differing predictions for sentences like (16). The evidence is somewhat mixed. Some studies have found that long-distance dependencies, which require the integration of the elements that are structurally distant, are hard to process, which is consistent with DLT. Other studies, however, have found that for certain structures, longer distances facilitate processing, which is consistent with surprisal.

It is not clear how integration costs and surprisal should be theoretically integrated to explain these data. More experimental research is required to understand the conditions under which these two sources of processing difficulty play a role.

Summary

Sentence processing is highly incremental. The processing system incorporates each incoming input immediately into the syntactic structure being currently constructed. As the sentence is heard or read, the processing system integrates various sources of linguistic and nonlinguistic sources of information, including syntactic and semantic knowledge, lexical frequency, referential context, and prosody, to choose an appropriate analysis. In addition, factors like ambiguity, long-distance relationships, and predictability play a role in how a sentence is processed and understood.

See also: Aphasia; Bilingualism and Multilingualism; Dyslexia; Gestures; Inner Speech; Language Development; Nonverbal

Communication; Phonetics; Psychology of Reading; Reading and Phonological Processing; Sign Languages; Syntax; Word Retrieval.

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Separation Anxiety

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Glossary

Anxiety A state of apprehension, uncertainty or fear resulting from the anticipation of a real or imagined event or situation, often impairing physical and psychological functioning. Anxiety is characterized by cognitive, somatic, emotional, and behavioral components.

Anxiety disorder A dysfunctional behavior pattern that interferes with adjustment and is marked by distressing, persistent anxiety or maladaptive behaviors intended to reduce anxiety.

Cognitive-behavioral therapy A treatment approach that focuses on monitoring and altering cognitive activity and exposing the individual to the feared situations to affect desired behavior change.

Externalizing behavior problems Behavior patterns directed outwardly toward the social environment,

characterized by undercontrolled responding. Examples include aggression, disruption, defiance, and impulsivity.

Fear A feeling of agitation or dread caused by the presence or imminence of real or imagined danger.

Internalizing behavior problems Behaviors that are directed inwardly toward the self, as seen in an overcontrolled pattern of responding. Examples include social withdrawal, depression, and anxiety.

Multimethod multiinformant assessment An assessment strategy that uses diagnostic information gathered by varied procedures, such as interviews, questionnaires, and observations, from multiple sources of information, including the child, caregivers, teachers, peers, and other important figures.

Introduction

Johnny, a 9-year-old boy described by his mother as her 'shadow,' follows close behind her wherever they go. He reports getting very scared when even thinking about being apart from her and does whatever he can to try to be near her. Getting Johnny to go to school each day is a challenging endeavor, one usually accompanied by pleas to stay home, complaints of stomachaches, as well as temper tantrums that often follow an extended period away from school. He has missed over half of the school days in the last month because of these behavior outbursts, causing his parents to consider home schooling because of Johnny's absenteeism. When Johnny does attend school and is apart from his mother, he sends her multiple text messages to seek assurance that she is all right. His parents were reluctant to buy him a cell phone, but it seemed to be the only thing that could ameliorate his anxiety, even though it was supposed to be used only in emergencies. Johnny has a number of close friends, but playdates always seem to occur at his house. He needs his mother to lie next to him in bed until he falls asleep, and he will often wake up in the middle of the night and crawl into his parents' bed – an occurrence that has been increasing in its regularity and disrupts his parents' sleep.

What is the nature of Johnny's behavior? Is this typical for his age or does it exceed what would be considered appropriate at his developmental level? If the latter, is it a problem that warrants some form of intervention or is creating accommodations in an attempt to conform to the anxiety (e.g., use of cell phones, sleeping in parents' bedroom) a useful approach? These are important questions, ones that many parents frequently ask themselves. This article presents a summary of the clinical picture of this type of child behavior – a pattern

that is referred to as 'separation anxiety' – describing assessment modalities and effective treatment strategies supported by research to address this common yet distressing and interfering behavior in children and adolescents.

Clinical Description

Separation anxiety disorder (SAD) officially became a diagnostic category in 1980 in the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM). SAD is defined as developmentally inappropriate and excessive anxiety about separation from the home or from significant attachment figures (e.g., parents, primary caregiver). To receive a diagnosis of SAD, youth must demonstrate three or more of the following eight symptoms: (1) recurrent and excessive distress upon separation, or anticipation of separation, from home or major attachment figures; (2) persistent and excessive worry about losing, or about possible harm coming to, major attachment figures; (3) persistent and excessive worry that some event – such as getting lost or being kidnapped – will lead to being separated from a major attachment figure; (4) persistent reluctance or refusal to go to school or other places due to a fear of separation; (5) persistent and excessive fearfulness or reluctance to be alone, or without major attachment figures at home or in other settings; (6) persistent reluctance or refusal to go to sleep without a major attachment figure present, or to sleep away from home; (7) recurrent nightmares about being separated from major attachment figures; and (8) repeated complaints of physical symptoms (e.g., headaches, nausea) when separation from major attachment figures occurs or is anticipated.

For a diagnosis, the symptoms must cause clinically significant distress or impairment in domains of life that are relevant

to youth, such as disturbance of family functioning at home, academic performance at school, or social relationships with peers. Additionally, a diagnosis of SAD is not warranted if the behaviors occur exclusively as part of another disorder (e.g., pervasive developmental disorder). Finally, symptoms must persist for at least four consecutive weeks and emerge prior to the age of 18 (with a specification of 'Early Onset' if they begin before the age of 6). SAD is typically conceptualized as a problem in youth most commonly occurring in early to middle childhood (e.g., 6–12 years old) and less frequently into adolescence (e.g., age 13 and older); it is the only anxiety disorder within the DSM to be located within the section that describes disorders that are usually first diagnosed in infancy, childhood, or adolescence. The presence of SAD during youth may be associated with increased risk for future mental health issues, particularly phobias, panic, and depression. Adults with SAD may seem excessively attached to their spouses or children, and experience distress when needing to be apart from them; they may also find it difficult to effectively cope with major life transitions (e.g., moving, or the commencement of children's schooling).

Separation anxiety has been hypothesized as stemming from a number of possible causes including poorly developed attachment with caregiver (e.g., insecure attachment style), early separation trauma (e.g., death of a parent), and parental reinforcement (e.g., parents reward attachment rather than autonomy). Epidemiological research indicates that SAD is slightly more common in females than males, though boys tend to outnumber girls in clinical samples, a trend that has been explained by gender norms and treatment seeking patterns. That is, because the display of separation anxiety is less readily culturally accepted as typical for males, its emergence in boys may be interpreted by adults as more of a cause for concern and warranting intervention, resulting in their being brought to clinics for intervention more often than girls. Overall, prevalence estimates suggest that SAD is quite common among children and adolescents, affecting approximately 3–4% of youth.

Clinically distressing separation anxiety must be distinguished from fears and anxiety that are typical in youth and are considered part of a normal developmental pathway. During the months spanning late infancy and early toddlerhood, nearly all children exhibit distress when confronted with actual or anticipated separation from their primary caregiver for any amount of time. At this age, anxiety over separation is normal. As they get older (e.g., ages 4–6), some degree of anxiety is common for children facing their first experience with prolonged separation, such as for daycare or preschool. Indeed, research has found that separation-based concerns persist through middle childhood (e.g., ages 7–12). Interviews with nonreferred elementary school children have revealed that being kidnapped, harm befalling self or a significant other, and being apart from one's parents constitute some of the most frequently reported fears and scary dreams during this stage of youth. However, for many children, concerns are not clinically significant. In general, fears of separation decrease with age from a developmentally normal peak during the preschool years and subside by the time a child reaches his or her teens. Thus, to distinguish between typical and abnormal separation anxiety, one must examine the nature of symptom expression, its severity, duration, and amount of interference.

Features to consider are whether the anxiety is disproportionate to the situation, whether it leads to associated avoidance, and whether it is maladaptive given the child's developmental level.

Assessment

The determination of whether a child is suffering from SAD may not be a straightforward endeavor. For example, there is considerable overlap in symptom presentation among the various anxiety disorders outlined in the DSM, and SAD often occurs with noteworthy rates of comorbidity. To accurately distinguish among disorders and obtain the most comprehensive diagnostic picture, a multimethod approach of gathering information from multiple informants across multiple settings is recommended.

Clinical interviews are one of the most valuable tools for learning about the issues for which a family presents to treatment. Several semistructured interviews are available for assessment of youth, such as the Diagnostic Interview Schedule for Children (DISC), the Schedule for Affective Disorders and Schizophrenia in School-Aged Children (K-SADS), and the Diagnostic Interview for Children and Adolescents (DICA). Another semistructured interview has been constructed specifically to assess anxiety in youth: the Anxiety Disorders Interview Schedule for Children (ADIS C/P). The ADIS C/P allows the clinician to differentiate SAD from other anxiety disorders, as well as from other potential comorbid mood and externalizing disorders. With distinct formats for parents and for children, youth and their caregivers can be interviewed separately to provide multiple perspectives on the problem. Information from both reporters is merged with the interviewer's impressions to produce an overall evaluation of the magnitude of impairment caused by the reported symptoms. The ADIS C/P has good reliability between interviewers as well as over time and is also able to capture beneficial changes produced by intervention.

Questionnaires can also be a useful tool for measuring anxiety, allowing respondents to endorse symptoms of anxiety quickly and discretely with less concern for another individual's immediate judgment. Questionnaires are valuable for gathering information from significant figures in the child's life (e.g., teachers) who can provide critical input but are less realistically able to visit a therapist's office. A drawback to questionnaires is that they are insufficient, by themselves, to yield a clinical diagnosis, though the extensive samples on which measures are normed provides a backdrop against which to determine whether a child is experiencing developmentally typical or problematic levels of anxiety. Questionnaires commonly used include the Revised Children's Manifest Anxiety Scale (RCMAS), the State-Trait Anxiety Inventory for Children (STAI-C), the Screen for Anxiety and Related Emotional Disorders (SCARED), and the Multidimensional Anxiety Scale for Children (MASC). Questionnaires are also particularly useful for providing cross-situational perspectives of the child's mood and behavior.

Behavioral observations of the child are immensely valuable for the clinician to consider when forming an impression of the presenting issue. The interview itself provides an opportunity for informal observation of the child's behavior.

When assessing for SAD, the separate interview format of the ADIS C/P provides the unique opportunity to take note of how the youth behaves when faced with separating from his or her primary caregiver – the very process about which information is being gathered. It should be noted, however, that an absence of distress upon this separation does not immediately rule out the possibility of SAD, as the interviewer's efforts to make the child feel comfortable (e.g., by explaining what is involved in the interview process) may help to alleviate anxiety. On the other hand, observing the youth becoming distressed, crying, and/or clinging to a parent at the moment of parting is a noteworthy behavioral indicator that separation anxiety may be a problem. Although less common, formal behavioral observation can be conducted in naturalistic settings, such as the home or school, where separation difficulties are likely to occur.

Overall, there are a number of avenues to assessment that can be taken in order to determine whether a child's presentation is consistent with SAD. Though interviews are reliable for reaching a diagnosis, other assessment modalities are worthwhile as well. Questionnaires can be a brief and less threatening way to collect data from multiple informants, and behavioral observation offers a first-hand look at how youth react to and cope – or fail to cope – with impending separation. An informed diagnosis incorporates information from as many assessment options as possible. However, arriving at an accurate diagnosis for a given child's presentation may remain a challenge. The following section considers some of the finer distinctions between SAD and another disorder which can sometimes share similar concerns and thus present a particular challenge to accurate case conceptualization.

Differential Diagnosis

A distinct challenge that arises in the assessment of SAD is the difficulty in differentiating it from other mental health disorders that may exhibit separation concerns as an associated feature. This is a particularly difficult task for SAD, which, by virtue of its designation as predominantly a disorder of early youth, already requires that special attention be paid to the appropriateness of the behavior in terms of developmental norms. Thus, it can indeed be difficult to distinguish separation anxiety as a disorder from that which is quite typical of normal development and that which occurs only as a symptom in the context of another disorder.

One disorder that raises special questions in terms of its distinctness from SAD is generalized anxiety disorder (GAD), a disorder characterized by excessive worry about a number of events or activities that is difficult to control. Although some individuals with GAD share very little resemblance to those with SAD, a common occurrence is to encounter children and younger adolescents whose focus of anxiety is centered on their own well-being and that of their parents or other family members. Thus clinicians must pay particular attention to differentiating the focus of the fear as specific to separation concerns or in a wider context involving health and safety. The DSM suggests that GAD and SAD are distinguished by the former's not being restricted to worry about being away from home or relatives while this is the predominant focus of the latter. However, in practical terms, this distinction is often less clear.

Given that two of the main diagnostic criteria for SAD include persistent and excessive concern about (1) harm befalling major attachment figures and (2) being parted from loved ones, it is easy to see how the dividing lines between fear of separation (as in SAD) and worry about health and safety (as in GAD) can become blurred. The diagnostic picture can become even more complicated when parents are described as security figures for their children. In such cases, children are often reported to be unable to engage in various activities if not accompanied by parents, but perfectly able to do so if a parent is present. Moreover, both SAD and GAD are associated with the experience of somatic distress (e.g., stomachaches, nausea, sleep disturbance) when confronted with the situational trigger for anxiety. Thus, the overlapping nature of these common youth anxieties poses a considerable challenge to professionals seeking to accurately understand and categorize a child's presenting problem.

How, then, can one correctly differentiate these two disorders? The key is to pay special attention to particular features of the symptom presentation such as the specific feared outcome and the point at which anxiety surfaces. For example, in the case of a child with SAD, a worry about being kidnapped is focused primarily on the subsequent separation from the primary caregiver that it would cause. Though the notion of being abducted is naturally and normally distressing, it is primarily a concern about being away from loved ones that causes the upset in SAD. By contrast, a youth struggling with GAD who worries about safety will be concerned, not as much about being apart from attachment figures, but rather more so about the danger and possible harm that could result from being kidnapped. Further, with regard to timing, the child with SAD typically feels at ease when in the presence of major attachment figures and is more likely to become distressed only when separation is occurring or expected. This is distinguished from the child with GAD who may be perpetually worried about threats to personal health and safety, even while in the presence of parents or significant others. Thus the focus and timing of anxiety can assist professionals in differentiating SAD from GAD. Of course, it should also be noted that considerable research has shown that children and adolescents commonly present with comorbid anxiety disorders in addition to a principal anxiety disorder. This tendency for comorbidity of SAD with additional psychological disorders, particularly other anxiety disorders, points to the importance of multimethod and multiinformant assessment to develop a comprehensive diagnostic profile for the child presenting with separation concerns. This task, though difficult, is crucial for proper case conceptualization and treatment planning.

Separation Anxiety and School Refusal

Separation anxiety co-occurs at high rates with school refusal, a behavior characterized by child-motivated refusal to attend school and/or difficulties with being able to successfully remain in the classroom for the duration of the school day. Indeed, estimates have suggested that up to a third of youth who refuse school meet criteria for a diagnosis of SAD; further, between one-third and one-half of youth with SAD demonstrate what has been referred to as 'school phobia,' a marked

and intense fear of school that leads to avoidance behavior. Although the long-term consequences of comorbid SAD and school refusal are not yet fully understood, preliminary investigations suggest that these problems lead to higher rates of psychiatric consultation later in life.

An important consideration in determining the presence of SAD when presented with school refusal behavior is that school refusal is a heterogeneous pattern of behavior which encompasses externalizing disorders as well as internalizing disorders. Thus, effectively distinguishing school refusal caused by underlying separation anxiety from that which stems from the pursuit of reinforcement obtained by staying at home (or from noncompliance and/or social nonconformity) is important. This may include, but is not limited to, receiving extra attention from a parent, being able to watch television or play video games, or spending time with peers who may also be refusing school.

This differentiation is accomplished through a process known as 'functional analysis.' Functional analysis determines the purpose of a behavior by investigating what is being achieved by avoiding the school environment. By examining the antecedent causes of the school refusal behavior, its subsequent consequences, and maintaining factors, a clinician can determine the underlying motivation for the behavior. For instance, if the functional analysis reveals that the antecedent to school refusal is threatened parental separation when told to leave for school, the consequence of tantrums is staying home with the parent, and the maintaining factor is negative reinforcement of avoidant behavior, then it is reasonable to conclude that the motivation for school refusal behavior is related to separation anxiety.

Treatment

Cognitive-behavioral therapy (CBT) has been widely recognized as the psychosocial treatment of choice for SAD. A number of clinical trials have demonstrated the efficacy of CBT, and according to accepted criteria, it has been recognized as a well-established, evidence-based treatment for anxiety disorders in youth. The development of the essential components of CBT has been equally influenced by both behavioral and cognitive theories. These approaches emphasize the importance of exposure experiences and change in children's cognitive processes with the intention of enhancing more adaptive coping mechanisms. Additionally, integrative models have incorporated pathways in which early family environment and biological vulnerabilities contribute to childhood anxiety. These models have contributed to the creation of a multifaceted CBT approach that has received empirical support (e.g., the *Coping Cat* program). The following section describes the principal components of CBT treatment for SAD, which consists of: (1) assessment, (2) psychoeducation, (3) coping skills, (4) exposures, and (5) relapse prevention.

Assessment is an essential component of therapy because it provides an idiographic diagnostic picture from which treatment can begin and serves as a means to monitor change over time. Multimethod approaches to assessment throughout therapy aid in the prioritization of the child's problems and are useful in setting goals. Furthermore, evaluating the child's

reactions to, and impairment level in, situations involving separation provides valuable data to guide the treatment process.

The *psychoeducation* component of CBT is an opportunity for the therapist to provide information to the child and parent about the biological, behavioral, and psychological underpinnings of anxiety. The therapist discusses ways in which excess levels of anxiety are learned and maintained and explains the rationale for various treatment techniques. The goal is to foster the understanding that anxiety is an adaptive emotion and that treatment goals are geared toward the reduction and management of anxiety rather than its complete elimination. Specifically, children learn how to uncover the triggers of their separation anxiety and to describe how SAD affects them physically, cognitively, and behaviorally, providing the structure for anxiety management skills.

The *coping skills* component is where the child begins to learn and gather specific tools to manage his or her separation anxiety. There are three crucial techniques that CBT therapists emphasize. *Somatic management techniques* help the child hone in on the skill of relaxation through practice. Procedures most frequently used are diaphragmatic breathing and progressive muscle relaxation, which involves systematically relaxing major muscle groups through the use of tension-release procedures. Children are often provided a personalized relaxation recording that helps them to review and practice these techniques as homework assignments. In addition, these recordings can be used during situations that provoke heightened states of anxiety, such as bedtime, that can be part of a routine to help temper the arousal system. *Cognitive restructuring* is a technique that involves identifying maladaptive thoughts and beliefs and challenging these thoughts with coping-focused thinking and action plans based in reality. Clinicians typically involve parents by teaching them to coach their children in questioning the evidence for their thoughts in order to arrive at other coping solutions. Lastly, *problem solving* is a collaborative step-by-step process that allows the child to create and focus on nonavoidant solutions to a problematic situation. Anxious children frequently utilize avoidant problem-solving strategies that lower anxiety by simply escaping the situation. Though effective in the immediate short term, such strategies only serve to maintain and increase anxiety in the future. Alternatively, the clinician encourages the child to generate a variety of solutions without prejudging the efficacy of these solutions, in order to select, implement, and verify the effectiveness of the chosen result.

A key ingredient in CBT treatment of anxiety-based disorders is *exposure*. Through a collaboratively established hierarchy of anxiety-eliciting events, objects, and situations, the child suffering from separation anxiety is systematically and gradually exposed to his or her fears about being apart from home or attachment figures. Through imaginal, simulated, and *in vivo* methods, the child is given the opportunity to experience the increase and decrease of his or her anxiety in a controlled environment. Additionally, the child experiences the feared situation in a new light, aiding him or her to feel mastery over the ability to manage the anxiety. These exposure tasks provide an avenue for the child to successfully generalize the skill to other anxiety-provoking situations outside of therapy. To increase and encourage brave behavior (e.g., nonavoidant

strategies), clinicians utilize contingency management procedures (e.g., rewards). Such reward systems promote engagement in treatment and behavior change, with the ultimate goal to have the child engage in self-reinforcement that encourages the continuation of brave behavior.

Finally, the *relapse prevention* component in CBT programs is geared toward the consolidation of skills and promoting the generalization and maintenance of treatment gains over time. Skills are practiced across multiple settings and events to practice brave behavior in a variety of contexts.

Manual-based CBT interventions for anxiety disorders in youth have received considerable empirical support. In recent years, several randomized control trials have been conducted with children experiencing a range of anxiety disorders, including SAD, GAD, and social phobia (SoP). In 1994, Kendall conducted the first controlled trial to evaluate a manualized CBT intervention called the *Coping Cat Program*. This study assigned 47 children, aged 8–13 years old, with an anxiety disorder – 38% of whom had a diagnosis of SAD – to a CBT intervention consisting of sixteen 60 min sessions or to a waiting-list control condition. Pre- to posttreatment results revealed a significant change in anxiety for the treatment group, whereas the control group remained relatively unchanged. The majority of the treated children (64%) no longer met diagnostic criteria for an anxiety disorder at posttreatment, indicating clinically significant treatment effects. In a follow-up study of these treated children, results indicated that treatment gains were maintained approximately 2–5 years after treatment.

A second randomized control trial evaluated a CBT intervention for 94 children between the ages of 9 and 13 (23% with a SAD diagnosis) assigned to a treatment or wait-list control condition. Results revealed that 50% of the treated children were free of their primary diagnosis at posttreatment, with significant reductions in anxiety levels for those who continued to report anxiety symptoms. At 1-year follow up, these gains were maintained, and children continued to show improvements. In one of the longest follow-up studies conducted, at an average of 7.4 years later, not only did children continue to maintain treatment gains but also treatment responders reported significantly less substance use and other related problems compared to those with a less successful response. These findings support the long-term utility of CBT in treating anxious children and adolescents, including those with SAD.

Further outcome studies have demonstrated evidence for the efficacy of using CBT in a group treatment format (GCBT) for SAD. Controlled trials demonstrate that GCBT is equally as effective in treating anxiety disorders as child-focused individualized CBT. For instance, a randomized clinical trial evaluated the outcome of 37 anxious children (ages 8–14) assigned to CBT, GCBT, and wait-list control. Results revealed that a majority of children who received 18 weeks of CBT or GCBT did not meet criteria for their anxiety disorder (73% and 50%, respectively) compared to the control condition (8%). In addition, the study concluded that CBT interventions delivered individually or in a group format were similarly effective in treating SAD and other anxiety disorders.

In recent years there has been an emphasis on the parent–child relationship in understanding the maintenance of child anxiety, and studies have examined the role of parent

involvement in treatment. Randomized controlled trials have revealed that family CBT (FCBT) compared to a wait-list control group is efficacious, while each of the two versions of CBT (child-focused CBT and FCBT) were comparably effective. In 2008, another randomized clinical trial assigned 161 anxious children (29% with SAD) of ages 7–14 years to 16 weeks of CBT, FCBT, or a family-based education, support, and attention therapy (FESA) that served as a comparative alternative treatment to CBT. Results revealed that both child and FCBT interventions were superior to FESA in reducing anxiety symptoms and the presence of an anxiety disorder, concluding that the two versions of CBT were comparable.

Recent evidence suggests that medication can also be an effective and well-tolerated treatment for SAD. Double-blind control trials have found the use of selective serotonin reuptake inhibitors (SSRIs) to be efficacious in treating SAD, GAD, and SoP. The promising effects of SSRIs and CBT interventions sparked further examination of the relative efficacy of CBT, medication, and their combination to identify the best ways for treating anxiety disorders in children and adolescents. In the CAMS multicenter controlled trial, 488 children (ages 7–17), diagnosed with SAD, SoP, and GAD, were assigned to four conditions of short-term (12-weeks) treatment: CBT, sertraline (SSRI), their combination (CBT + sertraline), and a placebo drug. These results indicated that the three active treatments – CBT, sertraline, and their combination – compared to placebo were effective treatments for children with SAD, SoP, and GAD. The combination treatment of CBT and sertraline (81%) was superior to CBT alone (60%) and sertraline alone (55%) in terms of the percentage of youth rated as ‘much improved’ or ‘very much improved’ by the end of the study. Additionally, results revealed that CBT alone and sertraline alone were equally good treatments for child anxiety.

Building on the success of programs appropriate for multiple types of anxiety disorders, recent efforts have also sought to evaluate the efficacy of interventions specifically tailored for the treatment of SAD. Santucci and colleagues developed an approach to delivering components of CBT through an intensive 1-week summer camp-like program. In a progressive fashion, children and parents moved from receiving joint psychoeducation and spending most of the first day together, to parting immediately upon arrival for separate child and parent groups by the fourth day. Participants also engaged in creative and developmentally appropriate play activities (e.g., artistic crafts, field trips) akin to what might be experienced at a summer camp. The program culminated with a sleepover on the final night and an award ceremony the following morning. Initial pilot testing of this approach yielded promising results, as participants exhibited reductions in separation anxiety at posttreatment and further decreases in anxiety at 2-month follow-up. This program is currently in its next phase of evaluation.

Some recent efforts have sought to determine whether other existing models of treatment can be applied to the treatment of SAD. In one example, Pincus and colleagues applied Parent–Child Interaction Therapy (PCIT), an empirically supported intervention originally designed for reducing disruptive behaviors in youth, with SAD children. As an approach developed to alter the dynamic of maladaptive interactions between youth and their parents, the PCIT model thus lends itself well to SAD treatment. More appropriate child behavior could be

fostered through parental reinforcement of bravery and coping in the face of separation while decreased attention is paid to clingy or even oppositional behavior that can sometimes be exhibited. After observing some shortcomings of conventional PCIT applied to SAD, Pincus developed an adaptation of this approach. A formal evaluation is ongoing, with preliminary results suggesting favorable outcomes.

As described earlier, most of the research on the treatment of SAD has been obtained from evaluations of CBT interventions that have been established as efficacious in the treatment of several childhood anxiety disorders; however, several modifications to these manual-based treatments are recommended to adapt them to treat children with SAD. Specifically, the treatment of SAD typically involves a multimodal approach that, within a CBT framework, includes school consultation and intervention, additional family components to treatment, and depending on the severity of the child's symptoms, pharmacotherapy.

Family-based treatments are relevant for treating SAD due to the uniquely close child–parent relationship and the frequent account of separation anxiety symptoms in the parent. For instance, parents of anxious children may inadvertently engage in anxiety-enhancing behavior by modeling fear or avoidance and not promoting autonomy. Thus, a parent training component in CBT interventions geared specifically toward working on effective parenting strategies that encourage brave behavior and extinguish excessive anxiety in their child may further enhance treatment outcome. Time may be spent preparing parents for their child's exposures and emphasizing that an essential component of treatment is allowing the child to independently experience and learn to cope with anxious feelings. A preliminary, multiple-baseline study examined the efficacy of an integrated cognitive-behavioral parent training protocol specifically for parents of children with SAD. Six children, aged 7–10, and their parents received 10 weeks of CBT, with the first two sessions devoted solely to parent education and training. Results revealed that treatment led to positive parental outcomes (e.g., enhanced self-efficacy) that were also associated with positive treatment outcomes for their anxious children. Moreover, five of the six child participants did not meet the criteria for SAD at posttreatment, further supporting the efficacy of family-based CBT for child anxiety.

Due to the high comorbidity rate between SAD and school refusal, consultation with school staff may be essential to CBT interventions. Children with SAD are likely to have school situations as part of their exposure component of treatment; consultation can therefore involve working with school personnel toward gradually reentering the child in the classroom. Guiding teachers and school nurses on how to contribute effectively to treatment goals can aid in limiting the child's visits to the school nurse or calls home to check on parent safety. Consistency on how to manage the child's anxious behavior both at home and in school is optimal for a positive treatment outcome.

The essential components of CBT are tailored to the individualized needs of the child. Clinicians should approach treatment from a developmental perspective and take into consideration the child's environmental and family needs. Despite the solid evidence supporting CBT as an efficacious treatment and the benefits of SSRIs for treating anxiety

disorders in children and adolescents, including SAD, it is suggested that future research continue to examine unique treatment aspects for this particular type of anxiety disorder. Additionally, ongoing investigations are focusing on the dissemination of these treatments to nonclinical settings, such as schools, primary care settings, and community centers as well as identifying at-risk youth for prevention interventions.

Conclusions

SAD is one of the most prevalent disorders in preadolescent youth. It is characterized by developmentally inappropriate anxiety and fear of separation from home or significant attachment figures, followed by avoidant behavior, such as refusal to attend school or to sleep alone. Such pathology causes significant impairment in functioning, including peer relationships, academic performance, and relationships within the family. If left untreated, SAD has the potential to have long-term negative effects on social and emotional development.

Due to its common co-occurrence with other related disorders, utilizing a multimethod and multiinformant approach to assessment is most effective in achieving a comprehensive diagnostic picture. Multiple pathways accounting for the etiology and maintenance of SAD has fueled the creation of multifaceted approaches to treatment. There is solid empirical evidence supporting the efficacy of CBT, and the benefit of SSRIs, for the treatment of child and adolescent anxiety disorders, including SAD. Preliminary and ongoing investigations focused on treatment tailored specifically to SAD have thus far yielded very promising results. Overall, assessment and treatment of this disorder should be conceptualized and examined from a developmental perspective. As we continue to further understand the etiological mechanisms of SAD, the investigation and implementation of integrated approaches to treatment will be important.

See also: Anxiety and Fear; Anxiety Disorders; Behavioral Pharmacology; Clinical Assessment; Cognitive Behavior Therapy; Generalized Anxiety Disorder.

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Relevant Websites

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- <http://www.apa.org/> – American Psychological Association.
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- <http://www.nimh.nih.gov/health/topics/anxiety-disorders/index.shtml> – National Institute of Mental Health, Anxiety Disorders.

Sex Differences

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Glossary

Cultural success The achievement of status and the control of resources that are important in a given society or cultural niche.

Operational sex ratio The ratio of sexually receptive males to sexually receptive females in a local area and at a given point in time.

Relational aggression Use of gossip, lies, and rumors to derogate sexual competitors and disrupt their romantic and social relationships.

Sexual selection Competition among member of the same sex (intrasexual competition) for access to mates or control of the resources mates need to reproduce, and discriminative choice of mating partners (intersexual choice).

Darwin's theory of sexual selection and the component processes of intrasexual competition (e.g., male–male competition) and intersexual choice (e.g., female choice of mates) have guided the scientific study of sex differences in hundreds of nonhuman species. These same processes have occurred during human evolution and provide a means to organize our understanding of the many sex differences in our species. The usefulness of this theory for approaching the study human sex differences is illustrated with a discussion of sex differences in mate preferences and in intrasexual competition. Cultural influences on these behaviors demonstrate that the social context and evolutionary history interact in the expression of evolved biases.

Introduction

Over the past 100 years, social and biological scientists have identified many human sex differences, ranging from risk of cardiovascular disease to brain organization to competence in reading and writing. Most of these differences are found across cultures and historical periods, although their magnitude and how they are expressed can vary across these social contexts. Despite wide agreement about the existence of sex differences, their origins remain a matter of debate. The search for these origins has included studies of hormonal, social, and evolutionary processes, and often results in an unproductive focus on either social and environmental explanations or biological ones. Many, if not most, of the human sex differences that have been identified result from multiple social and biological influences that can be traced in varying degrees to our evolutionary history. An evolutionary perspective is not an alternative to social influences, but rather a different level of analysis. The former provides a broad theoretical framework that places human sex differences in the context of sex differences found in other species, and social influences along with hormones help to explain how these differences are expressed in one context or another.

Sexual Selection

Darwin is of course well known for his masterwork, *On the origin of species*, and the codiscovery (with Wallace) of the principles of natural selection. Darwin also discovered another

group of processes that operate within species and are the principle sources driving the evolution of sex differences. These processes are called *sexual selection*, and involve competition with members of the same sex over mates (*intrasexual competition*) and discriminative choice of mating partners (*intersexual choice*). Although both intrasexual competition and intersexual choice can be found for both sexes, as is the case with humans, the most common pattern involves male–male competition over access to mates and female choice of mating partners. The reason this pattern is so common can be found in underlying sex differences in the rate of reproduction and in investment in parenting.

Parenting and Rate of Reproduction

More than 100 years after Darwin introduced the concept of sexual selection, Williams and Trivers proposed that the tendency to compete or choose is tightly linked to parenting. In brief, any sex difference in the tendency to compete or choose largely, but not exclusively, turns on the degree to which females and males invest in parenting. The sex that provides more than his or her share of parental investment becomes an important reproductive resource for members of the opposite sex. The result is competition among members of the lower investing sex (typically males) over the parental investment of members of the higher investing sex (typically females). Members of the higher investing sex are in demand, and thus can be choosy when it comes to mates.

The bias to invest in parenting or not is influenced by the potential rate of reproduction. The sex with the higher potential rate tends to invest more in competing for mates than in parenting, and the sex with the lower rate tends to invest more in parenting. The pattern emerges because members of the sex with the higher potential rate of reproduction can rejoin the mating pool more quickly than can members of the opposite sex and it is often in their reproductive best interest to do so. Individuals of the lower investing sex typically have more offspring if they compete for mates than if they parent, whereas members of the higher investing sex show the opposite pattern, and benefit more from being choosy than do members of the lower investing sex.

For mammals, internal gestation and obligatory postpartum suckling create a very large sex difference in the potential

rate of reproduction, and thereby creates the potential for large female–male differences in the mix of parenting and competing; this difference is found in 95–97% of mammalian species. Basically, female care of offspring frees males to compete for mates, and successful males have many offspring each breeding season and most other males never reproduce.

Intersexual Choice

Female choice is more common than male choice, because females' investment in parenting makes them a valuable resource for males and allows them to choose among many prospective mates. One evolutionary result is an exaggeration of the male traits on which females base their mate choices. In many species, traits such as those shown in Figure 1 are an indicator of the physical or genetic health of the male, or serve as an indicator of his ability (e.g., vigor in searching for food) to provide parental investment. Male birds with an elaborate and colorful plumage or more complex songs are chosen as mating partners more often than their duller peers, because these traits provide females with information on males' immune system and physical health; the former has a heritable component and thus offspring sired by healthy males have lower mortality. Males who are sick or cannot tolerate high levels of

testosterone – which can suppress the immune system – cannot develop these traits and thus are not chosen as mates.

In short, male ornaments, such as the long tail features of the male shown in Figure 1, are barometers that are strongly affected by the condition of the male, and female mate choice reflects the evolution of the female's ability to read these barometers. Females have evolved to be sensitive to these barometers and males to develop them if they can, because they advertise the reproductive benefits the female will accrue if she mates with the male. For species in which males' parent and species in which there are differences in females' ability to successfully rear offspring, male choice is also found and females evolve traits that males use in their choices.

Intrasexual Competition

One of the more common expressions of male intrasexual competition is physical threats and fights over access to receptive females or for control of the territory or resources that females need to raise offsprings (e.g., nesting spots). The typical result is that physically larger, healthier, and aggressive males monopolize access to sexually receptive females. The accompanying individual differences in reproductive success – some males have many offspring, others few or none – result in the selection for and evolution of sex differences in physical size, armament, and weaponry, as well as aggressiveness, as illustrated in Figure 2.

The traits that facilitate intrasexual competition are not always physical. Sexual selection will operate on brain and cognitive traits in the same manner as physical ones, if the associated abilities and behavioral biases provide reproductive



Figure 1 Male *Paradisea Papuana*. From Darwin C (1882) *The Descent of Man, and Selection in Relation to Sex*, 2nd edn., vol. II, p. 386. London: John Murray. In the public domain.

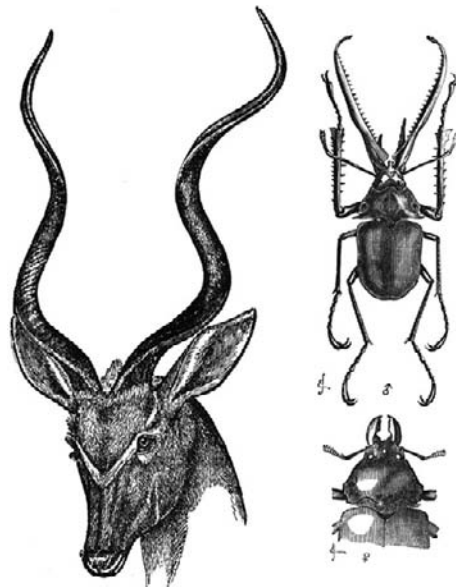


Figure 2 Sexually selected characteristics used in physical male–male competition. To the left is the male kudu (*Strepsiceros kudu*). From Darwin C (1871) *The Descent of Man, and Selection in Relation to Sex*, vol. II, p. 255. London: John Murray. To the right are the male and female of the beetle *Chiasognathus grantii*. From Darwin C (1871) *The Descent of Man, and Selection in Relation to Sex*, vol. I, p. 377. London: John Murray. In the public domain.

benefits. Competition can also involve a strong social component, when males form coalitions to facilitate their ability to compete for access to females or resources needed to attract females. Female–female competition occurs when males provide some investment in offspring. Whether it occurs among males or females, evolution will favor the exaggeration of whatever traits are needed to successfully compete. Sex differences emerge when the intensity or nature of intrasexual competition differs for males and females.

Operational Sex Ratio and Sex Hormones

Social and ecological conditions as well as sex hormones can also influence how evolved sex differences are expressed. The operational sex ratio (OSR) is one of the more important of the social influences. The OSR is the ratio of sexually active males to sexually active females in a given breeding population at a given point in time, and is related to the rate of reproduction. An actual sex ratio of 1:1 represents a population in which there are as many sexually *mature* females as males, but any sex difference in the rate of reproduction will skew the OSR. Because mammalian males have a faster potential rate of reproduction than females, there are typically many more sexually *receptive* males than sexually *receptive* females in most populations. The resulting bias in the OSR creates the conditions that lead to intense male–male competition over access to a limited number of sexually receptive females. Male–male competition, in turn, creates the conditions in which female choosiness can evolve.

In some situations, the sex with the higher potential rate of reproduction is better off by investing in parenting than in competing for mates. For instance, social monogamy and high levels of male parenting are common in *canids* (e.g., coyotes, *Canis latrans*), where females tend to have large litters. Large litter sizes, prolonged offspring dependency, and the ability of the male to provide food during this dependency result in *canid* males being able to sire more offspring with a monogamous, high-parenting reproductive strategy than with a polygynous high-competition strategy. The result is a more balanced OSR. Generally, it appears that paternal investment occurs in species in which males are reproductively more successful when they parent than when they compete, although a mix of competing and parenting is evident in some species, including humans.

The proximate expression of the above described sex differences and many others are also influenced by prenatal and postnatal exposure to sex hormones. The influences of sex hormones on physical development and on the brain, cognition, and behavior are complex and sometimes very subtle, often interacting reciprocally with genetic sex, physical health, as well as social and ecological contexts.

Sexual Selection and Human Sex Differences

The same processes of intrasexual competition and intersexual choice and the social factors (e.g., OSR) and sex hormones that influence the expression of the associated traits can be used to understand many human sex differences. Among the evidence supporting this conclusion are the same patterns of human sex

differences in physical size, musculature, rate and pattern of physical development, and hormonal and other physiological responses to stressors and competition as that found in other primates with intense physical male–male competition. Unlike most other primate and mammalian species, human reproductive dynamics are complicated by men's investment in their children. This investment results in female–female competition over investing men and male choice of long-term mates, in addition to the more common male–male competition and female choice. A full discussion of the associated sex differences in physical and social development and in brain and cognition is beyond the scope of this article, but the utility of sexual selection for understanding human sex differences is provided by a contrast of women's and men's mate choices and how they compete for mates. The contrast also illustrates how the expression of these social dynamics is influenced by social and cultural contexts.

Mate Choices

In all species, female choice is influenced by the reproductive benefits they will receive from males. These benefits may be genetic, assistance with provisioning for the offspring, social support, direct parenting, or some combinations. Women are no different. They prefer long-term to short-term mates and long-term mates who are in good physical health, who control culturally important resources, have social influence, and are willing to invest these in the woman and her children. Men also have preferences and these are similar to many ways to those of women, which follows from men's investment in parenting. There are nonetheless several areas of difference that can be understood within an evolutionary context. These include enthusiasm for casual sex, the importance of cultural success, the preferred behavioral traits of long-term partners, and the age and beauty of these partners. Before we move to these, note that due to competition over mates, there is often a gap between actual and preferred choices. This is because not everyone can marry the most attractive or successful member of the opposite sex, even if this is their preference, and the corresponding sorting of mates reduces the magnitude of many sex differences in the traits of actual mates.

Casual sex

A sex difference in *preference* for casual sex follows from the sex difference in the costs and benefits of reproduction. As with all mammals, the biology of reproduction results in higher costs and a slower potential reproductive rate for women than for men. In addition to a 9-month pregnancy, women in traditional cultures will typically breast feed for 2–3 years. These costs are predicted to result in an evolved bias for women to be selective and cautious in the choice of mating partners, and a parallel prediction that men who do not bear the same costs and have the potential to benefit reproductively will show an evolved bias to be less discriminating and more enthusiastic about casual, short-term mating relationships.

Many lines of evidence support these predictions. Men fantasize about casual sexual partners and more of them more frequently than do women. Prostitution is by definition a short-term sexual relationship and the demand is almost entirely driven by men. Women are more likely to feel disgust

and regret following a short-term sexual encounter than are men, and women are more likely to become emotionally attached to casual sexual partners than do men.

There are cultural influences as well. Over the past 50 years, mores against sex outside of marriage have changed in Western culture and the number of women (and men) engaged in such relationships has increased. This is not however the same as casual sex, as most women who have sex before marriage do so in the context of what they believe will be a long-term relationship. Socially, the OSR greatly influences how well men are able to put their preferences into practice. When there are more women than men, men are more successful in achieving their preference for casual relationships, but when there are more men than women, women are better able to enforce their preference for long-term committed relationships and men's investment in children.

Cultural success

The costs associated with pregnancy and breast feeding also have the benefit of making women more biologically valuable than men; breast feeding is now optional in modern societies but is not in traditional ones, nor during our evolutionary history. In other words, women have more to offer, reproductively, than do men. Men's contribution comes in part from the genes passed to their children, but most of their investment comes from the resources they can provide to their wife and children during their children's development. In traditional cultures and modern ones, women of course contribute resources (e.g., through gathering) to their children's development, but are also better able than men to use their reproductive potential to demand more postnatal investment from their partner. Stated differently, women's heavier biological investment in parenting should not only make them choosier when it comes to mates but also allow them to demand more cultural resources from a prospective marriage partner.

It follows that the social status of men is an important consideration in women's choices of and preferences for marriage partners, because these men have the resources that women can use for their own benefit and to successfully raise their children. Although indicators of social status can vary across cultures, the basic relation is the same – culturally successful men are preferred as mating and marriage partners. The reason is clear: in all cultures in which it has been studied, the children of culturally successful men have lower mortality rates than the children of other men, due, at least in part, to the social and material resources these men invest in their children. Even in cultures in which mortality rates are low, children of culturally successful men benefit in terms of psychological and physical health and in terms of longevity in adulthood. These are exactly the conditions that would result in the evolution of women's preference for socially dominant and culturally successful marriage partners.

Confirmation is found in social-psychological studies about women's actual marriage and divorce patterns and their preferences. In many cultures, choice of marriage partners is technically made by the young woman's kin, but in most cases the parents' decision is influenced by their daughters' preferences. In such cultures, these joint decisions are strongly influenced by the quantity and quality of the resources (e.g., land, cattle) the man and his kin will provide to her and her

future children. In modern societies, men who are culturally successful – indexed by educational level, occupation, and income – are chosen as marriage partners more often than their less successful peers. And, across societies a woman's decision to stay married or not is influenced by the quantity and quality of resources provided by her husband; women married to men who are more successful than they are (e.g., higher educational levels) report higher levels of marital satisfaction, have lower divorce rates, and have more children than women married to men who are less successful than themselves.

Social-psychological studies of women's and men's preferences for marriage partners are an important adjunct to research on actual choices. These preferences more clearly capture the social and psychological processes that influence reproductive behavior because unlike actual choices they are not constrained by the competing interests of others. Studies of peoples' preferences for a prospective marriage partner reveal that women throughout the world rate a partner's social status, cultural success, or attributes that are likely to lead to success (e.g., ambition) as more important than do men. It is not that men do not rate these traits important, it is that they are not weighted as heavily by men as other traits or as heavily as women.

There is also cultural variation in how strongly women weight these traits. In contexts where women do not have political power, access to education, or independent incomes, they rate a man's cultural success or indicators of the likelihood of his achieving success more highly than do women living in societies in which they have independent social and economic resources. In societies with social 'safety nets' (e.g., subsidized income for housing or child care) women tend to rate these traits less highly than do women in societies without these nets. Men's relative focus on women's cultural success or the resources she can bring to a marriage also varies across cultures. Polygyny is found to varying degrees in about six of seven traditional societies, that is, successful men are able to marry more than one wife if they have social influence and material resources to do so. In these societies, men must provide the resources (e.g., access to land, cattle) that women will need to start a family. In societies in which monogamy is legally imposed (i.e., it is against the law to marry more than one person at a time), which includes all Western societies, men value women's income or other resources (e.g., dowry) that they can bring to the marriage, but less highly than do women in these same societies. The increase in men's choosiness in societies with socially imposed monogamy follows from their heavier investment in a single marriage partner (at a time) and a single family, as contrasted with multiple partner's and families for successful men in other societies.

Preferred behavioral traits of a long-term partner

A preference for a culturally successful marriage partner is not enough to be a successful reproductive strategy for women. These successful men are often arrogant, self-serving, and are better able to pursue their preference for multiple mates than other men. As a result, the personal and behavioral characteristics of men provide women with information on his ability and willingness to make a long-term investment in the woman and her children. In addition to ambition and cultural success,

women tend to rate the emotional stability, kindness, and the family orientation of prospective marriage partners more highly than do men, although the sex differences are not as large as those found for cultural success or physical attractiveness (below). These patterns indicate that women prefer husbands who have resources, and have the personal and social attributes that suggest they will invest these resources in a family. Women also seem to prefer men with whom they feel physically safe, and who are physically capable of protecting them from other men, should the need arise.

Many women prefer men with whom they can develop an intimate and emotionally satisfying relationship, but there are cultural differences in the importance of this relationship. In the educated, professional classes of modern societies, families are more isolated from their extended families and thus the spousal relationship becomes a more central source of social and emotional support than is typically the case in traditional societies. Women in these contexts rate this relationship as more central to their marriage choices than do men or women in other societies. It is not that women in these other societies do not want such relationships, but rather these are more of a luxury than a necessity. This is because day-to-day living is more difficult and there are real risks of serious illness or death of their children; as many of 50% of children die before adulthood in many of these societies. In this circumstance, women's focus is on the traits of men that will reduce these risks and help them keep their children alive and healthy.

The behavioral attribute that men rate more highly than women is sexual fidelity. Men's concern over sexual fidelity makes evolutionary sense, because of men's investment of time and resources in their children. The implicit concern is that they will be cuckolded, that is, they will be deceived by their partner into raising the child of another man. The definitive study of human nonpaternity rates has not been done, but it appears that 3–10% of children are raised by cuckolded men; as found in other species, the risk of cuckoldry is higher for lower status than for higher status males. This implicit fear underlies men's sexual jealousy and often contributes to men's violence toward their partners; male-on-female aggression is often about controlling the sexual behavior of their partners and through this, reducing the risk or often times the imagined risk of infidelity. It is not that women are unconcerned about sexual fidelity and do not become jealous at the prospect of a partners' infidelity, it is that it is a deeper concern for men, on an average.

Age and beauty of a mating partner

Throughout the world, the age and facial and body attractiveness of a prospective partner is more important for men's mate choices than for women's. These sex differences make reproductive and therefore evolutionary sense. Age is more important in men's choices than in women's, because women's fertility peaks in their mid-20s and then steadily declines to very low levels over the next 15–20 years; men's fertility also declines with age but much more slowly. Men with a preference for younger wives will necessarily have more children than men with a preference for older wives. When they can, men throughout the world put this preference into practice. In their 20s, men tend to marry women who are 2–3 years younger than themselves, whereas successful men in their 50s

tend to marry women 15–20 years younger than themselves (e.g., following a divorce).

Women's physical traits that men find especially attractive include a waist-to-hip ratio of about 0.7 (i.e., an 'hour glass figure'), facial features that signal a combination of sexual maturity but relative youth, symmetric body and facial features, proportionally longer legs, larger than average breast size and symmetry, and a small abdomen and waist. The key facial features are large eyes, prominent cheek bones, and a large smile area. Body mass index (BMI) – a measure of leanness to obesity independent of height – is also associated with rated attractiveness. Women with these features are more likely to become pregnant, carry the pregnancy to term, and have healthy children than are other women, although the strength of these relations is smaller in societies with modern health care than in other societies. A preference for relatively slender (i.e., a BMI in the average range) women is not universal, however: across 62 cultures, one study found that relatively slender women were preferred in 12 (19%) cultures, moderately fat women in 23 (37%) cultures, and 'plump' women in 27 (44%). The latter are preferred and considered beautiful in cultures in which the food supply is unreliable. Average weight to somewhat slender women are preferred in some societies in which food is readily available and where lower status women are heavier, on an average, than higher status ones.

Again, it is not that age and physical attractiveness are not important to women. Rather, these traits are necessities for men and luxuries for women. When it comes to making decisions about a marriage partner, men will trade a prospective partners' cultural success for her youth and beauty, whereas women will trade a partners' attractiveness for his cultural success. If there were not real life trade-offs when making these choices, women and men would of course want both success and beauty in a partner. Women's preference of partners that have it all is found in classical literature and in romance novels, where the male protagonist is almost always socially dominant, wealthy, *and* handsome.

As with men, a preference for an attractive mate makes biological sense for women. Not only are handsome husbands more likely to sire children who are attractive and thereby sought out as mating and marriage partners in adulthood, these men and their children may be physically healthier than other men. Handsome husbands are somewhat taller than average, and have an athletic (but not too muscular) and symmetric body shape, including a 0.9 WHR, and shoulders that are wider than their hips. The facial features that women rate as attractive include somewhat larger than average eyes, a large smile area, and prominent cheek bones and chin. These facial features and the V shape may be good indicators of genetic variability, which is important for disease resistance, and suggest a healthy developmental period. However, the relation between men's physical attractiveness and their health is lower in modern societies than in traditional ones, due to modern medical care. In societies without this care and high risk of infectious disease, physical attractiveness seems to be a better indicator of health for both sexes and both men and women rate it as more important (men still rate attractiveness more highly than women) than do men and women in societies with lower health risks.

Competition for Mates

As with other species in which females provide more parental care than males, intrasexual competition is more intense among men than among women, especially in traditional societies where successful men can marry polygynously. In addition to the physical sex differences mentioned earlier (e.g., men's larger size), genetic studies of human populations are consistent with an evolutionary history of more intense male–male than female–female competition. Of particular importance is variability of mutations in mitochondrial DNA (mtDNA) genes and genes on the Y chromosome. Children inherit mtDNA genes only from their mother, and boys inherit the Y chromosome from their father. The variability of mtDNA and Y-chromosome genes and their geographic distribution can be used to make inferences about the reproductive dynamics of our maternal and paternal ancestors, respectively. If there has been an evolutionary history of intense male–male competition and polygyny – resulting in some males having several wives and many children and many men dying childless – we should have fewer male than female ancestors. This is the case, throughout the world. In fact, Y-chromosome genes indicate a repeating pattern of one population of men replacing another in Africa, Europe, and Asia.

Competition in traditional societies

One-on-one and coalitional male-on-male aggression is a common feature of hunter–gatherer, horticultural, pastoral, and agricultural societies. Ambushes, raids, and occasional larger-scale battles between male kin groups from neighboring villages or bands are common features of social life in about 70% of hunter–gatherer societies and is even more common in other traditional societies; many of the remaining societies are relatively isolated or politically subjugated to larger groups. In more than half of these societies, intergroup conflict occurs more or less continuously, that is, at least once a year, and ultimately results in the death of about 30% of the group's young men, on an average. Across societies, motives for these conflicts include 'blood revenge' (i.e., retaliation for the killing of a member of the kin group), economic gain (e.g., control of land, cattle), the capture of women, and personal prestige. The latter typically involves the accumulation of culturally important trophies (e.g., the heads of competitors) that influence the man's reputation and social status within the community, which in turn influences his desirability as a marriage partner. One-on-one physical male–male competition (e.g., club fights) are also common within communities but typically occurs to establish social dominance or to resolve conflicts (often involving sexual jealousy) that are not resolvable in other ways.

Whatever form it takes, the reproductive benefits for successful men can be considerable. Dominant men usually have several wives and many children, other men marry monogamously, and still others never reproduce. Almost all women, in contrast, marry and have children. The variability in the number of children sired by men as compared to the variability in the number of children born to women is often 3:1; that is, the reproductive differences among men are three times larger than the differences among women. These are the patterns that would result in the Y-chromosome and mtDNA

gene differences mentioned above, and that explain the sex differences in physical size, strength, development, and behavioral aggression; specifically, traits that facilitate these forms of male–male competition.

It is not that women do not compete or that this competition does not escalate to physical violence, sometimes it does. Typically though the competition is more subtle and often among the co-wives of polygynously married men. The level of competition is likely to vary with whether or not a co-wife is a sister and the extent to which co-wives must cooperate to produce food. Whatever the specifics, polygynously married women typically have children who are not as healthy and who have lower survival prospects than the children of monogamously married women. The reasons for this are not fully understood, but cannot be completely attributed to the level of investment the father makes in each individual child. The covert and sometimes overt maltreatment of children by co-wives is also a contributing factor; sometimes women will poison the children of co-wives to increase the resources available to their children.

Competition in modern societies

Warfare of course occurs among modern societies and is typically over control of culturally critical resources, and is largely a male activity. One-on-one physical aggression sometimes escalates to homicide in these societies, with the precipitating events often centered on sexual jealousy or male status competition, as in traditional ones. Nonetheless, in modern societies with socially imposed monogamy, male–male competition is most generally focused on the acquisition of social and material indicators of success. Successful men in these societies have a college education and a high paying job, which on the surface is very different than establishing dominance through club fights or the murder of rivals from neighboring villages, but the underlying motivation is the same: men throughout the world are motivated to achieve social status vis-à-vis that of other men and control of socially important resources. They want to achieve cultural success.

Prior to wide-scale industrialization and modern health care, the relation between cultural success and reproductive success was the same in modern nations as is currently found in traditional societies. As a result of socially imposed monogamy, birth control, and the sharp decline in infant mortality over the past 200 years, the relation between cultural success and reproductive success is no longer as strong as it once was, but it still matters. Men with higher incomes report more sexual activity than men with lower incomes and women at any income level, in keeping with the importance of a man's cultural success in women's choice of mating partners. Large-scale studies in the United States and other nations indicate that men in the top 25% of income have, on an average, 2.5 children as compared to an average of 1.4 children for men in the bottom 25% of income. The pattern largely emerges because the risk of remaining childless is higher for lower status men; about one out of three men in the bottom income category are childless by age of 50, as compared to one in nine in the top income category.

The achievement of cultural success is important for women too, as it determines the quantity and quality of the social and material resources they can provide to their children.

To a much greater extent than men, however, women can achieve status and access to resources through marriage. In fact, the relation between years of education and thus earning potential and number of children is the opposite of that found in men. Over the past 100 years in the United States, women with a high school diploma had, on average, 2.8 children, whereas women with a graduate degree had 1.8 children. Compared to high school graduates, three times as many women with postgraduate degrees were childless (9% vs. 27%). These education and income differences are largely due to the delay in childbirth commonly associated with obtaining a higher education in modern societies.

Even if women do not compete as intensely for cultural success as men, they do compete with one another. In modern societies, men and women put considerable effort into enhancing the traits that members of the opposite sex find attractive, which includes men's focus on cultural success. Among women this competition involves enhancing or bringing attention to physical traits that influences men's mate choices, as well as the derogation of these traits in potential competitors; men do this as well, but it is not as central to male-male competition as it is to female-female competition. Women, for instance, are more distressed than men after viewing an attractive face or body of a same-sex competitor, whereas men are more distressed by the cultural success of a competitor. The same tactics used by single women to attract mates are often used to keep them. Women married to culturally successful men (e.g., ambitious men with relatively high incomes) use more mate retention tactics, including enhancing their appearance and monitoring his activities, than do women married to less successful men.

Women and girls may not injure and kill one another as frequently as men and boys do, but they manipulate relationships and spread malicious gossip at least as frequently if not slightly more so. These social tactics are called relational aggression, which includes use of gossip, rumors, and lies to sully the reputation, manipulate the friendships, and socially ostracize potential competitors. This form of aggression emerges during the preschool years and becomes especially prominent for girls during early and mid-adolescence and becomes increasingly focused on competition with other girls over romantic relationships. Although both sexes engage in and are the targets of relational aggression, it affects girls and women more than boys and men. This is because girls and women are more socially attuned to the subtleties of these behaviors and because they reveal more personal and potentially more embarrassing information to their best friends than do men and boys. If the relationship with their best friend dissolves, as it often does, girls and women often use this information to embarrass or disrupt the relationships of the former friend.

Sex differences in the form of intrasexual competition should result in sex differences in the supporting cognitive and brain systems. There are in fact many sex differences in the areas that are likely to be related to intrasexual competition; and others that are related to intersexual choice. The point is illustrated by relational aggression. If relational aggression has been a more important feature of female-female competition than male-male competition during human evolution, then the supporting traits should be more elaborated in women than men for the same reason men are physically larger than women; it facilitates

success at intrasexual competition. These traits include language fluency, sensitivity to social information, such as the facial expressions of members of the same sex, biases in social comparisons such that women focus on physical attractiveness and men on physical size and strength, among others. The empirical research is consistent with these predictions: Girls and women have advantages in most areas of language production and comprehension; in sensitivity to and memory for faces and facial expressions, especially those of other girls and women; and, self compare on traits men use in their mate choices. There is also evidence that areas of brain that support aspects of language processing are larger in women than in men, after controlling for the sex difference (favoring men) in overall brain size.

Summary

Darwin's sexual selection is a firmly established and well-supported area of study within evolutionary biology. The corresponding processes of intrasexual competition and intersexual choice and the hormonal and social (e.g., OSR) influences on how these behaviors are expressed have been studied in hundreds of nonhuman species. Sexual selection thus provides a solid foundation for the theoretical and empirical study of human sex differences.

The dynamics of intrasexual competition for status and control of reproductive resources helps to explain why men are physically larger, stronger, and more physically aggressive than women, and why boys develop more slowly (associated with achieving larger size, among other things) than girls – male-male competition during human evolution, in traditional societies and today is often physical and lethal. In traditional societies, groups of related men cooperate in order to compete with other men for control of resource-rich ecologies and control of other important resources. Within these groups, men compete for dominance and political influence, and dominant men have more wives and children than do other men. Laws, cultural mores, and other factors can influence the details of how this competition is expressed – for instance by suppressing polygynous marriage and lethal male-male competition – but the underlying motives and behavioral biases remain the same. Men compete intensely for the achievement of status vis-à-vis that of other men and for control of culturally important resources.

On the basis of men's investment of resources in children, competition among women for marriage to the most successful men is predicted and found. Women do not typically use physical aggression to compete, but they do enhance the appearance of the physical traits men use in their mate choices, and they try to manipulate the social relationships and reputations of their competitors and in some cultures maltreat their competitors' children; the latter are future competitors of the aggressors' children. There is no real mystery to these findings, as they all follow logically from cost and benefits of intrasexual competition in the social context in which men and women are embedded, as in many other species.

Intrasexual competition and intersexual choice are often opposite sides of the same coin. Men compete for cultural success and control of culturally important resources

(e.g., money, cattle) and women choose mates based on this success. The bottom line is that women choose mates based on the social, material, and in some societies interpersonal resources the man has to offer her and her future children. In traditional and developing societies, access to these resources influences how many of her children will survive to adulthood. The man's physical traits are important as well, but if forced to choose one or the other, most women choose success over looks. Men are different. They focus more on the age and physical appearance of a prospective mate than on her cultural success. Again, this bias makes reproductive and therefore evolutionary sense. The physical traits that men find most attractive are indicators of the woman's fertility.

Of course, humans form more complex societies than other species, have language, social customs, and sophisticated cognitive competencies that can result in more nuanced social and developmental influences on the expression of sex differences than found in other species. The point here is not that these other influences are unimportant, but that the evolutionary footprint of sexual selection remains with us today, despite these other influences.

See also: Comparative Primate Psychology; Cross-Cultural Adaptation; Evolutionary Social Psychology; Jealousy; Mate Selection; Sex Roles; Sexual Behavior.

Further Reading

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Sex Roles

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Glossary

Femininity Socially constructed behavioral and personality expectations based on being perceived as female.

Gender role stereotypes Rigid ideas about appropriate role behaviors.

Gender roles Organized patterns of interpersonal behaviors defined by a culture as appropriate for one's biological sex.

Masculinity Socially constructed behavioral and personality expectations based on being perceived as male.

Opposite sex Popular societal approach to gender, defining behaviors and emotions of women and men as polar opposites.

Sex roles or gender roles can be defined as role-related behavior ascribed by society to women because they are women and to men because they are men. The designation of an individual as a woman or a man may be done by the individual, by the society, or by both. Factors used as designation criteria are not consistent. The field of sex roles is one in which definitions have had more than usual importance. The questions in this field are emotionally loaded ones, which are tied to social expectations, history, taboos, and strong biological urges. Definitions determine what is studied, and what is seen as unchangeable or 'given' by nature over the life span. Sex roles, roles once seen as simple and unchanging, are now seen by psychologists as more complex, more context-determined, and more malleable, especially considering issues relating to an individual's identity as heterosexual, lesbian, gay male, bisexual, or transgender.

Further Definitions and Models

Several definitions and further distinctions need to be made to avoid confusion. The first distinction can be made between *sex* and *gender*. In 1979, Unger attempted to clarify the distinction between sex and gender for the discipline of psychology. She argued in the *Encyclopedia of Human Behavior, Volume 4* that sex should be limited to the biological bases of producing the two primary genders: the presence of XX or XY chromosomes, hormonal output from the gonads, internal and external reproductive anatomy, and secondary sex characteristics. Gender on the other hand is what culture does with the evidence of biological sex. Ultimately the culture creates expected behavior patterns or styles which are deemed gender-specific. A second distinction can be made between *sex roles* and *sex role stereotypes*. The former include the actual behaviors of males and females, which have considerable variability. The latter are oversimplified, socially-shared perceptions of idealized 'male' or 'female' actions, perceptions which usually allow little variability. Third, *sexuality* differs from *sex roles*. The roles are overt behaviors of many kinds, including sexuality, linked to 'maleness' and 'femaleness.' Sexuality is the behavior directly associated with having sex or being sexually involved. Fourth, *gender identity*, one's sense of oneself as essentially 'male' or 'female,' may or may not be reflected in one's *roles* or one's

sexuality. Fifth, *gender schemes* are the cognitive constructs used to conceptualize 'male' or 'female' roles or identity, and, although held very deeply by the person, may not be congruent with his or her behavior.

Gender differences, defined as distinctions that can be made between maleness and femaleness or between males and females themselves, are a problematic category. Psychologists often find it difficult to decide *how much* difference is a true difference. We often confuse differences in perceptions or constructs of sex roles with differences in the actual behavior of males and females. Yet, decisions about 'differences' often lead to broad public policy decisions.

Defining and measuring sex roles in polarized terms (i.e., 'male' vs. 'female') may be erroneous. *The idea that there are only two biological sexes needs reexamination.* Rabin emphasizes numerous examples from biology that indicate more possibilities than just two complementary sexes. We find hermaphroditic species which contain both reproductive capacities within one body, and even *all-female species of whiptail lizards and Hawaiian geckos* which reproduce parthenogenetically. There are large numbers of coral reef fishes and tropical sand fishes which change sex.

The popular polarization of the enormous range of human variability into two boxes at opposing ends of the human spectrum may be the consequence of normative thinking in the social sciences, added to our penchant for creating dualities by ignoring the overlapping frequency distribution curves for male and female performance. Even when a statistically significant sex difference in performance in math skills or verbal skills can be demonstrated, this larger overlap between distributions means that the individuals whose performance falls within the overlap area cannot be distinguished on the basis of gender. Many females excel in math. Many males do poorly in math but excel in verbal skills. Differences that emerge are far more likely to be individual differences than actual gender differences separating all women from all men. So the most useful approach may be to think of and to measure maleness and femaleness on a continuum.

Confusion among these terms and models leads to negative results for science and for individuals. Conceptualizations of sex roles have been a function of philosophy, history, economics, and politics. Awareness that sex roles exist, and are influential, and that this occurs at all times in life, has also been a

function of those four forces. These influences quietly shape the choice of problems to investigate and research projects to pursue. Most scientists in a given field accept some view of the world that dominates their field and choose problems accordingly. Driven by a need for cognitive consistency, individuals adopt the new view as 'natural.' In a world at war, for example, the role of a man is seen as that of a warrior, 'naturally,' and the role of a woman 'naturally' becomes that of a worker/mother; after a return to peace, the woman may be 'naturally' redefined as mother (only) while the now suddenly 'non-war-like' male is redefined as worker. Theories of adjustment, development, and mental health are quick to conform to the demands of the belief system and historical situation. For example, the integration of women in the military is taxing cognitive consistency needs in a novel way. As women are seen in warrior modes at a time when most men are not in the military, a fascinating cognitive challenge is emerging for society and for researchers. Social psychology has made it clear that even radical shifts in ideas and behavior are accepted to maintain thinking consistency, provided motivation is high enough. Researchers in human development are not immune to these general laws. We study what seems important at the time.

Gender Role Development Across the Life Span

Childhood Developmental Theories

Early views of sex role development considered masculine and feminine roles as biologically based and, once established in childhood, consistent throughout the life span. The testing movement provided the impetus to quantify and validate such views. Masculinity and femininity were conceptualized as marking the two extreme endpoints of a continuum. Individuals were assumed to be optimally adjusted if their biological sex and their sex role identity were the same. An individual who deviated from a prescribed sex role was seen as one whose psychosexual development was inadequate, rather than as possibly a person who was flexible in meeting changing environmental demands. This view reflected the Freudian approach which depicted sex role identification in terms of resolution of the Oedipal conflict. Such a resolution involved the identification of a boy with his father and the girl, in a somewhat more circuitous way, with her mother. The possible learned nature of sex roles came to the forefront with the advent of social learning theory, cognitive developmental theory, biologically oriented inquiries, anthropological investigation, and the life span approach. We are currently examining the potential validity of biological factors in gender-differentiated (on the average) behavior; for example, fetal testosterone predicts gender-differentiated behavior to some extent in both girls and boys.

Social Learning Theory

Whereas Freud and other functionalists implied that sex roles merely unfold out of an innate potential, the social learning theorists such as Bandura posited that such roles were learned via imitation and observation of parents and other adult models. Reinforcement then led to the establishment of behavioral patterns. Although changes in reinforcement contingencies allowed the possibility for sex role change, it was assumed

that the sex-typed roles did not change significantly during one's life span. Modeling the behaviors of the same sex was thought to begin at a very early age and to be reinforced into adulthood. However, research that has focused on modeling of adult behavior or global personality traits shared by parent and child has *not* found that children closely follow the behavior or personality of the same-sex adult.

Cognitive Developmental Theory

A cognitive developmental approach such as Kohlberg's held that the child's perception of sex role identification precedes sex appropriate behavior. The child discovered that two sexes existed, thought about himself or herself as being a boy or a girl, considered differences between the sexes, and came to some fairly stable notions as to what 'boy/man' versus 'girl/woman' connoted. Some of the same behavioral factors that the social learning theorists proposed were also expected, except that cognitive identification with a same-sex parent *preceded* the modeling of behaviors in terms of observation and imitation. Cognitive developmental psychologists also assumed that both children and adults maintained a relatively consistent concept of themselves as male or female, and that the search for congruence between beliefs and behavior led to the maintenance of appropriate roles. This view may be contrasted with the social learning view in which reward is the key to the persistence of sex-appropriate behavior. Both theoretical viewpoints, however, emphasize the establishment of such an identity early in life with consistency in adulthood.

The learning perspective on sex roles has also received a valuable contribution from the biological perspective of Money and Ehrhardt. These researchers have studied children who genetically, and on the basis of prenatal hormones, would have been expected to develop the gender identity of one sex but because of mishap (e.g., structural damage or deformity of the genitals) were assigned to the other sex. Interview data collected from the families of such children indicated that seeming acceptance of the assigned sex and gender role identity development proceeded commensurate with the child's acceptance of assigned gender identity. While these studies are by no means conclusive, they do point out the overwhelming impact of socialization.

Anthropological Investigations

Anthropological study has supported the learned nature of sex roles and has led to questioning the notion of consistent, appropriate behaviors for each gender. The large impact of culture on any given society's notion of what is appropriate male and female behavior dates back to Mead's (1936) comparison of three primitive societies. Both the men and women of the Arapesh tribe were described as being passive, nurturant, cooperative, and sensitive, traits perceived as feminine in American culture. The Mundugamore men and women were characterized as aggressive, suspicious, and uncaring, traits perceived as masculine in American culture. The Tchambuli men behaved in ways our society typically defines as feminine while the women exhibited what we might define as stereotypically masculine traits. The importance of culture-specific specialization has been expounded in numerous articles and

books with respect to more modern societies as well, for example, Wood and Eagly. Division of labor between the sexes is universal in traditional societies, partly because whatever women do has to be compatible with infant and child care, and partly because division of labor is an efficient survival mechanism. Sex roles show a high degree of variation across cultures, even to the point of the sex role reversal of the Tchambuli.

The issue is not the existence of sex roles so much as the unequal valuation of women's and men's roles common in so many cultures, including that of North America. Even in Tchambuli society whatever men do is valued more than what women do. The roots of gender inequality were first studied by Sanday and continue to be examined by anthropologists. Sanday's premise was that gender inequality (not valuing women's roles and men's roles equally) comes about largely as a consequence of the physical environment in which a group is trying to survive. Harsh environments are associated with patriarchal societies high on aggression including both war and rape. Gentle environments are associated with equalitarian societies which are typically peaceful and where rape is rare or unknown altogether. The most extreme environments (the polar regions and the Kalahari desert) produce gender equality because everyone must contribute fully just to survive (Tanner) and there is no time or energy for war.

The anthropological perspective has been used by researchers such as Gutmann to explore the function of sex roles in terms of survival of the species. Cultural universals are presumed to reflect basic human propensities; their consistency is assumed to be of some importance in terms of survival. Proponents of the learning approach, which emphasizes socialization, view exceptions to cultural universals as evidence for the greater impact of environment on heredity. Opponents point out that a few exceptions do not make a case against biological mechanisms but rather show evolutionary change within some special environmental conditions. These arguments are completely superseded by the new science of epigenetics in which the old nature-nurture dichotomy is made irrelevant. Epigenetics reveals complex ways in which gene expression is turned on and off by environmental influences. The mechanisms enabling the environment to modify genetic readout are RNA interference which can silence the DNA, histone modification, and DNA methylation, both of which can alter gene function. Rabin has long maintained that dualistic thinking needs to be replaced by developmental-interactionist paradigms, which the emergence of epigenetics now makes imperative.

Adult Developmental Theories

The life span approach to sex role development has been a relatively recent phenomenon. In early work, Neugarten, Gutmann, and Block explored changes in male and female role expectations during adulthood that were based upon social expectation and major developmental tasks. Block and Riegel viewed the manifestation of cultural sex roles as a function not only of biological demands and past learning experiences, but also of the nature of economic systems, the historical moment, and the philosophical system within which they are defined. Thus, sex roles in this perspective imply dynamic change based upon the individual change and the social and cultural climate.

Loevinger's milestones of ego development and their extrapolations to sex role development form the basis of Block's approach. In the earliest period, the main development concerns of the child are genderless, and identity constitutes a mere naming of gender: 'I am a boy/girl.' Later, conformity to learned patterns becomes the main task; this is reflected in the development of sex role stereotypes and sex role bifurcation. This conformist stage is followed by one of self-criticism based on comparison with an abstract ideal, thereby moderating the stereotypical role. With the advent of autonomy, individualization results as conflicts, aroused during the conformity and conscientious stages, are resolved. At this point, differentiation of sex role is said to occur. The highest, most integrated level of functioning finds the individual evolving a complex identity which combines aspiration, experience, and previously polarized traits. In sex role terms, this period is one of androgyny.

Hefner, Rebecca, and Oleshansky have proposed a life span approach to the development of sex role identity. Their hierarchical stages include: (1) global, undifferentiated sex roles, (2) polarized or traditional masculine/feminine roles, and (3) transcendent roles which combine both masculinity and femininity. While the young child most likely has not defined a sex role and the adolescent most likely has overdefined it, the adult synthesizes roles into more complex wholes. For individuals who have 'transcended' masculinity and femininity, psychological adjustment is no longer tied to these dichotomous sets of traits, or even the blend of androgyny. Unfortunately, the measurement of 'sex role transcendence' as distinct from androgyny has not yet been fully operationalized.

A problem with sex roles is that they are most often unequal in power. The social dominance theory of gender (Pratto and Walker) indicates that males promote hierarchy-enhancing values based on male power and status whereas women use hierarchy-attenuating strategies that favor equality.

Garnets and Pleck have presented a concept called sex role strain analysis. Their viewpoint combines social learning and life span development. They feel that the ultimate harm of traditional sex roles is the devaluation an individual may experience if he or she does not conform to traditional standards set by sex role norms. Thus, strain results from discrepancy between the individual's self-perception and his or her perceptions of social expectations. Pleck delineates the damage that the male sex role does to both the individual and society. As long as the core of masculinity is perceived as power and dominance there can be no equality between the sexes. Femininity defined as niceness and nurturance is counterproductive to success and achievement in North American culture. As women increase their access to power, they are accused of being unfeminine and threatened with being labeled lesbian. Gender role nonconformity in males is dealt with far more harshly as being labeled a gay male typically results in violent consequences.

Sinnott described a postformal theory of adult sex role development. A number of investigators have recently addressed the topic of 'postformal' operations, that is, those structures of thought which are a stage more complex in organization than Piaget's formal operations. More work on postformal, mature adult thought is being done, possibly since the idea of cognitive development beyond adolescence is an appealing one. The question of interest here is: How might

formal and postformal operations be related to a life span model of sex role development? To address this question, it is necessary to examine some aspects of postformal operations and the argument itself more closely. The argument is a post-modern one.

What kind of case is being made for a relation between cognitive development, especially formal and postformal operations, and sex roles? To oversimplify, it is the same type of case that Kohlberg makes about cognitive development and early sex role development and about cognitive and moral development. Social relations, of which sex roles and moral development are examples, may be seen as based upon cognitive skills. As cognitive skills develop, social relations can be understood and can also become more complex. At those times, when the world can be known in a manner more complex than an abstract, formal one, roles also might be known in a way that is more complex. Having thought of the role in a complex way, one could then live it in a complex way.

How would roles be known in postformal terms? To answer this question, one must look at theories of postformal operations. According to Kramer, authors of these theories all state that postformal thought is: (1) a distinct stage, (2) which subsumes formal operations, and (3) which incorporates a relativistic view of truth. Generally, then, a postformal cognitive stage could underlie a view of sex roles in which roles are not absolute but are created relative to the actor. Some given formal structure of roles would be consciously chosen, based on some belief system that is a subjective view of 'truth' from among a number of formal role structures. Further, what constitutes a given role would be known to be somewhat arbitrary and based partly on the perceiver's own experiences and resultant ideas of the role. The postformal concept of sex roles, then, includes a necessary subjectivity. It operates by laws such as those of the new physics as described by Sinnott.

The role taken, or the role which one perceives that another takes, becomes what is agreed on by the persons in the interaction. The reality of the role is therefore determined by a system of beliefs held by the persons in the interaction. The individual is not in a roleless, undefined state, nor in possession of an absolute unchanging role, which is a permanent descriptor of one's identity. Rather he or she is constantly, perhaps even consciously, creating a flexible role definition in relation to individuals and circumstances in context. In the framework of Kelly's theory of personality, persons are always constructing a new social meaning for the self in the context of evolving social structures within a given society's institutions.

Role behaviors also may be seen as attempts to solve everyday life problems. Individuals learn to act in a way which helps them meet their goals. In the context of problem-solving, which is a cognitive function, postformal thought-based roles might permit greater creativity in using strategies to solve problems where the problem goal is unclear. Most everyday problems fall into this category.

Systems Theory and Adult Sex Roles

Systems theory is a theory of interacting processes and the way they influence each other over time to permit the continuity of some larger whole. Systems act so as to continue. Systems

change because their own balances are not optimal or because they are influenced by other systems. Some authors who provide excellent descriptions of these general ideas are van Bertalanffy and Miller. Miller's discussion of *living* systems is especially useful to consider for a discussion of sex roles. Individuals, societies, and cells all appear to use similar processes to create boundaries, to take in stimulation, to process information, to act, and to change. For example, for cells, information may be chemical and may be filtered by cell walls; for persons, information may be conceptual and may be filtered by perceptions; for societies, information may be news and may be filtered by censors. Cells, persons, and societies all exist in relation to each other, which further complicates matters. Within systems theory, roles are structures of the social system which are equivalent to organs in the physical/person system; they are organized ways of ensuring that some vital function is performed.

As living systems – be they cell, person, or society – develop and age, they appear to proceed through a regular set of stages. They begin in disorder, that is, with a few parts concrete and defined. They become more orderly, defined, and bounded over time. They become rigid before they disintegrate and die as systems. System changes may be further described in chaos theory and complexity theory.

How does this relate to sex role development over the life span? Consider the person and society as living systems, each seeking continuity and meeting survival needs. These needs include control of information and energy flow. Sex roles are ways in which persons and social systems can regulate the flow of information and energy (effort) while taking care of survival needs. The early stages of these systems are disordered with regard to roles, that is, no roles are apparent. For example, the newborn is sex roleless, and a group of strangers are roleless as a group. Later stages are associated with more concretized roles; in the person and in the group, masculinity and femininity may emerge. Final stages find the roles rigid and inflexible, so they would fail to respond to the pull of new needs. This failure of response leads to disorder and a search for new, more complex order. Systems theory suggests that this may be the kind of transition we are seeing in societies now, and in the individual after the reproductive period and parental imperative (Gutmann). The person having rigid roles (sex roles or other roles), faced with new demands, might adapt with new complex integrations of role-related behaviors, or might keep a *dysfunctional* system. Chaos theory and theories of self-constructing systems may also prove to be important sources of hypotheses.

Major Conflicts in the Field of Sex Role Research

Six major conflicts have emerged in the field. Future research is likely to focus on these, as well as moving along to others. First, to what extent are roles fixed or flexible? Early theorists saw roles as biological and fixed, at an early age, for life. More recent theorists see roles established, then evolving, based on age, societal demands, etc. Second, how central are roles to personality? In more traditional societies in need of population growth, sex roles seem to be a core organizing principle of

personal functioning; in less traditional cultures, they seem to be adopted and cast off with less impact on the person's sense of self. Would the population or environmental concerns influence behaviors today? Third, how closely do roles relate to identity? This is a subdivision of the second question. Fourth, should roles be measured taking into account context and self-perception versus actual behavior? If roles need not be fixed, *context* might be extremely important to self-description since success as a parent (for example) often requires different traits from success as an employee. In another example, the single female parent may best use a combined role the earlier theorists labeled 'masculine' as well as 'feminine.' Also, one's consistent self-concept, as perceived by the self, may be very different from what witnesses see the person actually doing, since the person may be verbally expressing what he or she has been told *should* be said. Fifth, are stereotypes, sexism, and power politics inherent in sex roles? Some theorists maintain that since roles have always been connected to power, domination, discrimination, and stereotypes, this is a part of their dynamics. Other theorists maintain that roles could be conceived of (and studied) as value free and power neutral. Sixth, should we study *change* over time in roles? Developmental studies have demonstrated that changes seem to occur, based on age and history. How important are they for day-to-day applications of sex role knowledge?

Consideration of these conflicts, and the issues on which theorists agree, leads to several recommendations for future research and theory. Several conclusions can be drawn from early and recent literature on life span sex role development.

1. We must not jump to conclusions that responses on a scale will be predictive of behavior. Individuals may say that they are 'masculine' by their scale responses, but may mean they are masculine with regard to stereotyping concepts. They may perceive themselves differently in different situations, may act other than their self-ratings, and their behavior may vary from situation to situation. They may do what is most rewarding and that may happen to be masculine. They may score themselves masculine due to the development of an identity labeled masculine. They may do so since masculine behavior is socially desirable. They may change in self-definition due to life stage demands, or when their own concept of masculinity is no longer like their behavior, even if to everyone else they are still 'masculine,' by some other definition. And they may label themselves or act as they perceive society expects them to do. Since all these factors may underlie their responses to the scale, it is difficult to predict behavior based on scale responses.
2. Responses to sex role instruments do mean something. What is meant may be tempered by each person's perception of unspoken situational constraints and other factors mentioned above. If individuals respond appropriately, they are matching themselves to global standards designed to reflect the clearest opposition between gender-assigned roles.
3. Masculinity, femininity, and androgyny have been shown to be adaptive. Depending upon the situational demands, subject to the constraints above, any of the roles might be adaptive. The real question is, what is the most useful role in a certain setting: masculine, feminine, both, or neither? Useful may mean 'liable to be rewarded' or 'consistent,' or 'workable by some external criterion.' Androgyny may be the most adaptive response in terms of the last criterion; masculinity may be the most adaptive in terms of the first.
4. Sex roles are meaningful in terms of social expectations. The concept of global, oppositional, gender-linked roles is present for all members of society, and society imposes these role expectations on individuals so long as the real characteristics of those individuals are not known. So whatever complex designation of role and behavior one adopts, the general 'other' is still seen as conforming to the global stereotypes. Individuals also perceive role expectations projected by others, and, to the degree they are conformists, attempt to conform to them.
5. Sex roles are meaningful ways to order one's sense of self as socially efficacious, to create a sense of personal conformity, and to order self-concept. The creation of the self-concept is partially accomplished by acting and noticing that the self is the center of effective actions. Roles permit structured action likely to work in a society. They are also labels that live on beyond the individual and can be generalized to many situations. Knowing a sex role without knowing the meaning of that role to the person is to take only half a step toward knowledge.
6. We must distinguish between gender roles and gender identity. An individual can engage in gender role nonconformity and still be completely self-identified as the gender congruent with their biological sex. Lesbians and gay men are often perceived as gender-role nonconformists and punished by society for upsetting the social order. The societal assumption that lesbians identify with masculinity and gay men with femininity entirely misses the female gender identity of lesbians and the male gender identity of gay men. Further, the large number of lesbians and gay men who are gender-role conformists are often viewed as less problematic in terms of sexual orientation diversity than are gender nonconformists.
7. The meaning of sex roles depends on age and developmental stage. Meanings are related to modes of cognition and social demands at each period. They are also related to the previous history and experience of the person and the historical period in which the society finds itself. Infants can know roles in direct physical forms, but cannot know them in the abstract. The concrete operational person can know roles in the abstract, and the formal operational person can build logical systems of roles. The postformal person can see roles relativistically as cocreated by persons in them.
8. Models of sex role changes over time can be of many types. Change can be more complex than increase or decrease in global qualities. Change might occur on one dimension but not on another, or in global role traits but not in behavior, or vice versa. Change might be triggered by specific events or might represent an accretion over time. It may be reversible. Change might result from diffusion of a self-concept until its meaning is so muddy that it can

become something new. Change might depend on past rates of change. It is useful for investigators to be clear about their underlying model of change as they discuss sex role development.

9. Sex role complexity and adult sex role development may be linked to cognitive abilities like postformal thought or problem-solving skills. Roles have been linked to cognitive processes such as concept formation. As cognitive operations become more complex, their associated roles might be seen as multifaceted rather than one-dimensional.
 10. Sex role development-related questions (e.g., 'Am I being feminine?' 'What is the masculine thing to do at any age?') may be conceptualized in decision theory or problem-solving theory as ill-structured problems. This means among other things that they have an unclear goal. Decisions must be made about the nature of the goal as a part of solving the problem. Problem-solving literature can be a guide to dimensions we need to test to understand the process of solving sex role behavior/self-concept problems. This application of cognitive theory has not yet been attempted.
 11. Sex role developmental theories suggest new physics concepts and might make use of them. A multivariate approach needs to be taken in sex role studies, in that adjacent centers of causality – other persons, the social order – cause changes in an individual's sex roles. The person, in turn, causes changes in the social order by his or her perception of roles and by action on that perception. It is clear that one's vantage point in measuring sex roles is very important in drawing conclusions about the results. These models have companion models in the physical sciences that could be used in studies of change, both change in a person and change among systems.
 12. Sex role development theory can make use of ideas in systems theory. Personal and social systems are connected by many roles, among them sex roles. Theories of living systems give us an outline of the processes within and between those two systems. The flow of information can be studied within and between systems, and roles are part of that information flow. A study of system boundaries can be conceptualized as a study of rigid or flexible roles and the capability of the society or person to perceive or enact them. Future studies can take this model of living systems into account. Models of complexity and chaos may also be useful.
 13. Emerging ideas suggest that in the future, roles will be orchestrated consciously by the person, rather than being imposed consciously or unconsciously by society, or being left to the mercy of unexamined forces. Each child may grow up aware that she or he has a wide spectrum of role possibilities that can be acted out in spite of any biological predisposition.
 14. Sex- or gender-related behavior may have some biological underpinnings. To what degree might they be influenced by other factors over the course of the life span or be in circular causal relationship with other factors?
1. Role stereotypes (positive and negative), role-related behavior, and gender-linked expectations must all be considered as potentially different phenomena in sex role research. The nature of test questions themselves is important. The scope, nature, variability, and contextual factors in each must be explored.
 2. Roles must not be assumed to be linked to actual behavior or to be predictive of behavior, without evidence.
 3. Role strength must be considered; one can be considered masculine, feminine, or androgynous only relative to some standard.
 4. Perceptions, intentions, belief systems, and meanings are important neglected variables in sex role research.
 5. Sex role life span research should be integrated with Piagetian approaches, cognitive work in general, and problem-solving research.
 6. Sex role development research should use models of change over time from new physics, chaos theory, complexity theory, and systems theory to broaden the repertoire of multivariate approaches at its disposal and better reflect the reality of these complex multisystem changes.
 7. The impact of roles on society and the species and the utility of roles for society and species need to be considered.
 8. Learning and developmental effects need to be considered jointly in future research.
 9. The degree of intersection of biological and other factors in sex/gender roles and behavior cannot be assumed but must be tested.
 10. What is adaptive depends on situation, developmental stage, reward and punishment contingencies, past history, and the energy-available state of the person-system at that time. The factor of fear of change or deviance is important.
 11. People have different styles of achieving the same goal or enacting the same intention, or reporting the same attitude.
 12. Self-concept personal continuity, and personal effectiveness are seldom examined but enter into the picture of sex role development.
 13. Methodological issues need to be clarified, especially including longitudinal research on factor changes. But current approaches still give useful information with careful interpretation.
 14. Evolutionary psychology strives to reduce sex differences to genetic differences derived from human evolutionary history, and gender roles are explained as deriving from genetic advantage. Yet, same-sex attractions abound in nature. We need to clarify the effects of the degree of equality between the sexes in each society, which appears to have a stronger impact on the selection of a human mate than does evolutionary history.

Future work should address the following questions and issues:

See also: Interpersonal Perception and Communication; Personal Relationships in Everyday Life; Personality Development; Sex Differences; Social Cognition.

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Sexual Behavior

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Glossary

Atypical sexual behavior Sexual activities that many people consider outside the norm, often motivated by sexual fetishes.

Female orgasmic problems Difficulty in becoming sexually aroused, staying excited, and reaching orgasm.

Fetish A body part, material, or object that arouses sexual desire and may become necessary for sexual functioning.

Premature ejaculation Ejaculation before a man wishes, also called early or rapid ejaculation.

Typical sexual behavior Sexual activities that fall within typical developmental patterns.

In an article of this length, human sexuality is best approached from a developmental perspective, starting with infancy and tracing behavioral changes into adulthood. This is arguably the most interesting and theoretically valuable approach for understanding human sexuality. Some form of sexual behavior has been observed in utero, before birth; and babies engage in a variety of sexual activities in the first few years of life. It is most informative to study how more complex sexual behavior develops from the earliest manifestations. Understanding the biosocial processes behind sexual development is intellectually fascinating and of great practical value for people who want to improve their own sexual lives – even if they do not draw upon this knowledge until some later phase in life.

Before Puberty

Infants are born with sexual reflexes, and newborns can have vaginal lubrication and penile erections from the earliest days of life. In fact, ultrasound imaging of pregnant women reveals that male fetuses sometimes have erections before birth. It is more difficult to study the sexual responses of female fetuses, but there is evidence that some of them have vaginal lubrication and genital swelling in utero.

After birth, many infants and children have sexual experiences, such as spontaneous erections and vaginal lubrication in the first months of life. Many infants discover masturbation by their second year. Most people cannot recall these events later in life, as the early years of life are often poorly remembered, if recalled at all. The earliest sexual activities are not consciously planned or intentional in nature: they are based on inborn reflexes that are mediated by the lower parts of the spinal chord.

Infants are born with numerous other reflexes, using their fingers, arms, and other body parts in exploratory movements, gazing at various stimuli in their visual field, and startling with sudden sounds. Beginning in the first week of life, they are exploring the world of novel stimuli they have been born into – using various sense modalities. As they develop better hand-eye coordination and improved motor control, they gradually gain improved skills at exploration and eventually their hands make contact with their genitals, along with many other parts of their bodies.

As touch to the genitals is capable of eliciting the sex reflexes and activating the pleasure centers in the brain, babies

experience pleasurable feelings when their exploratory fingers stimulate their genitals. Because of these reinforcement processes, many infants learn to repeat such genital touching with increasing frequency over time. Infants do not innately know that they should or should not touch their genitals during early exploration, but such touching is very common.

Infants may also experience sexual responses when bed sheets or clothing rub against their genitals. In some cultures, adults touch babies' genitals to sooth and calm them with pleasurable sensations, although that could be called 'child sexual abuse' in many developed nations.

Some parents accept their infants' masturbatory behavior as natural and allow their children to learn additional masturbatory skills. When children are not punished for genital self-stimulation, the natural reinforcers associated with touch to the genitals can lead children to learn increasingly effective habits of self-touching. A small percent of children learn how to stimulate themselves to orgasm in the first couple of years of life.

In homes where parents punish their children for genital touching, the punishment may suppress genital exploration and leave the children with inhibitions about doing sexual activities – if the punishment is frequent and strong enough. As these children grow up, they may never remember why they feel inhibited about genital self-stimulation – or sex in general.

The degree of inhibition that children feel about masturbation lies on a continuum from low to high. Repeated experiences with the pleasures of self-stimulation along with low levels of punishment produce few inhibitions, and uninhibited children may even masturbate in public places, such as grocery stores, parks, preschools, and so forth. Usually, there comes a time when someone – a family member or preschool teacher – senses that the child is engaging in too much public masturbation. At this time, some socializing agent may try to teach the child a basic discrimination: "It is all right to touch your genitals in the privacy of your own bedroom, but not in public." Sooner or later, most children learn to abstain from public masturbation, but many children also learn that genital self-stimulation can be done in privacy – without negative consequences – when done discreetly.

Children from homes where genital touching has been strongly inhibited may not masturbate for years, if ever. Many factors influence the time at which a young person may overcome earlier inhibitions and begin to masturbate. If a young person hears peers talking about masturbation or sees peers

doing it – or sees the activity portrayed in a movie – even well-established inhibitions may eventually be countered by observational learning or sex-positive information, after which the pleasures of genital self-stimulation may boost the frequency of masturbation and either partly or completely diminish the earlier inhibitions.

Young children often have questions about their bodies, other people's bodies, where babies come from, and more. These childhood questions are often simple, as children's understanding of life is still quite rudimentary. If parents answer these youthful questions simply and honestly, children can begin to learn explicit verbal knowledge about sexuality – along with the fact that their parents are happy to help them understand sexuality. As they continue to learn, children tend to ask increasingly complex questions, and parents can answer with increasingly detailed answers – or say that they need to check a book or website before they can answer. Parents should not feel bad if they cannot answer all of a child's questions about sex, especially if their willingness to locate the information shows their openness to the child's questions and an appreciation of the child's curiosity.

Unfortunately, many parents do not respond to their child's questions with relaxed and useful answers. If they show nervousness, discomfort, or other negative emotions in their voice or demeanor, they may signal the child that there is something bad or inappropriate about the topic. After several such experiences, many children stop asking sex questions, which is unfortunate, as parents can be very effective at giving sexual information to their children. Many families claim that parents should be the primary source of sex education, yet the majority of parents continue to cause their children to feel inhibited about asking questions and talking freely about the topic.

Parents may fear that their children might become overly interested in sex if they answer their children's questions, but that is usually not a warranted fear. Most children are curious about so many facets of their lives that sex usually does not occupy a large portion of their total range of concerns. Most children ask about a few dimensions of sexuality, and then move on to explore other interests.

Some children engage in sex play with other age mates and learn about sexual things on their own. The number of possible scenarios and learning experiences is enormous, as the dynamics of sex play can vary so much from child to child. Children may play 'doctor,' 'show,' 'house,' or kindred games with other children. A child 'doctor' may listen to another child's complaints about a sore throat, and then decide to examine the other child's genitals. Childhood sex play is usually quite innocent and may go no further than viewing the genitals of a playmate.

A few children learn about taking off their clothes and rubbing their bodies together, and a smaller number discover sexual intercourse. Even though people often think that incest taboos would prevent brothers and sisters (or other relatives) from exploring coitus, most children have never heard about incest taboos – or do not know what those words mean. Even though there exist some evidence for the presence of inborn psychological mechanisms that diminish children's interest in exploring sex with relatives, such mechanisms do not completely prevent incest. Once these children discover that their incestuous sex play is socially unacceptable, they may feel

guilty and be mortified that they have done such things; but it is understandable that unguided sex play can lead closely related, similar aged individuals to discover intercourse. Several empirical studies show that even explicit childhood sex play does not produce long-term adverse effects in most cases – although abusive relations involving adults can.

Parents and teachers should know the normative data about sexual learning. By the ages of 2–5 years, children commonly masturbate, reach toward or touch female breasts and try to observe others when they are undressed or disrobing. Psychologists do not consider these activities to be unusual or problematic. By ages 10–12, these types of public sexual activities tend to decrease in frequency, although many children at this age begin to show an increased interest in the other sex – or the same sex if homosexual.

There are a few warning signs that suggest a young child might be too interested in sex. The very mildest sign is that the child shows a preoccupation with sexually explicit conversations or frequent masturbation. The next more serious signs include a child's repeatedly touching the genitals of others or having sexually explicit conversations with people who are of quite different ages. The most serious signs of possible problems involve a child's having oral, vaginal, or anal penetration with dolls, animals, or other children: this most serious level might warrant professional counseling.

Theoretical Interlude

This article began by stating that a developmental perspective on sex is theoretically valuable, and we can now explain why. Tracing the emergence of sexual behavior from infancy onward helps us understand how nature and nurture interact. Both biological and learning processes are involved in the gradual emergence of sexual behavior, and developmental studies reveal how nature and nurture interact and entwine with each other.

In the past, many people tended to fall into the trap of wanting to explain sexual activities – and many other types of behavior – as 'completely due to biology' or 'completely due to learning.' This is still seen when people begin arguing for *either* 'nature' or 'nurture' in the frequently held discussions about nature *versus* nurture. Modern science avoids this 'either/or' logic by focusing instead on ways in which biological, learning, and social inputs interact to shape our thoughts and behavior – which in turn are mediated by multiple neural systems that operate at both the conscious and unconscious levels.

Studies on sexual behavior allow us to intertwine data and theories that incorporate biology, psychology, and sociology. Men and women are biologically different in many ways and some of these differences influence their thoughts, emotions, and behavior significantly. People's location in society also affects their thoughts, emotions, and behaviors. The simplest way to integrate all the elements that shape sexual behavior is to follow a developmental time line that starts with birth and traces the following decades of maturation, learning, and socialization.

We have already given descriptive information about several features of prepubertal sexual development. It is time to detail the key elements of the nature–nurture interactions, beginning where this article started.

Reflexes

Both vaginal lubrication and penile erection are based on sexual reflexes, which are biologically built into the body's neural and cardiovascular systems. From infancy, stimulation of the genitals activates these reflexes – causing the sexual organs to swell – and elicits pleasurable feelings in the reinforcement centers of the brain. These positive emotions are the primary reinforcers which lead to various types of learning.

Operant Learning

The pleasurable feelings associated with sex serve as reinforcers that can strengthen behavior, through a process called operant learning. Reinforcers explain why an infant's early random touching of the genitals can become more frequent and eventually a habit. In common parlance, this type of learning is often referred to as 'trial-and-error' learning, although the word 'trial' is a bit misleading. When infants are first touching their genitals, they are not 'trying' to get sexually excited or reach orgasm. They are merely exploring with their hands and they accidentally discover the pleasures associated with sexual stimulation. Infants have no intentions of discovering sexual pleasure, but when early random explorations lead to pleasing feelings, positive reinforcement increases the chances that, on later occasions, exploring infants will repeat those types of self-stimulation that were pleasurable in the past.

As infants touch themselves in different ways, the more rewarding forms of self-stimulation become 'habits' and the less rewarding ones gradually become less frequent. The result is that infants become increasingly skillful at self-stimulation, and adults begin to call the behavior masturbation. Of course, babies do not have a word for masturbation; hence, they cannot verbalize or subjectively understand the words adults use to describe the activity.

Operant learning derives its name from the fact that some behaviors (such as touching) operate on the world in ways that may produce consequences. There are two kinds of consequences that affect operant learning: reinforcement and punishment. The pleasure that a child experiences when touching the genitals provides positive reinforcement for repeating the activity. To reinforce means to 'strengthen,' and reinforcers strengthen behavior (much as steel rods can be used to strengthen concrete, to produce reinforced concrete). The pleasures of genital stimulation are called 'primary reinforcers' to indicate that they are biologically 'wired in' as part of the sexual reflexes. This shows how biology and learning interact, helping to avoid an 'either/or' approach to the nature-nurture debate that emphasizes the importance of one element and devalues the other.

There are 'primary punishers,' too; and they are also biologically 'wired in.' Hitting the testicles or ovaries is painful for biological reasons: it endangers these important reproductive organs, and we have evolved to find such experiences aversive. The primary punishers of pain help us learn to avoid hurting our ovaries and testicles when possible.

Not all reinforcers and punishers are 'primary,' meaning biological, in origin. Social reinforcement for exploring sex with others can occur when a child's peer group rewards taking a dare about some sexual activity. As we have already seen,

social punishment can occur when caregivers punish a child for masturbation; the stronger the punishment, the more the inhibitions it produces.

Rule-Guided Learning

Young infants can learn how to masturbate, even though they cannot put words on the behavior or think about it in symbolic terms. Once children begin to use language, they can take verbal information and use it as 'rules' to hasten operant learning. If a teen frequently hears about the importance of using condoms to reduce the risks of becoming pregnant or contracting sexually transmitted diseases (STDs), the words can serve as rules that help the teen avoid the errors that too many young people still experience through 'trial-and-error' learning. Rules can be helpful in guiding people to learn more effective bedroom techniques, relationship skills, and much more. Having positive consequences strengthens the habits of continued rule use.

Observational Learning

Even when no words are spoken, people can learn operant activities by watching others, through a process known as observational learning. For example, sex therapists encourage people to observe how their partner masturbates to see what they can learn from these observations. It can help both observers increase the range of techniques they can use together. When a girl sees her best girlfriend getting pregnant, this observation can be a big wake-up call about the need for using contraception. Movies, DVDs, books, and the Internet make it easy to learn about sex, although not all the information is accurate. Much of our behavior is learned by observing others, and sex is no exception.

Pavlovian Conditioning

While operant learning affects the frequency of behaviors that operate on people and things, Pavlovian conditioning alters the reflexes – which evolved to respond to a narrow range of stimuli. Pavlovian conditioning allows inborn reflexes to be linked with *new* stimuli in ways that we did not evolve to experience. Because salivation helps start the digestion of food, dogs (and many other species) have evolved to salivate when they smell food. By ringing a bell before presenting food, Ivan Pavlov conditioned dogs to salivate to the sound of a bell, thereby expanding the range of stimuli that elicit salivation.

The pleasurable feelings of the sexual reflexes can be associated with all sorts of stimuli via Pavlovian conditioning. We are biologically prepared such that touch to the genitals triggers the sex reflex, but many other stimuli can become associated with sex via Pavlovian conditioning. A young woman who pays attention to her boyfriend's hairy chest while having sex may come to find hairy chests to be a sexual 'turn-on' or 'erotic stimulus.' Later she may notice that she becomes sexually aroused when she sees other men who expose hairy chests.

Whatever people are thinking about when genital touch elicits the sex reflexes can become a sexual turn-on. A young man who masturbates while watching pornography is pairing new stimuli with the sex reflex, and he may end up feeling

sexually excited by seeing or thinking about such activities in the future. Even if he does not masturbate while viewing porn, he may think about the pornographic images when he masturbates at a later time, thereby sexualizing those stimuli. If he asks his girlfriend to do some of the things shown by the porn videos, his girlfriend may be happy to oblige; but some girlfriends are surprised that their boyfriends would even think about enacting porn scenes, and this can create problems for the couple.

Masculinization of the Brain

During a critical period of fetal development, boys' testicles produce a burst of prenatal testosterone, which alters their brains in ways most females do not experience. As a result, boys and men tend to prefer somewhat higher levels of rough-and-tumble play, rowdy activities, and vigorous physical movements, compared with girls and women. There is a great deal of variation in optimal activity levels in both males and females, but males tend to prefer higher activity levels than females do. These differences often persist well into adulthood. This does not mean that boys cannot learn to control themselves and play gently with others, but many males continue to prefer higher levels of activity and sensory stimulation than do females well into adulthood. This contributes to a commonly observed gender difference in the activities that males and females gravitate toward. For example, it is easier for males than females to learn to love football, soccer, and dirt biking.

There are genes that lead some males not to secrete enough testosterone to fully masculinize the brain, and this may predispose these males to become homosexual. The biologically heritable component of male homosexuality is about 50%. Lesbians appear to have about a 25% heritable component to their sexual orientation. Personal learning, culture, and many other variables complement the heritable influences in the development of homosexuality.

In summary, both biology and learning are important in the development of sexual behavior and both are intertwined starting from infancy. The following sections show how nature and nurture continue to interact after the onset of puberty.

Puberty and Afterward

During puberty, males begin to produce higher levels of testosterone than in childhood, and females begin to produce more estrogen and progesterone. As a result, the genitals become larger and hair develops in various parts of the body. Girls develop breasts, and boys who exercise vigorously see their muscles grow larger. Testosterone allows males to develop considerably more muscle mass in the upper body than can females who do the same amount of exercise.

The sex hormones also make the sexual reflexes more sensitive and responsive than in childhood. Sexual stimulation feels more exciting and rewarding; sexual responses are more noticeable. Therefore, masturbation feels better after the onset of puberty than before. No wonder the frequency of masturbation tends to increase after the sexual hormones rise to the adult levels.

As adolescents experience these bodily changes, they may feel proud or embarrassed, depending on the family and

society in which they live. Families and cultures that acknowledge the beauty of the natural processes of puberty and sexuality are likely to have children who feel good about the changes in their bodies and sexual feelings. On the other hand, sex-phobic homes and communities create conditions where children may feel unhappy or guilty about the changes of puberty and try not to think about them.

Girls who are not told in advance what might happen with their first menstruation can be terrified when they have their first period, thinking that their bleeding stems from a disease. As sex education has become better incorporated in elementary education curricula, fewer girls are traumatized by their first menstrual period than in the past. Boys who are not told in advance that they may begin to have nocturnal emissions (or 'wet dreams') can likewise be frightened when these natural processes begin. Some think that they may have a cancer or some other serious disease. If they have already learned to masturbate, they may fear that the nocturnal emissions are symptoms of a malady caused by their self-stimulation.

Obviously, good sex education can help young people avoid the anxieties and fears that many adolescents had in the past. Young people who learn accurate sex information early in life are most likely to make the transitions of puberty with the least anxiety and trauma. Many studies have shown that young people who receive comprehensive sex education do not become more sexually active or promiscuous than peers who are deprived of such knowledge. Additionally, well-educated young people are more likely to use contraception and take precautions about STDs, which reduces their risks of having problems, compared with peers without accurate sex education.

The increased interest in sex that many young people experience during puberty may lead to more questions and a hunger for knowledge. If young people can talk with their parents and/or teachers, they can learn valuable information from them; but many young people turn to their peers – where they may obtain various mixes of accurate and inaccurate information. The mass media and Internet also contain a complex assortment of valuable and misleading information, and it can be difficult to distinguish between the two types of inputs.

One important point in life for most young people is the time at which they lose their virginity. There are various definitions for the milestones that mark the loss of virginity, and these vary from culture to culture. The traditional definition for heterosexuals is the first experience of penile–vaginal intercourse, but teens may not know if the first experience with oral or anal sex marks the loss of virginity.

In cultures where young people think that engaging in oral or anal sex does not involve a loss of virginity, some may explore these activities in hopes of remaining 'technical virgins.' Unfortunately, oral and anal sexual activities can transfer STDs, some of which have serious repercussions. Gays and lesbians typically define the loss of their virginity without reference to penile–vaginal intercourse, which can include their first passionate kissing, naked body rubbing, oral sex, or anal sex.

Modern industrialized societies tend not to place as much emphasis on the importance of virginity and having an intact hymen nearly as much as in the past. However, there are still many cultures that focus on the intact hymen as the proof of

virginity, thinking that a torn or broken hymen is proof that a female is no longer a virgin. This is unfortunate because a female who has never had penile–vaginal intercourse may tear her hymen by other means, and this event can have serious repercussions for females in cultures that value the intact hymen as proof of virginity.

The age of losing virginity varies from society to society, and even within subcultures in any given society. In the United States, typical ages of virginity loss are the mid-teens and the next 2 years. It is best to think of there being a bell-shaped curve of ages with these ages being in the middle, with fewer and fewer individuals starting sex as the bell curves spread out before and after these ages.

After the sexual revolution, starting in the late 1960s in modern industrialized societies, there was an increase in the frequency of sexual activities – as people began to use more effective forms of birth control. Sexual exploration continued to rise until around 1990 in many industrialized nations, after which it began to decline. Many people became more sexually cautious after 1990 when the mass media made it increasingly clear that a new disease – HIV/AIDS – was becoming epidemic and that it could be fatal. After 1990, people have gradually shifted to having fewer partners than before.

Fetishes and Atypical Sexual Behavior

As males tend to masturbate more than females and think about sexual stimuli while masturbating, males are likely to learn more sexual turn-ons and fetishes. Many males and a number of females eroticize such things as short shorts, bikinis, high heels, biceps, hairy chests, leather clothing, heavy metal chains, certain hair colors, and far more.

The strength of sexual turn-ons can vary from mild to strong. Mild fetishes are very common, and most people have heard others say that they get turned on by breasts, butts, or legs. Stronger fetishes can lead people to obsess about the object of their sexual desire, and sometimes engage in atypical sexual behavior. A man with a fetish for female underwear may love to masturbate with women's panties, and he may try to steal such clothing from laundromats or stores, because of the sexual excitement this brings. A man who masturbates while wearing women's clothing may develop a clothing fetish and become sexually aroused by merely thinking about wearing women's clothing. Men who enjoy cross-dressing are referred to as transvestites, and the behavior is called transvestic fetishism.

People who link sex with the giving and/or receiving of pain may develop sadomasochistic fetishes. Urophilia is the fetishistic attraction to urine. People with klismaphilia derive sexual pleasure from receiving enemas. Those who sexualize feces develop coprophilia.

In some circumstances, people with atypical sexual behavior can cause problems for themselves or others. Some men like dressing in diapers while masturbating, thereby turning diapers into a fetish object. All may be fine until they want to use diapers when having sex with a partner and discover that it is difficult to find a partner who wants to participate in these sexualized fantasies, which can cause the diaper fetishist much frustration.

Some atypical sexual behaviors can cause a person to be arrested. Exhibitionists, voyeurs, and frotteurs may be arrested for violating the privacy of others. People who derive sexual pleasure from exhibiting their bodies to other people are called exhibitionists and they often masturbate before exposing themselves, or afterward as they mentally recall the events. Voyeurs love to spy on others who are undressing or nude, especially if they masturbate during or after the event. Frotteurs get sexually excited by rubbing sexually against others – usually in public places. People who engage in atypical sexual behavior are mostly male, and the data presented on Pavlovian conditioning helps explain why.

Many people have mild fetishes that are not problematic for individuals who have them or their partners. 'It's just fun.' Even more extreme atypical sexual behaviors may not be problematic for people who can find willing partners who want to share in the activities. In recent years, the Internet has allowed many people to locate others who would be interested in participating in atypical sexual activities.

Not only can Pavlovian conditioning create sexual turn-ons, but it can also create 'turn-offs,' which are negative emotions that can inhibit or suppress the sex reflexes. If parents punish a child who is masturbating, the negative emotions evoked by the punishment become associated with sex. This can make a child feel guilty, shameful, anxious, depressed, or fearful about sexual thoughts and actions. People with such fears are called erotophobes, having phobias about sex, which can make them fearful of sex education and many sexual behaviors. It can also inhibit their ability to have and enjoy sexual activities. Fortunately, such negative conditioning can be reversed by discontinuing the aversive conditioning and switching to more positive sexual interactions. This may happen when a sexually anxious person finds a loving partner who shows how positive and caring sex can be.

Sexual Problems

Many young people think that sex is 'natural,' hence good sex should be easy and ecstatic. There are countless joys during the first years of sexual interaction, but many young adults are surprised by the difficulties they experience in their early sexual explorations. That is because many of the sexual techniques that make sex most gratifying are not innate: they have to be developed through operant learning, which often involves trial-and-error processes, and the errors can be painful or embarrassing. A few of the solutions that people need to minimize errors are somewhat obvious, but many are not.

The most common sexual problems that do not disappear quickly are premature ejaculation (for males) and difficulty in reaching orgasm (for females). The causes of the problems are easy to understand with the information we have presented in this article, again revealing the interplay of nature and nurture.

Male Concerns

Premature ejaculation – also called early or rapid ejaculation – is the most common sexual problem for males. When males are in a sexual situation, many become very excited and move vigorously, reaching the point of orgasm and ejaculation quite

quickly. It is not uncommon for early ejaculators to reach an orgasm in 1 or 2 min, and some take less time than that. Anthropologists who have studied simple tribal societies around the world note that such timings are typical in many societies. Biologists observe that being fast might have an evolutionary value.

After the 'sexual revolution' in Western societies (starting in the late 1960s), many women have encouraged men to learn how to last for longer time periods so that both partners can enjoy prolonged sexual pleasures, and this increases the chances that women can reach orgasm during intercourse. Many men have learned how to last 10 min or longer before ejaculating, and it seems to make many people's sex lives happier when men can master this type of ejaculatory control.

Why do many men tend to come quickly? Teenage males begin having experience with spontaneous sexual arousal and nocturnal emissions about 2 years earlier than females do – and they experience these sexual feelings more strongly – which helps males learn to like masturbatory sex early in adolescence. During masturbation, many males discover that strong forms of stimulation get them excited quickly, so they receive immediate reinforcement for rapid masturbation.

In addition, there are sociological reasons why many males learn to masturbate quickly: boys are less likely to be caught by their parents or roommates if they masturbate quickly rather than taking a leisurely approach. When they begin having sex with a partner, they are less likely to be walked-in-on by parents or roommates if they have quick sex. After a couple of years of learning the habits of seeking strong and fast stimulation, it can be difficult to change those patterns.

If the cause of premature ejaculation is getting too much stimulation too fast, one obvious solution is for males to slow down and enjoy sexual stimulation at more leisurely rates. One of the most popular therapies for premature ejaculation is called the 'stop-start' method, in which a man learns to alternate between enjoying the sexual stimulation that activates the sex reflexes and then stopping movement long enough to slow the reflexes and prolong the rise toward orgasm. In a variation on this theme, a man can learn to do sex in 'slow motion,' which allows him to appreciate the sexual sensations over a prolonged period, without becoming overly stimulated in 1 or 2 min. Men who master these techniques begin to have voluntary control over their sexual response and can adjust the timing of their orgasm to suit the needs of each sexual situation.

Female Concerns

The most common sexual problems that women report involve difficulty in becoming sexually aroused, staying sexually excited, and reaching orgasm. All three of these problems are closely related and occur when women do not receive enough sexual stimulation to fully elicit the sexual reflex.

In essence, the most common female problems are the opposite of the male problem of premature ejaculation – which arises when men receive too much stimulation too fast. Females often do not receive enough appropriate stimulation to reach orgasm in 5–30 min of sexual interaction. In addition, many women do not like to continue having sex for 40 min or longer, as their natural vaginal lubrication tends to dry up after those longer periods of time, making coitus uncomfortable.

Women's orgasmic problems can be traced to their (1) receiving too little pleasurable stimulation to fully elicit the sex reflex and (2) having too many inhibitions about sex. Both of these involve nature and nurture – biological and social factors.

First, many couples lack the knowledge and/or skill to bring enough effective stimulation to the female to activate her sexual reflex enough to reach orgasm. On the biological side of the nature and nurture interaction, genital size is important. The area of greatest erotic sensitivity on the female body is the glans and shaft of the clitoris, and these organs are considerably smaller than the glans and shaft of the male penis. The small size of the clitoral structures can make it difficult for girls and women to find these erotic zones and discover the pleasures they afford.

Society plays an important role, too. Throughout history most societies have not focused much attention on female sexual pleasure, and few have amassed or passed on enough information for girls and women to learn about their genitals and the types of stimulation they need to reach orgasm. In the past several decades many significant steps have been taken to improve the science of female sexuality, but many females still do not have access to the information, because of limited amounts of sex education about and distorted media coverage of these topics. Even today many people think that the vagina is the woman's most erogenous zone, even though the vagina and the G-spot (on its front wall) do not activate the sex reflex as effectively as does clitoral stimulation. Few people learn that cunnilingus (oral stimulation of the female genitals) is the most effective way for women to reach orgasm, especially when the tongue explores above, below, and on the clitoris. Fortunately, there are increasing numbers of books and websites that make this information available.

The second main cause of female orgasmic problems involves sexual inhibitions. Negative social experiences related to sex can produce guilt, shame, and other painful emotions that can (a) cause a woman to limit her range of sexual experimentation, hence decrease the chances of her receiving the most effective stimulation; and/or (b) inhibit the sexual reflex, even if she does obtain good stimulation.

Many societies raise their girls to feel uncomfortable if not guilty about their sexuality, causing females to have various sexual inhibitions about exploring their sexuality, touching their genitals, masturbating, and asking their partner to provide better stimulation. The negative emotions learned during childhood and adult socialization help explain why many girls and women do not discover how to reach orgasm. These inhibitions are also sexual 'turn-offs' which can suppress the sex reflex even when a woman does experience effective sexual stimulation.

Most forms of female sexual therapy focus on exercises that encourage a woman – and her partner, if she has one – to touch the erotic zones of her body in sensitive and caring manners. Special attention is focused on the entire clitoral area, the minor lips, the vagina, the G-spot, the mons pubis (above the pubic bone), and the breasts. Different women like various combinations of stimulation of these areas, so each woman needs to explore what works best for her. As a woman and her partner discover her areas of greatest sensitivity, they can play with various means of stimulating those areas, using different

levels of pressure, patterns of movement, and so forth. Many couples need to take the time for prolonged trial-and-error learning as they experiment to discover what feels best.

Sex therapists encourage women to start by masturbating in private, then showing their partner the types of stimulation that work best. Some women benefit from using a vibrator as a sex toy for exploring the kinds of stimulation that are most effective in reaching orgasm. Women may also need to increase their general bodily muscle tone to facilitate orgasm, perhaps tensing the pelvic floor and leg muscles. Also helpful is focusing on positive thoughts about sex (rather than worrying about getting excited or reaching orgasm); therefore it is important for the woman's partner to tell her all sorts of positive things about her body (how good it feels, looks, and smells) so she will be free of negative thoughts during sexual activities. Sexual fantasies provide another useful tool for boosting the positive sexual thoughts that excite a woman's mind.

Many of the sexual problems that both males and females experience could be averted if children were raised with better knowledge and fewer inhibitions about sexuality. If they are also raised to respect all individuals and their personal boundaries, this sexual knowledge will not lead to abusive or coercive actions.

The science of sexuality is still only a few decades old, so we can expect that future generations will know more than we do. There is still much work that needs to be done to reduce the frequency of unintended pregnancies, STDs (including HIV/AIDS), rape, sexual assault, domestic violence, and

discrimination against sexual minorities. The more people advocate for advances in the science of sexuality, the faster we may progress in reducing the dark side of sex and helping people experience the pleasures of intimacy and sexuality.

See also: HIV/AIDS: The Role of Behavior and the Social Environment in a Global Pandemic; Personal Relationships in Everyday Life; Sex Roles; Sex Differences.

Further Reading

- LeVay S, Baldwin JI, and Baldwin JD (2009) *Discovering Human Sexuality*. Sunderland, MA: Sinauer Associates.
- Northrup C (2006) *Women's Bodies, Women's Wisdom: Creating Physical and Emotional Health and Healing*, 3rd edn. New York: Bantam Books.
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Relevant Websites

- www.thetaskforce.org – National Gay and Lesbian Task Force.
- www.4woman.gov – National Women's Health Information Center.
- www.sexuality.org – Society for Human Sexuality.
- www.SexInfoOnLine.com – University of California's Sexuality Resource.

Sign Languages

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Glossary

Iconic When the form of a sign resembles the concept or object that it denotes.

Modality Language modality refers to the medium by which a language is perceived and produced. Sign languages are perceived and produced in the visual-manual modality, while spoken languages are perceived and produced in the aural-oral modality.

Morphology The structure of words and the rules governing the structure of words.

Nonmanual grammatical markers Elements of a sign language that are not produced by the manual articulators (hands). Nonmanual elements are produced by movements in the torso and head, and by changes in facial configuration.

Phonology The system of nonmeaningful elements and rules for their combination to form words or signs.

Syntax The system of rules for building grammatical sentences out of words or signs.

Sign languages are visual-spatial languages primarily used by deaf people. In contrast to spoken languages, which are produced using the vocal tract and perceived by the auditory system, sign languages are produced in the manual modality, with the hands, upper body, and face, and are perceived by the visual system.

This article debunks common myths about sign languages, and then lays out their linguistic properties, acquisition, and neurological underpinnings. The ways in which sign languages are similar to and different from spoken languages are considered throughout the article.

A Note on Modality Differences

The modality of sign languages is visual-spatial, whereas the modality of spoken languages is aural-oral. This article considers whether differences in modality lead to differences in the structure, the acquisition, and the neural organization of a sign language.

Much of the research on sign languages has focused on American Sign Language (ASL). The following review reflects that bias; but, when possible, examples from other sign languages are included. Although the review focuses on ASL, the principles outlined are believed to apply to all sign languages.

Myths About Sign Languages

Myth 1: Sign Languages Are Universal

No single sign language is used by all deaf people around the world. Sign languages emerge naturally among communities of deaf people. Sometimes divisions among sign languages parallel those among spoken languages. For example, in Spain, Catalan Sign Language is used in Catalan-speaking areas, while Spanish Sign Language is used in Spanish-speaking areas. Conversely, some areas that share the same spoken language do not share the same sign language. ASL and British Sign Language are mutually unintelligible even though English is the dominant spoken language in both countries. Sign languages are generally named after the country or region in

which they are used (e.g., French Sign Language, Quebec Sign Language, Israeli Sign Language). In a few cases, different countries share the same sign language, for example, ASL is also used in the English-speaking parts of Canada.

Myth 2: Sign Languages Are Mimetic Gestures

One of the hallmarks of a language system is that its words have an arbitrary relationship to their referents – the form of the word does not resemble the referent. The word ‘cat’ does not represent any feature of the animal. Sign languages, because they are visual languages, more readily lend themselves to iconicity. In other words, many signs look like their referents. But not all sign languages iconically depict a referent in the same way. Whereas the sign CAT (signs are glossed in all capital letters; [Figure 1](#)) in ASL appears to trace a cat’s whiskers, the same sign in Australian Sign Language depicts petting a cat. Both signs are iconic, but each represents a different characteristic of the referent; thus both languages conventionalize the sign differently.

Although some signs are iconic, most have an arbitrary relationship to their referent. For example, the ASL sign APPLE ([Figure 2](#)) is made by a hooked index finger twisting at the side of the cheek, and thus bears no resemblance to an apple. Other signs may have iconic origins that have become less transparent over time. The ASL sign GIRL ([Figure 3](#)) traces the string of a bonnet, but in today’s bonnet-less society, that iconic relationship is virtually invisible.

Some signs look like pantomimed actions. But sign languages differ from pantomime in several distinct ways. First, they constrain the articulation of a sign to a limited space in front of the signer’s body extending from the hips to just above the head, whereas pantomime can be articulated anywhere on or around the body. Second, sign languages are communicated with movements by only the arms, torso, and head, but in pantomime the entire body can be engaged (e.g., running in place to represent running). Finally, pantomime lacks the requisite hierarchical structure that characterizes language. Both spoken and signed languages are built up from the smallest units (phonemes), which combine to create words, which then combine

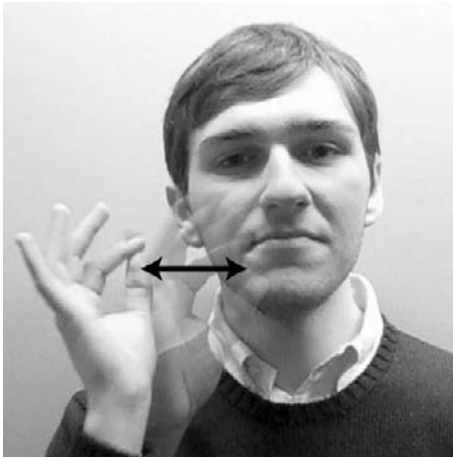


Figure 1 ASL sign CAT.



Figure 2 ASL sign APPLE.



Figure 3 ASL sign GIRL.

to create sentences. The brains of fluent signers are sensitive to this structural difference between sign languages and pantomime: different areas of the brain are activated when perceiving signs than when perceiving pantomime.

Myth 3: Sign Languages Are Just Spoken Languages on the Hand, and Have No Formal Grammar of Their Own

Sign languages are not signed versions of the local spoken language. For example, the word order in a sign language often differs from the word order of the spoken language. The word order in German Sign Language is subject–object–verb, whereas the word order in spoken German is subject–verb–object. In English, verbs carry information about when an event happened; the ending ‘-ed’ tells us that the event happened in the past. ASL, on the other hand, conveys tense information by adding a separate sign like YESTERDAY or BEFORE to the sentence. This tense system is similar to that observed in Mandarin.

Sign languages have developed their own grammar distinct from spoken languages and are not derived from the local spoken languages. Although we cannot trace the origins of all sign languages, recently emerging sign languages such as Nicaraguan Sign Language and Al-Sayyid Bedouin Sign Language reveal that sign languages emerge across multiple generations when there is a critical mass of deaf people. Other sign languages emerge through contact with another sign language. For instance, ASL traces part of its origins to an earlier form of French Sign Language (LSF). A deaf French teacher, Laurent Clerc, helped establish the first deaf school in the United States where he and other teachers from France used LSF. LSF mixed with the sign languages and the gestural systems used by children entering the school, and became the foundation for what is now ASL. Although ASL has its origins in LSF, its current form is distinct from LSF, and both languages are mutually unintelligible.

Myth 4: Sign Languages Cannot Convey the Same Meaning as Spoken Languages

Sign languages share the same level of complexity and productivity as spoken languages. Consequently, they can capture the same array of meanings with equal eloquence, and can convey complex concepts in all fields of study from neuroscience to philosophy. For words that may not have a sign equivalent, fingerspelling offers an alternative way to manually express the word (see section ‘Fingerspelling’).

Some reports indicate that the vocabulary size of sign languages is generally smaller than that of spoken languages. But languages such as English or Spanish have been used in such comparisons, and these spoken languages have amassed very large vocabularies as they emerged as the dominant languages used in academic and technical arenas. When comparing sign languages to most spoken languages around the world, we see comparable vocabulary sizes. As sign languages gain more use in academic and technical fields, new signs are generated to meet the needs of specific fields of study.

Linguistic Structure of Sign Languages

Phonology

In spoken languages, phonology includes the system of sounds that combine to create words, and the rules that constrain how sounds are combined. A phoneme is the smallest sound unit that, when changed, can create an

entirely new word with a different meaning. For example, the English words *cat* and *bat* differ in a single phoneme /k/ and /b/; a change in the initial phoneme changes the meaning. The word *phonology* contains the Greek root *phono* (sound). Accordingly, it would seem that phonological systems only appear in sound-based languages. Yet research spanning the last 50 years has established that sign languages have a sublexical structure that can be characterized as phonology.

A salient way to see the phonological structure of any language is to find minimal pairs, words that differ in only one phoneme, for example, *cat* and *bat*. Close examination of minimal pairs in sign languages has uncovered four phonological parameters that define a sign: handshape, location, movement, and orientation (Figure 4). Signs can differ in handshape, in where they are located on the signer's body, or in how the movement of the sign is articulated. Movement in a sign can travel along a path (e.g., straight, arc) from one location to another, and can include a sign's internal movement (e.g., wiggle, change in handshape). Finally, several signs differ in the way the hand is oriented in space: the signs *SOCK* and *STAR* are articulated with the same handshape, location, and movement, but with a different palm orientation. Psycholinguistic studies have demonstrated that the movement and location of a sign are the strongest part of the representation of the word and consequently are more resistant to errors, while handshape is the most error prone. The phonological structure of all sign languages seems to include the same four phonological parameters, although each language may constrain the variability within each parameter differently.

Recently, a fifth phonological parameter has been considered: the incorporation of facial expressions, called nonmanuals (see section 'Nonmanual Markers'). Some signs are produced alongside facial expressions, and without them, the signs are incorrect. For example, the sign *TRY-OUT* in the Sign Language of the Netherlands is articulated with a puffing of one cheek; without the puffed cheek, the same manual sign takes on a different meaning, *DAYS*.

In spoken languages, phonemes are sequentially strung together to form a word. The first phoneme of the English word *cat* is /k/, followed by /æ/ then /t/. Such sequentiality suits spoken languages because rapid changes in sound are deftly produced by the vocal system and perceived by the auditory system. But manual articulators are larger and move slowly, and therefore sequential information cannot be produced as rapidly. Consequently, sequentiality is observed in sign languages to a lesser extent. The need to transmit and perceive linguistic information efficiently likely shaped the evolution of sign languages to convey many of the componential elements of language simultaneously. Thus, a single sign is made up of a set of simultaneously articulated phonological units.

Sign languages have also developed phonological rules that guide sign formation. For example, such rules can govern when a movement of a sign can be deleted or a handshape can be assimilated during a signed sequence. The existence of a set of phonological parameters and rules in soundless languages establishes the universality of sublexical structure in human languages, spoken and signed.

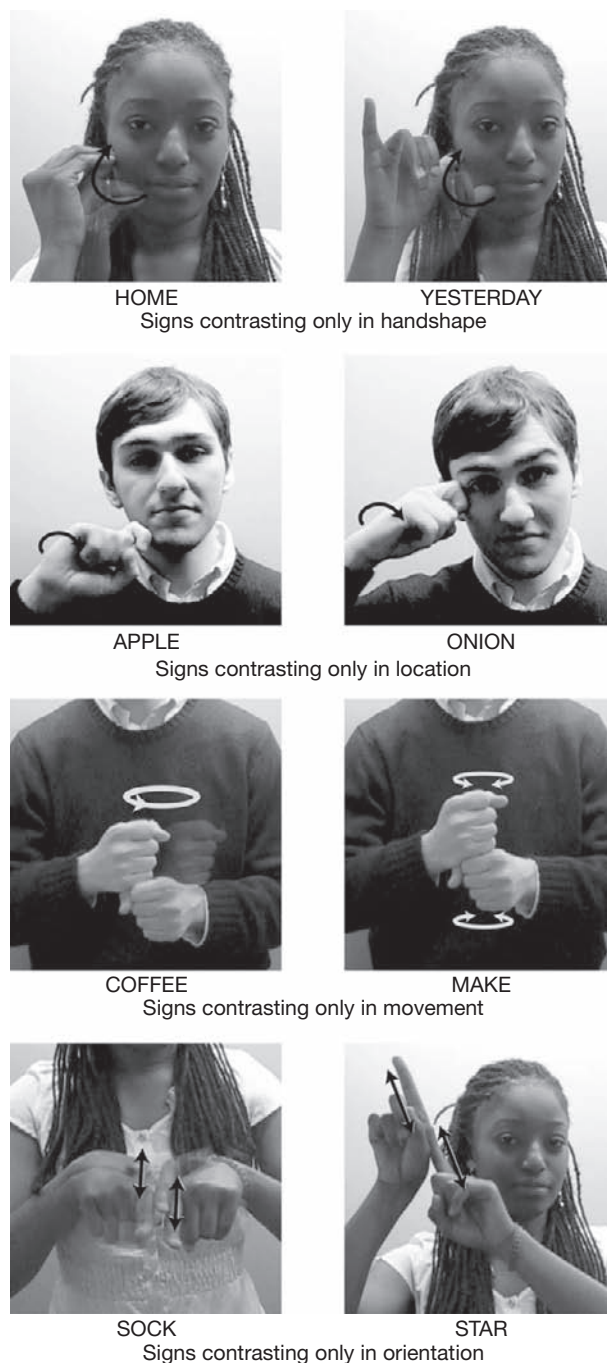


Figure 4 Minimal pairs in ASL.

Morphology

In the hierarchical structure of language, the next level up from a phoneme is a morpheme, the smallest meaningful unit of a word or sign. As with spoken languages, sign languages have free morphemes, which can occur on their own, like the sign *CAT*. They also have bound morphemes that attach to a stem (i.e., a sign). In spoken languages, bound morphemes sequentially attach to a word as an affix (e.g., prefix or a suffix). For example, the suffix '-s' conveys plurality. In sign languages,

most bound morphemes are simultaneously, not sequentially, presented. Remarkably, sign languages allow for the modification of all possible parameters of a sign (movement, handshape, location, or orientation) to convey additional meaning.

Sign languages exhibit both derivational and inflectional morphology. The process of derivational morphology creates new words from existing words. In English, the suffix '-er' can change a verb to a noun (e.g., *teach*, *teacher*). In sign languages, nouns are derived from verbs by reduplicating and reducing the size of the sign's movement. The ASL sign CHAIR and SIT share the same handshape, location, and orientation (Figure 5), but the movement is reduplicated (i.e., repeated) for the noun. New compounds can be formed from two independent signs. In English, compounds such as 'wallpaper' have a different stress pattern than that of the independently articulated words 'wall' and 'paper.' ASL constrains what elements of two signs are preserved in a compound. In the compound GOOD-NIGHT, the end point of the sign GOOD is eliminated. In addition, the handshape of some signs can be replaced by numeral handshapes to specify the exact amount represented. For example, the sign WEEK (Figure 6) is made with an

extended index finger handshape. To specify two weeks, the index finger handshape is replaced with the handshape for TWO, but the movement, location, and orientation of WEEK remain the same (Figure 6). Enumerable signs can specify up to nine units; for amounts greater than nine, the specific number sign is produced before the sign (e.g., TWELVE WEEK).

Finally, to talk about spatial relations in English, speakers use prepositions such as *in*, *on*, and *under*. Sign languages rarely use such prepositions and instead describe objects in relation to each other with a system of classifiers that refer to different object classes (e.g., vehicles, animals, cylindrical objects, flat surfaces, etc.). To describe a cup on a table, a signer would place the hand articulating the classifier for a cylindrical object on the hand denoting a flat surface (Figure 7). For the cup under the table, the signer would move the cylindrical object under the flat surface (Figure 7). In essence, the signer diagrams the spatial relation. Although the utterance appears almost gestural, it is subject to a set of rules dictating the form of the morphemes.

Under the process of inflectional morphology, grammatical information is added to existing words (e.g., the English

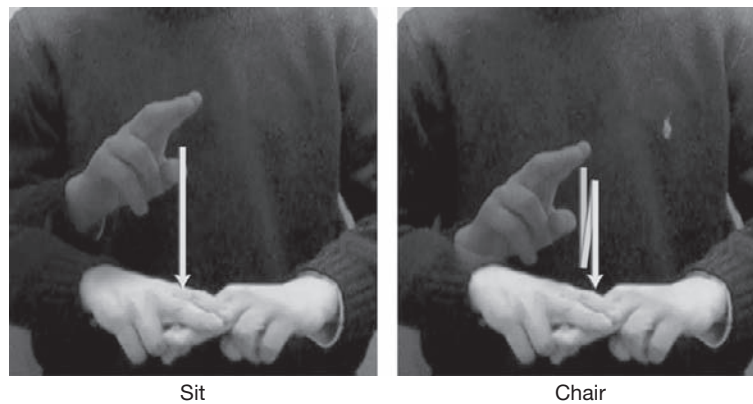


Figure 5 Example of derivational morphology in ASL.

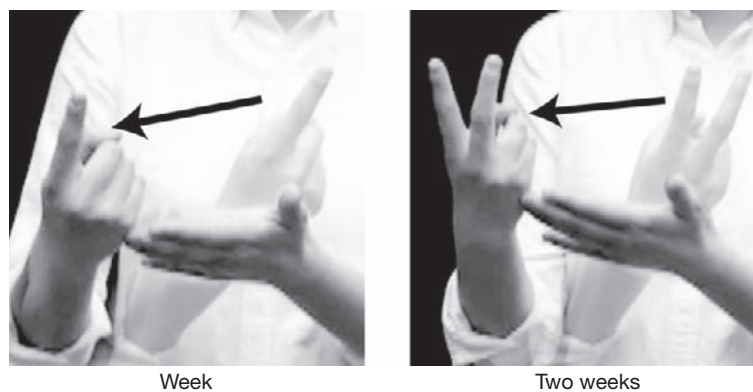


Figure 6 Example of numeral incorporation in ASL.

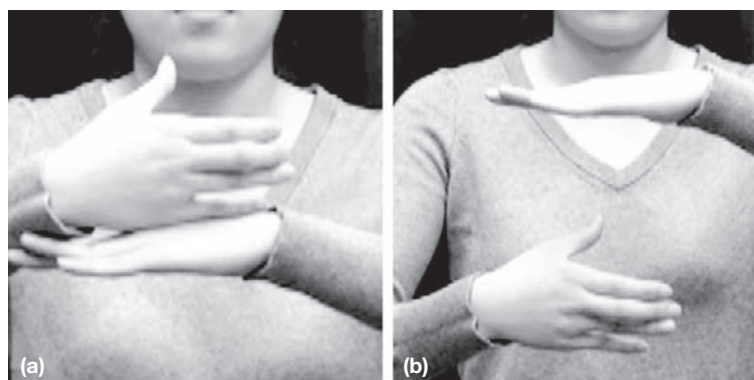


Figure 7 Example of a spatial classifier describing (a) a cup on a table and (b) a cup under a table.

plural marker ‘-s’). Inflectional morphology in ASL can convey verb aspect and agreement. Modifying the movement of a verb expresses temporal information, such as whether the action was habitual, continuous, or iterative (i.e., repeated). The movement in the verb *STUDY* can be changed to communicate whether someone is studying regularly, occasionally, or continuously. Information about who is doing what to whom (who is the subject, and who is the object) is also conveyed by differences in the start and endpoints of a sign’s movement. Signers associate referents with locations in the signing space, and then use those locations as the verb’s arguments. In the sentence, ‘the father watches the boy’ the signer can indicate which part of the signing space will stand for the father (e.g., to the right) then locate the boy somewhere else (e.g., to the left). The sign *WATCH* begins at the location of the father and moves toward the location of the boy to convey that the father watches the boy. The location where the verb begins agrees with the location associated with the referent of the subject, and the endpoint agrees with the location associated with the referent of the object. As such, changing the start point of *WATCH* in the above example, to the location of the boy and directing the sign toward the location of the father, puts the boy in the role of the subject, the one doing the watching. Only a subset of ASL verbs falls in this class of agreeing verbs.

Syntax

For plain verbs, like *LOVE*, which cannot be spatially modulated to express agreement, word order can provide information about who is doing what to whom. The canonical word order in ASL is subject–verb–object. Thus the sentence *CAT LOVE DOG* means the cat loves the dog, and switching the order changes the meaning of the sentence. Other sign languages, such as German Sign Language and Brazilian Sign Language, have auxiliary signs that can be spatially modulated to indicate person agreement. Under such a system, *CAT* and *DOG* are first associated with different spatial loci, *LOVE* is expressed, then a separate sign marking person agreement is articulated by moving from the location associated with the referent of the subject to the location associated with the referent of the object.

Although ASL has a basic word order, its word order is more flexible than English word order. Through topicalization, the signer can move the object to the beginning of the sentence, for

example, *DOG, CAT LOVE*, meaning, ‘as for the dog, the cat loved it.’ The fronting of the topic is also marked by the signer raising her eyebrows (see section ‘Nonmanual Markers’). In addition, ASL, like many other spoken languages including Japanese and Italian, allows speakers to drop the pronoun when context supplies sufficient referential information. In the sentence, *MY WIFE SICK. NEED GO-TO DOCTOR*, the pronoun in the second sentence can be inferred from the previous sentence mentioning the wife.

Overtly articulated nominative pronouns (e.g., I, you, he, she) in ASL are articulated with an extended finger that resembles the pointing gesture. Given the surface similarity, there is debate over whether the pronominal system is gestural or grammatical. From the perspective that takes the pronominal system to be grammatical, changes in fingertip orientation mark changes in person. The direction of the point indicates whether it is a first-person (toward the signer’s chest), second-person (away from the signer), or third-person pronoun (toward the space to the right or left of the signer). Although most methods of ASL instruction focus on a three-person pronominal system, most linguists agree that the ASL pronominal system is best characterized as a first/non-first person system. Changing the handshape from an extended pointed finger to a flat open hand creates a possessive pronoun, and adding a sweeping movement (moving from left to right) to either the nominative or possessive pronoun indicates plurality.

Pronouns can refer both to immediately present and non-present entities. As with agreeing verbs, signers assign arbitrary locations in the signing space to referents; any pronominal point to an assigned location refers to that referent. The assigned locations remain constant across the discourse until they are reassigned to new referents. This spatial system can be used for pronominal reference, verb agreement, reported speech, and reported action. In reported speech and reported action, a signer shifts his body toward an established locus to adopt the perspective of the associated referent; any utterance or action following the shift is attributed to the referent, not the signer, just as in the English example of direct speech, “The teacher said, ‘you better do your homework!’”

Both the system of inflectional morphology and the pronominal system illustrate how sign languages convey all of the syntactic complexity of a spoken language through both sequential and simultaneous presentation of grammatical elements.

Nonmanual Markers

Signers produce facial expressions to convey both affective and grammatical information. The grammatical facial expressions are called nonmanual markers. Changes in eyebrow, mouth, head position, and body position can systematically affect the meaning of a signed sequence. For example, if a signer raises his eyebrows while signing YOU GO STORE, it becomes the question, 'Are you going to the store?' Adding a headshake changes the meaning to, 'You aren't going to the store?' Without the raised eyebrows, the same sequence of words is an imperative, 'You are going to the store.' Nonmanual markers produced on the mouth provide adverbial information. In Sign Language of the Netherlands, a pursing of the lips accompanying a verb carries the meaning, 'in a relaxed manner,' while puffing the cheeks and squinting the eyes conveys, 'with difficulty.'

Nonmanual markers are produced alongside the signed sentence and mark sentence types such as topicalizations, conditionals, yes/no questions, wh-questions, and negation. Their production is usually timed with the onset and offset of the signed clause. Nonmanual markers can be distinguished from affective facial expressions by their precise timing, constrained linguistic function, and specific form.

Across different sign languages, there is some similarity in the form and function of nonmanuals, yet there are some reported cross-linguistic differences. Nonmanual markers are argued to have their origin in the affective facial gestures produced by the hearing community. For example, in ASL and some other sign languages, wh-questions are marked by the signer furrowing his brows. The furrowed brow is a facial gesture often used to express puzzlement and a request for more information. Users of spoken language produce the furrowed brow sporadically, but signers produce it consistently, indicating that it has become a grammatical marker. Where we observe cross-linguistic similarities in affective facial expressions we may also observe similarities in nonmanuals across different sign languages. Conversely, any cross-linguistic differences in nonmanuals may be related to cross-cultural differences in the use of affective facial expressions.

Fingerspelling

Many signing communities use a manual alphabet – a system of individual hand configurations that matches the local orthographic system. By all accounts, the manual alphabet is an artificial system invented by hearing adults. Some countries use a one-handed alphabet, while others use a two-handed alphabet. Items that are fingerspelled but not lexicalized (see below) are not subject to the grammatical rules of the sign language.

Few deaf people use fingerspelling as their sole means of communication because it is labor intensive. A signer fingerspelling all of the time is equivalent to a speaker spelling out every word. Signers anecdotally report that the use of fingerspelling varies across different sign languages and socioeconomic status. In general, signers use fingerspelling when there is no sign equivalent, but they may also fingerspell words with sign equivalents for discourse purposes, such as to add emphasis.

Frequently fingerspelled items can undergo a gradual process of lexicalization where they become new signs incorporated into the sign lexicon. A set of phonological rules governs this process. Typically one or more letters are deleted or assimilated so that not all of the individual letters can be identified. For example, the sign #BACK (the # denotes a lexicalized fingerspelling) is articulated without the 'C.' Lexicalized fingerspellings often exhibit reduplication: the sign #DO is a reduplicated movement from the letters 'D' to 'O.' Once lexicalized, they are subject to grammatical rules and, for example, can become agreeing verbs (see section 'Morphology'). The process of lexicalization of fingerspelling looks very similar to the phonological process that shapes the way words are borrowed from foreign spoken languages.

Dialect Differences and Register Use

Speakers of the same language who are from different regions or socioeconomic classes often speak slightly different variations of the same language. Regional and ethnic differences have been documented in the dialectical variation observed in ASL, and they are argued to stem from the decentralization of deaf education. Many schools for the deaf are regulated by state governments, and as such, policies about language use in the classroom varied state by state. Until recently, most schools did not use ASL, and if they did, there was often no formal instruction in ASL. With little standardization of ASL in the educational system, the communities in each school developed and passed down region-specific signs. Deaf adults report that they can identify where someone went to school from their signing. Countries with even less centralization of deaf schools report greater dialectical variation in the local sign language. The history of segregated schooling of African-American deaf children in the United States has also contributed to dialect differences. However, with school integration, these ethnic differences seem to be fading. In addition to regional and ethnic differences, some researchers have observed generational differences in sign vocabulary.

Although most of the discussion of dialect differences centers on vocabulary, some regional phonological variation in ASL has been observed. Signers in the southern regions of the United States tend to use more two-handed signs, whereas signers in the northern regions use primarily one-handed signs. In some regions, signers produce signs with a thumb extension, and in other regions, they tuck in the thumb (e.g., BUTTER, FUNNY).

Social situation can also affect the form of signing. In formal situations, signers sign slowly, use a larger signing space, and accentuate the pauses between signs. In less formal settings, the pace speeds up, the signing space is reduced, moving closer to the center of the body, and sequences of signs blend together such that you can see elements of the next sign appearing before the previous sign has been fully articulated (i.e., coarticulation). These situational modifications in signing style parallel the speech modifications made by speakers in different settings. In formal settings, speakers also speak slowly, include more pauses, and choose different words than they would in less formal situations.

Fluent signers acquiring a second sign language seem to exhibit something like a foreign accent. The most consistent finding is that accent appears in hand formations and is most pronounced with handshapes that are not among the handshapes allowed in the signer's first sign language.

Poetry in Sign Languages

Deaf communities have had a long tradition of storytelling, but the artistic use of sign languages has emerged only recently with the broad acceptance of sign languages as natural languages and with the founding of organizations such as the National Theater of the Deaf in the United States. The art of poetry is one of the fastest growing areas of artistic expression in sign languages.

Spoken language poets play with the sounds and rhythms of language and often use metaphor to create a poem. Sign language poets also play with the phonological structure and rhythm of a sign language, and take advantage of the visual-spatial modality to create metaphors. Rhyme in sign languages, like spoken languages, is based on the phonological parameters that create a sign. For example, a poet may select one handshape to appear periodically in a poem. Rhythm and meter are created by manipulating the flow of movement and the pauses of signs – both may be longer or shorter than would be observed in normal discourse. Sign language poets often go beyond modifying existing signs and create novel signs as a part of their artistic expression. Because of the great potential for iconicity in sign languages, poets will manipulate or even generate novel iconic signs to create a more metaphorical mapping between the sign and the target. Poetry in sign language has become such a wide-reaching art form that schools for the deaf are incorporating poetry lessons into their curriculum as early as kindergarten.

The Acquisition of Sign Languages

The modality differences between signed and spoken languages could lead to differences in the pattern of language acquisition, yet research over the past 30 years has uncovered striking similarities. Children learning a signed language hit the same developmental milestones at the same time as children learning a spoken language. They also make similar errors along the way, indicating that the mechanisms underlying the language acquisition process are common to both spoken and sign languages. This article considers first the native acquisition of a signed language by children born to deaf parents, then the late acquisition of sign languages by deaf children born to hearing parents.

Infant-Directed Signing

Infants' first exposure to language is from caregivers who subtly modify their language production to sustain their infants' attention. Infant-directed speech is characterized by an elevated pitch, expanded pitch range, and frequent repetition relative to normal speech. Similarly, infant-directed signing has large slow movements with frequent repetition. And surprisingly both deaf and hearing infants, regardless of whether

they have had previous exposure to a sign language, find infant-directed signing attractive.

In the first year of life, hearing infants engage in 'joint attention,' following their parents' pointing and eye gaze while listening to their parents' speech. Joint attention is a multimodal activity that requires the infant to incorporate both visual and auditory information. Deaf infants, however, must attend to both the object of their caregivers' attention and the linguistic information being signed in a single modality. Skilled caregivers help infants learn how to balance their visual attention by moving signs into the infant's field of vision or by displacing signs normally articulated on their own bodies onto the infant's body. Sign displacement happens when the infant is not looking at the caregiver or when the child is sitting in the parent's lap and cannot see the caregiver.

Caregivers also negotiate the dual functions of the face – affective and grammatical – when signing with their infants. Some research has demonstrated that deaf mothers primarily use affective facial expressions with infants, and rarely use grammatical facial expressions, especially those that could be mistaken for negative facial expressions. In this way, caregivers continue to make their language attractive to their infants.

Babbling

Infants exposed to a spoken language begin babbling – producing vocalizations with no meaning or reference – between seven and ten months of age. Deaf children exhibit early vocal babbling, but such babbling declines just at the age when hearing infants' babbling increases. Thus, babbling may begin as a function of motor development but is only maintained when reinforced by auditory feedback.

Studies of infants exposed early to sign language have documented a manual equivalent of babbling that shares many of the same characteristics of vocal babbling. Babbling includes a reduced set of phonological parameters that reflect the syllabic organization of the language. Several handshapes appear frequently in manual babbling, and are often produced in a variety of locations, most typically in neutral space, on the head or on the face, and within a more constrained space relative to the arm movements produced by nonsigning infants. In addition, the manual babbles of infants exposed to a sign language are typically repetitive, multicyclical movements articulated at a slower velocity. Manual babbling has been documented in different sign languages, providing cross-linguistic support that babbling cannot merely stem from the maturation of the vocal system. Rather babbling, vocal and manual, serves a linguistic purpose for infants – to help them figure out the phonological properties of their language.

First Words

Although some researchers have reported first sign production as early as 6 months of age, the average is around 10 months. The observed early production of signs may be related to earlier development of the gross motor skills necessary to produce a sign relative to the fine motor control required by the oral articulators. This observation is the foundation of the movement to teach hearing infants signs to allow them to communicate at an earlier age. However, when more stringent criteria

of symbol use are applied – where the sign produced is not imitative or context dependent – the sign advantage disappears. Consequently, the sign advantage may actually be a gestural advantage. Both signing and speaking children produce their first true symbols at about 12 months, indicating that the cognitive prerequisites for symbol use are common to signed and spoken language. Indeed, signing children reach all of the same word learning milestones as children learning a spoken language, for example, producing their first 10 signs at 12 months and first 50 signs at 24 months.

Signing children also make errors similar to those made by nonsigning children. Their first words are bare, uninflected signs, often with phonological errors. The handshape parameter seems to be the most error prone. Children replace more complex handshapes with the easier ones that appeared most frequently in their babbles. Movement and location seem to be more resistant to errors, likely a consequence of the earlier developing gross motor skills. Infants tend to correctly produce the phonological elements that are easiest to articulate, easiest to perceive, and are the most frequent in the sign language. The differential development of the motor skills required to produce a sign versus a word leads to a unique set of movement errors in sign development. Some signs that are made with distal joints (e.g., wrist, elbow) are first produced by children using more proximal joints (e.g., shoulder). For example, adults produce the sign YES with a movement at the wrist, but infants often produce the sign with a movement at the elbow or even the shoulder.

Crucially, the first words an infant acquires are not necessarily iconic. Less than one-third of a child's earliest vocabulary consists of signs with iconic properties. Instead the earliest words focus on the people (e.g., DADDY), things (e.g., COOKIE), and events (e.g., BYE-BYE) of their daily routine. The development of semantic relations in spoken and sign languages appears to follow the same trajectory, with children first talking about the existence or nonexistence of objects, followed by action and state relations, then locative relations. In both types of languages, the later-developing semantic expressions are datives, instruments, causatives, and manners of action.

As their vocabulary grows, children start combining signs. The first stages of this transition can be seen just after their first birthday when they point to an object and then sign the name of the object. At about 16 months, infants point to an object and produce a separate sign, for example, pointing at a cookie and signing EAT. Once children acquire a vocabulary size of approximately 115 words, they reliably start producing two-sign combinations, for example, MORE COOKIE.

Morphology/Syntax

When speech-exposed children begin stringing words together, they reveal their understanding of the grammatical rules of their language through the errors they make. For example, they often overgeneralize the past tense marker '-ed' to irregular verbs such as 'go' even though they have never heard the form 'goed' in their input. Their overregularization errors reveal an internal system of rules for which they have yet to learn the exceptions. Sign-exposed children make similar errors as they acquire a sign language.

An obvious question is whether early gesture experience facilitates the acquisition of a sign language. For example, as speech-exposed children acquire the pronoun system they make pronoun reversal errors, using 'you' as a first-person pronoun, and 'I' as a second-person pronoun. The nominative pronoun in ASL is expressed with a handshape that resembles a pointing gesture (see section 'Syntax'). Like other children, sign-exposed children use the gestural point, but this experience does not support an error-free entry into the pronominal system. Sign-exposed children also make pronoun reversal errors because they treat the second-person pronoun, 'you,' as an alternative name for themselves. Thus signing children interpret the pronominal point as a lexical item, not as a pointing gesture. At 24 months, sign-exposed children start to use pronouns with some errors, producing them correctly only with immediately present referents. After 27 months of age, they use the pronouns with absent referents.

The use of affective facial expressions also does not facilitate the acquisition of nonmanual markers (see section 'Nonmanual Markers'). For example, negation in ASL can be expressed with a headshake that extends over the element being negated. All children readily know how to shake their heads, but the negation in ASL requires coordination of the headshake with the signed sentence. Although the negative headshake emerges as early as 12 months, sign-exposed children prefer to use manual signs for negation instead of the headshake. The manual signs are acquired around 18 months, but there is a 1–8-month delay before children produce them with a negative headshake. In essence, sign-exposed children acquire the freestanding lexical item, before acquiring the 'bound' facial expression. The correct production of the nonmanual marker for negation is not acquired until 24–28 months. But for many other nonmanuals, the timing and scope of their production is not mastered until the age of 8. The sum of the evidence on the development of nonmanual markers shows that experience with affective facial expressions does little to speed up the acquisition of grammatical facial expressions.

Finally, iconicity does not seem to support children's acquisition of verb morphology. Recall that there is a class of verbs that is spatially modified to indicate the arguments of the verb; the form of these verbs relates to the spatial location of the referents associated with the verb (see section 'Morphology'). There is an iconic relationship between the movement of the verb and the movement of the action represented. Yet children take years to master this verb agreement system and other aspects of spatial syntax. Initially, children produce bare verbs without any spatial inflection. Three-year-olds begin modifying these verbs spatially, but only with present referents. Four-year-olds start to associate locations in space with absent referents, but do so inconsistently. Only once children are 5 years of age do they consistently use loci for absent referents and maintain those loci across an extended discourse for verb agreement. Between 7 and 8 years of age, children have mastered most of the elements of spatial syntax, including classifier constructions and referential shift. The pattern of acquisition documented for the verb agreement system in sign languages reveals that sign-exposed children acquire the morphology of the language in a componential way, mastering one element at a time before they are able to consistently and flexibly articulate the agreement system.

Late Acquisition

Studies of second-language learning have demonstrated that language is best acquired during infancy and early childhood. This sensitive period of language acquisition is argued to be related to maturational changes in the brain. But what are the consequences of never fully acquiring a first language within the sensitive period? Most of our understanding of late-language acquisition comes from studies of second-language acquisition. With the exception of a few case studies of so-called 'wild children,' little is known about the effects of the late acquisition of a first language. However, the case of deaf children acquiring a sign language late in life gives us greater insight into what aspects of language can and cannot be acquired after the sensitive period.

First-language acquisition in childhood is the norm for typically hearing children but not for deaf children. Ninety percent of deaf children are born to hearing parents who do not know a sign language. Consequently, some deaf children do not learn a sign language until they enter a school that uses one. Others learn a sign language only in adulthood because some schools withhold sign language exposure, believing that it hinders the acquisition of spoken language. No empirical research supports the belief that sign language use interferes with learning a spoken language. In fact, research shows that most deaf children who are not exposed to a sign language early in life rarely acquire full competence in a spoken language. Thus, when congenitally deaf people learn a sign language later in life, it is often their first experience with a fully accessible first language. These circumstances mean that many deaf signers are late learners of a first language.

Research on deaf late learners of a sign language shows that late language acquisition leads to imperfect acquisition. Late learners are less fluent and have poorer comprehension and retention of signed narratives. They make many phonological errors and use words in incorrect semantic and syntactic frames. Their morphology is significantly affected; they tend to produce fewer grammatical inflections than early learners. Importantly, these delays are not related to the number of years of signing experience. When number of years of signing experience is equated, those who acquired the language earlier still show greater proficiency. Age of first-language exposure also affects the ability to acquire a second language. The earlier you learn your first language, the better you are at acquiring a second language at any age. Deaf adults who learned a sign language early in life are more proficient in the spoken language than those who learned a sign language later in life.

Brain Organization

Identifying the neural underpinnings of sign languages helps us understand the role that different areas of the brain play in producing and comprehending all languages, signed and spoken. The study of patients with brain damage and of unimpaired adults using neuroimaging technology, for example, event-related potentials (ERPs), functional magnetic resonance imaging (fMRI), and positron emission tomography (PET), have convincingly demonstrated that spoken language processing primarily takes place in the left hemisphere. Two left

hemisphere regions, Broca's area and Wernicke's area, are involved in speech production and in speech comprehension, respectively. Some researchers have proposed that Wernicke's area plays a role in language comprehension because of its proximity to the primary auditory cortex, and that the left hemisphere's specialization for language evolved because of its sensitivity to rapidly changing temporal patterns found in speech. Such proposals would predict that sign languages are not necessarily processed in the left hemisphere (perhaps relying more on spatial processing in the right hemisphere), and therefore may not recruit Wernicke's area for comprehension.

Most studies, however, have uncovered striking similarities in the neural organization of spoken and sign languages. Sign aphasia is observed only in patients with left, not right, hemisphere damage. In addition, neuroimaging studies have documented left-hemisphere activation in sign language processing. Broca's area (left inferior frontal gyrus) is activated during sign language production, even though signs are articulated manually instead of orally. And Wernicke's area (left posterior superior temporal gyrus) is activated during sign language comprehension, even though signs are perceived visually. Importantly, the iconicity of a sign (e.g., the sign for HAMMER looks like the action of hammering) does not affect its neural processing; the same neural systems are activated for both iconic and noniconic signs. In sum, spoken and sign languages engage similar areas of the brain, indicating that these areas are central to language and that the left hemisphere serves all language processes, regardless of modality.

Although signs, gestures, and pantomimes are articulated in the manual modality, the sum of the research shows that sign languages are processed differently than gestures and pantomimes. Sign aphasics can produce and understand pantomime, but not signs, even signs that appear gestural, like 'BRUSH TEETH'; they can pantomime the act of brushing their teeth but not produce the sign. This dissociation between pantomime and sign in aphasic patients indicates that their sign impairment is not a motor impairment but rather a language impairment. Furthermore, the strong left-hemisphere activation observed for signs and words is not observed for nonsymbolic gesture and pantomime; pantomime activates areas in both hemispheres. However, experience with a sign language does lead to different patterns of activation when observing pantomime; pantomime elicits less activation in the parietal regions of signers' brains versus nonsigners. Further, gesture and sign are not completely independent; similar areas of the brain are also activated when processing signs and gestures. Ongoing research is working to uncover the properties of gesture and sign that lead to a subset of shared neural systems.

Although there is strong left hemisphere involvement in the production and processing of sign languages, some features of sign languages may recruit the right hemisphere. For example, because the facial grammar of sign languages (see section 'Nonmanual Markers') shares some characteristics with affective facial expressions, the facial grammar may be processed in the right hemisphere where affective information is processed. The evidence, however, does not support this claim. Some patients with left-hemisphere damage omit nonmanual grammatical markers but produce affective facial expressions. Conversely, some right-hemisphere damaged patients produce nonmanual markers but omit affective facial expressions.

Neuroimaging studies have also confirmed more left hemisphere involvement for perceiving linguistic facial expressions compared to affective facial expressions. However, the right hemisphere shows some activation during the processing of facial grammar. Whereas nonsigners process all facial information predominantly in the right hemisphere, signers show bilateral activation during the processing of both linguistic and affective facial expressions. Thus, the signing brain may reorganize the neural systems used for affective facial expressions to process the facial grammar of a sign language.

The right hemisphere is also specialized for processing spatial information; most patients with right hemisphere damage have problems perceiving spatial orientation and spatial perspective. Thus, some of the spatial grammar of sign languages may recruit areas in the right, not left, hemisphere. Recall that sign languages talk about spatial relations by mapping these relations in signing space through the use of 'classifier constructions' (see section 'Morphology'). Strikingly, this very aspect of sign languages is impaired in signers with either left or right hemisphere damage. In addition, imaging studies show activation not in Broca's area but in the inferior parietal cortex in both hemispheres for processing spatial classifiers. Studies with nonsigners have demonstrated that as spatial descriptions increase in complexity (e.g., number of objects), more of the right hemisphere is recruited. It has been proposed that the mapping of a real-world spatial relation onto an internal representation of the signing space recruits the areas of the right hemisphere that are crucial for processing how objects are located with respect to other objects in the environment. Even nonsigners show right parietal activation when describing spatial arrays of novel shapes. Thus, the unique characteristic of sign languages that allows for the analogical representation of spatial relations recruits more right hemisphere regions than is observed in spoken languages, where such an analogical representation of space is absent.

As the technology develops, we will learn more about the neural systems supporting the processing of both spoken and sign languages. The inclusion of sign languages in the study of the neurological basis of language has yielded strong evidence that the left hemisphere is specialized for language regardless of modality. However, the mystery of why the left hemisphere is so good at language remains unresolved. In recent years, the neurological study of sign languages has uncovered some of the ways in which sign language and spoken language processing differ. Identifying the similarities and differences between signed and spoken languages tells us which aspects of language processing are universal to all languages, and which aspects are shaped by language modality.

See also: Language Development; Reading and Phonological Processing; Psychology of Reading; Syntax.

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Sleep, Biological Rhythms, and Performance

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Glossary

Chronotype Morning and evening chronotypes describe the tendency to feel most alert and function optimally at either morning or evening times of the day.

Circadian rhythm A biological rhythm with a period of about 24 h, for example, the sleep–wake cycle.

Electroencephalogram (EEG) EEG is the tracing of brain wave activity typically recorded with electrodes placed on the scalp. The waveforms which vary in frequency and amplitude arise from the postsynaptic potentials of mainly pyramidal-type neurons in the higher cortical layers of the brain.

Lapses Slow or missed behavioral responses during periods of sleepiness which represent deficits in attention processes.

Masking Confounding variables or factors that, if not controlled through careful research design, may remove all measurable effects of sleep deprivation.

Non-REM sleep Includes Stages 1–4 sleep which are increasingly deep stages of sleep.

REM sleep Rapid-eye movement sleep constitutes about 20–25% of the night in adults. It is characterized by saccadic eye movements, low muscle tone, and active EEG.

Sleep architecture The pattern of change in sleep stages as they vary across the night, typically seen as a progression from wakefulness to increasingly deeper stages of non-REM sleep (Stages 1–4), followed by an REM period. The non-REM–REM cycle repeats every 90 min throughout the night in healthy adults.

Sleep debt Describes the cumulative increase in sleepiness and deficits in neurocognitive performance that build up over successive days of sleep loss.

Sleep hygiene Behaviors that promote and are conducive to healthy, efficient sleep. Some examples include a regular sleep/wake schedule, avoiding stimulants, and having a good sleep environment (dark, quiet).

Sleep inertia Refers to the feeling of grogginess one experiences upon awakening. After a full night of sleep, the sleep inertia period lasts from 10 min to an hour or more depending on the nature of the performance test.

Sleep and wakefulness are controlled by two interacting processes: sleep homeostasis reflects the drive or propensity to sleep that builds up while awake, and circadian rhythms are our endogenous biological clocks that govern the timing of when we are sleepy and alert. There is a bidirectional relationship between sleep and waking function. The quantity, quality, and timing of sleep impact waking cognition, emotion, and performance. Waking behaviors also impact sleep. For instance, napping, medications, and common substances like caffeine may affect the ability to sleep at night, and newly learned information and skills are rehearsed and consolidated during sleep. The following article will review the current understanding of the role of sleep and circadian rhythms in waking alertness and performance.

Sleep Characteristics and Function

Sleep is ubiquitous behavior, occurring in all mammals and birds, characterized by observations of reduced movement, a stereotypic posture within species, diminished responsiveness to stimuli, and the ability to awaken (which differentiates it from states like coma or brain death). Since the application of the electroencephalogram (EEG) to the study of sleep in the 1930s, sleep has more often been described by electrophysiological variations in brain waves, eye movement, and muscle activity to determine the stage or depth of sleep. The measurement of sleep is referred to as polysomnography (PSG). Respiration and limb movements are also often recorded in the Sleep Disorders Clinic to assess common sleep disorders. Normal

sleep is characterized by five distinct stages which are called rapid eye-movement (REM) sleep and Stages 1–4 (collectively termed non-REM sleep). Refer to [Table 1](#) for a description of physiological features of each sleep stage relative to the waking state. Healthy young adults will typically fall asleep within 10–20 min, first entering Stage 1 which is a brief transition state to deeper sleep. During this transition, there is awareness of the outside world but dream-like reverie at the same time. The sleeper then descends into Stage 2 sleep, a light stage of sleep that will be the predominate stage of the night. Next, the sleeper moves into deeper sleep, Stages 3 and 4, which is characterized by slow brain waves and is therefore also termed slow-wave sleep (SWS). It is more difficult to awaken the sleeper from this deep sleep, and when roused the person is often confused and reports only vague mental activity. Often after a brief return to lighter sleep or an arousal, the sleeper then enters the first REM period. REM sleep was not identified until the 1950s when Eugene Aserinsky and Nathaniel Kleitman observed periodic eye movements under the lids of sleeping infants. REM is a paradoxical state of sleep where the brain waves are similar to the waking state, yet it is difficult to awaken the sleeper. A defining characteristic of REM is widespread muscle atonia where most of the body's muscles are paralyzed. REM sleep is an active brain state, where the most vivid and bizarre dream reports occur; however, dreaming or mentation is present in all stages of sleep. Identification of the REM sleep state led to a paradigmatic shift in the field of sleep research; sleep was no longer seen as a unitary state. There were two distinct states within sleep, REM and non-REM, which were as different from one another as sleep was from the

Table 1 Physiological features of sleep stages

Wake – alert, eyes open	EEG is low voltage, mixed frequency (e.g., 0.5–70 Hz) and desynchronized. Eyes show scanning of the environment, and muscle activity is high often depicting gross body movement
Wake – relaxed, eyes closed	Alpha EEG waves (8–12 Hz) are predominant
Stage 1	EEG is low voltage, mixed frequency. Alpha waves (8–12 Hz) begin to disappear, theta waves appear (4–7 Hz), and slow rolling eye movements are observed
Stage 2	EEG is relatively higher voltage and slower frequency compared to the waking state. Two periodic EEG events are apparent: (1) sleep spindles (12–16 Hz sinusoidal waves lasting 1–2 sec) and, (2) K-complexes (the largest human brain wave, observable as a biphasic negative wave followed by a positive wave)
Stage 3	EEG is highly synchronized, consisting of large delta brain waves (0.5–4 Hz) for 20–50% of a 30-s time window
Stage 4	The large delta waves appear for more than 50% of the 30-s time window
REM	EEG is low voltage, mixed frequency, and desynchronized. Muscle activity is low, and rapid eye movements appear in bursts

waking state. This distinction led to a greater understanding of brain mechanisms controlling sleep, more focused research methods for dream researchers, and improvements in diagnosis and treatment of a number of sleep disorders (including sleep apnea, narcolepsy, and REM-sleep behavior disorder).

A complete non-REM–REM cycle as described above takes the adult sleeper about 90 min, and then the cycle repeats four to five times throughout the night. REM periods get progressively longer as the night continues. REM thus dominates the later half of the night, while SWS dominates the earlier half of the night. The functions of sleep are still debated among scientists. In general, SWS is thought to play a restorative role for both the brain and the body. There is a great deal of evidence that newly learned information (e.g., language) is consolidated in REM sleep and procedural learning (e.g., learning to play piano) is rehearsed in Stage 2 sleep. The sleep spindle, the 12–16 Hz periodic waveform generated in non-REM sleep, is a marker of this sleep-dependent learning process. Experiments show that spindles increase during the sleep period following procedural learning compared to a control group; they are also correlated with measures of learning potential (i.e., IQ). Sleep also plays a role in maintenance of physiological systems, such as the endocrine and immune systems. It is likely that there are multiple functions for this complex state which takes up approximately one-third of our 24-h day. Some functions of sleep may be primary (i.e., sleep developed to serve that specific purpose), while others may be secondary (i.e., sleep provides an optimal time for certain variables to act or be maintained). Some researchers look to the phylogeny of sleep for clues about its function. By determining the presence or absence of sleep (or REM sleep) in different species through evolution, researchers may be able to

hypothesize when and why sleep emerged as a behavior. The presence of REM in both mammals and birds would be best explained by its emergence in their common ancestor, the reptile. However, there is currently no evidence for REM sleep in modern-day reptiles, and thus researchers surmise that REM must have developed independently in mammals and birds. Despite the lack of understanding about the function(s) of sleep, it is clear that lack of sleep leads to impaired mood and alertness, and deficits in attention and performance.

Sleep and wakefulness are regulated by both homeostatic and circadian processes. Sleep homeostasis refers to the drive for sleep that builds up while awake. SWS is a marker of this homeostasis in sleep; the longer one remains awake, the more intense the SWS during the next sleep episode (i.e., its onset is abbreviated, duration longer, and magnitude of the slow-waves greater). Over the course of the sleep period, the amount of slow-wave activity falls off exponentially as sleep pressure dissipates. In the waking state, theta brain wave activity (i.e., 4–7 Hz waveforms in the EEG) is thought to reflect this homeostatic process because its presence increases in parallel with the level of sleepiness.

Widespread brain regions and mechanisms are implicated in the control of sleep and wakefulness. In order to determine what areas of the brain play a role in wakefulness, non-REM and REM states respectively, researchers use techniques such as transection (cutting the brain tissue systematically at different areas to determine if the behavior remains intact), lesions (destroying brain tissue in isolated areas), or chemical or electrical stimulation. Using these methods, researchers have determined that wakefulness is controlled by neurons located in the ascending reticular activating system (ARAS) of the brainstem. Neurons in this area project to the thalamus, hypothalamus, and basal forebrain, and from there project to the cortex which results in the EEG activation observed in wakefulness. Sleep onset involves active inhibition of neurons in ARAS, which in turn leads to the generation of sleep spindles from the reticular nucleus of the thalamus, effectively blocking transfer of information to the cortex. The spindles and delta waves recorded on the scalp during non-REM sleep arise from hyperpolarization of thalamocortical systems. Lesions to areas in the brainstem and forebrain will lead to loss of SWS, while stimulation will lead to EEG synchrony. Transection studies reveal that the pons and medulla brain areas are needed for the generation of REM sleep. In sum, there is not one single localized area in the brain that controls sleep; rather, sleep is a behavior that involves widespread regions and connections throughout the brain.

Circadian Rhythms

A biological rhythm is an event or function that repeats over time with a predictable period. Circadian (meaning ‘about a day’) rhythms are those with a period of about 24 h. These daily biological rhythms are controlled by our endogenous clock, the suprachiasmatic nucleus (SCN), located at the base of the hypothalamus in the brain. Peripheral oscillators have also been identified in cells and organs throughout the body which may play a role in regulation of various physiological systems and health; however, the SCN is regarded as the master clock controlling the timing of sleep and wakefulness.

These rhythms are linked to and reset by the natural light–dark cycle in our environment. They control fluctuations in physiological variables, arousal, mood, and performance. Ultradian rhythms are those that have a period of less than 24 h. Examples of ultradian rhythms are the non-REM–REM cycle that repeats throughout the night, and a basic rest and activity cycle (BRAC) that describes peaks and troughs in our alertness level throughout the day. Both have a periodicity of about 90 min.

Homeostatic and circadian processes interact to determine our level of alertness and the timing of sleep onset and awakening. Circadian rhythms determine the timing of sleep and wakefulness, but they do not explain the function(s) of sleep. Circadian rhythms can be measured in individuals using core body temperature or melatonin concentrations in urine. An early afternoon period of reduced alertness and performance commonly referred to as the postlunch dip is in fact determined by a nadir in circadian rhythms and not actual food intake. A time of peak alertness occurs in the early evening and has been called the forbidden zone because it is a time when it is most unlikely to fall asleep in a nap. A number of neuroendocrine factors are under circadian control. For example, cortisol and prolactin rise and fall within the 24-h period regardless of whether sleep takes place. Other factors such as growth hormone and thyroid-stimulating hormone are sleep-dependent; they are secreted during sleep and will not be released when deprived of sleep. Sleep disruption will alter the natural secretion profile of these endocrine factors which is thought to contribute to the negative health consequences of chronic sleep loss.

Circadian rhythms can be altered by natural light in the environment and other zeitgebers. Zeitgebers are external cues that synchronize circadian rhythms with the environment. In addition to the light–dark cycle, other nonphotic zeitgebers controlling our circadian rhythms include food and a variety of social interactions and habits. Our biological rhythms are entrained or reset by these zeitgebers each day. If we are removed from the influence of these external time cues (e.g., living for an extended period in a bunker or cave with no natural light or other time cues), we begin to free-run, that is, the usual 24-h period of the circadian rhythm changes, resulting in the timing of sleep/wake episodes shifting systematically around the clock. In summary, circadian rhythms are physiological phenomena which allow organisms to interact with their environment in an optimal or efficient manner.

Circadian rhythms can be disrupted by conditions such as shift work, jetlag, and daylight savings time. Research has shown that the disruption to sleep and circadian rhythms following daylight savings time in the Spring leads to increased automobile accidents on next morning. It is more difficult to adapt to the clock change in Spring when the clock is moved forward compared to the Fall when it is moved back; this is because it is more difficult to phase-advance our rhythms (i.e., going to bed earlier vs. staying up late). Humans can adapt to changes in timing and schedules more easily by shifting sleep episodes gradually and seeking or avoiding daylight exposure appropriately. There are individual differences in the ability to adapt, particularly with shift work and especially if the shifts changes are rapid (e.g., after limited time off), extreme (e.g., days to midnights vs. days to evenings), or

require phase-advancing. Shift work becomes more difficult to adapt to for older adults and has been associated with higher cancer rates in women. A maladaptation syndrome has been described which outlines factors associated with the likelihood of failure to adapt to shift work. These factors include fixed ones, such as age and individual differences in tolerance or adaptability to changes in circadian rhythms, and adjustable factors, such as work and social schedules. Taken together, these factors aim to predict individuals who will fail to adapt immediately and over months to years of shift work. One particular individual difference variable that may affect the ability to tolerate shift work or disruptions to sleep schedules is one's chronotype. Morning or evening types that feel they function optimally during morning or evening hours respectively have long been referred to as larks and owls. Recent research has identified genetic markers underlying these chronotypes that may account for their differences in tolerance to sleep deprivation.

There are disorders of circadian rhythms that disrupt the timing of sleep and wakefulness. If sleep cannot occur at the appropriate time, sleep architecture and quality of sleep are affected. In turn, waking arousal, mood, and performance are impacted. Some disorders of circadian rhythms include: delayed phase syndrome, advanced phase syndrome, jet lag, irregular sleep/wake pattern, and non-24-h sleep/wake syndrome. In advanced or delayed sleep phase syndrome, the total sleep time is the same as a normal bout of sleep, but the timing is different (e.g., an advanced sleep phase may occur 9 p.m.–5 a.m. and a delayed sleep phase may occur 2–10 a.m.). Older adults are normally somewhat phase-advanced and adolescents are normally phase-delayed, but delayed or advanced phase syndromes can occur at any age. Jetlag occurs when there is a misalignment between one's endogenous circadian rhythms and the zeitgebers of the destination several time zones away. Although one may experience fatigue associated with a long-distance travel, jetlag is specifically the result of travel east or west across three or more time zones. Traveling east is more difficult because it requires the biological clock to phase-advance as opposed to delay. Irregular Sleep/Wake Pattern refers to a disorganized pattern of sleep and wakefulness due to a loss of circadian rhythms, where the total amount of sleep may be normal but it is fragmented. It is often seen in Alzheimer's patients or other neurological conditions where there is damage or reduced function of the SCN. Non-24 h sleep/wake syndrome refers to a sleep cycle that has a periodicity of more than 24 h. For these individuals, the sleep period is continually phase-delayed around the clock, leading to difficulties in falling asleep at the desired time and daytime sleepiness. All of these disruptions to circadian rhythms make sleep less optimal and less efficient thereby affecting waking arousal and performance.

Sleep Need

Each person has an individual sleep need (e.g., a person with a 9-h daily sleep requirement cannot function well on less sleep). While adults sleep 7.5–8 h on average, people vary in their sleep need with most adults reporting a habitual sleep time between 6 and 9 h. Women report a greater sleep need

than men. A small number of people are thought to be true short sleepers, that is, they sleep efficiently for a short time (e.g., <5 h), but experience no ill effects in their waking function. Research has shown that both short and long sleepers have a shorter lifespan. While this striking finding has been replicated many times in various cultures, it is not known to what extent sleep length is causally related to mortality. Other factors such as health and genetics that are related to sleep likely play a role. There is no evidence that we can change our innate daily sleep need. The strong homeostatic drive for sleep generally ensures that we typically meet our personal biological sleep need. However, sleep and medical disorders, normal aging, and intentionally reducing sleep due to work or social demands can impact the ability to get the sleep one needs.

Sleep Across the Lifespan

Sleep duration and characteristics, as well as circadian control of sleep, vary considerably across the lifespan. In utero, sleep/wake patterns are irregular and poorly organized, and are in part dependent on the mother's sleep/wake cycle, hormones, and substance intake. By about 12 weeks of development, a state similar to non-REM sleep is apparent; REM is evident by 36 weeks. The newborn baby shows a phase-delay each night around the clock, such that sleep occurs later and later each night, and then begins to entrain to external cues around 16 weeks. The newborn sleeps 16–18 h per day, and spends about 50% of that time in REM sleep. Their non-REM–REM cycles are shorter than adults, with a periodicity of about 50–60 min. Researchers have argued that this large proportion of REM sleep in newborns is evidence in support of a role for REM sleep in learning and memory because newborns have a tremendous amount of novel information to process. Adult-like sleep stages are apparent by 6 months of age. The toddler has well-organized and entrained circadian rhythms, and by age 2 he or she typically takes only one nap per day. They sleep 11–12 h of the day, and REM sleep is already reduced to about 25% of the sleep period. In children aged 6–12, sleep is extremely well organized and entrained. Sleep efficiency, that is, percentage of time in bed spent asleep relative to time awake, is 95–97%, the best it will be over the entire lifespan. Daytime naps are no longer needed, but children may continue to nap. Children require 9–11 h of sleep, but many do not achieve this optimal amount of sleep due to early school start times, poor sleep habits, or lack of parental guidance on healthy sleep behavior. At this time, REM sleep has already reduced to about 20% and will remain at that level for the remainder of life; SWS has peaked and already begun to diminish. In adolescents, circadian organization is reduced and there is a tendency for phase delay, that is, going to bed later and sleeping longer. Although adolescents now have adult-like 90-min non-REM–REM cycles, they still require 9 h sleep on average. The amount of SWS has diminished considerably, by 30–40% relative to childhood, and sleep is more fragmented. The tendency for a phase delayed rhythm, combined with the 9-h sleep need and earlier school start times in many high schools, leads to significant problems with daytime sleepiness and poor academic performance in adolescents as a group.

Sleep in adults can be quite organized and efficient; however, lifestyle factors, behaviors, and poor sleep hygiene can grossly disrupt sleep. For example, shift work, high social or work demands, alcohol and drug use, and prescription medications will affect the sleep–wake patterns in otherwise healthy young adults. Adults sleep, on average, 7.5–8 h, although, as mentioned previously, there are considerable individual differences in sleep need. While total sleep time and sleep architecture are generally similar for men and women, premenstrual symptoms, pregnancy, and menopause can have profound effects on sleep due to both hormonal changes and associated physical symptoms. Women report a greater incidence of insomnia, whereas men are diagnosed more often with sleep-related breathing disorders. Older adults as a group sleep on average about 6 h, but often spend more time in bed which leads to greater sleep fragmentation and reduced sleep efficiency. They tend to be phase-advanced, going to bed earlier and waking up earlier. Most of the common sleep disorders increase in prevalence with age (e.g., insomnia, sleep apnea, periodic limb movement). Importantly, the age-related change to sleep duration is not thought to reflect a change in sleep need but rather a change in the ability to sleep. The brain's ability to regulate sleep and the function of the SCN are thought to be compromised as we age. There are a number of changes to sleep architecture with aging, including less SWS, fewer spindles, and smaller amplitude K-complexes. One interesting gender difference in sleep is apparent in older adults; the age-related decline in SWS begins much sooner for men than women.

Despite the fact that we outgrow our biological need for daytime naps in childhood, many adults continue to nap throughout the lifespan. Indeed, for some cultures, daily napping is the norm. For healthy adults, napping leads to improvements in alertness and well-being without disrupting the ability to sleep at night. For poor sleepers, who have difficulty falling asleep and staying asleep, naps are not recommended because they may reduce the efficiency of sleep at night. People nap for a variety of reasons. Naps may be taken to recover from sleep loss, as a prophylactic measure to minimize sleepiness and performance impairment for an upcoming period of extended wakefulness, or for appetitive reasons. Older adults nap more frequently, possibly due to increased time for napping in retirement or to compensate for age-related changes to sleep quality and increased daytime sleepiness. Naps of 10–20 min have been shown to have benefits for alertness and performance with minimal sleep inertia (i.e., the grogginess experienced upon awakening). Longer naps allow time to enter SWS and REM which will result in greater sleep inertia. Naps longer than 20 min are therefore not recommended, particularly in the workplace where it is necessary to awaken and return immediately to work duties.

Sleep Deprivation and Performance

The first research study on the effects of sleep loss on human performance was published by Patrick and Gilbert in 1896. Despite not having the use of technology that exists today to measure brain activity, a number of observations were made about human behavior that remarkably still hold true today.

These early researchers noted uncontrollable micro-sleeps or naps, dream reports during these brief periods, mental lapses during performance, diurnal variation in performance, and recovery sleep that was characterized by deeper sleep. Although few studies were conducted in the first half of the twentieth century, some contributions of this early work included identifying task characteristics that were sensitive to sleep loss (e.g., long tasks, requiring more extensive processing and sustained attention), revealing factors that masked deficits in performance (e.g., learning, effort, motivation), and observations of variability in the data (both individual differences and diurnal fluctuations). This early work on sleep deprivation was driven by an interest in elucidating the functions of sleep; removal of a behavior would reveal its function. However, sleep deprivation was not found to be an ideal way to determine its function since researchers cannot entirely eliminate sleep (e.g., micro-sleeps and brain slowing occur despite efforts to remain awake), and when we deprive individuals of sleep, we are replacing it with extended wakefulness (to which there may be physiological consequences apart from the lack of sleep).

The use of EEG to study sleep, first applied in the 1930s, drastically changed the number of studies performed in this area and the knowledge gained on the effects of sleep loss. The 1950s through the 1970s was a period of intense study into the effects of sleep deprivation, largely driven by a military interest in optimal human performance and sustained operations. This work further refined our understanding of the types of performance tasks that were impaired during sleep loss. Researchers described and characterized changes in EEG associated with the frequent pauses in reaction time; they referred to these momentary changes in responsiveness as lapses. These lapses were observed to accompany EEG changes similar to those seen at sleep onset. Quantitative analysis of the EEG spectra has shown that alpha (8–12 Hz) and theta (4–7 Hz) are sensitive markers of physiological sleepiness. Similar to EEG changes seen at sleep onset, a sleepy individual with eyes closed will show lower alpha and higher theta EEG. When recorded with eyes opened or during task performance, alpha, theta, and high-frequency EEG bands (e.g., beta, 16–30 Hz) are higher in sleep-deprived compared to well-rested individuals. During task performance, greater alpha reflects inattention and greater beta may be associated with effort (i.e., the sleepy participant exerting more effort to perform on the task). A few studies have shown that these EEG changes are strongest at frontal sites. Over several days of continuous sleep restriction, the frontal brain regions show reduced arousal immediately, while posterior regions are preserved until the restriction is more severe. This corresponds with findings that performance tasks involving frontal brain regions (e.g., involving organization, planning) are compromised during sleep loss. Studies examining the brain's processing of stimuli using event-related potential (ERP) techniques show that sleep deprivation impairs attentional mechanisms involved in early encoding as well as more complex cognitive processing such as target discrimination and novelty processing.

Brain imaging techniques can provide insight into understanding behavior during sleep loss by identifying brain areas associated with the performance deficits. The earliest studies used PET imaging techniques and showed that certain brain areas were deactivated during sleep loss (notably the thalamus

and cortical regions), and that the extent of deactivation increased with the length of time awake. Later, using fMRI imaging techniques, a series of studies showed patterns of either brain activation or deactivation that seemed to depend on the specific task that was performed during the brain scan. Drummond put forth the compensatory recruitment hypothesis to explain the phenomena that additional brain regions (e.g., parietal regions) could be activated in order to compensate for reduced function in other brain regions (e.g., frontal). Thus, the brain appears to be adaptable during the challenge of sleep deprivation which may explain performance instability and variability during sleep loss. It is not currently known what limits or constraints influence such brain adaptation during sleep loss.

Together, a substantial body of research on sleep loss, conducted for more than a century, converges to show that performance and well-being are profoundly and systematically affected by sleep loss. Sleep loss impairs alertness and mood, memory and attention, visual and motor acuity, and response time. Meta-analyses show that mood is one of the most robust effects and that reaction time is impacted more than accuracy. Despite the fact that mood changes were described in the earliest studies on sleep deprivation, and that alteration to mood is one of the most reliable findings in this large body of research, researchers have just recently begun to explore the impact of sleep loss on emotion regulation and reactivity. Many neuropsychological tests are not ideally suited to assess cognitive deficits related to sleepiness because they were designed to assay more severe and stable impairment. One of the hallmark features of performance during sleep loss is increased variability in performance. Indeed, brain function and performance do not simply decrease linearly as the extent of sleep loss worsens. Human performance varies because of homeostatic and circadian influences, other factors at play such as effort, motivation, the environment (see section 'Factors Affecting the Impact of Sleepiness on Performance'), and rapid fluctuations in arousal and attention. Despite being awake for more than 24 h, a medical resident may be able to perform a particular task with 100% accuracy at one moment; however, the sleepy brain will lapse more often and for longer periods of time. This lapsing in attention is beyond one's control and leads to performance variability and failure (including catastrophic accidents in the case of the transportation workers and power station operators).

Studies of total sleep deprivation (i.e., greater than 24 h awake) have helped to reveal the nature of impairment during extreme levels of sleep loss. More recently, researchers have focused on levels of sleep loss more commonly experienced in modern society and have approached this research with an interest in understanding the impact of sleepiness on health and safety. Sleep fragmentation studies have been carried out in healthy, good sleepers to model the type of frequent disruption to sleep that occurs in disorders like apnea and periodic limb movement. These studies show that when sleep is fragmented, without reducing total sleep time, deficits in performance and information processing are apparent. Thus, sleeping for a consolidated, uninterrupted period of time is important for optimal waking function. Studies of continuous sleep restriction (e.g., reducing an 8-h sleeper down to a daily sleep time of about 5 h for a week or two) have shown that deficits in performance and physiological arousal and attention accumulate

over the period of sleep restriction. Moreover, there is a dose-response effect, such that the deficits in neurobehavioral performance and EEG arousal change systematically with the degree of sleep restriction. Most remarkable is that the performance deficits observed even after a night or two of sleep restriction are similar in nature and extent to those reported following total sleep deprivation. Researchers are now interested in the impact of a long-term sleep debt from chronic sleep restriction on performance and health, as well as understanding factors related to individual differences in vulnerability (or resiliency) to sleep loss.

Research has also been carried out to investigate performance during the recovery period following either total sleep deprivation or cumulative sleep restriction. Recovery sleep will not be equal in duration to the exact amount of sleep lost. Instead, sleep will be somewhat longer than usual in duration, but it mainly changes in character. A sleep-deprived individual will typically fall asleep immediately, descend into SWS more rapidly, and spend more time in both SWS and REM. The lighter Stage 2 is minimized in order to get more SWS and REM. Performance and well-being may not improve after a single night of recovery. More research is needed to characterize the time course of recovery for various types of performance tasks, the physiological aspects of sleep associated with recovery, and individual differences in the extent of recovery. People should take caution in assuming they can make up for lost sleep at some later time. One reason for this is that the effects of sleep loss, even a few hours on a single night, have consequences for performance and safety on the following day. In other words, one cannot wait for the weekend to catch up on sleep lost during the week. Secondly, chronic sleep restriction has been shown to have long-term consequences for health, including increased risk of weight gain, diabetes, heart disease, and depression.

Factors Affecting the Impact of Sleepiness on Performance

There are a number of factors that will affect the degree of sleepiness and performance deficit that is experienced during sleep loss. Researchers need to be aware of these influences when studying the impact of sleep loss on performance. A failure to control or account for these factors may lead to erroneous conclusions about the effects of sleep loss. Factors that affect homeostatic and circadian processes, individual differences in participants, variation in arousal, and testing conditions may all play a role. The following variables may mask or cover up the true effects of sleep loss on human performance in an experimental setting. These factors could also influence the level of subjective alertness and perception of impairment in individuals who are not getting sufficient sleep.

Time of Day

Due to both circadian influences and the number of hours since awakening, the time of day can affect the sensitivity of measures in revealing deficits due to sleepiness. For people with regular sleep schedules, peaks in alertness and performance typically occur in the morning (9 a.m.) and evening (6 p.m.);

troughs occur following lunch (1 p.m.) and mid-afternoon (4 p.m.). A person who has stayed up all night will experience a period of relative well-being early in the morning despite having been awake; this is due to the underlying circadian rhythms.

Sleep History

The amount and quality of prior sleep and the duration of time since awakening could affect performance assessment due to variation in homeostatic sleep pressure. Moreover, cumulative sleep debt will influence the extent of sleepiness and performance deficit that is experienced in an acute sleep loss scenario.

Individual Differences

The same amount of sleep deprivation may affect people in different ways, some showing greater vulnerability while others apparent resiliency. Factors contributing to these individual differences may include sleep history and habits, genetics, gender, intelligence, experience with sleep loss, etc. General health and fitness, as well as personality, mood, or psychiatric disorders may also play a role.

Gender

Much of the earlier work on sleep deprivation was done primarily on male subjects, and more recent work lacks the sample size to properly investigate the influence of gender. Studies are needed which systemically investigate the effects of sleep deprivation in male and female participants matched for age and education, as well as investigation of phases of menstrual cycle.

Genetics

Circadian rhythms are under genetic control and the genetic basis of chronotypes has been described. While one's circadian profile might influence the impact of sleep disruption, the genetic basis of sleep homeostasis (i.e., differences in sleep pressure) has not been determined.

Age

Sleep deprivation is generally not as well tolerated in older adults. However, in some cases, older individuals may perform better than younger adults during sleep loss due to other factors that vary by age such as motivation or conscientiousness. Alternatively, a task involving fine motor movements practiced in video games may be better performed by the younger group simply due to experience with similar technology.

Health

General health may affect mood, arousal, and tolerance to sleep deprivation.

Exercise

Exercise will influence heart rate, body temperature, and ultimately arousal level. If aerobic activity is not controlled in a sleep deprivation study, participants could use exercise to temporarily improve arousal for periods of time.

Substance Intake

Food, beverages, over-the-counter vitamins and herbal remedies, and pharmaceutical drugs all could increase arousal and mask the effects of sleep loss. The influence of food and drugs on the central nervous system must be understood and controlled, for example, caffeine and nicotine use is typically eliminated in experimental investigations of sleep deprivation.

Effort/Motivation

Both effort and motivation may influence the level of performance during sleep loss. For this reason, short tasks are generally avoided since it is possible to maintain effort and motivation for short periods of time.

Workload/Fatigue

Tasks or performance batteries that are too long or demanding on participants may lead control participants to show performance deficits due to workload or fatigue. Thus, ample breaks are needed when monitoring human performance over an extended period.

Environment

Light, temperature, and noise all could influence the effects of sleep deprivation by impacting arousal level. Typically, the light and temperature are kept constant during a sleep deprivation protocol.

Practice Effects

If a participant continues to perform better on a task over time due to practice, learning, or insight into the task, the effects of sleep loss could be diminished. It is thus important to choose tasks that do not have a substantial learning curve (e.g., simple reaction time) or make sure that participants have ample practice before the experimental manipulation of sleep (e.g., achieve a high score or asymptote level of performance).

Test Characteristics

A variety of test characteristics can influence the extent to which individuals will show deficits during sleep loss. For example, deficits are more likely to be captured in tasks that are of longer duration, more difficult, and cognitively complex. Further, tasks involving multitasking, no feedback on performance, and a fast, automated rate of presentation will optimize the likelihood of measuring deficits due to sleepiness.

Conclusion

Daytime sleepiness is a pervasive phenomenon in contemporary society. People experience sleep loss because of lifestyle choices, shift work, normal aging, and sleep and medical disorders. Sleep loss leads to impairments in broad aspects of waking function, including mood, arousal, attention, memory, and visual-motor function. The risk of performance failure and accidents increases as the length of sleep loss continues. Sleep restriction that is chronic over days to weeks has an impact on waking performance similar to that seen following total sleep deprivation. It is important for people to know their individual sleep need and to make an effort to get this amount of sleep each night. Insufficient sleep has profound consequences for alertness and performance as well as health, safety, and productivity. Future directions of research in this area aim to elucidate the neural mechanisms controlling performance deficits, and the nature of individual differences in vulnerability to sleep loss.

See also: [Sleep Disorders](#).

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Relevant Websites

- <http://www.css.to/brochures.html> – Canadian Sleep Society website, for information brochures on sleep in English and French.
- <http://nationalsleepfoundation.org> – National Sleep Foundation website, for information on sleep awareness and disorders.

Sleep Disorders

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Glossary

Apnea Abrupt cessation of respiration.

Cataplexy Abrupt paralysis of muscle tone.

Chronotherapy Treatment of sleep–wake schedule misalignments by resetting the biologic clock.

Circadian rhythm Near 24 h rhythm.

CPAP Device used for noninvasive ventilation.

Hypopnea Shallow respiration.

Neurosomnology Body of neurological sleep disorders.

Parasomnia Undesirable motor or sensory events during sleep.

Polysomnogram Recording of sleep parameters.

Polysomnography Registration of nocturnal sleep physiologic parameters.

Introduction

Sleep is a universal function of all vertebrates and some invertebrates. Sleep develops, matures, and declines in consonance with other functions of the brain. Despite extensive research, the ultimate physiological function of sleep remains unknown. It is known, however, that sleep intervenes in functions of growth, regeneration, and memory.

Such is the importance of sleep that its severe and prolonged deprivation may lead to death in lower mammals. Severely sleep-deprived humans have an uncontrollable tendency to fall asleep and appear slow when performing mental or motor tasks. Profound sleep deprivation has been equated to the effects of alcohol intoxication. Most individuals require between 6 and 8 h of sleep at night. In Mediterranean countries, the daytime siesta allows subtraction of an equivalent amount of time from nocturnal sleep.

Sleep is a preconceived function of the brain modulated by the circadian rhythm. Nocturnal sleep progresses in stages and cycles. In the first half of the night, non-REM sleep (N1 – light sleep, N2 – intermediate sleep, and N3 – deep sleep) predominates, whereas in the second half, rapid eye movement (REM) sleep or dream sleep is increasingly prevalent. The fetus spends much of its time in REM sleep and the infant shows great abundance of REM sleep. Sleep exhibits consolidation to the nocturnal period by the age of 2 years, with ~25% of the total time asleep in REM sleep. In old age, deep stages of non-REM sleep decline while REM sleep remains at 20–25% of total sleep time, despite modestly reduced requirements of total sleep every 24 h.

Polysomnography is the name of the clinical method used to record nocturnal sleep and to register clinical phenomena associated with it. The technique is generally performed in the sleep laboratory and combines recording of brain waves, eye movements, electrocardiography, electromyography, respiratory excursions, and saturation of oxygen. Video-taping of the sleeping individual serves to record motor behaviors when present and constitutes an integral part of polysomnography.

Landmarks in sleep research have included the discovery of various forms of brain waves during sleep that determine the different stages of sleep, as well as the discovery of REM sleep and its association with dreaming. The identification of the brainstem and the diencephalon (thalamus and hypothalamus) as centers of localization of sleep generation, and the

discovery of hypocretin (also called orexin), a neurotransmitter produced by the hypothalamus that is necessary to maintain alertness, have given anatomical and physiological structure to the clinical science of sleep.

More than 80 clinical sleep disorders are codified in the 2005 International Classification of Sleep Disorders and the list keeps growing. Sleep disorders may provoke family pathology, disturb work routines, alter social activities, increase the risk of serious accidents, and affect the health of the affected person. Sleep disorders are common and pervasive, modifying the quality of life of the individual. Excessive daytime somnolence may lead to motor vehicle accidents, poor academic performance, reduced work productivity and social decline. On the other hand, sleeplessness causes fatigue, daytime misery and reduced efficiency. Although sleep is a function of the brain and the brain is central to most sleep alterations, a variety of clinical specialists other than neurologists, psychiatrists, and psychologists are interested in sleep and its disorders. This diversity illustrates the ubiquity and far reach of sleep alterations. Sleep disorders may not only cause abnormal nocturnal behaviors but may also modify respirations, heart function, endocrine secretions, blood composition, and cause many other significant changes. Medicine for sleep disorders uses diagnostic tools centered in the sleep laboratory, and sleep specialists have been trained to procure comprehensive management of most sleep afflictions.

Neurosomnology is an active subspecialty of neurology and of sleep medicine that will acquire increasing notoriety among neuroscientists and clinical neurologists as basic and clinical research continue to unravel the neurological intricacies of sleep and its disorders. The growth of sleep medicine will follow the expansion of neurosomnology. As a function localized in the brain, sleep is channeled in the dynamics of growth, maturation, and decline that modulate other complex functions also localized in the brain such as cognition and language. Sleep lodges in a multiplicity of structures tightly linked in a network of nuclei and tracts served by neurotransmitters that respond to the mandates of the circadian rhythm. The demands to comprehend and manage sleep dysfunctions is driven by sleep disorders as a medical discipline, in which ailments such as narcolepsy, sleep apnea, restless legs syndrome (RLS), and others are studied. Evolving fronts are also emerging in the academic camp where alertness is needed to enhance learning

efficiency, as well as in government sectors to reduce fatigue while improving safety on the road; in labor, where guidance is required to best align shift-work programs; and in aerospace science, where jet-lag creates safety hazards.

Restorative sleep, like a healthy diet and regular exercise, has become one of the pillars of today's health program. And yet, violations continue to occur despite the fact that sleep is the only free voluptuousness given to humans by nature. Better education and more widespread access to sleep clinics will undoubtedly increase public respect for the importance of sleep and enhance prevention of sleep disorders, while improving their management by certified sleep specialists in accredited sleep centers.

History of Sleep Medicine

The intuition that altered sleep was a manifestation of poor health and vice versa was tersely expressed by Hippocrates (~460–370 BC) in his aphorism 'Somnus, vigilia, utraque modum excedentia, malum' (sleep and wakefulness, when excessive, anticipate a bad prognosis). In the middle ages, the Persian Avicenna (980–1037) identified in his Canon, three factors conceding good quality to sleep: continuity, depth, and duration. Furthermore, Avicenna stated that sleeping supine weakened the body, a phenomenon that is well established today in patients with sleep apnea.

In Vienna, Sigmund Freud (1856–1939) and his disciples popularized the analysis of dreams as a portal to subconscious brain content. Hans Berger's (1873–1941) demonstration in Germany of changes in the electroencephalogram during sleep provided the first confirmation that the dormant brain is functionally active. In the early twentieth century, the classic neuropathological studies of encephalitis lethargica by Constantin von Economo (1876–1931) in Vienna localized sleep functions to the hypothalamus. Later in the century, experiments of thalamic stimulation and the discovery of the reticular activating system of the brain provided major advances in the understanding of the neuroanatomical substrate of sleep and wakefulness. In the 1950s, the identification of paradoxical sleep or REM sleep in the cat by Michel Jouvet (1925) in France, the association of dreaming with REM sleep reported by Eugene Aserinsky (1921–1998) and Nathaniel Kleitman (1895–1999) in the United States, and the detection by William C. Dement (1928) and Eugene Aserinsky in the United States of periodic cycles of REM and non-REM sleep throughout the night led to a new view of sleep as an active process with distinctive neurophysiologic substrates underlying two major states, non-REM and REM sleep.

The recognition of specific sleep disorders started in the latter part of the nineteenth century. The neuropsychiatrist Jean-Baptiste-Édouard Gélinau (1859–1928) practicing in Paris described several patients with irresistible sleep and brief episodes of muscle collapse. He termed the condition narcolepsy and called the collapses cataplexy. The breathing disorder of sleep, popularly known as sleep apnea, was first described by various European investigators in 1965. Today we know that sleep apnea affects up to 4% of the general population and is a risk factor for aggravation of several vascular diseases such as hypertension, myocardial disease, and stroke, and for ailments

such as diabetes. The first sleep clinics devoted specifically to diagnose and treat sleep disorders appeared in the 1970s. In the United States, the Association of Sleep Disorders Centers was organized in 1975 and provided a strong platform for the development of sleep disorders medicine. Specialized journals appeared soon after and the first classification of sleep disorders was published in 1979. The International Classification of Sleep Disorders was updated in 2005 by the American Academy of Sleep Medicine. By the end of 2005, 3249 professionals in the United States were diplomates of the American Board of Sleep Medicine. The first board exam on sleep medicine sponsored by the American Board of Medical Specialties took place in November 2007. National and international sleep organizations have proliferated worldwide and the first World Sleep Day was celebrated on March 14, 2008, under the slogan *Sleep well, live fully awake*.

Major Sleep Disorders

Sleep complaints generally fall into the following categories: insomnia, excessive somnolence, snoring and sleep breathing difficulties, sleep-wake cycle disruptions (circadian dysrhythmias), bizarre sleep-related behaviors (parasomnias), and sleep-related movement disorders. Insomnia refers to difficulty falling asleep, staying asleep, awakening too early, and a feeling that sleep has not provided the usual sense of restoration. Conversely, excessive daytime sleepiness is the term for pervasive drowsiness and unwanted sleep episodes during waking hours. Circadian dysrhythmias are disorders of timing of the sleep/wake pattern with the night/day cycle. Parasomnias are defined as undesirable physical phenomena that occur primarily during sleep. A particular sleep disorder may be associated with one or more major categories of symptoms. The chief complaint provides a focus for assessing the disorder of sleep. Information from the bed partner or other observers must often be obtained, as many patients are partially unaware of their sleep manifestations.

The daily schedule, including time of awakening and going to bed; time of naps; time of meals and social activities; and time and use of caffeine, alcohol, tobacco, and prescription and over-the-counter medications may point to particular sleep disorders. Patients with excessive sleepiness may describe drowsiness, increased need for sleep, or irresistible daytime sleep episodes. Mild sleepiness most often occurs after lunch in the afternoon particularly in quiet, boring situations, while severe sleepiness may render the patient asleep when eating, in conversation, or while standing even in the mornings.

Symptoms associated with sleep provide important clues to diagnosis. Loud snoring and witnessed apneas during sleep strongly suggest the presence of obstructive sleep apnea. This condition is highly prevalent in the general population and is one of the most common sources of daytime fatigue, as well as a risk factor for a variety of vascular disorders and motor vehicle accidents.

Generalized muscle abrupt weakness in conjunction with laughter or other emotions is characteristic of cataplexy, which in combination with excessive sleepiness is virtually diagnostic of narcolepsy.

Patients who complain of insomnia may have a psychophysiological disturbance or a psychiatric disorder affecting

sleep. Insomnia and excessive daytime sleepiness may also occur as a result of a circadian rhythm disorder like jet-lag syndrome, shift-work, or more rarely congenital delay of the onset of sleep. Patients with parasomnias complain of a variety of abnormal nocturnal sensations or exhibit bizarre movements, behaviors, or bodily events. Some patients are entirely unaware of the nighttime activity, and a history from the bed partner or other observers is necessary. Some of the more distressing symptoms include nocturnal urinary incontinence (enuresis), shouting or screaming, and violent motor behaviors.

Sleep Apnea

Sleep apnea is a very common disorder and a major sleep-related risk factor for cardio- and cerebrovascular disease. It is also known by the name of sleep-disordered breathing. It becomes the sleep apnea *syndrome* when snoring and sleep-related respiratory lapses are associated with clinically significant symptoms, such as excessive daytime sleepiness and morning headaches. The sleep apnea syndrome affects 2% of women and 4% of men in the general population. It becomes increasingly common as age advances past 45 years and is very prevalent in morbidly obese individuals with a BMI higher than 40 kg m⁻². Snoring when loud, sustained, disruptive, and obnoxious is a marker of clinically significant obstructive sleep apnea and in itself a source of disease. In addition, patients with sleep apnea exhibit lapses in respiration (apneas), shallow respirations (hypopneas) and restless sleep, as reported by bedmates; they also complain of excessive daytime somnolence, morning headaches, physical and mental fatigue, and depression.

The presence and severity of sleep apnea are best diagnosed with attended full polysomnography in the sleep laboratory. Unattended home polysomnography with limited recording channels is acceptable but serves best as a follow-up diagnostic tool. Treatment of sleep apnea with noninvasive positive airway ventilation is generally successful. Compliance with treatment applications has failed in about one fourth of patients, particularly when sleep apnea is of mild severity. For mild forms of sleep apnea the application of mandibular advancement devices, also known as oral appliances, can be beneficial. Surgery removing excessive tissues in the oropharynx may be considered for individuals who cannot tolerate noninvasive equipment or who have severe obstruction to airflow in the oropharynx by redundant tissue growth that includes globular tonsils. Excessive daytime somnolence generally improves with successful treatment of sleep apnea.

Epidemiological studies have shown that the severity of sleep apnea determines the risk of developing vascular complications such as systemic hypertension, stroke, myocardial infarction, and sudden death in sleep. There is proof that successful correction of sleep apnea with noninvasive positive airway pressure ventilation lowers ambulatory mean blood pressure. More recent reports have suggested that clinically significant sleep apnea is also a risk factor for development or aggravation of diabetes.

There is a strong association between sleep apnea and traffic accidents. In patients with an apnea/hypopnea index (AHI) of 10 events or higher, the odds ratio for having a traffic accident is multiplied by a factor of 6. Consumption of alcohol increases the odds even further.

Narcolepsy

Narcolepsy is characterized by severe, unrelenting excessive daytime sleepiness. In the classic form, cataplexy is added, often in association with sleep paralysis and hypnagogic hallucinations. Gélinau coined the term 'narcolepsy' (narcos = somnolence and lepsy = seized) to describe sleep attacks and muscle weakness following intense emotion. In the mid-twentieth century, the classic narcoleptic tetrad of hypnagogic hallucinations, sleep paralysis, excessive sleepiness, and cataplexy was described; in 1960, the occurrence of REM sleep at the onset of sleep in a narcoleptic subject was reported. The observation that narcolepsy was associated with human leukocyte antigens (HLA)-DR2 suggested a biologically based substrate rather than a psychiatric condition. More recently, investigators reported a decrease of the neurotransmitter hypocretin in cerebrospinal fluid of patients with narcolepsy-cataplexy, providing a firm neurobiological explanation and a new test to diagnose the condition. Narcolepsy may occur without cataplexy in milder forms of the disease, or more rarely as the manifestation of a structural disease of the brain, such as tumors or multiple sclerosis.

Onset is typically in the second or third decade of life. Sleep tends to occur in boring or monotonous situations and may be temporarily forestalled by physical activity and mental stimulation. Following brief naps, the patient awakens refreshed. Patients often report episodes of amnesia with 'automatic behavior' during which they may carry out complex nonsensical activities. Accidents due to sleepiness and automatic behavior may occur while driving or operating dangerous equipment. Cataplexy is characterized by sudden loss of muscle tone, usually provoked by strong emotions, particularly laughter. Consciousness is preserved and memory is intact. Hypnagogic hallucinations are vivid dreams that occur at sleep onset, often associated with fear or dread. Sleep paralysis is a transient, generalized inability to move or to speak during the transition between sleep and wakefulness. The experiences are often frightening. Disrupted nocturnal sleep with frequent awakenings is common.

Polysomnography provides objective confirmation of narcolepsy and helps to rule out other disorders that could explain the symptoms. The multiple sleep latency test (MSLT) or daytime nap test provides an objective measure of excessive sleepiness and demonstrates the presence of sleep-onset REM sleep periods which are diagnostic of narcolepsy.

Narcoleptic patients have an increased risk of accidents while operating automobiles and other dangerous equipment. Other psychosocial complications include interpersonal and marital difficulties, loss of employment and academic opportunities, and depression. Personality changes and memory problems are common. Some patients appear to adapt well to narcolepsy; however, for most patients, the disease has a pervasive adverse effect on social and occupational functioning. Many patients report that narcolepsy seriously affects interpersonal, marital, work, academic, and social activities.

Effective treatment of narcolepsy often includes pharmacologic, educational, and lifestyle interventions. The primary treatment for excessive sleepiness consists of brain stimulants. Many patients with narcolepsy take stimulants daily for decades without significant adverse effects. Overuse and abuse of

stimulants are rare in narcoleptics; usage below the amounts prescribed is more common.

Sodium oxybate is approved for treatment of cataplexy. It is also effective for treating excessive daytime sleepiness. Other drugs useful for treatment of cataplexy are imipramine, clomipramine, protriptyline, fluoxetine, and some antidepressant serotonin reuptake inhibitors.

Planned daytime naps may help control sleepiness while reducing the total required daily dose of stimulants. Education of the patient, family, and coworkers plays an important role in adaptation to narcolepsy. Families should understand that narcolepsy is a chronic neurologic disease, and that pathologic sleepiness should not be confused with poor motivation or low intelligence. Patients with narcolepsy should be cautioned about the hazards of driving an automobile or operating dangerous equipment.

Restless Legs Syndrome

RLS is a common, frequently undiagnosed sensorimotor disorder characterized by an urge to move the legs, often accompanied by uncomfortable, unpleasant sensations. RLS impairs sleep and reduces the quality of life. RLS is a dysfunction of the dopamine system. The essential diagnostic criteria are:

- urge to move the legs, usually with uncomfortable leg sensations,
- worsening of symptoms at rest or inactivity,
- worsening of symptoms in the evening and at night,
- relief with movement, walking, or stretching.

Secondary RLS may occur in patients with iron deficiency, renal failure, pregnancy, and advanced peripheral neuropathy. Signs supportive of the diagnosis of RLS are the presence of periodic limb movements (PLMS) in the polysomnogram. These are repetitive movements of the legs, sometimes of the arms, occurring at 5–90 s intervals, often associated with arousals and altering the continuity of sleep. Blood pressure and heart rate rise with PLMS, increasing the risk of hypertension and cardiovascular disease.

Nonpharmacologic therapy of RLS and PLMS rests on abstention from nicotine, caffeine, and alcohol, as well as discontinuation of medications that exacerbate RLS. Iron replacement should be added if appropriate. Pharmacologic drugs of choice are dopamine agonists, followed by gabapentin and low potency opioids. L-DOPA preparations are also effective but may cause augmentation, a peculiar worsening of symptoms caused by pharmacologic intervention. Dopamine agonists are safe but in rare occasions individuals may develop excessive somnolence and compulsive behaviors such as pathologic gambling.

Parasomnias

These are undesirable motor behaviors or abnormal perceptions that occur during non-REM or REM sleep. Patients with parasomnias complain of a variety of nocturnal sensations or exhibit bizarre movements, behaviors, or bodily events. Some patients are entirely unaware of the nighttime activity, and a history from the bed partner or other observer is necessary. Shouting or screaming and violent behavior are highly distressing symptoms and patients are rightly concerned about possible nocturnal accidents or injuries to the bedmate. Some

violent behaviors occur in response to a dream (dream-enacting behaviors) as is commonly observed in REM sleep behavior disorder, a condition that generally appears in older adult males and may signal the future appearance of Parkinson disease or some other neurodegenerative disorder.

Arousal disorders including sleep walking, sleep terrors, and confusional arousals are quite common in childhood and tend to disappear in the early teen-age years. Proper evaluation in an accredited Sleep Center of parasomnias that are frequent, disturbing or distressing is highly recommended. A differential diagnosis with seizure disorders is frequently entertained. Proper treatment is necessary when events occur more than once per week or are considered risky to the patient or the bedmate.

Insomnia

Insomnia is the inability to initiate or maintain sleep. Loss of continuity, lack of depth or insufficient sleep duration contribute to poor quality of nocturnal sleep and lead to complaints of insomnia and fatigue. Insomnia only becomes clinically relevant when the individual reports subsequent daytime sleepiness and fatigue. In addition to a complaint of difficulty initiating and maintaining sleep, or of dissatisfaction with nocturnal sleep, there should be daytime impairment taking one of the following forms: fatigue or malaise; attention, concentration, or memory impairment; social or vocational dysfunction or poor school performance; mood disturbance or irritability; daytime sleepiness; motivation, energy, or initiative reduction; proneness for errors or accidents at work or while driving; headaches, or gastrointestinal symptoms in response to sleep loss; concerns or worries about sleep. The complaints should occur despite adequate opportunities and circumstances for sleep.

When sleep fails, the individual suffers physically, emotionally, and mentally. Sleeplessness and poor restorative sleep are the consequence of a diversity of pathologic mechanisms that interfere with the complex fabric of neural events that lead to restorative sleep and a sense of satisfaction and refreshment every morning when we wake up. Severe sustained lack of sleep over many months can lead to physical disease, whereas partial loss of sleep modifies many brain functions and is very distressing.

Approximately 70 million Americans suffer insomnia that is sufficiently intense or chronic enough to warrant medical consultation. And yet, few physicians outside sleep centers can give patients a proper answer regarding causes, prognosis, and management of an insomnia disorder. Sleep medicine investigates the diversity of factors that predispose, precipitate, and perpetuate insomnia. Events involving the circadian rhythm, the suprachiasmatic nucleus of the hypothalamus (biologic clock), the secretion of melatonin by the pineal gland, and the complex sequence of electrophysiological stages marking sleep, need to be invoked to understand insomnia. Psychophysiological factors and psychiatric disorders generally become imbricated in the mesh of mechanisms leading to chronic insomnia.

Most psychiatric disorders, virtually all psychophysiological conditions and many neurodegenerative disorders such as Parkinson disease and Alzheimer dementia are associated with

complaints of insomnia. Special mention should be made of idiopathic insomnia a condition starting in childhood with familial origins that leads to a life-long litany of complaints and misery related to insomnia. Fatal familial insomnia is a rare neurological disorder that is emblematic of the neuropathology of insomnia and certifies the brain as the source of sleep and its failures. Other conditions associated with insomnia are RLS, the circadian dysrhythmias and even the common sleep apnea disorder.

Psychophysiological insomnia is likely one of the most common forms of insomnia. It develops when the individual focuses attention on the inability to sleep, which is perceived to be the only source of distress, while other emotional or mental concerns are put aside. Contributing factors such as stress, caffeine ingestion, and poor sleep hygiene are modifiable factors and should always be addressed. Not uncommonly there is a precipitating factor such as divorce or the death of a relative, followed by perpetuating factors at the core of which is the negative conditioning to sleep. Predisposing factors such as idiopathic insomnia are not modifiable and when present reduce the efficacy of therapies.

Patients with psychophysiological insomnia respond initially to hypnotic medications but long-term results are more favorable with cognitive behavioral therapy and similar techniques imparted by psychologists. These methods include sleep restriction with sleep consolidation, sleep hygiene education, relaxation therapy, stimulus control therapy and correction of distorted perception of sleep. Sleep laboratory tests are of value when used to exclude underlying contributing physical problems, such as sleep apnea or PLMS affecting sleep.

Testing in the Sleep Center

Polysomnography is the central test performed in the sleep laboratory. It consists of simultaneous recording of brain waves (electroencephalogram, EEG), eye movements (electrooculogram, EOG), heart rate (electrocardiogram, EKG), respiratory effort and airflow, oxygen saturation of oxihemoglobin, and chin muscle tone (electromyogram, EMG) along with videotaping. Polysomnograms (Figure 1) are required to diagnose

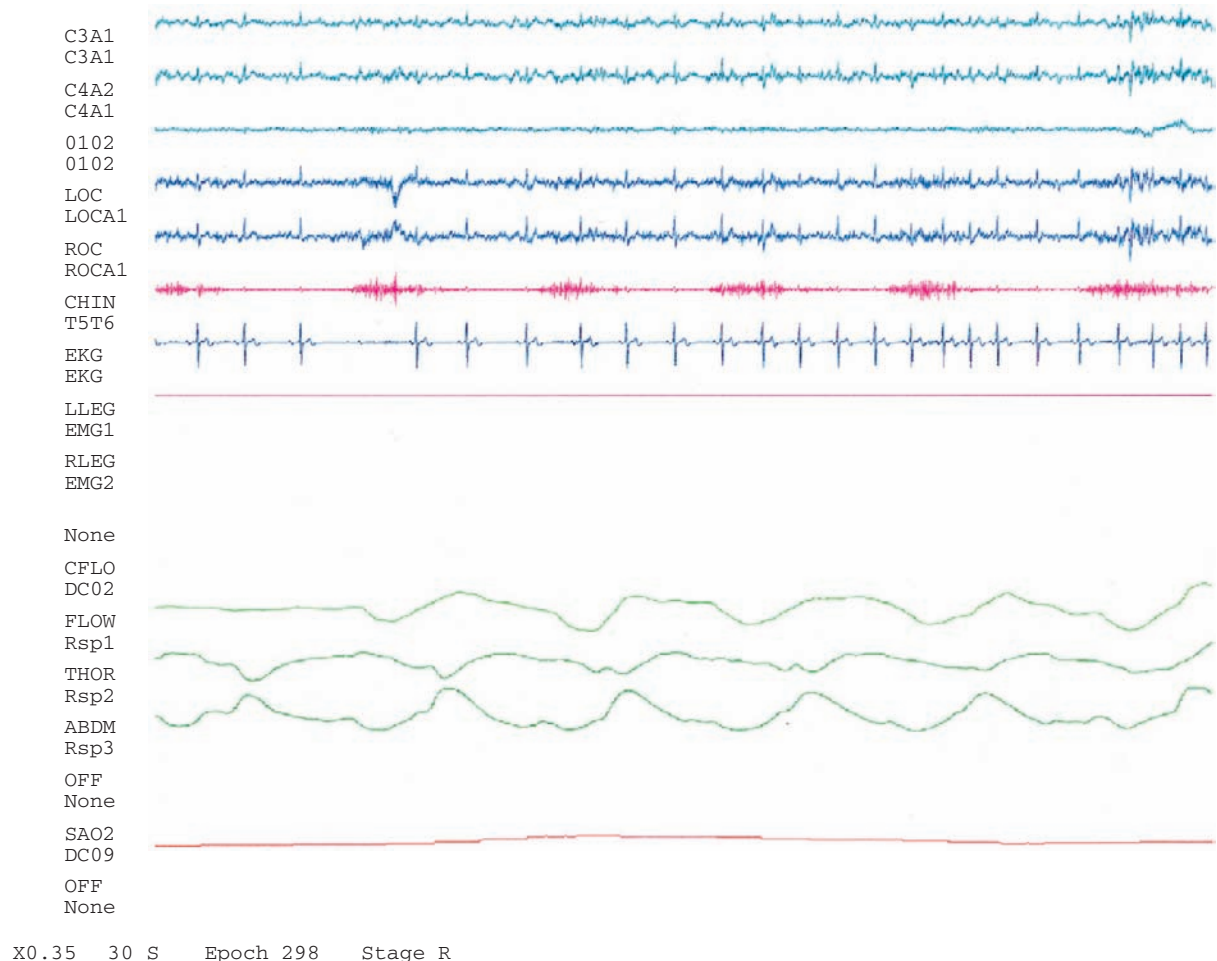


Figure 1 Epoch of polysomnogram showing channels for electroencephalography (C3A1, C4A2, 0102), electrooculography (LOCA1 (left ocular), ROCA1 (right ocular)), electromyography (CHIN muscles), electrocardiography (EKG), surface electromyography left leg (LLEG), flow of air nose and mouth (CFLOW), thoracic excursions (THOR), abdominal excursions (ABDM), oxihemoglobin saturation of oxygen (SAO2). Epoch shows REM sleep with intermittent enhancement of muscle tone (CHIN) registering snoring.

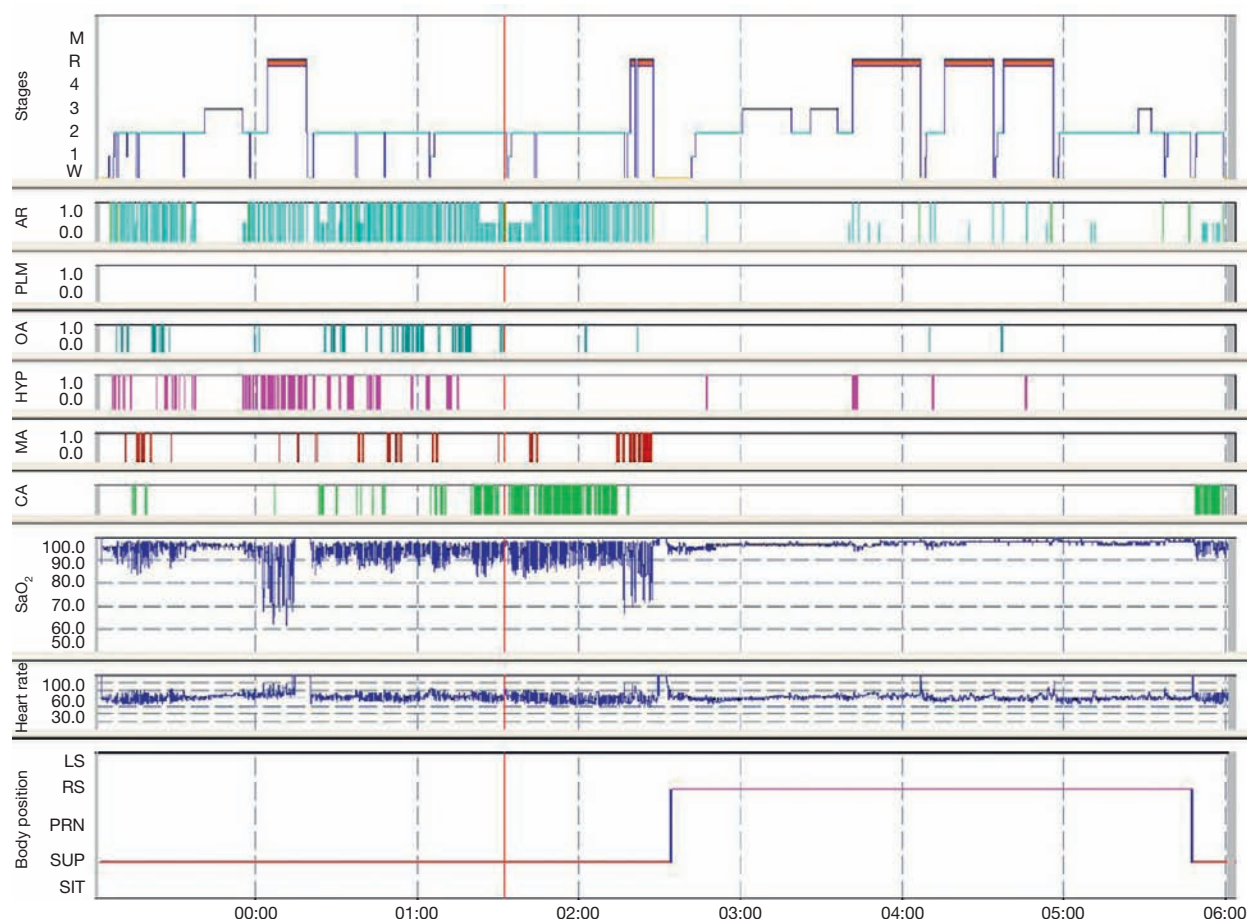


Figure 2 Hypnogram (histogram integrating sleep-related parameters) shows positional sleep apnea. During the first half of the night the patient slept supine. The hypnogram shows many arousals (AR – vertical blue lines), obstructive apneas (OA – vertical green lines), hypopneas (HYP – vertical red lines), mixed apneas (MA – vertical brown lines), central apneas (CA – vertical light green lines), desaturation of oxygen (SaO_2), and heart rate instability (heart rate). Supine (SUP). Right side (RS).

sleep apnea (Figure 2), titrate continuous positive airway pressure (CPAP) devices, diagnose narcolepsy, register PLMS, and record motor disorders of sleep, including REM sleep behavior disorder. The MSLT is a nap test performed during daytime hours, starting at 8 a.m. after a nocturnal polysomnogram. Recordings are conducted over 20 min at 2 h intervals. Four or five naps are generally registered. The MSLT is necessary for the diagnosis of narcolepsy without cataplexy (presence of REM sleep in two or more naps). It also serves to quantify excessive daytime sleepiness. Although polysomnography is not required for diagnosis of insomnia, it may be helpful to identify factors that interrupt the continuity of sleep, or to ascertain the occurrence of sleep in some patients with refractory insomnia with sleep state misperception. The maintenance of wakefulness test (MWT) is designed to test the capacity of the individual to remain awake over 40 min of testing time in the sleep laboratory in four consecutive segments. It is helpful to assist in the determination of the ability to drive continuously without falling asleep.

Portable monitoring devices that record esophageal acidity, electrocardiogram, respirations, oxihemoglobin saturation of oxygen, or sleep/wake electroencephalogram may be useful in

selected patients. Although laboratory polysomnography is the diagnostic gold standard, portable monitoring has been developed and is widely used outside the United States as an alternative diagnostic approach for sleep apnea evaluation. A portable monitor records fewer physiologic variables but is typically unattended and can be performed in the home. In 2008, the US Centers for Medicare and Medicaid Services released a statement allowing the use of portable monitoring to diagnose sleep apnea and prescribe continuous positive airway pressure equipment.

Wrist actigraphy, a device that monitors body movements over an interval of hours to weeks, may provide a cost-effective approach to diagnosis in some patients with insomnia or circadian disturbances (cycles of movement and quiescence).

Cerebral function can be studied with neuroimaging techniques in human subjects who are asleep. Human brain activity during sleep alternates within specific areas in relation to the sleep stage and previous waking activity. The work on neuroimaging is providing new data that describe aspects of the mechanism of insomnia, sleep apnea, and RLS. Future studies will offer the opportunity to use neuroimaging in correlation with clinical and electrophysiological evaluations,

as a helpful tool in the diagnosis, classification, treatment, and monitoring of sleep disorders in humans.

The measurement of hypocretin-1 in CSF may be most useful in cases of narcolepsy without cataplexy, in children with excessive somnolence who have not, as yet, developed cataplexy, or when the MSLT is difficult to interpret because of medication effect, and in psychiatric conditions.

Management of Sleep Disorders

Management depends on the particular sleep disorder. Treatment of sleep disorders includes nocturnal application of non-invasive ventilators, oral appliances, pharmacotherapy, surgery, chronotherapy and cognitive behavioral therapies, along with education in proper sleep hygiene.

Continuous positive airway therapy and its variants are the most effective treatment modalities for alleviation and control of clinically significant sleep apnea. Most sleep specialists follow the guidelines posted by The Centers for Medicare and Medicaid Services that recommend the following criteria for prescription of CPAP:

Apnea/hypopnea index > 15 events/hour of sleep, or apnea/hypopnea index > 5 and < 14/hour, with documented symptoms of excessive daytime sleepiness, impaired cognition, mood disorders, or insomnia, or documented hypertension, ischemic heart disease, or history of stroke.

CPAP devices have a fixed pressure titrated in the sleep laboratory. AutoCPAP machines have pressures set between wide parameters and will adapt to the required nocturnal airway pressures from breath to breath. These more expensive devices are useful when defined pressures are unobtainable or when set pressures begin to fail and it is not practical to repeat polysomnography. Bilevel devices deliver a high pressure on inspiration and a lower pressure on expiration. Patients with neuromuscular disorders tend to prefer bilevel machines. Modern noninvasive devices carry a computer chip that records therapeutic compliance over many weeks of treatment.

Oral appliances are useful to decrease the intensity of snoring and alleviate mild to moderate forms of obstructive sleep apnea. The diversity of oral appliances requires that the devices be fitted by dental sleep specialists.

Pharmacologic treatment includes stimulants for hypersomnolence, hypnotics and melatonin agonists for insomnia, dopamine agonists for RLS and PLMS, and sodium oxybate for narcolepsy/cataplexy. A diversity of benzodiazepines and antidepressants are also used in a variety of sleep disorders.

Surgery may be indicated in some forms of obstructive sleep apnea with advanced structural obstruction of the oropharynx by large tonsils or redundant soft tissue. Children and younger adults tolerate better and benefit more than older adults with these forms of oropharyngeal surgery that are generally undertaken by specialized ear, nose, and throat physicians. Maxillofacial surgeons have also devised interventions that reconstruct and augment the oropharyngeal space.

Cognitive behavioral therapy is useful to improve sleep efficiency and continuity in patients with psychophysiological forms of insomnia. This form of therapy is generally delivered

Table 1 Ten commandments of sleep hygiene

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1. Fix a bedtime and an awakening time
 2. If you are in the habit of taking siestas do not exceed 45 min of daytime sleep
 3. Avoid excessive alcohol ingestion 4 h before bedtime and do not smoke
 4. Avoid caffeine 6 h before bedtime. This includes coffee, tea, and many sodas, as well as chocolate
 5. Avoid heavy, spicy, or sugary foods within 4 h before bedtime. A light snack before bed is acceptable
 6. Exercise regularly, but not right before bed
 7. Use comfortable bedding
 8. Find a comfortable temperature setting for sleeping and keep the room well ventilated
 9. Block out all distracting noise and eliminate as much light as possible
 10. Reserve the bed for sleep and sex. Do not use the bed as an office, workroom, or recreation room
-

in a few sessions by psychologists with special training. Chronotherapies for restoration of conventional sleep–wake schedules are less well defined and variably effective. Chronotherapy is generally aided with the administration of melatonin or a melatonin agonist at bedtime along with the application of light therapy upon arising. Compliance with strict rules of sleep hygiene (Table 1) is necessary for chronotherapy to be effective.

Social Implications

Education pertaining to sleep, sleep hygiene, and awareness of sleep disorders is probably the most important means of prevention. High school and college students learn little about sleep and the effects of sleep deprivation. Findings of the National Sleep Foundation Sleep in America poll from 2007 revealed that tiredness is an epidemic in adolescents. Twenty-eight percent of high school students admit to falling asleep at least once a week while in school, and 10% of high school seniors admit to have nodded off while driving over a 1-year period. Although physicians are well positioned to educate patients about sleep and sleep disturbance, they also receive little education on this topic. It has been suggested that hypnotic medications are being used excessively. In the United States, sleeping pills worth \$2.5 billion are sold each year.

Sleep deprivation is common in modern society and perhaps constitutes one of the most pervasive of sleep alterations. It may be the result of behavioral traits or of work demands. In 2008, the CDC examined data from over 400 000 subjects throughout the United States and found that 11.1% reported insufficient rest or sleep every day during the preceding 30 days. The consequences of sleep deprivation are as devastating as those associated with primary sleep disorders. Fortunately, sleep deprivation is a modifiable condition if properly identified by the health provider and duly acknowledged by the patient.

Individuals suffering excessive daytime sleepiness and fatigue are less productive at work and in the academic setting. Furthermore, they are at higher risk of motor vehicle accidents and complain of a decreased quality of life. Not uncommonly,

family relationships are strained. Control and alleviation of sleep disorders improve quality of life and well-being, while reducing the risk of accidents. Although the ultimate goal of a cure may not be achievable for many sleep disorders, an accurate diagnosis and proper management to control and alleviate the alteration are always desirable.

See also: Aging and Cognition; Alcohol: Psychosocial Effects; Caffeine; Cognitive Behavior Therapy; Depression; Developmental Psychopathology; Generalized Anxiety Disorder; Hypnosis; Posttraumatic Stress Disorder; Schizophrenia; Sleep, Biological Rhythms, and Performance.

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Relevant Websites

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- <http://www.aan.com> – American Academy of Neurology, Sleep Section.
- <http://www.aasmnet.org> – American Academy of Sleep Medicine (AASM).
- <http://www.absm.org> – American Board of Sleep Medicine (ABSM).
- <http://www.apss.org> – Associated Professional Sleep Societies Annual meeting (APSS).
- <http://www.apweb.org> – Association of Polysomnographic Technologists (APT).
- <http://www.brpt.org> – Board of Registered Polysomnographic Technologists (BRPT).
- <http://www.sleepresearchsociety.org> – Sleep Research Society (SRS).
- <http://www.wasm.org> – World Association of Sleep Medicine (WASM).
- <http://www.wfnepurology.org> – World Federation of Neurology, Sleep Research Group.
- <http://www.sleepresearchsociety.org> – World Federation of Sleep Research Societies (WFSRS).
- <http://www.worldsleepday.org> – World Sleep Day.

Social Anxiety Disorder

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Glossary

Acceptance and commitment therapy (ACT) A form of psychotherapy that is based on radical behaviorism combined with techniques that are consistent with Eastern philosophies.

Cognitive-behavioral therapy (CBT) A form of psychotherapy targeting maladaptive thoughts and avoidance behaviors.

D-cycloserine (DCS) A partial agonist of the NMDA receptor that facilitates fear extinction in animals and exposure therapy in humans.

Generalized subtype Diagnostic specifier to identify individuals with SAD who fear most or all social situations.

Interpersonal therapy (IPT) A form of psychotherapy focusing on bereavement and interpersonal relationships.

Mindfulness A process that leads to a mental state characterized by nonjudgmental awareness of the present

moment to encourage openness, curiosity, and acceptance of emotional states.

Monoamine oxidase inhibitors (MAOIs) A class of drugs for treating symptoms of anxiety disorders by inhibiting the breakdown of the neurotransmitter monoamine.

Selective serotonin reuptake inhibitors (SSRIs) A class of drugs for treating symptoms of anxiety disorders by inhibiting the reuptake of the neurotransmitter serotonin.

Social anxiety disorder (SAD) The clinical expression of extreme fear of negative evaluation by other people.

Taijin kyofusho (TKS) A unique expression of social anxiety prevalent in Asian countries, such as Japan and Korea, in which the concern is doing something or appearing in a way that offends or embarrasses another individual.

Introduction

Approximately 50 000 years ago, probably somewhere in Africa, the modern human was born. Compared to its ancestors, this new species had a much greater brain, walked upright, and used hands to make sophisticated tool. Members of this species developed ways to communicate with one another and created a complex social system that gave them an enormous advantage over potential predators.

Social contact and affiliation are fundamental needs of essentially all species. Humans in particular have evolved such that they possess high-level motivational incentives to compete for the approval and support of others. Evolutionary psychology assumes that humans need to be liked, valued, and approved of in order to elicit parental investment, develop supportive peer relationships, attract desirable mates, and engage successfully in many types of social relationships. Our species is highly dependent on the social support of others. Ostracism from the social group impacts negatively on a variety of health-related variables, including one's self-esteem and sense of belonging. Humans are, therefore, constantly engaged in a competitive bid for social resources, and failure in this regard is costly. Because time and energy are precious commodities, humans choose to invest their resources in people who are likely to be useful to them and help them achieve their own self-interests in order to defend and maintain, or increase their social standing (e.g., attractiveness and reputation) in the eyes of others.

Social standing is maintained partly through displays of submissiveness that are directed toward higher-ranked individuals, and by displays of dominance or hostility that are directed toward other, lower-ranked members of the social group. Social contact is perceived as rewarding, and the lack thereof as punishing. If an individual of a social group violates

social norms by showing deviant behaviors, this individual is often punished by being isolated or expelled from the group. In serious offenses, such as criminal behaviors, the person is sent to prison, which reduces social contact with the rest of the community. Furthermore, if the individual violates social norms in prison, this individual is sent to solitary confinement. Thus, social contact is an essential human need, and withholding social support creates a great degree of psychological, and also physical, pain and suffering.

This basic need for social support and the associated fear of negative evaluation by others is at the heart of social anxiety disorder (SAD). Because of its evolutionary significance, the possibility of losing social support as a result of negative evaluation by other humans causes a great degree of suffering in the affected person.

Description

People who suffer from this disabling condition fear and avoid a wide range of situations that involve social performance and social interactions. Examples of such situations include eating or writing in public, initiating or maintaining conversations, going to parties, dating, meeting strangers, or interacting with authority figures. Among those, public speaking is the most commonly feared situation. When the person fears most or all social situations, the individual may receive the generalized subtype specifier of SAD and may also meet the additional criteria for avoidant personality disorder.

The average female to male gender ratio in community studies of SAD prevalence ranges between 1:1 and 3:2. The problem often begins in the mid-teens, but can also occur in early childhood. During childhood, SAD is commonly associated with

anxiety-related disorders, including overanxious disorder, mutism, school refusal, separation anxiety, behavioral inhibition, and shyness.

Epidemiological data show that the lifetime prevalence rate of SAD among US adults is 13.3%. Very similar rates are observed in Latin countries, such as Chile (10.2%) and Brazil (11.8%), and slightly lower rates in European countries (7%). Considerably lower rates were reported in Middle-Eastern countries, such as Iran (0.8%), and Asian countries (0.6%). Although epidemiological rates of SAD are lower in Asian countries than non-Asian countries, studies have found that social anxiety symptoms are endorsed more frequently on self-report scales by East Asian samples than in the United States and Europe. It is possible that countries such as Japan or Korea with stronger collectivist orientations may consider social anxiety symptoms to be more acceptable. This could lead to higher endorsement on self-report scales and a lower likelihood of meeting the excessiveness and impairment criteria of SAD. In addition, there is evidence to suggest that social anxiety is expressed differently among Asian people than among non-Asian people. Studies from Japan and Korea suggest that there is a subgroup of patients, who do not avoid social situations because of fears of being observed, but whose concern is doing something, or presenting an appearance, that will offend or embarrass the other person. This type of presentation is locally labeled as the offensive subtype of Taijin kyofusho (TKS) or 'fear of interpersonal relations' in Japanese. The offensive subtype is characterized by two features considered atypical of SAD, namely the belief that one displays certain physical defects and/or socially inappropriate behaviors that are rarely reported in western SAD samples, such as an unpleasant body odor or staring at others' body parts in public, and the fear of offending others as a result of these presentations.

SAD often co-occurs with other psychiatric disorders, such as other anxiety, mood, and substance use disorders. Because SAD typically precedes onset of other disorders, SAD may be a risk factor for other psychopathologies at a later point in life. A longitudinal study of adolescents with SAD found their risk for later onset of major depression to be increased by 3.5 times. Furthermore, comorbid depression occurs in about one-third of individuals with SAD.

When left untreated, the course of SAD is generally chronic. The disorder is associated with significant impairment in work and social functioning and reduced quality of life. In clinical samples, patients with SAD describe difficulty keeping a job, attending school, or getting married. SAD causes considerable economic cost to society, primarily in the form of academic and employment difficulties.

Etiology

It is often assumed that unpleasant or traumatic events might 'cause' an anxiety problem in the future. However, there is little evidence to suggest that traumatic experiences play a dominant role in the onset of social fears. In fact, traumatic external events, as well as vicarious and informational learning, are notably uncommon among individuals with SAD. Other theories assume that social fears are largely biologically determined and that people with SAD are overly sensitive to

threatening social cues, such as disapproving human facial expressions. Consistent with this notion are studies that have shown that angry faces and happy faces elicit different patterns of electromyographic activity in people, and fear conditioning to angry faces shows much more resistance to extinction than do responses to happy or neutral expressions. Interestingly, this conditioning effect is only obtained when the stimulus person directs his or her anger towards the subject; angry faces looking away are as ineffective as happy faces in conditioning paradigms. This suggests that direct eye contact is crucial. In primates, direct eye contact is interpreted as frightening. Moreover, various species display eye-like spots to frighten potential predators. Although the response to eye contact is greatly altered by contextual and learning factors among humans, it is also a hard-wired evolutionary response that is common to all mammals. Therefore, it has been suggested that for individuals with SAD, the fear of being watched is an exaggeration of the normal human sensitivity to eyes. Memory experiments further suggest that individuals with SAD recognize more critical than accepting faces, whereas people without SAD recognize more of the accepting than critical faces. Interestingly, this effect has not been found in studies using words as stimulus material.

Evidence for a genetic contribution to social anxiety comes from family studies and twin studies. Family studies suggest that the risk for developing SAD is ~ 3 times higher for relatives of individuals with SAD than for control relatives who have never been mentally ill. Similarly, twin studies report substantial concordance rates for SAD in identical (24%) and fraternal (15%) twin pairs.

Although the genetic disposition to develop SAD may be nonspecific, it seems to be closely connected to certain temperament variables. In particular, shyness, one of the most heritable temperament factors, seems to be closely related to SAD. Another likely precursor of SAD is behavioral inhibition, which refers to a child's fearfulness, timidity, and weariness when encountering novel people, objects, or events. Numerous studies have found that behavioral inhibition in childhood is closely associated with social anxiety and SAD during adolescence. For example, there is evidence to suggest that behaviorally inhibited children are more likely to have parents with SAD than noninhibited children. However, it has yet to be examined whether parents with SAD are also more likely to have behaviorally inhibited children, and whether behavioral inhibition in childhood leads to SAD in adulthood. If this relationship between behavioral inhibition and SAD holds true, future studies will need to identify the factors that protect behaviorally inhibited children from developing SAD in adulthood. Examples of such protective factors could include family factors and strong peer relationships.

Prevention

SAD typically starts at an early age, with the highest standardized incidence rates per person-year between 10 and 19 years of age. Familial factors and peer relationships can have a profound influence on the onset and course of the disorder. For example, studies suggest that parents who reinforce avoidance behaviors in anxious children tend to reinforce avoidance

behaviors in the future. Furthermore, school-based prevention programs can target highly anxious and shy children by providing coping skills and building peer relations. Finally, children of parents who have SAD may benefit if their parents undergo therapy for SAD.

Pharmacological Treatments

Biological Models

Since SAD was officially recognized as a diagnostic category in 1980, a number of pharmacological agents have been examined. Similar to other anxiety disorders, pharmacological treatments are based on the assumption that medications, which regulate neurotransmitters in the brain, should alleviate symptoms of social anxiety.

The most common drug treatments for SAD include monoamine oxidase inhibitors (MAOIs; i.e., phenelzine), selective serotonin reuptake inhibitors (SSRIs), benzodiazepines, antidepressants, and β -blockers. Thus far, paroxetine (an SSRI) is still the only Federal Drug Administration (FDA) approved drug for SAD.

Monoamine Oxidase Inhibitors

The results of various double-blind placebo-controlled trials show evidence for the efficacy of phenelzine in SAD. One of these studies showed that 64% of patients receiving phenelzine, 30% of patients receiving atenolol, and 23% of those receiving placebo were classified as responders. Similar results were reported in a study that compared the efficacy of phenelzine, the reversible MAOI, moclobemide, and placebo for treating SAD. Overall, these findings demonstrate the short-term efficacy of MAOIs for the treatment of SAD. However, the use of irreversible MAOIs is limited by the risk of hypertensive crisis if dietary restrictions are not followed, as well as its adverse effects profile.

Selective Serotonin Reuptake Inhibitors

The FDA approved paroxetine HCl (Paxil) for the treatment of SAD, making it the first (and only) medication approved for this disorder in the United States. The study that eventually led to FDA approval of paroxetine was a 12-week, placebo-controlled, double-blind, and flexible dose design that included 187 patients. The results showed that 55% of patients receiving paroxetine and 23.9% of those receiving placebo were classified as responders. On average, the reduction in social anxiety from baseline was more than twice as large in the paroxetine group (39.1%) as in the placebo group (17.4%). In addition, various smaller studies have tested the efficacy of other SSRIs, including fluvoxamine and fluoxetine, with promising results.

β -Blockers

β -blockers (such as propranolol or atenolol) have been widely used for treating performance anxiety since the 1970s. However, despite the enthusiasm for this drug to treat social anxiety, its efficacy has not been supported by double-blind studies. For example, when comparing the effects of phenelzine, atenolol,

and placebo for treating SAD, there is no documented advantage of atenolol over placebo. Only 30% responded to atenolol as compared to 64% of patients receiving phenelzine and 23% of patients taking a pill placebo. These and other studies provide little empirical support for atenolol as a treatment of SAD when used on a standing dose. However, β -blockers might be clinically useful for treating individuals with a nongeneralized subtype of SAD when administered on an as-needed basis.

In sum, there is considerable evidence to suggest that gains from medications are not well sustained once these medications are discontinued. For example, recent data from placebo-controlled discontinuation trials with paroxetine indicate that about 40–60% of patients relapse when they are switched from paroxetine to placebo. Furthermore, the relapse rate is high with rates at 6-month follow-up ranging from one-third to about two-thirds of respondents. A further limitation of medication is that many patients with SAD may not be appropriate for medication treatment because of medical problems or pregnancy. In addition, a significant percentage of SAD patients seeking treatment are unwilling to take medication and express a preference for psychotherapy. Therefore, investigators have examined psychological treatments as alternative intervention strategies.

Psychological Treatments

Cognitive-Behavioral Therapy

Cognitive-behavioral therapy (CBT) is the most studied and validated form of psychotherapy for SAD. It is most accurately described as a family of interventions that are derived from the behavioral and cognitive traditions. Early formulations of CBT emphasized psychoeducation, in-session and in vivo exposure to feared situations, techniques intended to modify maladaptive or irrational thinking patterns common among persons who have SAD, relaxation techniques, and social skills training.

The initial formulation of the CBT model posited that individuals with SAD believe that they are in danger of behaving in an inept and unacceptable fashion, and that such behavior will have disastrous consequences in terms of loss of status, loss of worth, and rejection. More specifically, it is assumed that effective psychotherapy provides patients with a range of learning experiences that modify the patient's anxio-genic beliefs and expectations, or deactivates them while making other interpretations and beliefs available. More recent formulations of the CBT model assume that individuals with SAD are apprehensive in social situations in part because they perceive the social standard (e.g., expectations and social goals) as being high. They desire to make a particular impression on others but doubt that they will be able to do so, partly because they are unable to define goals and select specific achievable behavioral strategies to reach these goals. This leads to a further increase in social apprehension and increased self-focused attention, which triggers a number of additional cognitive processes.

CBT models predict that, once a situation is perceived as holding the potential for social evaluation, individuals with SAD become preoccupied with negative thoughts about themselves and the way other people perceive them. The negative impression is assumed to occur in the form of an image from

an 'observer' perspective in which people with SAD can see themselves as if from another person's vantage point. Therefore, it can be assumed that the treatment is most effective if it targets the dysfunctional cognitions directly and systematically via cognitive therapy.

Consistent with this notion are results from studies showing that socially anxious individuals believe that negative social events are more likely to occur than positive social events. Additionally, they assume that most people are inherently critical of others and are likely to evaluate them negatively. The belief system of individuals with SAD appears to magnify the competitive aspects of interpersonal relationships but minimizes the cooperative, supportive aspects.

The efficacy of earlier formulations of CBT for SAD has been demonstrated in a number of well-designed studies. Treatment drop-outs are generally low and not systematically associated with any patient variables. Traditional group CBT is administered by two therapists in 12 weekly 2.5-h sessions to groups consisting of four to six participants each. A comparison between fluoxetine (a popular SSRI), CBT, placebo, CBT combined with fluoxetine, or CBT combined with placebo showed that that all active treatments were superior to placebo. Interestingly, the combined treatment was not superior to the other treatments. The response rates in the intention-to-treat sample were 50.9% (fluoxetine), 51.7% (CBT), 54.2% (CBT plus fluoxetine), 50.8% (traditional CBT plus placebo), and 31.7% (placebo only). Although these results emphasize the efficacy of CBT, either alone or in combination with pharmacotherapy, the data also show that many participants remain symptomatic.

More recent formulations of CBT for SAD specifically target some of the core maintenance factors, safety behaviors, self-focused attention, and perceived social cost. The efficacy of these targeted CBT protocols has considerably improved over earlier, more traditional CBT protocols. The treatment efforts of targeted CBT are directed toward the systematic teaching of an alternative cognitive framework for understanding social situations, social performance, and social risk. Interventions are richly cognitive in nature, as they ask patients to examine their expectations about social situations and the social costs of imperfect social performances. Patients then specifically examine the veracity of these expectations as evaluated by logical evaluation, and particularly by specific 'behavioral experiments' that are designed to test anxiogenic expectations. An effect size analysis of such a targeted CBT approach showed that the uncontrolled effect size of the severity rating based on the clinical interview was 1.41 (pretest to posttest) and 1.43 (pretest to 12-month follow-up) in the targeted CBT group. The composite score was associated with an uncontrolled pre-post effect size of 2.14. These are exceptionally strong effects, suggesting that CBT for SAD can be significantly improved by targeting the specific maintenance factors.

Mindfulness-Based Treatments

Mindfulness refers to a process that leads to a mental state characterized by nonjudgmental awareness of the present moment experience, including one's sensations, thoughts, bodily states, consciousness, and the environment, while encouraging openness, curiosity, and acceptance. The techniques are based

on ancient Eastern philosophies, most notably Buddhism and Zen. In recent years, these treatments have been combined with traditional CBT to reduce stress and anxiety (e.g., mindfulness-based cognitive therapy and mindfulness-based stress reduction). Although these treatments are very popular, relatively little data exist to support their efficacy.

A related treatment to mindfulness-based cognitive therapy on the level of therapeutic techniques is acceptance and commitment therapy (ACT). ACT recently has been applied to the treatment of SAD. In the first stage, patients came to understand the failure of their past efforts to control anxiety. The next phase encouraged patients to accept their unwanted or distressing thoughts while being exposed to difficult social situations. Mindfulness techniques were presented in the third stage to help teach nonjudgmental experience and appraisal of anxious thoughts and to move toward cognitive defusion, which is the exercise of distancing the self from internal experiences. The final stage facilitated participation in experiences that reflect the participant's valued choices. The treatment incorporated traditional behavior therapy techniques such as in-session role-plays, in vivo exposure, and social skills training. Patients displayed significant decreases in social anxiety, fear of negative evaluation, experiential avoidance, and a significant increase in quality of life at posttreatment and 3-month follow-up. The size of the treatment effects was similar to more recent formulations of CBT.

Interpersonal Therapy

Interpersonal therapy (IPT) is a new form of treatment that is based on the assumptions that psychiatric disorders occur and are maintained within an interpersonal context. Similar to CBT, IPT is a time-limited 12- to 16-week therapy. The treatment has been primarily used in the past for depression and eating disorders. More recently, IPT has also been adopted for the treatment of SAD.

IPT focuses on core interpersonal problem areas rather than social interaction and performance situations through various techniques that primarily focus on the patient's affective response to interpersonal issues and unresolved conflicts. This is done with role playing of target situations but without a focus on exposure. Nevertheless, there are striking similarities to CBT on the level of the therapeutic techniques.

The empirical support of this relatively new treatment is fairly sparse. In an uncontrolled study of IPT for SAD, seven of nine individuals (78%) were classified as responders, but a randomized trial that compared IPT to a supportive therapy control group failed to replicate these initial findings. Both groups demonstrated improvement in social anxiety, but they did not differ on the majority of measures or in the proportion of responders. Another recent study, however, did provide some support for the efficacy of IPT for social anxiety. Conducted in an inpatient setting, this study compared 10 weeks of IPT and CBT. Patients in each condition received four group sessions and one individual session per week. Treatments were modified to include individual and group components to better fit an inpatient setting. Both groups demonstrated improvements on measures of social anxiety, and these gains were maintained at 1-year follow-up. Definitive conclusions about the efficacy of IPT for social phobia cannot be made, however,

because there were few differences between inpatient IPT and CBT (CBT was superior on a single secondary measure), and no control condition was included.

Psychodynamic Therapy

Little empirical evidence exists to support the use of psychodynamic therapy for SAD. In fact, not a single randomized controlled trial exists of this widely practiced intervention. The psychodynamic treatment model for SAD assumes that people with SAD experience shame because of an unconscious need to be the center of attention, guilt related to an unconscious need to eradicate social competition, doubt concerning the ability to eradicate social competition, separation anxiety because of an unconscious need for autonomy, and loss of love from a caregiver because of autonomy. Representations of others, such as caregivers or parents, are assumed to be internalized as critical, shaming, or abandoning. These internalized representations are then projected onto others, which bring about a need to avoid social situations. The treatment typically focuses on the conflicting relationships, goal setting, enhancing insight, and understanding the role of shame and unrealistic demands. Patients are often encouraged to confront feared social situations as part of the treatment.

Combined Pharmacotherapy and CBT

Traditional Combination Treatments

Combining pharmacotherapy and CBT is a popular strategy for treating anxiety disorders in general. Between 55% and 95% of patients are estimated to receive such combination treatment. A recent meta-analysis showed that combined therapy was only effective for patients in the short term. These effects disappeared at follow-up. Moreover, the combined therapy was not equally effective for all anxiety disorders. Large average effects were found for panic disorder and medium to large effects were found for generalized anxiety disorder, but only small and nonsignificant effect sizes were found for obsessive-compulsive disorder and SAD. For example, one recent study that investigated the efficacy of the combination of fluoxetine with traditional CBT relative to either treatment alone or pill placebo showed that combination treatment was associated with less than a 3% increase in response rates for the addition of fluoxetine to CBT. For this reason, authors have cautioned against the routine use of combination therapy over provision of CBT alone when available.

Novel Combination Treatments

CBT is an exposure-based treatment. Its efficacy can be enhanced by targeting specific cognitive maintenance factors. For example, recent animal (preclinical) and human studies have shown that the efficacy of CBT can be improved by enhancing extinction learning, which is an important mechanism through which CBT leads to fear reduction, with a pharmacological agent. This process is more likely to be enhanced if the pharmacological agent (1) produces few side effects and has little affect modulating effects to minimize state-dependent learning; (2) allows full activation of the fear structure and

emotional processing of feared stimuli during the exposures; and (3) can be delivered in isolated dosing to allow patients to attribute a significant degree of the therapeutic effects to the successful exposures. Finally, and perhaps most importantly, the pharmacological agent should support aspects of the therapeutic mechanism of exposure-based therapy. These recommendations seem to be overly ambitious and practically unattainable with conventional pharmacotherapy for anxiety disorders. However, basic research in animal extinction learning has recently been translated into clinical applications. This research points to a pharmacological agent that meets all of the above-mentioned recommendations for enhancing exposure-based therapy.

Modern learning theories of extinction assume that conditioning occurs as subjects form representations of the relevant cues (conditioned stimulus, CS; and unconditioned stimulus, US) and situational contexts, and as they acquire information about the association between these cues and the situations. These associations can be either excitatory (i.e., activation of one representation activates another) or inhibitory (i.e., activation of one representation inhibits activation of another). Acquisition of conditioned responses is explained by the formation of an excitatory association between representations of the CS and US. The US representation is activated indirectly through its association with the CS representation, which in turn triggers the conditioned response. Extinction is assumed to proceed through multiple mechanisms that also include new learning that inhibits the excitatory association between CS and US. As part of this new form of learning, the subject changes the CS-US contingency in such a way that the CS no longer signals an aversive event and thereby inhibits the expression of the fear response.

Glutamate is one of the most important excitatory neurotransmitters in the mammalian brain and performs an important role in the brain circuitry underlying fear processing. The *N*-methyl-D-aspartate (NMDA) receptor is an ionotropic receptor for glutamate. In fact, fear and extinction learning are both blocked by antagonists at the NMDA receptor. Activation of NMDA receptors requires binding of both glutamate and the coagonist glycine for the efficient opening of the Ca^{2+} ion channel. Some of the subunits bind the coagonist glycine and other subunits bind the neurotransmitter glutamate. It has been shown that D-serine can coagonize the NMDA receptor with even greater potency than glycine. D-4-amino-3-isoxazolidone (D-cycloserine, DCS) is an analog of D-alanine and a partial agonist at the glycine recognition site of the glutamatergic NMDA receptor that works very similar to D-serine. Studies have shown that DCS facilitates the process of extinction of conditioned fear when administered in individual doses prior to or soon after extinction trials in animals. DCS also happens to be an established antibiotic medication for the chronic treatment of tuberculosis at high doses (500 mg daily) in humans. It should be noted that the antibiotic effects are unrelated with DCS's ability to facilitate extinction learning.

Our research team conducted the second double-blind placebo-controlled study in 2006 in a human sample of anxiety disorder patients. This study randomly assigned 27 patients with a principal DSM-IV diagnosis of SAD to either receive exposure therapy plus DCS (50 mg) or exposure therapy plus pill placebo.

The first treatment session consisted of an introduction of the treatment model and psychoeducation. The following four sessions emphasized stepwise social exposures, with administration of the study pill 1 h before each session. The exposure exercises consisted of giving speeches of increasing difficulty level about topics chosen by the therapists in front of the other group members or confederates and a video camera. At the end of each exposure session, patients were encouraged to continue to apply home-practice strategies (such as giving speeches in front of a mirror). Although the in-session exposure exercises only focused on public speaking, 51.9% of the subjects had a generalized subtype of SAD, and 40.7% had at least one additional DSM-IV Axis I diagnosis. The level of social anxiety was assessed at baseline, posttreatment, and at 1-month follow-up. Participants who received DCS augmentation as compared to placebo augmentation demonstrated significantly greater improvement at posttreatment as assessed by clinician-rated and self-report instruments, with evidence of maintained and extended treatment effects at the follow-up evaluation.

The difference between the DCS and placebo group increased linearly with time, with the greatest effects of DCS being evident at the 1-month follow-up. Similar results were observed for the other measures. The between-group effect sizes at both posttreatment and follow-up indicated a medium to very-large effect size for the advantage of DCS over placebo, with larger effects at follow-up than immediately following treatment. Similarly positive effects of DCS as an augmentation strategy for CBT have been reported for the treatment of other anxiety disorders, including specific phobia, obsessive-compulsive disorder, and panic disorder.

It is possible that we are at the beginning stage of a genuine paradigm shift of treatment research, as basic knowledge from the field of neuroscience is directly translated into novel clinical applications. These new applications are unlike the traditional 'horse race comparisons' of clinical trials that typically lack a sound theoretical rationale for combining pharmacotherapy and psychotherapy. For the first time, a pharmacological agent that does not have any anxiolytic properties was used to enhance some of our most effective psychological treatments for anxiety disorders on the basis of a known mechanism. Future research in this exciting field may not only maximize the efficacy and cost-effectiveness of the treatments, but may also answer some of the remaining important theoretical questions concerning the mechanism of treatment change of exposure-based therapy for anxiety disorders.

Summary

SAD is the clinical expression of social anxiety, an evolutionary adaptive fear of negative evaluation by others. It is one of the most common mental disorders and associated with significant suffering to the affected individual. The disorder begins at

an early age and follows a chronic and remitting course, unless it is effectively treated. The cause for this disorder is still not very well understood, but genetic factors that predispose people to extreme shyness are likely involved. Family factors and other peer relationships are also implicated. Focusing on these factors can offer effective prevention strategies for high-risk individuals. The most popular and best-studied pharmacological treatments include monoamine oxidase inhibitors (i.e., phenelzine), SSRIs (i.e., paroxetine), and β -blockers (i.e., propranolol and atenolol). The empirical data question the efficacy of these interventions as long-term strategies. The most studied psychological treatment for SAD is CBT. The efficacy of CBT is promising, especially for the newer formulations of the treatment protocol and as a long-term intervention strategy. Among the less studied or less empirically validated therapies are IPT, psychodynamic therapy, and mindfulness-based interventions. Combining traditional antianxiety medications and psychotherapy (predominantly CBT) is not more effective than either of the treatments alone. A more promising approach is combining exposure-based treatment with a pharmacological agent that enhances extinction learning.

See also: Avoidant Personality Disorder; Cognitive Behavior Therapy; Evolutionary Clinical Psychology; Interpersonal Psychotherapy.

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Social Cognition

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Glossary

Category accessibility The readiness or ease with which a stored category is activated from memory and used to encode stimulus information.

Cognitive heuristics Mental rules of thumb used for reducing complex judgmental tasks to simpler procedures.

Cognitive process The mental operations that are used to make a judgment or engage in behavior.

Concept activation The process of bringing an element of knowledge from long-term memory into preconscious or conscious awareness.

Dual-process models A class of theoretical models that distinguish between a style of information processing that is

effortful, deliberative, and controlled, and one that is fast, effortless, and automatic.

Implicit processes Affect-laden associations between cognitive elements that can be automatically activated by an internal or external stimulus.

Schemas Abstract knowledge structures containing the attributes of a stimulus, along with the rules specifying the interrelationships among the stimulus attributes.

Social stereotypes Knowledge structures that contain beliefs and expectations about the attributes of people belonging to specific social groups.

Introduction

The manner in which social information is interpreted, encoded, stored, and retrieved from memory is critical to understanding how we perceive and interact with the social world. Social cognition represents the scientific approach within social psychology dedicated to studying these processes. With its emphasis on the cognitive structures and processes underlying social behavior, social cognition also has much in common with cognitive psychology. However, social cognition is not synonymous with either field. Furthermore, it is not associated with any one theory or tied to any specific area of research. Rather, it examines a wide range of questions about how people form impressions and attitudes and make social judgments and decisions. The following sections sketch the framework of social cognition, discuss its relation to traditional social psychology and cognitive psychology, and consider its origins and intellectual history. Finally, by presenting a selective overview of theory and research in several substantive domains, the last section illustrates how social-cognitive approaches have contributed to an understanding of social behavior.

Social Cognition, Traditional Social Psychology, and Cognitive Psychology

Social-psychological theories have long accorded cognitive processes a central role. However, as cognitive processes are not directly observable and cannot be easily measured, social-psychological research has traditionally inferred the existence of cognitive processes based on overt behavioral data. By using outcome data to explore questions of process, social psychologists employed S–R methodologies to test S–O–R (stimulus–organism–response) models of social behavior. What distinguishes social cognition from this more traditional approach in social psychology is the relatively formal way in

which it treats the O's unobservable processes. The major thrust of social cognition research is to provide conceptual models of, and consequently more detailed evidence for, the mediating role of cognitive processes.

To illustrate how social cognition more clearly addresses the 'why' and 'how' behind the relationship between a stimulus and a response, consider research on attitudes and behavior. In one line of research, social psychologists have examined how the amount of experience one has with an attitude object affects the strength of the relationship between attitudes and behavior. This research indicates that attitudes formed on the basis of direct experience more strongly predict behavior than attitudes formed in the absence of such behavioral experience. Typically, researchers only studied the beginning and end of the presumed causal sequence, neglecting questions regarding why experience strengthens the relationship between attitudes and behavior. Subsequent social-cognitive research by Fazio and others has shown that attitudes based on direct behavioral experience are more cognitively accessible – that is, more easily retrievable from memory – than attitudes formed on an indirect basis. Moreover, this research has shown that people who can quickly retrieve their attitudes from memory demonstrate higher attitude-behavior correspondence than those whose attitude retrieval is slower. Therefore, one reason why attitudes based on direct experience better predict behavior is because they are more accessible in memory than attitudes formed via indirect means.

This research illustrates how more direct measurement approaches in social cognition research, compared with traditional social-psychological research, bring the processes that mediate social behavior into clearer focus. By directly incorporating cognitive processes into theoretical models of social behavior, theory and research in social cognition is able to enrich our understanding of the processes that underlie various forms of social behavior.

To be clear, social cognition is not merely the application of cognitive psychology's theories and methods to a social

context. Broadly speaking, cognitive psychology and social cognition use similar methodological tools and share a concern for cognitive representation (structure) and process. Despite these surface similarities, fundamental differences between social and nonsocial cognition do exist. As social psychologists Leonard Martin and Leslie Clark observed, "We do not think about people in the same way that we think about other things." Perhaps most importantly, in social – as opposed to nonsocial – cognition we are simultaneously the perceivers *and* the targets of perception. This fact has important implications for social perception and behavior. For example, research has shown that how we categorize others strongly influences the ways in which we think about them and interpret their behavior. Our impressions of others also directly influence our behavior toward them, which has in turn, been shown to influence their actual behavior. In this way, if I am a female CEO, whether others categorize me as a female CEO, as a woman, or as a CEO likely determines how they perceive and treat me, and consequently, how I come to see myself and behave toward others.

Social cognition also differs from nonsocial cognition in that the former is more highly intertwined with emotion; in the social domain, certainly more so than in object perception, our feelings influence our thoughts and vice versa. For example, research shows that when people feel angry, they are more likely to stereotype others. In a somewhat different vein, research shows that our attributions about the causes of other people's behavior affect the emotions we experience toward them. If we believe that Laszlo failed his chemistry test because he chose to party with his friends rather than study, we may feel anger or disgust toward him. In contrast, if we attribute the failure to illness, we may pity Laszlo.

To better appreciate the work of contemporary social cognition, a brief discussion of its intellectual origins follows.

Historical Background and Intellectual Origins

Social psychologists have always stressed that people are thinking organisms. At the turn of the century, prominent scholars such as James, Cooley, and Mead had already placed a thinking, evaluating self at the center of social-psychological inquiry. Even during the reign of behaviorism, social psychologists continued to accord cognitive constructs a central place in their theorizing. By World War II, an influx of psychological scientists escaping fascism and genocide in Nazi Germany found an intellectual home in American social psychology, with its emphasis on unobservable processes.

Moreover, the war itself dominated the attention of many seminal thinkers in the field. German and American psychologists alike wondered how a nation like Germany could undergo such a massive and rapid 'attitude change' as to blind the German people to the overthrow of humanitarian values and the genocide of millions. Focusing on the powerful Nazi propaganda machine, some social psychologists (e.g., Kurt Lewin) investigated the factors that influence attitude indoctrination and persuasion, while others focused on persuasion as a form of authoritarian compliance. But the Holocaust also brought to the forefront the problems of stereotyping, prejudice, and discrimination that continue to occupy the field today. Thus, the war was instrumental in terms of channeling both cognitively

oriented scientists and phenomena into the newly developing area of social psychology.

Nevertheless, it was not until the early 1970s that social cognition began to emerge as a subfield of social psychology in its own right. As a consequence of the cognitive revolution, researchers studying social perception began to apply experimental psychology's models of human cognition and memory. Developments within social cognition informed and influenced social psychologists' understanding of social behavior – from attribution to stereotyping and from impression formation to persuasion.

Although the subfield of social cognition is relatively young, we can trace its influences to two philosophical orientations: The first, which has been referred to as the *elemental* perspective, focuses on how different pieces of information are combined to form organized cognitive structures. The second, which has been termed the *holistic* perspective, focuses on the subjective nature of perception and on the organizational principles that guide higher-order cognitive and perceptual processing.

Within the elemental school, associative network models early on probably had the greatest influence on social cognition. Developed within cognitive psychology in the 1960s and 1970s, these models address two fundamental questions in cognition. First, how do people cognitively represent and organize (i.e., structure) information from the external world? Second, how do we process information that we have perceived and stored? In answer to the first question, associative network models suggest that cognitive structures arise through the pairing or association of cognitive elements in memory. These pairings and associations are based on similarity, temporal or spatial contiguity, and frequency and recency of association. In a similar fashion, further associations and connections can build to form more complex cognitive structures, a process known as 'bottom-up' processing. Structurally, these models posit that verbal propositions represent concepts or nodes in long-term memory and that links represent the relationships between nodes. Associative network models also make important assumptions about the processes that operate on memory structures, such as the metaphor of concept activation. When a concept is encountered in the environment (e.g., when I see a dog), its corresponding memory node is activated. This activation then emanates outward, spreading along the associative pathways to other concepts linked to the activated concept (e.g., the concept of 'attack' may be brought into conscious awareness or may unconsciously affect behavior). The strength of association between concepts or nodes determines the degree to which a given concept activates other linked concepts.

In contrast to the 'bottom-up' perspective of associative network theories, adherents of holistic or 'top-down' notions of cognition emphasize that all the information represented within a given cognitive structure operates as an indivisible cognitive unit. The cardinal axiom of this school is the original Gestalt idea that the whole is more than the sum of its parts. For example, Sir Frederick Bartlett, who emphasized the constructivist nature of social perception, demonstrated that people perceive and remember stimuli as higher-order units, rather than as collections of independent elements. Bartlett's work also foreshadowed important developments in social cognition by proposing that existing cognitive structures provide

interpretive frameworks from which people process new information in the environment. In fact, a major theme of Bartlett's research was that cultural expectations and previous experience often distort social perception. Indeed, as will become evident below, subsequent research has shown that cognitive structures can have wide-ranging effects on perception; they influence the environmental features to which people attend, the manner in which such information is interpreted and encoded, and which information is most likely to be available for later retrieval. In essence, this approach highlights the inherently subjective nature of perception, thought, and memory.

The Structure and Processing of Social Information

One of Sir Frederick Bartlett's long-lasting contributions has been his coining of the term *schema* to refer to the ideas, or cognitive structures, of narratives. Now employed in most modern research, the definition has expanded to include stimuli of a wide variety of entities, including objects, persons, social categories, events, or situations. More formally, it is defined as the abstract generic knowledge about the attributes of any stimulus and about the interrelationships among the stimulus attributes. A stereotype (or schema) about the social group 'scientists,' for example, may contain descriptive information in the form of beliefs, expectations, and knowledge about scientists (e.g., scientists are 'ingenious,' 'unsociable,' 'eccentric,' and 'no fun at parties'). The schema also provides a framework for understanding how the attribute information relates to each other (e.g., 'scientists are eccentric because they are very intelligent').

In addition to providing cognitive representations of stimuli, schemas also guide the processing of subsequent information and facilitate the construction of social reality. Social situations are often ambiguous or contain limited information, and consequently, are open to many interpretations. When information is limited, schemas allow us to 'go beyond the information given' and to make inferences about a given stimulus. Using solely the information that a person is a scientist, people could conclude that that same person is also 'unsociable' and 'ingenious.' These schemas about the attributes of social groups – social stereotypes – can affect what kinds of behaviors we expect from individual members of those groups, thus potentially biasing the interpretation of ambiguous behavior. Such behavioral expectations are often based on visually prominent characteristics such as gender, race, and age. For example, Sagar and Schofield showed that when a Black and a White child engaged in identical ambiguously aggressive behaviors, people viewed the Black child's behavior as more aggressive and the White child's behavior as more playful.

Expectations about others can also influence our own behavior toward others. Gendered schemas about occupations, for example, can lead to further sex segregation of employment by altering expectations about the appropriateness of the occupation for each sex. Indeed, Rudman and Glick found that people who stereotyped men as more assertive and directive and women as more nurturing were more likely to hire men for a masculine managerial job. Perhaps most important, research on behavioral confirmation suggests that schema activation results in self-fulfilling prophecies. Studies have shown that when our beliefs

and schemas lead us to perceive others in stereotypic terms (e.g., as an African American) rather than as unique individuals, our behavior (e.g., unfriendly) elicits from them confirmatory behavior (e.g., hostility), thus bolstering our preexisting schemas. This dynamic provides an important insight into the reasons why social stereotypes are so difficult to change.

Another function of schemas is that they allow us to simplify and organize information from otherwise unmanageably complex environments. By taking a 'top-down' approach and inferring information based on category membership rather than learning each individual's personal attributes, we expend less effort and conserve cognitive energy. Observing that people often exert minimal cognitive effort and tend to overrely on schemas, Fiske and Taylor coined the term *cognitive miser*. They argued that people habitually tend to take mental shortcuts, even when they are capable of more careful analytic thought. In addition to schemas, people also overrely on heuristics, or general rules of thumb that allow people to make quick and easy inferences. And like schemas, heuristics can lead to systematic errors. Instead of taking the time to learn base-rate information, for example, people use the availability heuristic to quickly infer the frequency or probability of an event occurring based on how easily it comes to mind (cognitive accessibility). Because people tend to overestimate the probability of more salient or familiar events, a person might overestimate the frequency of deaths that result from something dramatic, like a plane crash over the more common but mundane heart disease. By relying on these mental shortcuts rather than engaging in more analytical thought, people sometimes sacrifice accuracy for the sake of efficiency.

As the role of motivational influences on information processing emerged, social cognition researchers in the 1990s began to view people as *motivated tacticians*. According to this perspective, people are not *always* motivated to exert minimal cognitive effort. In addition to efficiency, other motives (e.g., accuracy, ego defensive, consistency) can affect the cognitive strategies people use when processing social information. The *tactician* component implies a more deliberate choice of processing strategy than suggested by more recent research on unconscious motivations. As a result of research on automaticity and control (see below), social psychologists began to develop models that examined when and how people automatically (and sometimes unconsciously) adjust their motivations, emotions, evaluations, and behavior as a function of adapting to different social environments.

Dual-Process Models

We have discussed how people may default to processing information in a low-effort manner, relying on mental shortcuts in everyday contexts. At other times, however, we take a more effortful, data-driven approach to gathering information. To explain when and why people use one approach over the other, a number of dual-process models have appeared in different subdomains of psychology – attitudes and persuasion, person perception, implicit social cognition. All these models distinguish between two different modes of processing: one that is effortful, deliberative, and controlled, and one that is fast, effortless, and automatic. According to Smith and DeCoster, despite differences in domain, level of specificity,

and underlying motivations, all dual-process models tend to possess three major components: (1) they explain when or how people process information in a 'quick and dirty' fashion; (2) they explain how people process information more extensively when motivated and capable; and (3) they outline the conditions that facilitate shifts between the two modes. Capturing many of the similarities in models across domains, Kahneman recently proposed a two-system model with an intuitive system and a reason-based system, with connections to underlying neural subsystems.

Dual-process models were originally developed to account for impression formation processes and have typically focused on the long-lasting effects of stereotypes, a category-based form of processing that tends to occur automatically. The pioneer dual-process models were Brewer's dual-process model of impression formation and Fiske and Neuberg's continuum model. Both of these distinguish between when people will rely on more individuating pieces of information and when they tend to use stereotypes when forming impressions of others. In general, these models propose that people tend to rely more on individuating pieces of information when they observe inconsistency between the stereotype and a target's behavior, but people otherwise predominantly rely on social categories in making social inferences and judgments.

When forming impressions of others, people's motivations can also affect which mode they rely upon. According to Fiske and Neuberg's continuum model, the motivation to belong encourages people to take a more piecemeal (or data-driven) approach in interdependent situations. When people must work with others to succeed, as on a sports team or military squad, they tend to pay more attention to stereotype-inconsistent information. Learning individuating pieces of information, rather than relying on stereotypes, enables people to better predict others' behavior, and as a result to work more effectively together as a cohesive unit. In addition to interdependent situations, when people want to be accurate or they think they may be held accountable to others for the reasoning behind their judgments, they tend to be motivated to process information more carefully and consciously.

Researchers who study attitudes and persuasion are interested in the different processes by which people make attitudinal judgments based on available information. Introduced at approximately the same time, Chaiken's heuristic-systematic model and Petty and Cacioppo's elaboration likelihood model dominate the field of persuasion. The heuristic-systematic model proposed that people can process information in a heuristic or systematic mode, or both. The heuristic mode involves judgments based on rules of thumb or 'heuristics,' which guide processing, often automatically, but in accordance with various principles that account for when one or the other mode of processing is in play. In the more analytic systematic mode, people exert effort to pay attention to message-relevant information. Likewise, the elaboration likelihood model distinguishes between two routes by which a person can process a message: the peripheral (similar to, but not isomorphic with, the heuristic) and the central route (similar to systematic). As with the HSM, which route a person takes depends on his or her ability and motivation to think carefully about the quality of the arguments contained in the message. For example, if you are deciding whether to buy a Honda or a Toyota and

processing information heuristically, you might be particularly persuaded to buy the Toyota because of Cameron Diaz's celebrity endorsement. However, if buying a car is an important decision for you, then you would be more likely to consider such issues as recent recalls, cost, gas mileage, warranty, and environmental impact, more than a celebrity endorsement.

For reasoning about attitudinal judgments, three major motives converge in the attitudes and persuasion literature. These motives correspond to concerns about the self, concerns with rewards/punishments associated with other people, and a desire to form a valid picture of reality. These motives line up nicely with the three included in the heuristic-systematic model (HSM) of persuasion, which affect both the extent and direction of processing: accuracy, defense, and impression motivation. According to the HSM, when driven by accuracy motivation, people should engage in an effortful and unbiased search for judgment-relevant information. The defense motivation, in contrast, can lead people to process information superficially or carefully, depending on which method better serves the self. Striving to defend the self-concept, people may select information that preserves preexisting beliefs about the self. Information that is inconsistent with the self-concept, however, should motivate people to carefully process that information in an effort to discredit it.

Despite the prominence of dual-process models, critics have raised several issues pertaining to the pros and cons of different modes of processing. Most of the criticism has revolved around the theory and research behind Kruglanski's unimodel of persuasion. Kruglanski and colleagues argue that distinctions between the two processing modes are artificial and that both modes operate according to hypothesis-testing and inference. That is, because effortful and automatic processing both rely on 'if-then' syllogistic reasoning, the two 'modes' are qualitatively the same. According to Kruglanski, rules of thumb such as 'if an expert makes this argument, then it must be valid' operate similarly to message-based processing (e.g., if this argument is true, then the proposal must be bad). He further argues that differences in judgments previously observed between the two modes simply correspond to quantitative differences in degrees of processing that have been methodologically confounded in past dual-process research.

However, the main premise of the unimodel – that the two processes are qualitatively the same – does not square with recent neurological findings. In particular, Lieberman's research on X and C systems, identified by functional magnetic resonance imaging (fMRI), indicates that some regions of the brain are associated with effortful processes and others with automatic processes. Further, these neurological differences cannot simply be explained by quantitative differences in the extent of processing, as evidenced by research on people with damage to the hippocampus (an area associated with automatic processing). Smith and DeCoster point out that although people with damage to the hippocampus cannot form new associations with novel stimuli, they nevertheless can apply previously learned knowledge (prior to the damage) to perceive similarities in the stimuli. That is, it seems that they used previously learned heuristics. People without damage to the hippocampus, in contrast, are able to automatically learn new associations from experience, often without conscious awareness.

Implicit and Explicit Processes

Another distinction researchers have made between the two modes involves the emotional component of automatic processing. Gawronski and Bodenhausen made this distinction most clearly in their associative propositional evaluation (APE) model of explicit and implicit attitudes. In typical dual-process fashion, the APE model classifies implicit attitudes as automatic processes and explicit attitudes as more controlled. More specifically, however, Gawronski and Bodenhausen define implicit attitudes or associations as *affect-laden* associations activated automatically by an internal or external stimulus. Importantly, these associations do not depend on whether people believe the association to be valid. A person may have a negative association with people with foreign accents simply because he or she grew up watching a lot of movies with accented villains. This does not necessarily mean that the person believes that people with accents tend to be evil. All that matters for implicit attitudes is that the stimulus automatically activates the affect-laden association. Explicit attitudes or propositions, in contrast, depend on whether a person accepts the belief or evaluation to be true and valid.

Conceptualizing implicit processes at a theoretical level is a relatively easier task than measuring them at an empirical level, given that implicit processes presumably occur automatically and outside of a person's awareness. That said, measures of implicit attitudes and associations have become increasingly popular in the last decade. The most popular of these measures are the implicit association test (IAT) and affective priming tests. The IAT uses a timed computer-categorization task to measure the strength of association between a category (e.g., Black and White people) and an attribute (usually affect-laden like 'good' or 'bad'). For example, a person might first be asked to categorize all Black faces and positive words (e.g., summer, good) with their left forefinger and all White faces and negative words (e.g., bad, vomit) with their right forefinger. Then they would be asked to categorize Black with bad and White with good. Faster responses for the Black-positive/White-negative pairing would indicate a stronger association between Blacks, as compared with Whites, with positive valence. Lending validation to this new tool, a recent meta-analysis revealed that compared to explicit measures (most commonly assessed using self-report), the IAT better predicted socially sensitive criterion variables, such as those related to race or other intergroup relations. For example, a Black-White IAT better predicted nonverbal behaviors such as participants' eye blinking and physical distance between the participant and a Black confederate than the participants' self-report of their feelings toward Blacks.

Based on a similar rationale of associative pairing, Fazio and colleagues developed the affective priming method for measuring implicit attitudes. In this paradigm, a computer quickly flashes a prime (e.g., a man or woman's face) before showing a positive or negative word and then measures the amount of time it takes participants to categorize each word as good or bad. This paradigm is based on the assumption that positive attitudes toward a category like women should increase the speed with which a person categorizes positive words (e.g., summer, smile) as positive. Like the IAT, research on affective priming has found that response latencies after the prime predicted subtle racial behaviors (e.g., eye contact,

blinking, physical closeness). In one study of implicit racial bias, Fazio et al. found that people who categorized negative words more quickly after a Black prime also tended to place more blame on Blacks for the Los Angeles riots that followed the not-guilty verdict for the police accused of beating Rodney King.

Automaticity and Behavior

Automatic processes, such as implicit attitudes, affect many areas of social life. Social cognition researchers have found that subliminal primes can affect behavior and perception by activating mental representations outside of a person's awareness. In one study, Bargh et al. subliminally primed people with either a Black or White face. When the experimenter subsequently told participants that the computer had lost all their data and they would have to repeat the tedious task, participants primed with Blacks exhibited more hostile facial expressions. Automatic processes also occur when someone is consciously exposed to a stimulus, yet unaware that the particular stimulus has any effect on seemingly unrelated behavior or judgments. In another clever study, Bargh et al. had participants unscramble words that primed the category 'elderly.' As a result, participants were aware that they had just seen words such as 'old' and 'forgetful,' but had no idea that these words might affect their behavior in a completely unrelated domain. After the experiment had ostensibly ended, however, they walked more slowly down the hall to the elevator than participants who had unscrambled neutral words.

People also seem to automatically engage in self-protective processes and behaviors when their self-esteem is threatened. Telling people they did poorly on a task (threatening their self-esteem), for instance, tends to increase their negative stereotyping of others. Such research paints a rather bleak picture of the pervasiveness of automatic biases. But, automatic processes do not all have to be negative and, in fact, people can override their negative biases given the motivation and ability to do so. For example, if people are motivated to be egalitarian, then negative stereotyping does not have to occur. If people admit their potential for prejudicial responses and feel guilt over it, they can learn a new association between the problematic category and a warning for careful processing. Over time, and with practice, people can learn to inhibit the negative response and replace it with a more positive one, thus making the positive response the dominant and automatic one.

Social Neuroscience

As mentioned earlier, recent neuroscientific findings have begun to offer convergent evidence of two separate systems in the brain responsible for controlled and automatic processing. The newly developing interdisciplinary field of social neuroscience – still less than two decades old – uses cognitive neuroscience research tools (e.g., fMRI and PET) to examine the neural locations of social information processing. It allows social psychologists to investigate hypotheses – such as whether automatic and controlled processes are qualitatively distinct – using neuroscience methods. Since the beginning of the 1990s, known as the Decade of the Brain, neuroscientific studies have generated a great deal of excitement about a possible window

into the brain. The marriage of these two previously separate fields should not be particularly surprising given that both neuroscience and social psychology are concerned with how the mind works and how affective and cognitive processes connect to action tendencies and actual behavior.

Studies of neurological processes using functional magnetic resonance imaging (fMRI) are increasingly popular, with new data appearing routinely. Part of the appeal of fMRI to social cognition researchers comes from the belief that self-reports and observations of overt behavior provide only a limited picture of the mechanisms underlying complex attitudes and behavior, especially automatic attitudes. Functional magnetic resonance imaging provides images of brain activity by measuring changes in blood flow and oxygen use while people engage in a particular activity (e.g., categorizing faces as male or female, thinking about someone with whom they are passionately in love). These images of brain activity during different tasks provide clues about the possible functions of different regions of the brain, thereby providing another part of the picture of the mechanisms underlying social cognition processes.

Although social neuroscientific findings have contributed to our understanding of social phenomena such as attachment, morality, prejudice, and decision making, we must be mindful that neuroscience is still conceptually and methodologically in a relatively early stage of development. The colorful images depicting brain activity published in magazine articles suggest a deceptively clear and compelling picture of a highly complex and nuanced process. Most research suggests that complex psychological or behavioral constructs do not cleanly map onto a single area of the brain. It is most likely the case that no region of the brain serves one singular function. With these caveats in mind, general themes have emerged in the literature on social-cognitive neuroscience.

Studies have shown, for example, that different areas of the brain are associated with object perception and person perception. The medial prefrontal cortex (mPFC) – located on the outer side of the brain, about one-third of the way back along the midline – seems particularly important for social-cognitive tasks. For example, along with the superior temporal cortex, the intraparietal sulcus, and the fusiform gyrus, the mPFC was implicated in a social judgment task. Compared to object judgment (could the word ‘shabby’ describe a pair of pants?), social judgments (could the word ‘assertive’ describe a person named Mark?) were associated with a unique pattern of brain activity in the medial prefrontal cortex. Interestingly, thinking about one’s own life and experiences also predicts activation in the mPFC.

As described in the dual-process section, recent neuroscientific evidence provides support for the distinction between controlled and automatic processing, as each kind of processing seems to be associated with different regions of the brain. Lieberman’s research indicates that automatic processing is associated with activation in the amygdala, basal ganglia, ventromedial prefrontal cortex, lateral temporal cortex, and dorsal anterior cingulate cortex. To simplify, Lieberman and colleagues refer to the collective of these regions as the X-system. As further evidence of the amygdala’s involvement in automatic processing, other researchers have found that activation of the amygdala correlates with implicit measures of racial attitudes, but not explicit measures. Controlled processing, in contrast, seems to be associated with the lateral prefrontal

cortex, medial prefrontal cortex, lateral parietal cortex, medial parietal cortex, medial temporal lobe, and rostral anterior cingulate cortex. Lieberman and colleagues refer to these regions as the C-System.

Other neuropsychological evidence supports Baumeister and Leary’s contention that the need to belong and connect with others may be a fundamental motive, or at least has a biological association. Simply being excluded from a computerized ball-tossing game has been shown to increase activation of the dorsal anterior cingulate cortex (dACC), the same part of the brain that reacts to physical pain. Activation of the dACC has also been found to be associated with losing important social connections such as caretakers.

All these findings demonstrate that the use of new neuroscientific tools has helped to create an exciting new subfield within social cognition. As our understanding of brain imaging continues to develop, this new research has considerable potential to enrich theory and research in social cognition.

Conclusion

Since our last review more than 15 years ago, the field of social cognition has steadily evolved. Perhaps the two most promising new directions are implicit attitudes and social-cognitive neuroscience. In bypassing an individual’s conscious awareness, these theoretical frameworks have the capacity to deepen our understanding of the intersection between social interaction and the workings of the mind. Over the last two decades, social cognition has also contributed to a scientific database that serves the research interests of more applied social scientists. For example, political psychologists have relied on social-cognitive concepts such as priming and framing to understand the dynamics of public opinion. In laying out a theory of *implicit* racial priming in elections, Mendelberg argues that the rise of egalitarian norms in American society requires that campaigns seeking to mobilize resentful White voters use subtle forms of racial communication. Social-cognitive concepts have also informed our understanding of the nature of candidate evaluation. In particular, by noting that voters often extract the evaluative implications of political information at the moment of exposure and then proceed to forget the nongist descriptive details, political psychologists have forcefully challenged the long-standing assumption that rational choice flows from information holding and ideological awareness. In sum, we expect that conceptual and methodological advances in social cognition will continue to serve as the basis for scientific advancements both within and beyond the field of social psychology.

See also: Cognitive Bias; Impression Formation; Motivation; Persuasion; Self-Fulfilling Prophecy; Prejudice, Discrimination, and Stereotypes (Racial Bias).

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Social Comparison

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Glossary

Assimilation Looking for similarities between oneself and the comparison target and feeling close to or like the target.

Contrast Looking for dissimilarities between oneself and a comparison target and feeling distant or unlike the target.

Lateral Same-level comparison.

Prototype An individual's subjective perceptions about the typical member of a certain category.

Self-enhancement The desire to improve one's feelings of self-worth.

Self-evaluation The desire to evaluate one's behaviors or opinions.

Self-improvement The desire to gain new skills to better oneself.

Social comparison Comparing oneself along one or more dimensions with a real or imagined person.

Target The person, real or imagined, with whom one is comparing.

Introduction

Every day, whether we are aware of it or not, we compare ourselves with others. We compare on a variety of dimensions from appearance ('Am I underdressed for this party?') to opinions ('Is my belief valid? What do others think?'), to performance on a task ('What does my exam score mean? Should I be happy or worried?'). Sometimes, the person we are comparing ourselves with may not even be real. For instance, students might compare themselves in terms of level of stress with their perception of the average student at their school. Although no truly 'average' student exists, feeling that one is experiencing more stress than the average student will nonetheless be disheartening. Thus, it is possible that comparing with an imagined other person will have just as profound an impact as comparing with a real person. These comparisons may be deliberate and conscious, but they also can be triggered unconsciously or can happen spontaneously. It's not just that people are being nosy; these comparisons have specific purposes. In fact, these comparisons serve many adaptive functions. The present article lays out a brief history of research on social comparison and highlights the many factors that influence the type, frequency, and effects of social comparisons. Real world applications are described and future directions in social comparison research are also discussed.

objective information is absent will people compare with others to better appraise the situation. Subsequent research has shown that Festinger was actually underestimating social comparison, and that, in fact, people often prefer knowing their relative status, via comparisons with others, as opposed to their absolute standing. The basic principles of the theory, however, have held the test of time and continue to influence research in the field of psychology.

Social Comparison and Self-evaluation

Festinger proposed that the best way for a person to gain insight about his or her performance would be to compare with someone who is perceived to be similar. For instance, an amateur musician might compare his performance with a person who has similar years of experience, rather than comparing with a professional musician (clearly superior) or someone who has never played before (clearly inferior). The greater the similarity of the comparison target (the person to whom one is being compared), the more precise is the evaluation. Festinger believed that only when similar comparison targets are unavailable will people resort to comparisons with others perceived to be dissimilar from the self; in these cases, the comparer will have less confidence about the conclusions he or she can draw from the comparison.

Festinger's Original Social Comparison Theory

The term social comparison was coined in 1954 by Leon Festinger. His article proposing social comparison theory was instrumental in jumpstarting this line of research. According to his theory, there is a universal drive for people to evaluate their abilities and opinions. One way to gain perspective on one's abilities or opinions is to compare with others. If objective information is available that can inform a person regarding his or her performance or opinion, then social comparison should not be necessary. According to Festinger, only when

Social Comparisons and Groups

Festinger was particularly interested in the role that social comparison plays in the behavior of group members. He demonstrated how social comparison could be used to explain various group processes, including group formation, conformity, and competition. If the group is important to a member and the ability or opinion being evaluated is central to the group, then the member should be motivated to regularly compare with other group members. For example, a member of an important committee at work may find it necessary to compare with his coworkers to assess his status in the group

('Am I contributing enough?'), as well as assess his opinions ('Do others agree with my idea for the project?'). If the worker feels that his status is slipping or his opinions are not shared, then he should be motivated to conform with the group – if it is important to him. If the comparison dimension is not much valued or the group is seen as less important by a member, then he or she will not face the same pressure to engage in social comparison. Members who, upon comparison, are deemed too dissimilar from the rest of the group are most likely to be excluded from the group.

Social Comparison and Improvement

In addition to the desire to evaluate oneself, Festinger also recognized that there is a constant desire to improve one's abilities. Thus, people might be motivated to compare with others who have performed slightly better than they have. This would allow the comparer to gain insight as to why his or her performance was inferior and provide motivation to work harder. Festinger noted that this upward drive for abilities may be more pronounced in Western cultures, because traits such as individualism and autonomy are seen as more important in Western cultures, where people will feel the need to stand out from the crowd. These cultural norms provide motivation to compare as a way to improve one's standing. In Eastern cultures, more value is placed on group harmony. These two motives, self-evaluation and self-improvement, are discussed in more detail in the next section.

Directions and Motives

As noted earlier, Festinger originally proposed that people are most likely to engage in social comparison with those who they think are similar to themselves. These same-level comparisons, referred to as lateral comparisons, were believed to result in the most accurate evaluation of a person's own abilities or opinions. Comparing with a person who is highly divergent, either greatly superior or inferior, would provide less precise information to the comparer. Although self-evaluation is still viewed as a primary reason why people engage in social comparison, researchers now recognize two (at least) additional types of motives: self-improvement and self-enhancement. As these terms suggest, people may wish to compare with others in order to learn new skills or become inspired (self-improvement), or to feel better about themselves or their situation (self-enhancement). Self-improvement is often associated with upward comparisons – it should be easier to gain inspiration and learn new skills from a person who is doing better than oneself as opposed to worse. The reasoning behind providing children with role models is the assumption that they will be motivated to be more like the admired individuals. Role models act as upward social comparison targets that children can learn from and aspire to be like, motivating them to work harder to achieve similar goals.

Self-enhancement is also a common motivation behind social comparison. As a general rule, individuals prefer to view themselves in a positive light and are motivated to sustain their positive self-images. Comparing with others who are perceived to be worse off allows individuals the opportunity

to feel better about their own situation. The self-enhancement motive gained popularity in the late 1970s and early 1980s, as will be discussed in the next section.

Whereas the early focus of social comparison research was selection of comparison targets, it has shifted over the last 30 years to an emphasis on the motives behind, and effects of, engaging in social comparison.

Milestones

Broadening the Scope

As noted in the previous section, Festinger proposed that social comparison played a role in people's assessments of their opinions and abilities. Thus, the initial studies investigating the theory focused on these two dimensions. This line of research was soon broadened to include emotions as well. Stanley Schachter's research in the late 1950s on fear and affiliation demonstrated that during times of high anxiety, people showed a preference to be around others who were in a similar high-stress situation. This was the case even when participants knew they would not be allowed to converse with each other. It was proposed that people could gain insight into how nervous they should be (and how they might cope) by comparing with someone facing the same stressor.

An important outgrowth of Schachter's work on emotional comparison was his two-stage theory of emotion developed with Singer. They suggested that when people experience physiological arousal (increased heart rate, rapid breathing), they will attempt to label that arousal as a particular emotion. Schachter and Singer cleverly showed that, when the source of the arousal is unclear, the emotional label given can be influenced by social factors, specifically, others in the situation. Participants were given adrenaline to produce physiological arousal, but only some were told what symptoms they could expect. All of the participants were then paired with a confederate who acted either euphoric or angry. Those who had not expected the injection to cause physiological arousal behaved similarly to the target (becoming either euphoric or angry themselves), suggesting that these participants labeled their mood state on the basis of a comparison with the confederate. Of course, most of the time when people are aroused they do not try to label and they do not socially compare – they do not need to, as the cause and the emotional reaction are clear. Nonetheless, Schachter's research clearly demonstrated the important role that social comparison can play in emotions, as well as other behaviors.

Downward Comparisons

Another milestone in social comparison research came with the publication of Wills' article on downward social comparison theory. According to the theory, people who compare with others who are thought to be faring worse experience an improvement in their mood (in other words, their subjective well-being increases). People who feel threatened should be most likely to engage in downward comparison, especially if there is no direct way to confront the source of the threat. If there is a direct way to deal with the stressor (instrumental coping), then this will be the first option. Downward social comparison is an emotional coping technique that can help

one feel better in the short-term, although it is often not the best long-term strategy for dealing with a threat (see Coping entry). The threat need not be physical – threats to a person's ego will lead to the same motivation to compare with a less fortunate person. Wills proposed that people with low self-esteem should be more likely to engage in downward comparison than those with high self-esteem, as they are more likely to experience low levels of subjective well-being.

Wills maintained that self-enhancement through downward comparisons can be accomplished through either an active or passive process. The latter occurs when people learn about others who are worse off and then use that information as an opportunity to improve how they feel. With more active forms of downward comparison, the comparer can derogate the target or cause them physical harm, both of which will have the result of lowering the status of the target, and making them appear inferior. For instance, Wills suggested hostile forms of humor can be used to derogate a person or group of people. Putting others down, even in jest, serves to boost one's own status – in comparison. Another illustration of self-enhancing comparisons is when a teenage girl who is feeling insecure about her own appearance calls a classmate overweight and unattractive. Wills also noted that people are generally ambivalent about downward comparisons. On the one hand, they don't like to take joy in someone else's misfortune or be seen as gloating (this has been referred to as *schadenfreude*, or 'joy from damage'). On the other hand, they realize it can have emotional benefits. Wills used the self-enhancement motive and the concept of active downward comparisons to explain a broad range of research, from prejudice to physical and verbal aggression.

Related to downward social comparisons is the notion of downward shifts put forth by Gibbons and colleagues. Whereas downward comparisons are usually motivated by a desire to enhance (damaged) self-esteem, downward shifts usually reflect a desire to protect threatened self-esteem. Downward shifts are more common, because true downward comparison with a person who is believed to be worse off may not always be feasible or desirable. This may be the case for the student who received the lowest grade in the class; there simply is not a classmate who is worse off to compare with. Other times, downward comparisons are unwanted because of the discomfort that arises. In these situations, when people are feeling threatened but either cannot or do not want to engage in true downward comparisons, there is a tendency to lower one's preferred target level. For instance, the aforementioned student will not want to compare with the best student in the class, but selects a classmate who is not quite as accomplished (a student who is doing okay rather than excellent). This downward shift has been demonstrated in a variety of situations, including health: people who are attempting to quit smoking and then relapse show decreasing interest in comparison with successful abstainers.

Factors that Influence Comparisons

Similarity

Researchers have long focused on what factors influence who is selected as a comparison target. As Festinger noted in his seminal article, similarity plays an important role, with people

selecting targets that are viewed as similar to themselves. The more similar the comparison target, the easier it is for people to make a comparison and the greater the certainty they have in their conclusions. Similarity may be on the basis of a dimension relevant to the comparison, such as a golfer comparing with someone with the same handicap; however, people may compare with others who are similar on dimensions less central to the comparison. It has been shown that the type of similarity with the target can be important. A person is more likely to identify with a comparison target if the two share a distinctive quality as opposed to a nondistinctive one. If the target shares a birthday or also has a rare hobby, then the comparer is going to be more influenced by him or her. If the target shares a more common quality, such as a popular hobby, then this target is less likely to have an influence on the comparer.

Assimilation Versus Contrast

The more similar the target, the easier it is to identify with him or her; identifying with a comparison target is known as assimilation. The more a person identifies with an upward comparison target, for instance, the greater is the positive impact of the comparison; conversely, the more similar a downward target is perceived to be, the greater is the negative impact. If comparers identify with someone superior, then they should feel hopeful that they too can experience that level of success. If they feel similar to a person who is worse off, then they are likely to worry that they, too, will experience the same fate. There are times when the comparison target may be viewed as different from oneself along dimensions important to the comparison. Rather than identifying with the comparison target, comparers in this case will contrast themselves with the target. Contrasting with an upward target will have a negative impact ('There's no way I can perform that well'), whereas contrasting with a downward target is more likely to have a positive impact ('I am not like him – that will never happen to me').

Originally, researchers believed that downward comparisons were generally self-enhancing and that upward comparisons could be threatening. Since then, it has become apparent that whether a comparison has a positive or negative impact is determined by whether a person identifies or contrasts with the comparison target. To paraphrase Bram Buunk, both upward and downward comparisons have their ups and downs.

So what determines whether people identify or contrast with a comparison target? Mussweiler has proposed that people do a quick holistic assessment as to whether they are similar to or different from the target. This initial determination of similarity, in turn, influences how they go about making the comparison. If they view themselves as similar, then similarities are more likely to come to mind (target-consistent knowledge becomes more accessible). If they view themselves as being different from the target, then dissimilarities are more likely to come to mind (target-inconsistent knowledge becomes more accessible). Similarity testing is more likely to lead to identification with the target, whereas dissimilarity testing is more likely to lead to contrasting with the target. It has been shown that similarity testing, as opposed to dissimilarity testing, seems to be people's initial default tendency.

Perceived Future Similarity

Another factor that has been identified as playing an important role is attainability – that is, whether comparers believe that what the target is experiencing could happen to them. If people feel that they can be like superior others, for instance, then they will be motivated to work harder. If they feel that they cannot be like superior others, then an upward comparison will be potentially threatening. Along those lines, Lockwood and colleagues demonstrated that whether comparison with a ‘superstar’ – in their case, a graduating senior who had succeeded both academically and socially – had a positive or negative impact on undergraduate college students depended on whether participants were freshmen or seniors. Those in their first semesters in college were inspired by superstars who shared their major. Seniors, however, did not have the time left in college to reach the same level of success. Lockwood and colleagues found that the seniors tended to react defensively in an ego-protective manner, apparently to prevent them from feeling worse about their own situation. For instance, seniors were less likely than underclassmen to rate the superstar as being superior and downplayed the importance of the superstar’s accomplishments.

Similarly, if the experiences of a downward comparison target are seen as likely to occur to the self in the future, then it will affect the impact that the comparison will have. Using an example from the health domain, patients with a deteriorating illness will not want to compare themselves to a patient experiencing more severe symptoms (a downward comparison target), as they realize that they will likely be in the same situation in the future. If people have a health condition that is not likely to deteriorate, however, then making a downward comparison should be self-enhancing and should improve one’s mood.

Individual Differences

Although, social comparison is a universal phenomenon, and often done automatically, there are clearly individual differences in the extent to which people compare – some people compare more regularly than others. Gibbons and Buunk created a scale to measure individuals’ tendencies to engage in social comparison. They have found that people who are more self-conscious socially compare more often. People who are aware of themselves when they are around others, and who often reflect on their thoughts and feelings, are more frequent comparers. High comparers also have a greater ability to imagine themselves in others’ shoes, leading them to be more empathetic than those who compare less often. There is also a downside to frequent comparison, however, as those who socially compare more also are more likely to have lower self-esteem, be more depressed, and experience more mood swings compared to those low in social comparison orientation. Finally, women compare more frequently, on average, than men.

Adaptive Benefits

Why is social comparison so common? Researchers have suggested that social comparison has a number of adaptive benefits. As Festinger originally noted, comparisons with others allow individuals to get a better idea of where they stand in

the group. It was likely important for our ancestors that group members avoid potential harmful competition. Comparing one’s abilities with other group members, can allow a member to determine which specialized role should be taken and which abilities he or she should focus on improving. Thus, members are motivated to improve on behaviors they feel that they are specifically qualified to engage in and that bring a unique contribution to the group. For example, a member who, upon comparison, discovers that he is particularly adept at fishing but not at hunting, will be better off focusing on his role as a fisherman as opposed to his role as a hunter. Feeling like an important, contributing group member, in turn, helps to enhance a member’s self-esteem. Social comparison also plays a role in the cohesiveness of the group. By making sure one’s views and goals are in line with those of the group, members prevent themselves from potentially being excluded – which could have dire consequences. Maintaining the cohesion of the group increases its likelihood of prospering.

In addition to evolutionary benefits, social comparisons are adaptive in terms of how humans process information. Social comparison makes processing information more efficient in that it allows a person to limit the range of information that is needed to make an evaluation or judgment. Humans have many demands on their time and attention (and thus have scarce available cognitive resources), so having a way to simplify the processing of information is extremely beneficial.

Social Comparison and Biased Perceptions

As the field of social psychology turned its collective attention to cognition in the late 1980s and early 1990s, researchers began applying this new approach to the study of social comparisons. People are predisposed to hold themselves in high regard and are motivated to maintain these overly positive beliefs of themselves relative to others, and social comparison processes appear to drive these biased perceptions. One illustration of this phenomenon is that people tend to view their ideas and opinions as being correct or appropriate and therefore more prevalent among the public than they actually may be (this is known as the false consensus effect). Believing that the majority of others share their views strengthens people’s confidence in the validity of these beliefs. This increase in confidence, in turn, will influence their future behavior. There are times, however, when individuals prefer to see themselves as standing out from the crowd, in other words more different or special than they actually are (this is termed the false uniqueness effect). This belief in false uniqueness is maintained by underestimating the prevalence of an ability or belief in the general population.

It has been shown that people have a tendency to select comparison targets that are most likely to lead to these biased conclusions. For instance, a person might compare his or her political views with those of his or her close friends and find that they all hold similar beliefs. Of course, an individual’s group of friends is likely not representative of the general public. Individuals tend to be friends with similar people, and so it is likely that they hold similar political beliefs. In this case, the result is that the person overestimates the percentage of people who share his or her political opinions. This belief, in turn, results in increased confidence in his or her

views and strengthens his or her resolve to promote the political party most associated with his or her views.

Applications to Health

Social comparison plays an important role in health behaviors and cognitions. For instance, the decision to seek medical attention is often influenced by social comparison. When deciding whether to go to the doctor or not, a person will compare his or her symptoms to those of others he or she knows ('My friend had similar symptoms and needed antibiotics. I may be at risk and should see a doctor' or 'My friend had similar symptoms, but was fine the next day. It's not worth seeing a doctor'). Thus, people with the same symptoms may make different decisions on the basis of whom they compare themselves with. Additional examples of health-related social comparison research are described below.

Risk Perceptions

Social comparison plays an important role in people's perceptions of risk. How vulnerable people feel to negative outcomes is largely based on their relative judgments. Along these lines, Jemmott and Croyle found that the more prevalent a behavior or event is thought to be (in their case, contracting a fictitious disease), the less severe it is viewed; in other words, there is safety in numbers. If the behavior or event is less common, then people tend to see it as being more severe and are more worried about the possibility of negative consequences. As noted earlier, people tend to overestimate the extent to which others share their opinions and abilities in order to normalize them. Thus, college students who binge drink overestimate the number of their peers who also drink heavily. Because they think that, 'everyone is doing it,' they perceive the behavior as less risky and are less concerned with its potential consequences.

When estimating the likelihood of experiencing different events, people also display an optimistic bias. As Weinstein has shown, people underestimate their likelihood relative to other people of experiencing negative events (such as getting divorced, experiencing a heart attack), but overestimate their likelihood of experiencing positive events (e.g., winning the lottery). One way that people maintain these beliefs is to choose social comparison targets who lead them to these biased or overly optimistic views of themselves. For instance, when estimating his risk of having a heart attack, a man may choose a target that has a poor diet, or smokes, or does not exercise; by choosing a prototypical unhealthy target, he ends up feeling less vulnerable.

Affiliation

As noted earlier, Schachter proposed that people under stress will be motivated to affiliate with people who are in the same situation, as a way to gain insight into how they should react to and cope with a threatening situation. More recent research, however, has shown that people facing major surgeries (and therefore experiencing stress) actually prefer to spend time with people who have already undergone the surgery, rather than someone who is also waiting for the same procedure. The reason,

apparently, is that they can gain useful information from a person who has already experienced the threat. In fact, several studies support the idea that upward targets are more beneficial in these instances. In a novel field experiment, Kulik and colleagues found that patients who, prior to cardiac operations, were randomly assigned a roommate who had already undergone a cardiac operation were less likely to experience anxiety before the operation, more likely to walk in the days following the operation, and more likely to be discharged from the hospital earlier than those who had been assigned a roommate who was also about to have a cardiac operation or who had a noncardiac condition.

Similarly, one reason support groups work well is that members can learn from each other. For example, a member of a weight loss group may learn better coping strategies from those who have been more successful (upward comparison targets) or they may feel less deviant if others report experiencing the same (or worse) struggles and temptations. Members of the group who may be struggling can gain inspiration from those who have had more success ('if she can lose 25 pounds and keep it off for 6 months, then so can I'), as well as learn new ways to deal with their own obstacles (such as tips on eating healthy while on vacation). The benefits for successful members of support groups are less clear, as they are more likely to make lateral or downward comparisons to other group members. Thus, successful members have less of an opportunity to improve by comparing with upward targets, but they can feel better by making downward comparisons.

Coping Techniques

Although, as Wills suggested, many people are reluctant to admit that they engage in downward comparisons as a way to feel better, research with cancer patients has shown that it is a relatively common coping technique. In a series of studies, Shelley Taylor and her colleagues interviewed breast cancer patients and their spouses. During these interviews, it was found that patients would spontaneously make downward comparisons (e.g., a woman who had a lumpectomy would comment how bad it must be for women who have had a mastectomy). Even though others would probably judge their condition as being quite serious, patients coped by believing that it could be even worse. In some cases, patients did not have a specific person in mind, but imagined the downward comparison target. When interviewing the husbands of breast cancer patients, for instance, many of the men mentioned, 'At least I am not like those husbands who leave their spouses.' They viewed this behavior as being relatively common, even though, in fact, only a small minority of husbands actually left their cancer-stricken spouse. For this reason, Taylor called these comparison targets 'mythical men.' By creating a downward comparison target (or image) of someone who was not coping well, these men were able to feel better about the difficulties they were experiencing by consoling themselves with the fact that they had (at least) stuck around.

Prototype Images

Similar to the 'mythical men' that Taylor found, other mental images have been found to influence health-related behaviors and cognitions through a similar social comparison process.

Gibbons, Gerrard, and colleagues have proposed a prototype/willingness model of health behavior that is based on social comparison. They have demonstrated that people often compare themselves to a prototype, that is, their idea or image of what a typical person who engages in a behavior is like. Using smoking as an example, adolescents have a general idea of what the typical smoker their age is like in terms of popularity, intelligence, etc. They realize that if they were to start smoking, their peers would then see them as being like a typical smoker. The more negative their prototype is of the typical smoker, the less willing they are to engage in the risky behavior for fear of being stereotyped. So, if they view the typical smoker as being uncool and unattractive, then they should be less willing to smoke than an adolescent who has a more favorable image of the typical smoker their age. Not only do prototypes influence a person's future behavior, but the reverse has also been demonstrated, with behavior influencing future prototypes. Adolescents who begin smoking have been shown to increase the favorability of their smoker prototype. Thus, they come to see smokers their age as less negative than they had seen them before they started engaging in the behavior ('They're really not that bad'). And that, of course, can lead to more smoking, and can interfere with quitting.

Gibbons and colleagues examined the prototypes of members of smoking cessation groups both before and after they attempted to quit. They found that the more members were able to distance themselves from their prototype of the typical smoker, the more successful they were at quitting smoking. Contrasting themselves with the smoker prototype actually facilitated quitting. However, for those who identified with their smoker prototype or who had family members who smoked, derogating the typical smoker became more difficult, and, in turn, quitting smoking became harder. Finally, research has shown that prototypes are more influential for those who are chronic social comparers. Those who generally avoid making social comparisons have images that may be positive or negative, but they are less likely to be influenced by those images.

Future Directions

The Influence of Culture

As noted briefly earlier, cultural norms can influence the motivations behind comparison with others. In more interdependent cultures (in East Asian countries, for example), people place great significance in maintaining group harmony and so conformity is stressed. Social comparison is integral to assuring that one is fitting in with the group. In Western cultures, social comparison may be used to assess conformity, but it also plays a large role in competitions, as people will often compare when they are trying to get ahead. In addition to the motives driving social comparison, cultural norms also influence whom one selects as the comparison target. Much attention has been placed on how individuals view themselves (in other words, their self-construals) and how these views differ between men and women. Stronger gender differences have been found in Western as opposed to Eastern cultures for personality traits, values, and emotions. These gender differences are surprising given the greater emphasis placed on gender equality in Western cultures. It appears that these cultural differences

may be driven by the fact that individuals in Eastern cultures, comparatively speaking, are more likely to select a same-gender target, whereas those in Western cultures are more likely to select a target of the opposite gender. Whether a same or opposite gender target is selected, in turn, influences the type of knowledge that comes to mind. Researchers in this area have been exploring the roles of cultural norms, especially beliefs in the social hierarchy, and how these normative beliefs influence people's intergroup versus interpersonal comparisons. We expect future research to give more empirical attention to social comparison processes across cultures.

Neurological Mechanisms

With the development of new technology, researchers have begun investigating the neurological mechanisms involved in social comparison. One important and intriguing question is what happens in the brain when one makes an upward or downward comparison? Functional magnetic resonance imaging (fMRI) and event-related potentials (ERP) have been employed to identify specific neural substrates that are activated when a favorable or unfavorable comparison is made. This burgeoning area of research has so far focused on the impact that social comparison has on reward processing in the brain. As much remains unknown about the neural mechanisms underlying social comparisons, we expect this research to become more popular in the future.

Boundary Conditions and Other Influential Factors

Attention is increasingly being drawn to the factors that impact various aspects of the social comparison process. In particular, more consideration is being given to elements such as comparison dimensions: How does the type of dimension on which a person compares influence the impact of upward and downward comparisons? Patients with a health condition, for instance, can compare themselves on a variety of dimensions and can learn about ways to deal with symptoms and side effects (coping techniques), or feelings they may experience (emotions), or they can learn more about what they should expect from future doctor visits (procedural information) by comparing with others. Buunk and colleagues have been exploring the impact of these three various comparison dimensions among samples of cancer patients. They have also examined the role of neuroticism and how this individual difference factor influenced the reaction that patients had to the different types of comparisons. Neuroticism is a personality trait, with those high in neuroticism (neurotics) being more emotionally volatile than those low in neuroticism. Neurotics are often described as being tense, anxious, or moody. Previous research has shown that people high in neuroticism tend to react more negatively to social comparisons than those low in neuroticism. However, Buunk and colleagues found that these negative effects could be buffered among neurotics if they compare with someone who is either coping well or who describes the procedures the patients will undergo. We expect this exploration of additional individual difference factors and comparison dimensions to continue.

Interest in objective factors that affect social comparisons has also increased. In a recent study, Garcia and Tor investigated

how the number of competitors influences people's desire to socially compare and how this relates to their motivation to compete. Although having others present can facilitate people's performance and act as a motivator to perform better, it is not the case that 'more is always better.' In cases where there are an extremely large number of competitors, an individual's motivation to compete actually decreases. They termed this the N-effect and found that it is driven by the fact that as the number of people increases, interest in social comparison diminishes, which, in turn, lowers motivation. Identifying these boundary conditions will continue to be important in social comparison research.

Broadened Applications

Social comparison research has been conducted in a number of areas in addition to health (such as educational and work settings). It is likely that social comparison will continue to be studied in these real world settings. With the immense popularity of social networking sites, such as Facebook, people routinely find themselves in situations that are ripe for social comparison (whether automatic or deliberate); these situations will increasingly warrant further study. The role of social comparison in other social psychological phenomena has also been investigated. For instance, social comparisons have been shown to influence the stereotypes people hold, how attitudes are formed and changed, and how the impressions of other people are established. As social comparison has proven to be a central part of our daily lives, we expect that social comparison processes will continue to be integrated into a number of different areas of human behavioral research.

Summary

Social comparisons are an integral part of human nature and occur on a regular basis in a wide variety of situations. As Festinger theorized, social comparisons can be used to evaluate one's abilities or opinions. They can also be used to self-enhance or self-improve. The impact that a comparison has on the comparer depends on a number of factors, such as personality traits (self-esteem, neuroticism) and perceptions of the target (similarity). These factors will continue to be explored. In addition, more attention is being paid to the neurological mechanisms that are involved when making social comparisons. Because of its ubiquity, social comparison

can be studied in a variety of settings, including, but not limited to, health-related situations. It is expected that these applications of social comparison theory will continue to expand and, in the process, broaden the theory and our understanding of human social behavior.

See also: Coping; Evolutionary Psychology; Evolutionary Social Psychology; Preference Judgments (Individuals); Social Cognition; Uncertainty.

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Social Development (Attachment, Imprinting)

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Glossary

Attachment A close, enduring emotional relationship between two individuals (e.g., infant and parent), characterized by pleasure in interaction, and a desire to maintain proximity, particularly in times of stress.

Ethology A theory concerned with the adaptive or survival value of behavior, its evolutionary history, and similarities between human behavior and the behavior of other species.

Imprinting An innate or instinctive form of species-specific learning, occurring during a restricted (or sensitive) period, in which the young of certain species will follow and become attached to a moving object (typically their mothers).

Internal working model Representations of self, caregiver, and relationships that infants construct based on their interactions with the caregiver, as well as rules guiding the processing of self- and attachment-relevant information.

Secure base Use of a caregiver as a base from which to explore the environment, and to return to for emotional support.

Sensitive period A loosely bounded period of time that is optimal for the development of particular capacities or behaviors, and during which the individual is especially sensitive to environmental influences that affect these developments.

Strange situation A standard procedure used to determine the quality of attachment security based on infant behavior during a series of separations from and reunions with the caregiver.

Synchrony Harmonious interactions between two individuals in which attention and emotion are matched and shared, and each participant adjusts behavior and emotion in response to the partner.

Children develop in a network of relationships, and the most important social connection in an infant's world is the connection to the caregiver. This attachment relationship – a long-lasting, emotional bond between child and parent – should provide the infant with a sense of comfort and security, and function to promote the infant's safety and survival. However, the character and quality of these bonds can differ dramatically, and according to attachment theorists are a source of variability in later socioemotional development. In the first half of this article, we focus on normative early social development, starting with a description of human attachment behaviors, and contrasting this with ethologists' observations of imprinting in other species. We discuss the emergence of social behaviors and attachment across the first year, along with evidence of the importance and universality of the attachment relationship. In the second half of the article, we describe individual differences in attachment, including infant attachment classifications, and predictors and correlates of secure and insecure attachments. Finally, we consider attachment past infancy, focusing on two questions. First, are attachments stable in development past infancy, and second, what changes in attachment systems take place in childhood and adolescence?

Roots of Attachment Theory: Ethology and Imprinting

The theory of human attachment is rooted in ethology. John Bowlby, a British psychologist and psychiatrist, developed attachment theory, drawing on observations of the developing connection between infants and parents that are common to humans and animals. Particularly influential was ethologist Konrad Lorenz's work in the 1930s on imprinting. Lorenz described imprinting as the irreversible development of a preference for a social partner that was acquired during a critical

period, was found across the species, and was established prior to the preference being evident in behavior. His work demonstrated the innate tendency of young goslings to instinctively follow the first moving object encountered, typically the mother, serving to keep the goslings close to their source of protection. Images of Lorenz followed by geese – Lorenz being the first moving object they saw during their critical period for imprinting – illustrated a powerful and adaptive mechanism at work (Figure 1). Bowlby had been working with colleagues to understand the close emotional bond between child and mother, in part because he sought to explain the often devastating consequences of disrupting this bond. Based, in part, on Lorenz's work, Bowlby proposed that the young child naturally relied heavily on the presence of the mother and was disturbed by her absence, because the formation and maintenance of this close emotional bond was beneficial for safety and survival. In other words, Bowlby came to see the human infant–mother attachment as a 'special case' of imprinting, albeit with a more complex and reciprocal relationship than the ones described by ethologists. Thus, for both young goslings and human infants, maintaining close proximity to the mother facilitates physical protection as well as exploration of the environment. In particular, the human infant's connection to the caregiver gives the infant confidence to explore the environment, knowing that she is watching over him, and that he can return to her when needed. Bowlby's description of the attachment relationship between human infants and caregivers contained some unique features, shared with only a few other primate species. For humans, the function of close proximity and contact during infants' early, vulnerable years goes beyond physical safety. Human infants experience a decrease in distress through contact and soothing behavior from the primary caregiver. Partly for this reason, the attachment relationship is entwined with the early development of emotion and emotion regulation.



Figure 1 Like Konrad Lorenz and his goslings, these ducklings have imprinted to their young caregiver, and now follow her lead.

The organization of behaviors involved in human attachment relationships is also more complex and reciprocal than the systems involved in imprinting. Finally, the timeline for developing a bond between the human infant and the caregiver is relatively protracted. Imprinting in nonhuman species typically occurs during a well-defined and irreversible critical period very early in development, prior to the behaviors fundamental to imprinting. In other words, the gosling quickly imprints to the mother, which gives rise to following her. Unlike this instant connection, the human attachment bond develops over an extended and more flexible sensitive period across early development, with interactions during this period promoting attachment.

Early Social Connections – Building an Attachment Relationship

Do newborn infants have a special connection with their mothers at birth? Newborns may recognize the mother's voice from muffled sounds heard prenatally. If breast-fed, within days the infant may recognize the mother's scent and even prefer her familiar scent over that of an unfamiliar breast-feeding woman. This early recognition of sound and scent helps infants to identify their own mothers. However, in human infants, the process of forming a specific attachment relationship to a primary caregiver is an extended one, in typical situations occurring across the first year. Human infants are born with powerful tools for engaging in this relationship. In short, humans are primed for social interaction and for attachment. From the beginning, infants behave in ways that elicit nurturing and protection and that engage caregivers in delightful interactions. Infants pay special attention to human faces and voices, picking them out of a world of new sights and sounds. Around 6 weeks, infants begin to display a 'social smile,' smiling most readily in response to human faces and positive social interaction. Starting around 3 months, infants develop exquisite attunement to the behavior and responsiveness of caregivers. Prior to the 1970s, the idea that infants could be active social partners was considered a figment of mothers' imaginations. In the early 1970s, psychologist Edward Tronick developed the 'still-face' paradigm, which has since been widely used to demonstrate infants' active and

engaging social behavior starting between 2 and 3 months. In the still-face paradigm, the parent and the infant first engage in face-to-face play, but this positive interaction is followed by the parent abruptly turning away. The parent then turns back toward the infant, but maintains a neutral expression, and does not respond to the infant's bids for interaction. Tronick hoped to identify how infants would respond to mothers' breaking the rules of social interaction and also how infants would work to regain interaction. Infants are distressed when the connection is broken, and an expansive body of research has since documented infants' use of gaze and gaze aversion, reaching and other gestures, smiling, and both cry and noncry vocalizations to invite, entice, and demand a return to normal social engagement (Figure 2). These early face-to-face interactions are an important context for infants to practice interaction skills, and they also provide infants with a developing sense of self and effectiveness as they influence the behavior of their partner. Importantly, sometimes face-to-face play is synchronous, but most of the time interactions are slightly mismatched. Caregivers can help infants move from nonsynchronous interactions back to a state of synchrony, facilitating the infant's developing capacity for self-regulation (as the caregiver and the infant adjust behavior and affect) and also for relationship repair.

All of these early behaviors are instinctive, but social bids are not at first directed exclusively, or even primarily, toward the mother. Attachment relationships develop in a series of gradual transitions across the first year. Why do infants take such an extended period to develop a specific attachment? One reason may be that waiting to discern which adult figure will be most devoted to their well-being, and retaining the flexibility to become attached to that individual, regardless of biological connection, is adaptive. Another is that the cognitive and physical capabilities needed to recognize and participate in this complex reciprocal relationship take time to develop. Based on observations of infant behavior, Bowlby identified four phases in the early development of attachment relationships.

Phase 1: Preattachment

Between birth and 2–3 months, infants simply respond and orient to people, making little differentiation between their social partners. Newborn infants emit signals such as crying, grasping, and smiling to all potential social partners. Although these signals are not initially intentional, they are effective in eliciting responses. During this period, especially if caregivers are consistent in responding to infants' cries and other behaviors, patterns of interaction may start to become predictable for infants.

Phase 2: Attachment in the Making

Between 2–3 and 5–6 months, these predictable interactions, along with cognitive developments, support the infant in beginning to respond in unique ways to a primary caregiver. Where the infant previously smiled at any friendly person, the largest smiles are now elicited by this familiar caregiver, with whom the infant is developing a special relationship. The infant shows more engagement and positive emotion and is more easily soothed by this person. Near the end of this phase,



Figure 2 In the first part of the still-face procedure (a), the mother and her 6-month-old infant engage in typical face-to-face play. In the second part of the procedure (b), the mother maintains a neutral facial expression and does not interact with the infant. The infant expresses mild distress while reaching out to the mother, and as the distress escalates, the infant fusses and turns away (c). Finally, we observe the infant's delight as the mother reengages (d).

infants begin to display wariness toward unfamiliar individuals. This 'stranger anxiety' signals infants' further discrimination of preferred social partners. Although infants recognize and respond especially to their familiar caregiver, during this phase, infants are not distressed when separated from the caregiver, and thus have not yet developed a true attachment relationship. The end of Phase 2, typically around 7 months, is marked by the appearance of 'separation anxiety,' the infants' clear distress upon separation from their preferred caregiver, even when left with another familiar person.

Phase 3: Clear-Cut Attachment

Between 7 and 12 months, a clear attachment relationship with a primary caregiver emerges. Infants become distressed upon separation from that person and actively seek to maintain proximity to and contact with their preferred caregiver. Although infants will develop more than one attachment relationship if more than one person consistently responds to their needs, they first show a preference for one caregiver over the others. Attachment to a secondary caregiver is typically expressed within weeks following clear attachment to a primary caregiver. Infants may develop attachment relationships with a small number of close caregivers. However, the relationships are thought to be hierarchical, with one relationship preferred over others. Although mothers are often primary caregivers, it is important to recognize that fathers, grandparents, and nonrelative caregivers (such as childcare providers) may all become attachment figures. During this phase, physical and cognitive developments such as crawling and increased communication skills support new attachment behaviors. In particular, the infant's newly mobile status means that the infant can actively approach the preferred caregiver and follow the latter from place to place. Hallmark behaviors of the

attachment relationship are now evident, including secure base exploration, returning to the caregiver for 'emotional refueling,' seeking refuge with the caregiver when distressed, and clinging to maintain contact. Infants have a strong desire to stay close to the caregiver, who has become a source of comfort and protection, as well as delight. However, physical and cognitive advances also support a new desire and ability to explore the environment, and infants must balance these competing desires. A central tenet of attachment theory is that infants are best able to explore when the attachment figure is near and supportive, often referred to as the 'secure base' function of attachment. Infants stay fairly close to their caregiver, look back to check reactions to uncertain situations, and also to share discoveries and positive emotions with the caregiver. These things make for an easy return to the caregiver when needed. Not coincidentally, infants develop these tendencies to stay close and check parents' reactions around the same time that they are newly capable of crawling away to explore.

Infants' attachment behaviors during this phase also become 'goal-directed.' The infant can conceptualize a goal (e.g., contact with the attachment figure when distressed) and develop skills for adjusting behaviors as needed to meet this goal. For example, the infant may plan a path across the room to the caregiver, but if the caregiver leaves the room, the infant can adjust his or her path or vocalize to signal the attachment figure. The infant can flexibly use a variety of attachment behaviors, depending on the situation, to accomplish his or her goal in a particular situation.

The emergence of goal-directed behavior also indicates that infants have become representational, and consideration of the attachment relationship now must include both representation and behavior. The organization of infants' attachment behaviors reflects their internal working model (IWM), or representations of self, the attachment figure, and their interactions.

As noted previously, even during the first few months of life, patterns of interaction may become predictable to the infant. Certainly by 1 year, infants can develop representations of how the caregiver will respond to their behavior (e.g., my parent will pick me up when I am upset) and can also anticipate how the caregivers' behavior will affect them (e.g., 'being held makes me feel better'). Although the IWM in infancy supports basic means–ends connections, it will become more complex and reflective across development and continue to transform along with cognitive and social cognitive changes.

Phase 4: Goal-Corrected Partnership

Beginning around 3–4 years, children develop a basic capacity to understand that the attachment figure has goals independent from their own and to take those goals into account. The relationship transforms into a 'goal-corrected partnership,' where both partners are able to adjust their goals and behaviors with consideration of the other person's plans. With this development, children's capacities for cooperation and relationship grow.

The Need for Attachment

The formation and maintenance of an attachment relationship is a basic human need. One indication of the importance of this relationship is that its absence or severe disruption produces negative effects. In addition to Lorenz's work on imprinting, Bowlby's theory of attachment drew on the Robertsons' observations of the emotional, behavioral, and relational problems exhibited by children experiencing a long separation as a result of the child's or mother's medical care. The Robertsons documented severe declines in children not accompanied in the hospital by their caregiver; this documentation was so alarming that it led to widespread changes in hospital visitation policies. Bowlby also drew on Harry Harlow's groundbreaking (but controversial) work in the 1950s examining infant rhesus monkeys deprived of caregiver contact. Following the accidental discovery that isolated infant monkeys became dependent for comfort on cloth diapers that covered the cages of their floor and that monkeys with no contact comfort quickly withered, Harlow began a series of studies testing infants' reliance on wire or cloth-covered monkeys as a source of comfort. The infants directed attachment behaviors toward the soft, cloth-covered monkey, even when the wire monkey was the source of food. Harlow observed that the young rhesus monkeys needed to rely on the minimal comfort provided by the cloth monkey, using them as a source of security in a novel, moderately stressful environment. However, as they got older, monkeys that had been deprived of a responsive caregiver showed serious deficits in their social behavior, and especially their caregiving.

More recently, attachment theorists have examined the effects of severe early deprivation as a result of institutional rearing. One longitudinal study has followed children initially raised in institutions with very little caregiver contact, and with no individual consistently responding to their needs. These children were adopted into families in the United Kingdom at different points in their development, some before 6 months, and others not until nearly age 4. Children who experienced

early severe deprivation showed an increased prevalence of 'atypical' attachment behaviors, most notably, indiscriminate friendliness, or directing attachment behaviors toward unknown individuals. These atypical attachment behaviors were less common in children who had been adopted before 6 months of age, but they became increasingly common with longer amounts of time in the institution before adoption (at least between 6 and 42 months). This finding was independent of the physical and cognitive deficits associated with longer periods of deprivation. One major conclusion of this study has been that in the absence of opportunity to develop an attachment, children become increasingly less likely to develop typical social bonds.

That children adopted very early in life were likely to show typical social development suggests that infants are initially capable of relatively easy adjustment to a new caregiving environment. This conclusion is also supported by research on infants in foster care. Infants placed into care at ages younger than 1 year begin to consistently direct attachment behavior toward a new foster parent within 1–2 weeks of placement. For infants older than 1 year, this transition takes longer (and adjustment depends also on characteristics of the foster parent). Together, this work suggests a sensitive period for human social development. Prior to 6 months, infants seem to have little difficulty adjusting. That flexibility diminishes somewhat between 6 and 12 months, with even greater loss of flexibility after 12 months. The need to develop an attachment relationship with a caregiver during this sensitive period is so important that infants can flexibly reorganize their behavior around a new person and begin to redirect attachment behavior toward them. This is consistent with ethologists' proposal that there is an optimal window of time for developing particular capacities, and that during this time infants are especially sensitive to environmental influences on those capacities.

Attachment Across Cultures

Since attachment has strong roots in human biology, it is expected that children from all cultures, despite culture-specific child-rearing practices, will display attachment behaviors that support proximity and contact with the caregiver. In other words, the bias in infants to become attached should be universal, and a sizable body of research has been devoted to testing the limits of this claim to universality. Cross-cultural studies of attachment indicate that both attachment behavior and the development of a preferred attachment figure or figures are indeed universal and serve the same functions across a broad range of rearing environments. Still, there is enough flexibility in the organization of attachment behavior to function within a range of possible caregiving environments. Studies of attachment across cultural contexts with quite varied approaches to child-rearing confirm this notion. For example, among the Gusii of Kenya, infants are raised by multiple caregivers, including both the biological mother and a consistent nonmaternal caregiver. Although adults and infants display culture-specific forms of attachment behavior (e.g., greeting by shaking hands or clapping, rather than with a hug, as is typical in many Western cultures), infants' behavior is organized around and directed toward the primary caregivers. Further, infants demonstrate attachment to both the mother

and the nonmaternal caregiver. Children reared collectively on Israeli kibbutzim, and primarily cared for by professional caregivers, provide further support for the universality of attachment. Typically, these children have contact with their parents for several hours in the evenings. However, children spend most of the day away from their biological parents. From early infancy, parents put their children to bed in the children's house – without a parent or regular caregiver – during the night. These children also demonstrate attachment to both their biological mother and caregiver, despite their limited contact with parents. Even in these circumstances, children become attached to the person or people who consistently respond to their bids. However, compared to a group of kibbutz-reared children who slept in the family home, with access to parents at night, those who slept in the children's house showed less optimal quality in their attachment to the mother. Thus, even in caregiving contexts in which children do not have a single primary caregiver, the need for access to an attachment figure, especially during potentially stressful times, remains evident.

Individual Differences in Attachment Security

Although all typically developing infants who have an opportunity to form an attachment relationship will do so during the first year, there is some flexibility in the organization of attachment behavior. In the 1950s, Mary Ainsworth, a colleague of Bowlby, conducted extensive naturalistic longitudinal observations of infants and families in Uganda. Based on those observations, Ainsworth described great variation in how infants interacted with their caregivers. Starting even before 1 year, infants began to organize their attachment behaviors in different ways. Ainsworth continued to think about those differences, and back in the United States in the 1960s, she developed the Strange Situation Procedure (SSP), a brief, standardized laboratory paradigm to assess individual differences in the organization of attachment behavior in 12–18-month-olds. The introduction and validation of the SSP was a major advance in the study of early social development because it allowed psychologists to reliably observe, in a short period of time, the nature of the infant–caregiver relationship. The SSP involves the introduction of an unfamiliar individual and a series of brief separations from and reunions with the parent

to gradually increase distress in the infant (Table 1). Infant behaviors during the reunions indicate how the infant uses the parent to relieve distress caused by separation. In other words, how the infant organizes his or her behavior with respect to the caregiver indicates the former's expectations about the latter's willingness and ability to restore comfort and trust (Figure 3). Ainsworth's early work, in both naturalistic observations and in lab settings using the SSP, identified three categories of infant attachment. A fourth category was later identified; all four categories of attachment based on behavior in the SSP have been extensively validated.

Secure

Secure infants demonstrate an emotionally positive and trusting relationship with the caregiver in which the infant derives comfort from the caregiver's presence. For secure infants, a balance is met between attachment and exploration needs; the infant feels confident to explore and is also easily able to return to the caregiver when distressed or wary, or when the infant simply needs emotional refueling. In the SSP, the secure infant openly and confidently approaches and/or signals the parent upon reunion and thus achieves the desired proximity or contact. This contact calms the infant – both behaviorally and in terms of physiological arousal – supporting the infant's return to exploration.

Insecure-Avoidant

Insecure-avoidant infants do not seek contact or proximity during reunion with the parent. Although they may exhibit some distress during the separation, they maintain neutrality when reunited. Avoidant infants convey the appearance that they do not need the attachment figure, downplaying the importance of attachment needs, and may actually ignore the caregiver's overtures. Instead of seeking the parent, they appear to focus on exploration. Outwardly, these infants may simply seem more independent than other infants, giving the impression that perhaps little distress occurred during separation, and they therefore do not need to be comforted by the caregiver upon reunion. However, avoidant infants' physiological arousal during the separations is equal to that of other groups, suggesting that although they are experiencing distress, they defensively hide this from the caregiver.

Table 1 Episodes in the strange situation

<i>Episode</i>	<i>Events</i>	<i>Attachment behavior observed</i>
1	Researcher introduces parent and infant to playroom, and then leaves	
2	Parent is seated while infant plays	Parent as secure base
3	Stranger enters, sits, and then talks with parent	Stranger anxiety
4	Parent leaves. Stranger responds to infant, and offers comfort if infant is upset	Separation anxiety
5	Parent returns, greets infant, and offers comfort if infant is upset. Stranger leaves	Reunion behaviors
6	Parent leaves	Separation anxiety
7	Stranger enters and offers comfort	Ability to be soothed by stranger
8	Parent returns, greets infant, offers comfort if necessary, and tries to interest infant in toys	Reunion behaviors

Note: Episodes two through eight last for 3 min each, although separation episodes may be cut short if infants are extremely upset, and reunion episodes may be extended if infants need more time to calm down and return to play.

Adapted from Ainsworth MDS, Blehar M, Waters E, and Wall S (1978) *Patterns of Attachment*. Hillsdale, NJ: Erlbaum.



Figure 3 In Episode 2 of the Strange Situation Procedure (a), the infant interacts with the stranger while the mother is in the room. In Episode 5, the mother leaves the infant alone in the playroom, and we see the infant attempting to follow the mother as she is leaving the room (b). In Episode 6, although another friendly adult is in the room, the infant cannot be enticed to play with her or the toys and waits at the door for the mother (c). Finally, in Episode 7, the mother returns to the playroom and the infant signals to be picked up (d).

Insecure-Resistant

Insecure-resistant infants, on the other hand, openly exhibit anxiety about both exploration and the availability of the attachment figure. This hyperactivation of the attachment system serves to keep the infant close to the caregiver, but at the expense of exploration. These infants often become more distressed during separation than secure or avoidant infants. On reunion, infants show obvious anger and resistance to contact with the caregiver. It is characteristic of resistant infants to seek contact, but to then push away efforts to comfort. For resistant infants, the presence of the parent does not have a calming effect, and returning to exploration can be difficult.

Disorganized

A fourth group, more recently identified by Mary Main and colleagues, includes infants whose defining characteristic is that they lack a clear pattern in the organization of their attachment behavior. Disorganized infants do not integrate their behavior in a way that fits into one of the original patterns, or may show anomalous behavior within an organized pattern. These infants lack a successful strategy for resolving the distress caused by separation. This lack of strategy means that they cannot turn fully toward either the caregiver or the environment, and may thus show simultaneous or sequential contradictory behaviors, odd behaviors such as freezing or stilling in response to the caregiver's return, or disordered sequences of behavior (e.g., approaching the parent followed by dazed avoidance).

In typical, middle-class samples, a majority of children (about 60%) develop a secure attachment. However, a sizable minority of infants is classified as having an insecure attachment, either avoidant (15%), resistant (10%), or disorganized (15%). The relative distribution of these classifications differs somewhat in lower-income and clinical samples, where

there is typically a smaller proportion of secure infants. Further, although a secure attachment is normative across cultures, the distribution of the insecure categories varies. For example, compared to typical samples in the United States, infants classified as avoidant are uncommon in Israeli samples, while infants classified as resistant are uncommon in German samples. These subpopulation and cultural differences in the relative distribution of attachment classifications reflect variations in family environments, such as economic or social stressors, or cultural differences in normative socialization values and child-rearing practices.

Early Experience and Attachment Security

Ainsworth's naturalistic observations of infants and families in Uganda directed attention to caregiver sensitivity as the main source of individual differences in attachment organization. Caregiver sensitivity has been operationalized in many ways, but research across diverse social and cultural contexts confirms Ainsworth's initial observations that a secure attachment is fostered by the caregiver's accurate perception of, and prompt and appropriate response to, the infant's needs or distress. Sensitive, synchronous interactions, warmth, and support, especially as infants are developing expectations of how their caregiver will respond, predict infant security. Less sensitive and supportive care in infancy predicts insecure attachment. Caregiving that is intrusive, controlling, or hostile is linked to insecure-avoidant attachments, and caregiving that is inconsistently responsive, or unresponsive, is linked to insecure-resistant attachments. Although the way in which insecure infants organize attachment behavior does not facilitate an optimal balance between exploration and proximity, in the context of a less-supportive caregiving environment, their strategies may be adaptations that allow them to best maintain

proximity to a caregiver. For example, avoidant infants are thought to defensively hide their distress, ignore the caregiver, and turn their attention to the environment. If the caregiver has been hostile toward infant's bids for comfort in the past, infants may gradually come to understand that they can better maintain proximity to the caregiver by directing attention away from their attachment needs. Similarly, resistant infants may benefit from intensifying attachment behaviors to engage an inconsistently responsive caregiver.

Experimental intervention studies support a causal link between sensitivity and security. Multiple studies indicate that by providing support and training to improve parenting sensitivity, infant attachment security can be enhanced. Importantly, this finding generalizes to dyads in challenging ecological contexts and to infants with more difficult predispositions such as an irritable temperament. Overall, however, relations between sensitivity and security are modest (i.e., sensitivity does not explain all of the variability in attachment security), and additional predictors of security that operate independently of sensitivity, or that moderate the effects of sensitivity, should be explored.

Caregiver sensitivity is less clearly related to attachment disorganization. Rather, disorganized attachment is associated with parenting that induces fear in the infant. Disorganization is more prevalent in samples with abuse or neglect and in samples with high levels of parental depression and unresolved loss. Patterns of affective communication that result from frightened or frightening caregiver behavior (e.g., contradictory emotional cues, withdrawal) also correspond to infant disorganization.

Infant Characteristics and Attachment Security

What is the role of infant characteristics in attachment security? Early attachment researchers faced the criticism that differences in how infants respond to the SSP were simply manifestations of temperament. Proponents of temperament argued that avoidant infants are simply low in distress and relatively independent. The temperament of resistant infants, on the other hand, made them prone to high levels of distress on separation. These critics further argued that differences in temperament would impact interactions between the caregiver and the infant. However, several pieces of evidence have largely contradicted these claims. For instance, avoidant infants experience high physiological arousal during the SSP, which contradicts the notion that they are simply not distressed by the procedure. Further, avoidant infants at home tend to be fussy and show clear discomfort when separated from their caregiver. Results of interventions aimed at improving sensitivity of parents of highly irritable infants also contradict the idea that temperament determines attachment. As noted above, with sensitive caregiving, even highly irritable infants may demonstrate secure attachments. Although the precise role of temperament in attachment security is complex and not yet fully understood, there is consensus that temperament does not directly influence attachment classification.

Behavioral and molecular genetics studies continue to elucidate the role of child characteristics in attachment. Behavioral genetics research identifying the relative contributions of heredity and environment to differences in twins' attachment

classifications suggests that heredity assumes virtually no part in security of attachment. Additionally, links between sensitivity and security are not influenced by heredity. These findings are consistent with attachment theory's ethological foundations, in that inheriting fixed patterns of social behavior would negate the flexibility that infants maintain by organizing attachment behavior within a particular caregiving environment. Recent studies in molecular genetics, on the other hand, offer the conclusion that certain gene polymorphisms may make infants more prone to developing insecure attachment, particularly in the context of insensitive caregiving, or simply more receptive to caregiving influences. These studies support an emerging consensus on the critical role of gene-environment interaction in development.

Correlates and Sequelae of Early Attachment

One assumption of attachment theory is that early individual differences in security will be a source of variability in later socioemotional development. Several explanations for this have been proposed. First, IWMs are thought to contribute to enduring effects of security in the parent-child relationship. The IWM initially consists of representations of the attachment figure's availability and responsiveness. These basic representations generalize into broader ideas about the self, the attachment figure, and relationships. Further, these representations color and guide our response to new information, promoting consistency in what and how we think about self and relationships. Second, early security may be connected to later outcomes because early adjustment and behaviors support particular trajectories of personality development. For example, secure attachment facilitates exploration, and may therefore support greater autonomy in early childhood, in turn leading to better adjustment in school and in social relationships. Third, consistency in the parent-child relationship may explain outcomes associated with early security. The sensitive caregiving that initially fostered a secure attachment continues to support the child's development in other ways, either in concert with or in addition to attachment security. From this perspective, any benefits conferred by a secure attachment are contingent on continued, developmentally adapted sensitivity.

A vast body of research, some examining early correlates and others later outcomes predicted by early security, indicates that a secure attachment does indeed confer some advantages. We review a sampling of these findings with respect to relationships, emotion, and social- and self-understanding. In general, outcomes associated with a secure attachment most clearly differentiate between security and insecurity, with less consistent differences between avoidant and resistant attachment. However, disorganized attachment puts infants at the highest risk of negative developmental outcomes, including emerging psychopathology.

In infancy and early childhood, a secure attachment initiates a more affectively positive, close, and cooperative parent-child relationship. This extends also to more advanced conscience development in early childhood, perhaps a result of the desire for mutual cooperation and greater compliance. Security as a predictor of parent-child relationships beyond early childhood is less clear, and probably depends on how

caregiver behavior and dyadic processes are maintained over time. Security is also related to social competence and more positive peer relationships, especially for behavior in close friendships. Consistent with the IWM hypothesis, security also predicts more positive representations of the self in friendships. Connections between attachment and peer relationships are particularly evident in middle childhood and adolescence, as friendships take on greater developmental significance.

One function of attachment relationships is to aid infants in managing their emotional arousal, first through sensitively responding to infants' distress, and over time through fostering the expectation that the parent will be available and effective in providing support to the child. Indeed, secure infants show more adaptive strategies for emotion regulation, more adaptive displays of emotion expression, and lower physiological stress response as toddlers. Over time, secure infants become more effective in regulating their response to frustration and show lower levels of fear, anger, and distress in preschool.

Attachment security also predicts children's developing social cognition. Understanding of emotions begins to emerge during the toddler years, and attachment security is one proposed source of individual differences in early emotional understanding. The emotionally open relationship and communication of securely attached dyads supports children in understanding the causes and consequences of emotions in self and others. Security assessed in both infancy and toddlerhood predicts higher levels of understanding emotions in preschool and middle childhood. There is also growing evidence for effects of security on other areas of social cognition, such as making more positive attributions about peer behavior. Finally, security in early childhood is related to expressing a more positive and open self-concept during this period, as well as higher confidence and fewer negative self-evaluations when faced with a challenging task. In fact, security in early childhood may be especially important as children are beginning to develop ideas about their psychological characteristics.

Is Attachment Security Stable over Time?

Are secure and insecure attachments of infancy maintained into childhood, adolescence, and beyond? It is important to note that this question is complicated by shifts in how attachment is conceptualized and assessed after early childhood; we might naturally expect little consistency between a behavioral measure of attachment in infancy and a measure of attachment representations in adolescence. However, studies using the most well-validated and developmentally appropriate measures, examining stability over both short and long durations, arrive at the same conclusion. Whether the duration is a few months, or many years, sometimes attachment security remains stable and sometimes it does not. Just as security is initially forged in relationship experiences, so too may later experiences continue to alter attachment security. In fact, movement between security and insecurity is predicted by changes in the quality of caregiving that young children experience. Circumstances that alter caregiving interactions, including both inherently stressful life events (e.g., divorce, death of a family member) and nonstressful life events (e.g., job changes, birth of a new child), increase the chances of a

change in attachment security. Stressful life events, in particular, are associated with a shift toward insecurity. This effect is also apparent for children's and adolescents' own experiences. For example, adolescents who experience a major psychological stressor are more likely to decline in security over time, compared to peers who do not experience a major stressor. This capacity for change in attachment organization is positive for those who initially develop an insecure attachment. As noted above, intervention studies that increase sensitive caregiving can be effective in improving parent-child relationships. However, developmental psychologists understand less about what can move a child from insecurity to security under everyday conditions, outside of the context of therapeutic intervention. One hypothesis is that cognitive shifts in adolescence enable us to reflect on IWMs, which may provide an opportunity for change in how we think about the self and relationships.

The Attachment System in Childhood and Adolescence

The majority of attachment theory and research has focused on infancy and early childhood. Recently, though, attachment theorists have offered rich conceptualizations of parent-child attachment in light of the broader developmental changes of middle childhood and adolescence. Although many questions remain, a growing body of empirical research has begun to address the nature and correlates of attachment past early childhood. Overall, despite many changes in cognitive, behavioral, social, and regulatory capacities, connections with parents remain a major source of support across middle childhood and adolescence. The manifestation of those relationships does, however, shift to accommodate new capacities and new goals.

Middle Childhood

Middle childhood brings a decline in the frequency and intensity of attachment behavior. Greater experience and personal resources, improved cognitive understanding of time and context, and reductions in physiological arousal mean that children in this period experience less attachment distress. Additionally, children begin to take on a more active role in monitoring their own behavior and maintaining proximity to their caregiver. The experiences that a young child finds threatening (e.g., a short physical separation from the parent, or a skinned knee) may not threaten an older child; conditions requiring support are likely to be psychological threats (e.g., a fight with a friend). The nature of contact that children now seek for support may also change, with a warm supportive conversation taking the place of physical comfort. With the cognitive advances in middle childhood, the attachment relationship also becomes more internalized. Children can now easily wait to contact parents; for example, if distress occurs while the child is in school, the child can wait until they are home to communicate with the parent. This means that attachment becomes much more difficult to observe in middle childhood. Because clear physical returns to the parent are not always evident, and relational strategies become much more elaborate and sophisticated, the potential variety of behaviors that will satisfy the child's goals is much greater. Middle childhood might

be considered a transition between the relative dependency of early childhood and the autonomy typically emerging in adolescence. The parent–child attachment relationship remains central, but during middle childhood, new close relationships are developing. These ‘affective bonds’ may share some of the functions of an attachment relationship (e.g., a child may feel more comfortable with a close friend in class) but do not yet serve all of the functions of an attachment relationship.

Adolescence

Adolescence is a period of even greater transition. As adolescents prepare for adult life, it is normative and developmentally appropriate to seek and achieve greater autonomy from parents. In this process of negotiating autonomy, balancing attachment needs and exploration is still a key developmental issue. The normative transitions of adolescence (e.g., autonomy seeking, identity exploration) may themselves activate the attachment system. Exploration may be more extensive and pressing, but most adolescents still turn to parents when they are distressed. In fact, a secure parent–child relationship in adolescence may best support developing autonomy while allowing the adolescent to maintain a close connection to the parent. As adolescents become more capable of abstract and reflective thought, and taking a more sophisticated perspective, reflection on the self and relationships adds a new dimension to the IWM. Secure behavior with parents may take the form of open, full, dyadic communication, while insecure behavior may be more closed or conflictual. Adolescents’ close relationships with friends and romantic partners become new sources of intimacy and support. More than in middle childhood, these relationships in adolescence start to take on some attachment functions, and friendship quality in adolescence may facilitate relational patterns that continue into early adulthood. However, it is clear that the parent–child relationship continues to play a unique role throughout adolescent development, with psychological functioning during early adulthood reflecting the quality of parent–child relationships during adolescence.

See also: Evolutionary Developmental Psychology; Parenting; Socioemotional Development.

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Social Exchange

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Glossary

Dependence Dependence is determined by the extent to which an actor values the resources (or services) to be obtained in an exchange relation and the degree to which such resources (or services) are available from alternative sources.

Direct exchange When two actors engage in the mutual exchange of benefits.

Indirect exchange When actors are connected only through their exchange ties with other parties (typically called 'third' parties).

Power The potential of one actor to obtain favorable outcomes from another actor despite resistance, which is determined by relative dependence.

Social exchange This involves the more or less rewarding or costly exchange of resources or services between two or more parties.

Uncertainty The extent to which an outcome is unknown.

Social exchange theory is one of the major approaches to the study of social interaction within sociology. It conceptualizes interaction in terms of what the actors involved obtain from one another that they value, either in the form of resources or services. Research on social exchange is primarily concerned with the more or less enduring relationships that develop over time and the social structures created by these interactions. Some are short term, almost market-like exchanges. Others are long-term exchange relationships that extend over time and often grow to encapsulate a varied range of behaviors and resources. Such interactions can be embedded in groups or in networks and the actors involved can be individuals, groups, organizations, or even larger entities that engage in exchange most often through agents or other forms of representation.

The social exchange perspective on social interaction has its origins in several disciplines, but most notably sociology. Contributions to this theoretical orientation also come from psychology and anthropology. *The Social Psychology of Groups* (1959), written by John Thibaut and Harold Kelley, introduced to the field of social psychology a number of concepts and principles consistent with the parallel development of social exchange theory within sociology. In particular, their notions of behavioral interdependence, fate and behavior control, and their matrix analyses of the outcomes of linked behavioral processes were influential in future developments within this tradition. B.F. Skinner, the well-known proponent of behaviorism in psychology, also had a major influence on the early formulation of exchange theory through his friendship with and impact on the work of George C. Homans, his colleague at Harvard. Behaviorism subsequently influenced the early work of Richard M. Emerson and later the research program of Linda Molm.

Anthropologists were also influential in the development of social exchange theory through the writings of Claude Lévi-Strauss, Bronislaw Malinowski, and Marcel Mauss, among others. Early research in economic anthropology, cultural anthropology, and other subfields also contributed to the development of the study of social exchange and later work on exchange networks, reciprocity, and gift-giving. Carrier and

Carrier conducted important fieldwork in New Guinea examining the linkages between informal, culturally embedded forms of social exchange and the imposition of more formal, market-based systems of exchange. Economic transitions in various parts of the globe continue to provide fruitful venues for the study of exchange systems and the cultural and political factors that determine the nature of the transition and its economic and social effects.

Within sociology George Homans, Peter Blau, and Richard Emerson are widely viewed as the pioneers in the development of what has come to be known as social exchange theory. Homans' work derived from his interest in what he called 'elementary' or subinstitutional social behavior and his approach was developed during the heyday of Talcott Parsons' influential writings about social systems and institutional theory. To some extent, Homans' theoretical orientation was constructed as a counterpoint to the more macro-level theorizing of his colleague, Parsons. In this sense Homans was much more influenced by B.F. Skinner than by Parsons. For Homans social behavior was the bedrock of sociological theory and he argued that such behavior could be understood by examining the basic principles of human behavior that had been developed within psychology and codified in propositions derived from the work on behaviorism. This approach was criticized extensively as reductionist. For Homans the primary focus was the social behavior that emerged over time as a result of the mutual interdependence of two parties involved in direct, dyadic exchange.

Peter Blau wrote the influential book, *Exchange and Power in Social Life*, in 1964. This volume represents his major contribution to the development of the social exchange perspective in sociology and in it Blau attempts to address some of the limitations of Homans' approach, most notably, the effort to embrace reductionism. For Blau exchange theory provided a vehicle for the development of a microsociological perspective that served as a foundation for the analysis of macro-level social processes and social structures. He considered social exchange to be the "prototype of a social phenomenon and thus an elemental process or particle of social life well suited for sociological inquiry" (Blau, 1986: viii). Later he argued that

microsociological analysis and macrosociological phenomena could be bridged by various approaches indicating that social exchange processes were only one such source of the 'linkages' between levels of analysis. He decoupled these levels in his 1986 revised introduction to his path-breaking book on social exchange and power, though he spelled out a number of ways in which work at each level can be complementary or used to supplement analysis at each level.

Richard Emerson's work on social exchange theory was influenced by the work of both George Homans and Peter Blau, though his power-dependence formulation, which preceded his work on exchange, was influential in Blau's analysis of power. Emerson came to exchange theory after developing power-dependence theory in two publications that have become citation classics. In a sense Emerson's main contribution to social exchange theory derives from his unique approach to the study of power articulated in these companion papers. He developed what is known as *power-dependence* theory as an approach to the analysis of power relations that did not ask 'who' has power, but rather what is entailed in *relations* of power. His approach is now one of the standard ways in which power is understood in the social sciences today.

Briefly, power-dependence theory proposes that power is a function of a social relationship in which one actor's power is directly proportional to another actor's dependence forming a dyadic conception of a power relationship between two actors. In his 1962 piece Emerson defines power in terms of dependence. It is the potential of one actor to obtain favorable outcomes from exchange with another actor. Dependence is based on the extent to which an actor values the resources (or services) to be obtained and the degree to which such resources (or services) are available from alternative sources. The main postulate of power-dependence theory is that the power of one actor A over another actor B is equal to the dependence of actor B on A for resources of value, represented symbolically as $P_{AB} = D_{BA}$. Thus, as the dependence of actor B on A increases so does the power of actor A over B for valued resources. A reduction in dependence either through alteration in the value of what is obtained or as a result of gaining access to other sources (i.e., an increase in availability) reduces dependence and thus power inequality.

A key part of Emerson's formulation is the discussion of the ways in which power balance can be achieved in relationships and networks with power differentials (i.e., inequalities in the distribution of power across actors or positions within an exchange network). Derived from his theory of power-dependence relations, Emerson argues that power can be balanced in one of four ways. In a power-imbalanced dyadic exchange represented as (Ax:By) in which actor A with resource x has power over another actor B with resource y, power balance can be achieved if B reduces the extent to which he values the resource (x) that he receives from A in exchange for (y), or B attempts to increase the value of the resource (y) that he supplies to actor A by 'status-giving' adding some form of approval in an effort to increase the value of what he offers. These two mechanisms are referred to respectively as 'withdrawal' or value reduction and 'status-giving.'

Two additional mechanisms have implications for the network in which the dyadic exchange relation is embedded. Power can be balanced through coalition formation in which

actor B (the less powerful) locates another actor in the network with which he forms a coalition to reduce the availability of resource y to actor A by agreement. Power balance can also be altered in the Ax:By exchange relation if actor B locates another source of the resource(s) he values which typically results in network extension. In the years after Emerson's formulation was published there have been few direct investigations of these four power-balancing mechanisms (with notable exceptions such as Cook and Gillmore, 1984; Gillmore, 1987, etc.).

One of the major extensions of exchange theory was Emerson's effort to expand the theory to include connected dyadic exchange relations that form networks of exchange. Homans had focused primarily on dyads and groups of actors engaged in dyadic exchange. Blau moved beyond the dyad to groups and larger associations by expanding the size of the group in which the actors were embedded, but he did not focus on networks of actors engaged in exchange (an element of exchange theory that has become highly significant in the current decade in which there are multiple forms of computer-mediated network exchange). Emerson's approach to extending dyadic conceptions of exchange (including his own formulation of dyadic power-dependence relations) was to treat networks as connected sets of dyadic exchange relations. First, he formalized a conception of connections as positive and negative focusing on the ways in which exchange relations determine the nature of the flow of resources of value within larger networks. Later he formalized a more structural conception of power within such networks of actors connected through processes of social exchange. This formulation was developed further by Cook and Yamagishi.

For Emerson networks were composed of sets of exchange relations between actors connected in various ways that significantly determine not only the locus of power in such networks, but also the potential for coalitions to form and the nature of the flow of resources (or lack of it) between actors connected in various ways. In particular, he defined two primary types of connection between exchange relations: *positive* and *negative*. A positive connection between two exchange relations is one in which exchange in one relation facilitates or increases the rate or frequency of exchange in the other. For example, if exchange in the A-B relation increases the amount of exchange in the A-C relationship the two relations are positively connected at position A in the three-party exchange network including actors A, B, and C. If A obtains something of value from B that she can use in exchange with C the relationship is positive. If, on the other hand, obtaining a resource from B makes it less likely that she will need it from C, the relationship is negatively connected at position A. That is, the connection between exchange relations A-B and A-C is negative if exchange in the A-B relation reduces the rate, frequency or amount of exchange in the A-C relation. An empirical example, easily understood, is a dating network in which B and C compete for A's attention. Of course, there are many networks in which such connections are mixed and actors have relations of each type with a variety of other actors.

Subsequent work with Cook, Gillmore, and Yamagishi extended Emerson's formulation to apply to exchange networks and facilitated determination of the locus of power within networks of connected exchange relations. Cook and Emerson, for example, conducted experimental investigations

of several types of exchange networks that varied in size and in degree of power differentiation between the actors in the network. In addition, subsequently they varied the nature of the exchange connections, comparing networks that were positively connected with those that were negatively connected. In this empirical work based on a program of laboratory research they were able to demonstrate that changing the nature of the connections in the network fundamentally altered the distribution and the locus of power within the network. A simple finding was that positional centrality in the network (typically a five-actor network) was correlated with higher power only in the positively connected network, but not in the negatively connected network in which central actors lost power as a result of competition with other alternative sources of the resources of value for those they were connected to. Other network variants were investigated as well and this work led to a plethora of studies on the determinants of power in social exchange networks (often also referred to as *network exchange* by Willer) and several related research programs on power, network dynamics, and commitment between exchange partners. We comment briefly on some of these related research programs before identifying current research emphases within this tradition and potential future theoretical and empirical developments.

Exchange Networks and Power

The work of Emerson, Cook, and their colleagues from the 1970s through the 1990s focused primarily on the structural determinants of the distribution of power in various types of exchange networks and the dynamics of power use, including coalitions, which often altered the power balance within a network, and commitment formation (akin to coalition formation) between exchange partners as a response to uncertainty and risk in the environment for exchange. A separate major research effort building on the early work of Willer and Markovsky provides an extensive treatment of the network determinants of power. This research, while referred to as network exchange theory, originally derives from what Willer refers to as 'elementary theory,' a broader treatment of types of social interaction in which exchange is only one form. Others include coercion and conflict relations, as examples in which exchange is not typically at issue. One of the most focused subprograms in this research effort involved the extensive study of networks and a typology of connections that differed to some extent from the work of Richard Emerson and his collaborators.

The book edited by Willer, entitled *Network Exchange Theory*, is the fullest treatment of this alternative to the power-dependence formulation and exchange network theory developed by Emerson, Cook, and their collaborators. While there are some misrepresentations concerning the development and character of social exchange theory in sociology and failure to distinguish between versions of the theory developed by Blau, Homans, and Emerson, the book does provide extensive treatment of 'elementary theory' in which coercive relations, exchange relations, and conflict relations are investigated. The bulk of the volume, however, focuses on exchange relations, the structural determinants of power in a variety of networks

connected in different ways (exclusive, inclusive, null, etc.), and linkages between this approach and several other theories, especially the status theories developed by Berger et al.

One of the useful distinctions introduced by Willer and his collaborators was identification of 'weak' versus 'strong' power structures, a distinction that differentiates the type of power at stake under varying network conditions in which actors have different degrees of dependence on one another as determined primarily by the nature of the connections and the structure of the network. A key factor in determination of strength of the power at stake in a network is the extent to which actors are differentially likely to be excluded or required to be included in the exchanges among the actors connected by exchange relations in the network. A typical monopoly structure in which all actors are connected to the same actor as their only alternative is a strong power structure. In such a network power-disadvantaged actors, those in competition for the resources of value, can easily be excluded from exchange, while the monopolist (and sole provider of the resources the competitors value) must be included to provide those resources if any exchange is to occur. In such structures the exclusion principle from elementary theory and the power-dependence principle in Emerson's exchange theory make similar predictions concerning the distribution (and locus) of power in the network. The monopoly structure is maximally negatively connected to use Emerson's terminology. Weak power structures are those in which there is less competition for resources and in which there is greater inclusion required of the actors in the network for exchanges to be consummated. In Emerson's terms such networks tend to be more positively connected.

While Willer and his collaborators have produced one of the most extensive treatments of network power, several other investigators have developed useful approaches that bring in other factors not included in the formulations of Emerson, Cook, and their colleagues or Willer and his team of researchers. Two of the main contributions in this category come from Phillip Bonacich and his former student, Elisa Bienenstock, and Noah Friedkin, separately. Bienenstock and Bonacich focus on game theoretic conceptions of relations of interdependence in networks of exchange, treating exchange as a form of coalition. They produce a formula for the determination of power differences based on the concept of the 'core' and measure power as a function of the strength of the coalitions required to consummate exchange.

In contrast, Noah Friedkin takes a different approach and identifies a method for calculating the distribution of power in a network of connected exchange relations by including a more complete determination of the frequencies of exchange and their effects on the outcomes of exchange (especially the distribution of profits from exchange). He was also among the first in the exchange tradition to explicitly treat differential values in connected exchange relations and their effects on power distributions in networks of exchange. Subsequently, Molm and some of her former students have addressed this same issue.

Types of Exchange

Before specifying the major types of exchange that have been investigated we provide the underlying assumptions that underpin predictions about behavior in exchange structures. Molm

and Cook specify four key assumptions that are shared by most current variants of the theory (with the exception of the research based on elementary theory). They include: (1) Actors are motivated to increase rewarding outcomes and to avoid loss. (2) Exchange structures emerge as a result of the actors' mutual dependence on one another for valued resources. Without mutual dependence there would be no need for exchange; that is, both parties must have some reason to engage in exchange. (3) Actors engage in mutually contingent exchanges with their partners over time in a series of interactions (i.e., the theory focuses on relations that emerge over time). Finally, (4) the resources exchanged obey the law of diminishing marginal utility such that each additional unit of a valued resource is of less value to the individual, once they are 'satiated.' These behavioral assumptions derive from earlier theoretical work of Homans, Blau, and Emerson.

The earliest work on exchange focused primarily on two forms of exchange, *direct* two-party exchange, and *indirect* exchange in which parties are connected through a third party. For both Homans and Blau these were the main types of exchange under consideration. Emerson expanded his treatment of forms of exchange to deal not only with direct, dyadic exchange, but also indirect forms of exchange (e.g., generalized exchange) and what he termed productive exchange. In subsequent work, primarily the research program developed by Molm, two major forms of direct dyadic exchange were distinguished: negotiated and reciprocal exchange, which differ in the nature of the social process involved in the exchange relation. Anthropologist Ekeh also writes about the nature of the underlying differences between types of exchange (e.g., restricted vs. generalized exchange) though his discussion is generally more polemical than empirical.

The key distinctions are between direct and indirect exchange and between negotiated and reciprocal exchange. Direct exchange connects two actors in mutual exchange (which may or may not be asymmetrical in terms of power). Indirect exchange connects actors through their mutual ties with another party or parties (typically called 'third' parties). These could be considered second-order exchange connections. Two employees in an organizational unit may thus be connected through their mutual employment and supervision by a third party, perhaps a boss. Indirect ties may lead to the formation of direct ties over time as when two employees connected through mutual employment by a third party meet and form their own direct exchange relation in which they may exchange relevant information or assistance. Such forms of exchange were the cornerstone of Blau's initial interest in the analysis of exchange relations in organizations.

The second distinction which Molm's work has made prominent focuses on the social process involved in the exchange. Many direct exchanges are negotiated and the two parties to the exchange actually negotiate over the terms of trade or the exchange of resources/services of value. The transaction is consummated when an agreement between the two parties is reached. This form of exchange is common in economics as well as in social exchange and necessitates mutual agreement for completion. Often such exchanges are enshrined in contracts to minimize risk, when there is much at stake, though in many circumstances a handshake is sufficient.

But many exchanges occur without explicit bargaining or negotiation. These exchanges are referred to by Molm as

reciprocal exchange relations and they most often entail the mutual performance of services (or transmission of resources) of value over time, such that one actor initially performs a behavior of value that then is reciprocated at a later time by the recipient to create a two-party 'transaction' in which the terms of trade are not negotiated, but are implicit in the act of reciprocity. They often involve greater risk of nonreciprocity since one does not know when an exchange is initiated whether it will be reciprocated. Examples include the reciprocal exchange of gifts, dinner party invitations, or even taking turns baby-sitting, mowing lawns, or other acts of service that carry an implicit obligation of return. Failure to return the favor, gift, or service would be viewed as a violation of the norm of reciprocity, which both Blau and Emerson viewed as the hallmark of social exchange. (In fact for Emerson it was a defining characteristic of exchange, thus he did not treat it as theoretically problematic.) For Molm and for Blau this type of reciprocal exchange is distinctive of social exchange in general and is viewed as a key factor differentiating this form of exchange from negotiated forms of exchange.

In the research on power in exchange networks Molm has provided the most extensive empirical work comparing negotiated and reciprocal exchange. In studies of the differences in power use in these two types of exchange Molm demonstrates that power use is more muted in reciprocal than in negotiated exchange. The salience of conflict is stronger in negotiated than in reciprocal exchange. In addition, reciprocal acts of exchange (which are not explicitly negotiated) provide a stronger signal of trustworthiness and relational intent referred to as affective regard, in part because they carry a higher risk of nonreciprocity. Because of the inherent risk in reciprocal exchange, actors are more likely to attribute a partner's positive behaviors to personal traits and intentions, which results in the emergence of stronger positive feelings and affective commitment in reciprocal exchange than in negotiated exchange. Given that the terms of the exchange are agreed on during negotiations there is little uncertainty about reciprocity and less room for the individuals involved to gain information about their partner's trustworthiness. Attributions are thus more likely to be situational than personal in negotiated exchange.

Solidarity

Although Emerson had written about cohesion in exchange networks it was not a major focus of his empirical work. Edward Lawler and his colleagues subsequently initiated a research program that addressed cohesion, relational commitment, affective regard, and emotions culminating in the recent publication of a book that extends this line of work. Lawler and Yoon first developed a theory of relational commitment arguing that positive and frequent exchange leads to positive emotions and commitment to the relationship between the actors engaged in such exchange. Building on this basis Lawler and his collaborators extended the theory to group and organizational commitment and cohesion, investigating the conditions under which positive exchange leads to greater unit-level commitment (to either the dyad, group, or organization in which they are embedded). Different types of exchange produce varying levels of positive outcomes, and have differing levels of

joint-action (those forms of exchange that involve multiple actors to contribute in order for all actors to profit). The greater the mutual dependence of the actors involved based on the need for joint action, the more likely actors are to feel solidarity with and commitment to their exchange partners. In addition, joint activities create positive emotions, which affirm and make salient social ties, further reinforcing solidarity. Given this reasoning they predict (and find) that productive exchange produces greater solidarity and commitment (as well as positive affect) than negotiated or reciprocal exchange.

Molm and her colleagues argue that not only do negotiated and reciprocal exchange vary in terms of the risk of nonreciprocity, but they also vary in the salience of conflict and the expressive value attached to acts of reciprocity. While reciprocal exchange presents a higher risk of nonreciprocity, it is lower in salience of conflict and higher in expressive value of reciprocity than negotiated exchange. Because of these differences reciprocal exchange should produce higher levels of solidarity than negotiated exchange, which contrasts to some extent with Lawler's approach since in his view negotiated exchange involves greater perception of joint action than does reciprocal exchange and thus should yield higher cohesion.

Trust

A topic that has more recently been the focus of empirical work in the exchange tradition is work on relational trust. Cook et al. treat trust as a form of 'encapsulated interest' in which one party A trusts another party B with respect to a particular domain (i.e., A trusts B with respect to x). In this formulation the key factor is the assessment of B's trustworthiness which can be based on the extent to which A believes B cares about her reputation and/or wants to maintain a relationship with A. In exchange theory terms A may come to trust B in an exchange relationship as B demonstrates her trustworthiness in terms of competence as well as integrity and benevolence (the dimensions often differentiated in trustworthiness judgments).

Blau argued that trust in an exchange relationship might emerge over time by first taking small risks and then larger ones as the relationship develops and both partners are able to demonstrate their commitment to be trustworthy with respect to one another. This type of incremental risk taking as the basis for building trust has been explored empirically in a number of studies in experimental economics as well as in social psychology. An important article on exchange relations published by Peter Kollock noted the effect of uncertainty in exchange on the emergence of trust and commitment especially when there was risk involved and trustworthiness mattered with respect to the quality of the goods being exchanged. In his experimental setting buyers and sellers either could assess the quality of the goods being exchanged or not (in a comparison of experimental conditions that have come to be referred to as 'rice' vs. 'rubber' markets in which quality either can or cannot be easily assessed). His results clearly indicate that commitment and trust are higher under conditions of uncertainty.

Molm and her colleagues have examined how the risk associated with different types of exchange (negotiated and reciprocal exchange) affects perceptions of trust. They argue that trust should be higher in reciprocal exchange compared

to negotiated exchange, precisely because the fear of exploitation should be stronger in reciprocal exchange. When the risk of nonreciprocity exists, the act of reciprocity provides a signal of the partner's trustworthiness, thus allowing trust to build over repeated acts of reciprocity.

While the majority of studies on exchange have focused on direct exchange, more recently there has been renewed interest in generalized exchange. One of the earliest descriptions of generalized exchange is Malinowski's account of the Kula Ring of the Trobriand Islanders. Additional accounts of real-life generalized exchange are included in Bearman's analysis of the exchange of women in a 1940s aboriginal population. Yamagishi and Cook first experimentally compared two types of generalized exchange and found that network-generalized exchange promoted higher levels of cooperation than did group-generalized exchange in which the risk of free-riding was higher. They also found that the emergence of mutual trust promoted increased levels of exchange. This effect was stronger in network-generalized exchange.

In addition, Molm and her colleagues and Lawler and his colleagues (2008) have begun to include generalized exchange in their empirical comparisons of types of exchange. In a recent study Molm et al. find that network-generalized exchange produces higher levels of solidarity, perceived trust and affect than either reciprocal or negotiated exchange. They argue that it is primarily the indirect reciprocity, typified by network-generalized exchange, that produces stronger feelings of attachment and solidarity, though it is clear that such systems of generalized exchange are not easy to maintain, especially with larger groups of actors. Lawler and his colleagues (2008) compare four types of exchange: negotiated, reciprocal, productive, and generalized exchange. Their results support Lawler's affect theory of social exchange, in which productive exchange creates the strongest feelings of affect, solidarity, and cohesion, followed by negotiated exchange, then reciprocal exchange, and finally generalized exchange which creates the weakest bonds of attachment between the individuals involved in exchange. Further investigation of the fundamental differences among the various types of exchange as well as the emergence of trust in networks of exchange will certainly be significant in the development of applications of exchange theory to the world of online exchange systems. We comment on the potential for such developments in our concluding section.

Future Directions

During the past three decades there has been a great deal of theoretical and empirical development in the study of exchange relations and exchange networks, the two main parts of Emerson's original formulation. Progress has been made in the analysis of power in dyadic exchanges as well as in networks of connected exchange relations in which position in the network, access to resources of value, and the strategic use of power afforded by position are now much better understood than in the era in which Homans, Blau, and Emerson first proposed this approach to the study of social interaction and social structure. In addition, a number of topics that were only mentioned in the early work have been developed further with the formulation of a range of theoretical extensions and new

'middle range' theories of related phenomena using a basic exchange framework. Such topics include social cohesion, relational commitment, solidarity, trust, coercive power use, and how these differ across various types of exchange (from direct dyadic exchange to productive exchange and generalized exchange characterized by univocal reciprocity). What is not yet fully developed is the study of power dynamics and network change as a result of the use of the power-balancing mechanisms first proposed by Emerson and other endogenous processes that occur within exchange networks. Three promising developments in this respect can be noted.

First, there is an increasing number of simulation studies that help us understand the impact of various factors such as network size, density and range (not to mention more complex forms of connection) that cannot easily be studied experimentally or in the 'real' world. Second is the increasing use of exchange theories to analyze systems of exchange that have emerged online and are facilitated by very large networks of suppliers and consumers (such as eBay and many other companies in addition to personal network sites). In particular, the study of generalized exchange systems in which typically anonymous individuals contribute to the development of public (or semipublic) goods for the benefit of group members or those connected to the network. Finally, related to these developments is the growing use of agent-based modeling in the social sciences, which may well have important applications for the study of exchange networks and processes. Progress along this latter path will aid in the investigation of more complex networks than can be studied in the laboratory, but may also advance our capacity to model the affective, cognitive, and behavioral aspects of the actors engaged in exchange and modeled fairly simply in the earliest theories of exchange. (An exception is Molm's effort to imbue the actor in the typical exchange theoretic model with loss and risk aversion in addition to the orientation to maximize gain.)

Other promising developments include the recent growth in techniques for analyzing complex networks, some emanating from what has been called the 'new' science of networks. The merging of these techniques with exchange theories of interaction and social structure and structural change may yield further insights into rapidly growing networked forms of interaction. We need better theories of action, interaction, and structure as well as techniques for taming the large amounts of data that are being generated concerning the nature of these network connections and the types of services and goods being increasingly transacted on a global scale.

See also: Behavioral Economics; Group Dynamics; Negotiation; Uncertainty.

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Social Loafing (and Facilitation)

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Glossary

Coactive task A task in which people work individually in the presence of others who are working on the same task.

Collective task A task in which people work individually and combine their inputs with those of others into a single group product or total.

Köhler effect A tendency for individuals to work harder collectively than individually when they are working with teammates who are moderately, but not dramatically, stronger or better able to perform the task.

Social compensation A tendency for individuals to work harder collectively than individually when they expect their teammates to perform poorly on a meaningful or important task.

Social dilemmas Situations in which behaviors that are beneficial to individuals are detrimental to the group as a whole when many individuals choose to engage in those behaviors.

Social facilitation A tendency for the presence of other people to enhance an individual's performance on a simple or well-learned tasks but to reduce it on complex or unfamiliar tasks.

Social inhibition Situations in which the presence of other people can inhibit behaviors that individuals would otherwise engage in.

Social loafing A tendency for individuals to expend less effort when working on a collective task than when working on an individual task or a coactive task.

People often work on various tasks individually while in the presence of other people. Indeed, much of the world's work is accomplished by groups of individuals who must combine their efforts into a collective product or outcome of some form. Moreover, even when individuals do work alone, it is not uncommon for this work to take place in the presence of either observers or other individuals who are also working on their own individual tasks. Thus, it is important to consider the role that social factors play in motivation. A large body of research on the phenomena of social loafing and social facilitation has documented that the presence of other people can have a significant influence on individual motivation and performance, and that this influence depends on the type of work being done and the type of other people who are present. Social loafing refers to a tendency for individuals to expend less effort when working on a collective task than when working on an individual task or a coactive task. On a collective task, people work individually and combine their inputs with those of others into a single group product or total. On a coactive task, people work individually in the presence of others who are working on the same task, but their inputs are evaluated individually and are not combined into a group product or total. Thus, research on social loafing focuses on group or collective task environments and suggests that individuals often reduce their efforts and slack off when working with others on group tasks.

Social facilitation refers to a tendency for the presence of other people to enhance an individual's performance on simple or well-learned tasks but to reduce it on complex or unfamiliar tasks. In social facilitation research, the other people present are coactors or observers rather than coworkers or teammates. A variety of mechanisms have been proposed for social facilitation. However, several prominent explanations follow the general logic that the presence of other people enhances drive (or some other aspect of motivational potential such as arousal, evaluation apprehension, or distraction) that

makes dominant responses more likely or frequent. Therefore, when other people are present as coactors or observers, performance is enhanced on simple or well-learned tasks where the dominant response is likely to be correct, but performance is reduced on complex or unfamiliar tasks where the dominant response is likely to be inefficient or in error. Social facilitation research thus considers the effects that the presence of others as coactors or observers has on individual performance, whereas social loafing research considers the effects that working on a collective task has on individual motivation.

Social Loafing

Historical Background

Although the bulk of social loafing research has been conducted within the last 30 years, it has a long and varied research tradition. In the 1880s, a French agricultural engineer named Max Ringelmann developed an interest in the efficient use of human and animal energy, as well as machinery, for performing various agricultural tasks. In what may constitute some of the first attempts at controlled experimentation in social psychology, Ringelmann asked male volunteers in groups of varying sizes to pull on a rope, tug-of-war style, as hard as possible. He used a strain gauge to measure the total pulling force. The results showed that as the size of the group increased, the total pulling force exerted was increasingly less than would have been expected by simply adding up the individual performances. The two most likely explanations for these results were coordination loss and motivation loss. Namely, the individuals may have had difficulty coordinating their efforts effectively, maybe adjusting their grip or angle while others were pulling. Alternately, they may have suffered a loss in motivation and reduced their efforts in larger groups.

It was not until the 1970s that studies finally attempted to experimentally separate motivation loss from coordination

loss. An especially influential study by Latané and colleagues cleverly isolated these two mechanisms and was responsible, in part, for stimulating a wealth of later research on motivation losses in groups. Male college students in a study depicted as examining the sensory sound dynamics of crowds were asked to shout and clap as loudly as possible, both individually and with others. The participants wore blindfolds and wore headphones that played masking noise so that they could not identify who was shouting with them on specific trials. On some of the trials, students shouted with others in actual groups, whereas on other trials they shouted in pseudo groups where they believed they were shouting with others but were actually shouting alone. Effort reductions were still evident on the pseudo-group trials, showing that a significant portion of the reduced performance in groups was due to motivation loss, as distinct from coordination loss. Latané and colleagues also coined the term 'social loafing' as a label for this individual motivation loss on collective tasks.

Current Status

To date, more than 100 studies have examined social loafing. Although most of the studies have been laboratory experiments, a number of field studies have also examined social loafing within groups or teams in a variety of settings, including sports teams, classroom project groups, and organizational work teams. Social loafing has been found on a variety of tasks, including work-related tasks, physical tasks, cognitive tasks, and evaluative tasks. The tasks studied have included rope pulling, shouting, swimming, running in a relay race, generating ideas, writing songs, navigating computer mazes, typing, selecting job candidates, identifying stimuli on a computer screen, evaluating poems and essays, working on group papers, and performing organizational tasks.

Although social loafing has been documented in the vast majority of empirical studies, a number of moderating variables have also been established. Specifically, a number of studies have shown that social loafing can be reduced or eliminated by increasing the degree to which group members' individual inputs can be identified and evaluated, enhancing the meaningfulness or personal relevance of the task, making individual inputs unique and less redundant with those of other group members, reducing group size, using incentive rewards or punishments, strengthening the cohesiveness of the group, strengthening individual members' identification with the group, and providing comparisons with competing groups.

A 1993 meta-analysis by Karau and Williams concluded that the available research evidence shows that social loafing is a fairly robust phenomenon that is moderate in magnitude and comparable in size to a number of prominent social psychological phenomena. That same meta-analysis also documented that the magnitude of the effect was smaller (but still significantly different from zero) among women than among men. The magnitude of the effect was also smaller (albeit still significant) for participants in Eastern countries such as Japan and China than for participants in Western countries such as the United States or Canada. However, only a limited number of studies have been conducted outside the United States and Canada, so additional research is needed before strong conclusions can be drawn regarding culture.

Prominent Theories

A number of scholars have advanced theories of social loafing. Four perspectives have been especially influential in the literature. First, Latané's social impact theory posits that people serve as either sources or targets of social impact (or social influence), and that the amount of social impact experienced in any social situation is a function of the strength, immediacy (i.e., physical or psychological distance), and number of sources and targets present. Thus, when individuals are working alone or coactively, the social impact of an outside source of influence (such as a manager or experimenter) is relatively strong because it is experienced directly by the individual. However, when working collectively with other group members, the social impact of a manager or experimenter is substantially reduced, because it is diffused across all group members. Social impact theory predicts that the division of social impact should follow an inverse power function such that impact decreases marginally with increases in group size. In a related viewpoint that adopts the central tenets of social impact theory, Jackson and Williams proposed an arousal reduction viewpoint in which the presence of other group members serves to reduce an individual's arousal level because these others serve as cotargets of outside social impact. Thus, individuals relax and reduce their efforts in the presence of coworkers. This viewpoint is consistent with studies in which people have chosen to wait with other people rather than alone when they expected to face a fearful situation.

Second, a number of scholars have used the concept of evaluation to explain social loafing. This perspective posits that individuals are motivated to work harder when their inputs can be evaluated, and that social loafing therefore occurs because it is typically much easier to evaluate individuals' efforts when they are working coactively rather than collectively. Specifically, individual inputs are readily identifiable when they are working on coactive tasks. On collective tasks, however, the contribution levels of each group member are masked by combining individual inputs into a group score or total.

Third, dispensability explanations suggest that individuals often do not contribute fully to collective tasks because they feel that their efforts are dispensable or unnecessary in order for the group to succeed. In a number of studies, Kerr and colleagues have found that individuals tend to free ride on the efforts of others when the group works on tasks with a disjunctive rule in which the group succeeds if any single group member succeeds in reaching a preestablished criterion. In some of these studies, these motivation losses have occurred even when each individual's performance can be easily identified by both themselves and by his or her coworker, documenting that the potential for evaluation is not always sufficient to reduce or eliminate social loafing.

Fourth, several scholars have used expectancy-value models to understand social loafing. Those models propose that individuals are most willing to work hard on tasks for which they believe their efforts will be instrumental in leading to outcomes that they personally value. These outcomes can be external and fairly tangible (such as in the case of pay or physical rewards) or internal and rather perceptual or subjective (such as feelings of achievement, enjoyment, positive self-evaluation, or belonging). This perspective suggests that social loafing

occurs because there are often potent barriers to perceived linkages between one's effort and one's outcomes when working on collective tasks, whereas fewer such barriers are typically present when working on coactive tasks. For example, when working collectively, the group's performance is determined not just by one's own efforts but by those of the other group members. Similarly, rewards will typically be distributed (perhaps unfairly) across group members rather than made available immediately and directly to the individual.

Research has provided strong evidence supporting each of these four perspectives and it appears that each viewpoint is valuable for understanding at least some of the key aspects of motivation losses. Social impact theory appears to nicely account for group size effects and to offer some tantalizing, and so far mostly untested, hypotheses regarding the strength and immediacy of influence sources. A large number of studies support the central premise of the evaluation perspective, although social loafing has also been documented in some situations where individual inputs to the collective task can be identified, in a manner consistent with the dispensability perspective. The expectancy-value perspective has been very influential in recent years, and shows some potential as an integrative viewpoint.

Motivation Gains in Groups

Most research examining individuals' motivation levels on collective tasks has focused on social loafing, as well as on moderators of social loafing. Thus, most work has focused on motivation losses in groups and on strategies for reducing or preventing these motivation losses. However, in recent years, a number of studies have started to examine the potential for motivation gains in groups. These studies have sought to identify conditions under which individuals might actually work harder on collective tasks than on individual or coactive tasks. Although several possibilities have been identified in individual studies, only two types of motivation gains – social compensation and the Köhler effect – have been submitted to detailed empirical examination across numerous studies.

Social compensation refers to a tendency for individuals to work harder collectively than individually when they expect their teammates to perform poorly on a meaningful or important task. This phenomenon was first isolated in a series of studies by Williams and Karau in which expectations for coworker performance were either inferred from interpersonal trust scores (using the reasoning that those low in trust would expect poor performance from coworkers) or were manipulated using confederates who made statements about their own effort or ability at the task. The results showed that individuals socially loafed when they expected their coworkers to perform well, but socially compensated when they expected their coworkers to perform poorly. In addition, consistent with the expectancy-value perspective, individuals did not bother socially compensating for poorly performing coworkers when the task was low in meaningfulness. Social compensation has since been replicated in a number of studies by a variety of researchers, though additional research is needed to identify the complete set of moderators and limiting conditions of the effect.

The Köhler effect refers to a tendency for individuals to work harder collectively than individually when working with teammates who are moderately, but not dramatically, stronger

or better able to perform the task. The effect is named after Otto Köhler, who likely presented the first documentation of a motivation gain within a group context in 1926. He asked athletes to lift a bar that was connected to a pulley, first individually and then in dyads. He found that athletes worked harder on the dyad tasks than on the individual task when their partner was moderately stronger than they were. No motivation gain was found when dyads were relatively equal or widely separated in ability. In recent years, a number of studies have examined the conditions under which the Köhler effect does and does not hold. A 2007 meta-analysis of 17 studies by Weber and Hertel concluded that (a) the effect was moderate in magnitude; (b) a number of moderators (e.g., task influences, performance information, and gender) influenced the magnitude of the effect; and (c) social comparison (i.e., a desire to appear favorably in comparison with one's partner) and dispensability both appeared to provide viable explanations for the effect. Because the paradigm typically used in the Köhler effect studies differs substantially from the standard social loafing paradigm (e.g., different control conditions, individuals whose inputs are often identifiable to their partners), making direct comparisons across the paradigms is somewhat difficult. Nevertheless, research on the Köhler effect clearly suggests that, under some conditions, group members who are moderately less able than their coworkers may show motivation gains in groups.

Social Facilitation

Historical Background

The simple observation that cyclists often ride faster in the presence of other cyclists inspired Norman Triplett to conduct research that led to the first published social psychology experiment in 1898. Triplett asked children to turn a fishing-reel-style crank as quickly as possible, both alone and alongside another child. He found that the majority of the children reeled the line more quickly when they worked coactively alongside another child than when they worked alone. This work initiated a wealth of research over the ensuing 110 years that has examined the influence the presence of others has on individual task performance. This research has focused on the presence of three specific types of others: coactors (individuals who are also working on the same task individually), audiences or observers (individuals who observe the individual's work or performance but do not work on the same task themselves), and other persons who are simply present in the environment but unlikely to be observing or actively attending to the individual. Research conducted during the first 50 years following Triplett's work often found that the presence of others enhanced individual performance, leading Allport to use the term social facilitation to describe these findings in a 1924 social psychology text. However, a number of studies also found the opposite, with the presence of others reducing individual performance.

Drive Theory

Due in part to conflicting results, social facilitation research was suffering from relatively slow empirical progress and conceptual stagnation when Robert Zajonc proposed a rather

ingenious theoretical resolution of the issue in 1965. This resolution focused on the concepts of drive and dominant responses. Specifically, Zajonc linked together two relevant bodies of research: (a) a large body of research on drive, individual motivation, and performance that had already established that drive, activation, or arousal serves to enhance dominant responses – those responses that are most likely to occur in a specific task environment given the individual's level of task-relevant behavioral experience; and (b) research that provided some indirect, but compelling, evidence that the presence of other people tends to increase an individual's level of arousal. He posited that the presence of others produces arousal or drive that enhances dominant responses. When working on tasks that are relatively simple or well-learned, these dominant responses are likely to be correct, thereby enhancing performance. However, when working on tasks that are complex or unfamiliar, in which the individual has not yet fully learned or mastered the requisite skills, dominant responses are likely to be incorrect, thereby reducing performance. Zajonc's drive theory account brought some crucial conceptual order to the study of social facilitation and stimulated a flurry of research activity that continues to this day, having reached its apex in the period between 1965 and 1983.

Other Prominent Theories

Several theories have been proposed as to why the mere presence of others may increase drive. Zajonc's original drive theory account suggested that the mere presence of others produces uncertainty that leads to increased drive. Distraction–conflict theory proposes that the presence of others is distracting, which produces conflicts in attention that increase drive. Finally, social monitoring theory states that the presence of others leads to uncertainty and increased drive when the behavior of those others cannot be monitored.

Although Zajonc proposed that the mere presence of others is sufficient to enhance drive, the evaluation perspective argues that mere presence alone is insufficient to create social facilitation, but that it instead activates evaluative processes that can enhance drive. Thus, the evaluation perspective argues that the presence of others increases drive because it enhances an individual's concerns with evaluation or with competitive comparisons with others. For example, individuals are likely to experience more concern with being evaluated favorably by observers when making a speech in front of an audience than when preparing for it or presenting it alone. Similarly, individuals are likely to be more concerned with having their performance evaluated or compared with that of others when working on a coactive task than when working on the same task alone. Several theories have proposed that the presence of others can increase drive through the activation of various evaluative processes. Specifically, evaluation apprehension theory states that the presence of others increases drive because people learn over time that the presence of others is typically associated with evaluation, social comparison, and/or competition. Distraction–conflict theory states that the possibility of being evaluated produces distraction that increases drive. Self-efficacy theory posits that individuals develop positive performance expectations while working on simple tasks and negative performance expectations while working on complex

tasks, and that the presence of others activates corresponding positive or negative expectations regarding performance evaluation. Finally, self-presentation theory suggests that the possibility for evaluation created by the presence of others enhances individuals' concerns with presenting themselves in a favorable light, thereby enhancing their drive and motivation in the presence of coactors or observers.

Though the mere presence and evaluation perspectives both suggest that the presence of others enhances the drive and motivation of individuals (enhancing performance on simple or well-learned tasks and debilitating it on complex or unfamiliar tasks), not all social facilitation theories assume that the presence of others always enhances motivation. For example, self-attention theory proposes that the presence of others makes individuals more self-aware and more attentive to their own performance in relation to relevant performance standards in the environment. According to this theory, on simple tasks individuals have favorable performance expectations and thus work hard in the presence of others, but on complex tasks individuals have unfavorable performance expectations and actually withhold their efforts because they have little chance of meeting the performance standard. Regarding processes other than drive or motivation, Baron has proposed an information processing version of distraction–conflict theory in which attention and information processing, rather than motivational processes, are responsible for social facilitation. He proposes that the presence of others leads to distraction and conflict in attention that requires a narrowing of attentional focus in order to accomplish the task. This narrowed attentional focus facilitates performance on simple or well-learned tasks because it directs one's attention to an appropriate, limited range of task performance cues. However, it debilitates performance on complex tasks because the task requires attention to a wider range of cues, especially when individuals have not mastered an understanding of which cues are most crucial and appropriate to attend to.

Current Status

More than 300 studies have been conducted on social facilitation. Laboratory research examining the implications of specific social facilitation theories has been especially popular, although there are a number of field studies that have examined audience effects on individual performance. A wide variety of tasks have been studied. The most common tasks have been of a physical or cognitive nature, though performance on judgmental, evaluative, and perceptual tasks has also been examined. Social facilitation effects have also been documented for a variety of animals, including rats and cockroaches. Although there is a good support for the basic notion that the presence of others can enhance performance on simple tasks and debilitate it on complex tasks, the magnitude of these effects is often rather small. Moreover, the empirical results show a good deal of variability and complexity. A 1982 meta-analysis by Bond and Titus concluded that the presence of others, on average, had small effects on performance and explained <3% of the variance in the typical experiment. They also concluded that evaluation apprehension had surprisingly little influence on the magnitude of social facilitation effects, and that studies deploying physiological measures

supported the notion that the presence of others enhances arousal only for complex tasks. Research conducted since 1982 appears to support the general existence of social facilitation, though effects are still often small in magnitude, and variability in findings still occurs across studies. In addition, research in the last 30 years has provided fairly good foundational evidence that evaluative processes are capable of creating social facilitation effects.

From a theoretical perspective, researchers have found it difficult to resolve some of the fundamental differences between theories through empirical testing. For example, one key issue concerns whether the mere presence of others is sufficient to create social facilitation or whether evaluation potential (or some other factor) needs to be activated as well. One important problem is that it is exceptionally difficult to create pure alone conditions in which other people are not present and evaluation is not possible (or at least is highly muted or unlikely). It is also challenging to create conditions in which coactors or observers are present who are unable or uninterested in evaluating the individual's performance. For example, in laboratory studies, the experimenter can easily serve as a source of both presence and potential evaluation. Indeed, Bond and Titus noted that in the alone conditions of the 241 studies they reviewed, the experimenter was actually in the same room with the participants in 96 studies, and was even directly visible to the participant in 52 of those studies. Even when individuals work on the task alone with no others present, it is typically plausible that the experimenter is interested in their performances and will be able to evaluate them at some point.

Nevertheless, there does appear to be some sound evidence for mere presence effects. In an influential 1993 literature review, Guerin identified 18 studies (out of a pool of 313) that met 12 criteria he felt were required for an adequate test for mere presence effects. Of these 18 studies, 11 found evidence of mere presence effects. In addition, despite the challenges involved, a number of studies have succeeded in developing relatively clean manipulations of mere presence and evaluation potential. For example, in a clever 1978 study, Markus asked individuals to dress in familiar or unfamiliar clothing either alone, in the presence of an attentive spectator, or in the presence of an inattentive spectator. In support of the mere presence perspective, she found that in the presence of a spectator (whether attentive or not), individuals dressed more quickly in familiar clothes and less quickly in unfamiliar clothes than they did when alone. Two 1987 studies by Harkins manipulated both the presence of others and the potential for evaluation in the same design and examined their influence on the performance of idea generation and vigilance tasks. In both studies, Harkins found that, holding evaluation constant, individuals performed better when working coactively than alone (providing support for mere presence). In addition, he found that, holding group size constant, individuals performed better when their efforts could be evaluated (providing support for evaluation potential).

Given that meta-analytic support has been found for mere presence effects in the literature broadly and that a number of well-controlled studies have documented that evaluation from an external source can increase motivation on coactive tasks, it seems reasonable to conclude that both mere presence and the potential for evaluation can create social facilitation effects.

However, research has yet to completely unravel the precise dynamics of how various sources of evaluation interact with one another, as well as with mere presence and other processes, to produce social facilitation. In addition, because most research has focused on the mere presence and evaluation perspectives, other potential processes that may be operative in social facilitation, such as self-attention, information processing, self-efficacy, social monitoring, and self-presentation, have yet to be fully explored.

Integrating Social Loafing and Social Facilitation

At first glance, social loafing and social facilitation may appear contradictory. After all, social loafing suggests that the presence of other people often reduces our motivation and performance, whereas social facilitation suggests that the presence of others can enhance our performance (unless the task is complex or we are unfamiliar with it). However, this apparent discrepancy is readily resolved by recognizing that the two phenomena consider unique aspects of social motivation by systematically manipulating different task environments that produce distinctive types of other people who are present in the situation. Specifically, the social loafing paradigm compares performance on collective tasks with performance on coactive tasks. Equal numbers of people are physically present in both conditions. The only difference is whether individual inputs are combined into a group total. Social loafing research thus speaks to the issue of how working on a collective task where inputs are combined into a group total affects one's motivation level. As highlighted by the evaluation perspective, when inputs are being combined, one has the opportunity to hide in the crowd and rely on the efforts of others. Additionally, as highlighted by the dispensability and expectancy-value perspectives, individuals may feel lost in the crowd and unable to make a distinctive or valuable contribution to the group.

In contrast, the social facilitation paradigm compares performance on individual tasks where participants work alone to performance on either coactive tasks or on individual tasks that are performed in the presence of either observers or an audience. Therefore, the number of people present across the alone and coaction conditions is systematically varied, and individual inputs are never combined into a group score. Thus, social facilitation research focuses on the effects that the mere presence of others has on individual performance rather than on the motivational effects of working with others on a collective task.

Although research on social loafing and social facilitation has developed into separate literature streams that focus on different aspects of social motivation, they nevertheless have some commonalities and compatibilities. Social facilitation explanations based on differences in the mere presence of others cannot account for social loafing, because the number of people present across conditions (and therefore, the levels of drive, arousal, or distraction) is held constant. However, several of the theories developed to explain one of these phenomena appear to be readily applicable to the other phenomenon as well, provided that the nature of the other people present is accounted for appropriately. Specifically, as previously mentioned, evaluation explanations provide viable accounts of both social loafing and social facilitation effects from a common

evaluation potential basis. Namely, this perspective suggests that individuals engage in social loafing because they are less easily evaluated on collective tasks than on individual tasks, and suggests that social facilitation occurs because individuals experience more concern for evaluation when coactors or observers are present than when they are working alone. The logic of social impact theory can also provide a means for integrating social loafing and social facilitation by positing that coactors and observers serve as additional sources of social impact when people work individually, but that coworkers provide a means for diffusing the impact of an outside source of social impact across multiple group members when people work collectively. The arousal reduction viewpoint expands on that social impact logic to state that the presence of others can actually reduce arousal when those others are coworkers rather than coactors or observers. From this latter perspective, social loafing is inversely related to social facilitation such that arousal reduction should reduce performance on simple collective tasks, but should enhance it on complex or unfamiliar collective tasks.

Relationships with Other Phenomena

Social loafing and social facilitation address the basic, fundamental issue of how the presence of other people influences the motivation and performance of individuals. Two additional phenomena address other aspects of the influence that the presence of others can have on individual behavior. Specifically, research on social dilemmas examines how conflicts between individual and group interests affect individuals' use of shared resources and contributions to pooled resources. Research on social inhibition examines situations in which the presence of other people can inhibit behaviors that individuals would otherwise engage in.

Social Dilemmas

Social dilemmas are situations in which behaviors that are beneficial to individuals are detrimental to the group as a whole when many individuals choose to engage in those behaviors. Thus, when many individuals are sharing a common resource (such as water, electricity, or space on a public freeway), it is to each individual's short-term benefit to use the resource freely, but when most people behave this way, the resource rapidly depletes or becomes ineffective over time. Similarly, when many individuals are responsible for contributing to a public good (such as a social service organization or a public television station), individuals may be tempted to withhold their contributions to the detriment of the larger group. Social dilemmas have significant conceptual overlap with social loafing, even though the two areas use distinctive research paradigms and are often viewed as separate phenomena. Namely, social loafing can be thought of as a type of social dilemma in which individuals may withhold their contributions from the group for their own convenience or efficiency by working less hard on collective tasks. However, if most members reduce their efforts in this manner, the performance of the group will suffer. Similarly, a social dilemma can be viewed as a situation in which individuals reduce their efforts to manage

pooled resources or to contribute to public goods because they can rely on the efforts and contributions of others. Thus, both phenomena are concerned with how considerations involving other people influence individuals' efforts and contributions on collective tasks or in collective situations. Significant methodological differences between the two paradigms, such as the direct combining of inputs in a small group setting in most social loafing studies and the absence of coactive comparison conditions in most social dilemma studies, require caution in extrapolating findings across the two areas. Nevertheless, the two areas can provide each another with some promising insights and linkages.

Social Inhibition

The presence of others people does not just influence motivation and task performance, it can also influence other types of behaviors. A number of studies of social inhibition have identified situations in which the presence of others inhibits people from behaving as they would when alone. For example, individuals riding in elevators were found to be less likely to take a free hamburger coupon or a free condom when others were riding with them. Similarly, individuals working on a computer task were slower to seek help with a malfunction when other people were present than when they were working alone. This phenomenon does appear to have some conceptual linkages with both social loafing and social facilitation.

In the case of social loafing, the paradigms are clearly quite unique in that social loafing is concerned with effort on collective tasks, whereas social inhibition studies a range of behaviors in situations where individuals do not combine their efforts with those of others. However, from a social impact perspective, both processes might be understood in terms of sources and targets of impact. In the case of social loafing, the other people are present as coworkers and therefore reduce the shared impact of a source of outside influence on the individual. In contrast, in the case of social inhibition, the others present serve as additional sources of social impact on a single individual, increasing the pressure to refrain from behaviors that could bring unwanted reactions or negative evaluations from others. Therefore, although the types of behaviors studied and outcomes produced clearly differ across these paradigms, some similar social influence processes may be operative.

Social inhibition also has some conceptual ties with social facilitation. Once again, the two paradigms clearly differ in that social facilitation focuses on motivation and performance on simple versus complex tasks, whereas social inhibition focuses on a range of behaviors that are relatively distinct from task performance. Yet, both compare behavior in alone settings to behavior in the presence of others, and some common processes may be shared across these phenomena in certain situations. For example, the presence of others could activate evaluation concerns in both situations. In the case of social facilitation, those evaluation concerns might enhance a drive to perform well (enhancing performance on simple tasks and debilitating it on complex tasks), whereas in the case of social inhibition, those evaluation concerns might lead individuals to refrain from behaviors that might lead to unfavorable evaluation or scrutiny from others.

See also: [Group Dynamics](#).

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Social Support

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Glossary

Buffering hypothesis Theory that social support is only beneficial to people who are under stress.

Invisible support Social support that is provided to a person without his/her awareness.

Social network The people with whom one has some form of regular social contact.

Social support Resources from the social environment that can be beneficial to psychological and physical health.

Support functions The quality of social relations a person has, as indicated by the material, emotional, and informational resources those social relations provide.

Support structures Quantitative indicators of the form, or nature, of a social network, such as its size or the frequency of contact with different members.

Types of Social Support

Social networks have different dimensions that may influence the availability of social support or the effectiveness of social support in maintaining individuals' health and well-being. Two dimensions of primary importance are the *structural and functional* characteristics of social networks. Structural characteristics are quantitative indicators of a social network. Structural measures of support assess the degree to which individuals are socially integrated in their family and community. Structural aspects of a social network include its size, the amount of contact a person has with social network members, or how many people in a network know one another. Functional characteristics are quantitative indicators of the resources provided by members of one's social network. In other words, functional aspects of social networks are the things that people do for one another, such as providing emotional and material aid.

Social support depends on both the availability of a social network and the provision of particular resources through that network. Obviously, with a network size of zero, one cannot receive any social support. Indeed, differences in social support availability might explain the different health prospects for socially isolated versus socially integrated people: as a group, social isolates have more health problems than people who are integrated in a social network. Aside from such extreme situations, social network functions usually are more critical to an individual's health than structural factors, such as size or type of relations between social network members.

Social networks appear to be supportive, or helpful, in four primary ways: (a) they provide emotional comfort and enhance self-esteem; (b) they provide financial or other material aid; (c) they provide information or advice; and (d) they provide assistance or instrumental help. People often benefit from social support if it is tailored to a particular problem. For example, a person who needs help in making a mortgage payment will probably get more benefit from a friend with money to loan than from one with advice to give. However, emotional support, or confirmation that one is loved and esteemed by others, appears to be beneficial to many individuals and under a number of diverse situations. People who cannot get financial support from friends can benefit psychologically by confiding in friends about their financial problems and worries. It is often

comforting to have someone to talk to about one's problems, even if that person cannot solve the problems.

Finally, it should be noted that social support is not always directly provided by the social network. Sometimes people benefit from having supportive social relations without having any direct exchange of support. The mere perception that support is available is often enough to boost a person's morale or to reduce the negative impact of a stressful situation. Support also can protect individuals' mental and physical health when they are unaware that support has been provided. 'Invisible support,' or support that occurs without the recipients' knowledge, may protect people by preventing exposure to stressors. For instance, one could protect loved ones, or provide invisible support, by keeping bad news from them. Thus, the supportive functions of social networks are not always tangible to the recipient, but are nevertheless effective in maintaining the well-being of that person.

Relation of Social Support to Physical and Mental Health

Social support has been linked to lower levels of mortality, morbidity, and psychological symptomatology. Over a century ago, sociologist Emile Durkheim observed that more socially isolated people had a higher risk of committing suicide than people who were more socially integrated. This was one of the earliest clues that interpersonal relationships might have a role in promoting and maintaining physical and mental health. Since Durkheim's study, many more studies have shown that people who are less socially integrated have more physical and psychological health problems, as well as higher rates of mortality. Many of these studies have tracked how social integration affects health over time. Moreover, some studies have shown that the differential mortality rates cannot be explained by differences in major health risk factors, such as blood pressure, cigarette smoking, or cholesterol levels in isolated versus integrated people. Thus, it appears that social integration can alter health outcomes and that the observed associations are not simply due to health altering the level of social integration.

It is possible that more socially integrated people have lower mortality risk than isolated people because there are health

benefits associated with being socially integrated. There is some evidence that people who have more social ties have low rates of psychiatric disorders, accidents, pregnancy complications, and tuberculosis. People who are more socially integrated also appear to be at lower risk for heart disease and death from heart disease than their isolated counterparts. For example, women who are less socially integrated appear to be at greater risk for ischemic heart disease; men who are less socially integrated are likely to live longer after surviving a heart attack; and Japanese-American men who are socially integrated appear to be less susceptible to coronary heart disease.

The associations between social integration and health outcomes, which range from psychiatric disorders to mortality, suggest that there are health benefits derived from having social ties. Whether the health benefits of social integration are due to the supportive functions provided by social networks is not entirely clear. It may be that some other factor that is associated with social integration or social isolation is responsible for the different health outcomes of integrated versus isolated individuals. For example, isolated people may be economically disadvantaged relative to more integrated people. If isolated people are also indigent, their health problems may be explained by a lack of affordable or adequate health care. To determine whether social support actually has a role in maintaining or promoting health, it is important to look directly at the relation between the quality of social support that people receive and their health status. Knowing that a person has regular contact with their social network, or that he/she has a social network, only indicates that a person can potentially receive social support. Many people who have frequent contact with their social networks may perceive their network as unsupportive or, worse yet, view their social ties as a source of stress.

There is emerging evidence that the quality of social support people receive from others can influence physical health. However, scientific investigations of the relation between social support and health do not always present consistent or clear results. For example, one researcher has found that people who believe that they have adequate social support are at lower risk of mortality than people who believe they have inadequate social support. In contrast, other researchers have found that people who are satisfied with their marriage and social interactions with others do not have a lower risk of mortality than their counterparts who are dissatisfied with their social relations. There are several reasons why studies present an inconsistent picture of the effects of social support on health. A primary reason is that social support is conceptualized and measured differently across studies. Different types of social support may be needed in different situations, but the right measure is not always used. The remaining discussion will present additional evidence on the relation between support and health, but with particular attention given to the type of support and the mechanisms through which support is expected to influence health outcomes.

Explaining the Positive Effects of Social Support

Social Support as Protection from Stressors

A central theory on the role of social support in health is that support functions by protecting, or 'buffering,' people from the

inimical effects of life stressors. According to the stress-buffering theory, social support will have positive effects on the mental and physical health of people under high levels of stress, but have no effect on people with less or no stress. The rationale behind this theory is that social support somehow helps people to cope with the stress of life, thereby reducing the health toll of stress. People who have social support available to them in the absence of stress would not be expected to gain any immediate health benefits from that support.

The buffering theory has been tested mainly with psychological rather than physical health outcomes. One of the reasons that so little is known about the role of social support in physical disease outcomes is that many of the major diseases, such as cancer and heart disease, develop over many years and are difficult to track. Thus, researchers are seldom able to identify and assess the social support networks of people before they develop a particular disease. Mental illnesses, on the other hand, have a relatively short onset and progression. Therefore, it is easier to test how social support influences mental illnesses than physical illnesses.

The stress-buffering effects of social support have been tested using both structural and functional measures of social support. Studies using structural measures, such as marital status and number of close friends, have consistently shown buffering effects on psychological health. People who are married or have a close friendship tend to experience less depression under stress than do people who lack significant social ties. People who have frequent contact with close friends during personal crises, such as health problems, divorce, and unemployment, also are happier and more satisfied with life than people who have relatively little contact with close friends. Although having close interpersonal relationships appears to protect people from the adverse psychological effects of stressors, having casual social connections do not seem to buffer stress. Casual social ties may develop through church membership, interaction with neighbors, or participation in clubs and organizations. People who have greater access to such ties tend to have less psychological distress and greater morale than people with relatively little access to such ties, but this is true regardless of the amount of stress in their lives. Thus, it appears that close social ties may be beneficial to mental health because they provide supports that help people to cope with stress, whereas more casual social ties may be beneficial to psychological well-being because they serve other functions, such as providing companionship. Increasingly, individuals are turning to computer-mediated social networks for social support through bulletin boards, listserves, and social networking sites. The Internet is obviously an effective tool for linking individuals to a vast amount of information and even emotional support and companionship, particularly through weakly connected social ties. However, it is not yet clear whether computer-mediated social support is an effective stress buffer.

There is only limited evidence that social support protects people from stress-related physical illnesses. For example, a study of male factory workers showed that workers with high levels of job-related stress had fewer health complaints if they perceived their spouse and supervisor to be supportive rather than unsupportive. A Swedish study has shown that a greater level of social involvement with coworkers appears to reduce the negative effects of work stress on coronary heart disease

prevalence in men and women. Finally, an Israeli study has shown that highly anxious men who perceive their wives to be supportive have a lower incidence of angina pectoris than men who do not perceive their wives to be supportive. Again, it appears that close, or significant, social ties are most beneficial. There is no strong evidence that casual social ties, or simply the number of social ties one has, can reduce the negative effects of stress on health complaints.

Social Support and Health Behaviors

Social support networks may influence health by regulating individuals' health-related behaviors. For example, in contrast to relatively isolated people, people who are more socially integrated tend to smoke less, drink less alcohol, avoid between meal snacks, eat breakfast, maintain a healthy weight, get adequate sleep, and engage in regular physical activity. Among the elderly, degree of social integration and contact, as well as perceived amount of social support available, is associated with better self-care. Among people trying to quit smoking, those who feel that they have others with whom they can discuss their problems are able to abstain from smoking for a longer period than those who do not feel that they have such confidant relations.

Social networks also may promote health by encouraging individuals to seek needed medical attention or to comply with medical treatments. For instance, the degree to which pregnant women consult with friends about health care issues has been shown to influence the degree to which they seek prenatal care. More generally, people who have relatively frequent interactions with friends tend to obtain preventive health care and seek help quickly when they are ill. Finally, in contrast to people who believe they have relatively little support from their spouse, friends, and health care providers, those who believe that they have high levels of support are more motivated to adhere to their medical regimen and are more acutely aware of the negative consequences of noncompliance. In turn, the heightened adherence motivation and awareness of the costs of noncompliance are associated with greater compliance. One way that support may protect people from stress is by increasing their medical adherence. For example, in a study of patients with hypertension, those facing many life stressors were more likely to miss appointments with their physician than those who had little stress. However, stressed patients who believed they had much support from significant others were less likely to miss appointments than stressed patients who felt they had little support.

Social Support and Physiological Functioning

If social support reduces stress-related health problems, it is possible that it does so by influencing physiological responses to stressors. A number of bodily changes tend to occur in people confronted by stressors. For instance, stress tends to activate the sympathetic nervous system, which causes increases in heart rate, blood pressure, and generalized arousal. The physiological responses to stressors are part of the body's coping mechanism. By increasing blood flow away from the organs and to the muscles, individuals are prepared to 'fight' or 'flee' in response to a stressor. Increased arousal also allows

people to be more vigilant or attentive to their environment or threatening stimuli.

The most common biological markers of stress are increased heart rate and blood pressure, and elevated levels of hormones known as cortisol and catecholamines. Catecholamines are basically responsible for increasing bodily arousal, whereas cortisol is primarily useful in reducing swelling in tissue that might be damaged during fight or flight. Although increased arousal and production of catecholamines and cortisol are adaptive responses to stressors, they also can have harmful effects on health. For example, extreme levels of stress-induced arousal might lead to heart attacks, and chronically high levels of stress-induced hormone production might contribute to heart disease. If social support can dampen the body's reaction to stressors, it might prevent stress-related illnesses and disease processes. Several laboratory studies have shown that people who are challenged by acute stressors, such as giving a speech or being socially harassed, experience smaller blood pressure and heart rate increases if they are in the presence of a supportive person than if they are alone or in the presence of a nonsupportive person. However, there is no evidence to date that social support in naturalistic settings, where people can experience very severe and repeated stressors, acts to reduce stress responding in the same way that it does in laboratory settings, with relatively mild stressors.

Social support also might be beneficial to health by enhancing immune system functioning. The immune system protects people from harmful viruses and pathogens, which are noxious or toxic materials that enter the body. The most familiar defense mechanism of the immune system is the production of white blood cells that can circulate throughout the body to fight infections. When people are under stress, the immune system becomes compromised, producing fewer and less effective immune cells than normal. Findings from several studies suggest that social support may enhance immune functioning. For example, lonely people have poorer immune functioning than nonlonely people. In addition, higher social support appears to be related to enhanced immune functioning among the elderly and spouses of cancer patients.

Conclusions

People who are socially integrated appear to be at lower risk for a variety of psychological and physical health problems, as well as mortality, than people who are relatively isolated. The psychological and health benefits of social integration are partly attributable to the supportive functions provided by social networks. People who receive social support from members of their social network, particularly if it is from significant others such as spouses and family members, tend to have fewer psychological problems than people who do not receive support. To date, there is more evidence linking social support to psychological well-being than to physical health. However, several studies suggest that social support does play a role in physical health.

Several theoretical models have been posited to explain how social support can influence physical and psychological health. Social support appears to be particularly beneficial to individuals under stress.

Therefore, support may operate by helping people to cope with stressors, which can be detrimental to physical and psychological health. Support also might function by promoting healthy behaviors, discouraging risk-taking and other unhealthy behaviors, and encouraging people to seek needed medical care or to adhere to medical regimens. Finally, social support appears to reduce stress-related arousal, dampen the production of catecholamines and cortisol, and to enhance immune functioning. These latter physiological effects of social support may prove to have health benefits.

See also: [Catecholamines and Behavior](#); [Stress and Blood Pressure Dysregulation](#); [Stress and Illness](#).

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Social Values (Influence on Behavior)

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Glossary

Competitors Individuals who tend to approach interdependence situations with the goal of getting more than others.

Cooperators Individuals who tend to approach interdependence situations with the goal of maximizing joint gain for themselves and others.

Decomposed game An instrument used to assess social values on the basis of preference for abstract distributions of resources to the self and others.

Individualists Individuals who tend to approach interdependence situations with the goal of getting as much as possible for themselves, with little concern for the outcomes provided for others.

Interdependence Situations where individuals' outcomes are a joint function of their own choices and the choices of others; often interdependence structures produce unexpected complications for participants.

Might over morality hypothesis The proposal that cooperators think about cooperation and competition in

terms of morality, whereas competitors think about them in terms of strength.

Prisoners' dilemma An interdependence structure between two individuals, characterized by a situation where the rational pursuit of one's own interests can produce suboptimal outcomes for both participants.

Social dilemma An interdependence structure similar to a prisoners' dilemma but extended to more than two individuals.

Social values Stable preferences for particular patterns of outcome distributions afforded to the self and others.

Tit-for-tat A strategy for playing a multitrial prisoners' dilemma game, characterized by choosing the option that the other player picked on the previous trial.

Triangle hypothesis The proposition that cooperators anticipate the possibility of either cooperation or competition from others, whereas competitors uniformly expect competition.

Defining Social Values

Social values refer to a stable personality trait of preferring certain patterns of outcome distributions between self and others. Social values have been used to explain behavior in a variety of negotiation and decision-making situations where people need to coordinate their actions. Social value orientations, which reflect a trade-off between self-interest and collective interest, can be divided into two broad categories. People with proself orientations focus on the benefits they can acquire for themselves, whereas those with prosocial orientations focus on balancing their own benefits with others' benefits.

The most common proself orientations are individualism and competition. An individualist tries to maximize his or her own gain with little or no regard for the welfare of others. Competitors focus on maximizing their own gain relative to others. To see the difference between these two orientations, consider [Table 1](#). A person has to choose among different monetary payoffs, labeled A through G. The choice determines his or her payoff, as well as what the other receives. Choice C provides the greatest gain to the self (60) and would be what an individualist prefers. In contrast, a competitor would prefer Choice B, even though it provides a lower dollar payoff than Choice C, because it provides a relative advantage of \$25 rather than the \$20 provided by Choice C.

The most common prosocial orientation is cooperation, illustrated by Choice A in [Table 1](#). A cooperator focuses on joint gain and would therefore prefer maximizing joint benefit between the self and another. The cooperator prefers \$55 to \$60

because Choice A also provides \$50 to the other person for a joint total of \$105, in comparison to the smaller joint totals for the other choices. Another prosocial orientation is egalitarianism, a preference for equality between the self and another. Choice D in [Table 1](#) represents an egalitarian preference because it minimizes the difference between the self and another person. Egalitarians would prefer Choice D over Choice A because of the value they place on equality of outcomes, whereas cooperators would prefer Choice A over Choice D because of the value they place on joint gain. Recent research has suggested that people traditionally labeled 'cooperators' may be more motivated to maximize equality than joint gain.

A number of other possible social value orientations do not appear with great frequency in the population. An altruist would prefer Choice E, which provides the other with the greatest payoff, even at a cost to the self. An aggressor would prefer Choice F, which provides the other with the lowest possible payoff, even though it costs the self as well and only provides a \$15 relative advantage compared to the \$25 relative advantage provided by Choice B. Finally, masochists would intentionally reduce their own outcomes and would, therefore, find Choice G the most appealing.

Problems Measuring Social Value Orientations

Because it is impossible to read someone's mind, it is necessary to infer a person's social value orientation on the basis of

Table 1 Different social value orientations

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>G</i>
You get	55	30	60	50	40	15	0
Other gets	50	5	40	50	55	0	15

observed behavior, that is, the choices they make to divide resources among themselves and others. There are two problems with making inferences about social value orientation on the basis of observed behavior.

One problem is that the same choice may reflect more than one social value orientation, depending on the others available. For example, compare Choice A and Choice D in [Table 1](#). A person who chooses A over D may be trying to gain a relative advantage (55 provides 5 extra points to the self relative to the other's 50 points). But Choice A also maximizes joint gain (a combined value of 110 rather than 100). It is impossible to be certain what social value orientation is being satisfied when a choice confounds two or more possible motives.

Another problem concerns the distinction between goal-oriented and strategic behavior. Goal-oriented behavior is performed to advance some agenda or cause. The motive to do better than others can be only satisfied by making competitive choices. Because a strategic choice is motivated by the desire to make the other person behave in a certain manner, it may actually contradict an actor's social value orientation. For example, a competitive person may make a series of cooperative choices in order to lull the opponent into a false sense of security for later exploitation. Altruistic cooperators are motivated to provide resources to others. They are more concerned with others' outcomes than their own. In contrast, reciprocal cooperators will cooperate strategically to get others to cooperate with them. A cooperator may make competitive choices to send a stern message to an opponent.

Decomposed Games

Decomposed games, the most widely used method to assess social value orientation, were developed to avoid measurement problems inherent in using behavior as the basis for inferring social value orientation. A decomposed game presents an individual with a set of (usually) three choices. Each choice provides an outcome for the self and a hypothetical other. The individual is asked to indicate the most preferred choice. People are presented with a series of decomposed games that vary the point payoffs in a systematic way. A person is assigned a social value orientation on the basis of making a majority of choices consistent with a particular orientation.

In [Table 2](#), Choice A maximizes joint gain, Choice B maximizes relative gain, and Choice C maximizes individual gain. These preferences reflect cooperative, competitive, and individualistic social value orientations, respectively. In practice, most research on social values has used a triple-dominance measure of social values that is designed to distinguish cooperators, individualists, and competitors; however, in theory, it would be possible to design decomposed game to assess any possible social value orientation.

Table 2 An example of a decomposed game

	<i>Choice</i>		
	<i>A</i>	<i>B</i>	<i>C</i>
You get	55	30	60
Other gets	55	0	40

Table 3 An example of a decomposed game that can distinguish between joint gain maximization and equality maximization

	<i>Choice</i>		
	<i>A</i>	<i>B</i>	<i>C</i>
You get	50	70	60
Other gets	50	60	40

It is important to note that Choice A maximizes equality in addition to maximizing joint gain. To eliminate this confound, people could also be presented with another decomposed game, such as the one presented in [Table 3](#). In this example, column B maximizes joint gain, but column A maximizes equality. If a person chose A in the first game and A in the second, he or she would demonstrate a consistent tendency to minimize the difference between the self and another. Such a person would be classified as an egalitarian. However, if a person chose A and then B, it would suggest a tendency to maximize joint gain. This person would be classified as a cooperator.

Typically, someone is classified by the decomposed game measure if a majority of choices are consistent with a particular social value orientation. There is evidence that about 57% of a sample can be categorized as cooperators, about 27% as individualists, and about 15% as competitors. In some cases, about 10% cannot be classified because they do not display a majority preference for a particular social value orientation. Researchers often combine individualists and competitors into a group called proselves and call cooperators prosocials.

The decomposed game measure has several advantages. By judiciously manipulating point values across a series of decomposed games, it is possible to narrow down a person's preferences to a single social value orientation. Because the decomposed game format does not require that people actually make choices with another player, strategic and self-presentational aspects of interacting with another person are removed. The decomposed game measure is also easy to administer and score, using either a paper-and-pencil format or computer.

The decomposed game assessment has several weaknesses. One important limitation is that the measure reduces a continuous variable to a few discrete categories. As a result, someone who indicates 10 out of 10 cooperative choices is classified the same as someone who gives 6 out 10, even though it is possible that a consistent cooperator is different from an intermittent one. Overall, the categorical classification produces a loss of measurement precision. Generally, researchers do not encourage people to give up a more sensitive measure in favor of a less sensitive one.

The majority rule fails to take into account the choices made in the minority cases. For example, someone who gives six competitive and four individualist choices would be scored the same as someone giving six competitive and four cooperative choices. The former individual seems to more clearly possess a prosocial orientation.

However, it should be noted that researchers have found that the categorical classification of social values performed about the same as a more complicated assessment that kept track of the total number of points awarded to the self and others. Thus, an argument on the basis of parsimony would suggest retaining the categorical level of analysis.

Another problem with the majority decision rule concerns how to conceptualize unclassified individuals (those who do not make a majority of choices consistent with a specific social value orientation). Often, data from unclassified individuals are discarded prior to data analysis. This loss of information is regrettable. It would be interesting to gain a better understanding of the motivations of people who shift from one social value orientation to another in the short span of time required to complete the measure. For example, it is possible that unclassified people are expressing one of the less common social value orientations, which most triple-dominance decomposed game measures are not designed to find.

Another area that has not been adequately developed concerns the relationship between social values and other psychological constructs. There is little research on whether different measures of social values produce similar findings. In addition, few researchers have examined how social value orientation relates to psychological constructs such as independent-interdependent self-construal, cultural values of collectivism, or personality traits such as introversion or narcissism.

Although the decomposed game is the most popular method of assessing social value orientations, other methods have been developed, in part to overcome some of the limitations of the decomposed game. Like the traditional triple-dominance decomposed game measure, because preferences are evaluated in the absence of actual social interaction, strategic influences for these new measures are also eliminated.

The ring measure requires people to choose between two pairs of own-other outcomes. The outcomes are derived from a two-dimensional axis of own and others' outcomes measured at a fixed radius from the origin. One advantage of the ring measure is that it includes negative payoff values, that is, asks subjects to choose between losses as well as gains. For example, a person might have to choose between +14.50 for the self and -3.90 for the other or +13.00 for the self and -7.50 for the other. With this measure, it is possible to conceptualize social value orientation as a vector connecting the origin to the point, representing the total amount of points allocated to the self and to the other.

Another technique uses multiple regression analysis to predict the desirability ratings of 49 self-other distributions from subjects' actual preferences for their own gain, others' gain, and relative gain. An advantage of the procedure is the judgment process, which is quite different from the act of making choices in a real situation of social interdependence. A disadvantage of the technique is that it requires sophisticated statistical methods such as multiple regression and conjoint analysis.

Interdependence and Social Values

Social interdependence exists when the outcomes that two (or more) people receive are determined by both (or all) of their choices. More specifically, in the two-person case, the outcomes that A receives depend on both A's behavior and B's behavior. Similarly, the outcomes that B receives depend on both B's behavior and A's behavior. Interdependence often creates a conflict between trying to do as well as one can for the self by competing against others and trying to benefit the group by cooperating with others. Social values describe how individuals differ in the way they approach interdependence problems.

The idea of interdependence characterizes many social relationships ranging from the way a married couple has to decide how to spend Friday night together to the way that rival nations decide how to coexist peacefully despite the threat of nuclear weapons. In the case of a married couple, the spouse who gets to decide what they do every Friday night is more satisfied than the one who does not. In the case of two rival nations, it is better to do the attacking than be attacked. But, in the long run, the relentless pursuit of self-interest can lead to a failed group outcome: A marriage goes sour or two countries go to war.

Much of the research on social interdependence has been carried out using the tool of matrix games, such as the one presented in Table 4. This matrix is for a two-person game. The actor's choices appear on the left side, and the other's choices appear along the top row. Each person has a choice between a cooperative act and a competitive act. A matrix like this is often called a mixed-motive game because of the temptation to make a competitive rather than a cooperative choice. Point values are assigned to each choice for each person. In this example, the cooperative choices are X and A. The competitive choices are Y and B. If the actor chooses to compete and the other chooses to cooperate, they end up in the lower left hand cell, with the actor receiving 4 points and the other receiving 1. If they make the mutually cooperative X, A choice, they end up with 3 points each.

The Logic of the Prisoners' Dilemma

The name given to a matrix with this pattern of point values is 'a prisoners' dilemma game' because it was originally presented as two prisoners deciding whether to cooperate with or compete against each other to avoid a potentially long prison sentence. There have been literally thousands of studies conducted using the prisoners' dilemma game in anthropology, biology, economics, political science, psychology, and sociology. This seemingly simple problem is very important because the

Table 4 A two-person, two-choice interdependence game

	Other's choices	
	Choice A	Choice B
Actor's choices		
Choice X	3,3	1,4
Choice Y	4,1	2,2

instability of the solution calls into question how to define rationality. Often, especially in economics, rationality is defined as maximizing own gain. This is the case made for the invisible hand of Adam Smith as a fundamental principle of economics: the greatest good comes from people pursuing their own self-interest.

In the case of the prisoners' dilemma, the competing choice is more logical than the cooperative choice because it affords more points. The competitive choice will yield either 4 or 2 points, depending on whether the opponent chooses to cooperate or defect, respectively. The cooperative choice will yield either 3 or 1 point, depending on whether the opponent cooperates or defects. Thus, the competitive choice is more logical because 4 is greater than 3 and 2 is greater than 1. This analysis points toward competition as the logical choice. Because the matrix is symmetric, the other player goes through the same analysis. But the consequence of a rational analysis is the suboptimal 2,2 outcome.

The dilemma that these two people face is that having made the jointly cooperative choice, each will regret not making the competitive choice. If they had, they would have ended up with 4 rather than 3 points, and the other would have ended up with 1 rather than 3. However, if they had both made the competitive choice, they would have regretted their decisions and preferred to have made cooperative choices (so as to have 3 rather than 2 points each). The problem with this game is that the relationship of point values among the cells prevents it from having a stable solution.

In the case of the married couple planning their Friday night, the defecting choice would be to buy nonrefundable tickets to a play. The cooperative choice would be wait to decide what to do until both the husband and wife could meet and discuss a plan that was mutually beneficial. In the case of two rival nations, the defecting choice is attack the other country before it attacks. The cooperative choice is to delay attacking. In both the marital and rival countries examples, the problem with making the cooperative choice is that the cooperator becomes open to exploitation by the other. If the wife does not buy tickets to her favorite play, but the husband comes home with tickets to his, then she has little choice but to attend his choice. If one country resists the urge to bomb the other, it may leave itself open to attack. The worst outcome occurs when both parties pursue their own best interests. The married couple has paid for two sets of tickets to two different plays but can use only one set. Each country has destroyed the other.

The payoff structure is what gives the prisoners' dilemma matrix an unstable solution. Consider, for example, what would happen if the payoffs in the upper left corner were changed to 6,6. Then, cooperation would be the logical choice because it would lead to the greatest gain. Competing would at best provide 4 points, which is less than 6. Although the prisoners' dilemma is the most extensively studied matrix game, other games have been identified and have received empirical attention. For example, the case of nuclear attack has often been described as a chicken game because the consequence of mutually defecting choices is so extremely negative. The name chicken is derived from a dangerous game where two people drive their cars toward each other at high speed. The first one to swerve loses and is the chicken. If neither swerves,

they both die. In this kind of high-stakes game, a likely outcome is mutual death. This is a much worse choice than the mutually competitive cell in [Table 4](#) where the payoff for being exploited is not too much worse than the payoff for joint exploitation.

To produce cooperation in a mixed-motive game, players need a cooperative mindset. They have to be willing to adopt the goal of cooperation. But being willing to cooperate is not enough to guarantee cooperation. People must also expect that other players will cooperate, so they do not worry about being exploited.

The development of cooperative or competitive behavior in an ongoing mixed-motive game may operate like a self-fulfilling prophecy. If people initially expect competition, they come out with guns blazing and preemptively compete as a defensive, self-protective measure. As a result, they may cause a person who would have cooperated to compete, also as a self-protective measure. In contrast, if people initially expect cooperation from others and they act cooperatively in response, they may create a beneficial cycle of mutual cooperation.

The inherent problem with acting cooperatively is the danger of being exploited in a multitrial mixed-motive game. A cooperative cycle might be terminated because one of the actors decides to take advantage of the other's cooperation. The more cooperative the opponent, the better the chance of being able to take advantage of him or her on the next trial. Research has shown that one of the best strategies to maintain a cooperative cycle is to use a tit-for-tat strategy. The tit-for-tat strategy starts out cooperatively, but if the opponent makes a competitive choice, then the tit-for-tat also does so in the next trial. However, the tit-for-tat strategy is also forgiving. That is, if an opponent returns to a cooperative choice, a tit-for-tat will also return to cooperating, unless it is once again provoked.

The logic of the prisoners' dilemma can be extended to more than two people. Multiperson games are called social dilemmas, but the conflict between collective and individual gain is the same. Social dilemmas occur frequently in the real world. Plunging real estate markets in 2009 had the characteristics of a social dilemma. Once housing prices started to fall, people faced the choice between holding out and selling right away. By getting out of the market quickly, they minimized their own personal loss. But as more houses flooded the market, prices dropped even further, and everyone ended up worse off. Because of the additional players, social dilemmas can be almost impossible to solve.

Research Findings on Social Value Orientations

The concept of social values emerged out of research on social interdependence. A personality trait can be considered an internal disposition that influences how a person thinks, feels, or behaves across a variety of situations. A particular social value orientation can be thought of as a tendency to respond in a similar manner across a range of interdependence patterns and interaction partners. We would expect a cooperator to cooperate in different situations and with different people. Competitors would tend to make self-interested choices across a variety of contexts.

One reason why proselves and prosocials play the prisoners' dilemma game differently can be understood in terms of a matrix transformation. The given matrix is the actual matrix presented to players and can be considered an objective presentation of available point values. The effective matrix represents the socially constructed meaning applied to the given matrix. The socially constructed meaning can be considered different weightings of the value of outcomes for the self + value of outcomes for the other + value of equality.

Consider the A,X cell of Table 4. A joint gain transformation views the 3,3 outcomes as a joint gain of $(3+3=)$ 6 points. In contrast, a relative gain transformation views them as a relative gain of $(3-3=)$ 0 points. If prosocials tend to create a joint gain effective matrix that sees outcomes for the self, and others, and for equality as all important, it makes sense that they would prefer the 3,3 option. If proselves assign a high degree of importance to their own outcomes and little or no importance to the outcomes of others or for the goal of equality, it would make sense that they would opt for the 4,1 cell. Competitors would actually negatively weight equality and outcomes for the other, thus making the 4,1 cell even more attractive.

One difficulty with studying behavior in interdependent structures is the way that past behavior and outcomes may influence future choices. Consider, for example, a cooperator who is playing a series of repeated trials of the game in Table 3 against a competitor. In the beginning, the cooperator makes Choice X, but the competitor makes Choice B. The end result is 1 point for the cooperator and 4 points for the competitor. Strictly speaking, the cooperator should see this outcome as relatively positive. After all, the joint gain is 5 points, which is only 1 point away from the maximum benefit. Prior research has shown that in this environment, the cooperator is likely to begin making competitive choices. Even prosocials will shy away from being exploited by others.

Prosocials and proselves differ in the extent to which they expect cooperation from others. Proselfs enter into social situations expecting others to compete. Given this expectation, it makes sense that they would immediately adopt a competitive stance to avoid being exploited. In contrast, prosocials are more open to the idea of either competition or cooperation from others. As a result, they may adopt an initially cooperative stance but shift to competitive choices if others behave competitively. The idea that people with different social value orientations hold different expectations for cooperation from others is known as the triangle hypothesis.

Prosocials and proselves respond differently to opponents' emotions in social interaction. Surprisingly, research indicates that proselves are more sensitive than prosocials to an opponent's disappointment during a negotiation. When faced with an opponent who expressed disappointment, proselves reduced their level of demand more than prosocials. One way to make sense of this finding is that proselves will engage in strategic cooperation to ensure their own future outcomes, so they must pay careful attention to information about others' opinions of them. Individualists' willingness to make sacrifices in close relationships is closely tied to their level of commitment to the relationship. One explanation for this finding is that, because individualists are focused on their own gain, they will only give up something they feel is worth their sacrifice.

A long-term, committed relationship may create the assumption of an eventual payback and return to equity.

Proself and prosocial individuals think differently about the meaning of cooperation and competition. The might over morality hypothesis suggests that prosocial individuals think about the competition-cooperation dimension in terms of morality and view cooperation as morally good and competition as morally bad. In contrast, proself individuals tend to think about competition as strength and cooperation as weakness. Prosocials tend to see cooperation as an intelligent behavior and competition as an unintelligent behavior, whereas proselves view them in the opposite manner. Proselfs tend to expect cooperative behavior from unintelligent people, whereas prosocials expect cooperation from more intelligent others.

There is also speculation that people with prosocial orientations take on a different time perspective when dealing with a social dilemma. They are more likely to take into account a longer time perspective on the future fate of a shared resource. Perhaps as a result of this longer time perspective, they are better able to appreciate the way that social dilemmas can trap people into engaging in behaviors with long-term negative consequences.

Most of the research on social values has focused on how social value orientation influences preferences to distribute resources to self and others. The focus of distributive justice research is on what would be considered a fair allocation. Prosocials tend to see fair allocations as those that benefit the group. In contrast, proselves define fairness in terms of personal gain. When evaluating another person who had produced equal inputs as themselves, prosocials saw equal outcomes as fairer than either overbenefit or underbenefit. In contrast, proselves saw favorable outcomes to the self as fairer than unfavorable outcomes to the self.

The focus of procedural justice is on whether the process used to distribute resources is considered fair. Often, people will be satisfied with unfavorable outcomes if they feel that the procedure used to arrive at a certain outcome distribution is fair. Proselfs show more concern with procedural fairness than prosocials. In comparison to prosocials, proselves have been shown to prefer having a voice in outcome allocations and will report being more satisfied when they do so.

A final issue about the influence of social value orientation is whether findings obtained using mixed-motive games will generalize to more realistic aspects of human interaction. There is evidence that social value orientation, as assessed with the decomposed game measure, can predict other, qualitatively different behaviors, such as volunteering for charity work or taking steps to protect the environment by using mass transportation. Proselfs are also more likely than prosocials to take advantage of another person when setting a selling price in a negotiation. Prosocials are better than proselves at inferring others' mental states.

When Social Value Orientations Do Not Make a Difference

People do not always behave in accord with their social value orientation. Often, personality variables, such as social values,

have their greatest influence when situational cues are weak or ambiguous. With strong situational constraints, people tend to conform to environmental cues. For example, given a choice between a million dollars for the self and a million dollars for another versus \$20 for the self and \$1 for another, a competitor should – technically – choose the latter choice, which affords a \$19 advantage to the self rather than the zero advantage of each receiving a million dollars. In practice, it is probably safe to assume that everyone, regardless of social value orientation, would prefer the million dollar outcome. In other words, the external pressure to obtain a certain reward overwhelms the influence of an internally based social value orientation.

Social norms might influence behavior in interdependence settings. The norm of social responsibility is the tendency to help those who are in need of help. Although people, especially competitors, might be tempted to exploit someone who seemed weak or vulnerable, it is also possible that people would act more charitably toward someone in need or who acted in a supplicating fashion. The norm of reciprocity refers to behaving toward a person in a manner similar to how the person behaved. This is how a tit-for-tat strategy works. Reciprocity would mean making cooperative choices toward an opponent who acted cooperatively and making competitive choices toward an opponent who acted competitively. One application of the norm of reciprocity involves keeping promises to cooperate. One interesting research program found that people were willing to keep promises when they played a prisoners' dilemma with a computer program, even when they knew they were playing against a computer. Equality is another influential decision rule because it seems to appeal to a sense of fairness. There is research that shows both prosocials and proselves will adopt an equality allocation rule when dealing with a social dilemma. However, if group members see that they are failing to manage the task properly, then social value orientation will exert a greater influence on choice, with prosocials restricting their consumption to a greater degree than proselves.

Much of the research on social values has been conducted in the United States or other Western cultures. As a rule, these Western cultures tend to have more individualistic rather than collective orientations. Cultural norms toward collectivism could increase levels of cooperative behavior. However, in a recent research conducted in Taiwan, ROC has found evidence for the presence of both prosocial and prosocial value orientations, thus suggesting that social value orientations may exist among very different cultures.

Increasing incentives for cooperating or competing will reduce the influence of social value orientation. Expecting to interact with the person in the future would increase the social costs of competing and, therefore, encourage cooperation. Sharing a collective identity can also increase the tendency to cooperate, especially among proselves. Interpersonal dynamics would probably affect cooperation rates. People might be less likely to exploit a likeable or attractive opponent. It is interesting to speculate on the role of sexual attraction on behavior in a mixed-motive game. We would expect more competitive behavior when people are deindividuated, that is, given a situation where their identities are anonymous. In this instance, there would be fewer social costs associated with competing.

One limitation of using matrix games such as the prisoners' dilemma to understand social behavior is that the game, while useful, is only a limited model of human social behavior. People are required by the experimental instructions to make one of two possible choices. One feature missing from game simulations is that people often walk away from aversive real world situations with a mixed-motive structure. Research has shown that everyone, regardless of social value orientation, will avoid interacting with a competitive opponent. Cooperators and individualists appreciate tit-for-tat partners, but competitors avoid them. Thus, social value orientation may influence not only the way a person acts in an interdependent situation but also the types of situations people get into in the first place.

Origins of Social Value Orientations

Certain matrix transformations may require a greater level of cognitive development than others. For example, an individualistic orientation only requires that a person look at his or her own outcomes. In contrast, competitive and cooperative orientations require that people compare their own outcomes to others' outcomes using a mathematical transformation (either subtraction or addition). There is evidence that social value orientations develop across the life span. Very young children (<4) tend to satisfy individualistic motives. Between the ages of 4 and 5, competitive orientations emerge. Finally, between 6 and 7 years, cooperative social values begin to manifest themselves.

Socialization is another basis for the development of social value orientations across the life span. Children learn that competition may be necessary to acquire scarce resources, particularly attractive toys, parental attention, and candy. At school, children learn that they can gain the attention of their teachers by performing at a higher level than their peers. At the same time, it is likely that as children grow older, they are exposed to the cultural value placed on cooperation through lessons from teachers, parents, and religious authorities.

One important influence on a person's development is family. Paradoxically, prosocial orientations are associated with coming from a larger family and with having more siblings, despite the greater competition for resources that would occur in a large family. Rather than leading to greater conflict among siblings, the competition for resources might lead children to develop a joint gain orientation as a more skillful way to negotiate their share of resources. In addition, parents may delegate child care duties among their children, and, as a result, children may develop the habit of thinking about the welfare of others from a relatively early age.

Another factor that may contribute to the development of prosocial social value orientations is sufficient wealth and comfort so that sharing becomes feasible. In an impoverished environment, it might be more difficult for people to develop the insight that greater overall benefit might be derived from cooperation rather than the pursuit of self-interest.

Social values may develop in part as a result of biological predispositions. If there is a genetic component to social values, then the correlation of social value orientations between identical twins would be higher than it would be for

siblings. Of course, it would be necessary to rule out similarities due to similar home environments rather than a biological predisposition. The fact that related constructs, such as altruism and empathy, show a genetic relatedness component of about 50% hints that a similar finding might be obtained for social values. However, such work has not been conducted to date. Even if such a relationship were obtained, it would also be necessary to determine what aspect of biology was producing similarity in the development of social values.

Both the triangle hypothesis and the might over morality hypothesis implicitly favor an etiology based on socialization. People learn to expect cooperation, competition, or both from prior interactions with others, observation, and exposure to mass media. As these expectations develop, they become tinged with a connotative meaning of morality or strength. Thus, it seems likely that biological dispositions will be moderated by learning that occurs in the home, at school, and elsewhere.

Conclusions

Much of the early research on social values focused on explaining the behavior of individuals playing mixed-motive games such as the prisoners' dilemma. In this research, the general finding was that people with different social values transformed the payoff outcomes in a given matrix into a new set of outcomes that reflected the actor's underlying values. In general, transformations seemed to focus on an actor's own gain, relative gain, or joint gain. An individual difference approach was successful in explaining some of the variation in how people played matrix games.

Much of the initial work on social values conducted in the 1960s and 1970s focused on the behavior of college students playing mixed-motive games in the United States. Starting in the 1990s, the external validity of the social values concept was greatly expanded. Many cross-cultural studies have demonstrated that social value orientations describe people's choice behavior in a wide range of countries, including the Netherlands, Sweden, and Taiwan. Another important contribution of recent research on social values has been to expand the

ecological validity of social values as an explanatory construct. This research has tried to gain a better understanding of how social value orientation influences the way people respond to real-world situations of social interdependence. Rather than focusing on behavior in an artificial game, researchers have examined how social values influence a variety of prosocial behaviors. An important and growing trend among social values researchers is to better understand individuals' subjective experience of cooperation and competition. This work has focused on the symbolic meaning that cooperation and competition have for individuals who choose to behave one way or the other.

See also: Altruism and Helping Behavior; Behavioral Economics; The Clinical and Cognitive Psychology of Conflict; Competition; Decision Making (Individuals); Equity Theory; Expectation; Group Dynamics; Negotiation; Self-Fulfilling Prophecy; Social Exchange.

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Socioemotional Development

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Glossary

Differential susceptibility The idea that certain genes are not just 'vulnerability genes,' but rather that they seem to make children more sensitive to environmental influences, whether they are positive or negative.

Emotion regulation The internal and external processes involved in monitoring, evaluating, and modifying emotional reactions (especially their intensive and temporal features) to accomplish one's goals.

Functional view of emotions The idea that emotions are related to changing or maintaining relations between the organism and the environment in ways relevant to one's goals.

Gene polymorphism The variations in genetic characteristics that are associated with different physical or behavioral tendencies.

Limbic-hypothalamic-pituitary-adrenocortical (LHPA) axis A network of nervous system and endocrine system

processes that constitute the body's primary stress system, and which contributes to the immediate surge of energy, attentional focus, and emotion following threat as well as the long-term arousal that is also associated with stress.

Molecular genetics Molecular genetics is the study of the structure and function of genes at a molecular level.

Social referencing Looking to the emotional expression of another person for cues about how to evaluate an ambiguous person, object, or situation.

Socioemotional development An aspect of developmental science concerned with the convergence of social and emotional growth.

Structural view of emotions The idea that emotions are discrete, coherent constellations of physiological, subjective, and expressive activity that are organized neurobiologically, and are thus structured consistently across culture and history.

Socioemotional development can be defined by the convergence of social and emotional growth. This is a broad field of developmental study because of how significantly, throughout life, emotional reactions influence social behavior, and how social experiences affect emotional growth.

The field of socioemotional development addresses many issues. These include: how emotion is expressed in social contexts, the social elicitors of emotional responses, the social and cultural construction of emotion understanding, the social consequences of emotional reactions, the sociocultural influences on emotion and emotion regulation, and the effects of emotion on social behavior. It also includes the study of empathy and its development, understanding and enactment of emotional display rules, the social dimensions of temperamental individuality and its genetic determinants, the development of guilt, shame, and other self-conscious emotions, the effects of developing neurobiology on the growth of emotion and emotion regulation, changes in the social environment that alter emotional demands, and many other topics.

Socioemotional development is central throughout life. In infancy, for example, socioemotional development is reflected in the emotional attachments of infants to their caregivers and their emotional reactions to unfamiliar people. In adulthood, socioemotional development is reflected in how older adults become more selective in their social interactions to create and maintain an emotionally satisfying life.

The field of socioemotional development has important practical implications. It is concerned, for example, with understanding the impact of social relationships on risk for affective pathology (such as depression or anxiety) and social

influences on the prevention and treatment of emotional disorders. Socioemotional development is also relevant to the origins of school readiness, social competence, and coping with stress. The field of socioemotional development integrates themes of cognitive development, neuroscience, developmental biology, molecular genetics, culture, developmental psychopathology, and many other fields. It is a broad, complex, and integrative field of study.

In this entry, we do not strive to discuss each of these facets of socioemotional development. Instead, we begin with a discussion of current views of emotional development and its relevance to social functioning. This is because the field of socioemotional development is enlivened by a new theoretical understanding of the nature of emotion, its development, and the influence of emotion on social behavior and growth. In the sections that follow, we focus on selected topics in socioemotional development that highlight emerging directions for this field. First, we discuss the interaction of genes and environment in socioemotional development and its implications for the traditional 'nature versus nurture' debate. This discussion profiles the increasing importance of genetic approaches to understanding socioemotional development. Second, we discuss how socioemotional development is based on the developing brain and biological systems in the body as they respond to environmental events. This discussion profiles how emotion is a complex neurobiological process in which social influences can have immediate and long-term effects. Finally, we discuss emotion regulation and its development. This discussion profiles the complex foundations on which emotions are managed, and their implications for socioemotional development.

Current Perspectives on Emotional Development

The field of socioemotional development is enriched by new perspectives on the influence of emotion on social behavior and development. Traditionally, children have always been viewed as emotional in nature, with emotions accounting for children's exuberance, carefreeness, irrationality, disorganization, or at times their disturbing behavior. This is one reason why emotional self-control is traditionally viewed as a mark of growing maturity. Similarly, personality theories in psychology have also emphasized emotion as creating stress, disorganization, or impulsivity, with therapy sometimes required to restrain emotional influences and channel them in productive directions. These views of emotion are consistent with our everyday experience, of course, but they neglect the constructive role of emotions in behavior and development. Although emotions always retain their capacity to disorganize or undermine effective functioning, the idea that emotions contribute constructively to social understanding, self-awareness, social competence, morality, and many other aspects of effective functioning is central to the field of socioemotional development.

One source of this new awareness of the influence of emotion is evolutionary psychology. Emotion is deeply rooted in the evolution of our species. Emotion has neurobiological foundations in subcortical structures that have a long biological heritage. Basic emotional reactions are universally evident in human behavior across cultures, and the universal recognition of facial expressions of basic emotions further suggests that emotion is an innate feature of human functioning. Adding to this view, emotional arousal is associated with many biologically adaptive motivational tendencies: the impulse to flee potentially threatening events (fear), the capacity for self-defense (anger), quickly gathering information concerning unexpected events (surprise), attentive information intake (interest), expelling noxious events (disgust), and so forth. Emotional expressions are also potent social signals that convey one's arousal and action tendencies, contribute to social bonding, and alter the behavior of others (such as when an attacker withdraws after perceiving the victim's anger).

Understanding emotions in this way helps explain why we are so sensitive to the emotional expressions of others, and how emotions function in development. Consider, for example, the powerful emotions that contribute to infant-parent attachment: the mutual joy that occurs in parent-infant play, the baby's wariness or fear of unfamiliar people who are not caregivers, the distress that occurs in the parent's absence that is readily relieved when the caregiver returns, and the parent's pleasure in the baby's recognition of him or her. Attachment theorists believe that these emotions and associated behaviors are not just learned reactions to a familiar caregiver, but have evolved to promote the baby's proximity to familiar caregivers as a means of ensuring the baby's survival. They argue that in the natural settings of human evolution, where predation, natural dangers, desertion, and other risks posed formidable challenges to individual and species survival, such emotions and behaviors helped to ensure that infants remained close to caregivers who would be protective, nurturant, and instructive. They have functioned, in other words, to ensure that infants survived to maturity and contributed to the survival of the human species. Viewed in this light, emotions are central to

the adaptive, psychologically constructive behaviors that have long been part of our species.

Emotion in Psychological Development

The conclusion from evolutionary psychology that emotions are adaptive and psychologically constructive is consistent with what we observe in child development, as attachment research illustrates. Even though casual observation of young children contributes to the view that emotions lead to irrational exuberance or defiant tantrums, upon closer examination, developmental researchers have learned that emotions are central to the development of social understanding, self-awareness, morality, and other aspects of behavioral competence.

Consider the emergence of social understanding in infancy. Even though infants and toddlers are commonly viewed as 'egocentric' – that is, incapable of understanding how another's perspective, feelings, or thoughts differ from the child's own – researchers have discovered that very young children have an early, nonegocentric awareness that what other people see, feel, and think is different from the child. A simple and easily-observed example is social referencing, which consists of looking to the emotional expression of another person for cues about how to evaluate an ambiguous person, object, or situation. Adults engage in social referencing all the time (recall the last time you were in a group and heard a comment that could either be interpreted as funny or sarcastic), and so do infants. When 1-year-olds encounter a friendly but unfamiliar adult, for example, they typically look to their mother's face for cues about how to respond. If mother looks positive or reassuring, infants are more likely to respond sociably; if the mother looks fearful, infants will withdraw and may become distressed. Babies are thus aware that even if they do not know how to respond, mother does, and by 'reading' her emotional reaction while she is looking at the ambiguous event (e.g., a friendly stranger), they can gain information from her emotional reaction about whether this event is positive or negative. (Incidentally, if mother is *not* looking at the ambiguous event, 1-year-olds will work hard to attract her attention to that event). Social referencing is an early example, therefore, of acquiring understanding through the emotions of another.

Infants are capable of social referencing because early in the first year, they learn to appropriately 'read' the facial and vocal emotional expressions of others. They respond distinctively and appropriately to expressions of anger, sadness, fear, and happiness that they detect in another's face or voice. Emotion is thus an early entrée into another's internal experience (in this case, feelings), and infants use others' emotions to learn more about people. In one experiment, 18-month-olds watched as a friendly experimenter ate broccoli (while showing expressions of delight and pleasure) and goldfish crackers (showing disgust and unhappiness). Even though the toddlers themselves preferred the goldfish crackers, when they were asked by the experimenter to give her more of the food that she liked, they nonegocentrically handed her more broccoli. The emotions of others provide young children with tools for social understanding. As they grow up, they appraise the emotions of others even more insightfully as they develop greater social competence and an appreciation of how people are similar and different.

Emotions are also crucial to how young children understand themselves. Although developmental scientists used to believe that young children perceive themselves primarily in terms of their physical characteristics and what they can do (e.g., 'I'm big!' 'I run fast!'), careful research has revealed that preschoolers also have psychological self-awareness. The earliest words they use to describe their own internal states describe their feelings, needs, and desires. By the ages of 4 and 5, preschoolers are aware of some of their personality characteristics, which they describe primarily in terms of emotional characteristics, such as their timidity (or boldness), agreeableness, negative mood, and positive or negative self-image. These self-descriptions are influenced by how young children are perceived by their mothers and the quality of the parent-child relationship (one study reported that preschoolers with low self-concept had mothers with high parenting stress and depressive symptomatology) but they are also based on children's experience of themselves. One reason why emotional characteristics are so prominent in young children's self-awareness, in other words, is because the emotions associated with being shy, negative, or agreeable are experienced every day in recurrent social situations.

Emotions also have a positive, constructive influence on the growth of moral awareness. Traditional moral development theories have emphasized emotions such as fear of punishment, anxiety over the loss of parental love, anticipated rewards for compliance, and feelings of guilt and shame. These emotions are undoubtedly important, but young children's sensitivity to the feelings of others is another important influence on the early development of moral awareness. Emotional sensitivity is central to children's earliest judgments of good or bad behavior ('that made her sad') and of people ('he was mean'), and the human consequences of behavior are crucial to young children's judgment of the seriousness of wrongdoing. Because young children understand others' feelings from such an early age, emotion is a bridge between moral standards and the human consequences of good and bad behavior. Several studies have shown that children were more advanced in moral development if their mothers talked to them about people's feelings and the human consequences of misbehavior, in contrast with when mothers instead discussed rules and the consequences of breaking them. Emotions are a foundation for the development of moral understanding based on the consequences of actions for people.

Emotions are also important to the growth of social competence, especially as children develop significant networks of peer relationships. The ingredients of successful peer relationships, including the capacity to be a self-confident, outgoing play partner, manage conflict constructively, be appropriately assertive in expressing preferences and opinions, and maintain positive expectations for friendship are each based on skills in emotion understanding and emotion self-regulation. By contrast, children who develop significant problems with peers are characterized by aggressive conduct, deficient social problem-solving skills, and a hostile attribution bias that causes them to interpret benign social behaviors of others as having hostile intent. Some intervention programs designed to help children with poor social skills are focused on enhancing children's sensitivity to the emotions of others and enlisting that understanding into social problem-solving skills that include respect for the feelings and needs of other children.

One important reason that emotions can have psychologically constructive influences on social understanding, self-awareness, morality, and social competence is emotional development is embedded in children's relationships with their caregivers. Parent-child relationships are important to the organization of emotional development beginning in infancy, when parents help to manage infants' emotions, buffer stress, and contribute to the baby's emotional well-being. Later, parents help young children understand emotions through their responsiveness to the child's feelings and in conversations when they talk about the causes and consequences of others' feelings. Parents also coach children in emotion self-regulation. The importance of close relationships to emotional development is one reason that children in secure parent-child attachment relationships are higher in emotion understanding and social competence than are insecurely-attached children. Through parental responsiveness and parent-child conversation, emotion becomes connected to children's understanding of themselves and others, emerging values, and other relationships.

Emotion: Its Structure and Functions

Another feature of the study of socioemotional development is a new understanding of emotion itself. Traditionally, researchers have viewed emotional life as a set of distinct emotions that arouse and subside, much as we experience emotions in everyday life. According to this structural view of emotions, emotions are discrete, coherent constellations of physiological, subjective, and expressive activity that are organized neurobiologically, and are thus structured consistently across culture and history. In this view, humans possess a repertoire of basic emotions – including anger, fear, joy, sadness or distress, surprise, interest, and disgust in most theories – that are differentiated by unique patterns of physiological activation, subjective experience, action tendencies, and expression (in particular, facial expression). The emotion of anger, for example, includes a unique subjective experience, the physiological concomitants of that feeling (which accounts for the specific kind of energized arousal that accompanies angry feelings), a unique facial expression (e.g., lowered eyebrows, narrowed eyes, mouth grimace), and specific behavioral tendencies (which may include approach and attack).

Some basic emotions (such as distress) are apparent at birth. Others (such as anger and fear) develop early as the baby becomes capable of relevant conceptual appraisals of people and events. In later years, the repertoire of basic emotions is supplemented by a range of secondary emotions – such as embarrassment, guilt, and gratitude – that are not as strongly organized by biology and are thus more culturally variable. The circumstances eliciting secondary emotions can differ markedly in different societies (e.g., shame is a more significant moral socializer in Asian societies, than in the United States), and not all cultures have the same repertoire of secondary emotions. As earlier noted, basic emotions and the facial expressions signaling them are universally evident in humans. This has led researchers to use facial expressions as indicators of emotion, even in infants and young children. By carefully measuring facial expressions of children as they respond to different experimental events, in other words, researchers

guided by a structural view of emotions expect that they will learn about the underlying subjective emotion that the respondent is experiencing.

Although we typically think about our feelings in a manner consistent with the structural view, other emotion theorists have questioned whether emotional experience is organized in this manner. Cultural theorists point out that people in different societies refer to emotional experiences for which there is no English term, and which are thus not captured in most structuralist accounts of emotion. Some developmental researchers have noted that the facial expressions of young infants are often inconsistent with their circumstances (such as a baby who shows surprise while staring at a soft light), suggesting that facial expressions may not always be reliable indicators of underlying subjectivity. Furthermore, many students of emotion suggest that typical emotional experience consists not of the succession of discrete emotions, but rather subtly nuanced blends of a broad variety of emotional states that range in their intensity and timing. This, too, is consistent with everyday emotional experience.

For these reasons, another way of understanding emotion has emerged to complement the structural view. According to the functionalist view, emotions are defined not by biologically based constellations of expression, experience, and arousal, but rather by an organism's goals and their attainment. Emotions not only reflect success or failure in goal achievement, but are also related to changing or maintaining relations between the organism and the environment in ways relevant to these goals. The emotion of anger, for example, is associated with one's goals being blocked by another, and the action tendencies of anger are directed toward removing this obstacle in order to better achieve the goal. Functionalist approaches emphasize the motivational qualities of different emotions, the importance of emotional expressions as social signals (not necessarily direct reflections of underlying feelings), and the association between emotional arousal and how a person appraises the meaning of environmental events. Although functionalist approaches use the language of discrete emotions, they also refer to broader 'families' of emotions that are connected by common patterns of organism-environment transactions.

A functionalist view of emotion is thus more open to the influence of cultural meanings on emotional life and the view that emotional experience includes blends of feelings rather than discrete emotions. From a developmental perspective, a functionalist approach highlights the importance of the child's goals in specific situations, and these goals may be complex, rapidly changing, and very different from that of accompanying adults (e.g., a toddler seeking candy during a supermarket visit). Measuring emotion also requires attention to more than facial expressions and includes the variety of behavioral, vocal, gestural, postural, and other indicators of emotional experience.

Taken together, structuralist and functionalist views enliven the study of socioemotional development by underscoring the multifaceted influences on emotional experience, and how these change with development. Understanding emotion in these ways also aids researchers in understanding the role of emotion in parent-child attachment, social competence, moral awareness, or other topics in the field of socioemotional development.

The Intersection of Genes and Environment in Socioemotional Development

Socioemotional development is a complex and integrative field of study, uniting consideration of social influences, cognitive development, language ability, the growth of the self, culture, and many other developmental influences with emotional development. Traditionally, developmental study has tended to emphasize either nurture (such as parenting influences or neighborhood quality) or nature (such as genes or brain development). In recent years, however, research in the area of molecular genetics – which studies the structure and function of genes at a molecular level – has rejected the traditional 'nature versus nurture' debate by showing how the expression of specific genes in behavior depends critically on characteristics of the environment. 'Nature versus nurture' has become scientifically obsolete as researchers are discovering that nature and nurture are completely intertwined and that socioemotional development occurs at the intersection of biological processes and social contexts.

Each child enters the world with a unique genetic profile that significantly influences how the child responds socially and emotionally. Molecular genetics research has identified several common genetic polymorphisms (i.e., genetic variations) with specific socioemotional characteristics. These include the dopamine D4 7-repeat (DRD4 7-repeat) which is associated with novelty seeking and impulsivity, and the serotonin transporter promoter short allele (5-HTTLPR), which is associated with negative emotionality and cautious, inhibited behavior. Children with these polymorphisms are more likely to show the social and behavioral characteristics associated with them.

However, children with the same genetic polymorphisms often show *different* behavioral profiles, and research on gene-environment interaction illuminates why. While individual differences in genetic characteristics are set at conception, these differences interact with the environment as the child grows up. In particular, the quality of care is an important influence on how specific genes are expressed in behavior. For example, children who have the DRD4 7-repeat polymorphism and experience harsh, insensitive parenting are significantly more likely to show later behavioral problems compared with children with the DRD4 7-repeat who experience high quality parental care. Beyond the family, social support can also be important. One study, for example, indicated that children with the 5-HTTLPR polymorphism whose mothers reported low levels of social support were more likely to show inhibited behavior in middle childhood compared with children with the same polymorphism whose mothers experienced greater social support. These studies indicate that knowledge of genetic individuality is important in the context of the environment in which that individuality develops.

In light of these conclusions, it is not surprising that children with genetic proneness to negative or inhibited behavior who develop warm, secure parent-child relationships have better socioemotional outcomes than children in insecure relationships, and indeed this is true. One study showed that children with the 5-HTTLPR polymorphism with insecure parent-child attachments showed higher levels of distress and fear.

But children's genetic characteristics may also contribute to the security of the parent-child relationship. Children with the

DRD4 7-repeat or the 5-HTTLPR polymorphisms are more likely to develop insecure, especially disorganized, attachment relationships when their mothers are insensitive and unresponsive. In each case, the polymorphism may heighten children's susceptibility to negative parenting, making these children more vulnerable to developing insecure attachments. Although parental sensitivity is the key influence on the development of secure attachment, hereditary influences may cause some children to be more affected by variations in parental responsiveness than others. In this respect, genetic characteristics can moderate the effects of environmental influences (such as the quality of parental care) on socioemotional development.

Genes and Risk for Emotion-Related Psychopathology

An understanding of gene–environment interaction can help answer some of the perplexing questions of socioemotional development. Why do some children who are abused and neglected early in life appear to develop normally, whereas others become aggressive, depressed, or show other negative outcomes? More generally, why do two children who experience similar rearing environments turn out so differently? The answers to questions like these concern how genetic characteristics can buffer or enhance the effects of environmental influences.

One illustration comes from research on the monoamine oxidase A (MAOA) gene, which encodes the MAOA enzyme that plays a role in regulating aggression and antisocial behavior. Genetic characteristics leading to low MAOA enzyme production are associated with aggressive conduct. One researcher found that in a large sample of men, some of whom had been abused as children, the long-term effects of early maltreatment depended on whether genetic characteristics led to high or low MAOA activity. Men who had low MAOA activity and had been abused as children exhibited, as adults, higher rates of conduct disorder, violent behavior, and antisocial behavior than men with high MAOA activity, even though both groups had experienced child maltreatment. Men who had not been abused in childhood showed low levels of adult negative behavior regardless of their MAOA activity.

Thus, while maltreatment heightened the risk of later problem behavior, this risk was especially increased for men with a particular genetic characteristic. Another study found that when young adults experienced stressful events (such as problems with health, employment, or significant relationships), whether they later became depressed was predicted by whether they also had the 5-HTTLPR polymorphism. Those with 5-HTTLPR were more likely to later show depressive symptoms after encountering life stress compared to those without the 5-HTTLPR polymorphism, whereas individuals who had not experienced significant stress showed little depression. These findings are a good illustration of gene–environment interaction, and how genetic characteristics can moderate the effects of even severe environmental challenges.

Based on these findings, it is easy to conclude that children with the 5-HTTLPR or DRD4 7-repeat polymorphisms or with low MAOA activity have inherited genetic characteristics that increase their risk of socioemotional difficulty. For this reason, they are sometimes described as 'vulnerability genes.' However, some researchers suggest instead that these genes contribute to

the child's differential susceptibility to *both* negative *and* positive environmental influences. Some studies find, for example, that children with the DRD4 7-repeat polymorphism show greater negative behavior when they experience harsh parenting compared to children without this polymorphism, but also that they respond more positively to responsive parenting than children without the DRD4 7-repeat. Viewed in this light, certain genetic characteristics seem to make children more sensitive to environmental influences, whether they are positive or negative. Clearly, this view changes the portrayal of these genes from 'vulnerability' genes to 'sensitivity' genes, and this has implications for how to construct environments that enable children with different genetic tendencies to thrive socioemotionally.

The research on molecular genetics adds to the field of socioemotional development the recognition that genetic individuality is an important contribution to the growth of emotional and social characteristics. It shows that the environment influences how genes are expressed in behavior, and that the effects of the environment (such as parental warmth and responsiveness) depend, in part, on the child's genetic characteristics. This research puts to rest the traditional 'nature versus nurture' debate by showing that genes and environments interact continuously in development, and that an understanding of genetic influences requires an appreciation of the environments in which genes are expressed.

Socioemotional Development and the Developing Brain

The field of socioemotional development is also enriched by current research on brain development. Research in this area highlights, in particular, how children's social experiences can influence the complex neurobiological processes in the brain and body by which emotional responses are constituted and regulated.

Emotional responses are complex neurobiological phenomena. An emotional reaction typically begins in the reciprocal influences among multiple brain areas relevant to the appraisal and evaluation of environmental events. Some of these brain areas in the subcortex (such as the amygdala) are deeply rooted in our mammalian heritage, while others in the cortex are evolutionarily newer regions involved in complex judgments. As events are appraised, these brain systems lead to the activation of multiple processes in the sympathetic nervous system and endocrine system that create the physiological and subjective experience of emotion as the body responds to the instigating event. For example, the limbic–hypothalamic–pituitary–adrenocortical (LHPA) axis is a network of nervous system and endocrine system processes that constitute the body's primary stress system, and in coordination with other neurobiological systems, it contributes to the immediate surge of energy, attentional focus, and emotion following threat as well as the long-term arousal that is also associated with stress. At the same time that sympathetic nervous and endocrine systems are activating the body to respond, other systems are beginning to help the body self-regulate and recover. The parasympathetic nervous system, for example, restores nutrients and modulates the increase in heart rate and other physiological systems to restore the body. In addition, regions of

the prefrontal cortex, which contribute to the brain's initial activation of an emotional response, also contribute to the regulation of emotional reactions as they unfold.

There are two important characteristics of the neurobiology of emotion that are sometimes overlooked. The first is that these systems are in constant interaction, with mutual influences that contribute to the complexity of socioemotional responding. Although researchers have long understood how the prefrontal cortex regulates brain structures like the amygdala, for example, it is also true that activation of the amygdala affects cortical areas associated with thinking and judgment – which is reflected in the cognitive focus on threat and danger that accompanies stress responding. Because multiple higher and lower neurobiological systems associated with emotion are deeply interconnected, emotional responding derives from the complex interaction between them.

The second important point is that these brain and biological systems develop over time, and this helps explain certain features of socioemotional growth. As the parent of any newborn can attest, the LHPA system is functional at birth, but as it matures, emotional reactions become less intense and labile, more modulated, and more easily managed. These changes in emotionality also occur through the gradual maturation of other neurobiological systems associated with emotion regulation. Some of these systems, particularly in the prefrontal cortex, have a very extended maturational timetable, which helps to account for the slow growth of skills in emotion self-regulation throughout childhood and adolescence.

The development and functioning of brain areas associated with emotion is also affected by caregiving experience. This can happen in at least two ways. First, in the immediate situation, a parent's warmth and support can buffer stress for a child. One study showed that when physiological stress responses were measured in toddlers following a series of challenging events, the highest levels were shown by toddlers who were temperamentally inhibited and were in insecure relationships with their mothers. For inhibited toddlers in secure relationships, the mother's presence helped to buffer the physiological effects of challenging events, and toddlers who were temperamentally uninhibited were not bothered by the challenges at all. Caregiver sensitivity provides support that better enables children to manage emotional challenges. Second, in the long term, the responsiveness of caregivers and the quality of early experiences can alter the development of neurobiological systems governing stress reactivity and emotion. Children growing up in early adversity, for example, are more likely to become attentionally focused on signs of threat, biologically and emotionally more reactive to challenge, and less capable of adaptive self-regulation. It appears that recurrent experiences of adversity cause neurobiological systems associated with emotion and stress to recalibrate to adjust to the greater threats and difficulty the child regularly encounters. This results in over-reactions to perceptions of threat or danger.

This developmental process is observed most clearly in children who have been maltreated. Many studies indicate that abused children are hypersensitive to adult expressions of anger, perhaps because this enables them to anticipate and prepare for abusive conduct before it begins. Some researchers have identified areas of the brain that contribute to abused children's heightened attention to angry (but not happy or

fearful) adult expressions in the face and voice. Furthermore, maltreated children are more likely to develop heightened LHPA reactivity to stressful events that can cause them to respond with more intense emotion and behavior to threats and challenges. These changes in neurobiological stress systems can help to explain why maltreated children are more physically and verbally aggressive to peers, tend to interpret others' benign social behavior as having hostile intent, and are more likely to develop conduct disorders and other problems later in life.

Understanding socioemotional development in the context of the developing brain underscores that emotional responses to social events are neurobiologically complex, involving constant interaction between multiple neural and endocrine processes. These biological systems mature throughout childhood and adolescence, which helps to account for the progressively more modulated, socially sensitive, and self-regulated quality of emotional responding with growing maturity. These studies also highlight how the neurobiological systems governing emotion and stress reactivity are affected by social experience, particularly the quality of parental care. In situations when children experience significant early adversity, this increases the probability that brain systems governing stress and emotion will become hypersensitive to threat in ways that may pose long-term problems for social functioning.

Emotion Regulation

Emotion regulation consists of the internal and external processes involved in monitoring, evaluating, and modifying emotional reactions (especially their intensity and temporal features, such as speed of onset and recovery) to accomplish one's goals. Emotion regulation is an important topic in the field of socioemotional development because of its theoretical and practical implications. Theoretically, emotion regulatory processes incorporate individual goals, parental socialization processes, societal values, and cultural beliefs into the construction of emotional life, and contribute to how people are emotionally distinct but also share emotional qualities in different social groups. Practically, research on the development of emotion regulation is important to designing interventions that can help children and adults with problems associated with emotion dysregulation, including depression, anxiety, aggression, and relationship disturbances. More generally, research on this topic addresses the challenges of enlisting emotional reactions constructively into adaptive social functioning.

The definition of emotion regulation given above highlights that regulatory processes can be involved in managing positive as well as negative emotions (such as suppressing laughter when hearing a joke at a serious event), and can involve how other people regulate one's emotions as well as one's own self-regulatory efforts. Emotion regulation by others is, of course, especially important to infants and young children. This definition of emotion regulation also underscores that emotion is managed by altering its intensity and its temporal features (such as its escalation, decline, or lability). Individuals self-regulate in order to reduce the intensity of feelings of sadness, for example, or to retard the rapid escalation to anger when provoked, and it is the intensive and

temporal features of emotion that are often characteristic of emotion-related psychopathology like depression.

Emotion regulation is important for accomplishing one's goals. This is consistent with the functional view of emotion earlier described, and is important for understanding how and why individuals manage their emotions as they do. In developmental analysis, adults may misperceive children as emotionally dysregulated in situations where children are functioning quite well as emotional tacticians (e.g., a toddler fussing for candy, an adolescent becoming moody to elicit sympathy from friends). Multiple goals can guide emotion regulatory efforts, and different self-regulatory strategies can serve different goals in different situations. A child who is being threatened by a peer, for example, may manage emotions differently to accomplish the immediate goal of averting the bully (e.g., crying loudly to elicit help) or to deter future intimidation (e.g., controlling fear and enhancing anger to defend oneself). The efficacy of alternative emotion regulatory strategies in accomplishing goals depends, of course, on the presence of other people and the child's relationships with them, cultural values (e.g., Nepalese children, are socialized to avoid *any* expression of negative emotions), and many other factors.

In some circumstances of emotional adversity, the self-regulatory challenge faced by children is that there are no optimal strategies for coping with the emotional demands they face. Their emotion regulatory strategies are likely, therefore, to involve inherent trade-offs that purchase immediate coping at the cost of long-term difficulty, and which ultimately may increase rather than diminish their emotional problems. Some of the problems faced by abused children discussed earlier, for example, derive from their hypersensitivity to signs of adult anger that enables them to anticipate an abusive encounter to come, but also renders them more prone to socially inappropriate, aggressive conduct with others. Likewise, children with anxiety disorders devote considerable self-regulatory effort to avoiding encounters with anxiety-provoking stimuli, but in doing so they obtain immediate emotional relief at the cost of long-term dysfunctional behavior. Viewed in this light, emotion regulation for children in conditions of emotional adversity can be seen as a double-edged sword.

Developmental changes in emotion regulation provide significant contributions to social and emotional competence. Whereas a newborn infant may cry uncontrollably, the toddler can seek assistance from others, the preschooler can reflect on and talk about her feelings, the school-age child can redirect attention and use other deliberate strategies to reduce distress or anxiety, and the adolescent can evoke personal strategies (like listening to favorite music) that manage emotion. Many developmental advances in the skills of emotion regulation account for these changes. With increasing age, children become familiar with and adopt sociocultural expectations for emotional expressions, especially in public settings. They assume greater responsibility for managing their own positive and negative feelings. Their repertoire of self-initiated strategies for managing emotions grows, from an initial reliance on behavioral tactics that often rely on social support (e.g., seeking help; avoiding emotionally arousing events) to increasing use of mentalistic strategies of emotion self-regulation (e.g., attentional redirection; cognitive reappraisal). Over time, furthermore, children show increasing breadth, sophistication, and

flexibility in their use of different emotion regulation strategies, and are capable of adapting preferred strategies to the demands of the situation, substituting more effective strategies after others have proven ineffective, and even using multiple strategies when needed. Children also develop strategies that are more effective in managing certain emotions (such as fear) than others (such as anger). The development of emotion regulation is also based on developing an understanding of emotion, growing capacities to monitor one's feelings and appraise the effectiveness of self-regulatory efforts, and incorporate emotion self-regulation into a broader variety of circumstances (such as to enhance problem-solving effectiveness).

As noted earlier, the development of emotion regulation is also associated with brain development, and especially with the slow maturation of areas of the prefrontal cortex that assume a significant influence in emotion management. However, as earlier noted, many brain systems are mutually influential in emotion arousal and regulation, which means that cortical brain regions relevant to emotion self-regulation are also influenced by the activity of brain structures associated with emotion activation. For children and adults who suffer from emotion-related psychopathology that involves alterations in normal hormonal and neurobiological processes associated with emotion, the effectiveness of prefrontal and other cortical areas involved in emotion self-regulation is blunted because of the effects on these areas of lower emotion processes that have been affected by psychopathology.

The study of emotion regulation enlivens the field of socioemotional development because of the important issues it raises concerning how emotional experience is individually and socially constructed, and because of its important practical implications for understanding the origins and treatment of emotion-related psychopathology. As this short discussion has also illustrated, the study of emotion regulation is also uniquely integrative, involving neurobiology, cognitive development, social understanding, cultural values, individual goals, and a variety of other developmental influences.

Conclusion

The field of socioemotional development highlights new understanding of the constructive role of emotion in behavior and development, the continuous interaction of social influences with emotional development, and the importance of integrating the understanding of developing neurobiology, genetics, culture, cognitive growth, temperament, and many other developmental influences. Study of socioemotional development also has significant practical implications, including the importance of understanding emotion and self-regulation to social competence, the significance of emotion to morality, and understanding the origins and treatment of emotion-related psychopathology.

In the specific topics discussed in this article, new ideas concerning the interaction of genetics and environment in socioemotional development are profiled to underscore the obsolescence of the traditional 'nature versus nurture' debate. In addition, the importance of social influences on the developing neurobiology of emotional and stress reactions, and the multiple influences on the growth of emotion regulation,

were also discussed. Taken together, the field of socioemotional development continues to expand in important and provocative new directions.

See also: Developmental Psychopathology; Moral Development; Parenting; Social Development (Attachment, Imprinting).

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Relevant Website

<http://www.developingchild.net> – National Scientific Council on the Developing Child.

Somatoform Disorders

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Glossary

CBT Cognitive behavioral therapy.

CSD Complex symptom disorder.

CSSD Complex somatic symptom disorder.

FSSs Functional somatic syndromes.

MU(P)Ss Medically unexplained (physical) symptoms.

SD Somatoform disorder.

SSD Somatic symptom disorder.

SzD Somatization disorder.

USD Undifferentiated somatoform disorder.

Introduction

Definition

The primary hallmarks of somatoform disorders (SDs), according to DSM-IV-TR, are “somatic symptoms presumed caused by general medical conditions, but are not fully explained by them, other mental disorders, malingering or substance intake. They must cause major clinical distress or decline in daily function.” The SDs according to DSM-IV-TR are multidimensional, primarily seen in primary care, have ~50% comorbidity with anxiety and depression, and are categorized in the following seven subtypes: somatization disorder (SzD); undifferentiated SD (USD); conversion disorder; somatoform pain disorder; hypochondriasis; body dysmorphic disorder (BDD); and SD not otherwise specified (NOS).

Subtypes

SzD is characterized by a history of lifetime multiple unexplained medical problems or physical complaints beginning prior to the age of 30. Patients report symptoms affecting multiple organ systems or physical functions, including pain in at least four unexplained localizations, at least two nonpain gastrointestinal conditions, at least one sexual problem, and pseudoneurological symptoms. Although medical explanations for the symptoms cannot be identified, individuals with SzD experience genuine physical discomfort and distress, and they will usually visit a number of medical specialists.

USD is similar to SzD, but has fewer symptoms or of shorter duration. Common symptoms by one or more medically unexplained physical symptoms (MUPSs) lasting for at least 6 months include for example, chronic fatigue, pain, loss of appetite, and gastrointestinal distress. This diagnosis is appropriate for patients who do not meet all the diagnostic criteria for SzD. Escobar and colleagues have proposed the label ‘abridged somatization’ to be applied to men experiencing four or more unexplained physical symptoms or to women experiencing six or more unexplained physical symptoms, while Kroenke and colleagues have suggested the term ‘multi-somatoform disorder’ to describe men or women currently experiencing at least three unexplained physical symptoms and reporting a 2-year history of somatization.

Conversion disorder is marked by unexplained sensory or motor symptoms that resemble those of a neurological illness

or injury. Common symptoms include paralysis, loss of sensation, double vision, seizures, inability to speak or swallow, and problems with coordination and balance. Doctors often detect conversion disorder when symptoms do not make sense anatomically. Conversion disorder is characterized by the presence of one or more pseudoneurological symptoms that are associated with psychological stressors or conflicts. The conversion disorder construct reflects that somatic symptoms are the result of psychogenic distress.

In somatoform pain disorder, the patients perceive that physical pain causes significant distress or disability, or leads an individual to seek medical attention. Pain is medically unexplained, or associated with a medical condition, but far more severe than expected from the condition itself. Like patients with SzD, people with somatoform pain disorder often have a history of consultations with numerous physicians.

Hypochondriasis is diagnosed when a person is excessively concerned by fears of having a physical disease or injury. Individuals with hypochondriasis usually do not complain of disabling or painful symptoms. Instead, they tend to overreact to minor physical symptoms or sensations, like rapid heartbeat, sweating, small sores, or fatigue. Many people with hypochondriasis develop fears in response to the illness or death of a friend or family member or after reading about a condition or seeing a feature on television. Hypochondriacal fears can be confined to a single disease or may involve a number of different physical concerns. Individuals with hypochondriasis seek frequent reassurance by consulting physicians or talking about their fears, which provide only temporary relief from their fears.

BDD is characterized by preoccupation with a defect in physical appearance. It is a somatic delusion that a part of one’s body has been injured or altered in some manner. Often, the perceived defect of concern is not apparent to other observers, or if there is a genuine defect, it is far less disfiguring than the patient imagines. Common preoccupations include concerns about the size or shape of the nose, chin or cheek, skin appearance, body or facial hair, hair loss, or ‘ugly’ hands or feet. Individuals with BDD may be extremely self-conscious, avoiding social situations because they fear others will notice their physical defects or even make fun of them. They may spend hours examining the imagined defect, for example, hair loss, or avoid mirrors altogether. Time-consuming efforts to hide the defect, such as application of cosmetics or adjustments of clothing or hair, are common. Many people with BDD undergo

procedures like plastic surgery or cosmetic dentistry, and plastic surgeons should be advised not to perform such procedures on this group of patients. Somatic delusions are more serious than other SDs, which can explain why BDD is suggested to be removed in the new DSM-V revision.

SD NOS, is diagnosed when somatoform symptoms are present but criteria for another SD are not met. DSM-IV-TR includes several examples of symptoms that could merit this diagnosis, including false pregnancy, and hypochondriacal fears or unexplained physical symptoms of recent onset or short duration.

Historical Overview

Briquet was the first scientist who conceptualized specific multiple somatic symptoms as one syndrome, which he named hysteria. Others have later applied the term Briquet to this syndrome. Freud later noticed patients who were appearing with the same phenotypes, but unlike Briquet, he distinguished between two different phenomena which both presented somatic symptoms, namely, *conversion hysteria* and *neurasthenia*. Freud defined conversion hysteria as psychic in origin, but neurasthenia as being somatic in origin. The so-called nerve-sick epoch suggested a detrimental effect on the nervous system by fast walking, fast driving, fast eating, fast drinking, fast bargains, fast business, fast 'everything.' The eyewitness descriptions from that time could be as follows: "The noise from the streets, the ceaseless thunder from the vehicles, the rush to-and-from of multitudes of people is more than people can bear. The ceaseless hurry and disruption of business life, the feverish pace, the clamor of the wagons, the endless variety, all the entertainments that exhaust body and soul and continue until late at night; it exhausts the nervous system." Briquet's hysteria concept was further developed by Purcell et al. in 1951 and operationalized by Perley and Guze in 1962. Hysteria, as defined by these authors, was characterized not only by the presence of multiple somatic complaints, but also by anxiety and depressive symptoms. Hysteria was the precursor to the SzD concept, which had an unclear nosological status until the DSM-III defined it in 1980. Anxiety and depressive symptoms were from then no longer a necessary diagnostic criterion for SzD. Lipowski has placed the behavioral dimension into the somatization and SD conceptualization of DSM, based on Pilowsky's abnormal illness behavior paradigm: It is the "tendency to experience and communicate somatic distress and symptoms unaccounted for by pathological findings, attribute them to physical illness and seek medical help for them." Later, several other classifications and terms have been introduced. A line of descent can be traced from the DaCosta syndrome through soldier's heart, shell shock, and battle fatigue to the Gulf War syndrome. Musculoskeletal pain in the workplace, which previously manifested as writer's cramp and telegraphist's wrist, was later termed repetition strain injury in Australia in the 1970s. There are similarities between railway spine, common in the early twentieth century, and the more recent chronic whiplash syndrome. Although the similar constellations of benign symptoms acquire different diagnostic labels, they can be attributed to different causes in different time periods, and thus seem to appear in epidemics or as 'contemporary diseases.'

DSM-IV Compared to ICD-10

SDs are also defined in the International Classification of Diseases (ICD) classification system. As in the DSM system, it relies on subjectively perceived and expressed symptoms. The DSM classification indicates that there are mental causes for SDs, but has also a plausible multilevel conceptualization as expressed by its five axes (*Axis I*: clinical disorders, including major mental disorders, and learning disorders; *Axis II*: personality disorders and mental retardation; *Axis III*: acute medical conditions and physical disorders; *Axis IV*: psychosocial and environmental factors contributing to the disorder; *Axis V*: Global Assessment of Functioning).

The ICD-10's interpretation of SDs is similar, but is not multileveled: "SD's are disorders characterized by distressing, subjective physical symptoms, but without biological changes that can satisfy the requirements of any recognized physical illness." In the ICD-10 system, which classifies both mental and somatic disorders, the SDs criteria differ from those in DSM-IV-TR in several important respects. In ICD-10, BDD is incorporated in the criteria for hypochondriasis. In addition, the ICD-10 includes a category called somatoform autonomic dysfunction (SAD). The criteria for SAD claim symptoms of autonomic arousal in the absence of any known disturbance of structure or function. The criteria for SzD demand at least 2 years of multiple and variable unexplained symptoms representing at least two organ systems. The ICD-10 criteria for pain disorder call for persistent, severe, and distressing pain, continuously for at least 6 months, that cannot be explained by a objective measures or a physical condition. DSM-IV-TR, by contrast, specifies an important role for psychological factors in somatoform pain disorder, but claims no duration requirement. A problem with the ICD-10 classification system is that it has only one category for the diagnosis (e.g., fatigue can be respiratory (R-diagnoses), neurological (G-diagnoses), or psychiatric (F-diagnoses)), but cannot claim more than one explaining factor. However, there is also a problem with the DSM system because it merely is a psychiatric classification system. However, its five axes broaden the perspectives of the causality (e.g., *Axis II* expresses personality features, *Axis III* expresses medical and physical disorders, and so on).

Common characteristics of SDs both in the DSM and ICD system are that the symptoms suggest a medical condition, but that no objective, medical state can be found by a physician. In other words, a person with an SD might experience significant pain without a known medical or biological cause, or they may constantly experience minor aches, pains, and fatigue without any clear reason for these symptoms to exist.

Other Conditions Approximating the SDs

Phenomenon, Symptom, Illness, and Disease

To conceptualize SDs, it is convenient to apply both subjective and objective measures of medical terminology, and to distinguish between phenomena (what we observe), symptoms (abnormal functions or feelings subjectively noticed by the patient), illness (subjective apprehension by a patient of an objectively defined disease), and disease/disorder (i.e., abnormal conditions affecting the body of an organism with known

pathogenesis). A question is whether it is plausible to apply descriptive or etiological diagnoses, as well as process or outcome evaluations. Traditionally, the golden standard for a diagnosis features an explanation in its name, that is, it is etiologic (sinusitis informs about a sinus infection, while fibromyalgia just describes 'pain in muscles'), and while somatization describes a process, somatoform describes an appearance or outcome and thus borrows nomenclature both from Greek ('soma') and Latin ('form').

Medically Unexplained Physical Symptoms

MUPSs or medically unexplained symptoms (MUSs) are defined as subjective patient symptoms for which the treating physician, other healthcare providers, and research scientists have found no medical cause. The term does not mean that a physical cause does not exist, but rather that causes for the given symptoms are uncertain, unknown, or disputed, that is, there is no scientific consensus. Subjective health complaints (SHCs) are also a term for these unexplained symptoms.

Indications of a major or substantial illness can be concluded by using the following parameters: the amount/number of the MUPSs, for example, how many pain localizations or gastrointestinal problems do the patients have; the length of the illness, that is, the illness duration of the symptoms, for example, pain lasting for more or <6 months; their impact on the quality of life; increased medical consumption; the number of symptom groups (e.g., pain, fatigue, bowel problems, sexual dysfunction); and psychological comorbidity. In some patients, the symptoms are attributable to a known somatic disorder; in others, they result from unrecognized factors which may involve physiologic or immunologic hyperactivity and perceptual hypersensitivity. Others may have symptoms that are caused by a psychiatric disorder, or stressful life circumstances. Our knowledge of the functional somatic syndromes (FSSs) is incomplete, and we do not fully understand the etiologic roles of biological, psychological, and socio-cultural factors. How can we understand the patients with subjective symptoms without objective findings?

These patients represent a large and troubled group. Many symptoms coexist and overlap in the patients, for example, fatigue, pain, insomnia, paresthesias, headache, depression and anxiety, sicca symptoms (dry mouth and eyes), gastrointestinal problems, urge incontinence, and Raynaud phenomena (very cold and white hands/feet). They are diffuse, nonspecific, and ambiguous, and they are very prevalent in healthy, nonpatient populations. The similarities seen have led some to propose that the somatic syndromes share a common pathophysiology. However, we do not know if there is one syndrome or discrete syndromes, or if they share common etiological factors. The boundaries between these conditions and their relation to more traditional and accepted diagnoses are still not clear.

Although we are not yet able to explain these conditions satisfactorily, it is recommended that research has a direct focus on the common features with an open-minded multidisciplinary approach. Syndromes characterized by chronic, medically unexplained fatigue, effort intolerance, cognitive dysfunction, widespread musculoskeletal pain, and tenderness are highly prevalent in medicine. They cause a great deal of problems and grave physical, mental, social, and vocational disability. MUSs

are given various labels mainly as a result of their most pronounced symptoms. Examples are central sensitization syndromes (CSSs), for example, chronic fatigue syndrome/myalgic encephalopathy (CFS/ME), fibromyalgia (FM), irritable bowel syndrome (IBS), painful bladder syndrome/interstitial cystitis (IC), temporomandibular joint disorder (TMJD), tension headache, vulvodynia, and multiple chemical sensitivity (MCS).

Factitious Disorder and Factitious Disorder by Proxy

In some cases, patients intentionally produce or pretend physical or psychological signs or symptoms, where the motivation for this behavior is to assume a sick role and external incentives for the behavior are absent. According to the DSM-IV-TR or ICD-10 classification systems, the official diagnoses of these cases are called factitious ('artificial') disorder (FD); F68.1 in the ICD-10; 300.16 or 300.19 in the DSM-IV-TR. The craving to obtain a behavior according to the patient's role, rather than to gain external rewards, distinguishes FD from malingering. However, both malingering and FD differ from the SDs in the DSM-IV-TR and ICD-10 classification systems, but not according to the up-to-date DSM-V draft per October 2010. The primary purpose of this behavior is to gain some form of internal gratification such as attention for themselves. A few FD subtypes are specified in the DSM-IV-TR: patients with primarily physical signs and symptoms (300.16), patients with primarily psychological signs and symptoms (300.19), or combined subtype (300.19). Some experts also use the term Munchausen's syndrome, which actually is not regarded as a discrete disorder, but more like a subtype of factitious disorder (FD) (also called 'Adult Munchausen' and 'adult factitious disorder').

Factitious disorder by proxy (FDP) (also called Munchausen's syndrome by proxy, MSBP or Munchausen's by proxy syndrome) is a label characterized by hidden and often misinterpreted child abuse. Proxy means substitute. FDP can be difficult to detect and confirm. Richard Asher introduced the term MSBP in 1951 to describe behavioral traits of caretakers who deliberately exaggerate and/or fabricate and/or induce physical and/or psychological-behavioral-mental health problems in others, mainly their own children. DSM-IV introduced the term factitious disorder by proxy (FDP) in 1994 to describe the mental illness of a perpetrator who fabricates illnesses on their victims. However, FDP is not regarded as an official category in the DSM-IV, but there is a description of it in Appendix B, in the section of disorders which need further study. The DSM-IV advises practitioners to use the diagnosis of FD NOS for individuals who satisfy the FDP criteria. In both diagnostic systems, ICD-10 and DSM-IV, the criteria for FD and FDP are nearly identical (see [Table 1](#)).

Somatic distress and MUSs have always been endemic to daily life, but the social and cultural characteristics of every era shape the expression, interpretation, and attribution of these symptoms. SHCs without or with minimal somatic findings (pain, fatigue) are common and frequent reasons for encounter with the general practitioner (GP) and for long-term sickness leave and disability. The complaints are often attributed to the stressors of modern life. However, studies have shown that common, MUSs are not specific for industrialized societies. For example, aborigine mangyans living under primitive conditions in the jungle and by the coast of the

Table 1 Diagnoses of somatoform disorders/somatic symptom disorders in the DSM-IV-TR, ICD-10, and draft of the new DSM-V classification system per October 2010

<i>DSM-IV-TR</i>	<i>DSM-IV-TR codes</i>	<i>ICD-10</i>	<i>ICD-10 codes</i>	<i>DSM-V draft per October 2010</i>
Somatoform disorder		Somatoform disorder		Somatic symptom disorder
Somatization disorder	300.81	Somatization disorder	F45.0	Complex somatic symptom disorder (CSSD)
Undifferentiated somatoform disorder	300.81	Undifferentiated somatoform disorder	F45.1	CSSD
Hypochondriasis	300.7	Hypochondriasis	F45.2	CSSD
Somatoform pain disorder (with subgroups)	307.8x	Somatoform pain disorder (no subgroups)	F45.4	CSSD
Somatoform disorder not otherwise specified NOS	300.82	Somatoform disorder, unspecified	F45.9	Somatic symptom disorder not elsewhere classified
Conversion disorder	300.11	Dissociative disorder; somatoform autonomic dysfunction	F45.4-7	Functional neurological Symptoms
Body dysmorphic disorder	300.7	Body dysmorphic disorder/hypochondriasis	F45.2	Anxiety disorder NOS or CSSD
??		Neurasthenia	F48.1	??
Factitious disorder	300.16/ 300.19	Factitious disorder	F68.1	Factitious disorder
Factitious disorder by proxy (FDP)/ factitious disorder NOS	AppendixB/ 300.19	Factitious disorder NOS	T74.8-9	Factitious disorder imposed on another
[Specified psychological factor] affecting ... [Indicate the general medical condition]	316.xx	[Specified psychological factor] affecting ... [Indicate the general medical condition]	F54.x	Psychological factors affecting medical condition, PFAMC

Philippines have more musculoskeletal complaints, fatigue, mood changes, and gastrointestinal complaints than a respective Northern European population, but they ignore them to a greater extent.

New Definitions?

The classification of SD is a complicated task, and while this article is written, there is a debate going on about how these should be defined in the new classification system DSM-V, for example, to replace the term SDs by the new term somatic symptom disorders (SSDs) and for example, the subcategory SzD with the term complex somatic symptom disorder (CSSD) (see Table 1). Thus, we debate some of these taxonomic issues, especially from a clinical point of view, and eventually present our own related term complex symptom disorders (CSDs) which we have not proposed as a new diagnosis, but used as an adjuvant to the official diagnoses.

Is SD a Mental or Somatic Disorder?

Somatization has been defined in many ways, but despite their differences, the definitions have one element in common, namely, the presence of somatic symptoms that cannot be adequately explained by organic findings. Somatization and SDs are poorly understood, both in view of conceptuality, nosology, causality, pathogenesis, clinical phenotypes, and treatment. However, somatization has traditionally been categorized as (1) "a phenomenon secondary to psychological distress, that is, *presenting somatization*" or (2) as "a primary phenomenon caused by somatic distress characterized by MUSs, that is, *functional somatization*." The so-called *presenting*

somatization from psychological distress is considered to be a psychiatric disorder. This is why psychiatrists and psychologists have considered somatization as their sphere of influence. However, somatic symptoms are also the features of the so-called functional somatization due to somatic distress, that is, where specific suppositions about causality are excluded. It is interesting to note that it is exactly the relation between somatization, anxiety, and depression, which are the two discrete ways in which somatization has been conceptualized, namely, as a somatic manifestation of psychological distress on the one hand versus somatic distress or the experience of MUS on the other hand. Thus, earlier theoretical speculation and empirical investigations of SD have been difficult to evaluate and compare with later versions.

It is plausible to view SDs on a continuum from symptoms to disorders, and from subjective to objective measures. MUSs present no objective findings, or their symptoms are more apparent than could be expected from the objective findings.

Functional Somatic Syndromes

These health symptoms may cluster and can thus be conceptualized as somatic *syndromes*, which are named FSSs by some authors. The term functional somatic syndrome refers to several related and overlapping syndromes that are characterized more by symptoms, suffering, and disability than by disease-specific, demonstrable abnormalities of structure or function. These are, for example, chemical sensitivity, sick building syndrome, repetition stress injury, chronic whiplash, chronic Lyme's disease, side effects of silicone breast implants, candidiasis hypersensitivity (yeast infection), the Gulf War syndrome, food allergies, chronic carbon monoxide poisoning, chronic mononucleosis, symptoms resulting from exposure to video

and PC display terminals, carbonless copy paper or weak electromagnetic fields, CFS, total allergy syndrome, burnout, CFS/ME, fibromyalgia, psychogenic headaches, MCS, el-allergy, environmental illness, and dental amalgamism.

Although the FSS are not new, patients who have these syndromes today differ from their predecessors by being less relieved by negative findings on medical evaluation and less responsive to explanation, reassurance, and palliative treatment. Several factors may account for this shift. To explain the endemic of our time, we have three hypotheses. First, the authority and prestige of the physician have declined: the reassurance of one's personal physician and the opinions of medical and public health authorities are no longer as calming, reassuring, and palliative as they once were. Second, the current situation is powerfully shaped by the mass media, which often use tabloid and uncritical reporting to portray the FSSs. Preliminary data, tentative findings, and the personal accounts of individual sufferers are reported as conclusive medical evidence. Finally, the contemporary climate is marked by the prominent political, legal, economic, and regulatory ramifications of the FSSs. Individuals and organizations may have interests in the status of these syndromes, and the actions of these persons and groups thus reinforce sufferers' beliefs that their symptoms have a medical basis.

Epidemiology

According to various European and American studies, an SD has been diagnosed to ~16% of consecutive consulting patients in a general practice and up to 30% in the community. According to a Norwegian study, 7.8% of the population has SDs according to ICD-10; 9.8% for females and 5.7% for males. The prevalence of SzD in the general population and general practice has been estimated to 0.1–0.7%. USD appears significantly more prevalent than SzD as defined by DSM-IV-TR, counting from 4% to 13.8% of the community samples and up to 13.0 in general practices. Prevalence of conversion disorder ranges from 0.01% to 0.3% both in the community and in general practice, while somatoform pain disorder has a corresponding prevalence of 0.6–1.6 according to the DSM criteria, but probably much more when including disorders with no or mild impairment, as the estimated prevalence of chronic pain in the general population is about 30%. Furthermore, an Italian survey also found the following 1-year prevalence: 0.7% for BDD and 4.5% for hypochondriasis, in addition to the disorders mentioned before. In most SD categories, a female predominance exists. The female-to-male ratio has been estimated to 10:1 for SzD, from 2:1 to 5:1 for conversion disorders, from 1:1 to 9:1 for pain disorders (chronic low back pain and fibromyalgia, respectively), and 1:1 for hypochondriasis. These figures tell us that the epidemiology of these disorders is difficult.

MUSs/MUPs: 86–95% of the general population has at least one somatic symptom in a given 2–4-week period. The typical adult has a symptom every 4–6 days and 81% of healthy college students report having at least one somatic symptom in a 3-day period. A total of 33% of all physical symptoms are MUS. A total of 50% of people suffering with depression have MUS, which can cause two to three times higher risk for anxiety and depression, and younger females

have more bothersome symptoms than males. Pain and gastrointestinal problems are the most customary symptoms. Longitudinal studies are few with methodological difficulties and thus must be treated with caution. Nevertheless, the occurrence of MUS seems to come and go, but also stays steady for a subgroup of about 8%. Negative predictors are female sex, age, and psychological distress. Approximately two-thirds of the patients have kept their DSM-III SzD, conversion disorder, or hypochondriasis after 4–5 years. More specifically, 48% of the entire SD group (DSM-IV) still have their diagnoses after three and a half years, with 28% continuing to have SzD/Briquets syndrome (DSM-IV) after 1 year. Approximately 60% of MUSs are forgotten after 12 months measured by Composite International Interview (CIDI).

Treatment

SzD and USD

In a recent review, Kroenke revealed the efficiency of treatment for SDs. He found that cognitive behavioral therapy (CBT) was effective for SzD, USD, and MU(P)S in five of the seven trials. Most positive outcomes were for somatic symptoms (5), and then psychological (3) and functional outcomes (3). Antidepressants were effective in three of the four trials on somatic and psychological symptoms, but not on function. A psychiatric consultation letter to the primary care physician about strategies for managing the somatoform patient to improve physical functioning and reduce costs was effective in three of four trials, but on function only. A multicomponent nurse-administered intervention, using a type of CBT and antidepressants as indicated, was beneficial in one trial on psychological symptoms, whereas one of the two trials using non-CBT psychotherapy was positive on function and psychological symptoms. One trial found aerobic exercise ineffective, and emotional disclosure through writing was ineffective in a single trial. Other studies have revealed that short-term psychodynamic psychotherapies induce modest effects on physical and psychiatric symptoms and social adjustment. *Hypochondriasis*: according to Kroenke's review, CBT was effective in four of four trials, and one using educational intervention methods. All trials benefited in psychological symptoms, that is, hypochondriacal cognitions and behaviors, while somatic symptoms and function only benefited in one of the four trials. BDD: CBT did well in two of two trials, while fluoxetine (an SSRI) was effective in one single trial. All the three trials showed benefits in terms of obsessive-compulsive BDD beliefs and behaviors, while function improved in one CBT trial and the SSRI trial, while none improved somatic symptoms. *Conversion disorder*: the results were inconclusive for the *conversion disorders*.

The review reveals that two types of interventions, antidepressant medication and CBT, are supported by level I (systematic reviews) evidence as benefiting patients with MUSs, but there were no studies comparing the efficacy between pharmacological and psychological treatments. There were poorer evidence for other pharmacological and psychological interventions, for example, collaborative care model, consultation letter, bioenergetics exercise, St. John's wort extract, and levosulpiride. We recommend reading Kroenke's review in *Psychosomatic Medicine* (2007) for further details.

A review conducted by Lesley Allen in 2010 showed that CBT work satisfactory for SzD, hypochondriasis, and BDD. All in all, CBT seems to be effective across a spectrum of SDs, including SzD, USD, hypochondriasis, and BDD. Antidepressants seem beneficial in some trials, but it is not clear whether it is a general effect mediated through reduced depression and anxiety or a specific effect on somatic symptoms. All treatment reviews have recommended further high-quality studies and also commented on the low number of studies in primary care. There is still too little data about how the treatment works on health care use, and there are still too few good studies on the treatment of conversion disorder or of pain disorder to make any conclusions.

Challenges and Controversies

The SDs represent a difficult taxonomic/nosological challenge. They are primarily seen in primary care settings, have significant comorbidity with anxiety and depression, and are often dimensional in nature. Their classification is a complicated task that offers no easy solutions. In primary care, most symptoms are not related to somatic or an explainable organic disease, but rather have unexplainable causes. A 3-year incidence of ten common symptoms in primary care of chest pain, fatigue, dizziness, headache, edema, back pain, dyspnea, insomnia, abdominal pain, and numbness showed that <10% had organic causes. Approximately 50% of the symptoms in primary care appear to be medically unexplained; in follow-up studies, ~10–15% are organic after 1 year, while ~4% appear mainly organic after 6 years. Secondary care specialists have their own ‘symptom disorder phenotypes’; for example, in orthopedics (low back pain), gynecology/obstetrics (pelvic pain and premenstrual syndrome), otolaryngology (tinnitus and vocal-cord dysfunction/dysphonia), neurology (unspecific dizziness, headache), cardiology (tachycardia and atypical chest pain), pulmonology (hyperventilation, chest pain), rheumatology (fibromyalgia), dentistry (TMJD), internal medicine (CFS), gastroenterology (IBS, nonulcus dyspepsia), urology (IC), endocrinology (hypoglycemia, hypothyreosis, labile hypertension), rehabilitation (closed head injury), and occupational medicine MCS. Some authors assume a psychobiological neuronal sensitization, which maintain somatoform symptoms by major symptom attention and vigilance, and risk individuals are those with low self-efficacy and a high level of helplessness and hopelessness.

Patients with these syndromes very often have explicit disease attributions for their symptoms, and they resist information that contradicts these attributions. They may have a strong sense of assertiveness and embattled advocacy with respect to their etiologic suppositions, and they may devalue and dismiss medical authority and epidemiologic evidence that conflicts with their beliefs. Moreover, dysfunctional beliefs concerning unexplained medical symptoms are powerfully shaped by the mass media, which often use hyperbole and uncritical reporting to portray the FSSs.

Complex Symptom Disorders

The contemporary climate is marked by the prominent political, legal, economic, and regulatory ramifications of the FSSs. Individuals and organizations may have interests in the status

of these syndromes, and the actions of these persons and groups thus reinforce sufferers’ beliefs that their symptoms have a medical basis. In many patients, it is unclear if the appearance of somatic symptoms is caused by mental or somatic factors. Actually, it is a Cartesian dualistic paradigm to distinguish causality in this manner. Expanding on the biopsychosocial perspective might highlight the problems of assuming a Cartesian attitude. Probably, many somatic symptoms appear as a result of both dimensions.

As the authors of this article have experienced that many patients classified as having SDs, for example, chronic pain and chronic fatigue patients, neither satisfy a somatic nor a psychological diagnosis, we have chosen to use the neutral term CSDs as a supplement to the DSM and ICD diagnoses. This includes states with significant somatic symptoms when biopsychosocial factors are particularly closely interwoven, and where no single recognized mental or somatic diagnosis or factor can fully explain the symptoms. Examples can be generalized muscular pain and CFS when one cannot identify a single triggering cause. Those syndromes can be conceptualized as CSD, that is, complex symptoms of both mental and somatic factors with unknown contribution to the causality. The CSD term was first introduced clinically by our group in the 1990s, in order to describe patients with ‘psychosomatic illness,’ when psychopathological and somatic conditions were disproved. The conceptualization has since been used as a term when one cannot conclude what is the triggering cause or dominant maintenance factors, and when it is plausible that somatic symptoms and psychological and social factors mutually influence each other. The CSD term is neutral, and the patients seem to accept it as less stigmatizing than functional disorders, psychosomatic illness, or SD.

An experienced GP rarely needs to refer patients with CSD in early phases to specialist services. At that stage, he probably would rule out both physical and mental illness and convince and motivate patients to pick up their pace of normal function and to empower them to be healthy. If such an understanding has not been conceptualized, however, the management of the early phases can be complicated by extensive somatic investigations, unnecessary surgery, and addictive drugs. The term CSD should only include patients with significant functional impairment and multiple symptom appearances often complicated by iatrogenic factors. When these patients are referred to specialist health services, we are talking about a patient group that preferably requires close coordination between various medical specialists, psychologists, and physiotherapists in order to exclude well-defined disease and to understand and treat the disorder. While a CSD in the early stages usually can be prevented in primary care, it usually requires substantial resources in the specialist care. In specialist care treatment, the clinician will aim to convince the patient that the pursuit of an undetected disease is detrimental and that invasive and drug treatment must be terminated, and that thoughts and behaviors ought to change. Based on our criteria, it is misleading to speak of a ‘CSD’ when you have (1) a defined chronic physical illness with psychiatric symptoms, (2) a defined psychiatric illness combined with somatic symptoms, or (3) a combination of several well-defined diseases. The related concept MUSs or MUPs is a useful term to use in general practice, but would probably be harder to use by an outpatient clinic in specialist

health services. Another difference in relation to CSD is that MUS/MUPS previously have been conceptualized as dominantly 'somatic in origin,' and also include less severe problems which can easily be solved by a GP.

Conclusion

The question we need to ask is whether diagnosing the somatic symptoms as SDs helps or impedes us to understand and treat these patients. DSM-V suggests renaming SD into SSD and also changing the categorization of the subtypes, for example, SzD to CSSD (see [Table 1](#)). The author group of this article introduces the term CSDs as a supplement to certain complex or multifaceted disorders, where no known somatic or mental factors can explain the illness. A problem with the complex term is that it might be understood as *difficult* rather than primarily communicating that there are *many different levels* of analyses that need to be understood. Evidence-based investigation indicates that CBT is the best documented treatment for SDs.

See also: Behavioral Medicine; Cognition and Personality; Cognitive Behavior Therapy; Cognitive Bias; Hypochondriasis or Health Anxiety; Psychological Predictors of Heart Disease.

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Spatial Orientation

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Glossary

Action, afference, and efference Actions are goal-oriented movements. They are coordinated with the actor's spatial orientation relative to one or more features of the surrounding environment. Actions involve efference, that is, sets of motor commands to the relevant muscle and limb systems together with expectations of the results of one's own actions. And actions involve afference, that is, feedback about the results of the action, from joint and muscle receptors, from vestibular receptors about the body's linear and angular accelerations, and from seeing or hearing or touching the environment.

Bayesian weighting of different forms of information Humans coordinate most actions with a single unified cognitive representation of their spatial orientation. Spatial orientation is specified by partially redundant types of information about the body and environment. There is not a singularly important type of information, so the various types are integrated with different weights to form a unified representation. Bayesian weighting schemes base the weights of the different types of information on the relative reliabilities of the different types of information.

Body axes The left-right or 'x-axis,' the front-back or 'z-axis,' and the head-toe or 'y-axis.' By convention the body axes are used to specify both object locations relative to an observer and degrees of freedom for actions used to change orientation. Facing direction can be controlled along each of the three body axes: rotating around the y-axis is called turning, rotating around the z-axis is called rolling, and around the x-axis is called tilting or changing pitch. Location can be translated along the same three axes, moving along the y-axis results in change in elevation relative to an object, along the x-axis in radial direction, and along the z-axis in distance.

Calibration of perception and action People can see, hear, and/or touch (sometimes smell or feel a temperature gradient) to know their location relative to the goal of their action. But knowing the goal's distance, direction, and angle does not, by itself, specify the actions needed. The system needs to know the calibration of the perceptions with their possible actions, that is people need to know how various

forms of actions map onto needed changes in self-to-object distance and direction.

Cognitive mapping Processes by which people come to know the straight line distances and directions relating objects and features of their surroundings that are experienced across circuitous walks which are mutually occluded from view during the walk.

Frames of reference Information used to define direction and distance. Egocentric frames of reference depend on using body information to specify facing direction and location; it can include left, right, up, down directions and it can include distances expressed in terms of the body's scale, for example stride lengths or eye-heights. Environmental frames of reference depend on using environmental information to specify facing direction and location. It can include large features visible from great distances like mountains or ridgelines, or small features visible in the local surroundings like buildings or road signs; and it can include gravity to specify tilt.

Spatial structure A network of distances and directions. The structure of a person's perspective from a given point of observation consists of the self-to-object distances and directions from that point. These change dynamically whenever the person moves. The dynamic changes in perspective can be computed from the rotations and translations occurring during locomotion. Spatial layout, the structure of the environment, consists of object-to-object distances and directions. It is intrinsic to the environment and is unchanging when the person moves. Knowledge of spatial layout is often referred to as a 'cognitive map.'

Spatial updating Processes to keep track of dynamic changes in spatial orientation that occur during locomotion. One major type of process relies on body-based information from locomotion, so that spatial orientation is updated by integrating information for locomotion with the initial orientation. Dead reckoning and path integration are examples of this. Another major type of process relies on environment-based information, so that spatial orientation is updated by noticing changes in orientation relative to large features of the surroundings that are continuously in view and using these to know position relative to small features that are occluded from view.

Spatial orientation refers to the alignment or position of the whole body or body part relative to some frame of reference. Research emphasis is on the whole body. Before the mid-twentieth century, emphasis was on understanding static cases of spatial orientation from a fixed position and body tilt relative to gravity. But spatial orientation is dynamic whenever an organism moves and emphasis has shifted to dynamic spatial orientation – that is, how people keep up to date

on their changing self-to-object distances, direction, and tilts when they move. Spatial orientation is essential for perceptual-motor coordination, since the force and direction of actions need to fit the distances and directions of the objects toward which the actions are directed. 'To orient' refers to producing motor actions that control spatial orientation. The four basic issues of spatial orientation are about (a) what information is used to guide actions, (b) space perception and how

the person-environment distances and directions are detected and represented, (c) perceptual-motor coordination and how the forces and directions of motor actions are calibrated relative to what is needed to get the job done, and (d) information integration in situations where multiple forms of information are available and are combined to form a single unitary representation. Much of the continuing research about spatial orientation relates to four practical problems: (a) falling and controlling balance; (b) becoming lost and way finding; (c) disorientation and nausea in conflicting cue situations, especially those involved in space travel; and (d) exploring information on the web and in electronic databases.

General Definitions and Issues

‘Spatial orientation’ and ‘orienting’ can be broadly defined as all states and actions that are actively ordered in space. Examples abound across the plant and animal species. For plants, consider tropisms accounting for plant growth to line up the roots, stems, and leaves with the direction of gravity and light, and consider the daily movements of sunflowers to face the moving sun. For insects, consider the foraging of honey bees and ants, flying or walking via sometimes long and circuitous paths in search of food sources and then returning to their hive or nest via much more direct routes. For long-distance migration without electronic aids, consider the one-way 2000 mile journey of Monarch butterflies weighing about 0.005 kg from Southern Canada to Northern South America, the 12 000 mile journey of the 0.9 kg Artic Tern from its Artic breeding grounds to the Antarctic and back, and the 6000 mile journey of the 30 000 kg gray whale from the Bering Sea to the Baja Peninsula and back.

Feats like these of nonhuman animal orientation are remarkable. They outstrip what most humans can imagine doing without electronic aids to maintain their spatial orientation and mechanical aids for locomotion. What does this mean? That is, how is it possible that the brain of a Monarch butterfly (weighing less than 0.0005 kg) outperforms the brain of a human being (weighing about 1.3 kg, about 2600 times more)? There are two parts to the explanation, natural selection and cognitive flexibility. As for natural selection, the idea is that some nonhuman animal species have evolved by mating in a location favorable to mating and navigating long distances to a location favorable for feeding. In some cases, their navigation is rigidly limited to the sun and/or stars as orientation guides, but in other cases their navigation can exploit a wider range of heavenly and earth-bound landmarks. But it is limited to a few well-defined strategies. Humans, on the other hand, can draw on a very wide range of strategies – the benefit of flexibility in spatial orientation comes at a cost of less specialization for each strategy.

Perception and Action: Spatial Orientation as Something that People Perceive or Figure Out and Know

People often know their spatial orientation. They can reflect on this knowledge and use it strategically, for example to think through alternative routes when they walk into a blocked

route. And they can use their knowledge with little reflection, for example their knowledge of their position relative to the walls of a racket-ball court while running to strike the ball. What ‘type’ of knowledge is knowledge of spatial orientation? By any definition it can be explicit and used self-consciously to plan future actions, and it can be implicit and used without self-conscious deliberation to plan and act. The explicit knowledge might often be referred to as semantic or conceptual knowledge, and it is easy to see that many features of spatial orientation are explicitly semantic, for example cardinal directions, landmark names, and names for metric distances. The implicit knowledge might often be referred to as motor knowledge or procedural knowledge, meaning that it was acted on or incorporated into decisions without conscious awareness. The access times for the explicit knowledge are likely slower than access times to the implicit knowledge.

People coordinate their knowledge of spatial orientation with a broad range of actions and across a broad range of situations. They need to do this in order to coordinate their actions with their spatial orientation and know how much force to exert and in what direction to exert it. The actions include tilting or leaning or stooping to control body posture, turning to face a conversational partner or turning to reach for a nonhuman object, walking to the grocery store or running to catch a Frisbee, manipulating the controls of an aircraft, and moving a mouse to search more deeply into a website. Consider each in turn.

In classic studies of spatial orientation, emphasis was on static visual object constancy. For static postures and situations, the classic issue is that people report seeing or hearing or feeling the same objects or situations when the proximal stimulus changed. By ‘proximal stimulus’ what is meant is the specific sensory receptors that would be stimulated when perceiving it – and these, in turn, depend on the body’s tilt and facing direction and distance from the relevant objects, no matter whether one is looking, listening, or touching. For example the visual or auditory or haptic stimulus for a given object is different when a person tilts (the retinal stimulus rotates in the picture plane, the auditory stimulus changes its relationship to the two ears, and the haptic stimulus changes in terms of the distance and orientation of the reaching hand)), or walks forward (the retinal stimulus expands geometrically, the auditory stimulus is louder, and the haptic stimulus involves smaller joint/muscle movements), or turns (the retinal stimulus undergoes a rotation, so that visible objects change in perspective and some objects go out of view while others come into view). The classic problem of ‘object constancy’ was that people perceived the same object or situation when looking, listening, or touching despite changes in their distance or direction from the object or situation. In other words, people perceived a constant stimulus object or situation across changes in the receptor level sensory input.

The same issues apply to dynamically changing postures and body locations. Beginning during the middle of the twentieth century, works by James J. Gibson and Gunnar Johansson emphasized that people are always moving and that events are always changing – consequently perceiving in most situations would depend on understanding how distal features of an object or event could remain constant while the proximal features signaled by sensory receptors would vary.

Their great insight was that constant properties of objects and events in the world are signaled by changing stimulus values at the receptors. For example, when moving toward a visible object, its retinal projection becomes larger and larger and yet people perceive the object's size to be constant; when moving toward a noisy object, its loudness at the ears becomes louder and louder and yet people perceive the object's perceived loudness to be constant; and when people touch an object and move toward it to lift it, the visual angles change in ways that are consistent with the object growing larger and larger, and yet people perceive its size to be constant.

Human and nonhuman animals alike tend to perceive constant distal events in the face of dynamically changing proximal stimulus values. On the one hand, for dynamic spatial orientation, the proximal stimulus values consist of self-to-object distances and directions and these change whenever a person moves. People need to coordinate their actions with the distances and directions. When they are moving, these distances and directions are constantly changing and they need to plan their actions before they launch their actions – in other words they need to anticipate their future spatial orientation and coordinate their actions with this predicted future. This prediction can be computationally complex. Research and theory on such predictive spatial orientation was initiated in books by James Gibson (1966) and by Nicoli Bernstein (1967) and developed by researchers and theorists like Emilio Bizzi, Claes von Hofsten, David N. Lee, Herbert L. Pick, Wolfgang Prinz, Michael T. Turvey, and William H. Warren.

History of Concepts and Research

The rise of modern philosophy in sixteenth and seventeenth century Europe emphasized the historical origins of knowledge and genetic epistemology, that is, the study of the ontogenesis of the capacities to perceive and to know. Early thinkers focused on stationary observers and static objects and worked to describe the visual cues that specified spatial orientation. Nativists like Descartes and Kant assumed that minds are organized to understand the spatial meaning of cues without the benefit of experiences. Empiricists like Hume and Berkeley, on the other hand, assumed that experiences associated with physical actions give meaning to visual cues. The early modern philosophers were touch/motor imperialists, in the sense that they assumed that information provided by touch and the motor system was the primary information and that people needed to learn how to interpret visual and auditory cues by way of their association with touch/motor cues, so that touch informed seeing and hearing. Twentieth century scientists, on the other hand, hypothesized that vision and hearing could be primary sources of information, so that seeing and hearing informed touch. In the twenty-first century, these issues have become central in the study of the multisensory basis of perception and of spatial orientation. The earlier thinkers argued about whether touch taught and dominated vision or whether vision taught and dominated touch. During the twenty-first century theorists agree that vision, hearing, touch, the other senses, and motor information contribute to perceiving and representing one's dynamically changing spatial orientation. They believe that all of these multiple sources of information

are unified together into a single representation, and that this unified representation generally serves to mediate action. A central argument is how the multiple sources of information are unified. The alternatives span a broad range. For example: Is a single source of information dominant and so the other sources are ignored? Are the multiple sources of information all equally represented? Or are the alternative sources all represented, and weighted differently in order to reflect their utility?

Principles and Research Strategies

The emphasis of this article is on two general principles and cognitive strategies that underlie spatial orientation. One is that spatial orientation is specified by multiple, partially redundant sources and types of information and that the most informative source and type depends on the situation and the person. For example, visual information is not useful in heavy snowfalls or when someone is blind, but it is quite useful in many other situations for persons who can see. Only a biologically reckless system would depend on visual information in the dark or other situations where vision provides little or no useful information. The potential utility of visual information not only depends on the situation, but it also depends on the visual status of the perceiving persons, and varies as a function of visual impairment and blindness.

Intersensory Integration

How is it that multiple modalities and types of information are combined and typically result in a unified representation of spatial orientation? Consider three possible models. One is a simple dominance model, through which the multiple types of information are evaluated, the most informative one is identified, and people perceive their spatial orientation based on the single, dominant cue. A simple dominance model seems wasteful in the sense that much of the potential information would be discarded. The second is an unweighted average model, through which all of the informative types of information are identified and added together in a simple average to create a unified representation. An unweighted average model seems wasteful, since it would give imprecise information as much weight in the unified representation as highly precise information. Finally, a weighted average model seems more optimal. A weighted average would include all forms of information in the final unified representation, but the different forms would be valued differently. Their values would be informed by past experience and depend on their relative degrees of reliability that were learned through the sometimes hard knocks of experience. Because the relative weightings of different forms of information depend on probabilities learned through past experience, these are broadly referred to as Bayesian weighting models. Some of the seminal writings are by Ernst, Banks & Bulhoff, by Huttenlocher and Hedges, and by Cheng, Shettleworth, Huttenlocher & Rieser.

Bayesian weighting models provide a powerful scientific advantage over simple dominance or equal-weighting models. The reasons are that they provide a method to estimate the relative degrees of reliability of different forms of information, and they suggest a simple algebraic combination of the

different forms of information, weighted by their respective degrees of reliability. They provide an optimal estimate of the weightings in terms of the relative degrees of reliability. Current challenges to the model are focused on two issues. One is that human perception occurs in complex situations involving many possible sources of information, and yet the estimates for the reliability of each cue are based on simpler stimulus situations, which generally involve only two possible stimulus cues. The other is that the evolution of human perceptual systems is not necessarily optimal, and instead follows fits and starts that are shaped by child development and by evolution.

The second general principle is that perceiving and updating spatial orientation depends on two types of cognitive strategy. Each can act alone or they can act in mutually supportive ways. One cognitive strategy is based on integrating information for locomotion to update one's initial egocentric representation of self-to-object relations. For example, if one looks at a room from one point of observation and then walks into another room so that the first room is occluded from view, one can use information from the walk to update the initial self-to-object relations. The second cognitive strategy is based on using the environment as a frame of reference. For example, if a hiker spots a notch in a ridge from a distance and then cannot see the notch but can still see the ridge, the hiker can navigate toward the notch by referring to the visible ridge and mental representation of the notch's position relative to the ridge.

A central component of successful control of spatial orientation is updating the information regarding the body in the physical space relative to the surrounding environment. This ability depends on the integration of multisensory feedback, mainly from the visual, auditory, vestibular, and motor systems. In addition, efference, that is, motor commands originating locomotion carry with them information about the expected consequences of locomotion in terms of expected changes in perspective. And this efferent information is thought to play a role in updating spatial orientation as well as afferent feedback.

How sources of afferent feedback from visual, auditory, vestibular, and proprioceptive modalities are integrated into a unified perceptual representation of spatial orientation is a topic of continuing investigation by brain scientists. Recent research is focused on the role played by multisensory integration areas of the cerebral cortex such as temporal-parietal junction, the central sulcus, the intraparietal sulcus, and the posterior premotor frontal network which seem especially active in updating spatial representations.

Methods and Approaches to the Scientific Study of Spatial Orientation

Human spatial orientation is studied from a wide array of approaches, focused on understanding the role of cognitive strategies, regions of brain activation, underlying computations, emotionality, child development, and culture-based variations. Cognitive scientists focus on cognitive strategies and the underlying computational models. They tend to measure how accurately people maintain their spatial orientation when walking with or without vision as a function of how much they can see or hear while walking, as a function of the complexity

of their walking path, and as a function of whether they are distracted by other tasks. Brain scientists focus on identifying which regions of the brain are activated when making different types of spatial orientation decisions, for example, whether they should turn left or right at a particular intersection when imaging standing at a particular intersection; a limitation of brain science methods for the study of spatial orientation is that typically the subjects of study need to be stationary while the brain recordings are made. Cognitive scientists and brain scientists alike create computational models, hypothesizing how different geometries and different network models might underlie the computational results.

Emotionality plays a role in spatial orientation. For example, wilderness experts are taught to calm down to think through their spatial orientation in crisis situations, firemen, and firewomen are known to lose their way in emergency situations, and first responders to large-scale crises often become disoriented, and lose their way, resulting in personal injury and failed support to others.

Children of different ages are studied to investigate the ontogenesis of the cognitive strategies and sensitivity to different types of information. On the one hand continuing findings indicate that during the first year of life infants can use motor information, local landmarks and the geometrical shape of the surrounding room in order to maintain their orientation relative to a hidden target. On the other hand, infants and young children become easily disoriented, in simpler situations and after simpler routes, than older children. Too little is understood about what changes with development.

There are well-known examples of culturally defined roles for which exceptional spatial orientation is central to the tasks of long range navigation. One example are the feats of expert long distance spatial orientation is of the navigators of the Puluwat Islanders. They traveled more than 1000 miles over open seas without losing their way. In order to accomplish this, they depended on 'childhood-long' apprenticeships in navigating, in order to learn how to use the stars, the sun, and underwater perturbations in wave patterns to help them keep track of where they were and to steer their course.

Historical Changes in Assistive Technologies for Human Spatial Orientation

Historical changes in spatial orientation describe changes in technologies. This is a historically old skill. Archeological evidence indicates that human ancestors roamed across the plains, among the mountains, and through the jungles. Clearly, they must have kept track of where they were relative to where they were headed. There are not records of how they did this, but logically their methods must have included strategies for estimating or sensing distance and direction. Later and in connection with sea travel records were kept about how such spatial orientation was accomplished. The problem remains the same, determining direction and distance traveled. Sometimes there are environmental cues and sometimes there are not. In the case of traveling along a coast environmental cues are available; the directions of points of interest are visually available, as is the progression or distance traveled. Staying oriented by such information is referred to in modern parlance as piloting. The environmental information is relatively close

at hand. When out of sight of land, environmental information that specifies direction can still be available, for example, information from the stars to guide celestial navigation. Even navigational systems of different cultures exploit stars for directional information. A beautiful example is that of traditional Micronesian navigators sailing their outrigger canoes on long journeys in the South Pacific. They take advantage of the fact that given stars always rise in the same direction on the horizon. As any particular star rises it is followed by another star in about the same direction, resulting in a series of stars appearing successively across the sky in an arc, all setting then in the same direction on the opposite side of the sky. The sky path of such a sequence of stars is called a linear constellation. The point is that such a linear constellation can always provide information about the direction of travel. Edwin Hutchins (1995) wrote about this.

Stars are not always visible, for example, in the daytime or when it is cloudy. Then determination of direction must be accomplished by different means. When out of sight, land distance must also be determined by different means than progression based on landmarks. The direction problem can be solved by use of a compass and the magnetic compass for such purpose came into use around the twelfth century. There are some disadvantages in the use of the magnetic compass for directional orientation, involving differences in the location of the magnetic north pole and geographic north pole. Thus, sailing due west according to your magnetic compass near the equator will be quite a different direction on a map than sailing due west by compass when you are in the arctic ocean. Many such disadvantages were overcome with the invention of the gyroscopic compass in 1907.

Distance traversed was not quite as easily solved when out of sight of landmarks. Of course, sailors have an intuitive sense of speed based on their experience with the strength of wind and how their ship progresses when landmarks are in sight. However, this is only approximate. A somewhat more definitive method came into practice by the sixteenth century. This was known as the chip log method. A chip of a log was tied to a rope and dropped over the stern of the ship. The rope was paid out as the ship moved on away from the log chip which was essentially stationary in the water. The time taken for a specific length of rope to be paid out provided a means for estimating the ship's speed. (The length of paid-out rope was indicated by knots tied in the rope and that was the origin of using the term knot for specifying nautical speeds.) Given that the ship's speed could be so measured, distance of travel was determined by multiplying how long one was sailing at that speed.

By keeping track of distances sailed in various directions, it was possible to estimate the distance and direction of one's homeport or other known locations even though they were out of sight. This process of integrating direction and distance of movement over time came to be called dead reckoning, a variation of the term 'deduced reckoning.' Keeping track of this information for extended periods of time became a problem in itself. One technique for a period of a few hours involved a device called a traverse board. It was a round board on which pegs could be inserted at various angles around the center indicating direction of travel, and distance from the center indicating distance traveled in that direction. Beyond this period of time the information needed to be transcribed into a logbook. It is interesting

to note that Columbus' logbook strongly suggests that he used dead reckoning to navigate in his voyages to America.

Of course another way of keeping track of the information of travel is by means of maps or navigational charts. One's estimated position can be represented on these graphic displays of the space of interest. Map making has a long history. One early and persistent problem was how to represent the spherical globe of the surface of the earth on a 2D surface. One solution is the Mercator projection developed in the sixteenth century. The Mercator projection has the disadvantage of distorting sizes and shapes of land masses and sea areas but for navigational purposes has the advantage that straight lines between two points on the chart would yield a constant angle or course which could be steered on the ocean to go from one location to the other. The general idea of representing spatial layouts by means of 2D maps became extremely common. It became so common that when psychologists and others began to think about how spatial information was mentally represented they coined the term 'cognitive map.'

Human Factors and Engineering Applications of Research on Spatial Orientation

Technologies to assist people in maintaining spatial orientation are rife throughout history and across cultures. They include education about way-finding that is ubiquitous across all cultures and eras. They include the specialized education of those selected and trained to be navigators in the Puluwat Islands. They include the development of maps and map projections, magnetic compasses, and electronic compasses. They include the creation of GPS systems, the debate about whether the user's position should be displayed egocentrically so that the person's heading was 'up' on the display or geocentrically so that north was 'up.' It is a telling indication of the flexibility of human spatial orientation that GPS displays provide humans with the option of being oriented egocentrically or geocentrically.

Computers provide a fast method of generating maps and updating the maps to take into account one's dynamically changing spatial orientation and changing environmental conditions. Such computer-based virtual environments are often displayed on desktop- or vehicle-based displays. For desktop computers, the changes in perspective are created when the person manipulates a computer keyboard or computer mouse.

A recent development is the study of the perception and representation of self-to-object distances and directions when exploring immersive virtual environments. These provide the observer with life-like spatial layouts and virtual objects placed at strategic points. A human observer can look at this environment through a helmet-like 'head-mounted display' unit, and can walk in this environment just as in a physical environment. Virtual environments are particularly applicable in situations where it may be difficult to explore actual, physical environments such as a battlefield, or behind-the-lines military operations. Studies have shown that humans treat virtual environments as functionally similar to physical environments. In studies that involve learning and remembering object locations following rotations and translations, humans' sensitivity to flow rates in virtual environments is comparable to sensitivity in real environments, albeit with longer decision latencies in virtual environments.

Virtual environments can be presented as desktop displays, in which people view a simulation of a place on a desktop computer and manipulate their view with a mouse or keyboard. They can also be immersive displays. In the case of immersive displays, human users either stand in a 'virtual cave' or wear a 'helmet mounted display'. In a virtual cave, the person is surrounded by three or four walls, with a floor and ceiling, all displaying a remote place. When the person moves, the visual (and auditory) information is updated, so that the person's changes in perspective are rendered in changes in the sights and sounds that would occur in the physical environment. In a helmet mounted display (an HMD) people wear binocular goggles that provide renderings of remote places, and when they locomote the images displayed on the HMD dynamically change in the ways they change when people locomote in the physical environment. The computer-based systems provide realistic displays, the visual displays are updated quickly enough to approximate the time constants of human vision, but the technologies limit the visual field of the display to about 90° of visual angle. Such displays are useful for training and for gaming. But they are not yet completely immersive: people are not tricked into perceiving themselves as 'being there' in the virtual environment and their performance in the virtual environment is often deficient.

Spatial orientation is especially problematic for some persons, more than for others. Biological factors seem to play a role, so that some of us can maintain our spatial orientation across complex 1–5 km routes in familiar or novel cities, in the woods, and in the desert without technological aids whereas other persons can lose their way walking or driving in their home neighborhoods. It seems likely that those who succeed at some occupations, such as wilderness explorers or taxi drivers, succeed in part because they have especially good spatial orientation. It seems clear that some persons, for example, persons who are born without vision, tend to report they are at a disadvantage for spatial orientation. This is intriguing, since people born without vision have life-times depending on non-visual information for spatial orientation, whereas persons who lost their vision after childhood tend to be more skillful and have fewer years of practice. This indicates that the experiences provided by watching and looking play a role in the

development of spatial orientation. And the research indicates that brain plasticity plays a role in the development of this skill. Continuing research is aimed at understanding what types of nonvisual experience might substitute for visual experience in the development of the underlying skills. And continuing research is aimed at understanding how technologies can be used to provide auditory and tactual information to substitute for visual information, to assist persons who are blind or have severe visual impairment.

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Spatial Perception

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Glossary

Allocentric reference frame A representation of the environment that reflects the absolute relationship between objects. For example, a street map shows the spatial relationship between streets regardless of the location of the viewer.

Binocular visual cue Perceptual information contributing to distance perception that uses input signals from both eyes. Examples of binocular cues include stereopsis and vergence angle (rotation of the eyes inward for close items, and apart as objects move away).

Egocentric reference frame A representation of the environment with regards to the viewer. For example, when you are face a building, it is in front of you, but if you turn around it is behind you.

Monocular visual cue Perceptual information contributing to distance perception that can be processed by information from a single eye. Examples of monocular cues include: occlusion, familiar size, linear perspective, shadow, atmospheric haze, and accommodation (change of lens shape to focus an image).

Peripersonal space The area immediately around the body that is within reaching distance of the hands.

Spatial imagery/spatial memory An internal 'mind's eye' representation of the spatial properties of an object or scene composed of multiple objects.

Stereopsis The perception of depth created by slightly different visual images (binocular disparity) impinging on each eye.

What Is Spatial Perception and What Is It For?

Spatial perception refers to the processing and interpretation of the spatial relationships present in the physical world. This broad term refers to a host of sensory and cognitive processing stages that ultimately enable us to interact with the world around us. In this article we will introduce some of the factors influencing spatial perception. Perceptual modalities including vision, hearing, and touch provide different types of spatial information. Visual information plays a dominant role in assessing spatial layout (e.g., Is that a ripe red apple on the tree?). Auditory information can indicate where and how quickly an out-of-sight item is moving (e.g., Is the train coming in on time?). These sensory signals are processed by the brain and used by the motor systems to plan future actions. We will include brief mention of some of the sensory illusions that create misleading spatial percepts. These illusions can shed light on how the brain processes spatial information and where there are limitations. These sensory components are processed for a reason: we use spatial information to plan actions. For instance, we are nearly always manipulating single objects (e.g., How wide do I have to open my fingers to pick that big round apple? How much pressure should I apply to pick up that egg without breaking or dropping it?); as well as navigating through the larger environment (e.g., Do I have time to cross the tracks before the train arrives? How far is the nearest Indian restaurant, and which way should I go to get there?). As humans are mobile beings, efficient action requires ascertaining the locations and properties of objects and surfaces.

How Do We Perceive Spatial Information?

Visual Cues

Monocular visual cues

In any 2D representations such as a photograph or drawing there is considerable spatial information. This can be verified by asking people to choose the item closest to them in a picture. People perform this task easily and consistently, choosing the item closest to the foreground. However, all of the items are at exactly the same distance in the flat plane of the picture. Cues that exist in these 2D representations are termed 'monocular' because a single eye can process them. When you close an eye, you are still able to look at a picture and decide which item is closest. Monocular cues are distinguished from binocular visual cues, which require inputs from both eyes. There are many examples of monocular visual cues including occlusion (interposition), motion parallax, texture, familiar size, relative size, linear perspective, shading, and atmospheric haze. *Occlusion* is visible when one object partially obscures a second object. This cue indicates the relative ordering of near-far objects. For example, the chair is in front of the window, because the chair can be seen in full but the window is partially blocked by the chair. *Motion parallax* also provides position information when the viewer is moving. Imagine you are walking down the street. You pass by closer objects such as fire hydrants more quickly than farther objects such as buildings. In addition, closer objects partially obscure more distant items. *Familiar size* serves as another estimate of distance. If a house appears to be only a speck in a large field, it is interpreted as very far away because we know that houses are relatively large.

Other information such as *texture* cues, like the grain in wood or the pattern on a carpet, become steadily less visible as distance increases. The distortion of a known texture provides information regarding the height of a stairway or the slope of a hillside. *Linear perspective* provides spatial information due to the fact that parallel lines appear to converge as distance increases. As such, the wider portion of a road is interpreted as closer than the narrower portions. *Lighting* and *shading* reveal information regarding the shape and dimensions of an object, in particular, whether something is concave or convex. A brightly lit spot on an item indicates that it is closer to the light, whereas darker spots suggest they are farther from the light. Additional shape information comes from shadows. A shadow beside an object suggests that it is resting on a surface, perhaps a glass resting on a counter. Whereas a shadow below an object suggests that it is suspended above, such as a light hanging above a table. *Atmospheric haze* describes the observation that farther items, such as distant mountains, appear more bluish than closer mountains. This cue provides a sense of distance over very large distances.

Finally, there is a physiological cue called accommodation that also contributes to spatial perception. Accommodation refers to the adjustment in curvature of the lens. Contraction and relaxation of the tiny muscles in the eye that hold the lens in place produce accommodation. These muscles automatically relax or contract to improve focus, but the lens can only change shape by a small amount, thus the contribution is modest and only effective when viewing items within approximately 6 ft.

Binocular visual cues

Human eyes are positioned several inches apart from each other. This distance means that the images on the retina of the left and right eyes are slightly different, a situation referred to as *binocular disparity*. The two eyes working together provide additional spatial cues. These types of cues are classified as binocular cues. The most prominent binocular cue is a stereopsis. Stereopsis refers to the compelling sense of depth that arises through the combination of differences between the images in each eye. If one closes one eye then the other, there is a subtle, but perceptible, shift between the images provided by each eye. This difference is more noticeable when you are looking at something nearby, for instance something in your hands versus something across the room. The difference between images is negligible for objects in the far distance. For a special group of objects at a particular distance there will be no shift at all. These objects are aligned on an imaginary arc of space called the *horopter*. When a small object is fixated and along the horopter the image will stimulate the same portion of the retina in each eye. There will be a single fused image of the fixated object, whereas objects in front of or behind the object will have two representations because they are stimulating different portions of the retina in each eye. It remains poorly understood how these different representations for each object are appropriately matched up in the brain. This problem is called the *correspondence problem*. Stereopsis serves as an effective cue for items within 100 ft. Surprisingly, in the general population there are a number of people who have difficulty seeing objects in depth. The incidence of this *stereoblindness* is thought to occur in about 2–4% of the

population, but up to 15% of the population have some degree of trouble seeing objects in stereo depth. Thus, the loss of stereo information does not eliminate visual spatial perception but it does reduce the quality of the spatial representation. There are also several cases in the literature suggesting that some people with impaired stereopsis can improve their perception with extensive training.

A second binocular cue comes from the fact that the eyes can move in the orbit, courtesy of the three pairs of muscles that hold them in place. In particular, the *vergence angle* refers to the angle of one eye with regard to the other. When the eyes move toward each other the angle is termed *convergent*. This situation arises when you look toward your nose and ‘cross’ your eyes. When you return your gaze forward to look toward the distance, your eyes will *diverge* or move in opposite directions. Over short distances up to about 25 ft vergence angle can serve as an effective cue to spatial distance (Figure 1).

Neural correlates of visual spatial information

The monocular and binocular distance cues described above are largely processed by the visual system. These issues have been investigated using a number of experimental techniques including functional neuroimaging (e.g., fMRI) and neurophysiological (e.g., recordings from neurons in nonhuman primates) approaches. There is clear evidence that portions of the brain including posterior areas in the superior occipital and inferior parietal lobes are essential for visual spatial processing. These structures are located in what is called the dorsal visual stream or the ‘where’ visual pathway. These findings are confirmed in neuropsychological patients with brain damage to these areas due to stroke, disease, or injury. Patients can have a variety of visuospatial deficits including the inability to attend to the full visual field. In some striking cases patients experience a condition called *hemispatial neglect*. These patients may ignore one side of space, usually the left side of the visual world. Patients may only eat the food on half of their plate, or they may not notice things happening in the ignored side of space. In some very rare patients, both the left and right hemispheres are damaged. This type of damage can lead to a condition called *simultanagnosia*. This peculiar condition prevents them from being able to see more than a single item at a time. For instance, such a patient may look at a computer keyboard and see the letter ‘H’ but no other keys. In these patients, spatial perception is tremendously disrupted. However, they may still be able to rely on familiar size cues, accommodation, and vergence angle to provide limited spatial information.

Auditory Cues

Although the visual system provides the dominant source of spatial information, at least in sighted individuals, other sensory modalities including the auditory system contribute spatial information. Auditory information provides key information indicating the spatial location of objects. There are three primary cues interpreted by the auditory system: *sound level*, *interaural differences*, and *reverberation*. If something is producing sound, the sound level will be louder as the listener gets closer. For familiar sounds, the overall intensity of the sound can be a strong cue to spatial distance. Another example



Figure 1 Examples of monocular visual cues. This 2D photograph provides 3D spatial information through a combination of monocular cues.

incorporates motion. If something is moving away from the listener, it will have a steadily decreasing sound level, likewise, something moving toward the listener will have a steadily increasing sound level. The second cue, interaural differences, accounts for the 'head shadow,' which produces a difference in sound intensity between the ear closest to the sound and the ear that is farther away. The head blocks some of the sound waves from the farther ear and muffles the sound. This information can help specify the spatial location of a sound source, particularly for lower sound frequencies. Thirdly, reverberation refers to sound waves from the sound source that reach the ears after first bouncing off from elements in the environment, such as walls and ceilings. For distant sound sources, the reverberation can improve distance estimations.

Perceptual Constancies

Our experience with objects in the world provides us with consistency when interpreting spatial information from all of these various visual cues and under different viewing conditions. One example of this ability is called *shape constancy*. This term refers to our ability to account for distortions in shape due to perspective. For instance, when we look at an open door, it does not look like a trapezoid. A second perceptual constancy is *size constancy*. Size constancy allows us to interpret objects as a single constant size regardless of how close we are to the item. For example, we do not perceive that a person grows taller as he approaches; instead we interpret the change as a reduction in distance.

Perceptual constancy, in particular size constancy, occurs so automatically that it is important to note that understanding the mechanism is not trivial. Our ability to appropriately make size judgments is an important precursor to interaction with any objects in our environment. Historically this ability was seen as a particular challenge since the retinal image varies with both actual size and viewing distance. In other words, a large object far away and a small object nearby could produce the

same sized retinal image. Size judgments required adding information to what was provided by the retinal image.

When we accurately perceive the size of an object the size is not coded as an abstract metric amount (e.g., 1 in. tall). Rather, humans perceive the size of objects relative to their bodies (e.g., bigger than me). This coding naturally scales objects to our hands and fingers, or whatever part of the body would interact with the object. Thus, an adult and a child would create different size codes reflecting their different interactions with the same object (e.g., grasping a ball requires one hand or two). This individually based coding may explain why the furniture in a childhood classroom seems so small when we return as adults. The size of a child's chair relative to an adult's body is much smaller than the size of the same child's chair relative to a child's body.

Perception of size is scaled to the effectors that interact with objects (e.g., hands and fingers) and to skill level. Another example comes from the automatic calculations related to locomotion, discussed more specifically below. Humans judge the width of openings relative to the width of their own bodies and also allowing extra room for the sway in the trunk that occurs when walking. For example, people will turn sideways in advance of entering a narrow passage, or a subway turnstile.

Perceptual Mysteries: Ames Room

One clever illusion that takes advantage of perceptual constancy is the *Ames room* illusion. In this illusion, a seemingly standard square room is shown, often with two people standing in the two far corners of the room. One person is shown with her head touching the ceiling and appearing to be a giant. The second person appears to be tiny, only half the size of the first person, with his head about half way up the wall of the room. The illusion relies on perceptual constancies to interpret the room as a standard square room. However, it is actually highly distorted such that it is trapezoidal in shape. The tiny person is actually standing at a much farther distance

from the viewer than the giant person. In addition, the ceiling is not flat, but slanted so that the height of the room enhances the distortion. These manipulations allow for two people of identical size to appear to be dramatically different in the trick room.

Perceptual Mysteries: Moon Illusion

A second, classic illusion related to size constancy is called the *moon illusion*. At one time or another most people have noticed that the rising moon looks much larger than a moon high in the sky. However, of course, the moon does not change size so something about our interpretation of the sensory information changes. Two classes of explanation have been offered for this illusion, a *taking-into-account theory* and a *direct size judgment theory*.

The taking into account theory is based on an account of size judgments that combines retinal image size with estimates of an object's distance. The actual sizes of distant objects can be calculated from these two quantities using simple geometry. Notably, if the distance estimate is in error then there will be a proportional error in the perceived size. So, according to this theory the distance-to-the-moon used to estimate actual size is smaller when the moon is overhead than when it is on the horizon. The greater distance on the horizon reflects the richer information for distance on the horizon (e.g., the moon is behind everything on the surface of the earth), while the moon overhead offers little distance information so the visual system uses a default value.

The challenge for this explanation is that when asked about the distance of the moon, people report that it appears closer when it is near the horizon. This is exactly opposite to the theory, which predicts that people would say it appears farther away. Fixes have been offered that distinguish between conscious experience of a perceptual value and a *registered distance*, a quantity used by the visual system in size calculation.

An alternative explanation is that we judge size by comparing adjacent objects. Thus when we compare the moon to nearby objects on the horizon, the nearest objects will likely be large (e.g., house, tree, or mountain), thereby enhancing the size estimate of the moon near the horizon. Whereas when the moon is overhead there is little to compare it to other than leaves of trees, perhaps. The final answer to this question is one of many areas of open inquiry in the field of spatial perception.

Development of Spatial Processing Skills

Over the course of development we gradually acquire the ability to process the spatial cues that were described above. Not surprisingly, the ability to process individual spatial cues develops at different rates. One classic illustration of the development of spatial processing is called the *visual cliff*. In this demonstration, babies' access to spatial distance information is evaluated. The demonstration apparatus consists of a clear glass table with an opaque band, such as a piece of wood, placed across the middle of the table. On one side of the band, there is a tablecloth pressed against the underside of the glass. On the other side of the glass, the tablecloth is laid against the floor so that the distance from the glass table to the floor is visible. Human babies will not crawl across this second

side of the table toward their mothers after the age of about 6 months old. Prior to this age, they will cross over the open side, suggesting that they are not yet able to incorporate spatial information that would show them they are suspended above the ground. This fear emerges after the crawling stage begins supporting the notion that locomotion provides the experience necessary to learn about spatial relationships underlying the visual cliff. Indeed, in adults this fear may prevent them from walking over clear glass floors in elevated viewing towers such as in the CN Tower in Toronto.

How Is Spatial Information Represented?

Space Around Us

In the paragraphs above, we described some of the perceptual information underlying spatial processing. Here, we note that all space is not considered the same. In humans and some other species, the closer space holding items within arm's reach is processed differently from more distanced space. The first area is called *peripersonal* space. Peripersonal space refers to the space immediately around the body. This space encompasses objects within our grasp. It also includes items in range to act on using a tool. For example, we are operating in peripersonal space when we write on a piece of paper with a pen, and also when we pile leaves with a rake. The second area is called *extrapersonal*, or *action*, space. Action space refers to the space just beyond peripersonal space. This is the space populated with objects that we *plan* to act on. For example, we cross the kitchen toward the cookie jar that we intend to investigate. Neuroimaging data reveal that items in peripersonal space increase activity in regions at the back of the brain such as the inferior parietal lobe including the supramarginal and post-central gyri. These areas are also implicated in the planning of motor actions. In contrast, items in extrapersonal space increase activity in more anterior brain areas including the ventral premotor area, middle frontal gyrus and superior temporal lobe. These areas are implicated in recognizing and interpreting the actions of others. The dissociation between peripersonal and extrapersonal space is also found in neuropsychological patients. Some patients with hemispatial neglect only ignore items within peripersonal space, while others may ignore items only in extrapersonal space.

Finally, there is a third space for very far distances up to the horizon, called *vista* space. Vista space refers to the objects and surfaces well beyond our immediate surroundings. On a scenic drive through the mountains, you allocate most of your attention to the far off distance to appreciate the view. In addition, the spatial configuration of vista space is perceived almost entirely by monocular visual cues.

Egocentric/Allocentric Reference Frames

Spatial perception supports motor planning and execution. With little digging it becomes clear that spatial representations are complex and multilayered. In the preceding section, we described how the factor of proximity is important in space perception. Here, we mention a second dimension of spatial processing: *reference frame*. The phrase reference frame indicates from where you are basing measurements. According to

an *egocentric* reference frame, spatial properties are interpreted with regards to the viewer. Since people are often moving, these representations require nearly continual updating. For example, the car is parked six blocks down the street. If I walk ten blocks down the street, the car is now going to be four blocks behind me. Egocentric reference frames can be parsed even more finely because our body parts are independently mobile. There is very active research investigating eye-centered, head-centered, and body-centered reference frames to help us understand how space is processed under various situations. Much of the time, these reference frames are in synchrony; such as when we are walking forward, or seated working in front of us. The eyes, body, and head are aligned; what is to the left of the eyes is to the left of the body and head. However, it is not clear which reference frame dominates spatial representations in more complicated cases. For example, imagine someone is seated at a desk (body facing forward), turning his head over his shoulder (head facing sideways) and looking toward the ceiling (eyes pointed upwards). In this case, all three egocentric reference frames would be providing different information about where the front of the classroom is located.

In contrast, an *allocentric* reference frame places objects in relationship to each other. Thus, allocentric reference frames do not need constant updating because they are independent of the viewer. For example, the car is parked on the corner of Broad and Main Streets or the park is to the South of the monument. An allocentric reference frame is what is used in a map.

Individuals differ significantly in their preference for the two types of reference frames – some prefer to give directions from a first person egocentric perspective while others from an allocentric overhead perspective. There is considerable evidence suggesting that egocentric and allocentric reference frames are processed by dissociable neural systems. This means that the ability to use one of these reference frames

can be selectively impaired leaving the second one intact. For example, brain damage to structures in the ventral occipital lobe and medial temporal lobe structures causes disproportionate deficits in allocentric spatial memory, leaving egocentric task performance intact. These findings show that medial temporal lobe structures perform computations essential for processing objects in an allocentric reference frame. In contrast, damage to the superior occipital and inferior parietal lobes causes impaired performance in patients when they are asked to conduct tasks using an egocentric reference frame (Figure 2).

Spatial Perception in the Service of Action

In the previous paragraphs, we have introduced factors related to the perception and interpretation of spatial relationships. As described above, there is a long list of perceptual abilities devoted to interpreting spatial relationships in the external world. We have provided a mere glimpse of the complexity and importance of spatial perception. Next, we address what this spatial information is used for, in essence why spatial perception is worth the effort. In short, the capacity to appreciate spatial information is essential because we are mobile. Perceiving the space around us allows us to plan and execute actions, interact with the things we need, avoid the obstacles in our path and even remember the route home. In the following paragraphs we touch on factors associated with moving through the environment.

Locomotion Requires Perception

Moving through the world, or locomotion, relies on spatial perception to avoid obstacles and steer a path toward a goal.



Figure 2 The divisions of space around us from closest to farthest: peripersonal, extrapersonal, or action and vista space. The dotted lines approximate the divisions between these areas of space. Demonstration of two reference frames: egocentric and allocentric. The egocentric reference frame takes into consideration the viewer, and considers the space between the viewer and the object. Here, the pitcher is in front of the viewer. The allocentric reference frame considers the relationship of one object to another, here the positions of the mug and pitcher are shown without regard to the position of the viewer.

We rely on the pattern of changes in the visual field as we move by. These changes in the visual signal accompanying locomotion are called *optic flow*.

Larger scale navigation includes moving to visible (e.g., to the doorway across the room) and invisible destinations (e.g., to the movie theater across town). When navigating, route selection is influenced by both environmental and individual factors. People will tend to use routes with the longest lines of sight at each intersection, meaning the path with the clearest view and the greatest extent of spatial information. People also avoid changes of direction whenever possible, a strategy that reduces the spatial complexity of the route traveled. Perceiving and acting on spaces beyond the sensory horizon (i.e., beyond the vista space) entails a constructive process of generating a mental model of a spatial layout. Such mental representations are necessary for a range of spatial tasks like perspective taking (e.g., the store is not visible from the Southern corner) and finding one's way. These points of consideration underscore the close relationship between spatial perception and the field of navigation research.

Locomotion Enables Perception

As much as perception is required for locomotion, the reverse is also true: locomotion enables and enriches perception. Indeed, the ecological school of visual perception argued that movement is essential to perceive the environment. Their rationale for advocating this perspective is the following. It is important to note that the 3D veridical structure of the external world cannot be fully reconstructed from the 2D representation provided by the two retinae to the visual system. This is a consequence of the fact that the retinal image is not in 3D.

Locomotion causes systematic changes in the retinal image that allow for a more robust reconstruction of the visual image.

Over changes in distance there is a greater accumulation of monocular and binocular cues providing spatial information. For example, there is increased motion parallax allowing occluded objects to come into view. These updated visual signals can have direct effects in terms of updating the motor plan for achieving a particular goal state. In many cases, there is even a direct coupling between the changes in the retinal image due to locomotion and a resulting motor action. For instance, when you run backward to catch a fly ball in baseball, you correct your position based on changes in the path of the ball and you do this continually until you catch (or miss) the ball. Other well-studied examples include steering during walking and posture control. In short, locomotion, and spatial perception enjoy close interactions that facilitate and improve each other in a reciprocal manner.

See also: [Spatial Orientation](#); [Touch](#); [Visual Perception](#).

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Stress and Blood Pressure Dysregulation*

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Glossary

Ambulatory blood pressure monitoring (ABPM)

A technique by which blood pressure can be assessed as patients go about their usual activities. ABPM measures are an important predictor of heart, brain, kidney, and arterial damage, and of cardiovascular events.

Blood pressure The force of the blood flow on the inner arterial walls. Sustained higher blood pressure is a cause of heart, brain, kidney, and arterial damage.

Cardiovascular reactivity The magnitude of the acute change in blood pressure from a resting level to the stressor

level. Greater reactivity is hypothesized to contribute to the development of hypertension and coronary heart disease.

Hemodynamic patterning The underlying forces that regulate blood pressure change, with initiation from centrally mediated processes, including cardiac output (amount of blood pumped from the heart on each beat), and peripherally mediated forces, including total peripheral resistance.

Hypertension Morbid condition in which the resting blood pressure is greater than 140 mmHg (systolic) or 90 mmHg (diastolic).

Introduction

Hypertension, a major risk factor for coronary heart disease and all-cause mortality, affects ~29% of Americans. The cause of most of these cases is unknown; however, a great deal of epidemiological data show that psychosocial factors such as stress, emotional self-regulation, and social support are strongly linked to its development. Generally speaking, there are two main pathways by which such factors may contribute to high blood pressure (BP): (1) by affecting other health risk-related behaviors (e.g., increased nicotine/alcohol/drug use, poor eating habits, less exercise) and (2) by exerting direct effects on the biological mediators of the stress–clinical outcomes' relationships. This article focuses on the second pathway.

Human stress psychophysiology has matured a great deal in the past couple of decades. The measures have become more sophisticated and now focus on a wide array of biobehavioral markers of the bodily systems involved in the stress response, instead of the exclusive focus on BP that marked earlier experiments. These markers include (but are not limited to) heart rate variability (HRV), endothelial function, platelet aggregation, cortisol and other neurohormonal markers, markers of immune function, and fMRI. Moreover, the laboratory has spilled over into the natural environment, where measurements are taken using ambulatory monitoring of BP, HRV, salivary cortisol, and self-reports of relevant state and situational dimensions, including affect, thoughts, persons with whom one interacts, what time the subject went to sleep and woke up, and when the subject took her/his medication. This work has progressed even further with the recognition that the biological systems under study operate not only in parallel but synergistically as well, and this has had the effect of fostering greater interdisciplinary research in which more than one such system is investigated in the same research subject at the same time. This is clearly a necessary development for the field to continue advancing.

Origins of Stress-Psychophysiological Investigations

Cannon's 'Fight or Flight' Studies: An Early Influence on Acute Stress Research

Modern ideas regarding stress and its effects on the body date from the classic studies of the physiologist Walter Cannon. Cannon first described the 'fight or flight' response to threat, work that led to modern conceptualizations of the role of the environment in provoking perturbations in the biological systems of the body. Relevant to the present article, he concluded that we could learn about regulation and dysregulation by observing physiological processes at rest and under an emotional 'load' – that is, upon exposure to stress. Thus, his work anticipated the basic laboratory stress paradigm that is prevalent today.

In his studies, Cannon showed the effect of emotional arousal – fear, in particular – on coordinated autonomic and neurohormonal activity, the latter notably involving adrenaline (epinephrine). Cannon identified the function of this process as preparation of the organism for a 'fight or flight' response. This response involves a chain of biochemical reactions that follow threat perception and include activation of the sympathetic nervous system and stimulation of the adrenal medulla to secrete the catecholamines, epinephrines, and norepinephrines. This sympathetic adrenomedullary (SAM) activity triggers the peripheral physiological processes associated with the fight-or-flight response, including cardiovascular and respiratory changes that increase the supply of oxygen to the brain and muscles to mobilize the organism for action. The sudden activation of these responses at the first sign of danger provides the basis for the study of physiological reactivity in response to acute laboratory stressors. These processes can provide a means of survival for the organism in the short term; however, they may have undesirable physiological consequences when sufficiently prolonged, frequent, or intense, and when provoked by threats for which vigorous behavioral activity is not an optimal solution.

*Conflicts of interest: None.

Selye Describes the General Adaptation Syndrome

An important advance in the stress field occurred in the early 1950s when Hans Selye put forward a model in which the term 'stress' referred to the nonspecific elicitation of a physiological response by diverse noxious stimuli. Selye referred to that response as the general adaptation syndrome (GAS) and characterized it as triphasic. In the initial *alarm* phase, the mobilization of metabolic resources is initiated, which is marked by an increase in adrenal activity and other physiological changes. Following this stage is the *resistance* phase, where the body begins to suffer effects of heightened activity. This stage is marked by continued increased physiological arousal, including the production of corticosteroids by the adrenal cortex, though this arousal becomes more moderate over time. Secretion of corticosteroids serves protective functions through metabolic effects that include elevations in blood sugar levels and through downregulation of immune responses, including inflammation of body tissue. Eventually, the body cannot maintain its heightened level of arousal, and the *exhaustion* phase begins. In this stage, resistance is depleted and the body is unable to continue to function at high levels, and corticosteroid production becomes depleted. If the stress persists, Selye proposed that exhaustion could lead to illness and disease because the adrenal gland and immune system cannot function properly.

Selye's formulation provided a heuristic basis for the study of stress: a different model for each environment-biology transaction was not required. Rather, a range of factors operate via the same channels, producing the perturbations described by Cannon and triggering a hormonal response from the hypothalamic adrenocortical axis (HPA). In addition, Selye suggests that stress can lead to illness and disease as the body becomes exhausted. Taken together, the work of Cannon and Selye anticipated the modern study of stress effects on biological dysregulation.

Strategy of Psychophysiological Investigations into Stress-Outcomes Research

The methodology for most stress-psychophysiological studies is based on Cannon's assertion that we can learn about bodily processes by placing them under a load. In stress-reactivity studies, the load is represented by having to cope with or overcome a stressor of some sort and the experience of the often negative emotions this engenders. The methodology across studies is remarkably consistent. Although differences in procedures exist due to the nature of the manipulation and the particular measures used, studies usually comprise assessment of the target measure during or following a resting baseline and then during or immediately following exposure to a stressor. (Figure 1 shows a theoretical example.) The methodology provides a means for the investigation of psychosocial factors as they affect the acute physiological response under controlled laboratory conditions. This article focuses on BP, which was the main focus of these investigations until the past 20 years or so.

The acute BP response to stress has been labeled cardiovascular reactivity (CVR) and refers to the change in heart rate

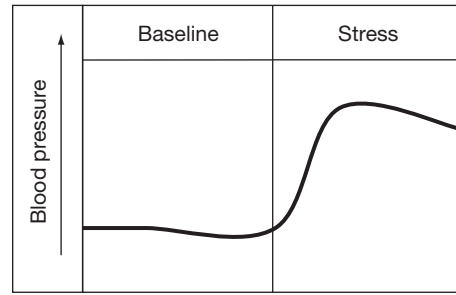


Figure 1 Schematic overview of CVR-testing procedures.

(HR) and/or BP that is observed in the laboratory upon exposure to a stressor. The basis is that persons who exhibit greater CVR to stress are thought to be at greater risk for hypertension (HTN) and coronary heart disease (CHD) than those whose responses are lower. This has been referred to as the 'reactivity hypothesis.'

It is clear that behavioral and psychosocial factors such as anger, hostility, lack of social support, and exposure to stress are linked to HTN and CHD. The pathways by which these factors increase risk for disease, however, remain controversial. The reactivity hypothesis suggests that the acute BP or HR response to stress serves as a marker for HTN and CHD risk and possibly as a mechanism underlying the stress-HTN-CHD relationship.

BP and Hypertension

BP is the force of the blood flow on the inner arterial walls. An increase in one's BP is generally due to a combination of increased sympathetic outflow, mediated centrally via cardiac output and more predominant in earlier stages of HTN, and by increased peripheral resistance, which is more predominant in the later HTN stages. In most people, the BP starts out low, but in many individuals the level becomes elevated over the course of the life span. High BP is not only a significant risk factor for heart disease and all-cause mortality, it is also a cause of damage to the heart, kidney, brain, and arteries.

It is often thought that developing high BP is an inevitable consequence of age. This is not the case, however, and one particularly evocative naturalistic study of an order of Italian nuns suggests this is not so. Over 20 years of observation of the members of a secluded order who spent most of their time in silence and prayer, and of the lay women who took care of the secular aspects of life, the BPs of the lay women, but not the nuns, rose with age (similar work has also been conducted and described by Gordon in the United States). The groups had the same diet, lived in similar quarters, and none in either group smoked or took oral contraceptives. It seems that it was only when individuals were exposed to the stress of dealing with the exigencies of everyday life that BP increased.

The study of the Italian nuns suggests that to understand the causes of developing higher and higher BP over the years, we must consider the role of psychological and environmental factors that contribute to HTN. The study of CVR has dominated this research.

The First Study of Acute BP Response

Early in the twentieth century, two physicians, Edgar Hines Jr. and George Brown, developed a test that could be applied to their patients with normal BP, which would allow the prediction of future HTN. The test involved first the taking of a baseline BP, followed by exposure to a 'cold pressor,' in this case an ice-water bath in which the patient immersed his/her hands while the BP was measured. The hypothesis was, the greater the difference between the baseline and cold pressor BP measurements, the greater the likelihood the patient would later develop high BP. To test the hypothesis, they conducted a simple study in which they took BP measurements in both normotensive and hypertensive patients, first during a resting (baseline) period, and then following exposure to a cold stimulus – the patient immersed both hands in an ice bath for 2 min. They found that, indeed, the BP of the hypertensives climbed during the ice bath more than that of the normotensives, supporting their hypothesis.

The cold test has not, unfortunately, proved useful for diagnosis, but it did provoke investigation that has continued for 80 years, until the present day. Their simple study was to become a template for how stress psychophysiology was accomplished, that is, to take measurements during an initial resting period and then again during a challenge or stressor of some sort.

The focus on CVR has persisted since Hines and Brown's study. It remains the predominant approach to the understanding of biobehavioral investigations into sustained elevated BP.

Does BP Reactivity Predict Future HTN and Cardiovascular Disease (CVD)?

Cross-Sectional Studies

Over the past several decades, many studies have replicated Hines and Brown's results, using the cold pressor and, later, psychological and emotional stressors. The most common has been mental arithmetic. These studies suggest that CVR may serve as a marker, and possibly as a cause, of future high BP. However, caution must be exercised in interpreting these results as they are cross-sectional, and in most studies, age, which tends to be greater in hypertensives in these studies, was not controlled.

Prospective Studies

Several prospective studies have examined the effect of increased CVR on a variety of endpoints, including the development of HTN, subclinical endpoints including left ventricular mass (a measure of heart damage), carotid atherosclerosis/coronary calcification, and of clinical endpoints (including myocardial infarction and death). An exhaustive review of this literature is beyond the scope of this article; however, the literature might be summarized as showing sufficient positive effects on prospective mechanisms and clinical outcomes to warrant the continued investigation into the magnitude of the BP response to stress.

Predictors/Determinants of Cardiovascular Reactivity

Hemodynamic Patterning as a Determinant of BP Reactivity

Acute BP elevation is determined by various factors, and the specific impetus for the BP increase is associated with the development of HTN and CHD. At the simplest level, the change in BP is a product of the cardiac output (CO: amount of blood pumped by the heart during a single cycle) and total peripheral resistance (TPR: systemic resistance to blood flow through the arteries). Addressing the conditions under which one system or the other is likely to predominate provides useful information regarding the underlying physiological mechanisms by which mental stress affects HR and BP. A noninvasive technique to assess these processes, called impedance cardiography (IC), provides a means to assess myocardial contractile force, particularly the cardiac pre-ejection period (PEP; the amount of time it takes for the heart to contract strongly enough to pump blood out of the heart during each heartbeat).

Identifying the source of the acute BP increase in response to stress – CO or TPR – is useful because, it has been theorized, each maps onto a different set of psychological responses. Thus, an individual who is late for an appointment, is driving, and is in heavy traffic may up his/her efforts to drive faster and to weave in and out of traffic, trying hard to arrive on time. Such a situation is referred to as 'active coping' by Paul Obrist, a prominent psychophysiolgist. That is, one can overcome the challenge if one puts the effort into it. Active coping-type stressors, according to Obrist, lead to BP increases that are mediated primarily by a *cardiac* response pattern, mediated by the sympathetic nervous system (SNS). This response also comprises increased CO, myocardial contractile force, HR, and systolic BP.

However, consider the situation in which you are late, driving, and in traffic, but stuck in bumper-to-bumper traffic that is not going to move for an hour. Once again, a stressful situation, but now there is nothing one can do about it. One's BP will rise in these circumstances – what is referred to as 'passive coping' by many – but Obrist suggests that the rise will be due, in this instance, to a *vascular* response pattern, also mediated by the SNS, and includes increases in TPR and diastolic BP, as well as HR responses that are mediated by the peripheral nervous system (PNS).

Factors Affecting Cardiovascular Reactivity

Social support

Individuals who report higher amounts of social support are at reduced risk for developing CVD. Some researchers have suggested that the presence of a supportive person may buffer the effects of stress and, therefore, will be associated with reduced CVR. Indeed, several studies have found that the presence of a supportive individual produces lower BP responses than not being provided with support, although a few studies have failed to replicate these findings.

Hostility

Recent literature suggests that persons who score high on trait hostility tend to exhibit larger CV responses compared to low-hostile persons, but only in situations in which this aspect of

personality is relevant, such as when the subject is being harassed while working on a stressful task.

Race

It is known that African-Americans are more likely to develop HTN and CHD than whites, but the cause is not well understood. Some studies have examined black-white differences to stress and found mixed results, although a preponderance of these studies has shown that both black children and adults tend to exhibit greater CVR compared to white subjects. The evidence is sparse, however, due to the paucity of published studies.

Sex

Men are more likely to develop HTN and CVD than women during early adulthood and middle age. However, women tend to catch up after menopause. Comparisons have tended to show that men exhibit greater systolic BP reactivity to stress, while women tend to have slightly greater HR responses.

Menopause

Few studies of pre- versus postmenopausal women have been conducted. However, the data that do exist suggest that postmenopausal women tend to have greater HR and systolic BP reactivity than premenopausal women.

Menstrual cycle

The role of the menstrual cycle on CVR remains unclear. The results comparing women's CVR using a between-subjects design have found little effect of the luteal or follicular phase of menstruation on CVR, and within-subject studies have tended to show positive but small differences. An analysis of the results across studies suggests that the menstrual cycle probably does not largely influence CVR. However, it is noted that reproductive hormones may play a role in modulating the stress responses in women with abnormal menstrual cycles and that changes in hormonal levels may play a role in stress reactivity.

Effects of family history of HTN

Individuals with one or two parents with HTN are themselves at greater risk for this illness. One research strategy has been to see if persons with a positive family history tend to have greater CVR than individuals with no hypertensive parents, and the evidence, although sparse, supports this.

Twin studies

Overall, there tends to be a stronger relationship between stress reactivity in monozygotic than in dizygotic twins, suggesting that there is a genetic basis for the magnitude of the BP or HR response to stress. The NHLBI Twin Study examined 101 twin brothers who were veterans of World War II and the Korean conflict. The results of a comparison of the CVR in both brothers in each dyad indicated that a moderate proportion of the variance in CVR appears to be attributable to genetic factors.

Limitations of the Reactivity Hypothesis

Perhaps the major limitation to the usefulness of the reactivity hypothesis concerns the degree of interpretation – and sometimes overinterpretation – to which the results are

subjected. First, of course there are many factors that are implicated in the observed association between stress and HTN/CHD; the reactivity hypothesis is one small part, but tends not to be incorporated into a larger framework, and this is crucial for progress in this area. Another aspect of overinterpretation concerns the nature of the data – we cannot examine the long-term health effects on manipulated CVR, so we do not have evidence that allows statements concerning the causal role of CVR in CVD.

Summary

The examination of the determinants and role of CVR in the development of HTN and CHD has been useful for understanding the important role that stress may play in this process. There are limitations concerning the interpretability of the data, but true to Cannon's notion, the study of the biological parameters – in this instance, of BP and HR – while exposed to a 'load' (a stressor or challenge) has the means to provide a window into biological mediators of stress and illness.

New Developments in Stress-Psychophysiological Research

Over the past 20 years or so, it has become increasingly apparent that to understand the nature of the effects of stress on chronic illness, we must examine the multiple biological systems that mediate the transactions between the environment and the future dysregulation of those biological systems, with the resultant increase in probability of developing HTN or heart disease. For example, it is now clear that the regulation of inflammation is subject to environmental stress and plays a central role in CVD and many other chronic illnesses. Thus, it must be considered in any model attempting to specify and understand the stress – illness connection.

A New Approach: Cognitive Underpinnings of Sustained Biological Dysregulation

Most of the research described in this article concerns acute dysregulations of the BP and other biological systems that are affected by stress and implicated in the development of HTN and CVD. Specifically, the research has focused on the acute biological response to a stressor. However, humans do not require an external stressor to provoke such responses; we are quite capable of storing the memories of those experiences and replaying them later, often over and over again. Moreover, some theorists, including the authors, have come to the conclusion that it is this chronic reexperience of past stressors that is the more important cause of illness. The effects of such 'replays' are often of lesser magnitude than that of the original stimulus, but a 30 mmHg increase in the BP over a period of a few minutes or an hour is not nearly as damaging to the cardiovascular system as a small change – just 2 or 3 mmHg – that is sustained over months or even years. Thus, the role of cognition, with a focus on perseverative cognition (e.g., rumination, worry), has begun to be seen as an important area of study, not supplanting but certainly augmenting the reactivity

models. A large body of research now shows that dysfunctional cognitive and emotional self-regulation, such as keeping one's anger in and ruminating about it, often long into the future, exercises pejorative effects on BP regulation, as well as other biological systems including the hypothalamic–pituitary axis, sympathetic–parasympathetic balance, and endothelial function.

Conclusion

It is unequivocal: Stress, and the way one copes with it, plays a critical role in cardiovascular health and psychological well-being. The effects of stress on the biological systems that are implicated in poor cardiovascular health are well documented. In addition to acute effects, the chronic sequelae of perseverative cognition and rumination are also implicated in the development of HTN and CHD.

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See also: [Psychological Predictors of Heart Disease; Stress and Illness.](#)

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Stress and Illness

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Glossary

Coping Physical or mental efforts made to manage perceived demands of a stressor.

Health Resilience, toughness.

Illness Sickness that has been diagnosed.

PAC Pituitary adrenocortical response system – evaluation of a threat triggers physiological responses resulting in cortisol release; a long-term stress response.

SAM Sympathetic adrenal medullary system – evaluation of a threat triggers physiological responses resulting in catecholamine release; a short-term stress response.

Stressor An external event deemed as a challenge or threat.

Stressor appraisals The perception that an impending or ongoing personally relevant event is taxing one's resources for coping with the event.

We all experience stress but only some of us will become sick because of it. This article begins with a brief history of how philosophers and scientists have thought about stress and illness, and how stress is physically and psychologically manifested. Next, we consider that although understanding physiological responses to stress helps us to understand how stress might lead to illness, it does not help us to define what stress is. Finally, specific links between stress and illness are examined, with an eye toward factors that can help organisms build resilience against stress.

Brief History of the Interaction of Mind and Body

Most present-day thinkers studying the body's adaptation to its environment believe that the mind and the body interact and that they are intimately linked to influence our ability to adapt to stressful situations. These beliefs were not always so prevalent. In the mid-1600s, the Western world was offered Descartes' mechanistic approach, in part, a product of the 'time of machines.' It suggested that the mind and the body were separate both in substance and in their distinct functionality. At that time in history, this conceptualization of mind-body dualism permitted investigation (dissection) of the human body (the 'machine') without concern for affecting the mind which held the soul (the 'ghost in the machine'). Although our knowledge of the physical functioning of the human organism increased greatly, there was no consideration of how the mind could influence or be influenced by the machine.

Cartesian dualism offered a philosophical separation of the mind and the body that allowed for an investigation of the machine, but it posed barriers for thinking about how the mind and the body may be functionally integrated. The father of American psychology, William James, believed that the body and the mind together have an adaptive relationship with the environment, even though they are physically different. In American psychology, however, the study of the mind became untenable for psychologists, largely because of John Watson's directive that as a natural science, psychology should focus on investigating only those things that were observable. Consequently, examination of mental states was unworthy of study because the mind is inherently unobservable. The study

of the interaction of the mind and body processes did not reemerge until the 1960s, when Schachter and Singer offered a neo-Jamesian model of emotion. Their research demonstrated that people would interpret their physiological arousal depending upon the situation in which they found themselves. Given physical arousal and a happy context, people were more likely to interpret their physiological symptoms as indicating happiness. Conversely, given arousal and an angry context, people were more likely to interpret their arousal as indicating anger. Subsequently, some scientists suggested that the physiological experience need not rise to the level of psychological awareness to influence thoughts and behavior. Research on nonhuman animals revealed that immune system suppression could be learned, demonstrating that awareness was not needed to influence physiological functioning. In human research, evolutionarily significant pictures (i.e., spiders and snakes) were presented below levels of awareness. Research participants had physiological and psychological distress responses to these stimuli, despite their lack of awareness of the pictures.

At present, we know that the body is comprised of multiple systems that coordinate with one another, and these systems are affected by the mind. The traditional biomedical model reflects a separation of mind and body. The model's focus was on pathogens that cause disease and their treatment. Conversely, the more recently developed biopsychosocial model considers the interplay of biological, psychological (e.g., thoughts, emotions), and social factors on health and illness. This model best explains how stress and illness can be linked. There have been three main approaches to studying stress and illness. The physiological approach focuses on physical disease and its mechanisms, the environmental approach focuses on external stimuli, and the psychological approach focuses on cognitive and emotional processes. Given this brief history of thinking about the interaction of the mind and the body, we now turn our focus toward understanding how these three main approaches have evolved.

Physiological Stress Responses

The body has multiple systems that allow for layered stress responding, making the organism quite adaptable to

environmental changes. Major historical contributors to present-day thinking about stress reactions, Cannon and Selye, believed that perceptions were the key to setting off physiological changes. We begin with a description of Cannon's contributions to understanding basic, so-called 'fight-or-flight' reactions to stress and then discuss Selye's investigation of chronic stress responses. These physiological responses, along with immune system functioning, provide a direct route through which perceptions of threat (below or above levels of conscious awareness) affect the body and influence physical illness.

Walter Cannon, a physiologist, coined the term 'fight or flight' to describe sympathetic nervous system (SNS) responses to stress that quickly prepare the organism for attack, defense, or escape. The most immediate response includes neural-induced physiological changes, including pupil dilation (to bring in more light), increased heart rate (to get more blood to the muscles for use), and hormonal changes including secretion of adrenalin (to increase cardiovascular and respiratory functioning for muscle mobilization and to reduce digestive functioning). These widespread and quick effects are beneficial as energy is mobilized throughout the body in preparation for vigorous muscle activity, such as would be needed to fight or flee. This is the sympathetic-adreno-medullary response system (SAM).

Physiologist Hans Selye refined our language about stress, referring to the external stimulus as the 'stressor,' and the physiological response as 'stress.' For Selye, stress was a non-specific biological response caused by all noxious stimuli. He focused on nonhuman animal stress responses of the hypothalamic-pituitary-adrenocortical (HPA) axis. Because of its anatomy and functioning (via the bloodstream), the HPA axis tends to be a slower stress response system compared to the SNS. Upon the perception of threat, the brain's hypothalamus signals the anterior pituitary to secrete adrenocorticotropic hormone (ACTH), which travels to the adrenal cortex (atop the kidneys) signaling it to secrete glucocorticoids, including cortisol. Cortisol not only travels throughout the bloodstream to mobilize the body's energy resources, but is also used as an anti-inflammatory. Having sustained energy and protection from injury would be helpful, for example, when an organism is fleeing from a hungry tiger and twists its ankle. Thanks to cortisol, running from the tiger can be sustained for some time without suffering too much pain and swelling. This stress response was dubbed the 'general adaptation syndrome.' Selye's model stated that adaptation to a stressor has three stages beginning with 'alarm,' the fight-or-flight response, then 'resistance' as the stressor continues, which includes physiological secretion of cortisol. The last stage is 'exhaustion,' the physiological breaking point where organisms might suffer depression or even death. As stressors continue, the physiological response sets the stage for diseases of adaptation. Selye was the first to show that stressors (both positive and negative) have a direct impact on the functioning of the body, and that this impact was driven by the HPA axis and cortisol specifically. This is the pituitary adrenocortical response system (PAC).

Another physiological system that has been more recently investigated in the domain of stress is the immune system. The immune system is the body's defense against foreign invaders and also has implications for stress and illness. When immune system functioning is reduced, organisms are more susceptible

to infection, and injuries are slower to heal. In the mid-1970s, researchers discovered that rats could learn to suppress their immune functioning, suggesting that the mind could affect this physiological system. The field of psychoneuroimmunology emerged soon thereafter, examining the interactions of the psychological, nervous, endocrine, and immune systems with health and illness.

Defining Stressors and Stress Responses

Understanding the physiology of stress responses may help us to understand how the body responds to potential or ongoing threats, but it does not help us to define stress. Given the idea that the body has a nonspecific response to noxious stimuli, psychologists began to investigate how conditions, called life events (e.g., death of a spouse, losing a job), relate to the development of later illness. Overall, this research was not promising because life events were not consistently or strongly related to the development of illness. Although the physiological stress response can prepare people for mobilization, people have different interpretations about the same stressor and will have different ideas about how to cope with the stressor – perhaps via approaching, attacking, or withdrawing. This (and nonhuman) research demonstrated that it is not the objective event but the interpretation of the event that is important for stress responses. It should be noted that while people can interpret the same stressor differently, there are some objective stressor characteristics that increase their potential for stress responses, such as unpredictability, uncontrollability, and negativity.

Richard Lazarus, a clinical psychologist, suggested that stress responses involve a transaction between the person and the situation, and that the person's interpretation of the event was more important than the event itself. Stress responses were determined by the interaction between evaluations of the personal importance of a situation (called primary appraisal) relative to evaluations of the coping resources available to manage the situation (called secondary appraisal). Over time as a stressor unfolds, a person will reassess the importance and relevance of the stressor as well as potential coping resources. Lazarus investigated minor life events, or more precisely, daily hassles (e.g., losing car keys), and found that if these events were interpreted as negative, then stress responses increased. Investigations of daily hassles revealed that they were better predictors of later illness than major life events. Psychological processes are important aspects of our stress responses and influence the development of illness. These influences can be direct, through physiological reactions, or they can be indirect, by altering our behaviors.

Mechanisms Linking Stress to Disease

A direct link between stress and illness occurs through physiological stress responses generated by perceptions of or in anticipation of a stressor. Repeated or continued exposure to a stressor can cause wear and tear on the body. Stressor evaluations of threat (personal relevance coupled with low coping resources) have been related to enhanced fight-or-flight

response. This type of response (when pronounced or frequent) could, for example, aggravate irritable bowel syndrome, cause headaches, or damage cardiovascular health (e.g., coronary artery disease). Repeated or chronically high levels of cortisol responses can increase susceptibility to various diseases and delay the body's healing processes. Excessive cortisol secretion may be an important link to reducing immune system functioning, leaving the body susceptible to colds and other respiratory infections.

Disruption of the normal functioning of these systems can foster mental health problems such as anxiety and depression. Loneliness, depression, and chronic stress, such as caring for a person with Alzheimer's, have been linked to lowered immunity. Research has shown that reducing negative stress (i.e., threat) can improve immune functioning to some degree. There are also behavioral effects that indirectly link threat and illness. When people experience high levels of threat, they may engage in poor health behaviors, such as increased cigarette smoking, alcohol consumption, poor diet, inactivity, and sleep disruption. These unhealthy behaviors can cause the body to function more poorly and reduce immune functioning in particular.

Vulnerability to Stress-Induced Illness

We all experience stressors, but most of us do not develop stress-related illnesses. The diathesis-stress model best characterizes who will succumb to the effects of stressors. The addition of stressors to an already existing personal vulnerability (e.g., biological, genetic, or personality trait) is more likely to result in illness. This model helps us to understand why some people who experience stress get sick and others do not. These so-called stress moderators (personal and social vulnerabilities) can influence exposure to and appraisals of potential stressors, as well as perceptions of coping resources.

There are stable aspects of people that influence their interpretation of the environment in similar ways over time. These stable aspects are personality traits. Optimism is one trait that characterizes the tendency to be hopeful and have positive expectations for the future. One might expect that those who are highly optimistic would have better health outcomes, which they do. Conversely, people who demonstrate hostile tendencies, who are cynical, mistrusting, and suspicious of others, are more likely to suffer poor health outcomes. Compared to those who are less hostile, those who are highly hostile are more likely to interpret situations as competitive and believe that others have negative intentions. When interpreting situations in this way, those who are highly hostile experience greater cardiovascular reactivity and other neuroendocrine responses which pose repeated degradation of the cardiovascular system. Neuroticism is the tendency to experience negative emotions and has repeatedly been found to be detrimental to health. People who are high in neuroticism interpret many of the situations they find themselves in as threats. Evaluations of threat have been consistently related to deleterious cardiovascular responses and worse performance on tasks. However, those high in hostility and neuroticism are not doomed to future illness.

Although there are stable intrinsic variables that can lead to illness for some individuals, there are also stress moderators

that can provide protection. The social context is important to consider for health and illness. Our social networks include the number of people we have for support and how often we use this network. The more people we have in our social network, and the more often we utilize their support, the better our health. Social support can have a direct effect on health by providing a form of assistance, through the good (no stress) and the bad (stress present) times. Having more social ties is linked to greater longevity and better health. However, a smaller network used frequently can still supply beneficial social support. The health effects of low social support are best demonstrated by those who are socially isolated. People who are lonely or isolated suffer more illness. Isolation and loneliness happen for many reasons. Those who are high in hostility may be difficult to be around and provide support to, and research suggests that this appears to be the case. Those who are highly hostile should seek help to change how they interact with the world, to experience less stress reactivity, and garner more social support.

Social support can facilitate coping mechanisms when stressful events occur. People in our social support network can be found in different places (e.g., work, spiritual community, school) and likely provide different functions. Some people might help to give you more confidence to deal with stressors. Others might provide helpful information and/or financial resources. Still, others might be a good source of listening so that you can talk about your stressful experiences, and thereby reduce your negative emotional stress response. It is important to note that not all social support is beneficial. For example, being around people who engage in hostile communication is detrimental to psychological health and can exacerbate psychological symptoms.

Social support can also indirectly affect health by fostering healthy behaviors. Those who have more social support are more likely to engage in health behaviors such as using seat belts and eating healthier. Of course, people can get together to eat more poorly too! Good social support can foster other healthy behaviors such as exercising together and taking better care to obtain health screenings. Engaging in health screenings can help people get the feedback they need to maintain a healthy body or to find problems early and seek treatment. Social support is one way to help us withstand the inevitable stressors we will face, but there are other ways to build up our resilience to stress.

Building Stress Resilience

Vulnerabilities can act as catalysts and actually increase harmful stress effects. However, personal resources and vulnerabilities interact with the stress process. Social support and other resources (such as dispositions like optimism) act as assets when we encounter stressful situations, decreasing the negative effects of stress. They may provide us benefits by exposing us to fewer stressors, helping us to appraise stressors as less threatening, enhancing our coping capabilities, and reducing our physiological stress reactivity. There are many ways to reduce the negative effects of stress. There are also ways to build up our stress tolerance, which can prevent experiencing stress in the first place. Stress tolerance will help our mind and body to be more resilient when faced with stressors.

Several effective stress reduction strategies are offered by the research and experiences of clinical psychologists and health psychologists. One technique includes relaxation training, which includes a combination of breathing exercises, mental imagery, and release of muscle tension. Progressive muscle relaxation is another technique that focuses on the tensing and relaxing of the major muscle groups. Various techniques implemented in cognitive behavior therapy can help to alter how we interpret our world. Psychologists work with clients to help them become aware of and change health-damaging beliefs and behavior. Therapy may focus on changing irrational beliefs that foster catastrophic interpretations of stressful encounters, or focus on increasing the confidence that one can effectively solve stress-related problems, or perhaps to change beliefs that foster hostile interactions with the environment.

Other effective stress reduction strategies stem from eastern cultures and include massage, acupuncture (which is particularly effective for reducing some types of pain such as lower back pain), and mindfulness meditation. Mindfulness meditation involves being still and observing one's thoughts nonjudgmentally. This type of meditation has demonstrated benefits for cardiovascular health and lowering anxiety levels. It may work through reducing stress-related reactivity at the outset, by reducing perceptions of threat. Exercise is another proven way to foster positive psychological and physical health.

Summary

It is clear that the mind and the body are linked. The body can influence the mind, the mind can influence the body, and

the mind and the body interact across different levels to influence how we relate to others and our environment. Repeated stressful interactions can have negative costs for both the mind and the body. A lack of personal awareness of the effects of stressors on our physiological and psychological functioning can exacerbate at worst, and continue at best, our deleterious interactions with the environment. However, there are effective ways in which we can boost our ability to respond to stressors and our tolerance for stress.

See also: Anxiety Disorders; Coping; Depression.

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Relevant Website

<http://www.mgh.harvard.edu/bhi/> – The Benson-Henry Institute.

Studying

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Glossary

Constructed outcome The expectation of acquiring a deeper level of understanding of the material, for the purposes of making inferences and connections to the material being acquired.

Distributed rehearsal The spacing of rehearsal of materials out over different time periods and contexts.

Interpreted outcome The expectation to be able to know the gist of what is being presented – exact wording is not required.

Massed rehearsal The rehearsal of materials in the space of a single, prolonged time period.

Mastery-oriented goal The aim or attempt to master or learn a new skill.

Metacognition A person's ability to know about and monitor his or her cognition.

Performance-oriented goal The aim or attempt to strive to do well – score highly, in reference to others.

Studying An intentional and effortful activity that has as its goal the learning or mastering of some new information or skill.

Verbatim outcome The expectation to be able to repeat back or recognize what was repeated.

Zone of proximal development A concept developed by the Soviet psychologist Lev Vygotsky, defined as the difference between what a child can accomplish independently and what can be accomplished with help from an experienced adult or mentor.

For most people, the word is not associated with pleasant feelings. Studying is an intentional and effortful activity that has as its goal the learning or mastering of some new information or skill. Studying is different from other types of tasks because it is often performed as an isolated and unsupervised activity. Unlike learning in classrooms, studying occurs while working alone and usually, the manner in which the activity is carried out is often executed without directions or feedback from others. As such, the success or failure of the studying activity is often attributable specifically to what the person is doing while studying.

The activity of studying actually begins during the first year of life when infants begin to show evidence of using intentional memory strategies and try to learn language. Studying behavior then evolves rapidly as one enters and progresses through the school years and educational demands increase. As people grow older and complete formal schooling, the activity of studying tends to decline as reliance on prior experience (e.g., real-world knowledge) becomes the predominant strategy for everyday activities.

As with any skill, people vary in terms of how well they execute the skill. Some of the factors that affect the efficacy of studying and their relation to the basic psychological processes that underlie them are presented. (Readers are encouraged to investigate these processes in more detail in the other sections of the encyclopedia.) Also, some recommendations as to how to study more effectively are provided.

Attention

Perhaps because studying is not perceived to be an enjoyable activity by many, people tend to study while also engaging in a secondary activity; for example, listening to music, watching television, texting friends, etc. Although we like to think that we can and should multitask (e.g., engaging in multiple tasks at

work, talking on the cell phone while driving, and even walking), the reality is that research from the area of attention shows that our cognitive system is not designed to do that very effectively. Research and experience has shown that one attribute of our cognitive system is that we have limited attentional resources; that is, we can only attend to a limited number of things at one time. To the extent that people pay attention to one thing (television), they are not paying attention to another (studying) – or vice versa. Research has shown that performance drops off significantly on a primary task when people multitask; the ability to acquire new skills suffers, the number of errors increases, and the time needed for mastery increases. The implication of the constraint of limited attentional resources is that when a person has the goal of studying, he or she should not attempt to multitask.

Interestingly, a second feature of attention leads to a different and slightly contradictory implication. Attention is selective as well as limited. Studying requires staying focused on one thing and this in turn requires effort. These demands lead to a number of consequences including fatigue, decreased motivation, and boredom. The mind has a tendency to wander or get distracted. Current research has shown that the tendency to become distracted actually increases with the amount of effort required by the task; the more effort required, the greater the tendency to become distracted. Studying requires a significant amount of effort! Because it requires effort, it is important to avoid condensing study into single extended periods of time and to create an environment that limits the possibility of distractions.

The suggestion to refrain from studying for extended periods of time in one sitting is supported by research from a number of different research areas. First, research looking at practice indicates that people with an exceptional ability to acquire new skills (experts) use spaced practice: they practice as much in total as other people who are good, but they tend to space out their practice over time (shorter sessions more

number of times a day). Because successful practice is effortful and requires focused attention, there is even evidence that people who are very successful are more likely to take naps after or between practicing! This suggestion is also supported by memory research on the effects of massed versus distributed practice. Many experimental findings demonstrate that massed rehearsal (rehearsing materials all at one time) is not as effective as distributed rehearsal (spacing rehearsal out over different time periods and contexts). People exhibit better memory performance with spaced as compared to massed rehearsal. Finally, research on memory has similarly revealed that the ability to remember something is very context specific; that is, we are able to retrieve information given specific retrieval cues. Information that a person clearly knows may not be retrievable unless the correct retrieval cue is provided. Studying all at one time and in one context limits the number of retrieval cues available. Spreading out studying over time and contexts increases the number of retrieval cues and thus makes the ability to recall something when needed more likely.

The second implication posited was to study in an environment that limits distractions. For example, it is often useful to have white noise (noise that will not demand attention but rather blocks out sounds that might be distracting). Examples of white noise would be the recordings of ocean waves or birds chirping quietly. It is also advisable to study in different places – not study in the same place each time. The research on context-specific memory has shown that studying in multiple locations actually improves retrieval.

So then, studying should not be done while working simultaneously on a secondary task, it should be spaced out over time – no cramming, and conducted in an environment with minimal distractions. All of these suggestions seem intuitive but few people actually follow them. These are suggestions for the context of studying but what should a person do when they actually sit down to study?

One way of thinking about studying is to regard it as a problem-solving task – an ill-defined problem-solving task. An ill-defined problem-solving task is one in which the goals are vague, the manner in which the task should be accomplished is unclear, and indicators of accuracy in task completion is not obvious. The ill-defined problem-solving task contrasts with a well-defined problem-solving task where the goals are well defined (the problem-solver knows when the goal has been reached) and the procedures necessary to achieve the goal are clearly stated.

Goal-Setting

A problem-solving task is defined as a goal-oriented task, where problem-solving people are trying to attain a specific goal. In describing goal-setting behavior, a distinction has been made at a general level between mastery- and performance-oriented goals. With a mastery-oriented goal, the person attempts to master or learn a new skill. With a performance-oriented goal, the person strives to do well – score highly, in reference to others. Research suggests that people who adopt mastery-oriented goals are more likely to try harder and persist in a task than those who adopt performance-oriented goals. However, performance is not always associated with goal type.

While it is hoped that most students study to understand a topic and not solely to perform well, this practice is not always appropriate. Success ultimately depends upon what will be tested. A student can study for comprehension and be tested for rote memory – being able to repeat back what was presented. One distinction that has been made regarding possible outcomes is between verbatim, interpreted, and constructed outcomes. A verbatim outcome is akin to rote memory – to be able to repeat back or recognize what was repeated. Acquiring foreign language vocabulary is one example, but a verbatim outcome is often exemplified by learning specific dates of historical events. An interpreted outcome only requires one to know the gist of what is being presented – exact wording is not required. A constructed outcome entails a deeper level of understanding, because it involves making inferences and connections to the material being acquired. Studying for an interpreted outcome does not lead to quality performance when being tested for a verbatim outcome and vice versa. It is important to know the information that will be used or tested and to adopt a studying strategy that compliments the intended outcome of that information (verbatim, interpreted, or constructed), which will reveal how information is applied. As stated earlier, when people sit down to study, they often do not know how the knowledge is going to be assessed or how it needs to be used.

Studying Strategies

Studying strategies are very often not taught in schools. Many times, students are just told that they are required to study something but not directed on how to go about doing so. Once again, studying is a problem-solving task. Students need to figure out what is the goal and how to accomplish it. Thus, students are left to their own devices to figure out how to do it effectively. Many students seem to be adept at figuring out how to study but many fail; that is, they spend a lot of time trying to study but what they do is not effective.

Alternatively, on the other end of the continuum, some teachers or parents are very prescriptive as to how to study. They demand that students study using a specific strategy. When given directions for studying, students are often told something like ‘this is how you should do it,’ or ‘this is a good studying strategy.’ The problem with this is that, as will be shown, there is no such thing as a *general* good studying strategy. A good studying strategy in one context might be a very poor studying strategy in another.

A distinction made within the problem-solving literature is between weak and strong strategies (or processes). A weak strategy is one that may be applied broadly to many different types of tasks but lacks the specificity for a particular task, meaning that success (achievement for the goal) is not guaranteed. A strong strategy, on the other hand, is one that is designed to work explicitly on a given task and because it is so specifically designed for a given task, it affords a high level of success. The problem with a strong strategy is that it does not necessarily work well for other tasks – it is not generalizable. Thus, if the task demands change slightly, the strong strategy may not work as well.

As mentioned before, studying is often seen as an ill-defined problem-solving task. A person often does not know

what the goal is (how he or she is going to be asked to use the knowledge), whether or not they have mastered the knowledge, or how they should go about the task itself. Given these characteristics, it is often impossible to develop a strong strategy to accomplish the task. People are forced to rely on weak strategies – strategies that are better than nothing but do not guarantee success.

An example of a set of strong strategies is using mnemonics to memorize something. There are a whole host of memorization strategies (called mnemonics) that have been developed to aid memory. Some of the more common ones are called the link mnemonic, the method of loci, and the keyword mnemonic. There are many books available on improving memory that describe the steps needed to be taken to use these strategies. The important point here is that mnemonic techniques (1) work very well for memorizing information and (2) are very detailed in terms of the process of using them effectively. They are designed very specifically to overcome problems with encoding and with retrieval. The problem with them is that they are limited in terms of what they are good for – they allow you to remember the materials in a very specific way with accuracy. However, they are not good for facilitating comprehension or for allowing alternative pathways of retrieval.

Contrast this description with that of a weak strategy. One example of a weak strategy would be subgoalting, a process in which a person breaks up a large goal into smaller composite goals. It breaks up that task into manageable components and allows the person to incrementally set and meet goals. A subgoalting strategy works for a wide variety of tasks. Other examples of weak studying strategies include relating information to prior experiences, trying to relate or integrate information from one source with another, trying to visualize or draw pictures of the information to be learned, trying to think of things from multiple perspectives, etc. Each of these strategies can be used in a variety of contexts and for a variety of tasks and have been shown to improve learning and comprehension. But when do you use each? It is not clear when a person should rely on one strategy or another. Also, unlike the mnemonics mentioned earlier, the steps required to go through to execute the strategy are not well specified. How are you supposed to go about relating something to your prior experiences? What should you specifically do when applying these strategies? The mnemonic strategies mentioned above have very detailed step-by-step descriptions of what to do. Weak strategies, in contrast, are general guidelines for how to go about studying. Different people would try to implement them in different situations – not always appropriate – and in different ways with differing outcomes. These weak strategies are very good processes and can be used in a variety of different situations. However, because they are general, they cannot be specified in great detail nor do they always work for what you are trying to accomplish.

A second point to be made about studying strategies is that people have been shown to not be very good at choosing the most effective strategy for a given task. An interesting research finding relevant to the issue of strategy choice is that apparently students prefer to use strategies that they perceive to be easy to use and require little effort on their part. These strategy choices are often independent of whether the strategy will help them or not. Given a choice between a strategy that is easy to use (requires little effort) but does not help learning much and

one that is more difficult to use (requires more effort) but is more effective, students often choose to use the one that requires less effort.

The implications of this discussion are that (1) people need to rely on a repertoire of different studying strategies to be successful, and they need to be flexible in their choice and use of strategies; (2) approaching a task with a preconceived strategy of how you are going to accomplish it could be just as harmful as having no strategy at all. Good learners tend to be flexible learners, adapting or creating strategies to meet the demands of the given situation. Finally, (3) people need to be aware of whether or not they are mastering the material.

The Importance of Self-Testing

Metacognition refers to a person's ability to know about and monitor his or her cognition. Are you on task? Are you doing things that will help you attain your goal? Is your strategy working? An interesting finding from the research on metacognition is that people are often not very accurate in assessing what they know and what they do not know. For example, when given a choice to study items that students knew versus items they were not as comfortable with, the students often did not allocate their study time very effectively – they did not concentrate on items that they did not know. Also, as illustrated above, people often are not aware if their strategies for learning are working. For this reason, it is important that people test themselves while studying. Research on self-testing shows that there are two benefits to doing this. The first is that it obviously gives a person information about what he or she knows and what he or she does not. Second, the research also indicates that it is a good study strategy for enhancing the ability to retrieve information later. Engaging in self-testing improves memory performance more than if a person just repeatedly studied the material.

Discussion

As can be seen from the preceding presentation, studying is not an easy task to master. It requires intention and a lot of effort. It is often an unguided activity and people often do not get feedback as to whether they are being successful or not. To confound things even more, there is no simple and best method for studying. People may need to try lots of different strategies and be willing to change their strategies depending on the demands of the task.

Very often people are not taught how to study. Starting in elementary school, students are often given assignments to study and they are left to figure out how to do it by themselves. As stated earlier, studying could be thought of as a problem-solving task where the student needs to figure out the best way of achieving the goal. On the other hand, when students are given hints on how to study, they are often told to do it in a formulaic way, being told that there is a set and best way to study. This type of instruction might be more harmful than no instruction at all. The point made earlier is that the student needs to be flexible in their studying behavior, adapting the activity to the specific goals of the task at hand.

So how do people become successful at studying? Again, some people just figure it out for themselves but most need guidance. One suggestion is at least early on, have the beginning learner (a young child) study with someone who is more skilled (a parent). In his theory of development, Vygotsky used the following illustration to show how children learn a number of tasks. Emphasizing the concept of the 'zone of proximal development,' he presented the context of a young child working on a jigsaw puzzle with a parent. Initially, it looks like the parent is doing most of the work in solving the problem and the child is just watching or making random decisions. Gradually, as the parent talks about what they are doing, the child takes more and more responsibility for solving the puzzle. After a period of time, the child is doing most of the work on the puzzle, internalizing the social processes initially exhibited by the parent and the parent can sit back and watch. Unfortunately, studying, as we stated earlier, is often seen as an activity that a person works on independently. If the beginning student has the opportunity to view and work with a more experienced student (one who exhibits the skills described in this section), the child will have the opportunity to learn and internalize the skills that are being displayed. Initially, as with the jigsaw puzzle, it would seem like the more-experienced person is doing most of the work, but gradually, the less-experienced person would take over more of the responsibility for the task and learn the skills that would make him or her successful.

See also: [Attention](#); [Motivation](#).

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Subjective Culture

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Glossary

Cultural assimilator Books or computer-based cross-cultural training devices to assess the degree to which individuals make correct (isomorphic) attributions of others' behavior.

Cultural complexity The degree to which societies are simple, with few roles, versus complex, where there are many roles.

Individualism and collectivism In collectivist cultures, the theme is centrality of the ingroup; in individualist cultures, it is the centrality of the individual. Similar contrasts include terms such as sociocentric,

group-oriented, *Gemeinschaft*, or interdependent culture versus idiocentric, or individual-centered, individual-oriented, *Gesellschaft*, or independent culture.

Subjective culture Subjective culture includes *shared* ideas, theories, and political, religious, scientific, economic, and social standards for judging events in the environment. Subjective culture includes also *shared* memories and ideas about correct and incorrect behavior, stereotypes, and the way members of the culture value entities in their environment.

Tightness and looseness The degree to which societies have strong norms and little tolerance for deviance from norms.

Introduction

People in every culture (defined by the conjunction of language, location, and history) have a characteristic way of viewing their social environment. Culture is to society what memory is to individuals; it consists of what 'has worked' in the past, and helped a group adjust to its environment, and therefore was worth transmitting to future generations. Another definition of culture is shared understandings made manifest in act and artifact. In short, it includes both what people do and what they make. Yet another definition is that culture is the human-made part of the environment. The human-made part of the environment can be split into material culture (tools, dwellings, food, clothing, pots, machines, roads, and the like) and subjective culture (categorizations, beliefs, attitudes, and the like).

Subjective culture includes *shared* ideas, theories, and political, religious, scientific, economic, and social standards for judging events in the environment. Subjective culture also includes *shared* memories, and ideas about correct and incorrect behavior, stereotypes and the way members of the culture value entities in their environment.

The elements of subjective culture are linked to social behavior. *The Analysis of Subjective Culture* explores the elements and the links as well as the description of the cultures of several countries, and also the cultures of African and Hispanic Americans.

Theory

The basic element for the study of culture is *categorization*. What stimuli are treated as equivalent by members of a culture? Members of each culture have unique ways of categorizing experience. For example, who is a member of my ingroup? In some cultures, it is those who are born in the same place, or belong to the same tribe, race, social class, religion, or who

are blood relatives. In other cultures, it is people who 'think like I do.' The two categories might overlap, but they are not the same. Both etic (universal) and emic (culture specific) elements define a category. By studying how people categorize experience we learn a great deal about their culture.

Members of each culture have unique ways of *associating* one category with another. For example, is 'socialism' referring to a political party, an ideology, or both? Are 'fathers' in this culture assumed to be severe or lenient with respect to children of different ages? In addition, cultures differ in the kinds of perceived antecedent-consequent relationships that people use (e.g., if you have 'hard work' then you have 'progress'; if you have 'progress' then you have 'health'), *attitudes* (e.g., is 'socialism' good or bad, would members of the culture support a socialist party?), *beliefs* (e.g., 'socialism' results in good health or in an impoverished society), *expectations* (e.g., if there is socialism then there is happiness, poverty or both), *ideals* (e.g., widows should not be cool or passionate), *memories* (e.g., I remember the names of each of my cows), *norms* (e.g., members of this society give their seat to old people), *role perceptions* (e.g., the mother-son role is warmer than the father-son role in this culture), *stereotypes* (e.g., lower class people are not intelligent), *tasks* (e.g., to make this tool one has to first get some redwood), *values* (e.g., 'security' is all important).

Later work by Triandis resulted in a model linking *behavioral intentions* (e.g., I intend to do X) and *behavior* (X), which included also *norms* (most people I respect think I should do X), *self-definitions* (e.g., I am the kind of person who does X), *habits* (e.g., I frequently do X), and *facilitating conditions* (e.g., I am highly aroused to do X, I am capable of doing X; the situation calls for me to do X). Facilitating conditions are so important that at times the situation takes over and people do what the situation demands even when the other factors require a different behavior. The theory of reasoned action was combined with elements of the 1980 model to form the unified theory of behavior of Fishbein and colleagues.

Sample Findings

Stereotypes

A number of studies produced data dealing with stereotypes. For instance, representative samples of the two largest cities in Greece provided one set of such data. The American data were obtained by employing 32 interviewers, who interviewed samples of convenience. A total of 750 Greeks and 435 Americans responded to items in the following format:

	In general, Greeks tend to be	
Systematic	— — — — —	Unsystematic

During face-to-face interviews, respondents pointed to the place on the line that represented their position on the scale. The attributes on which these judgments were made were provided by focus groups in the two cultures; they consisted of the attributes frequently used by focus groups in both cultures.

The Behavioral Differential

An adaptation of the semantic differential called the 'behavioral differential' was developed. It involved the presentation of a complex stimulus person such as 'A black 35-year-old male physician' and under this stimulus were presented scales defined by a particular behavior, for example:

Would	— — — — —	Would not
	Invite this person to dinner in my home	

In each study, complex stimuli were generated according to a factorial design. They could vary in race, occupation, religion, nationality, age, gender, and even in personality attributes.

The Role Differential

Another adaptation of the semantic differential was the role differential. The format consisted of a role relationship and a behavior such as:

	Male-female	
Would	— — — — —	Would not
	Let go first through a door	

The responses of the N participants from each culture were summed, so that a data set consisting of 100 roles by 30 scales was obtained in each culture. Factor analyses of the 30×30 matrix (based on 100 observations per scale) from each culture showed that four factors emerged in all cultures. They were: *association-dissociation* (defined by behaviors such as help, reward, advise, stand up for, be interested in, be eager to see, and respect versus grow impatient with, be indignant with, argue with, infuriate, fear, be prejudiced against, and exclude); *superordination-subordination* (defined by command, advise, treat as subordinate, inspect the work of, feel superior to versus

apologize, ask for help from, be dependent on, accept commands of); *intimacy* (kiss, cuddle, love, marry, pet, cry for); *hostility* (throw rocks at, fight with, quarrel with, exploit, cheat). Each role relationship can be defined, then, as a point in a four-dimensional space, and one could state that in this culture the mother-son role is more associative, subordinate, intimate, and less hostile than it is in that culture. In addition to the four etic factors, the data set of each culture produced emic factors. For example, the Greeks produced a factor called 'ingroup concern for consensus,' the Americans an 'envy' factor.

The study found that roles are perceived similarly within cultures but quite differently across cultures. The data suggested that some cultures use much association and intimacy and low hostility within ingroups while in other cultures participants express some hostility within ingroups and emotional distance from ingroup members. Some cultures see a large difference in behavior when the other person is a member of the 'ingroup' versus a member of the 'outgroup' while in other cultures this contrast is not nearly as pronounced. An ingroup in Greece was defined as a group of individuals about whose welfare a person is concerned, with whom the person is willing to cooperate without demanding equitable returns, and separation from whom leads to anxiety. As we discuss below, these kinds of data eventually resulted in the identification of *collectivism* and *individualism*, as well as an emphasis on *vertical* versus *horizontal* relationships in different cultures.

The Antecedent-Consequent Method

Twenty concepts (anger, courage, fear, laughter, freedom, peace, truth, punishment, crime, knowledge, power, progress, success, wealth, death, defeat, love, respect, sympathy, trust) were used in this study. They were concepts that previous work by Osgood and his associates had found easy to translate. In addition, Osgood provided the semantic differential profiles of these concepts in Greece, India, Japan, and the United States.

In Step I, the participants were asked to complete sentences by using these two formats:

If you have ____ then you have X; If you have X then you have _____. The most frequently given antecedents (As) and consequents (Cs) from each culture were noted. An attempt was made to identify As and Cs that were culture-common, as well as As and Cs that were unique to each culture. In Step II, the format required placing an X on one of five lines. Participants selected the 'best' answer that completed sentences such as (e.g., If there is ____ then there is MURDER. Revenge____, Hate____, Insanity, ____, Theft____, Fear ____). The five answers were selected so that one answer was culture-common, and the other four were unique to each of the four cultures of the study. The order of the answers from the four cultures was counter-balanced, requiring several forms of the questionnaire in each culture. Similarly for Cs the format was as follows: If there is a MURDER, then there is ____ Imprisonment____, Grief____, Execution____, Disgust ____, Police action____. Again one of the five responses, selected from Step I, was culture-common and the others were unique to each of the four cultures of this study, and the answers were counter-balanced, requiring several forms in each culture.

The antecedent–consequent method provided information about the themes that were especially important in each culture. They presumably reflect central values of the culture. The central values of Americans were individual progress, self-confidence, good adjustment, status, peace of mind, achievement, and joy. The central values of the Greeks were civilization, glory, victory, love, and appreciation by others. The central values of Indians were increased status, glory, and social well-being. The central values of the Japanese were serenity, aesthetic and general satisfaction, self-confidence, responsibility, peace, advancement, and good adjustment.

There were some culture-common themes, but the culture-unique themes stand out. The individualism of Americans, with their emphasis on individual achievement and adjustment, is different from the collectivist emphasis of the Greeks on love and on being appreciated by others, as well as the Greek ‘nationalist’ themes such as civilization, glory, and victory. The Indians showed much emphasis on status, as well as glory. The caste system makes India one of the most status-conscious cultures. The Japanese have a unique emphasis on aesthetic satisfaction and serenity. Perhaps Zen Buddhism is reflected in this response pattern.

Role Perceptions

In all cultures, role perceptions are patterned according to (1) ingroup roles, (2) outgroup roles, (3) conflict roles, and (4) status (high–low, equal, low–high). Numerous culture-specific findings were obtained. For example, there is much higher solidarity in high-to-low status ingroup roles in Greece (3.0) than in India (1.5) or the United States (1.7). On the other hand, solidarity in such roles toward outgroup members is very low in Greece (0.4) as compared to other cultures (about 1.0). However, this difference did not appear in roles of equal status, but it reemerged in low-to-high status ingroup roles (Greece, 2.8 and India, 1.6); the United States was similar to Greece (2.8).

One study examined if the information obtained from each of the ‘probes’ into culture by the various methods leads to similar conclusions. If there is consistency across the methods it would indicate that the methods have concurrent validity. The study argued that the data from each of the methods can be summarized by using certain themes. For example, the Greek data indicated much more contrast between behaviors toward the ingroup and outgroup members than was found in the United States. This turned out to be a major characteristic of collectivist cultures. The traditional Greeks (of the 1960s, when the data were collected) defined their universe in terms of the triumphs of their ingroup over their outgroups, while for Americans this world view was of little or no importance. In Greece, relationships with authorities and social relations in general reflected the ingroup–outgroup relationships. The 2010 demonstrations in Greece provide an example of the conflict between the people and the authorities.

Another study examined the stereotypes of Americans that Greeks had and of Greeks that Americans had. Americans saw the Greeks as *emotional*, *rigid*, with *poor working habits*, *inefficient*, *competitive*, and *suspicious* (e.g., are you going to be my ingroup member or an outgroup member?), but also as

sociable, *charming*, and *witty*. A representative sample of 800 Greeks, from the large cities of Greece, saw Americans as *arrogant*, *sly*, *suspicious*, and *competitive*, but also as *emotionally controlled*, *systematic*, and *flexible*. The Greeks admired American *cold efficiency* but they thought of Americans as *well-oiled machines*. The emphasis on Greek sociability, and spending much time with friends, contrasted with the American emphasis on getting things done and the admission of loneliness. This reflects the Greek collectivist placing of social relationships in center stage, while American individualism keeps a distance from ingroup members, which may also result in loneliness.

Both geography and history shape subjective culture. Greece is cut up into small segments because of the numerous mountains and islands, and this results in ingroups that are linked to a place. The 350-year-old Ottoman occupation required knowing who could be trusted (i.e., who was ingroup). Furthermore, competition for scarce resources made it difficult to be nice outside the ingroup.

Much of what was found in these studies later became the bedrock for individualism–collectivism research. For example, the study found that cooperation occurred only within the ingroup, and relationships with outgroups were competitive. The Greeks often defined themselves as *philotimos*. This means, literally, ‘friend of honor.’ Foreshadowing the large literature on culture and self, Triandis found that the Greek self-definition depended on the way ingroup members saw the person; thus individuals had relatively little control of their self-esteem. By contrast, American self-definition depended on the way individuals saw themselves, which provided more control, and hence their self-esteem was high. This contrast reflects the high levels of self-esteem observed in individualist cultures as opposed to collectivist cultures. Consistent with the collectivist–individualist contrast, the concept of MYSELF was rated (on semantic differential scales) ‘stronger’ by Americans than by Greeks, but the concept of MY RELATIVES was rated stronger by Greeks than by Americans. Finally, Greeks perceived emotions in *context* to a greater extent than did Americans, an attribute that later proved to be a key characteristic of collectivist cultures. For example, CHEATING was completely unacceptable for the Greeks when the target was an ingroup member, but was perfectly okay if the target was an outgroup member.

On the whole, the American data, obtained through different methods, indicated great emphasis on achievement and efficiency. The Greek data indicated great emphasis on interpersonal relationships and social control (e.g., they approved of severe punishment). The Greek emphasis on intimacy and self-sacrifice within the ingroup is a challenge for Americans who are unprepared to be so intimate and self-sacrificing, making cross-cultural social relationships difficult.

In all, *The Analysis of Subjective Culture* was one of the first systematic attempts to examine how key social–psychological concepts formed a syndrome to explain cultural differences.

Applications

The 1972 study was followed by studies by Triandis and Marin and colleagues and used the same theoretical framework and methods with black, white, and Hispanic participants.

Black Subjective Culture

Using survey research methodology, Triandis examined black and white hardcore unemployed, working class, and middle class samples. The studies examined *stereotypes* (e.g., is a mother intelligent?), *behavioral intentions* (e.g., would you date a black policeman?), *role perceptions* (e.g., would a mother hit her son?), *job perceptions* (e.g., are truck drivers well paid?), and *consequences of behavior* (e.g., is getting a good job likely to lead to satisfaction?). The samples made a total of 4600 judgments.

The results are too numerous to summarize here, but there are some broad findings and themes that stand out. For example, the hardcore unemployed black sample stood out from the other samples. In short, the subjective cultures of economically sufficient/stable blacks and whites, men and women, and people of different ages are not especially different. But the hardcore black unemployed see the world very differently from the way the other samples do. Often, the working class blacks had a point of view rather similar to the view of middle class whites. When the black hardcore shared a point of view with another sample it was usually the other black samples.

The concept of '*ecosystem distrust*' was developed to summarize the perceptions of the black hardcore unemployed. Ecosystem distrust means that most entities in one's environment – people, things, institutions – cannot be trusted. Most entities are seen as potentially harmful, and the individual does not see the self as able to improve the situation. In addition, a person cannot trust the dependability of relationships between what one does and the consequences of the action. Consider the connection between *to finish high school* and *to get a good job*. While the employed samples saw a clear connection, the hardcore unemployed did not. In general, the hardcore saw positive events not connected with positive outcomes and negative events unconnected from negative outcomes, while the other samples saw clear connections. There was also more suspicion of others and more distrust and rejection of authorities by the black hardcore unemployed than by the other samples. Blacks who are doing well under the current system were rejected by the black hardcore. Thus black policemen, black teachers, and the like did not receive good ratings.

It is likely that ecosystem distrust is due to the lack of resources. Imagine a parent who promises a toy, but is unable to deliver it. The child is likely to distrust future promises. Imagine a person who gets paid \$100, is arrested, and the police assumes that the funds were stolen, and confiscates all but \$20 (and tells him 'shut your mouth, otherwise you will be in real trouble'). Under these conditions, it is easy to see why there is less trust of people, suspicion of the motives of others, rejection of authority figures, a low degree of certainty that events will be followed by specific consequences, a sense of individual powerlessness, and a sense that if one is not extremely careful one will get into trouble. A person with this perspective is likely to believe that good behavior will not lead to good outcomes. In fact, the environment is seen as being chaotic, unpredictable, and capricious. One can make the case that this perspective is functional in a chaotic environment. The data also showed that receiving respect from others is more of an issue in the black than the white subculture. For example,

the black samples indicated that it was more appropriate to *call* someone *Mr.* than did the white samples. The black hardcore unemployed believed that it is important to have a good 'pose' so that others will see one as stronger and better than one is. They were ambivalent about I, MYSELF and rated this concept as less *important* than the other samples. They valued 'power' more than they valued 'being nice.' This may also be functional in their social environment.

The culture of family relations also varied across the groups. Blacks expected less formality in ingroup roles than did whites. Giving and taking of orders in family relationships were rated as less appropriate by the black than by the white samples. The role perceptions showed that the hardcore unemployed blacks saw more conflict in ingroup relationships than did the other samples. For example, they saw a higher probability that *a father would hit a son*. Also, the hardcore associated *friends* with *can be bad for you*, *teachers* with *unimportant* and *do not deserve respect*, *ministers* were seen as *exploitative*, and they *should be avoided*. In addition, the hardcore did not have a clear view of what one has to do in order to get a reward. For instance, they did not see that one has to complete high school in order to go to college.

In sum, the lack of clear connections between events and outcomes suggests the perception of a chaotic, untrustworthy environment by the black hardcore unemployed, which is not found in the white unemployed or the working class blacks or the middle class samples. In more modern terminology, the hardcore was extremely individualistic, while the middle class had a more balanced perspective, using both collectivist and individualist conceptions. Work by Oyserman and colleagues also found African Americans to be more individualistic than European Americans. More generally, the findings built on *The Analysis of Subjective Culture*, and were viewed within a theoretical framework in which the environment is linked to culture which is linked to behavior.

Hispanic Subjective Culture

Later work by Marin and Triandis summarized 20 studies of Hispanic subjective culture, based mostly on samples of recruits in the US Navy, who had Hispanic names and self-identified as Hispanics, compared to random samples of recruits who did not self-identify as Hispanics. Additional samples of high school students were obtained in Puerto Rico and El Paso, Texas. The data were examined to see if the origin of the person from Central America, Cuba, Mexico, Puerto Rico, or South America changed the results, and if the high school students provided different data from those obtained from the Navy recruits. In general, the subjective cultures of the participants from the various regions of the Americas and the subjective cultures of Hispanic high school students and recruits were similar.

However, the subjective culture of the non-Hispanic recruits was different from that of the Hispanic recruits. There was a definite relationship between level of acculturation (e.g., number of years in the United States, preference for use of English rather than Spanish, mostly watching English TV) and similarity between the Hispanic and non-Hispanic subjective cultures. In fact, the elements of subjective culture that

were most clearly linked to acculturation were the ones that made Hispanic culture distinct from non-Hispanic culture.

Again, there are too many findings to mention here in detail, but some themes were identified. For example, the Hispanics see more positive relationships (e.g., *less argue with, fight with*) and less superordination (e.g., *discipline, give orders to*) in family roles than the non-Hispanics. There is more *love, intimacy, and nurturance* and more *avoidance* of interpersonal competition in the Hispanic ingroup than in the non-Hispanic ingroup data.

A number of behaviors were rated more probable by the Hispanics (e.g., *be sensitive, simpatico, loyal, dutiful, gracious, conforming*) than by the non-Hispanics, but some were rated more probable by the non-Hispanics (e.g., *be sincere, honest, conservative, moderate*).

(e) Perhaps the most interesting finding was that the Hispanics had the *simpatia* concept. They saw more positive behaviors (e.g., *admire, respect*) than did non-Hispanics in positive situations (e.g., cooperative roles), and less negative behaviors (*criticize, give orders to*) in negative situations (e.g., in a confrontation) than did the non-Hispanics. The emphasis on harmony and nonconfrontation is an important aspect of Hispanic subjective culture and has also been found in other collectivist cultures.

In sum, Hispanic subjective culture is collectivist. There is an emphasis on the ingroup, that is, the self is perceived as an aspect of the ingroup, ingroup goals are given priority over personal goals, doing one's duty is more important than having fun, and one stays with the group even if one is not too pleased with it. By contrast, non-Hispanics are individualists. They define the self as independent and autonomous from the ingroup, they give priority to personal over group goals, they give more weight to attitudes than to norms as determinants of their behavior, and if they do not like their group they try to leave it.

Cross-Cultural Training

The Analysis of Subjective Culture was used to develop training programs to help expatriates better adjust to other cultures. After a culture is analyzed, the information can be placed in 'culture assimilators' which are books, or computer-based cross-cultural training devices. Assimilators consist of about 100 episodes that reflect a problematic interaction between members of two cultures. For example, an episode might be that an American teacher notices that a Hispanic child does not look at her when she is talking. Under each episode, in the format of a multiple choice test, are four or five attributions that could explain what is happening in the episode. The trainee is asked to select one of the attributions, and then receives feedback. Some of the attributions are incorrect, and when the trainee selects one of them he/she is asked to try again. When the correct attribution is selected, the feedback explains the cultural difference. In the example above, the cultural difference is that in the United States children are expected to look at a teacher who is talking; but in the Latino countries one is 'insolent' if one looks at a high status person in the eye, and the proper behavior is to respectfully look down.

The attributions are pretested with samples from the two cultures, and when members of the host culture select an attribution that is rarely selected by members of the trainee's culture, there is something to teach. The effect of this training is that trainees learn to make '*isomorphic attributions*,' that is, attributions that are more or less like the attributions that are usually made by members of the host culture in the particular situation. Trainees randomly assigned to a training and a no training condition show some improvement. The trained feel more comfortable when they are in the host culture.

Assimilators vary in quality, and it has been found that people learn better when the episodes provide feedback organized around cultural syndromes such as individualism and collectivism. Although people learn much about another culture, they do not change their behavior enough to be really successful in the other culture. Changes in behavior require clinical interventions and behavior shaping. Nonetheless, this application is reported in several handbooks concerned with cross-cultural training.

Extension to the Study of Individualism and Collectivism

The Analysis of Subjective Culture set the stage for a number of decades of research on culture and psychology that ultimately placed culture in the mainstream of the field. One important research direction it sparked was the investigation of individualism–collectivism as a cultural syndrome – that is, elements of subjective culture which are organized around a theme. In collectivist cultures, the theme is the centrality of the ingroup; in individualist cultures, it is the centrality of the individual. One could use other terms, such as sociocentric, group-oriented, *Gemeinschaft*, or interdependent culture versus idiocentric, or individual-centered, individual-oriented, *Gesellschaft*, or independent culture. All these terms contrast the centrality of the group with the centrality of the individual, and in each of the two sets of terms, the concepts can be considered equivalent.

In the decades since *The Analysis of Subjective Culture*, much research has documented the importance of individualism and collectivism for social–psychological phenomena in terms of the focus of attention, emphasis on different attributes, self-definitions, goals, emotions, cognitions, attitudes, norms, values, ingroups, social behavior, organizational behavior, and language and communication.

When culture is the unit of analysis, individualism and collectivism are the poles of one dimension. But when individuals are the unit of analysis, collectivism and individualism are often unrelated. Thus it was useful to use different terminologies for the two kinds of data. Triandis proposed the use of 'allocentrics' and 'idiocentrics' to correspond to collectivism and individualism. There are both collectivist and individualist cognitions present in every individual, and the tendencies are elicited by the *situation*. There are allocentrics and idiocentrics in every culture. The fit between culture and personality is very important. Allocentrics in collectivist cultures and idiocentrics in individualist culture are well-adjusted, but allocentrics in an individualist culture find that they do not have enough relationships, so they join

communes, unions, associations and the like. Idiocentrics in collectivist cultures feel oppressed by the requirements imposed by ingroups, and when they have an opportunity they leave such cultures.

Other cultural syndromes include cultural complexity and cultural tightness–looseness, or the degree to which societies have strong norms and little tolerance for deviance from norms. Gelfand's research has shown that tightness and collectivism are largely independent dimensions, correlated at ~ 0.4 . Thus, there are collectivistic cultures that are tight (e.g., Japan), collectivistic cultures that are loose (e.g., Brazil), individualistic cultures that are tight (e.g., Austria) and individualistic cultures that are loose (e.g., the United States). Tightness is positively correlated with population density (as far back as 1500) and negatively correlated with the amount of resources that societies have, suggesting that strict adherence to rules is in part an adaptation to environmental factors as *The Analysis of Subjective Culture* suggested. Tightness is also associated with more autocracy and less openness of the media, as well as more conservative attitudes as rated on the world values' survey. Crime and divorce rates are much lower in tight as compared to loose societies.

An Extension to the Study of Self-Deception Across Cultures

Triandis recently examined what aspects of subjective culture are prone to self-deception. Self-deception occurs because humans often use their hopes, needs, and desires to 'construct' the way they see the world. For instance, stereotypes are examples of self-deception (I know with certainty what the attributes of this group are). But almost all elements of subjective culture may be influenced by hopes, needs, and desires, and thus may contain a trace of self-deception. The self-deceptions of collectivists tend to glorify the ingroup, while the self-deceptions of individualists tend to glorify the individual.

Some examples of self-deception: (1) When the French revolution started, on 14 August 1789 with the storming of the Bastille, Louis XVI wrote in his diary only one word: 'Rien.' In other words, nothing happened! Had he avoided this self-deception he might have saved his neck from the guillotine. (2) "We will be greeted as liberators in Iraq" (John McCain); (3) "the West will convert to Islam" (bin Laden); (4) "Allah loves those who commit suicide for religion" (Al-Qaeda writings published by Ibrahim).

There are cultural differences in self-deception. In some cultures, self-deceptions are very common, while in others they are not. The nonacceptance of the Darwinian theory of evolution can be used as a clue to the tendencies toward self-deception. Nonacceptance in Scandinavia is about 20%, in Central Europe about 30%, in the United States 45%, in Turkey 60%, in Egypt it is 92% (*The Economist*). Much conflict is due to differences in the subjective cultures and the self-deceptions of various groups which result in different ways of constructing the way people see the world. The future of the planet may depend on further analyses of the subjective cultures around the globe in order to increase understanding, promote well-being, and decrease violence.

Summary

There are many ways to study cultures. One way is to study their subjective cultures. This article presents the elements of subjective culture that may be studied, and also a sample of findings from studies of subjective culture. Applications of such studies include methods of cross-cultural training that make the interaction of people from one culture with people from another culture more effective. Extensions of the work on subjective culture increased the understanding of collectivism and individualism and the distribution of self-deception across cultures.

Acknowledgment

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See also: [Cross-Cultural Adaptation](#); [Individualism](#).

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Relevant Websites

www.cccs.com — Center for Cross-Cultural Exchange. Student opportunities for academic semester abroad to participate in cross cultural exchange programs.

www.iaapsy.org – IAAP—The International Association of Applied Psychology. About 2000 members, is the oldest international association of psychologists to establish contact between those in different cultures through various areas of psychology; 14 divisions.

www.iaccp.org – IACCP—International Association for Cross-Cultural Psychology: 800 members from 65 countries aim to facilitate communication among persons interested in issues involving the intersection of culture and psychology.

<http://www.fit.edu/campuslife/clubs-org/sccr/index.html> – Society for Cross-Cultural Research (SCCR). 200 members pursuing cross-cultural research from a multidisciplinary prospective. Psychologists, anthropologists, sociologists, communications, business and education professions.

Subliminal Perception

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Glossary

Backward mask A stimulus, usually a meaningless letter string or image, presented immediately following a critical stimulus to eliminate its afterimage.

Dissociative paradigm A research methodology used in subliminal perception research that seeks to find a dissociation between measures of conscious and unconscious responses to stimuli. Participants will be unable to consciously recognize the stimuli that are presented to them, but will be unconsciously influenced by them.

Limen Threshold.

Mere exposure effect The tendency for repeated exposures of a stimulus to enhance a person's attitude to that stimulus.

Objective measure of awareness Measures of conscious awareness that rely on an individual's ability to discriminate between stimuli that were presented versus not presented.

Semantic priming The presentation of a particular stimulus (a 'prime') intended to facilitate responses to a subsequent, semantically related stimulus. For example, being exposed to the word 'bread' will make an individual faster to recognize the word 'butter.'

Subjective measure of awareness Measures of conscious awareness that rely on an individual's self-reports of their perceptual experiences or conscious processing.

Subliminal Below the threshold of consciousness.

Supraliminal Above the threshold of consciousness.

Tachistoscope A device used to present stimuli for short, but very precise, durations.

One of the most long-standing controversies in psychology concerns the existence of subliminal perception: whether it is possible to perceive something even when we do not have the subjective experience of perceiving it. Though the study of subliminal perception began in the 1800s, scientific attitudes toward it have vacillated between acceptance and denial. Additionally, the broader public, including the media and government officials, have been concerned about the possibility of individuals being influenced and manipulated without their conscious awareness.

The study of subliminal perception has intrigued scientists mainly for the insight it provides into consciousness. First, research on subliminal perception provides a way of testing whether conscious and unconscious processes are fundamentally different from one another. Does a particular stimulus, when presented subliminally, have different effects than when it is presented so that people are consciously aware of it (i.e., supraliminally)? Second, this research allows scientists to investigate the nature and function of consciousness, such as whether consciousness is necessary for some process or effect. Finally, presenting stimuli subliminally allows scientists to rule out demand or other active strategies on the part of experimental subjects as alternative explanations for their effects.

Definition

One of the primary controversies regarding subliminal perception has been how to define it. The word itself was introduced by Johann Herbart and comes from the Latin word *limen*, meaning threshold. Thus, subliminal perception, strictly speaking, is perception below the threshold of consciousness. What is meant by the terms 'threshold' and 'consciousness' have been enduring matters of debate.

Methodology

Subliminal presentation of stimuli hinges on presenting the stimuli in such a way that the stimulus is registered by the appropriate sensory system and activates its corresponding representation, but the activation is minimal enough that the stimulus does not reach conscious awareness. The amount of internal activation of the representation is a result of the duration of the stimulus and of its intensity.

The vast majority of research on subliminal perception has focused on visual stimuli. Initial research manipulated intensity by using very weak stimuli: stimuli that were too far away, too faint, etc., to be consciously perceived. As technology advanced, with the arrival of first the tachistoscope and later computers, research shifted to involve very briefly presented stimuli.

For how long should a stimulus be presented to be subliminal? Unfortunately, even after stimulus characteristics are taken into account, there is no absolute threshold that can be universally recommended: thresholds for a given stimulus vary both intra- and interpersonally. One method of handling such variability is to set thresholds uniquely for each individual. In such a threshold-setting task, researchers typically present subjects with stimuli for different durations. After each presentation, subjects indicate whether they saw anything or not. (While subjects may be able to report seeing 'something,' they generally cannot report exactly what they saw.) With such tasks, care must be taken in selecting the durations for which stimuli are presented and the order in which these durations are used. For example, if stimuli are presented at consistently shorter durations, as in a standard simple staircase procedure, subjects are likely to predict the duration of the next stimulus. An alternative method is to use a fixed duration brief enough to be subliminal for most subjects, using an awareness check on these same subjects to ensure the stimuli were indeed subliminal.

The appropriate duration for a given stimulus, in addition to being determined by characteristics of the stimulus and the subject, will also depend on whether the stimulus is presented foveally or parafoveally, and whether it is masked. Foveal presentation involves presenting stimuli in the center of a person's visual field, or at foveation, whereas parafoveal presentation involves presenting stimuli on the periphery or fringe of the field. The foveal visual field extends from 0 to 2 degrees of visual angle from the focal point of attention, with the parafoveal visual field extending beyond this, from about 2 to 6 degrees of visual angle.

To fix subjects' eye gaze, researchers usually begin by presenting a fixation point, followed by the stimulus. For foveal presentation, the stimulus is presented at the same location as the fixation point. For parafoveal presentation, researchers need to determine the parafoveal area of the screen, so the stimulus can be presented within that area. Calculating this area involves taking into account the distance between a subject's eyes and the screen: the farther away the subject is from the screen, the greater the area on the screen that falls within the foveal region.

Parafoveally presented stimuli may be presented for longer periods of time while remaining subliminal than foveally presented stimuli. However, it is important to ensure that the subject's visual focus is on the desired fixation point; otherwise, a parafoveally presented stimulus can become a foveally presented stimulus. Thus, researchers often vary the delay between presentation of the fixation point and presentation of the stimulus, as well as the location in which stimuli are presented, to prevent subjects from anticipating the stimulus and shifting their attention accordingly.

Brief presentation of a stimulus is usually not enough to guarantee subliminality because a visual stimulus tends to persist in the visual iconic memory store for a time after it has physically disappeared. This persistence is akin to the afterimage that is seen after viewing a bolt of lightning. Researchers use the technique of backward masking to erase or overwrite this afterimage: they present a pattern mask, typically a random letter string or other meaningless stimulus with the same structural characteristics as the critical stimulus (e.g., a random letter string for a word stimulus, a scrambled set of facial features for a face stimulus), immediately after the critical stimulus.

Subliminal presentation is often embedded in a particular task requiring some sort of response to keep subjects alert and engaged, as opposed to passive viewing. Additionally, the use of such a task ensures that the subjects' attention stays fixated on a particular location. A routinely used task for parafoveal presentation is a vigilance task wherein subjects must indicate which side of the screen the 'flash' (the subliminal prime-mask presentation) occurs. The onset of these flashes (i.e., the time between trials) is also varied to further maintain attention.

Historical Background

Early research on subliminal perception took a psychophysical approach, searching for thresholds of sensory experience. Peirce and Jastrow, in the late 1800s, were probably the first to empirically demonstrate subliminal perception. In their study (which was also the first properly randomized

experiment), subjects (actually Peirce and Jastrow themselves) were asked to distinguish between two objects of similar weight or between two similar pressures, to indicate which of the two was heavier or greater, respectively. In addition to making forced-choice discriminations, they also rated their confidence in their judgments on a 0–3 scale, where '0' denoted absence of any preference for one answer over its opposite, so that it seemed nonsensical to answer at all. Peirce and Jastrow found that even when subjects reported 0 confidence, they could still accurately discriminate between the two alternatives at well above chance levels.

A few years later, Sidis presented subjects with cards one at a time, each containing a single printed letter or digit. The subjects were so far away from the cards that they often reported seeing only a dim, blurred spot, or even nothing at all. However, the subjects performed better than chance not only at reporting whether the card contained a letter versus a digit, but also at guessing its precise identity. Stroh and colleagues found similar results with auditory stimuli: subjects were able to identify whispered letter names at better than chance levels under conditions where they reported not hearing any sound.

In these studies subliminal perception was demonstrated via a dissociation between two measures of conscious awareness: a subjective measure that used self reports, and an objective measure that used a measure of discriminative abilities. According to a subjective measure (e.g., asking whether subjects were aware of the primes), subjects did not appear to have been consciously aware of the stimuli. According to an objective measure (e.g., forcing subjects to guess which of two stimuli was presented), subjects appeared to have perceived the stimuli. This dissociation between subjective and objective measures was taken as evidence of subliminal perception.

A few other studies in this domain were published in the first half of the twentieth century. However, what was more notable was the outbreak of claims of subliminal influences on behavior in the mid-1950s, particularly by advertisers. In September 1957, James M. Vicary and Francis Thayer announced that they had presented messages such as 'Eat popcorn' and 'Drink Coca-Cola' for 1/3000 of a second during movie screenings in Fort Lee, New Jersey. They claimed that these subliminal presentations had increased popcorn sales 58% and cola sales 18%.

An outcry in the popular press followed, and both the US Congress and the Federal Communications Commission debated the legal and ethical implications of subliminal advertising. The practice of subliminal advertising was subsequently banned in the United Kingdom and Australia, and by American networks and the National Association of Broadcasters in 1958. However, Vicary's attempts to duplicate his claims under controlled conditions were unsuccessful, and in 1962 he admitted to lying about the experiment and falsifying the results. Nonetheless, the public seemed more convinced than ever of the possibility of subliminal perception and persuasion.

Meanwhile, the scientific community was meeting such claims as Vicary's with skepticism. In his 1960 critique of the scientific literature on subliminal perception, Eriksen argued against the use of subjective measures as valid measures of awareness. He stated that subjective measures were insufficient because they might not, or did not, represent an exhaustive measure of all relevant conscious experiences. Instead,

subjective reports might reflect subjects' response biases: subjects might partially or even fully perceive the stimulus, yet claim they had not seen it for various reasons. For example, a statement that a subject did not 'see' a stimulus may reflect the subject's preconceived ideas about the value of a particular conscious experience for making decisions, rather than a true absence of relevant conscious experiences. Thus, Eriksen argued that such subjective reports should be replaced by an objective measure, namely forced-choice discrimination. By this standard, a stimulus would be said to be subliminal only if subjects forced to choose which of two (or more) stimuli that were previously presented performed better than chance.

This represented a major shift in both theory and methodology for researchers working on subliminal perception. Previously, correct forced-choice performance had been assumed to reflect the perception of stimuli in the *absence* of conscious awareness. Now, according to Eriksen, correct forced-choice performance was assumed to reflect the *presence* of conscious awareness. This meant that researchers were now left with the problem of finding new indirect measures of subliminal perception.

Marcel was the first researcher to report the results of experiments showing evidence for subliminal perception while using an objective measure of awareness. In the 1970s and 1980s, he provided two types of experimental evidence for subliminal semantic processing. First, subjects who could not detect the presence or absence of a masked word were nonetheless semantically influenced by that word in their later responses. For example, subjects subliminally presented with the word 'salt' who were then asked to choose between 'pepper' and 'lotus,' chose 'pepper' more often. Second, he provided evidence for semantic priming with subliminal primes. In this paradigm, a prime word is first presented subliminally, and then a target word (to which subjects must respond) is presented supraliminally. Marcel found that target words were responded to more quickly when they were preceded by a semantically related prime word than by an unrelated prime word, even though the primes were presented subliminally. Such research was considered particularly surprising because it demonstrated higher-level processing of subliminal stimuli. Subsequently, other researchers replicated these effects not only with words but also with pictures.

However, as the supporting evidence accumulated, so did the skepticism and criticism. In 1986, Holender published a detailed review of masked priming, concluding that the findings were problematic in a variety of ways, including lack of reliability and poor assessment of whether stimuli were actually presented subliminally. Again, the identification of serious methodological flaws caused great doubt as to the existence of subliminal processing.

These cycles of new evidence, followed by skepticism, particularly skepticism as to the subliminality of stimuli, continue to be a recurring theme in the literature on subliminal perception. By now, the mere existence of subliminal perception has been firmly established. What continues to be controversial to this day is how deeply subliminally presented stimuli are processed, and, as a consequence, how much they can affect people's attitudes, judgments, and behavior. The evidence for simpler forms of subliminal processing is considered to be strong. For example, there is much evidence that subliminal

stimuli are processed orthographically (i.e., in terms of letter identities and positions). But researchers disagree as to the extent that higher-level subliminal processing, such as semantic processing, occurs.

Neurological Evidence for Subliminal Perception

What is the chronology of subliminal perception? Where does a stimulus go, if it is perceived without reaching consciousness? Some insight can be gained from naturally occurring forms of subliminal perception. Area V1, the primary visual cortex, plays a central role in visual perception, detecting the basic elements of a visual stimulus (e.g., orientation). Nearly all signals from the retina pass through this area before proceeding to the other areas specialized for different aspects of visual processing. Patients with partial or total damage to V1 have a loss of vision in part or all of the visual field. However, some of them can still make accurate judgments and discriminations about visual stimuli presented to the 'blind' area. This condition, the ability to respond appropriately to visual stimuli in the absence of conscious visual experience, is known as blindsight. Blindsight represents an organic form of subliminal perception. The most thoroughly studied blindsight patient is DB, whose right occipital cortex, including most of V1, was removed surgically. DB reported no conscious visual experience in an area of the lower left quadrant of the visual field. However, he could detect whether or not a visual stimulus had been presented to this area and could also identify its location, though he insisted he was just 'guessing.'

One issue in the study of blindsight, as with the study of subliminal perception in general, is determining whether patients truly have no conscious visual experience in their 'blind' area. Studies that require patients to report on stimuli in the 'blind' area are subject to the same critiques as subliminal perception research that uses subjective criteria. Rafal and colleagues sidestepped this problem by running a study that did not require patients to report on characteristics of the 'unseen' stimulus. They found that blindsight patients were slower to respond to a light presented to the intact part of the visual field when another light was simultaneously presented to the blind area – even though they could not consciously detect the latter light. Thus, a light not producing any conscious awareness nevertheless interfered with visual performance on another task.

Blindsight is not a homogenous phenomenon; patients vary greatly in their preserved visual abilities and subjective experience. The precise brain mechanisms involved in blindsight remain unclear and probably vary from patient to patient as well. Possibilities include subcortical mechanisms, residual functioning within V1, and the cortical visual system.

In contrast to research on blindsight, which focuses on stimuli that cannot activate a particular brain region (because that region is lesioned), research on subliminal perception has mostly explored which brain regions are actually activated by subliminal stimuli. Such activation has been used to determine both what types of processing are possible with subliminal stimuli, and whether the effects of subliminal stimuli are driven by different patterns of brain activation than those of supraliminal stimuli. In 1998, Dehaene and colleagues were the first to show that subliminal stimuli can cause detectable neural activity

not just in brain areas involved in sensory processing, but also in areas associated with motor programming of responses. Subjects classified numbers between 1 and 9 as smaller or larger than 5. These target numbers were preceded by subliminal number primes that were also smaller or larger than 5. Subjects were faster when both the prime and the target belonged to the same category (e.g., prime 1, target 4) than when they belonged to opposite categories (e.g., prime 1, target 6), indicating that they had processed the subliminal prime on a semantic level. The researchers also recorded event-related potentials (ERPs) during the task and found evidence of prime-induced covert motor activation (measured via differences in lateralized readiness potentials (LRPs)): participants unconsciously prepared the motor response appropriate to the subliminal prime. Moreover, the temporal resolution of ERPs enabled the researchers to determine that the subliminal prime itself induced this preparation. These results were replicated by other researchers using arrows as stimuli, and were also demonstrated using functional magnetic resonance imaging (fMRI) to measure motor cortex activation.

Other researchers have utilized neurological techniques to look for evidence of semantic processing of subliminal stimuli, using ERPs to compare semantic priming effects for subliminal versus supraliminal primes. With supraliminal primes, semantic priming produces an attenuation of the N400, an ERP component thought to index semantic processing. The evidence for subliminal primes producing similar modulation is mixed, with some more recent experiments showing an effect.

More consistent results have been found with subliminal repetition priming and fMRI. In repetition priming, visual recognition of a target word is facilitated when it is preceded by the same word, and as a result, neural activity is decreased in certain word-processing areas of the brain (contended to reflect tuning of cortical representations). Researchers have found evidence for such repetition priming even when the prime word is presented subliminally. Subliminal repetition priming has also been found when the prime and target are orthographically different, such as when they are written in the two different Japanese writing systems of Kanji and Kana, and when the prime and target are only semantically related (as opposed to being the exact same word). In such research, neuronal activity was found to be decreased in the left middle temporal gyrus, a region thought to be involved in semantic processing of words and objects.

fMRI has also been used to demonstrate emotional processing of subliminally presented faces. In these experiments, subjects saw subliminally presented fearful or fear-associated faces followed by a clearly visible neutral face that also served as a backward mask. Two studies found that the processing of these emotional faces was associated with increased activity in the amygdala, a brain structure integral to the processing of emotional stimuli, relative to neutral stimuli. Since then, these studies have been replicated with faces as well as other types of stimuli, including words.

Downstream Effects of Subliminal Perception: Attitudes and Judgments

Initially proposed by Zajonc in 1968, the mere exposure effect posits greater liking of a stimulus as a result of greater exposure to the stimulus. Experiments have demonstrated that the mere

exposure effect is highly reliable and, furthermore, that it does not depend on conscious awareness of the exposure. In fact, subliminal mere exposure effects seem to be stronger than typical mere exposure effects. In one experiment by Kunst-Wilson and Zajonc, subjects were first subliminally exposed to several irregular polygons, five times each. Later, they were given pairs of polygons, one that had been subliminally presented and one that had not been previously presented at all. Subjects were asked to make two judgments: which one had been presented previously, and which one they liked better. Although subjects were no better than chance at determining which polygon had been presented previously, they showed an increased liking for the previously presented polygons.

Other research has shown mere exposure effects with subliminal faces. In an experiment by Bornstein and colleagues, subjects were subliminally exposed to a photograph of one of two males. In a later phase of the experiment, both men pretended to be research subjects and engaged in a task with the actual subject. When the two men disagreed during this task, the subject sided more often with the man whose photo had been subliminally presented in the first part of the experiment, and also reported liking that individual more.

A more complicated method of altering individuals' attitudes toward stimuli is evaluative conditioning, a way to transfer valence from one stimulus to another. In this method, a target stimulus is repeatedly paired with a negatively or positively valenced stimulus, and the target eventually acquires the same negative or positive valence. Evaluative conditioning has been demonstrated even when the negatively or positively valenced stimuli are presented subliminally. For example, in experiments conducted by Murphy and Zajonc, subjects were shown a series of clearly visible, unfamiliar Chinese ideographs. Immediately after seeing an ideograph, they rated how much they liked it. For half of the subjects, each ideograph was preceded by either a subliminally presented smiling face, or a subliminally presented scowling face. For the other half of the subjects, each ideograph was preceded by either a smiling or a scowling face that was presented supraliminally (for 1 s). When the faces were presented subliminally, subjects liked ideographs that had been paired with smiling faces more than ideographs that had been paired with scowling faces. This effect vanished when the faces were presented supraliminally.

Subliminally presented stimuli can also affect judgments about both others and the self. In an experiment by Bargh and Pietromonaco, subjects engaged in an unrelated task in which words were presented subliminally. Either 0%, 20%, or 80% of the words were related to the trait of hostility. Afterwards, subjects read a paragraph about a fictitious person ('Donald') who behaved in an ambiguously hostile way. The impression subjects formed of Donald was influenced by their subliminal exposure to the words: the more hostile words subliminally presented earlier, the more negative the impression of Donald became. Similar results have been found in later experiments with other traits such as kindness, and with subliminally activated social stereotypes, including stereotypes activated by subliminal presentation of photographs. In an experiment by Baldwin and colleagues, Catholic undergraduate women rated themselves more negatively on a series of traits after subliminal exposure to a photograph of the pope, but only if they were relatively religious.

Another question that has emerged from research on subliminal priming is whether the processes set in motion by subliminal priming are equivalent to those involved when a concept is activated consciously. To investigate this matter, McCulloch and colleagues subliminally primed one group of subjects with words related to forming an impression of a person (e.g., judge), and gave another group conscious directions to form an impression (e.g., think about what kind of person this is). All subjects then read a series of behavioral sentences, and later were given a surprise cued recall task. Those in the subliminal priming group had recall of behaviors equivalent to those in the conscious impression formation condition. Thus, in this case, subliminal presentation of words relating to impression formation presumably activated similar cognitive operations as conscious instructions to form an impression.

Downstream Effects of Subliminal Perception: Behavior

Though evidence of subliminal stimuli affecting judgments and attitudes is intriguing, it does not necessarily follow that such stimuli will also affect individuals' overt behavior. Indeed, a lengthy literature in social psychology has demonstrated far less correspondence between, for example, attitudes and behaviors than might be expected. Effects of subliminal stimuli on behavior are also more controversial, as the issue of subliminal advertising and persuasion fall under this heading.

In the past 20 years, social psychologists have repeatedly demonstrated that the same subliminal stimuli that can affect judgments and attitudes can also affect overt behavior. Bargh proposed that stimuli, including subliminal stimuli, can influence behavior directly, via a perception-behavior link that bypasses conscious thought. In one experiment, Bargh and colleagues asked subjects to complete a long, boring task on a computer. During the task, subjects were subliminally exposed to photographs of either Black or White faces. (Previous research had shown that exposure to Black names or faces activated the concept of hostility, part of the Black stereotype.) Then, after many trials, an error message appeared, and the experimenter informed subjects they would have to start the task again from the beginning. Subjects' reactions to this news were recorded with a hidden camera. Judges (blind to condition) who viewed these tapes indicated that subjects subliminally exposed to Black faces responded in a more hostile manner than subjects exposed to White faces.

Though plausible alternatives to the direct perception-behavior link have been proposed in the last decade, the more fundamental idea that subliminally presented stimuli can affect behavior has not been questioned. However, it is important to note that this type of research involves behavior that is both natural and appropriate to the particular situation involved. In fact, most models of such subliminal effects emphasize that these effects would not occur if they were inappropriate to the situation at hand. In other words, subliminal priming cannot cause people to do what they would not naturally do. These effects are also assumed to be transient, lasting minutes at best.

However, not all subliminal priming effects are assumed to be transient. In addition to the direct, perception-behavior route, subliminal perception also affects behavior through an

indirect route, via goal activation. The representation of a goal consists of the means by which the goal operates or is carried out. Therefore, activating a goal representation will lead to the activation of its corresponding means, which in turn will result in the greater likelihood of the means being carried out. According to Atkinson and Birch's dynamic theory of action, goal-directed action tendencies increase in strength over time until the goal is acted on. Thus, in contrast to other forms of priming, in which construct activation decreases over time so priming effects are transient, the effects of goal priming actually increase over time.

Goals can be activated by a variety of primes. For example, people that are closely associated with particular goals can serve as primes for these goals. In one experiment, Shah used the names of significant others as primes for an achievement-related goal. Subjects were initially asked to provide the name of a significant other who would most want them to possess an achievement-related goal, and the name of a significant other who would care the least about this. Subjects were subliminally primed with either of the two names or a control prime (i.e., a random letter string). Subjects were then given an anagram task designed to measure goal-striving. Subjects subliminally primed with the name of the significant other who cared the most that they possess the goal persisted longer on the anagram task and found more correct solutions than those in the control group, and those primed with the name of the person that cared the least persisted less and found fewer correct solutions than those in the control condition. In sum, the subliminal activation of a goal can lead to not only better performance, but also persistence, another distinct feature of goal pursuit.

These sorts of behavioral and motivational effects differ from the single most controversial area within the domain of subliminal psychological processes: subliminal persuasion. The line between the previously described effects and the area of subliminal persuasion is fuzzy, but one key difference is that subliminal persuasion generally involves causing people to do things they cannot or would not normally do. Various people, beginning memorably with James Vicary in 1957, have made grandiose yet largely unsubstantiated claims about the effectiveness of subliminal persuasion. For example, in the 1980s, self-help audiotapes were very popular in the United States, despite the lack of rigorous scientific research on their effectiveness. When various researchers decided to test the claims of such tapes, they found that the tapes were ineffective. In one experiment, Greenwald and colleagues tested two tapes, one designed to improve memory and the other designed to improve self-esteem. Subjects were given one of the two types of tapes and were asked to listen to their tape daily. However, the experimenters switched the labels on half of the tapes. In other words, some subjects received a memory tape that had been mislabeled as self-esteem improvement, some subjects received a self-esteem tape that had been mislabeled as memory improvement, and the remaining half of subjects received correctly labeled tapes. After 5 weeks, the subjects completed self-esteem and memory tests and also indicated if they believed the tapes had been effective. The subliminal tapes had no effects on either self-esteem or memory, but there was an effect of subjects' expectations on whether they thought the tapes were effective. That is, subjects who thought they had listened to a self-esteem tape thought their self-esteem had

improved, and subjects who thought they had listened to a memory tape thought their memory had improved, regardless of which tape they had actually received.

What separates such tapes from the previously described research on subliminal effects on behavior, so that the tapes were not influential? One obvious difference is that subliminal self-help tapes claim to present long messages, such as phrases or entire sentences. Research by Greenwald and colleagues has demonstrated that individuals cannot process an entire sentence when it is presented subliminally. In one experiment, Greenwald and Liu subliminally presented two-word sentences to subjects. For each sentence, the meaning of the sentence differed from the meaning of the individual words. For example, the sentence 'enemy loses' has a positive meaning, but it consists of two words, 'enemy' and 'loses,' that are negative in meaning. The effects of the subliminally presented sentences were driven by the meaning of the individual words rather than by the meaning of the entire sentence.

Strahan, Spencer, and Zanna proposed that even presenting single words would not be sufficient for subliminal persuasion. They pointed out that a person's goals and motives are critical for subliminal persuasion to occur. Subliminal priming can be used to prime goal-relevant cognitions, but this priming needs to be combined with a motive to pursue the goal, for subliminal persuasion to occur. In one experiment, Strahan and colleagues brought subjects into the lab supposedly for a study on marketing research. All individuals were asked to refrain from eating or drinking for a few hours before the session. Once they arrived, half of subjects were given water to drink, and the other half were not. Thus, the latter group of subjects was thirsty and the former group not. Then all subjects completed a task on computer in which they were subliminally presented with either thirst-related words (i.e., thirst and dry) or neutral words (i.e., pirate and won). Finally, all subjects were asked to taste-test some beverages. Only subjects who were thirsty and had been subliminally presented with thirst-related words showed subliminal persuasion: they drank more of the beverages than the other subjects.

Can such persuasion be carried over to actual consumer choices? Strahan and colleagues found that their subliminal persuasion effects also led subjects to prefer products that were advertised as fulfilling their goal. For example, subjects who were thirsty and had been subliminally primed with thirst-related words preferred a beverage advertised as thirst-quenching over another beverage. Karremans and colleagues took this research a step further, proposing that if individuals already have a particular motive, they will be persuaded by subliminal priming of a brand that can satisfy that motivation. In one experiment, half of the subjects were given a very salty candy to consume to make them thirsty. Then all subjects completed a task on the computer in which they were subliminally presented with either the brand name of a beverage ('Lipton Ice') or nonwords made by scrambling the letters of the brand name ('Npeic Tol'). Finally, subjects were asked to indicate which of two brand name beverages they would choose if they were offered a drink right now. Subjects who were thirsty and had been subliminally primed with Lipton Ice were the only ones to choose Lipton Ice more often than the alternative. Hence, you can subliminally lead a horse to water only if it is thirsty in the first place. It is when people

are in a motivated state that specific subliminal primes can affect choice.

One of the last media outcries regarding subliminal priming was in the political sphere. In 2000, the word RATS was flashed very briefly in tandem with images of Al Gore before the entire word 'bureaucrats' was presented onscreen in a television commercial sponsored by the Republican National Committee. Could briefly presenting a negative word in combination with an image of a person indeed color the impression of that person? The scientific community largely dismissed this as unlikely for numerous reasons, the least of which was because a single pairing of a negative word with a well-known person is not likely to produce a change in the preexisting attitude toward that person.

Relevance to the Real World

Why should individuals perceive and be influenced by stimuli that do not reach conscious awareness? The processing capacity of consciousness is greatly limited: consciousness can only deal with a very small percentage of all incoming information. We would be unable to function if we were guided only by the information to which we could consciously attend. Being consciously aware of a stimulus redirects focal attention to that stimulus and decreases the amount of attention available for peripheral stimuli. Efforts to consciously 'take it all in' tax not only our attentional resources, but our self-regulatory resources as well. The depletion of our self-regulatory stores in turn has deleterious effects on our behaviors and judgments. Luckily for us, much of the time, we need not consciously attend to stimuli for adaptive behavior or accurate judgments to occur.

See also: Social Cognition.

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Suicide

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Glossary

Altruistic suicide In Durkheim's theory of suicide, altruistic suicide is committed by people with strong interpersonal ties who commit suicide in order to help others, such as a soldier throwing himself on a hand grenade in order to protect his fellow soldiers.

Anomic suicide In Durkheim's theory of suicide, anomic suicide is suicide by someone who has not adopted the prevailing norms and values of the society, such as an alcoholic, threatened with the loss of family relationships and failure in his or her career.

Chronic suicide Self-destructive behavior whose impact shortens the life span of the person, such as alcohol or drug abuse.

Egoistic suicide In Durkheim's theory of suicide, egoistic suicide is suicide by someone who does not

have strong social ties, such as an elderly widower living alone.

Fatalistic suicide In Durkheim's theory of suicide, fatalistic suicide is suicide by people who are strongly regulated by the social norms and customs and commit suicide because they are 'supposed to,' as in sati in which Indian widows throw themselves on their husband's funeral pyre.

Focal suicide Behavior that intentionally (and sometimes unintentionally) destroys a part of the body, permitting the organism to survive, such as blinding oneself intentionally or losing a limb in a piece of industrial equipment.

Parasuicide A term suggested by European scholars to refer to self-destructive behavior in which the person intends to survive and, in fact, does so. This behavior is more commonly called attempted suicide.

The term *suicide* can be used both narrowly and broadly. In the narrow sense, suicide refers to the actions of people who possess a mature concept of death and who kill themselves intentionally. In order to choose death, a person must understand what death entails. This criterion, therefore, rules out suicide as a possibility in animals, in young children, and in those who are mentally retarded, for such individuals may not have a mature concept of death. Most children, for example, think of death as like a temporary sleep from which it is possible to return. The criterion of having an intent to die rules out some psychiatrically disturbed people whose intent to die is in doubt. For example, a psychiatric patient may hear voices commanding the patient to jump in front of a train. In responding to such hallucinations, the patient may not intend to commit suicide.

However, scholars have begun to use the term suicide in a much looser sense in recent years. This broader use of the term permits the suicidal desire to operate in a covert, unconscious, and partial manner, as described in Sigmund Freud's psychoanalytic theory. In this view, the suicidal impulse may manifest itself in partial ways that do not necessarily lead to immediate death. For example, people with self-destructive lifestyles, such as drug abusers and alcoholics, can be viewed as suicidal (*chronic suicides*), as can those who injure or destroy part of themselves intentionally or accidentally (*focal suicides*). Many people, especially the elderly, refuse to take the medication necessary for their continued physical health, while others may refuse to eat. These indirect life-threatening behaviors can be seen to have suicidal motivation.

While sociologists tend to adopt the narrow definition of suicide, psychologists and psychiatrists tend more often to adopt the broader definition, perhaps because they encounter so much nonfatal self-destructive behavior in the patients

whom they treat. Biologists are also using the term suicide more often these days to describe self-destructive behavior in animals.

Many individuals make self-destructive acts but survive. They may take an overdose of a medication, which fails to kill them, or they may cut their wrists but not bleed to death. Sometimes survival may be planned (as in a person who knowingly takes one-half of the lethal dose of a medication) or unplanned (as in a person who runs a car engine in a closed garage but is quickly discovered by an unexpected caller). This behavior is usually called *attempted suicide*, in contrast to an act where the person dies, which is called *completed suicide*. Some investigators have pointed out that many attempted suicides do not intend to die and, thus, the term attempted suicide is inappropriate. Such individuals may be communicating distress to significant others in their life by their suicide attempt, or perhaps they are ambivalent in their decision to die. (Many suicide attempters, however, do admit to some intent to die even though their suicide attempt is not lethal.) *Parasuicide* has been proposed as an alternative term and is still used, particularly in Europe, but researchers have switched to using the term *deliberate self-injury*, a term that eliminates the presumption of suicidal motivation. Attempted suicide, however, is more serious than *self-mutilation* (a behavior in which people inflict mild harm on their bodies, usually motivated by frustration or boredom).

Recently, feminist scholars have objected to the terms attempted and completed suicide since these terms suggest that the behavior more commonly found in men (completed suicide) is the only possible goal of the behavior, and that women typically attempt to achieve this goal but fail to do so. They have suggested that the terms be replaced by fatal and nonfatal suicidal behavior.

Epidemiology of Suicide

Accuracy of Suicide Rates

It has been well documented that coroners and medical examiners often fail to certify suicides correctly. For example, in a study of deaths in one county in Ireland, investigators found an actual suicide rate of 13.1 per 100 000 per year rather than the officially reported rate of 5.8, and this undercounting of suicide has been documented in many other regions of the world.

Despite this, it has also been noted that the relative ranking of suicide rates of nations is similar to the relative ranking of suicide rates of immigrants from those nations to countries such as the United States and Australia, where their deaths are certified by the same coroners and medical examiners. Thus, though the underreporting of suicide may affect the *absolute* suicide rate of a particular group, it may not change the *relative* suicide rates of different groups by much.

Incidence of Suicide

The completed suicide rate in the United States in 2006 (the latest year for which complete statistics are available) was 11.1 per 100 000 inhabitants per year. There were 33 300 suicides, which comprised 1.4% of all deaths. It is estimated that there are 25 suicide attempts for every completed suicide in the United States, which means that about a further 832 500 Americans made suicide attempts in 2006.

Community surveys of the suicidal history of people reveal a wide range in the estimates of prior suicidal behavior. The percentage of residents who report having attempted suicide in their lives is usually in the range of 2–10%, and for reports of having thought about committing suicide is in the range of 10–50%. This percentage differs from community to community, and depends on the country studied and on the way in which the question is phrased.

Variations in Rates of Completed Suicide

In almost every nation of the world, men have higher suicide rates than women. For example, according to the World Health Organization, in the United States in 2002, the rates were 17.9 (per 100 000 per year) for men and 4.2 for women, in Japan in 2004, 35.6 and 12.8, respectively, and in France in 2003, 27.5 and 9.1, respectively. The relative difference between the suicide rates of men and those of women is less in Asian nations than elsewhere. In a rare reversal of this gender difference, mainland China has recently reported a higher suicide rate for women than for men (14.8 and 13.0, respectively, in selected urban and rural areas in 1999).

The variation in suicide rates by age differs from nation to nation. Typically, suicide rates increase with age, sometimes peaking among middle-aged people and at other times continuing to increase among the old-age group. In the United States, the suicide rates of men increase steadily with age whereas the suicide rates of women peak in middle age. However, among the less privileged groups in wealthier countries (such as native Americans) and among women in poorer countries (such as Thailand), suicide rates tend to peak in young adults.

The 1970s witnessed a rise in the suicide rates of those aged 15–24 in many nations of the world, including Canada, the

United States, and most European nations. The late 1980s witnessed a rise in the suicide rates of the elderly. Between 1950 and 2000, there has been a change in age distribution of suicide cases worldwide. The middle-aged and older (45+) people, who constituted 60% of suicides in 1950, accounted for 45% of self-inflicted deaths in 2000. Conversely, the younger people aged 5–44 years currently account for 55% of suicides (vs. 40% in 1950). Globally the highest suicide rates for males and females are among those aged 35–44 years.

The nations with the highest suicide rates in the world are Lithuania (with a rate of 30.9 in 2006), the Russian Federation (30.1 in 2006), and Kazakhstan (26.7 in 2006). The nations with the lowest suicide rates are Islamic countries in the Middle East (e.g., Kuwait 2.0 in 2002). (Retrieved from www.who.int, May 29, 2010.)

Societal Suicide Rate

The suicide rates of societies remain quite stable over time. The relative suicide rates of nations 50 years ago are similar to the present rates, despite changes in the absolute size of the rates. For example, Hungary, with one of the highest suicide rates, also had one of the highest suicide rates in the world at the beginning of the last century and between the two World Wars, and Hungarian immigrants to the United States have one of the highest suicide rates of all immigrant groups.

The stability of the societal suicide rates means that it is meaningful to inquire whether the characteristics of the society are associated with, and perhaps cause, the suicide rate.

Social Causes of Suicide

Emile Durkheim in his book on suicide published in 1897 suggested that two broad social characteristics of a society determined its suicide rate: the degree of social integration (i.e., the degree to which people are involved in social relationships) and the degree of social regulation (i.e., the degree to which people's desires and attitudes are governed by the societal norms). Durkheim felt that suicide would be especially common where social integration was very weak (leading to *egoistic* suicide) and where social regulation was very weak (leading to *anomic* suicide). These suicides are committed by people who are relatively socially isolated and whose values are less often congruent with the prevailing social norms.

To a lesser extent, Durkheim felt that the other extremes of social integration and social regulation might also cause some suicides: too strong a level of social integration leading to *altruistic* suicide (where individuals kill themselves to help others) and too strong a level of social regulation leading to *fatalistic* suicide (where individuals feel so oppressed that suicide is chosen as a means of escape). Later sociologists have, on the whole, disregarded these latter possibilities, claiming that such suicides are rare in modern societies. They have proposed simply that suicide rates are higher where social integration and social regulation are weak.

Possible indices of these social characteristics are indeed associated with suicide rates, over nations of the world, over regions within nations, and over time. For example, suicide rates are typically associated with the divorce rate, the extent of

migration within the nation, and alcohol consumption, and with unemployment (positively) and church attendance (negatively). Interestingly, where these indices of a lack of social integration and regulation are strong, suicide rates are higher in all groups in the society. For example, in regions where divorce rates are high, suicide rates are higher in the single, married, and divorced, indicating that social integration and regulation are broad characteristics of the *whole* society.

Another variable associated with suicide rates is unemployment, an indicator of hard economic times. Suicide rates tend to be higher in times when unemployment rates are higher and, among individuals, suicide rates are higher in the unemployed.

Publicity and Suicide

A great deal of recent research has shown that temporary changes in the society's suicide rate can be brought about by short-term social events. Political, civil, and religious events, such as presidential elections, national holidays, and religious holidays are linked to lower overall mortality rates (a 'death dip') and lower attempted and completed suicide rates.

The phenomenon in which a book, play, song, or film is linked to increase in the incidence of suicide is called the Werther Effect after the publication of Goethe's *The Sorrows of Young Werther* in 1774, which purportedly led to young lovers committing suicide in imitation. According to anecdotal evidence, there have been other such 'epidemics,' such as the rash of suicides in young Jewish females after the publication of Otto Weininger's 'Sex and Character' in 1903 and an alleged increase in suicides in the 1930s related to probably the best known song concerning suicide, 'Gloomy Sunday,' the 'Hungarian suicide song.' An earlier recorded epidemic occurred in the early 1700s in Japan in relation to kabuki plays, which often presented thwarted love followed by the suicides of the lovers as a common plot.

Suicides of people considered as celebrities may be linked to increased suicide rates in members of the general population, especially in individuals of the same gender, age, and race as the deceased. For example, the suicide of a celebrity, such as Marilyn Monroe in 1962 or a fictional character in a television soap opera, typically leads to an increase in the suicide rate and sometimes attempted suicides in the following 7–10 days, particularly in those similar to the suicide in age and sex.

This imitation effect in suicide is apparent in the existence of suicide venues, places where people go in large numbers to commit suicide, such as the Golden Gate Bridge in San Francisco and the Eiffel Tower in Paris. The 1980s and 1990s also saw the documentation of clusters of suicides occurring in communities, for example, among teenagers in small towns, on some Native American reservations, in some Australian Aboriginal communities, and among some groups of Pacific islanders.

Over the last decade, there have been concerns raised regarding the negative impact of the Internet on suicidal ideation and behavior, especially among adolescents and young adults. Such concerns are related to online availability of suicide manuals and descriptions of lethal methods, and the risk of a virtual 'Werther effect' ('copycat cybersuicides'). Also, there have been reports of suicide pacts initiated over the Internet. In some cases, however, involvement in suicide-related

websites and online forums might have a preventive effect and help people cope with their problems as the Internet can create a sense of community and provides empathic listeners.

Causes of Individual Suicide

Psychiatric Disorder

The most notable personal characteristic associated with suicide is psychiatric disturbance. Persons with an affective disorder (in particular, a major depressive disorder) have a very high suicide rate. Those with schizophrenia and those who are substance abusers also have high suicide rates. It has also been documented that particular personality disorders (i.e., chronic maladaptive lifestyles) are associated with a higher risk of suicide and suicide attempts, in particular, borderline personality disorder.

Depression can refer to a mood as well as a particular psychiatric disorder, and the mood of depression is strongly associated with and predictive of suicidality. In those suffering from any psychiatric disorder, the level of depression predicts the degree of suicidality. Aaron Beck has suggested, further, that one component of depression is particularly useful as a predictor of suicidality, namely, hopelessness, a feeling that life will not get better in the future.

Biochemical and Genetic Factors

Biochemical and genetic factors have been shown clearly to have a role in the etiology of psychiatric disorders. For example, studies of twins and adopted children have shown that both affective disorders and schizophrenia have a genetic component. The neurotransmitter serotonin seems to play a role in affective disorder while dopamine seems to play a role in schizophrenia.

This association of suicide with psychiatric disorder makes identification of biochemical and genetic factors for suicide per se difficult. It has proven difficult to show that biochemical or genetic factors play a role in suicide above and beyond increasing the likelihood of psychiatric disorder which itself increases the risk of suicide.

Medical Illness

The increasing frequency of long-term debilitating medical illnesses (such as Alzheimer's disease, AIDS, and cancer) has led to the documentation of many suicides committed by people dying of these illnesses or afraid of what their condition will be like as the disease advances. Some people commit suicide motivated by the fear that they might develop these conditions. The fact remains, however, that the vast majority of people suffering from these illnesses do die from the illness rather than suicide.

Childhood Experiences

Several childhood experiences have been found to increase the later risk of psychological disturbance and suicide. Among these is the loss of parents (through death or divorce) in the first 15 years of life. Although loss of a parent in the first 6 years of life is thought by many developmental psychologists to be especially traumatic, many eventual suicides have lost a parent during the period when they were 6–14 years of age

and have failed to resolve and complete the mourning process. In some cases, the suicide can be motivated in part by a desire to be reunified with the lost parent after death (as in the case of the American poet Sylvia Plath).

The experience of physical and sexual abuse as a child increases the risk of later self-destructive behavior, and dysfunctional families of all kinds (including those with parents who have psychiatric disturbance or who are substance abusers) also increase the risk of later self-destructive behavior. However, researchers have not yet shown that these experiences lead to suicide per se rather than merely increasing the severity of psychological disturbance, which in turn increases the risk of suicide.

Interpersonal Relations

Suicidal behavior, especially among adolescents and young adults, is often triggered by interpersonal friction and loss. Although suicide in the elderly is more often the result of long-term psychological distress, elderly men seem less able to cope with the loss of their spouse than elderly women. The significant others of potentially suicidal people sometimes harbor hostile and death wishes (both conscious and unconscious) toward them, and this increases the risk of suicide.

Recent Stress

Most of those who experience a psychiatric breakdown have experienced a recent high level of stressful life events. Similarly, those who attempt and complete suicide are generally found to have experienced a particularly high level of recent stress in the past year and to have had this stress level increase markedly in the weeks prior to the suicidal behavior.

Psychological Factors

Several personality traits have been associated with suicidal behavior, including a depressed mood, low self-esteem, a belief that what happens to you is outside of your control, poor problem-solving skills, and irrational thinking patterns.

Psychological factors or vulnerabilities can exacerbate the impact of other risk factors such as medical illness or recent stress and thus increase the risk of suicide. One of the strongest predictors for suicidal thinking and behavior is hopelessness, that is, a state of negative expectancies concerning oneself and one's future. Studies conducted by Aaron T. Beck and his colleagues have shown that hopelessness may predict as many as 91–94% of suicides in both outpatient and inpatient populations and that hopelessness is a better predictor of suicidal ideation and behavior than depression itself. According to Beck's cognitive theory of depressive schemata, in some individuals the level of hopelessness escalates during the depressive episode, later subsides with the course of the illness, and is indicative of the level of hopelessness during subsequent episodes. There are, however, individuals in whom high hopelessness seems to be a stable (trait) characteristic, such as people with personality disorders or people abusing alcohol, who are chronically suicidal.

Other psychological risk factors for suicide include aggression and impulsivity, poor problem-solving skills, cognitive

rigidity (i.e., 'all-or-nothing' thinking), and perfectionism. Also, the experience of psychological suffering and pain (or 'psychache') is a strong correlate of elevated suicide risk.

Edwin Shneidman described the psychological state of a person in suicidal crisis using '10 psychological commonalities of suicide,' that is, patterns of emotion, behavior, and cognition, which precede suicide. Although every suicide is different, there are certain common intercorrelated characteristics which can be found in almost all cases of suicide:

1. *The common purpose of suicide is to seek a solution.* For a person experiencing unbearable psychological pain, suicide seems to be the only and the best solution to his/her problem ('Suicide was the *only* thing I could do' or 'It was the answer to my problem').
2. *The common goal of suicide is cessation of consciousness.* The goal of suicide is not to die, but to stop the stream of consciousness which is filled with pain and suffering.
3. *The common stimulus of suicide is unbearable psychological pain, that is, psychache.* Psychological pain is different from depression and may be subjectively experienced as excessive feeling of guilt or shame, unbearable loneliness, great humiliation, or overwhelming anxiety. The sources of *psychache* are frustrated psychological needs.
4. *The common stressor in suicide is frustrated psychological needs.* Although there is a wide range of psychological needs, there are five major clusters of frustrated needs found in suicide cases: 'thwarted love,' 'grief,' 'excessive anger,' 'fractured control,' and 'avoidance of shame.'
5. *The common emotion in suicide is hopelessness-helplessness.* Although a person contemplating suicide may experience a range of emotions, the dominant emotions are hopelessness and helplessness. Shneidman disagreed with the widespread belief (originating in psychoanalytic theories of suicide) that suicidal behavior stems from hostility and aggression.
6. *The common cognitive state in suicide is ambivalence.* Quite contrary to common beliefs, suicidal people do not unequivocally want to die; they just cannot continue living with the unbearable psychological pain.
7. *The common perceptual state in suicide is constriction.* Constriction or 'tunnel vision' leads to narrowing of options and, in a suicidal crisis, dichotomous 'either-or' and 'all-or-nothing' thinking prevails. Interpersonal relations or personal values, such as family or religion, also lose their importance.
8. *The common action in suicide is escape.* For a person in crisis, suicide becomes an escape from the difficult life situation and from unbearable psychological pain. Thus, suicide can be defined as an ultimate escape. It is final and irreversible.
9. *The common interpersonal act in suicide is communication of intention.* People thinking about suicide usually communicate their intentions to others. Such communications are important warning signs of suicide, and if taken seriously, may lead to getting the necessary help and support.
10. *The common pattern in suicide is consistency of lifelong styles.* Suicide hardly comes as a surprise. It is closely related to and a consequence of a particular lifestyle. The way people react to difficulties and problems across their life span is a good long-term indicator of suicide risk.

Protective Factors

Sufficiently strong protective factors can balance out the negative impact of risk factors and thus reduce the risk of suicide. It may come as a surprise that research to date has focused mostly on identification and measurement of risk factors, neglecting the study of what helps people cope with life adversities and crises. It should be stressed that protective factors are not necessarily the opposites of risk factors (e.g., employment – unemployment) or their absence (e.g., good health – illness).

Protective factors are quite diverse and range from individual characteristics and beliefs to the features of the environment and culture. On the individual level, these include hopefulness, reasons for living, resilience, problem-solving and coping-with-stress skills, plans for the future, and constructive use of leisure time. Religiosity, spirituality, a sense of purpose and meaning to life, and personal beliefs that exclude suicide as an acceptable solution to life's problems can help people cope and, thereby, prevent suicide. Employment and good physical and mental health are other important protective factors. In the case of psychiatric disorders, early identification, the availability of effective and appropriate treatment, as well as the propensity to seek treatment and maintain it when needed, might counterbalance the negative impact of psychopathology.

Among protective factors on the interpersonal level are the availability and suitability of social support from family and others, involvement in stable and significant relationships (including marriage), responsibility for children and parenthood, especially having children under the age of 18 living at home. Certain features of the environment and culture might protect against suicide, such as religious and cultural beliefs that oppose suicidal behavior and support coping and resilience. Also, restricted access to lethal means of suicide (e.g., guns, toxic substances) is one of the most effective protective factors.

Psychological Autopsy

The tragic paradox of suicide research is the absence of the very person who is the subject of the study. It has been suggested that there is a continuum of suicidality and an overlap between the groups of people who think about suicide, those who make suicide attempts, and those who die by suicide. Therefore, a study of suicide ideators and attempters might shed light on fatal suicidal behavior. However, this approach has been questioned, and there are significant differences between those who attempt and those who complete suicide, starting with sociodemographic characteristics such as age and gender. In general, suicide attempts are more frequent among females and young people, completed suicides among males and the middle-aged and the elderly.

The psychological autopsy is a method developed by Edwin Shneidman, Norman Farberow, and Robert Litman which involves gathering information about the deceased from reliable sources in order to reconstruct his or her life in order to identify life events and other risk factors preceding suicide. Psychological autopsies are combinations of

interviews with people who were close to the deceased and knew him or her well (e.g., family members, friends, colleagues, medical professionals) and analysis of information contained in medical files, hospital notes, criminal files, and other documents. This method was initially developed to help coroners ascertain the mode of death (i.e., suicide, accident, homicide, or natural death) in a case of equivocal death. Currently, it is widely used to study proximal (triggering) and distal suicide risk factors such as life events, psychopathology, physical health, social support, recency of contact with health professionals, personality, and other psychological and socio-demographic variables. Psychological autopsies also allow the identification of patterns of behavior and communication which precede suicide and thus may be considered as suicide warning signs, for example, making final arrangements, talking about suicide, expressions of hopelessness, and preparing the means of suicide (such as collecting pills or buying a gun).

Preventing Suicide

There have been two major methods of preventing suicide in the past. First, the treatment of those with psychiatric disorders, and in particular depressive disorders, by medication and by psychotherapy, can prove useful in reducing the risk of suicide. A program in the Swedish island of Gotland to train physicians in the detection of depression and the prescription of appropriate medication reduced the suicide rate there.

A second method for preventing suicide has been the establishment of suicide prevention centers. In many countries (such as the United States) these centers are set up independently by different kinds of groups, while in others there is a centralized and uniform organization (such as the Samaritans in the United Kingdom). These centers typically establish crisis counseling services, using the telephone as a medium for communication, which are available 24 h a day and 7 days a week. Clients in distress can call and discuss their problems and search for alternatives to suicide as a solution for their problems. Some centers also have walk-in clinics for face-to-face contact, some have outreach services that can visit people in the community, and others have organized groups for those who have experienced the suicide of a loved one and are finding it hard to cope with the loss.

Recently, it has been noted that elimination of lethal methods for suicide, often inadvertently, can result in a reduction in the suicide rate. Domestic gas companies in many countries (such as the United States, England, and Japan) switched from highly toxic coal gas to less toxic natural gas for economic reasons, but the switch has virtually eliminated suicide by domestic gas. Emission controls on cars (which reduce the toxicity of the exhaust) reduce the lethality of cars for suicide. Several investigators have suggested, therefore, extending this tactic to other methods and have advocated, for example, reducing the amount and toxicity of prescribed medications, reducing the availability of guns, and fencing in bridges and subway platforms from which people jump. There is the possibility that some potential suicides will switch to an alternative method for suicide, but the evidence suggests that not all will do so.

Surviving the Suicide of a Significant Other

Surviving the suicide of a loved one appears to be especially traumatic for people. Not only is there the loss of the person, but there is often a feeling of stigma associated with the death. The survivors feel guilty for not recognizing and responding to the suicide's distress. Often, neighbors and friends do not know how to react to the survivors and withdraw, so that the survivors feel rejected and isolated.

In addition, many suicides commit suicide at home where they are discovered by their loved ones, often horribly disfigured (especially if they used a gun for their suicide). This trauma can haunt survivors for the rest of their lives and is similar to the trauma in those who witness murder and war. A posttraumatic stress disorder is not uncommon.

Furthermore, the risk of suicide in the relatives and especially the children of suicides is greater. For example, Ernest Hemingway's father committed suicide, and Ernest and two more of the six children also killed themselves.

Is Suicide Immoral?

The morality of suicide has been a subject of debate for many thousands of years. There are those who set up a clear principle, such as 'Thou shalt not kill,' and apply it to every situation. For these, suicide is immoral. There are others who place more importance on other principles, such as freedom of choice for autonomous individuals. For these people, suicide may be moral.

Utilitarian ethicists weigh the harm and the good from alternative actions and suggest minimizing harm and maximizing good. The problems here are that the weights are often subjective, and we can argue about for whom we should minimize the harm and maximize the good – the suicide, the survivors, or the society.

Suicide is, however, not illegal in many countries (including the United States), though assisting someone else to commit suicide may, in some jurisdictions, be a crime. Attempting suicide in such a way as to endanger the health and safety of others may be an offense, either in the criminal code or the public health code. However, contrary to popular belief, insurance companies in many countries do pay the full amount for suicides who bought the policy more than 2 years before their death (e.g., in the United States).

Can Suicide Be Rational?

There has been a great deal of debate over whether suicide can be rational, especially as many of those dying from chronic diseases commit suicide or ask for help to do so. Some argue that suicide can never be rational for the suicide is almost always psychiatrically disturbed or, at least, psychologically distressed. If they could be helped through this period, their

desire to live could be rekindled. Others argue that people are capable of weighing the disadvantages and advantages of continued life quite appropriately and of making a rational decision to die.

There are two issues here. First, are the premises of the suicidal person rational and, second, is the reasoning, given their premises, logical? Typically, the reasoning of suicidal people (other than those who are grossly psychotic) is quite logical. It is the rationality of the premises that we dispute. However, these are subjective. Pain (physical or psychological) which is bearable for one person may be unbearable for another. The only sensible resolution is to permit each of us to decide what is bearable for ourselves.

See also: Depression; Stress and Illness.

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Relevant Websites

- www.suicidology.org – American Association of Suicidology.
- www.afsp.org – American Foundation for Suicide Prevention.
- www.iasp.info – International Association for Suicide Prevention.

Surprise

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Glossary

Belief The mental state of holding a proposition to be true; one of the basic kinds of propositional attitude.

Emotions Mental states experienced as (typically positive or negative) feelings that typically seem to be directed at specific objects, and are more or less frequently accompanied by physiological arousal, expressive reactions (e.g., facial expressions), and characteristic actions. Examples are joy, sadness, hope, fear, anger, pity, guilt, and pride.

Expectation In common parlance, a belief regarding a future state of affairs. In the theory of surprise, 'expectation' is used more broadly, as a synonym of 'belief.'

Misexpected and unexpected Surprise is caused by unexpected events. Unexpected events cover two cases: those that are misexpected, and those that are unexpected in the strict sense. An event is *misexpected* if it conflicts with a preexisting, specific, and usually explicit belief concerning this event. An event is *unexpected in the strict sense* if it is inconsistent with the person's background beliefs.

Orienting response (OR) The OR is usually defined as a probabilistic syndrome of behavioral and physiological reactions, evoked in particular by novel or significant stimuli. Although the reactions characteristic for the OR and those characteristic for surprise overlap, the OR must be distinguished from surprise.

Schema According to schema theory, human perception, thought, and action are to a large extent controlled by complex, organized knowledge or belief structures called schemas. Schemas can be regarded as informal, unarticulated theories, or as sets of beliefs, about objects, events, event sequences (including actions and their consequences) and situations.

Startle reaction A reflex-like defensive response elicited by abrupt, intense sensory input, such as a pistol shot. The startle reaction consists centrally of a rapid muscular response beginning with the closure of the eyes that may extend to the body, but it also includes a variety of physiological changes. Although surprise is a frequent secondary reaction to startling stimuli, the startle reaction and surprise are entirely different phenomena.

Surprise A peculiar state of mind, usually of brief duration, caused by unexpected events of all kinds. Subjectively, surprise manifests itself centrally in a characteristic feeling; objectively, it may manifest itself in a variety of behaviors and physiological changes. It is argued that underlying these phenomena is an evolved mechanism whose function is (a) to detect discrepancies between cognitive schemas and newly acquired information, and (b) if they are detected, to instigate processes that enable the short- and long-term adaptation to them.

Pretheoretical Characterization of Surprise

Common-sense psychology conceptualizes surprise as a peculiar state of mind, usually of brief duration, caused by unexpected events of all kinds, ranging from unexpected sounds and lights to unexpected social events (e.g., the outcome of an election), to unexpected turns in novels and unexpected puns of jokes.

Subjectively (i.e., from the perspective of the surprised person), surprise manifests itself centrally in a phenomenal experience or 'feeling' with a characteristic quality, that can vary in intensity from just-noticeable to intense. In addition, the surprised person is often aware, at least if she observes herself carefully, of a variety of surprise-related mental and behavioral events: She realizes that something is different from usual or other than expected; she notices that her ongoing mental processes and actions are being interrupted and that her attention is drawn to the unexpected event; she may feel curiosity about the nature and causes of this event; and she may notice the occurrence of spontaneous epistemic search processes (attempts to make sense of the event).

Objectively (i.e., from the perspective of the outside observer), surprise may reveal itself – depending on circumstances – in any

of a number of behavioral indicators, including: interruption or delay of ongoing motor activities; orienting of the sense organs to the surprising event; investigative activities such as visual search or questioning others; spontaneous exclamations ('Oh!') and explicit verbal proclamations of being surprised; and a characteristic facial expression consisting, in full-blown form, of eyebrow-raising, eye-widening, and mouth-opening/jaw drop. Intercultural studies suggest that people from different cultures consider this facial display to be characteristic for surprise; this points to an evolutionary origin of the expression. Psychophysiological studies suggest that surprising events may also elicit a variety of bodily changes, similar to those characteristic for the orienting response (OR), such as a temporary slowing of heart rate and an increased activity of the eccrine sweat glands (see section on '[The Orienting Response](#)'). As to the brain processes that underlie surprise, research is limited; again however, the available evidence suggests that the neurophysiological events characteristic for surprise overlap partly with those characteristic for the OR. In particular, electrophysiological studies suggest that the so-called P300a component of evoked brain potentials elicited by rare deviant stimuli may also be characteristic for (some forms of) surprise (see section on '[The Orienting Response](#)'). Brain-imaging studies suggest that both unexpected stimuli and

rare deviant stimuli activate a large network of cortical and subcortical regions in the brain, suggesting a ‘whole-brain response’ to unexpectedness that would fit well with the theory of surprise detailed below, as well as with theories of the OR. As to the brain processes selectively associated with surprise, a recent study points to processes in the lateral prefrontal cortex.

Scientists can use the various external indicators of surprise (self-reports about surprise, action delay, brain responses, etc.) to infer the presence and intensity of surprise in their research participants. It must be noted, however, that the behavioral manifestations of surprise (e.g., the facial expression of surprise, or physiological reactions) occur by no means in all surprise-eliciting situations and are in general only loosely associated with one another. Although progress in brain-imaging techniques may eventually provide researchers with a precise, objective measure of surprise, for the time being the most direct indicator of surprise remains the person’s self-report about the presence and intensity of the feeling of surprise, typically measured using a rating scale (ranging, e.g., from 0 = not at all surprised to 10 = extremely surprised).

A Short History of Research on Surprise

Descriptions of surprise as a mental and behavioral phenomenon, as well as first attempts at theory-building, date back as far as Aristotle (about 350 BC). Among the first to discuss surprise in modern times were the philosophers David Hume and Adam Smith in the eighteenth century. Their ideas were taken up and elaborated further when psychology was established as an independent discipline in the nineteenth century. By 1920, most of the questions about surprise that are discussed today had already been formulated, and even first experimental studies had been conducted. However, during the subsequent, behaviorist era of psychology (about 1920–1960), research on surprise came largely to a standstill, to be taken up again only following the so-called ‘cognitive revolution’ of the 1960s. At that time, aspects of surprise first came to be discussed again under the labels ‘*orienting response*’ and ‘curiosity and exploration.’ Surprise as an independent phenomenon was first discussed anew by evolutionary emotion theorists Silvan Tomkins and Carroll Izard. Referring back to Darwin, these authors proposed that surprise is a basic emotion that serves essential biological functions. One of these functions – surprise as an instigator of epistemic (specifically causal) search and a precondition for learning and cognitive development – came to be particularly emphasized by developmental psychologists. This suggestion was subsequently taken up by social psychologists interested in everyday causal explanations, who emphasized unexpectedness as a main instigator of spontaneous causal search. In the 1980s, cognitive psychologists, including cognitively oriented emotion theorists, became interested in surprise. Since that time, research on surprise has steadily increased and is carried out today by researchers in several different subfields of psychology, as well as in neighboring fields such as artificial intelligence. Topics addressed by contemporary research on surprise (part of which is carried out under different labels such as ‘spontaneous attention,’ ‘OR,’ and ‘curiosity’) range from the relation of surprise to spontaneous attention capture, to the conditions of the facial expression of surprise, to the role

of surprise in advertising. Because surprise is involved in many different psychological phenomena, research on surprise is relevant for many areas of psychological investigation. These include belief updating and learning, the diagnosis of knowledge structures in children, spontaneous attention, automatic versus controlled processing, emotions, humor, the psychology of music, and esthetic appreciation.

Theories of Surprise: The Cognitive-Evolutionary Model

Classical psychological theories of surprise are formulated exclusively on the ‘intentional level’ of system analysis familiar from common-sense psychology, using concepts such as *belief*, *expectation*, *attention*, and, of course, *surprise*. Only in recent times have there been attempts to move beyond this level of analysis to the level of the underlying mental mechanisms, or the cognitive architecture. The aim of these newer, ‘process models’ of surprise is to provide a deeper understanding of the causal generation of surprise, its nature, and its functional role in the architecture of the mind, by describing (at least in outline) the information-processing mechanisms that underlie the experience of surprise and surprise-related mental events and behaviors. To illustrate, we describe in some detail the *cognitive-evolutionary model of surprise* proposed by Meyer and coworkers, which is the result of an attempt to integrate and elaborate the modal views of previous surprise theorists, as well as previous psychological analyses of humans’ reactions to unexpected events, within the framework of schema theory. This model has formed the basis of some recent empirical research on surprise in psychology, as well as inspired a computational model of surprise proposed by artificial intelligence researchers. The cognitive-evolutionary model of surprise is depicted in simplified form in [Figure 1](#).

Schema theory assumes that human perception, thought and action are to a large extent controlled by complex, organized knowledge (or belief) structures, called schemas. Schemas can be regarded as informal, unarticulated theories, or as sets of beliefs, about objects, events, event sequences (including actions and their consequences), and situations. Schemas serve the interpretation of present and past, and the prediction of future events, and thereby the adaptive guidance of action. To be able to fulfill these functions, a person’s schemas or informal theories must be at least approximately correct. This in turn requires – because knowledge of the environment is usually incomplete, and because the environment can change – that schemas are continuously monitored for their compatibility with newly acquired information and, if necessary, are appropriately updated. According to the cognitive-evolutionary model of surprise, the surprise mechanism plays a crucial role in this context.

The surprise mechanism is assumed to consist at its core of an innate, hardwired information-processing device that continuously compares, at an unconscious level of processing, the currently activated cognitive schemas (which may be regarded as constituting the person’s working-memory model of her present situation) with newly acquired information (new beliefs). As long as the ‘schema-discrepancy detector’ registers congruence between schema and input – colloquially, as long as events conform to expectations – the person’s informal

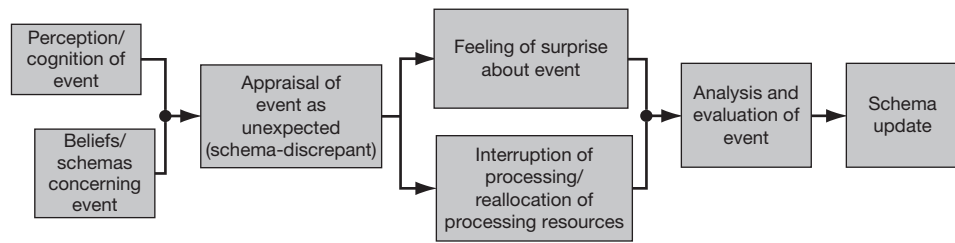


Figure 1 A cognitive-evolutionary model of surprise. After Meyer W-U, Reisenzein R, and Schützwohl A (1997) Towards a process analysis of emotions: The case of surprise. *Motivation and Emotion* 21: 251–274.

theories are supported by the evidence, and there is hence no need to revise them. Rather, the interpretation of events and the control of action take place largely automatically and effortlessly. In contrast, if a discrepancy between schema and input is detected, and if the degree of schema discrepancy (unexpectedness) exceeds a certain threshold, a ‘surprise reaction’ is elicited (see [Figure 1](#)): Ongoing information processing is interrupted, processing resources are reallocated to the unexpected event, and the feeling of surprise is generated ([Figure 1](#)). These processes enable and prepare the subsequent analysis and evaluation of the unexpected event plus – if this analysis suggests so – immediate reactions to this event and/or the updating, extension, or revision of the schema or schemas that gave rise to the discrepancy ([Figure 1](#)). The evolutionary function of the surprise mechanism is to (1) detect schema-discrepancies and (2) if they are detected, to prepare and instigate processes (of event analysis and schema update) that enable the immediate and long-term adaptation to unexpected events. Let us look at the processes postulated in [Figure 1](#) in more detail.

Detection of Schema-Discrepancies

The assumption that surprise is caused by the detection of schema-discrepancies is an explication of the common-sense psychological assumption – which is accepted by nearly all classical and modern surprise theorists – that surprise is elicited by *unexpected events*, that is, by events that disconfirm, contradict, or violate an expectation. However, to cover all cases of surprise, this idea is given an extended interpretation in the theory that includes the following assumptions: (1) The ‘expectations’ that are disconfirmed by surprising events are not restricted to beliefs about the future; rather, ‘expectation’ is used as a synonym of ‘belief.’ This assumption is necessary to take account of the fact that surprise can also be caused by disconfirmation of beliefs about the past (e.g., one is surprised that the train departed an hour ago) and about atemporal states of affairs (e.g., one is surprised that a particular theorem follows from the axioms of a theory). (2) The concept of ‘unexpectedness’ covers two cases: *misexpectedness*, and *unexpectedness* in the strict sense. An event is *misexpected* if it conflicts with a preexisting, specific, and usually explicit belief concerning this event. For example, Mary is waiting for Bob in her office; hearing a knock at the door, she expects Bob to enter, but Bill enters instead. This event elicits surprise because it is *misexpected*. In contrast, an event is *unexpected in the strict sense* if it does not conflict with an explicitly held belief (at least none that was active, that is, in the person’s working memory

at the time when the surprising event occurred), although it is inconsistent with the person’s background beliefs. For example, even if Mary does not expect anybody in particular to visit her, she will be surprised to see Bill walk into her office if she believes that Bill is currently attending a conference abroad. (3) The explicit or implicit beliefs whose disconfirmation causes surprise can be acquired in several different ways: They can be gradually built up through personal experience during an extended period of time (e.g., during many days in her office, Mary learns that Bob usually visits her at noon); they can be conveyed through verbal communication (Bob informs Mary that he will come to visit her at noon); and they can be inferred from other beliefs through reasoning processes (e.g., Mary reasons that, because Bob has promised to visit her the next time he is in town, and because he is in town today, he will probably visit her today).

Any plausible cognitive theory of surprise must take account of these facts. This means in particular that such a theory needs a suitably general and flexible account of the internal representations that serve as a reference against which an event is classified as ‘discrepant.’ This account must allow to represent beliefs about past, present, and future states of affairs; as well as beliefs about concrete events and abstract states of affairs; it must allow to explain how both *misexpected* and *unexpected* events can be classified as ‘discrepant’; and it must be able to accommodate different sources of belief acquisition (e.g., cumulative personal experience over an extended period of time, and explicit verbal information). The schema concept promises a description of adequate breadth: Surprising events are those not consistent with currently activated schemas, irrespective of the existence of a concrete expectation, and irrespective of the origins of the beliefs encoded in the schema. Schema theory postulates that schemas become activated as a result of current experiences, that may include the unexpected event itself. The activated schemas then serve as a reference against which experiences are compared; events that deviate from the currently activated schemas elicit surprise.

Interruption, Reallocation of Processing Resources, Event Analysis, and Schema Update

Usually the individual is engaged in some other activity when an unexpected event occurs. To permit the undisturbed processing of the unexpected event, these ongoing cognitive and motor activities are temporarily interrupted by the surprise mechanism, and the available processing resources are redistributed, now favoring processes that serve the analysis of the

event and the updating of currently activated schemas. The focusing of attention on the unexpected event amplifies information relevant for the updating process and simultaneously attenuates potentially interfering information from other sources. It should be noted that, although turning attention to the surprising event as a prerequisite for updating is in most cases adaptive, it is not always so, because there are situations in which even the shortest interruption of momentary activity can have disastrous effects. This is the case when the uninterrupted continuation of ongoing activities is vitally necessary, as may be the case for a fighter pilot or a cat burglar. From the perspective of the cognitive-evolutionary model of surprise, these occasional negative side-effects of surprise are the price that has to be paid for a mechanism that is overall adaptive in enabling the coping with unexpected events.

According to the cognitive-evolutionary model of surprise, the subsequent analysis and evaluation of the surprising event typically comprises the following subprocesses: the verification of the schema discrepancy (did one see or hear right; did one draw the correct conclusion from premises?); the analysis of the causes of the unexpected event (why did it happen?); the evaluation of the unexpected event's significance for well-being (is the event congruent or incongruent with one's desires; does it signal danger, or an unexpected opportunity?); and the assessment of the event's relevance for ongoing action (can one ignore the event, or does one need to respond to it?). Additional event appraisals, such as an assessment of the moral significance of another person's unexpected action, can also occur in special situations. Once the appraisals of an unexpected event (e.g., regarding its causes or action relevance) have been computed, they are stored as part of the schema for this event. As a consequence, the analysis of subsequent instances of the same or similar kinds of events can be substantially abbreviated.

The analysis and evaluation of the surprising event is usually a precondition for adaptive schema (or belief) update. A schema update may consist in the correction, restructuring, or extension of relevant schemas. Appropriate schema update enables the individual: to predict and possibly, to control (bring about or prevent) future occurrences of the schema-discrepant event; to avoid the event if it is negative and uncontrollable; or to ignore the event if it is irrelevant for further action. The long-term function of surprise is thus to ensure the adaptation of the individual by enabling and instigating processes that result in the updating of action-guiding schemas. To the degree that schema revision or belief update can be equated with cognitive development and learning, it follows that surprise should have an important function for the development of cognitive structures and learning. In agreement with this conclusion, many developmental psychologists consider surprise to be an important factor for children's cognitive development. Similarly, several learning theorists conceive of learning as a process in which an individual's schemas are brought into line with new input that deviates from the schemas. This suggests that at least one central form of learning – namely belief updating – occurs only if newly acquired information is unexpected and hence surprising. Surprise theory thus suggests a strongly 'localist' approach to belief updating.

The Behavioral Manifestations and the Experience of Surprise

The cognitive-evolutionary model of surprise assumes that the described mental processes are causally responsible, alone or in combination, for the various behavioral manifestations of surprise (if they occur): the interruption or delay of ongoing motor activities, investigative activities, facial and verbal expressions of surprise, and peripheral physiological reactions. For the greater part, these behavioral manifestations of surprise are probably adaptive processes that, in one way or another, subserve the major function of the surprise mechanism: the short- and long-term adaptation to unexpected events. For example, investigative motor actions are in the service of epistemic analysis, and eyebrow-raising may, as Darwin argued, facilitate the visual exploration of unexpected events in some situations. In addition, eyebrow-raising could serve to communicate the person's surprise to others, thereby soliciting their help in explaining the unexpected event. Indeed, a deliberately produced, stylized form of the surprise expression – raising the eyebrows to form an enquiring look – is frequently used as a nonverbal request for information in everyday conversation. In this way, the facial expression of surprise (and likewise surprise vocalizations) may assist the updating of beliefs by recruiting informational support from the social environment.

The subjective experience or 'feeling' of surprise can be regarded as the manifestation in consciousness of the encountered discrepancy between activated schema and newly acquired information. Because the intensity of experienced surprise is closely related to the degree of unexpectedness of the eliciting event, the feeling of surprise could simply be the conscious awareness of the signal produced by the schema discrepancy detector. (According to the model, this signal is characterized by a specific quality that codes the fact that a schema discrepancy has occurred, and an intensity that codes the degree of the schema discrepancy.) However, the subjective experience of surprise could include additional elements, such as a direct phenomenal awareness of mental interruption.

According to the cognitive-evolutionary model of surprise, the feeling of surprise has an informational as well as a motivational function. Its *informational function* consists of informing the conscious self (the person) about the detection of a schema discrepancy. This assumption relates to theoretical views of consciousness that stress the importance of consciousness for planning: Whereas the routine execution of simple activities may be carried out without conscious control, the generation of action plans for exceptional situations requires conscious processing. Seen from this perspective, the surprise signal acts on the one hand as a 'deautomatizer' that interrupts routine processes and calls for, as well as prepares, conscious processing; on the other hand, the surprise signal enters conscious processing (in the form of the surprise feeling) as information about the occurrence of a schema discrepancy. In addition to its informational function, the experience of surprise can also be ascribed a *motivational function*, for it is likely the feeling of surprise that triggers the conscious analysis of the surprising event, or at least provides an initial impetus for this analysis. The reason for this is probably that the information that something unexpected happened elicits curiosity. Hence, the motivational effect of the surprise feeling may be based on its informational effect.

The Theoretical Definition of Surprise

The cognitive-evolutionary model of surprise allows to replace the pretheoretical characterization of surprise by a more precise, theoretical (i.e., theory-based) definition. As evident from [Figure 1](#), the schema-discrepancy signal is the ‘causal hub in the wheel of surprise’: it is the direct or indirect cause of all subsequent mental processes postulated in the model (the feeling of surprise, interruption and attentional shift, event analysis, and schema revision), as well as of the various behavioral manifestations of surprise. Because of its central causal role, the schema-discrepancy signal suggests itself as the best candidate for the scientific referent of surprise. Hence, presupposing the correctness of the cognitive-evolutionary model of surprise, surprise can be theoretically defined as follows: *Surprise is the signal that is the immediate output of the schema-discrepancy detector.*

Surprise, the Startle Reaction, and the Orienting Response

The Startle Reaction

Surprise must be distinguished from the so-called *startle reaction* elicited by sudden intense sensory input. The startle reaction differs from surprise in terms of its causes, its topography, and its function.

Whereas surprise is elicited by the appraisal of unexpectedness (the detection of a schema discrepancy), startle is a reflex-like reaction to abrupt, intense sensory input, such as a pistol shot. ‘Abruptness’ in this context does *not* mean unexpectedness, but primarily a sudden onset and fast rise of the intensity of sensory input. For example, an acoustic stimulus (a tone or noise) with a high peak intensity will elicit startle only given a short rise time (in the range of some 10 ms), but not when it rises gradually. Furthermore, whereas the intensity of surprise is determined by the degree of unexpectedness, the magnitude of the startle reaction is mainly determined by the intensity of the sensory input. Because of these differences in eliciting conditions, a sensory stimulus that elicits startle (i.e., one with abrupt onset and high intensity) need not cause surprise (if it has been announced beforehand, or presented repeatedly); and a sensory stimulus that elicits surprise (i.e., one that is unanticipated or contrary to expectations) need not cause a startle response (if it is of low intensity, or if its intensity rises gradually). However, surprise is a frequent secondary reaction to startling stimuli because these stimuli are often unexpected as well. It is probably for this reason that the ordinary language word ‘startle’ can also be used to refer to some forms of surprise.

Surprise and startle also differ in terms of the typical behaviors associated with them. The startle reaction consists, centrally, in a specific pattern of facial and bodily muscle movements, varying considerably in completeness, which spreads from the head over the rest of the body. Its initial and most reliable component is the reflexive closure of the eyes; but if the reaction is more intense, it may include additional facial movements (lowering of the eyebrows and a horizontal stretching of the mouth) and postural changes: A forward motion of the head and neck, hunching of the shoulders, pronation of the lower arms, flexion of the fingers, bending of the elbows and

knees, contraction of the abdomen, and a forward motion of the trunk. These muscular reactions are accompanied by diverse physiological changes including an increase in skin conductance, blood pressure, and heart rate, plus an initial holding of breath followed by accelerated respiration. With the exception of the skin conductance reaction, these physiological changes are different from those attributed to surprise. Likewise, the postural changes characteristic for startle are quite untypical for surprise, and the facial changes that occur in startle (closure of the eyes, lowering of the eyebrows, stretching of the mouth) are even opposite to those characteristic for surprise (widening of the eyes, raising of the eyebrows, dropped open jaw). In addition, the temporal onset of the startle reaction differs from that of surprise: Whereas surprise needs at least 200–300 ms to develop in response to a sensory input (e.g., an unexpected tone), the startle reaction occurs with very short latency, with its earliest components appearing at some 40 ms after the onset of a startle stimulus.

Correlated to these differences in elicitors and response, the functions of surprise and startle are different: Whereas the function of surprise is to assist the updating of schemas or beliefs, the startle reaction is – as suggested by the short latency and topography of the described muscular response pattern – essentially a first-line defensive reflex against injury from a predator or a blow. In line with this conclusion, the neural pathways underlying the startle reaction have been determined to consist of a brain-stem reflex system that exists, in similar form, not only in humans but also in variety of animal species.

The Orienting Response

The OR is typically defined as a probabilistic syndrome of responses, evoked in particular by novel and significant stimuli, that includes a variety of behavioral and physiological components, the latter being of primary interest to most researchers of the OR. Although the reactions characteristic for the OR and those characteristic for surprise overlap, the OR must be distinguished from surprise.

The conditions that evoke the OR have been classified into three broad categories. The first category, *novelty* (the quality of an event or stimulus of being new), can be subdivided into (1) novelty of a stimulus or an elementary event, (2) novelty in a sequence of events, and (3) novelty in the patterning of stimuli. For example, a tone that is presented for the first time in an experiment is novel in the first sense; a tone that deviates occasionally from a sequence of regular tones (a so-called ‘oddball stimulus’) is novel in the second sense, and a melody that deviates from one heard before would be novel in the third sense. The second category, *conflict*, refers to situations in which an ambiguous stimulus leads to the activation of conflicting response tendencies (e.g., in a difficult perceptual discrimination task). The last category, *previous conditioning*, includes high-importance stimuli (e.g., one’s own name or a warning call like ‘watch out’), which have acquired their significance as a result of the individual’s learning history. In contrast to the startle response, the OR does not require an increase in the intensity of stimulation to occur. In fact, an event evoking an OR can consist of the occurrence, as well as the change, and even the removal (or omission) of a stimulus (e.g., the omission of a tone in a regular series).

Although there is overlap in the typical procedures used to induce either the OR or surprise in humans, they are not identical. In particular, not all events that elicit an OR also elicit surprise. A novel stimulus, as defined above, may well cause surprise, the reason being that novel stimuli are often also unexpected; however, novel stimuli can also be expected (e.g., an oddball stimulus that has been announced beforehand, or has been presented repeatedly), in which case they do not elicit surprise. And stimuli from the 'conflict' or the 'previous conditioning' categories of OR elicitors need not be unexpected, and hence surprising at all. However, it is possible that all events that cause surprise also trigger an OR (or a special form of the OR), in which case the physiological changes that occur in surprise could consist of the physiological aspects of the OR.

The behavioral components of the OR include movements of the sense organs toward the source of the eliciting stimulus, as well as an interruption of overt actions, accompanied by an increase in general muscle tonus. The physiological components of the OR comprise (1) an increased sensitivity of the sense organs, manifested in the lowering of sensory thresholds; (2) vegetative changes (a decrease of heart rate and respiration rate, an increase in skin conductance, and two opposing vascular changes, vasoconstriction in the limbs and vasodilation in the head); and (3) changes in the electroencephalogram in the direction of faster activity with a lower amplitude, indicative of an increase in cortical arousal or wakefulness.

As to the specific brain processes that underlie the OR, it has been found that novel events evoke a cortical response that differs in waveform from that caused by regular events. More specifically, this research (which has mostly studied the electrocortical responses to simple auditory or visual oddballs) has identified three characteristic components of the event-related brain potential evoked by these oddballs. The first is the so-called mismatch negativity, a negative peak around 200 ms after stimulus onset, which is thought to reflect the preattentive, automatic detection of the sensory (e.g., acoustic) change. The second is the P300a component (a positive peak around 350 ms after stimulus onset) that seems to reflect the involuntary attention switch to the oddball event. Third, the so-called reorienting negativity (a negative peak around 500 ms after stimulus onset), is thought to reflect the voluntary attentional reorienting to the task at hand. Brain-imaging studies found that oddball stimuli elicit widespread activity in diverse, spatially distributed cortical and subcortical systems. To the degree that these brain responses also occur in response to unexpected events, they would indicate that surprising stimuli elicit a 'whole-brain response' that would fit well with the function attributed to surprise. As to the brain processes selectively associated with surprise proper (the output signal of the schema-discrepancy detector), recent research suggests that they may be localized in the lateral prefrontal cortex.

Is Surprise an Emotion?

Common-sense classifies surprise as an emotion. In contrast, in scientific psychology, the question of whether or not surprise is an emotion is controversial: Some emotion theorists regard surprise not only as an emotion, but even as a basic

emotion; others regard it as an emotion, but not a basic one; and yet others do not classify surprise as an emotion at all, but as a cognitive state (although one that may play an important role in the process of emotion generation, e.g., by preparing the individual for the evaluative appraisal of events).

Surprise is typically considered a basic emotion by proponents of an evolutionary approach to emotions, in particular the adherents of the theory of 'discrete basic emotions.' Basic emotion theorists believe that the innate core of the human emotion system consists of a small set of modules – the basic emotion mechanisms – each of which developed in evolution as a solution to a different, recurrent adaptive problem. Surprise, they argue, fits this definition of basic emotions. Some theorists assume, in addition, that basic emotions are innately linked to communicative signals, in particular to facial expressions. Inasmuch as surprise is indeed associated with a specific facial expression, it would also qualify as a basic emotion according to this criterion.

Two main arguments have been advanced for *not* regarding surprise an emotion: (1) in contrast to paradigmatic emotions such as joy or fear, the feeling of surprise is *per se* hedonically neutral, rather than pleasant or unpleasant; (2) corresponding to, and explaining, this difference in feeling tone, surprise does not presuppose the appraisal of the eliciting event as positive (motive congruent) or negative (motive incongruent). The claim that surprise is hedonically neutral rests on the observation that the experience of surprise can be pleasant (e.g., surprise caused by an unexpected present), unpleasant (e.g., an unexpected failure), as well as neutral (neither pleasant nor unpleasant; for example, surprise about an unexpected solution to a quiz problem). This observation suggests that feelings of pleasantness and unpleasantness are not a necessary component of surprise, but result from processes different from those that elicit surprise. These other processes, that are responsible for the hedonic tone of surprise in those cases where it is either pleasant or unpleasant, can be construed as appraisals or evaluations of the significance of what is happening for one's well-being; specifically, the evaluation of the surprise-eliciting event as positive (motive congruent) or negative (motive incongruent). This appraisal of motive consistency, if it occurs at all, usually takes place in parallel to, or quickly after the onset of surprise, and it results in pleasant or unpleasant feelings that blend with the feeling of surprise in consciousness, thus endowing the experience of surprise with a positive or negative hedonic quality. This hypothesis allows to explain the differences in feeling tone in different instances of surprise. It also explains why some authors have come to think that surprise, like other emotions, is intrinsically hedonic or evaluative.

Although the proposed differences between surprise and paradigmatic emotions must be acknowledged, it is not clear whether they are great enough to exclude surprise from the realm of emotions. For one reason, surprise appears to be an essential ingredient of several unquestioned emotional states, such as disappointment and relief; and the intensity of most emotions is enhanced if their elicitors occur unexpectedly. For another reason, it can be argued that the cognitive mechanism that produces surprise (a mechanism that compares newly acquired beliefs to preexisting beliefs) and the mechanism that produces hedonic emotions (presumably, a mechanism that compares new beliefs to preexisting motives or desires)

have similar properties and are closely intertwined in their operation: They are both automatically and unconsciously operating mechanisms that 'supervise' representations (beliefs and desires, respectively); they seem to operate on the same inputs (newly acquired beliefs); and their outputs may be integrated at an unconscious level of processing (e.g., the signals of unexpectedness and desire-incongruence may be unconsciously integrated into the emotion of disappointment). If these assumptions are correct, they would constitute good theoretical reasons for (re-)classifying surprise as an emotion. In any case, however, surprise needs to be considered in theories of emotion, even if it is not regarded as an emotion itself.

See also: [Associative Learning](#); [The Brain](#); [Creativity](#); [Expectation](#); [Facial Expression of Emotion](#).

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Synesthesia

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Glossary

Associator synesthete A synesthete who experiences his/her synesthetic concurrent (e.g., colors) in the mind's eye.

Concurrent The sensory or conceptual experience triggered by the synesthetic inducer.

Grapheme–color synesthesia The experiencing of synesthetic color triggered by (hearing, reading, saying, or thinking about) letters and/or digits.

Higher synesthesia Synesthesia triggered by high-level conceptual stimuli (e.g., word meanings).

Inducer The stimulus that triggers a synesthetic concurrent.

Lexical–gustatory synesthesia The experiencing of synesthetic flavor triggered by (hearing, reading, saying, or thinking about) words.

Lower synesthesia Synesthesia triggered by low-level sensory/perceptual stimuli (e.g., auditory pitch).

Ordinal linguistic personification (OLP) synesthesia The experiencing of synesthetic personalities and genders triggered by ordered sequences such as letters, numbers, days, months, etc.

Projector synesthete A synesthete who experiences his/her synesthetic concurrent (e.g., colors) projected outside the body.

Synesthete A person with developmental or inherited synesthesia.

Introduction

Synesthesia (UK spelling: synaesthesia) is an inherited condition that gives rise to unusual experiences that have often been described as a 'merging of the senses.' For synesthetes, everyday activities such as reading, listening to music, speaking, etc. give rise to extraordinary sensations, such as colors or tastes. Synesthete JW, for example, experiences a 370-Hz single piano note as both an auditory phenomenon and as a dark yellow colored form in her visual field. Synesthete MM has specific sensations of flavor, which flood her mouth whenever she hears proper names (e.g., 'John' tastes of cornbread). Synesthete SD sees colors in his visual field in response to the tastes of food, and so the taste of rice, for example, triggers the color blue. In many cases, these experiences are as perceptually real as veridical sensations, although they are not considered hallucinations: synesthetes are almost always aware that these perceptions are not part of the outside world, but that they are inherently paired with the triggering stimulus. For example, synesthete JS sees colors when he reads letters and digits (known as grapheme–color synesthesia), and, although these colors are projected onto the written typeface, he is fully aware that the print itself is black on white. He knows, moreover, that individual letters and digits trigger individual color experiences, and that these colors are superimposed by his own mind. Synesthesia research has a broad appeal, and the cause of these unusual sensations has been of interest to psychologists for the last 200 years. In recent decades, however, the field has experienced a considerable renaissance of interest, and provided a contemporary source of study for scientists across a range of different psychological and neuroscientific disciplines.

Variants of Synesthesia and Phenomenology

Each variant of synesthesia is characterized by the pairing of a particular type of triggering stimulus (known as the 'inducer')

with a particular type of synesthetic experience (known as the 'concurrent') (Table 1). In the pitch–color variant, for example, the inducer and concurrent are musical pitch and colors, respectively. So for pitch–color synesthetes, hearing music at various pitches gives rise to the visual experience of colors. Another particularly common variant is known as sequence–space synesthesia (or visuo-spatial synesthesia) in which sequences such as numbers, letters, days of the week, or months of the year are visualized as occupying particular spatial arrays. Synesthete IB, for example, sees the months of the year as occupying a running-track shape, at chest height in front of the body. Synesthetic forms, colors, and other sensations are experienced either in the 'mind's eye,' or can be projected out into the space around the body. This distinction in the nature of the concurrent has been captured by the terminology of psychologist Mike J. Dixon and his colleagues as 'associator' and 'projector' synesthesia, respectively. Synesthesia has a wide range of different manifestations depending on the particular combination of inducer and concurrent, and at least 50 different manifestations have been recorded to date. The most common synesthetic concurrent is that of color, and this accounts for 95% of all synesthesias found in one recent prevalence study. Nonetheless, synesthetes can experience a range of different sensations, including taste, flavor, odor, texture, shape, touch, sound, and even bodily pain, and many other modalities of sensation have also been reported as concurrents. In lexical–gustatory synesthesia, for example, reading, saying, or even thinking about words triggers accompanying flavor sensations. These sensations are experienced either as similar to veridical flavor (e.g., the word 'jail' tastes of bacon in the mouth) or as an overwhelming association between the inducing word and the food type (e.g., the word 'jail' automatically evokes the notion of bacon). These food experiences are not generic simple tastes of bitter/salty/sweet, etc., but are complex sensations that are rich in detail. Synesthete JG, for example, experiences a complex flavor from the name 'Adrian,' which she describes as the taste of

Table 1 Classifications of synesthesia according to whether subclass definitions are based on the nature of the inducer (triggering stimulus) or the nature of the concurrent (resultant synesthetic sensation)

Inducer	Concurrent
<i>Lower synesthesia</i> : sensations are triggered by low-level, perceptual aspects of the stimulus. For example, for a lowercase letter–color synesthete: the color of <i>a</i> ≠ the color of <i>a</i> (because <i>visual/perceptual</i> properties determine color)	<i>Projector synesthesia</i> : synesthetic experiences are projected out into the world, in locations similar to real-world perceptions. For example, projector letter–color synesthetes might see colors projected onto the written typeface
<i>Higher synesthesia</i> : sensations are triggered by high-order, conceptual aspects of the stimulus. For example, for an uppercase letter–color synesthete: the color of <i>A</i> = the color of <i>a</i> (because <i>conceptual</i> properties determines color)	<i>Associator synesthesia</i> : synesthetic experiences are ‘known,’ or seen ‘in the mind’s eye,’ or in some internal space. For example, associator letter–color synesthetes might see colors only in the ‘mind’s eye.’

lettuce coated with Caesar salad dressing. Like all flavor experiences, synesthetic flavors can also incorporate texture and temperature, so for synesthete JIW, for example, the word ‘jail’ generates the experience of (specifically) cold, hard bacon.

Lexical–gustatory synesthesia demonstrates that the inducer to synesthetic experiences need not be a purely sensory stimulus. Synesthesia can be triggered by words, and indeed, linguistic units are the most common type of inducer. One recent study showed that 88% of synesthesias were triggered by language units such as words and graphemes (i.e., letters and digits). Importantly, it is often the abstract linguistic quality of these language units, rather than their purely sensory features (i.e., how they sound/look) that triggers the synesthesia to arise. One recent study from our lab showed that lexical–gustatory synesthesia, for example, is triggered by the abstract semantic meaning of words, rather than by the sensory features of their sounds and spellings. Together with psychologist Jamie Ward, I demonstrated that words can trigger synesthetic flavors even when the synesthete is in a tip-of-tongue state. Tip-of-tongue state is the familiar experience that we all encounter when we are unable to recall a known word from memory. In our study, we were able to place synesthetes in a tip-of-tongue state by showing them pictures of unusual objects (e.g., a metronome, a platypus). Like all people in a tip-of-tongue state, the synesthetes knew the meaning of these words but were temporarily unable to say their names. Importantly, we found that synesthetes began to taste the word even before they could say it. One synesthete, for example, tasted Dutch chocolate while struggling to retrieve the word ‘phonograph.’ Another felt the sensation of crumbly biscuit while struggling for ‘tambourine.’ The fact that synesthetes could sense their synesthetic flavors even though they could not remember how to pronounce the triggering word suggests that it is the word meaning, and not its sound or spelling that elicits the synesthetic sensation. In turn, this shows that synesthesia is far more than a simple ‘merging of the senses,’ and that its inducers can include complex higher order units of language.

Despite the astonishing range of different synesthetic experiences, all variants appear to share certain key characteristics. Synesthetic sensations are automatic and cannot easily be repressed. One simple demonstration comes in a type of Stroop-type task, in which grapheme–color synesthetes are shown letters in colored font and are simply required to name the color of the font. Synesthetes are particularly poor at this task if font colors clash with their own synesthetic colors. For example, a synesthete would be slow and error

prone when describing a red 7 if their own synesthetic color for 7 is, for instance, green. Hence, although the task requires them to say ‘red’ (the color of the font), they have an implicit notion that 7 should be green. Another key characteristic of synesthesia is the consistency of inducer–concurrent pairings, which tend to remain constant across the synesthete’s lifetime. Hence, when asked to describe their synesthetic experiences (e.g., A = red; B = yellow, etc.) synesthetes are typically close to 100% consistent in retests across many months or even years. In one recent study, we were able to show that the synesthetic associations of one lexical–gustatory (word–taste) synesthete had remained consistent across almost three decades, since they were first recorded in 1979. This trait of consistency has been used to distinguish synesthetes from malingerers, since nonsynesthetes are considerably less consistent in recalling invented associations simply by memory alone. In laboratory tests, nonsynesthetes tend to be only around 20–40% consistent over time, even if they are retested after only a few weeks. In contrast, synesthetes will always report the same experiences, and this is because they are apparently ‘reading off’ these experiences in real time, rather than relying on explicit recall from learned memory.

Although many variants of synesthesia give rise to experiences of sight, sound, smell, taste, and touch, there are also variants that trigger nonsensory concurrents. For example, the variant of synesthesia known as ordinal linguistic personification (OLP; also known as sequence–personality synesthesia) is triggered by archetypal inducers such as letters, numbers, day, and other sequences. The concurrent, however, is not color or taste, or any other sensory phenomenon, but is instead the overwhelming impression of a gender or personality type. For example, an OLP synesthete may not think that the number 7 is green, but rather, that it is a maniacal old man who shouts at his neighbours. Alternatively, they may feel that the letter F is a middle-aged woman who likes to gossip with friends, or that Tuesday is a young man who yearns for adventure, while November is a self-centered empty-headed boy. Such descriptions can be found in scientific reports dating back to the nineteenth century (see section [History of Synesthesia Research](#)), and are remarkably consistent across synesthetes from different centuries and different continents. Hence, the inducers to this type of synesthesia tend to be the linguistic units of ordinal sequences (e.g., letters, numbers, days, months) and these give rise to a range of complex concurrents, including gender (e.g., female), personality (e.g., shy), physical appearance (e.g., thin), occupation (e.g., businessman), cognitive

attributes (e.g., clever), and relationships to other inducers (e.g., A might be the mother of B). Such relationships tend to hold within, but not across, sequences (e.g., A might be the mother of B, but not of 7) and tend to hold only between units that are proximal (e.g., A might be the mother of B, but not of Q).

The OLP variant significantly co-occurs with other types of synesthesia, suggesting again that it is indeed a bona fide manifestation of the condition, with a shared neurological basis. OLP also possesses the key characteristics of synesthesia, being involuntary, highly consistent over time, and automatic. This automaticity can be seen in Stroop-type tasks (see above) where synesthetes are required to ignore their synesthetic sensations for the purpose of the test. One such study in my own lab required an OLP synesthete to ignore her synesthesia, and to simply read names silently from a screen (e.g., Michael, Anna, John, . . .). For every name, she was asked to press a button to indicate whether it represented a male or a female (e.g., John = male). This ostensibly simple task was rather challenging for the synesthetes because each name had been deliberately chosen by us to begin with a letter whose synesthetic gender posed a conflict. For example, although 'John' is a male name, the letter J for this synesthete is female. As a result, the synesthete was far slower and error prone in this task than a group of nonsynesthete controls, simply because she could not ignore her conflicting synesthetic genders.

The OLP variant shows that synesthetic concurrents can involve not just sensory experiences (colors, tastes) but also higher level cognitive features (e.g., personalities), just as variants such as lexical-gustatory synesthesia have shown the same for inducers (which can be either sensory percepts such as sound, or higher level cognitive units such as word meanings). The distinction between low-level sensory triggers and high-level more conceptual triggers has been captured in the terminology of neuroscientists V.S. Ramachandran and Edward Hubbard as lower versus higher synesthesia. This lower/higher distinction can be seen even within variants. Take, for example, grapheme-color synesthesia: synesthetes can experience color from either the low-level visual form of letters (e.g., their curves and intersections) or from their higher level category or class. Hence, lower synesthetes would experience different colors depending on the particular way in which a letter was drawn (uppercase vs. lowercase; italics vs. upright font, etc.), while higher synesthetes would experience the same color across every instance of that letter, irrespective of its visual form (because all of these visual instantiations represent the same category of letter).

Individuals with synesthesia are likely to have more than one variant. Hence a pitch-color synesthete might have different colors not only for the sounds at various pitch but also for different timbres of music (e.g., a sine wave might be overall less saturated in color than a piano tone at the same pitch). Indeed, even rather different types of synesthesia can coexist in the same individual. Synesthete ES, for example, experiences colors in response to both tones and tastes in the mouth, while Synesthete AP has grapheme-color synesthesia, day-color synesthesia, a sequence-space mental number line, and OLP synesthesia, and she also experiences tactile sensations of shape in response to tastes in the mouth (taste-shape synesthesia). Certain patterns have been detected in the clustering of synesthesias within individuals. For example, synesthetes who

experience concurrents of color, but not those who experience taste, are significantly likely to also have sequence-space synesthesia. Such cluster findings are now being verified in very large populations of synesthetes and might speak to the way in which the condition is inherited (see section [Prevalence and Inheritance of Synesthesia](#)).

History of Synesthesia Research

Synesthesia has fascinated psychologists since the earliest days of the nineteenth century, when a young Austrian doctoral student named Georg Sachs published the first case study about this unusual phenomenon. Sachs wrote of his own experiences of 'seeing' colors when hearing music, and when thinking about simple sequences such as numbers, days, and letters. He submitted his findings in Latin in his bound doctoral thesis in 1812, but died shortly after. His work fell into relative obscurity until the twenty-first century, when a revival in synesthesia research over the last 20 years brought about renewed interest in the condition. In that short time, a huge body of work has demonstrated the psychological, neurological, developmental, and genetic basis of synesthesia, and taken Sachs' seminal work in a direction he might never have imagined. At the same time, there has been a revival of interest in historical writings, many of which are surprisingly current. The Swiss psychologist Theodore Flournoy, for example, wrote an extensive book on synesthesia in 1893, which he termed at that time 'Synopsis,' and which describes many examples of the condition which have, in more recent works, been reexamined in great detail (e.g., OLP synesthesia). Another seminal work appeared in *Nature* in 1880, written by the eminent scientist Francis Galton, cousin of Charles Darwin. Galton described the experiences of individuals with 'visualized numbers,' which we now recognize as a type of sequence-space synesthesia. Many of these historical works cluster around the final two decades of the nineteenth century, when early interest in synesthesia was at its height, and scientists such as Flournoy, Galton, and their contemporaries Mary Calkins, W.O. Krohn, Ferdinand Suarez de Mendoza, and others were disseminating information about synesthesia throughout Europe and the United States. Suddenly, however, as quickly as it had arisen, the condition fell out of public consciousness. John Watson's seminal work of 1913 had described a new landscape of psychological study known as Behaviorism, in which there was no place for the investigation of internal experiences such as synesthesia. As a result, there was relative silence in the field of research regarding synesthesia for the next 70 years, until a neurologist named Richard Cytowic began a revival following a chance conversation with his neighbor. Having invited Richard Cytowic for dinner, the neighbor apologized for the lack of 'points' on the chicken, and Cytowic recognized this description of taste-shape correspondences as a variant of synesthesia. Many years of writing and research followed, and others, too, began their own research programs. Two other notable events transformed synesthesia science into the vibrant field it is today. First, a simple behavioral test devised by the Cambridge researcher Simon Baron-Cohen and his colleagues in 1987 allowed researchers for the first time to verify the genuineness of synesthetes' reports, by showing that their

associations (e.g., A = red, B = yellow, etc.) are significantly more consistent over time than those invented by controls trying to 'fake' the condition. Second, and the most significant event, perhaps, was the advent of brain imaging techniques, which have allowed us to see for the first time not only how the brain acts when experiencing synesthesia, but also how the very wiring of the brain permits these extraordinary sensations to be produced. The last 20 years have produced an astonishing set of insights into this condition, and the branches of synesthesia research now provide information regarding synesthetic behavior, genetic inheritance, neurological roots, cultural influences, and developmental path. In this article, I describe the most recent findings on the prevalence of synesthesia and on studies showing the inheritance and genetic roots of the condition.

Prevalence and Inheritance of Synesthesia

Synesthesia was once thought to be extremely rare, although estimates of prevalence have ranged from 1 in 250 000 to 1 in 6. Until recently, the most reliable figure had been based on the response rate from a newspaper advertisement in 1996, which called on synesthetes to come forward for a study in Cambridge, United Kingdom. Twenty-eight synesthetes responded from a circulation figure of 55 000, giving an estimate of prevalence of 1 in 2000. We now know, however, that this was a vastly underestimated figure: for every synesthete who responded, a further 85 did not. Recent studies no longer rely on self-referral, and have shown the true prevalence of synesthesia to be closer to 1 in 23. In two recent studies from our lab, several thousand members of the general population have now been randomly sampled and individually assessed for synesthesia with objective tests of genuineness. These show that synesthesia is present in at least 4% of the population, the majority of which have a small core of subtypes, which are overrepresented among synesthetes. In particular, the most common variants are triggered by linguistic sequences such as days, letters, and numbers, and give rise to synesthetic experiences of color and form. Less common experiences are of flavor, odor, touch, sound, and other sensations (see section [Variants of Synesthesia and Phenomenology](#)).

Early investigations based on self-report such as the advertisement study in Cambridge had suggested that female synesthetes may be six times more common than males, but this again appears to be a fallacy based on self-referral: it is known that women are more likely than men to report their atypical behaviors, which means that women likely dominated in self-reporting, but not in synesthesia, *per se*. Later estimates based on the more reliable random sampling method now show that women and men have synesthesia in almost equal numbers. Nonetheless, it is yet possible that women may slightly outnumber men by a small degree of around 1.5:1. However, sample sizes are, as yet, too small to confirm this bias statistically. Other sex differences might also be found in the study of familial transmission patterns, which appear to show a rarity of father-to-son transmission. In other words, while women with synesthesia have both sons and daughters with the condition, fathers are followed most often by synesthesia in the daughter only. This particular pattern of transmission led researchers to suspect a genetic influence with a dominant,

possibly X-linked, mode of inheritance. However, a whole-genome scan and fine-mapping linkage study has now revealed evidence of linkage only to chromosomes 2q24, 5q33, 6p12, and 12p12. In other words, this study, at least, found no support for a role of the X chromosome, and may indeed have provided the first documented cases of male-to-male transmission. Nonetheless, no explanation has yet been given for the comparative scarcity of male-to-male inheritance, and the possibility remains that the apparent male-to-male cases reported in this study in fact involve synesthesia passing through the mother's line without her having expressed the trait. Nonetheless, this discovery of genetic inheritance is a pivotal moment in synesthesia research, and has added enormously to our understanding of this condition.

Despite the genetic influences in synesthesia, the condition also involves a component of learning. First, and most obviously, many of the triggers for synesthesia are learned cultural symbols, such as letters and words. This suggests that some predisposition for synesthesia must necessarily interact with stages in development during literacy acquisition (see section [Neurological and Developmental Roots of Synesthesia](#)). More subtly, however, the learning component of synesthesia can be seen when considering data from very large groups of participants. It had been thought for some time that synesthetic sensations were highly idiosyncratic, since synesthetes often disagreed on their synesthetic pairings (e.g., A might be red for one synesthete but green for another). However, when very large numbers of synesthetes were compared in 2005, systematic patterns emerged to suggest more similarities than differences. For example, although the letter A can be any color, it is significantly likely to be red. B is likely to be blue, L is likely to be yellow, and so on. These shared preferences stem from shared subconscious 'rules' that each synesthete is following, even without awareness. For example, high frequency letters are significantly likely to be paired with high frequency color terms, and with more saturated and luminant colors. Hence, A is likely to be vibrant red, while V is likely to be a pale purple. Since grapheme–frequency is a learned feature of language arising from exposure to a language environment, its role in dictating synesthetes' colors again illustrates the place of learning in synesthetic development. Moreover, learning can be seen in other variants also. For example, the personality types found as concurrents in OLP synesthesia tend to reflect the society that was contemporary to the report. Older studies mention 'society girls' and 'housekeepers,' while these historical character types tend not to be found in modern accounts. Again, therefore, learning and experience appear to influence the synesthetic sensation.

One final point to note about the inheritance of synesthesia is that its transmission is not tied to any particular variant. For example, a mother who sees colors with letters can give birth to a son who tastes words. This suggests that heritability governs the predisposition for synesthetic cross-talk in a very general sense (see section [Neurological and Developmental Roots of Synesthesia](#)). Nonetheless, recent studies appear to suggest that certain variants of synesthesia may cluster together, at least within individuals (and so possibly also within families). This suggests, in turn, that synesthesia may not be a single heritable trait, but rather that it might be a grouping of several different cluster phenomena, each one underpinned by its own genetic

code. Very large-scale studies of synesthesia clustering, such as those being carried out by David Eagleman and colleagues via the online forum synesthete.org might hope to shed light on the subclasses and inheritance of synesthesia.

Neurological and Developmental Roots of Synesthesia

Synesthesia has a genetic mode of inheritance, and this inheritance is assumed to give rise to a predisposition for increased cortical communication. The roots of this communication may be functional or structural, in that the synesthete brain may have, respectively, extra connections that are not present in nonsynesthetes, or a disinhibition of the normal connections found in all people. One argument in favor of the latter is that certain hallucinogens such as lysergic acid diethylamide (LSD) can trigger a temporary state of synesthesia. The rapid onset of such experiences after consumption might appear to argue against a structural account of extra connections, simply because the time frame would not allow for the growth of new pathways (but might fit with the unmasking of existing ones). Nonetheless, the type of 'synesthesia' triggered by drug use is very different from developmental synesthesia in that it is temporary, inconsistent, and low-level (i.e., simple sensory crossings between sound and vision, for example, but not the complex, discrete experiences of grapheme-color synesthesia, etc.). This suggests, in turn, that mechanisms are likely to be different between developmental and acquired variants.

In contrast, there has been direct empirical evidence for structural differences in the brain of synesthetes. Neuroscientists Romke Rouw and Steven Scholte used diffusion tensor imaging (DTI) to examine the brains of grapheme-color synesthetes and controls. DTI provides an indication of the brain's white matter connectivity, by tracking the movement of water molecules (since this movement is more restricted in areas of high connectivity). Rouw and Scholte found that the brains of grapheme-color synesthetes contained greater structural connectivity in several areas, including regions close to V4, an area of the cortex known to be involved in color processing. The degree of this extra connectivity correlated with the strength of the synesthetic experience, since projector synesthetes (who experience strong synesthetic colors projected into space) had greater connectivity than associator synesthetes (who experience colors only in their mind's eye). This finding is consistent with studies using functional magnetic resonance imaging (fMRI), which indicates the degree of blood flow in the brain and demonstrates which brain regions are engaged during specific tasks. Neuroscientist Julia Nunn and her colleagues were the first to use fMRI to show that synesthetes' brains behave differently to controls when exposed to stimuli that can induce synesthesia. For example, various fMRI studies now show that area V4 is activated when synesthetes see graphemes or words. Studies show activation, too, in parietal areas, which may be involved as the synesthete brain 'binds' together the inducer and concurrent. Other studies have also suggested activation in frontal regions, although the role of such areas in synesthesia is, as yet, poorly understood.

If the gene mutation associated with synesthesia causes extra connectivity in the adult brain, how might this hyperconnected state develop? Daphne Maurer and colleagues have proposed the neonatal synesthesia hypothesis, suggesting that the adult

state of synesthesia bears a close resemblance to the infant state in all people. All humans are known to be born with excess connectivity, which is pruned over time by the normal process of cell death known as apoptosis. Maurer and colleagues suggested that synesthesia may represent a failure in this apoptosis, leading to a highly connected adult brain in synesthetes. However, their elegant theory remains, on the whole, untested in a neuroscientific sense, simply because neuroimaging techniques and testing environments have not yet allowed us to easily track the developing brains of child synesthetes. The question of synesthesia's development had also been underaddressed in behavioral work. The reasons for this are likely to stem from the difficulty in finding and recruiting child synesthetes. Some studies have achieved this by gathering self-referred samples via contacts with adult synesthetes whose children also have synesthesia. However, this approach may lead to biased samples, whose characteristics are not representative of child synesthetes as a whole. First, such children come from families with highly motivated parents (i.e., they are motivated enough to have contacted researchers) and from families where the synesthesia is known and so is likely discussed in family environments. It is likely that synesthesia may develop differently in such circumstances, being perhaps highly reinforced, or influenced by the experiences of other family members (e.g., young children may adapt their colored letters to resemble those of their parents, if these are discussed from an early age).

For all these reasons, my own lab initiated a research project 4 years ago, which aimed to find an 'untainted' sample of child synesthetes and to track their development over time. To this end, we individually tested over 600 children aged 6–7 years, to first identify the synesthetes among them, and then to track the real-time development of these synesthetes in comparison to the development of their nonsynesthete peers. Our longitudinal approach has allowed us to demonstrate, in a very real sense, that synesthesia 'grows' over time. Hence, although adult synesthesia is characterized by a fixed pattern of unchanging paired associations (e.g., if A is red for any given synesthete, it is always red) we were able to show that this systematicity is an acquired trait, with a protracted development. For example, the average child synesthete at the age of 6.5 years has only around 30% of fixed colors for the letters of the alphabet and digits 0–9. Twelve months later, at the age of 7.5 years, this has grown to around 55%. We have now returned to these children aged 10.5 years and seen, once again, a more stable system than was previously found. Perhaps the most remarkable finding for us was that grapheme-color synesthesia was present and visible (to the trained eye) in children as young as 6 years, who had only very recently begun recognizing the letters of the alphabet. This suggests to us that the predisposition for synesthetic mapping is very quickly 'called into action' whenever the necessary environmental stimuli are encountered.

Costs and Benefits of Synesthesia

Synesthetes often take pleasure in their synesthetic sensations, and many profit from them in artistic pursuits. It has been demonstrated that there is a significant tendency for synesthetes to spend time engaged in the creative arts, especially as these

relate to their synesthesia. For example, synesthetes who see colors from music are more likely than the average person to play a musical instrument. Synesthetes also score higher than nonsynesthetes in certain tests of creativity. For example, when people are asked to provide a missing link between word triplets such as elephant – lapse – vivid (answer: memory), synesthetes score significantly higher than the average person. Indeed, a growing body of evidence suggests that synesthesia may give superior abilities in a range of cognitive and perceptual tasks. Grapheme–color synesthetes, for example, have better skills in color awareness than the average person; they can better differentiate between subtle shades of color and can better recall test colors from memory when asked whether these colors were the same or different to colors seen previously. Some grapheme–color synesthetes (perhaps those with strong projector-type experiences) are able to detect hidden patterns in visual ‘pop-out’ studies: Ramachandran and Hubbard (2001) showed that their synesthete JS was able to detect a matrix of Hs forming a triangle shape, embedded in a background of distractor letters (Fs and Ps). This is a difficult task for nonsynesthetes because the black graphemes are perceptually similar and the triangle formed by the matrix of Hs is ‘lost’ in its background (see Figure 1). For synesthete JS, however, the Hs were seen as green, which made the triangle shape stand out among the distractor letters (which were yellow and red). Other variants of synesthesia, too, come with advantages. Sequence–space synesthetes who experience mental time lines are significantly better than the average person in dating events that took place in the past. In one study from our lab, a group

of these synesthetes were shown 120 world events of international news (e.g., the release of Nelson Mandela) and cultural significance (e.g., ‘The Godfather’ wins Oscar for best film) and were asked to write the date that each event occurred. The average person is around 8 years, on average, away from the correct date for each event, while synesthetes were only 4 years away. Synesthetes were also better than the average person when recalling events that had taken place within their own life. When asked to recall autobiographical facts from nine different years (e.g., 1984; 1997) the average person recalled on average 39 facts in 9 min, while the average synesthete recalled over 70 facts. Hence in both public and autobiographical memory recall, synesthetes outperform their peers.

It has been important to rule out motivational biases in any study where synesthetes perform exceptionally well. It has been suggested that as synesthetes are recruited as a special population, they may simply try harder. For this reason, studies claiming benefits for synesthetes also provide ‘control’ evidence that the same set of synesthetes also scores normally in tests where no exceptional abilities are predicted. For example, synesthetes with mental time lines might be expected to perform well on tests of event recall, but not, for instance, on tests of reading words. This is indeed the pattern of results found. Synesthetes might also be expected to perform well on visual imagery tests (given that their mental time lines are a form of mental imagery) and, as predicted, they do indeed perform well in this domain. Grapheme–color synesthetes have also shown enhanced visual imagery skills, as well as better memories when recalling lists of digits. The latter is likely because they are able to use their color associations to provide an aid to recall. For example, when recalling a list of digits, the synesthete might remember that the digits appeared in a sequence that was red, blue, green, yellow, etc., and be able to recall those digits on the basis of their color.

It is unclear whether this ability of grapheme–color synesthetes for enhanced digit recall extends to all grapheme–color synesthetes, or just to those who have learned to somehow profit from their sensations. Indeed, it has been suggested that an extreme ability to profit from synesthetic experiences may be at the root of the Savant syndrome. Savants are individuals with a developmental disorder (often autism spectrum disorder; ASD) who have a high ability in one area that sharply contrasts with their overall limitations. This ability is sometimes so refined that it would be considered phenomenal or genius even in a person without cognitive disabilities. Prodigious savants can recall, for example, sequences of more than 20 000 digits, or can remember exactly what they were doing in great detail on every day of their life extending back to early childhood. Research suggests that savantism may arise from the coincidental co-occurrence of synesthesia and ASD (or other neurodevelopmental disorders tied to obsessive traits). The synesthesia would give a predisposition for elevated memory recall, while the obsessive traits tied to ASD may create a compulsive drive to rehearse these skills. Over time, the savant ability would emerge. Evidence comes from the study of savants, many of whom do indeed have synesthesia and describe using their synesthesia to perform their phenomenal memory feats. For example, Daniel Tammet, a savant with phenomenal digit recall abilities, who has written an autobiography about his experiences, describes using his synesthesia

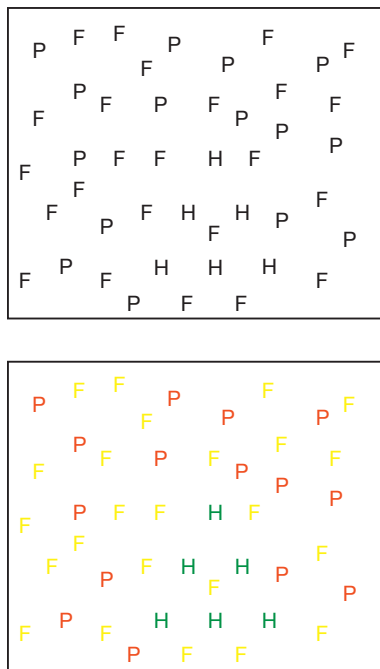


Figure 1 Top: A matrix of Hs forming a triangle shape embedded in a background of distractors (Ps and Fs). Controls find it difficult to identify the geometric shape. Synesthete JS is able to easily spot the triangle because for him Hs are seen as green, while background is red (P) and yellow (F). Below: The same matrix shown in the color associations of synesthete JS.

to create a 'number landscape.' Each digit has its own color, texture, and height, and these digits combine to create a visual landscape that can be mentally navigated when he recalls astonishingly long strings of digits.

Synesthesia, then, clearly provides the opportunity for cognitive and creative benefit; the extent to which it can be exploited differs from individual to individual. However, synesthesia is a multivariant condition, and in some cases, can present certain obstacles to the synesthete, as well as benefits. Indeed, synesthesia has a complex profile of benefits and costs, which manifest differently depending on the particular variant. For example, despite the assets described above for sequence-space synesthetes with time lines, those with number lines are slightly slower than the average person when performing certain types of mental calculation. It is known that subtraction and addition rely to some extent on spatial memory, while multiplication relies more heavily on verbal recall. Sequence-space synesthetes may over-rely on spatial memory, and so are slightly slower than the average person on multiplication tasks, but show no difference in addition or subtraction.

As another potential cost, lexical-gustatory synesthetes (who experience tastes from words) report significant problems maintaining attention when performing day-to-day tasks such as reading and speaking. This can pose problems in the workplace and in social environments, and indeed, in any place where words are exchanged. This is because every word uttered can trigger an overwhelming sensation of flavor that floods the mouth. Some of these tastes are pleasant (e.g., chocolate) but can arrive in such intensity that they distract attention. Other tastes are inherently unpleasant (e.g., mucous, earwax) and can make conversation an extremely challenging task. Other synesthetes show different types of difficulties. Grapheme-color synesthetes exhibit poor memory for letters and numbers presented in colors that conflict with their synesthetic sensations. For example, when asked to recall the numbers 5, 8, 2, and 6 presented in red, purple, orange, and green ink, respectively, a synesthete may show poorer abilities than the average person if their own synesthetic colors are, (for example) yellow, white, blue, and pink. This conflict between real-world colors and synesthetic colors not only impairs memory but can also cause a sense of malaise. Synesthetes report discomfort when viewing colored letters and numbers that clash with their own synesthetic sensations and this fact might have important implications on the ways in which synesthete children are taught at school. Many classrooms have colored alphabet charts, and some literacy systems are based on the careful pairing of colors with letters. For children with synesthesia, this approach could pose a significant challenge to learning.

Concluding Remarks

After falling into relative obscurity during the mid-twentieth century, synesthesia research has emerged again as a vibrant field of study, and psychological, biological, and neuroscientific investigations over the last 20 years have shed light on the roots of this unusual condition. Imaging studies have shown how the brain functions when experiencing synesthetic sensations, and how these sensations arise from the very structure of the synesthetic brain. Genetics studies have traced its roots in

the human genome, and familial inheritance studies have mapped its transmission through families. Cognitive psychological studies have uncovered a rich world of complex 'rules' governing the types of experiences generated by synesthesia, and developmental studies have been able to track the emergence of synesthesia in real time. Synesthesia is a condition of unique interest to a broad range of scholars, from neuroscientists, psychologists, philosophers, linguists, etc., to anyone wishing to understand the relationship between inner experience and the outside world. The experiential 'reality' of synesthetic tastes, textures, colors, odors, flavors, shapes, and other sensations experienced by synesthetes allows us to see, in a very direct way, that our understanding of the outside world is greatly reliant on internal mental processes, and can be idiosyncratically constructed. Moreover, synesthesia's blending of sensory experiences with cognitive constructs has forced a redefinition beyond a simple 'merging of the senses,' and has allowed us to better recognize the interplay between perceptual and nonperceptual systems.

See also: Agnosia (including Prosopagnosia and Anosognosia); Asperger's Syndrome and Nonverbal Learning Disorder; Autism and Pervasive Developmental Disorders; Autobiographical Remembering and the Self; Hallucinations; Mental Imagery; Neurotechnologies; Savant Syndrome; Sense of Taste (Effect on Behavior); Spatial Perception; Visual Perception.

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Relevant Websites

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- <http://doctorhugo.org/synesthesia/index.htm> – Belgian Synesthesia Association.
- <http://synaesthesia.org/1news/Aktuelles> – German Synesthesia Association.
- <http://synesthesia.com.au> – International Synesthesia Association Australian Branch.
- <http://synesthete.org/> – Online tests for synesthetes: Baylor Medical School.
- <http://syn.ed.ac.uk> – Online tests for synesthetes: Edinburgh University Synaesthesia & Sensory Integration Lab.
- <http://syn6th.com> – Resource site for Chinese-speaking synesthetes.
- <http://synesthetie.nl/> – Synesthesia in the Netherlands.
- <http://uksynesthesia.com> – UK Synesthesia Association.

Glossary

Ambiguity The property of having more than one meaning.

Anaphor A linguistic expression entirely dependent on another linguistic expression for its interpretation: for example, *himself* in 'John injured himself' is dependent upon *John*.

Argument Semantically contentful expression in an argument position.

Argument position Subject position, direct object position, indirect object position, etc. in a sentence.

Embedding The process of inserting one phrase or sentence inside another.

Grammar A theory of a language.

Language A computational system enumerating, for each of an infinite set of expressions, a full array of phonetic, semantic, and structural properties.

Parameter A two (or more) valued choice determining a general property distinguishing one type of human language from another.

Principle A property common to all human languages.

Syntax is concerned with the structural properties of languages. The term 'syntax' is used ambiguously to refer to both the structural properties and the branch of the field of linguistics concerned with investigating them. Included in this topic are the regularities governing word order as well as the grouping of words into larger units relevant to semantic and phonological interpretation. How these regularities are represented in the mind of the speaker, how they arise in the mind of the speaker, and how they are put to use in the production and comprehension of sentences are the psychological aspects of these issues.

Phrase Structure

A person who knows a language knows a huge number of words, including properties relevant to their pronunciation and semantic interpretation. In addition to this 'lexicon,' he or she has command of a productive system for the appropriate arrangement of words into sentences, the syntax of the language. Given the fact that brand new sentences are routinely used and understood, it could not be true that the syntax of a language consisted merely of a list of sentences which are memorized in the course of language acquisition. Rather, a set of processes, syntactic rules, must be involved in this creative use of language.

The computational system including these syntactic rules determines mental representations expressing not only the sequencing of words, but also their grouping into hierarchical structural units intermediate between word and sentence. Even a simple sentence such as (1) is not just a sequence of three autonomous words:

(1) The man left

The and *man* are closely associated in a way in which *man* and *left* are not. The former pair of words constitutes a unit based on the noun *man*. We can see this in a number of ways. First, that sequence can be substituted for by a 'pro-form,' in this case a pronoun:

(2) He left

No comparable substitution is possible for the sequence *man left* in example (1). Further, an adverb modifying the sentence can be inserted between *man* and *left*, as in (3), but not between *the* and *man*, as in (4):

(3) The man obviously left

(4) *The obviously man left (* indicates an ungrammatical sentence, a sequence of words that is not a sentence of the language under investigation)

This same structural grouping is evidenced in the phonology. A longer pause is possible between *man* and *left* than between *the* and *man*, again indicating that the sequence *the man* constitutes a unit while the sequence *man left* does not. There is a division of sentence (1) into two major parts, or 'constituents.' The first constituent, based on a noun, is called a 'noun phrase' (NP). The second constituent, based on a verb, is called a 'verb phrase' (VP). A typical English sentence like (1) consists of an NP followed by a VP, roughly corresponding to the traditional division of a sentence into subject and predicate. (5), a 'phrase structure (PS) rule,' is a shorthand way of stating this property of English sentences in a 'top-down' fashion:

(5) S[entence] → NP VP

A simple NP, in turn, consists of a noun (N) preceded by a 'determiner' (*the*, *a*, etc.) or not ('John left'), and a VP consists of just a verb (V), among many other possibilities:

(6) a NP → (Det) N (parentheses indicate an item that may or may not be present)

b VP → V

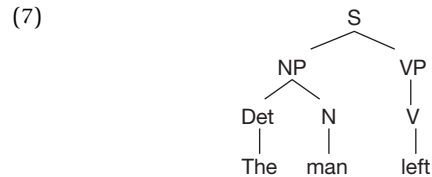
c V → left, etc.

d N → man, etc.

e Det → the, etc.

These can be thought of as part of the system of implicit knowledge underlying the procedures for the analysis and for the production of sentences. (This knowledge can also be characterized in a 'bottom-up' fashion taking lexical items as input, with, e.g., a determiner and noun merging to form an

NP, this NP merging with a V to form a VP, and so on. This ultimately eliminates PS rules, as in much current work in syntax.) The structure that the rules in (5) and (6) determine for sentence (1) can be represented by the 'phrase structure tree' in (7):



Such a diagram represents the linear and hierarchical properties of the sentence. Two standard relations defined on such structures are 'precedence' and 'dominance.' In (7), NP precedes VP, V, and *left*, but does not precede Det, *the*, N, S, etc. NP dominates Det, N, *the*, and *man*, but does not dominate VP, V, S, etc. Another way of representing precisely the same information is the 'labeled bracketing' in (8):

(8) [_S [_{NP} [_{Det} The][_N man]] [_{VP} [_V left]]]

Phrase structure trees and labeled bracketing representations are both widely used in the syntax literature. A structural representation (in either format) is called a 'phrase marker.'

In addition to very simple VPs containing only a verb and nothing else, there are also VPs that contain NPs, as in (9):

(9) The man saw the woman

(10) allows for this additional possibility of a 'direct object' for the verb:

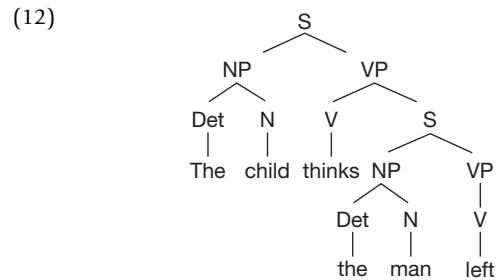
(10) $VP \rightarrow V(NP)$

As in (6a), the parentheses are to be understood as allowing, but not demanding that the enclosed material occur in a structure. Taken together, (5) and (10) correctly assert that just the same kinds of sequences of words that can be subjects of sentences can be objects of sentences because it is the constituent NP that occurs in either position.

Constituent structure analysis provides part of an account of the creative use of language. There is no limit to how long a sentence of English (or any other human language) can be. Thus, given a sentence of any length, a speaker can always create a longer, novel one. Infinitude and structure are two 'principles,' properties common to all human languages. One of the major ways in which ever longer sentences can be constructed is by 'embedding' one sentence inside another. We have already seen a VP consisting of just a V and also one consisting of a V followed by an NP. In addition to these possibilities, the material following the V can be an entire sentence:

(11) The child thinks [_S the man left]

In (11), the 'direct object' of the verb is not an NP but rather is our original sentence, (1). The structure of (11) is represented in (12):



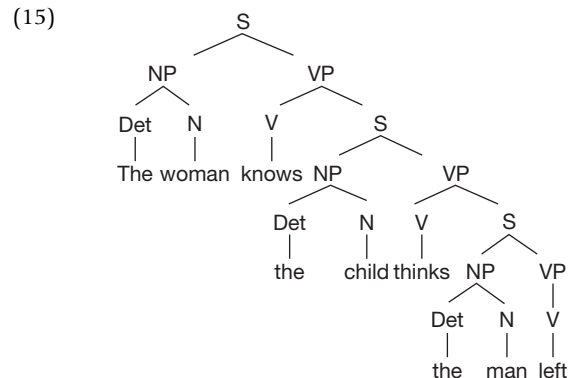
An additional VP rule of the standard sort allows for this possibility:

(13) $VP \rightarrow V S$

Now the structure in (12) can be produced by application of rule (5) followed by, among other things, application of rule (13), followed by another application of rule (5). Then, the usual rules for NP and VP can apply. This process can be continued indefinitely, with rule (13) introducing an S which, by rule (5), introduces (in addition to another NP) another VP, and so on. Systems of phrase structure with this property are called 'recursive.' It is important to note that with the addition of the simplest possible rule for generating structure (12), namely rule (13), the system of rules (the 'grammar') becomes recursive. Thus, with just the rules we already have, (12) can be further embedded to produce a still more complex sentence such as (14).

(14) The woman knows the child thinks the man left

The structure of (14) is as in (15):



Recursion thus provides finite means for generating an unlimited number of sentences. Given the interpretation of syntactic rules as pieces of a speaker's knowledge, this is crucial, in light of the finite character of the human brain.

The VP structures considered so far all contain a V. Similarly, the NP structures contain an N. The hypothesis that this is true more generally – that XP always contains X, for any choice of X (both for all structures of English and cross-linguistically) – is one of a complementary pair of fundamental tenets of what is called 'X-bar theory.' The name derives from a particular notation used for phrase structure rules, as in (16), where the lexical category symbol has a bar over it to represent a structure intermediate between lexical item and phrase:

- (16) a $\bar{X} \rightarrow \dots X \dots$
 b $XP \rightarrow \dots \bar{X} \dots$

By (16), XP always ultimately introduces X into a structure. The complementary claim is that whenever XP is present in a structure, it must be by virtue of (16). XP must have as its 'head' X, and X must 'project' the phrasal category XP. The merge operation briefly discussed above embodies the notion of projection. (In what follows, I will generally abstract from \bar{X} structural details.)

The Lexicon

As noted earlier, VPs occur in a variety of forms (though all of them contain V). We have observed VPs containing just a V, ones containing a V and an NP, and finally, ones containing a V and an S. Examples (17)–(19), repeated from above, illustrate these three respective types of VP.

- (17) The man left
 (18) The man solved the problem
 (19) The child thinks the man left

Left unexpressed so far, however, is the fact that not just any verb can appear in any of these VP types. For example, the verb in (18) would be ungrammatical in the VP of (17):

- (20) *The man solved

Similarly, the verb in (19) is incompatible with the VP in (18):

- (21) *The child thinks the problem

Lexical properties, that is, properties of particular lexical items (words), thus play a major role in determining syntactic well-formedness. In traditional terms, there are transitive verbs, such as *solve*, which require a direct object. Alongside these are intransitive verbs, such as *sleep*, which do not tolerate a direct object:

- (22) *Harry slept the bed

Further, among the transitive verbs, there are those like *solve* which take an NP, but not an S, for a direct object:

- (23) *Mary solved Bill left

And, as just noted, there are those like *think*, which take an S, but not an NP, as direct object. The large lexical category V is thus divided into smaller lexical 'subcategories,' each with its own special privileges of occurrence. The properties of the subcategories are expressed in 'subcategorization frames' such as the following:

- (24) a $\text{sleep} \langle __\rangle$
 b $\text{solve} \langle __\text{NP} \rangle$
 c $\text{think} \langle __\text{S} \rangle$

The categories that appear in the subcategorization frame of a particular verb are called 'complements' of that verb. (24a) is to be interpreted as the requirement that *sleep* can occur only in a \bar{V} that has no complements for the head V, that is, one like (25).

- (25)
$$\begin{array}{c} \bar{V} \\ | \\ V \end{array}$$

A verb with the subcategorization frame in (24b) can only occur in such a \bar{V} as (26).

- (26)
$$\begin{array}{cc} & \bar{V} \\ & / \quad \backslash \\ V & \quad \text{NP} \end{array}$$

And so on. These syntactic properties of verbs follow, in large measure, from their semantic properties. Thus, in a sentence with *solve*, the verb has a semantic function for a direct object to fulfill, while there is no such function in the case of *sleep*. These semantic functions that arguments (direct objects, subjects, indirect objects, etc.) fulfill are called 'thematic (θ -)roles' and are assigned by a predicate to its arguments. It is thus plausible that what is wrong with (20) is that a necessary semantic function has not been fulfilled – a θ -role associated with the verb *solve* has not been assigned. Conversely, the violation in (22) is that there is an argument NP, *the bed*, with no θ -role at all because *sleep* has no θ -role to assign to an object, just one to assign to a subject. These paired requirements on assigners and recipients of theta roles are called the ' θ -Criterion': Every θ -role must be assigned, and every argument must receive a θ -role.

Example (27) illustrates several additional subcategories of verbs. The corresponding subcategorization frames are given in (28):

- (27) a Susan put the book on the desk
 b Oscar convinced Harriet that she was brilliant
 c Richard envies Marie her intelligence
 d Stephen looked at the picture

- (28) a $\text{put} \langle __\text{NP PP} \rangle$
 b $\text{convince} \langle __\text{NP S} \rangle$
 c $\text{envy} \langle __\text{NP NP} \rangle$
 d $\text{look} \langle __\text{PP} \rangle$

As expected, given the \bar{X} schema for phrase structure, other lexical heads besides verbs can also take complements. For example, there often occur pairs of verbs and nouns with similar structure, meaning, and subcategorization, as in the following:

- (29) a John believes that Mary saw Fred
 b John's belief that Mary saw Fred

- (30) a Marion lectured about semantics
 b Marion's lecture about semantics

The nouns in the (b) examples are known as 'derived' or 'deverbal' nominals.

In all of the examples in (24) and (28), the head precedes its complement(s). In fact, that is more generally true in English: heads invariably precede their complements in basic 'unmarked' word order; verbs precede their objects, as do prepositions, etc. This property should thus be factored out of particular lexical entries because a lexical entry contains only what is idiosyncratic about individual lexical

items. However, the property does not hold of all languages. Japanese, for example, is just the reverse of English in this regard: heads invariably *follow* their complements; verbs follow their objects, there are postpositions instead of prepositions, etc. Simple, general differences of this type between languages are called 'parameters.' This particular parameter is known as the 'head parameter,' and it is assumed to be two-valued: a language is head-initial (English) or head-final (Japanese). Learning this structural property of a language involves setting the value of the parameter, on the basis of simple input data.

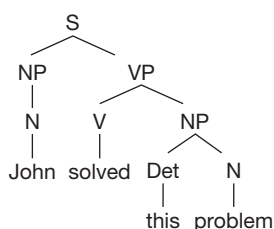
Syntactic Transformations

The phrase structure rules (arguably reduced to the \bar{X} template plus a specification of a value for the head parameter) along with the lexicon constitute the 'base component' of the syntax. The base component determines the structural representations of an unlimited number of sentences. However, there are sentence types requiring further machinery for an adequate characterization:

- (31) a Which problem did John solve
b This problem, John solved (... but not that one)

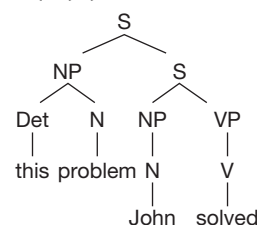
Solve belongs to the subcategory of verbs that can occur only in VPs of the form (26) because they have an object θ -role that they must assign. Yet the examples in (31), which both apparently violate this requirement, are grammatical. The key is that in these examples, although *this problem*, or *which problem*, is at the front of the sentence, it functions as the object of *solve* just as if it were in the VP. Considerations of this sort lead to the hypothesis that sentences have not just one structural representation, but (at least) two. For the examples in (31), the PF (Phonetic Form) representation, the more 'superficial' one, determines the pronunciation of the sentence. Another more 'abstract' representation determines the thematic relations of the sentence, and is thus responsible for the satisfaction of subcategorization requirements. In this more abstract representation, the so-called 'D (eep)-structure' of the sentence, the understood direct object will actually be in direct object position in the VP. In the more superficial representation, the so-called 'S(urface)-structure,' the direct object NP is displaced leftwards from the position that determines its θ -role. The D-structure of (31b) is then (32):

- (32) (D-structure of (31b))



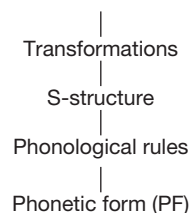
Structure (32) accounts for the major θ -relations of (31b), and is consistent with all of the principles and lexical requirements considered so far. It does not, however, account for the structure of the sentence as it is immediately perceived. Rather, the S-structure, in which the direct object has been displaced to the front of the sentence, as in (33), has that function:

- (33) (S-structure of (31b))



A displacement operation of this sort, relating one phrase marker to another, is known as a syntactic 'transformation' (hence, the name 'transformational grammar' for this general approach to syntax). The set of transformations in a given language constitutes the 'transformational component' of the grammar. Schematically, the grammar has the following organization (to be slightly revised below):

- (34) Lexicon – D-structure – Determination of θ -relations



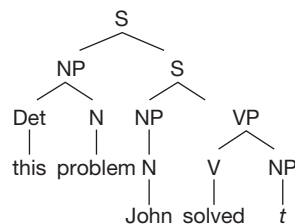
The transformation which relates (32–33) is standardly called 'Topicalization.' (The transformations responsible for (31a) include 'WH-movement'.) The mode of attachment of the fronted NP to the S in (33) is 'adjunction,' a transformational process attaching a moved item (in this case, an NP) to a target category (in this case an S) by creating a 'higher' instance of the target category from which both the moved item and the original target category hang. Example (33) displays left adjunction (i.e., attachment on the left) of NP to S. The structural representation in (33) captures one striking phonological property of sentence (31b): there is a major pause between the fronted NP and the remainder of the sentence, corresponding to the major constituent break created between that NP and the residual S.

Trace Theory

A potential question concerning the position from which movement takes place arises. (33) indicates that that position is totally eliminated by the operation of the transformation, but work begun in the 1970s indicates that a marker of

the previous occupant remains, in the form of a 'trace.' Example (35) represents this second possibility (which is known as 'trace theory'), with *t* a silent trace of the moved NP, *this problem*:

(35) (S-structure of (31b) with a trace)



The arguments for traces are based, among other things, on properties of a particular contraction phenomenon in English and on the patterns of subject-verb agreement, whereby the form of a verb depends on the properties of the subject of that verb ('He *comes*' but 'They *come*'). Three facts are relevant background for the former argument. First, the Topicalization transformation is not limited to direct objects of simple sentences. The displaced item can come from an embedded sentence, as in (36), where the topicalized NP is the direct object of the lower verb, or (37) where it is the subject of the lower verb.

- (36) This problem [_S Mary thinks [_S John solved *t*]]
 (37) This student [_S Mary thinks [_S *t* solved this problem]]

Second, an embedded sentence need not be 'finite,' with a verb in the past tense (like *solved*), or the present tense (like *thinks*). An embedded sentence can also be 'infinitival,' as in (38):

- (38) You want [_S this student to solve this problem]

Third, colloquial English has a contraction process by which *want* and *to* become *wanna* when they are immediately adjacent:

- (39) a You want to solve this problem
 b You wanna solve this problem

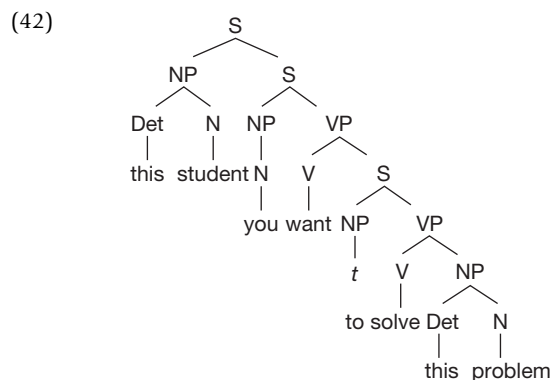
That this process demands adjacency between *want* and *to* is shown by the impossibility of (40), based on (38):

- (40) *You wanna this student solve this problem

The relevant (and surprising) property of *wanna* contraction is that even if *this student* in (38) is displaced by Topicalization, contraction is still blocked:

- (41) a This student, you want to solve this problem
 b *This student, you wanna solve this problem

Though there does not seem to be anything intervening between *want* and *to* in (41a), hence, nothing to prevent contraction, under trace theory, there is, in fact, something intervening – the trace of the moved NP, *this student*. (42) represents this hypothesis:



The same array of facts obtains with WH-movement:

- (43) Which student do you want to solve this problem?
 (44) *Which student do you wanna solve this problem?

Again, the trace of the moved phrase blocks the adjacency needed for contraction. Even though they are silent, traces are evidently real, as far as the syntax and/or phonology are concerned. One question remains, though. The θ -Criterion requires that even in (39b), where contraction succeeds, the lower clause must have a subject. Somehow, the trace is visible to the contraction process, but the silent subject in (39b) (standardly called PRO) is not. One traditional account posited that in the latter instance, the subject is simply deleted and therefore completely removed from the representation.

Properties of subject-verb agreement provide a second source of evidence for traces. Generally, such agreement is a strictly local process, relating elements within the same S, for example, *they* with *think*, and *he* with *likes* in (45):

- (45) *They think* [_S *he likes* psychology]

Agreement with a more distant NP is impossible:

- (46) **They think* [_S *he like* psychology]

However, when Topicalization or WH-movement has taken place from the subject position of an embedded finite sentence, apparent long distance agreement obtains:

- (47) *This student*, they think [_S *likes*/*like it]
 (48) *Which student* do they think [_S *likes*/*like it]

This dependency between a moved NP and a distant verb can be reduced to standard local agreement on the assumption that movement leaves a trace, and that the trace of a moved NP has the same agreement features (for person and number) as the moved NP. This is illustrated in (49):

- (49) *Which student* do they think [_S *t likes*/*like it]
 3rd person 3rd person
 singular singular

Constraints on Transformations

As just seen, the Topicalization transformation can move an NP to the front of its own sentence as in (31b), and can also move an NP out of its own sentence to the front of the next

'higher' sentence as in (36), (37), (41a). In fact, an NP can move still farther, as in (50):

- (50) This problem, Mary thinks John said Susan solved *t*

Similarly for WH-movement:

- (51) Which problem does Mary think John said Susan solved *t*?

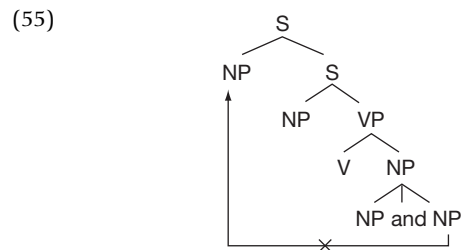
In fact, movement can be indefinitely far. However, there are certain 'locality' constraints on the operation of these transformations. Consider sentence (52):

- (52) I like this magazine and that book

In this example, the object NP is a 'coordinate structure' consisting of two NPs joined by the coordinating conjunction *and*. But while (53) is a good instance of Topicalization, (54) is entirely ungrammatical:

- (53) This magazine and that book, I like
(54) *That book, I like this magazine and

As (54) illustrates, extraction out of a coordinate structure is prohibited. This is schematized in (55):



(56) is another illustration of the general prohibition:

- (56) *This magazine [_S I think [_S [that book and *t*] impressed Fred]]

Examples (54) and (56) raise in a very clear manner the general question of acquisition of complex knowledge, particularly knowledge of the negative sort. It is not plausible that the child learning English is presented with evidence for the constraint (e.g., via correction). Thus, it is reasonable to conjecture that the relevant bit of linguistic knowledge is innate. If that conjecture is correct, we should expect the constraint not to be particular to English, since, as is well known, any normal human child can learn any human language. Hence, we should expect the constraint to show up in human languages in general. This expectation is confirmed. Of the hundreds of languages that have been investigated, no clear instances have emerged of languages that permit extraction out of a coordinate structure.

Coordinate structures fall into the class of 'islands' (or, as they are sometimes called, 'barriers'), structural configurations blocking extraction. 'Complex NPs,' such as the noun complement constructions of the type seen in (29b) above, also constitute islands, as evidenced by the following contrast:

- (57) Which problem did you announce [_β that John believed [that Mary solved *t*]]
(58) *Which problem did you announce [_β John's belief [that Mary solved *t*]]

When β is a sentence containing another sentence, extraction from the more embedded S is possible (57). But when β is an NP containing an S, such extraction is not allowed (58), a typical island effect. There have been a number of attempts to reduce the entire class of island constraints to one general locality condition on movement known as 'Subjacency.' The term is a 'portmanteau word' combining 'subordinate' and 'adjacency.' Subjacency stipulates that a step of movement can cross at most one 'bounding node' or 'barrier'; from a subordinate domain to the immediately adjacent superordinate one. (Apparent, unbounded movement is then compounded of a series of short movements.) If Subjacency and other general constraints on the operation and output of transformations are factored out of particular transformations, the statements of these particular transformations are correspondingly simplified. In fact, it has been argued that the transformational component can be reduced to one maximally simple, general transformation, 'Move α ' (Move anything anywhere), with all ungrammatical derivations 'filtered out' by such constraints.

Case Theory

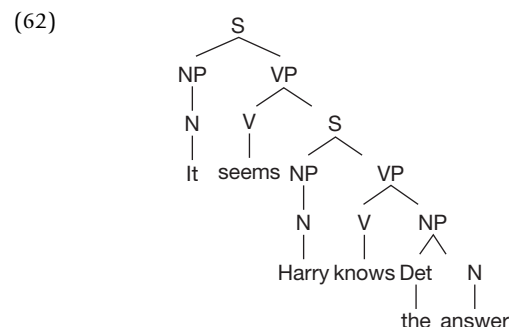
WH-movement and Topicalization both have the effect of moving a constituent to a 'non-A(argument) position' to the left of the subject of an S. There are other movement operations that move a constituent into the subject position, an 'A-position.' Consider the following pair of sentences:

- (59) It seems Harry knows the answer
(60) Harry seems to know the answer

Harry in (60) is in subject position at S-structure, as evidenced by the agreement pattern on the verb: 3rd person singular in (60), but 3rd person plural in (61):

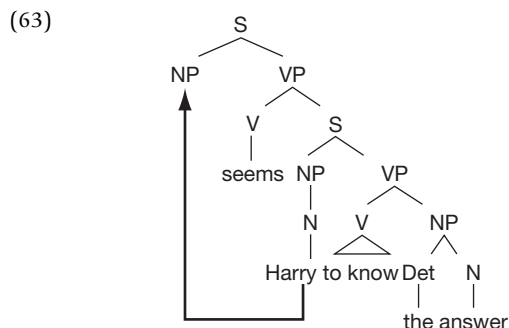
- (61) Harry and Bill seem to know the answer

However, given the close semantic parallelism between (59) and (60), especially with respect to θ -relations, their D-structures are assumed to be similar. In particular because *Harry* is the understood subject of *know the answer* in both examples, it must be in the subject position of that predicate in the D-structures of both examples. The D-structure of (59) is identical to the S-structure in relevant respects:



In (62), the subject of the main sentence *it* is not an argument, but rather, an 'expletive,' a place-holder lacking semantic import (unlike the referential *it* in 'It is on the table.'). The

D-structure of (60) is similar, the only differences being that the main subject position is empty, and the embedded sentence is an infinitive:



To derive the correct S-structure, the NP *Harry* raises into the empty higher subject position, as indicated by the arrow in (63). The movement is obligatory in this instance. If *Harry* remains in the lower subject position, the result is ungrammatical, whether or not the expletive *it* occurs as the higher subject:

- (64) *Seems Harry to know the answer
 (65) *It seems Harry to know the answer

This obligatoriness of the movement of the subject has been analyzed as a requirement of abstract 'case.' There are characteristic structural positions that 'license' particular cases, as in the following table:

(66)

Position	Case	Example
Subject of finite sentence	Nominative	<i>He</i> left
Direct object of transitive verb	Accusative	I saw <i>him</i>
'Subject' of NP	Genitive	<i>His</i> belief that Mary solved the problem
Complement of preposition	'Oblique' (in English, indistinguishable from accusative)	near <i>him</i>

In many languages (such as Latin, Russian, German), these case distinctions are overtly manifested as a morphological affix that is attached to the stem of the noun. In English, only pronouns show an overt distinction between nominative and accusative, but Case theory posits that all NPs have abstract case (henceforth, Case), even when it is not phonologically visible. The requirement that all NPs occur in appropriate Case positions is called the 'Case Filter.' The Case Filter is a well-formedness condition on the S-structure level of representation. The NP *Harry* in its D-structure position in (63) lacks a legitimate Case because that position does not license nominative, accusative, genitive, or oblique Case. Movement of *Harry* to the higher subject position salvages the example because that position licenses nominative Case. Such 'Subject raising' is not possible for structure (62), where the embedded sentence is finite:

- (67) *Harry seems [*t* knows the answer]

This, too, has been analyzed in terms of Case: movement of an NP from one Case position to another is prohibited. Metaphorically speaking, movement to a Case position is a 'last resort,' an option taken only if necessitated by the Case Filter.

Case theory has also been used to explain some of the properties of 'passive' sentences, such as (68):

- (68) This problem was solved

The S-structure subject, *this problem* bears the object θ -role assigned by the verb *solve*. Hence, by hypothesis, it must have originated in the object position in D-structure. But as in (63)–(65), movement is obligatory when the verb is in the passive form:

- (69) *Was solved this problem
 (70) *It was solved this problem

Passive verbs apparently lose the ability of the corresponding active verbs to license accusative Case. It has occasionally been suggested that this relates to the fact that passive verbs are not fully verb-like in that they share some properties with adjectives (cf. 'the solved problem'). The morphological process creating a passive verb from an active one neutralizes its verbal properties.

Adjectives, like passive verbs, lack the ability to license Case on an object, as seen in the contrast between the VP in (71) and the corresponding Adjective Phrase (AP) in (72):

- (71) I [_{VP} suspect Harry]
 (72) *I am [_{AP} suspicious Harry]

For (72), another saving strategy is available: a semantically null preposition is inserted to license Case on *Harry*.

- (73) I am suspicious of Harry

Passive verbs differ from adjectives in this respect. The *of*-insertion strategy is not available for the former:

- (74) *It was solved of the problem

Passive verbs are neither fully verbs nor fully adjectives.

Nouns pattern with adjectives with respect to the phenomena just outlined. First, they do not license Case on their objects:

- (75) Susan [_{VP} proved the theorem]
 (76) * [_{NP} Susan's proof the theorem]

Second, the strategy of inserting a semantically null preposition is available. (76), like (72), is salvaged by *of*-insertion:

- (77) Susan's proof of the theorem

Additionally, though, when the subject position of the NP is not already occupied, movement into that position is often available for the object of the head N, a process reminiscent of that seen in passive sentences such as (68) above:

- (78) The theorem's proof
 (derived from [_{NP} — proof [_{NP} the theorem]])

Of the four major lexical categories V, N, A, and P, V and P pattern together (as opposed to N and A) with respect to

licensing Case on an object, while N and A pattern together in triggering *of*-insertion. The lexical categories can be analyzed as bundles of values for binary (two-way) ‘distinctive features’ in such a way as to capture these various properties:

- (79) V [+v, -n]
 N [-v, +n]
 A [+v, +n]
 P [-v, -n]

The ‘Case-licensing’ lexical categories are those specified $-n$. The triggers for *of*-insertion are those specified $+n$. As passivized verbs neither license Case nor trigger *of*-insertion, the formal representation of their ‘neutralized’ status is as a $+v$ category with no specification at all for n :

- (80) Passivized verb [+v]

Logical Form

There are languages, such as Chinese and Japanese, in which interrogative WH-words are not fronted, as they are in English, but remain *in situ* in their D-structure positions. The Chinese sentence (81) contrasts with its English translation in this way:

- (81) [ni renwei [ta weishenme meiyou lai]]
 you think he why not come
 (82) Why do you think [he didn’t come *t*]

Even though *weishenme* in (81) seems not to have moved, the interpretation of (81) is as if *weishenme* had moved, that is, as a direct question about the reason for not coming. Further, the locality effects discussed earlier also seem operational for WHs *in situ* under certain circumstances. For example, when *weishenme* is inside a complex NP, it cannot be interpreted outside of that island, precisely mirroring the island effect on WH-movement:

- (83) *ni xiaangxin [_{NP} [_S Lisi weishenme lai] de shuofa]
 you believe Lisi why come claim
 (84) *Why do you believe [_{NP} the claim [_S that Lisi came *t*]]

(The relevant (and unavailable) construal here concerns the reason for Lisi’s coming. There is no other construal possible either, as neither the noun *claim* nor the verb *believe* takes an embedded question.)

This suggests that (81) and (83), like (82) and (84) respectively, do involve movement, though a kind of movement that has no effects on the phonetic form of the utterances. Given the organization of the grammar in (34), that kind of movement is not possible. But a modification introducing the component of logical form (LF) allows for the possibility of ‘abstract’ movement that does not feed into PF:

- (85) Lexicon — D-structure — Determination of θ -relations
 |
 Transformations
 |
 S-structure
 / \
 PF component LF component
 | |
 Phonological rules Transformations
 | |
 Phonetic form (PF) Logical form (LF)

PF and LF specify aspects of sound and meaning, respectively, insofar as they are linguistically determined. (Even θ -relations can be ‘read off’ LF, if movement processes leave behind traces.) Transformations do or do not have phonetically overt consequences depending on whether they operate between D-structure and S-structure (as in the English WH-movement examples above) or between S-structure and LF (as in the Chinese examples). Language variation of this kind can be stated as a parameter. This parameter distinguishes the languages at the level of S-structure, but at the LF level of representation, in both types of language the interrogative word will be in the position where its semantic scope is determined. The scope of an interrogative ‘operator’ can be an entire utterance, as in the examples considered so far, or it can be just an embedded sentence, as in (86):

- (86) John wonders [what Bill bought]

(86) is not a direct question, but it contains within it an embedded or indirect question. The scope of *what* in this instance is the embedded sentence. In a language without overt WH-movement, the same scope effects arise. In (87), *shenme* (‘what’) is *in situ*, but its scope is the embedded sentence:

- (87) Zhangsan xiang-zhidao [Lisi mai-le shenme]
 Zhangsan wonder Lisi buy what
 Zhangsan wonders [what Lisi bought]
 (Zhangsan wonders for which *x*, *x* a thing, Lisi bought *x*)

LF is the level of representation where this semantic parallelism is expressed.

The semantic notion ‘in the scope of’ thus has structural instantiation at the level of LF. This structural instantiation is characterized in terms of the relation ‘c(onstituent)-command’ defined in (88):

- (88) A category α *c-commands* a category β if and only if β is a sister of α or is dominated by a sister of α .

In (89), A *c-commands* B, C, and D; B *c-commands* A; C *c-commands* D; and D *c-commands* C. No other *c-command* relations hold.

- (89)
-
- ```

graph TD
 S --> A
 S --> B
 B --> C
 B --> D

```

A fronted WH-phrase *c-commands* the clause that it takes as its scope. Similarly, it has been argued that the scope of a quantifier is determined by an LF operation called quantifier raising (QR), which adjoins a quantificational expression to S, leaving behind a trace. The S-structure of (90) is mapped onto an LF like (91):

- (90) John likes everyone  
       (91) [<sub>S</sub> [everyone]] [<sub>S</sub> John likes *t*]

The interpretation of (91) is then straightforward:

- (92) For all *x*, *x* a person, John likes *x*.

‘Scope ambiguities,’ such as that in (93), receive a simple characterization in these terms.

- (93) Every student solved one problem



The relative heights of the raised quantifiers at LF determine the particular quantificational meaning that is assigned to the sentence. (94) represents the reading where every student solved some problem or other, and (95) the reading where there is a particular problem that every student solved. (Identical integer subscripts are assigned to a moved item and its trace.)

- (94) [<sub>S</sub> [every student]<sub>1</sub> [<sub>S</sub> [one problem]<sub>2</sub> [<sub>S</sub> *t*<sub>1</sub> solved *t*<sub>2</sub>]]]  
 (95) [<sub>S</sub> [one problem]<sub>2</sub> [<sub>S</sub> [every student]<sub>1</sub> [<sub>S</sub> *t*<sub>1</sub> solved *t*<sub>2</sub>]]]

Another ambiguity phenomenon that falls in the domain of syntax is a 'structural ambiguity.' Human languages are filled with ambiguity. Some instances of ambiguity are scopal, as seen above. Others are lexical, involving two different words that happen to be pronounced and/or spelled alike. An example is

- (96) Meet me at the bank

where I could intend that we gather after depositing our paychecks or that we get together to go fishing. But many other instances of ambiguity do not depend on homonymous words. Each of the following examples appears to be two different sentences in one, even though the words of each have constant meaning.

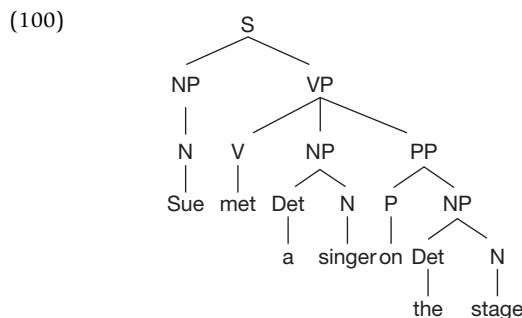
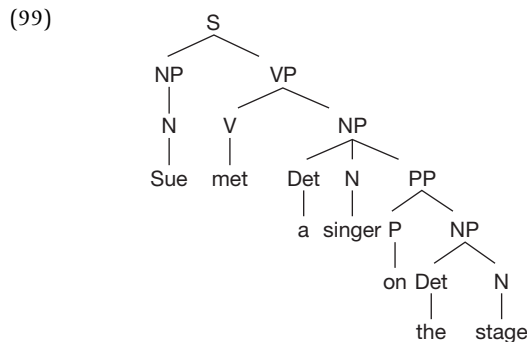
- (97) Sue met a singer on the stage

(Was the *meeting* on the stage, or just the *singer*?)

- (98) Susan said John resigned in order to protect his reputation

(Was the *resignation* or the *statement* to protect John's reputation?)

These ambiguities can be captured by positing two different syntactic structures for each two-way ambiguous sentence. For (97), the prepositional phrase (PP) *on the stage* can be inside the direct object NP (where it will modify *singer*) or outside that NP, but still inside the VP (where it will modify *met*). The two structures are in (99) and (100) respectively.



## Binding Theory

Among the imaginable 'anaphoric relations' (relations of referential dependence) among NPs, some are possible, some are necessary, and still others are proscribed, depending on the nature of the NPs involved and the syntactic configurations in which they occur. For example, in (101), *him* can take *John* as its 'antecedent,' while in (102), it cannot. (The antecedent of an expression E is another expression from which E picks up its reference.)

- (101) John said Mary criticized him  
 (102) John criticized him

That is, (102) has no reading corresponding to that of (103), with the pronoun *him* replaced by the 'anaphor' *himself*.

- (103) John criticized himself

A pronoun cannot have an antecedent that is 'too close' to it. In (101), where antecedence is possible, a clause boundary intervenes between the pronoun and antecedent. There is no such boundary between the pronoun and antecedent in (102). Thus, the presence of a clause boundary between the pronoun and antecedent puts them far enough apart to allow a relation of referential dependence and allows the antecedent to 'bind' the pronoun. This is sometimes called Condition B of the Binding Theory.

Conversely, an anaphor requires an antecedent quite close to it ('Condition A'). Compare (101) with (104).

- (104) \*John said Mary criticized himself.

Again, the pertinent locality is, roughly, being in the same clause. An anaphor must have a 'clause-mate' binder.

Distance in this sense does not always suffice to make antecedence possible. In (105), a clause boundary intervenes between *he* and *John*, yet an anaphoric connection is still impossible.

- (105) He said Mary criticized John

Importantly, it is not the linear relation between the pronoun and the name that inhibits anaphora. This is evident from consideration of (106), in which *he* once again precedes *John*, yet anaphora is possible.

- (106) After he entered the room, John sat down

The generalization covering (101) and (105)–(106) is approximately as in (107):

- (107) A pronoun cannot c-command its antecedent.

In (105), the c-command domain of the subject pronoun is the entire sentence. As the putative antecedent is included in that domain, the anaphoric interpretation is inconsistent with the generalization (107). In (106), on the other hand, the domain of the pronoun is the clause embedded in the adverbial phrase, which does not include the antecedent *John*.

In fact, Conditions A and B also involve c-command. For the former, the anaphor must not only be near its antecedent, but it must also be c-commanded by it. When the potential antecedent is buried in another phrase, the result is unacceptable.

- (108) \*John's mother criticized himself

Conversely, a pronoun with bound interpretation is fine in this position:

(109) John's mother criticized him

### Summary

In summary, syntax concerns the structural aspects of sentences, including the way words are grouped into phrases, and those phrases into still larger phrases, and the way those phrasal units are manipulated and interpreted. There are universal aspects of syntax (infinitude, structure) and parametric ones (such as the order of head and complement). Exactly which syntactic properties are universal and which are subject to variation continues to be a rich area of research.

**See also:** [Chunking](#); [Language Development](#); [Sentence Processing](#).

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# Temperament and Individual Differences

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## The Meaning of Temperament

Each individual possesses a large collection of biological and psychological properties that influence how the person will react in a particular situation. The biological properties include genes and the chemistry and anatomy of the brain. The psychological properties include diverse types of representations of past experience and the feelings that are linked to them. Although all humans possess these biological and psychological properties, they vary in the frequency and intensity of particular feelings, behavior, and desires because of variations in their life experiences and biological properties.

Temperamental bias is based on biological properties. Most scientists define a temperamental bias as a biologically based susceptibility for particular feelings and actions, usually appearing during infancy or early childhood, that experiences sculpt into a large but nonetheless limited number of personality traits. The settings in which the individual develops determine the specific traits that will be expressed. However, the local context in which the individual is behaving at the moment selects for expression one particular combination of biological and psychological properties from the larger number of possibilities. This means that when the context changes, a different combination could be selected. A person who is normally quiet and conforming to authority in the work place might be talkative and dominating at home.

## Origins of Temperament

A temperamental bias can be created by at least four different biological mechanisms: (1) an inherited neurobiology, (2) season of conception, (3) maternal stress or illness during fetal development, or (4) events during the first year or two that affect the still developing brain. Although an inherited neurobiology is believed to be the most common source of a temperamental bias, the other three factors can be influential.

For example, fetuses conceived in the northern hemisphere during the spring or fall months, when the hours of daylight are increasing or decreasing at a faster than usual rate, are exposed to decreasing (in spring) or increasing (in fall) levels of maternally secreted melatonin, which affects the developing brain. Therefore, a fetus with a particular genetic vulnerability to a low or high melatonin level could develop a temperamental bias if conceived during the fall or spring months. Children in the northern hemisphere who were conceived in the fall are biased to become shy and are at a slightly greater risk for depression disorder during adulthood. By contrast, adults conceived during the spring months are at a slightly higher risk for developing a drug addiction or becoming schizophrenic.

## Neurobiology

The human brain contains over 150 different molecules, each associated with a variety of receptors varying in density and location in the brain. The very large number of possible combinations of molecular concentrations and receptor distributions means that the number of possible brain profiles that could create a temperamental bias is much larger than the types of behavior psychologists observe. One way to categorize the large number of possible human temperaments relies on three criteria: (1) is the temperamental bias due primarily to a neurochemical profile or a feature of brain anatomy? (2) is the temperament due to a heritable set of genes or the result of prenatal or early postnatal events?, or (3) does the biological basis for the temperament influence primarily the limbic parts of the brain, which regulate feelings, or frontal lobe sites, which regulate impulsive behavior? Eight temperamental types emerge if each feature is divided into two opposing categories (see [Table 1](#)). Each of the eight cells in [Table 1](#) can contain many different temperaments.

Extremely irritable or minimally irritable infants who inherited a chemistry that affected limbic structures would be assigned to cell 1, but equally irritable infants who were born to mothers exposed to the flu virus during their pregnancy would be assigned to cell 2. Some children diagnosed with attention deficit or conduct disorder who inherited a chemistry of the frontal lobe that led to a compromise in the control of impulsive behavior would be assigned to cell 5, but equally restless or disobedient children born to a mother who was stressed during pregnancy would be assigned to cell 6. Children who display many tantrums because of a compromised anatomy in one of the limbic structures would be assigned to cell 3, but would be assigned to cell 7 if the cause was an inherited compromise in frontal lobe sites.

It is important to appreciate that a child's experiences shape the initial bias into a variety of forms that vary across cultures and historical eras and are always influenced by the child's gender, ethnicity, and social class. Thus, the pattern of behavior and emotions displayed by older children is usually influenced more by differences in experience than by their temperamental bias. Because young infants have not yet been exposed to much variation in experience, temperamental bias is more easily observed in the first year.

## Infant Temperaments

Infants vary little in behavior that appears to originate in their temperament. The most obvious are the reactions displayed to uncomfortable states of pain, cold, and hunger. Infants vary in the intensity and duration of crying as well as in the ease of

**Table 1**

|                           | <i>Mainly neurochemical</i> |                      | <i>Mainly anatomical</i> |                      |
|---------------------------|-----------------------------|----------------------|--------------------------|----------------------|
|                           | <i>Inherited</i>            | <i>Not inherited</i> | <i>Inherited</i>         | <i>Not inherited</i> |
| Variation in emotionality | 1                           | 2                    | 3                        | 4                    |
| Variation in impulsivity  | 5                           | 6                    | 7                        | 8                    |

being soothed. They also vary in their reactions to unexpected events that are not painful, such as new foods, sounds, or sights. Once again, some infants are active and others passive; some cry and others remain calm. Infants also vary in how they react to frustrations, such as losing a nipple they were sucking or being unable to retrieve a toy. Finally, infants vary in the frequency of babbling, smiling, and limb movements when they are simply lying in their crib with no intrusion into their perceptual space.

Mary Rothbart, an acknowledged expert in infant temperaments, suggests that there are four basic temperaments that vary in intensity. One type refers to a bias for the unpleasant emotions of fear, anger, or sadness. A second bias, called surgency, refers to behavior that accompanies pleasant states, especially smiling and babbling, and the tendency to approach unfamiliar people, objects, or settings. A third temperament biases infants to soothe easily when they are upset, although these infants do not always show behavioral signs of pleasure. The fourth bias refers to the regularity of eating and sleeping; some infants establish a regular rhythm while others do not.

The relation between the brain's neurochemistry and behavior that has a temperamental foundation is complicated and, therefore, not well understood. For example, serotonin is an important molecule that usually suppresses neuronal excitability. Thus, it is reasonable that infants and children with lower concentrations of serotonin are usually distressed more easily than others. However, the duration of serotonin activity is affected by the concentration of another molecule (called the serotonin transporter) that reduces the level of serotonin in the synapses of select sites. The gene that is the origin of this molecule has several alleles that determine the level of expression of this gene. Two of these alleles are called short and long because of the variation in their DNA string. The short allele is associated with less expression of the gene and, therefore, less transporter. As a result, serotonin remains active in the synapse for a longer time. However, this condition usually leads to a reduction in the number of serotonin receptors and, therefore, an overall reduction in serotonin activity. One consequence is greater excitability of the amygdala. Although this brain state should be correlated with a susceptibility to fear or anxiety, unfortunately the psychological consequences of possessing the short or long allele depend on the person's ethnicity, gender, culture, and life history. Possession of the short allele has different psychological consequences in Caucasians and Asians.

Opioids are a class of molecules that influence temperament. These molecules modulate the neurons in the medulla that receive information from the body and transmit it to the cortex. A high density of opioid receptors in the medulla

reduces the likelihood that changes in the body will pierce consciousness. Thus, a person with fewer receptors will be more aware of subtle changes in heart rate and muscle tension.

Oxytocin and vasopressin contribute to temperament bias. The males in a strain of mammals related to mice, called prairie voles, pair bond to a female after an initial series of matings, but the related strain of montane voles does not pair bond. This dramatic difference in behavior appears to be due to differences in the density of receptors for vasopressin in a brain site that contributes to the intensity of pleasure associated with sexual behavior. Oxytocin activity is increased when mothers are nursing and caring for their infants. If variations in vasopressin and oxytocin levels or receptor densities have similar outcomes in humans, some husbands will be faithful to their wives and some mothers will develop unusually close emotional bonds with their infants.

Dopamine and the density and distribution of its varied receptors also contribute to brain states that are the bases for temperamental bias. One psychological state, which humans interpret as pleasure, occurs when a person receives a desired event that was unexpected. This experience leads to a surge of dopamine in a structure called the ventral striatum. There is a complementary relation between the usual level of dopamine in the cortex and the level of dopamine in the ventral striatum. The lower the tonic level in the striatum, which could be due to a higher level in the cortex, the greater the increase in dopamine activity in the striatum when an unexpected event occurs, and the greater the probability the individual will experience an intense feeling of pleasure. By contrast, individuals with tonically higher levels of dopamine in the striatum will experience a smaller increase in dopamine activity and presumably derive less pleasure from the same experience.

Unfortunately, the current immaturity of our knowledge frustrates any attempt at the moment to posit a strong relation between any neurochemical profile and a temperamental bias. For example, a gene or cluster of genes rarely accounts for more than 5–10% of the variation in human behavior that has been studied. No single gene from a set of over 300 000 in a sample of close to 4000 adults accounted for more than 1% of the variation in five different personality traits measured with a questionnaire because most psychological traits are due to a particular life history shaping the pattern of temperamental bias into different forms. Although there can be a close relation between a set of genes and the brain states it produces, there is a much weaker relation between a brain state and the psychological state of an individual.

### **Variation in Reactions to the Unfamiliar**

Two temperaments that have been studied more extensively than others refer to the variation among infants and children in their reaction to unexpected changes in the immediate sensory surround (called stimulus novelty), and to events that deviate from their knowledge (called conceptual novelty). Both types of novelty automatically alert infants and young children and provoke them to try to relate the event to the setting and their knowledge. Every human, like every animal, anticipates a narrow range of events in a given setting. An adult wearing a clown costume unexpectedly entering a room in which a child is



playing falls outside this range and, therefore, automatically elicits a vigilant state, body immobility, and, in a smaller proportion, a scream of fear. This behavioral profile is usually called fear to novelty. Many animal species vary in their tendency to avoid or approach unfamiliar objects or places. Because the heritability of the variation in this trait in two breeds of dogs was significant but modest, we can be certain that experiences are also influential.

### High- and Low-Reactive Infants

The amygdala and the prefrontal cortex usually participate in the infant's reactions to unexpected or unfamiliar events. Some neurons in the amygdala are part of a system that alerts other parts of the brain to the presence of an unfamiliar event. One of these sites is the prefrontal cortex, which evaluates whether the event is a potential threat. Other locations in the amygdala initiate behavioral or physiological reactions intended to protect the individual from possible danger. Four-month-olds born with a chemistry that produced an especially sensitive amygdala are likely to thrash their arms and legs and cry when they are exposed to unfamiliar events that pose no danger (e.g., moving mobiles or the sound of human voices).

One team of scientists recorded the behavior of 450 4-month-old infants exposed to colorful moving mobiles, taped human voices, and a cotton swab that had been dipped in dilute alcohol. About 20% of the infants, called high-reactive, thrashed their arms and legs, lifted their back from the seat on which they rested (called an arching reaction), and cried on a substantial proportion of the trials. Another 40%, called low-reactive, were usually still, rarely cried or arched their back, and occasionally babbled or smiled. These two temperamental groups developed different personalities as they grew.

The high-reactive 1- and 2-year-olds were more fearful and timid to unfamiliar events, such as the placement of electrodes on their chest or the sudden appearance of puppets with flashing lights. The low-reactives were minimally fearful to these same events. At age 4, the children from these two temperaments played with two other unfamiliar children. Twice as many high- as low-reactives were shy, quiet, and remained close to their mother; more low-reactives played and talked with the other two children. When these same children were 7 years old, one of every two high-reactives, compared with only one of ten low-reactives, showed signs of anxiety such as a reluctance to sleep without a night light, to stay overnight at a friend's house, or a distinct fear of large animals or storms.

The high-reactive 11- and 15-year-olds were less exuberant and less relaxed than the low-reactives and the two groups worried about different experiences. The high-reactives worried about meeting strangers, entering crowds, visiting an unfamiliar city, or the unpredictable events of the future. Low-reactives worried primarily about their grade record and their performance on the athletic field. Not surprisingly, the high-reactives described themselves as serious and tense, whereas the low-reactives described themselves as happy and relaxed most of the time.

These two temperamental groups differed during the adolescent years in four biological measurements that reflect

the excitability of the amygdala and the circuit connecting the amygdala with the prefrontal cortex. The high-reactives showed a larger brain reaction to unfamiliar scenes, such as an infant's head on an animal's body, implying greater neuronal excitability to the unexpected. They also showed greater activation in the right compared with the left frontal lobe; the former is more likely when individuals are experiencing an unpleasant state. Two important differences involved the cortical thickness in two sites in the prefrontal cortex. The site in the ventromedial prefrontal cortex contributes to conscious feelings of tension that might be interpreted as anxiety and sends projections to the neurons that produce arching of the back. The high-reactives had a thicker cortex in this region on the right side; the low-reactives had a thinner cortex. A second site in the orbitofrontal cortex sends fibers to a small group of cells that inhibit the part of the amygdala responsible for the behavioral and biological signs of fear. The low-reactives had a thicker cortex in this area on the left side, whereas the high-reactives had a thinner cortex.

However, only one of four adolescents from the high- or low-reactive temperamental groups maintained over the first 15–18 years the behavioral and biological signs that were expected for their infant temperament. But very few children from either group developed a personality and biology that was characteristic of the other temperament. This fact means that a temperamental bias eliminates many more possible outcomes than it determines. The probability that a high-reactive infant will not become a consistently exuberant, sociable, fearless child with a minimally excitable amygdala is very high; that prediction was confirmed for about 90% of the high-reactives. However, only 20% of high-reactives became adolescents who were extremely shy and anxious and showed signs of amygdala excitability. By contrast, over 90% of low-reactives were not unusually anxious to unfamiliar events and did not show signs of amygdala excitability, but only 40% were consistently sociable, exuberant, and had a minimally excitable amygdala. Other scientists at the University of Maryland who observed similar temperamental groups have reported very similar results. Such a bias is related to the differences between introverts and extroverts and is reminiscent of the ancient distinction between a melancholic and a sanguine temperament.

### Temperament and Gender

Although the behavioral differences between males and females are affected by culture, a small number of traits separate most males from most females across continents and millennia because of differences in genes and neurochemistry that create temperamental bias. Boys in most societies engage in more vigorous activity involving the large muscles, prefer competitive games with a winner and a loser, and more frequently display physical aggression toward peers and disobedience toward adults. Most girls, by contrast, play with a smaller number of peers in relationships defined by emotional closeness and are more often anxious over possible physical harm or social rejection. Similar differences have been observed between male and female monkeys and chimpanzees. Male monkeys prefer to play with toys that have wheels rather than

plush animals or dolls because they can push the former objects. Female chimpanzees are less impulsive, less aggressive, and gentler with other animals; male chimpanzees are more active, more excitable, and more likely to dominate another animal.

The students of the anthropologists John and Beatrice Whiting studied the behavior of 4- and 9-year-old children in six different societies. In most cultures, girls were more nurturing of others; boys were more aggressive. Males were more concerned with their power and dominance over others than with the depth of their social relationships. Females were more often threatened by a dilution in the quality of their relationships with others.

### **The Biology of the Sexes**

The most robust sex difference is that males are more variable on most traits than females. More boys than girls have extremely high or extremely low scores on tests of cognitive abilities and more boys than girls are unusually tall or unusually short.

The sexes differ in the concentration of the two sex hormones, testosterone in males and estrogen in females. The surge in testosterone during the fetal development of boys slows the growth of the left hemisphere relative to the right. This condition produces more males with a dominant right hemisphere and allows more males to perform at very high levels of competence on the psychological functions mediated by the right hemisphere, especially the nonverbal talents of spatial reasoning, musical composition, and painting. The surge of testosterone also leads to a slightly larger cluster of neurons in a part of the hypothalamus that contribute to sexual arousal. Males, compared with females, usually have their first sexual experience earlier, have more sexual partners, and are more aroused by pictures of unclothed members of the opposite sex. Testosterone also suppresses the brain circuits that mediate fear and inhibits the contraction of the facial muscles that are used in smiling. Males of every age and in every culture smile less often than females.

The ratio of the lengths of the second to the fourth finger (the length of the index finger divided by the length of the ring finger and called the 2D:4D ratio), which is inherited, is a rough index of the amount of testosterone to which the fetus was exposed. Boys and men have slightly smaller ratios than girls and women. Girls with a more masculine ratio have a feminine identity but are more athletic than the typical girl. Men with very masculine ratios have greater muscle strength, faster running speeds, more sexual partners, and often have a broad upper face with a prominent jaw and large chin. The men who work on the trading floors of large investment firms are under extraordinary pressure to make decisions involving large amounts of money. The men who earn their clients the most money must control their anxiety because this emotion can lead to vacillation or impulsive decisions. The men who are the most successful in this stressful setting had extremely masculine finger ratios; the men who made less money had less masculine ratios.

The sexes also differ in the activity of oxytocin and vasopressin. Oxytocin activity, which is greater in females, in part because estrogen enhances its activity, mediates the

bonding of mothers to infants and of friends to each other. Hence, girls and women are more concerned with maintaining close emotional friendships. Vasopressin activity, which is enhanced by testosterone and is greater in males, mutes fear, raises the threshold for pain, and, in animals, facilitates aggression.

Dopamine, a fifth molecule contributing to sex differences, has many different functions and six distinctive receptors. It was noted earlier that one function is to mediate a feeling of excitement, often interpreted as pleasure, when a desired but unlikely event is anticipated or occurs. Addicted gamblers observed in a casino playing black jack showed larger rises in dopamine than nonaddicted men. When pathological gamblers were given a drug that suppressed dopamine, they reported that gambling had lost much of its pleasure.

Because the female brain binds dopamine to one of its receptors more effectively than the male brain, most female brains have fewer dopamine receptors ready to be activated. In addition, estrogen reduces the activity of the molecule that absorbs dopamine from the synapses; hence, dopamine remains active for a slightly longer time in female than in male brains, especially in the ventral striatum. These facts imply that the surge of dopamine in the striatum that accompanies an unexpected, but wished for, event will activate more dopamine neurons in men than in women and presumably create a more intense feeling of pleasure in males. However, these biological differences between the sexes are always inserted into a social fabric in which males and females interact with each other and use these encounters to arrive at conclusions about themselves.

### **Temperament and Ethnicity**

There is a strong relation between the geographical distance separating two human groups and the magnitude of difference in their genomes. Thus, Africans, Asians, South Americans, North Americans, and Europeans differ in a small number of genes that could contribute to temperamental bias. The proportion of humans possessing the allele that leads to greater expression of the gene for the molecule that modulates brain serotonin activity (the long allele discussed earlier) is highest among Africans (about 80%) but lowest among Japanese (about 20%).

Comparisons of the psychological and biological differences between Asians from China and Japan and Caucasians from Europe and North America have been studied more extensively than others. Asians and Caucasians differ in about 25% of the genes in regions that control the expression of the genes responsible for the proteins that make body organs. Alcoholism is far less common among Asians than among Caucasians because Asians inherit alleles that interfere with the liver's metabolism of alcohol. Asians are more sensitive than Caucasians to the setting in which a person behaves, as well as to the context in which an object or event occurs. More paintings and photographs composed by Asian, compared with Caucasian, artists depict many objects or animals in the backgrounds of scenes illustrating the central object. European and North American artists usually place the person or object of significance in the foreground and add fewer additional details.

Over the past 1000 years, Caucasians in western Europe made every person's skills, beliefs, and feelings the primary

features of their identity. Asians, by contrast, made every person's social roles and obligations to others the central feature of self. European and North American Caucasians regard every individual as an entity with fixed traits acting on others in the world. Asians regard every person as a collection of distinct roles that have to be altered to accommodate to the specific people with whom they are interacting.

The likelihood of temperamental differences between Asian and Caucasian infants is supported by observations of young infants. Asian newborn infants are calmer, less likely to struggle, less likely to remove a cloth on their face, and more easily consoled when they cry. But Asian infants smile and laugh less often and, when older, stay closer to their mother in an unfamiliar room containing unfamiliar children.

One possible contribution to these behavioral differences is the gene controlling the molecule that affects serotonin activity. As noted earlier, Asians possess the allele that leads to a prolonged presence of serotonin in the synapse, but lower tonic levels of serotonin activity. Serotonin contributes to some of the behavioral signs of pleasure, such as smiling and laughing, and activates a receptor for dopamine in places that mediate body movement. Thus, the infrequent thrashing of arms and legs and minimal emotion shown by Asian 4-month-olds could be due, in part, to possession of this gene.

Geographically distant human populations also differ in facial shape. Asians have the flattest faces of all human groups: the forehead, jaw, and nasal protuberance are less prominent in Asians than in Caucasians or Africans. One team of biologists bred a small number of tame silver foxes with other tame animals and in <20 generations all the offspring were tame. These tame foxes were less fearful and had shorter snouts – that is, flatter faces. Domesticated pigs, cattle, and horses also have shorter snouts than their less tame, wild relatives. The fact that Asians have flatter faces than Caucasians or Africans implies that, from a biological perspective, Asians may be the most domesticated humans. It may not be a coincidence that loyalty to one's family and social groups is a cardinal ethical value in Asian societies.

## Temperament and Mental Illness

A person's temperament influences the psychiatric categories for mental illnesses. Paul McHugh has suggested that there are four major families of mental disorders, and three are influenced by biological conditions related to temperament.

The patients in the first family, more often male than female, have profound deficits in attention, memory, reasoning, language, or states of consciousness, and are usually diagnosed as schizophrenic, bipolar, or autistic. Even though the symptoms of each of these diagnoses can be caused by more than one set of conditions, these symptoms are most likely to have a biological foundation that can be detected in the first 10 years of life.

The patients in the second family, more often female than male, report chronic or intense bouts of anxiety, depression, or both. These patients have phobias, posttraumatic stress disorder, panic disorder, obsessive-compulsive disorder, anorexia, or serious depression. Each category contains symptoms with different origins and different heritabilities. However, the

symptoms of this family are more often the result of an imbalance in brain chemistry rather than a compromise in anatomy.

A critical feature of the symptoms of this family is excitability in the set of connected brain structures that include the amygdala, the anterior cingulate cortex, and the prefrontal cortex. Individuals with high levels of excitability in this circuit are vulnerable to exaggerated emotional reactions when they have to select the best action among a number of alternatives and are not sure which one to choose.

The patients in the third family are addicted to drugs, alcohol, or gambling or have difficulty inhibiting sexual or aggressive urges and sustaining attention when it is adaptive. These symptoms are more common among males than females. Many patients in this family show compromised functioning in sites in the prefrontal cortex that facilitate the regulation of inappropriate action. The genes and brain molecules that affect the integrity of the prefrontal cortex differ from those that influence the amygdala and the anterior cingulate.

Historical and cultural conditions, and their associated ethical values, have a greater influence on the prevalence of illnesses in the third family than on the incidence of symptoms in the first two families. This claim is obvious for homicide. Mothers in many parts of the less developed world kill their newborn if they cannot feed it, and some mothers kill their infant daughters if they believe they will be unable to afford a dowry when their daughter is ready to marry. None of the mothers in these cultures is regarded as mentally ill by the majority in their society.

The fourth family contains patients whose symptoms are due, primarily, to the life history and current circumstances, rather than to a special temperamental vulnerability. These symptoms are more common among the poor and marginalized in every society.

The important point is that bouts of anxiety or depression can occur in patients who belong to any of the four families and these emotions can be the product of different combinations of genes, temperament, culture, and life history.

## Summary

Although temperamental bias has some power, the person's life history, and, especially, the social class and the background, usually have a greater influence on later personality than the initial bias. Individuals in every society vary in power, status, wealth, and privilege and those who believe they have less privilege are vulnerable to anxiety, envy, anger, depression, self-doubt, or a blend of two or more of these emotions despite no special temperamental bias. Societies with a very large difference between the privileged and less privileged will have more members of the latter group who are vulnerable to intense emotions compared with societies with minimal differences.

The historical era and culture also shape the traits of individuals born with a distinctive temperament. The changes in America and Europe over the last century that brought technology, education, and an economy based on information rather than agriculture have created new beliefs, values, and emotions that were not present 2000 years ago. The important point is that the setting in which an individual lives selects from the same pattern of temperaments the personality traits

that will be adaptive. An adolescent who had been a high-reactive infant who lives in a small village and knows everyone will be better adapted than a high-reactive in a large city. A low-reactive adolescent is at higher risk for criminal activity if he lives in a large city than in a small town.

Third, adolescents born with different temperaments find it relatively easy to control how they appear to others, but have more difficulty controlling their vulnerability to specific feeling states of tension, worry, or depression. Humans can learn to suppress the urge to avoid a certain place or object, but are less able to change their feeling tones.

Temperaments contribute to the substantial variation in the intensity of anxiety, shame, or guilt that can accompany the contemplation or commission of an action that violates a moral standard. Adolescents who were high-reactive, for example, experience more intense guilt than low reactives when they fail to honor their moral imperatives.

There is a serious gap between a measured brain state and the individual's thoughts, feelings, and intended actions. The brain is a tightly interconnected set of structures affected by many molecules that, in turn, influence complex patterns of excitation and inhibition. Therefore, there cannot be a determinant relation between a brain profile produced by an event and a psychological outcome across a large number of humans because the event is imposed on the person's usual brain state, which differs across individuals, and evokes distinctively different associations in different individuals. Thus, the final brain state that is measured can be the result of varied combinations of initial brain states and unique associations.

The current interest in human temperaments will lead to a more extensive study of the feelings and emotions of humans,

which are harder to measure than their behavior. Emotions are analogous to the hidden molecular structures responsible for the color or shape of plants and animals. At the moment, scientists do not possess procedures sensitive enough to measure with great accuracy either the quality of a person's conscious feelings or their brain states. However, future investigators will be more successful and these victories will provide a more profound understanding of the reasons for the differences among humans in their usual emotional reactions and the variation in the serious symptoms of chronic anxiety, depression, addiction, callousness, and cognitive impairments.

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## Terrorism

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### Glossary

**Antiterrorism** Defensive measures taken in place to protect a series of prospective targets from terrorist attacks.

**Counterterrorism** Preventive, offensive, and defensive measures – including military action, law enforcement, intelligence, conflict prevention, and political compromise – taken to deter or respond to the threat of terrorism.

**Extremism** The willingness to employ violence in the service of a set of radical or fundamental beliefs.

**Fundamentalism** A set of political beliefs which insist on strict adherence to a literal interpretation of the essential beliefs of a political ideology or faith.

**International terrorism** A terrorist attack which is funded, directed, or conducted across state boundaries by an

organization or state which seeks to use the violence for foreign policy advantage.

**Jihad** Literally meaning ‘struggle,’ refers to a religious duty of Muslims. It has been interpreted to mean nonviolent struggle (i.e., for nonviolent political reform, or an individual seeking to live a pious life) and to mean violent struggle against those who threaten the faith (holy war). The term ‘jihadi’ has been applied to those who engage in, or seek to engage in, violent struggle.

**Radicalization** The process by which an individual adopts a set of transformative ideas about political or social change.

**Terrorism** The use of indiscriminate violence on a target for some criminal, political, or idiosyncratic reason, with the primary objective of spreading fear to a population beyond the immediate target of the violence.

### Defining Terrorism

There is no single or universally accepted definition of terrorism, though it is widely acknowledged to be a type of political violence which uses indiscriminate attacks (or the threat of indiscriminate attacks) to spread fear to an audience beyond its immediate target. But beyond this basic description, the very nature of the terrorist act remains contested. For example, some scholars have argued that terrorism should be seen as a coercive act, designed to extract concessions from a target; others see it as a form of symbolic communication – the ‘propaganda of the deed’ – employed to illustrate a political cause. Others have argued that some kinds of terrorism – for example, suicide terrorism – cannot be explained solely with reference to some instrumental calculation of advantage, but must rather be explained with reference to the psychological characteristics and needs of the perpetrator. Still others argue that terrorism is a social act, conducted on behalf of an ascribed group and motivated by the incentives and pressures arising from an individual’s membership in groups or social networks. Whether terrorism is considered a tactic, a strategy, a form of symbolic communication (or some combination thereof) varies substantially across the literature; whether the motive for terrorism arises from a hard-nosed calculation of costs and benefits, or from a psychologically motivated desire to act on behalf of one’s group, (or both) remains a subject of intense debate.

The reasons for the lack of a consensus on terrorism are many, not the least of which is that the study of terrorism cuts across multiple academic disciplines. Psychologists, political scientists, sociologists, criminologists, and historians have all highlighted different aspects of the phenomenon, depending on the focus of their discipline. The result has been a

proliferation of definitions of terrorism. A survey conducted in 1988 by Alex P. Schmid and Albert J. Jongman found 109 separate definitions of terrorism, all highlighting different aspects of the phenomenon. This problem has been exacerbated by the vast increase in scholarly and popular literature on terrorism since the September 11th attacks. The emergence of popular literature on terrorism – some of it highly sensationalistic and unserious about its subject – has muddied the waters and made it more difficult to develop a consensus around a precise, analytically rigorous definition of the concept. Further complicating matters is the fact that the term ‘terrorist’ is a pejorative that actors often try – sometimes with success – to attach to their enemies. Given that the term is employed differently across disciplines, used carelessly in popular discourse, and deployed rhetorically to both delegitimize and condemn one’s enemies, it is hardly surprising that reaching an academic consensus on a definition has proven to be difficult, though some scholars, governmental agencies, and international organizations have made notable attempts.

Efforts to formulate a consensus definition of terrorism have run aground because there are at least four major areas where scholarly opinion on the subject is divided: (a) the essential characteristics of terrorism; (b) the difference between terrorism and other forms of political violence, especially insurgency; (c) the possible victims of terrorism (civilians or agents of the state); and (d) the possible agents of terrorism (e.g., substate actors or states). First, any well-formed concept in social science must have a cluster of conceptual attributes that are considered necessary (or in rare cases, sufficient) for its definition. For example, following a definition proposed by J. David Singer and Melvin Small in the correlates of war (CoW) project, interstate war has traditionally been defined as a violent conflict that involves sustained combat, at least two



organized combatants, and a minimum of 1000 battle fatalities per annum. While this definition has been critiqued and modified, it remains a widely accepted benchmark within the study of interstate war. By contrast, there is little consensus on the essential characteristics of terrorism that would distinguish it from other forms of political violence. In Schmid and Jongman's survey of scholars, disparate elements such as violence, political motive, the projection of fear, the use of threat, the organized nature of the attack, the indiscriminate selection of victims, the desire for publicity, the extra-normality of the violence, and the psychological effect of anticipated reactions were cited in varying frequencies by a range of experts as essential to the definition. Even the notion that terrorism must involve some kind of actual violence commanded support from only 84% of respondents, because the threat of an attack, if it induces fear or panic in an audience beyond the proposed target, may be sufficient to count as an act of terrorism.

Second, efforts to develop a precise definition of terrorism have run into difficulty when distinguishing terrorism from other forms of political violence. Although it is often treated as an entirely unique phenomenon, terrorism is little more than a specific type of political violence, which shares a number of important characteristics with other types of political violence such as insurgent attacks, targeted killings, and even genocide. For example, insurgent violence – such as attacks against military installations of an occupying power – shares some obvious similarities with terrorist attacks in that both are forms of asymmetric warfare which employ surprise to coerce an enemy. Similarly, targeted killings and assassinations are often designed to convey a political message, much in the same way that terrorism conveys a message of fear. The similarities between terrorist attacks, insurgent violence, and targeted killings – and the fact that these types of political violence are so often deployed concurrently within the same theater of war – have led many observers to blur the distinction between them. Indeed, one of the chief problems with the literature on terrorism since the September 11th attacks has been a conflation of terrorism with insurgency, with scholars attributing the causes, effects, and remedies of one to the other.

But while terrorism may share some important similarities with insurgent attacks and targeted killings, there are some key differences as well. First, terrorism is necessarily indiscriminate in that it aims to kill large numbers of people. As a form of violence, it is nonselective in that the perpetrator is typically indifferent to who the victims are. As Paul Wilkinson has pointed out, terrorism is most effective when it raises the prospect of random, arbitrary, or indiscriminate targeting in the civilian population, for this maximizes fear and convinces the wider audience that they may be struck 'like lightning in the dark' (p. 52). This is different in insurgent attacks and targeted killings, which can often be more discriminate and selective in execution than terrorism. Always mindful of the need not to alienate the civilian population, insurgents – particularly those who hope to topple a regime and assume control over a government – are often reluctant to employ too much indiscriminate violence for fear of backlash. Insurgents attack to keep pressure on a regime and to sow chaos, but they are often selective about whom they attack (representatives or agents of the state) and make efforts to convince the civilian population that they are on their side. There are cases in which

insurgents resort to terrorism frequently to sow chaos in the society (such as Iraq from 2003 to present), but there are many other cases where insurgents rarely employ the tactic (such as the Fuerzas Armadas Revolucionarias de Colombia (FARC) in Colombia) or deploy it selectively (such as the Front de Libération Nationale (FLN) in Algeria). Although terrorism and insurgency are overlapping conceptual categories, sharing many similar characteristics, it is a mistake to equate terrorist activity (which is by definition indiscriminate) with insurgent activity, which is not always indiscriminate.

Third, terrorism tends to have a wider communicative purpose than more selective forms of violence. Much of political violence is about communication – that is, signaling intent or capacity to harm – to other actors in a conflict. For example, insurgents use symbolic attacks to demonstrate their power and send a threatening message to the existing regime. Governments and rebel groups often use targeted killings to 'send a message' to a specific group. But the projection of fear with these other types of political violence is often different in scope than it is with most terrorist attacks. The purpose of terrorism is to send a message to a wider audience that anyone can be targeted at any time; in this respect, the message of fear is boundless and applicable to all those who take notice of the attack. By contrast, targeted killings, reprisals, and other forms of low-intensity violence are often accompanied by messages which are coded, subtle, and intended for only a specific group in the population. The insurgent, for example, does not want to threaten all members of the population in a state that he hopes to control, but only those actively supporting the regime. Similarly, targeted killings between governments and rebel groups – for example, between Israel and Hamas operatives in Gaza – are conducted in a tit-for-tat fashion, with little public acknowledgment or effort to communicate a message to the general public about the meaning of the violence. This is very different in purpose than that of the terrorist, who seeks to use violence in a demonstrative fashion to broadcast a message to a wider population. Indeed, the historical record suggests that terrorists are keenly attuned to their public message and spend much of the efforts insuring that their message, however abhorrent, is conveyed through the media. In contrast to other forms of political violence in which the message is limited in scope and secondary in purpose to the attack, with terrorism the public projection of fear is central to the purpose of the act.

Another important debate around the definition of terrorism concerns who can be understood as a victim of terrorism. Some definitions of terrorism limit the potential victims to civilians, implying that attacks against those deemed combatants must be considered an act of war rather than of terrorism. Such a position is designed to emphasize the indiscriminate nature of terrorist violence, specifically the fact that its coercive power arises from its promise of harm against civilians. The fact that terrorists knowingly violate the principle of noncombatant immunity means that terrorism can therefore be defined in Alex Schmid's words as the 'peacetime equivalent of war crimes.' Similarly, restricting the victims of terrorism to non-combatants implies that armed groups can attack those deemed as combatants (e.g., military personnel in a war zone) without being accused of terrorism. This restriction is designed not only to limit the careless use of the term 'terrorism' but also to imply that actors may be able to employ

violence against an oppressive regime or an occupying power without incurring the label 'terrorist' provided that they do not deliberately target civilians. In other words, restricting the definition of terrorism to noncombatant victims enshrines the legitimate right of resistance for armed groups under occupation or waging wars of self-determination provided that they do not resort to attacking civilians.

Critics of this view have argued that such a distinction is untenable because it is hard to determine who counts as a combatant in many cases. For example, it is not clear how off-duty military personnel or civilians working for an occupying government would be classified. Would they be considered combatants for supporting the regime or the occupation or noncombatants because they were not actively supporting military operations against the terrorist group? Terrorist organizations themselves tend to adopt an expansive definition of their victims, often arguing that all those who pay taxes are as guilty as those who are firing weapons in a war. This distinction between combatants and noncombatants, while important to legal experts, may have no purchase with terrorist organizations conducting the violence. Finally, restricting the use of the term 'terrorism' to attacks against noncombatants would appear to exclude some key events which were clearly intended as terrorism, such as the bombing of the US Marines barracks in Beirut in 1983. A definition which excludes attacks against combatants from the universe of terrorist attacks would not classify this act – conducted via truck bombs, by a known terrorist group (Islamic Jihad), and killing 241 US military personnel – as an act of terrorism.

The final controversial issue concerning the definition of terrorism relates to whether the state may be a perpetrator of terrorism. Some scholars have explicitly limited their definitions of terrorism to exclude the state as a perpetrator of terrorist violence, arguing that only substate actors can be considered 'terrorists.' Proponents of this view argue that to admit that the state can be a terrorist is to open a Pandora's box in which anything a state does in the context of an armed conflict that harms civilians and induces fear can be deemed an act of terrorism. This is particularly important given that governments often employ psychological warfare as a means of intimidating opponents; for example, the US invasion of Iraq in 2003 was accompanied by a range of psychological warfare tactics designed to 'shock and awe' the Iraqi government into surrendering. Also, as Bruce Hoffman argues, states often take some steps to observe the laws of war, particularly the principle of noncombatant immunity, which terrorists often deliberately violate. Proponents of this view argue that to include state and nonstate violent action under the category of terrorism is to classify so many heterogeneous acts as 'terrorism' that the term itself becomes meaningless.

Critics of this position argue that excluding the state as a potential perpetrator of terrorism is problematic for two reasons. First, ruling out the possibility of 'state terrorism' by definitional fiat appears to let states off the hook. As Paul Wilkinson and others have noted, the states are by far the greatest perpetrators of terror on their own populations, as examples such as Nazi Germany and Stalin's purges in Russia can attest. Indeed, the origin of the term 'terrorism' is the use of terror tactics by the French state following the Revolution. As advocates of critical terrorism studies (CTS) point out, this

exclusion appears to privilege state actors, holding them to different moral and legal standards than their nonstate opponents. Second, some states deliberately resort to terror tactics designed to terrify the population in an armed conflict. For example, the Allied bombing of German cities such as Dresden was acknowledged inside the British government to be a form of 'terror bombing.' It is hard to insist that such an act – which involves violence, the projection of fear, and clear communication of threats – bears no parallel with similar tactics by nonstate groups.

## History and Trends in Terrorism

Terrorism has a long history. The term itself arose during the French Revolution, in the Reign of Terror (1793–1794), when thousands of supposed 'enemies of the Revolution' were put to the death by the Jacobins. But the actual employment of terror tactics predated this example by centuries. In the ancient world, weak rebel groups would often resort to surprise attacks to weaken their enemies and terrify their supports. The Sicarii (first century) was a splinter group of the Jewish Zealots that used surprise dagger attacks to kill their enemies (usually supporters of the Roman Empire) in public places to terrify the population. Similarly, the Ismaili Shiite Assassins (also known as the Hashishin), who operated in the eleventh to thirteenth century, also conducted highly selective murders in public spaces to send a message to opposing factions. The similarities of these attacks to modern-day terrorism lie in the surprise of the attack and the communicative function of the violence, though these groups were far more selective in their victims than modern-day terrorist groups.

David C. Rapoport has identified four major waves of terrorism in the modern era. The first major wave came with the antistate revolutionaries of the nineteenth century. The intellectual father of these movements was Carlo Pisacane, an Italian radical who led a rebellion against the Bourbon kings and called for the symbolic use of violence – the so-called 'propaganda of the deed' – to spread the message of the group. In his view, violence was didactic, designed to not only inform the people about the cause but also to rally the masses in support of it. This belief in the demonstrative power of violence was picked up by a number of subsequent revolutionary actors in the late nineteenth century. Prominent among them was the Narodnaya Volya (People's Will), a Russian revolutionary group which called for constitutional reform of czar's regime. The Narodnaya Volya killed select members of the Czarist regime in Russia, including Czar Alexander II, as a way of rallying the Russian people to their cause. While they were eventually destroyed, their model proved influential with a number of other groups, including Black Hand, a Serbian radical group responsible for the assassination of Archduke Franz Ferdinand in 1914. Another important descendant of this first wave of revolutionary terrorism was the Anarchist groups, many of whom formed local chapters to threaten the overthrow of their governments. While most of their efforts were unsuccessful, anarchists were successful in assassinating several high-profile political leaders, including French President Marie-Francois Sadi Carnot in 1894 and American President William McKinley in 1901.

The second major wave of terrorist movements emerged during anticolonial revolts in the first half of the twentieth century and later partisan movements during the second world war. Among the earliest revolutionary/terrorist movements to form in the twentieth century was the Irish republican army (IRA), which formed in 1919 to oppose British rule in Northern Ireland. Terror was again in evidence during the second world war, as the Nazis often called the partisans in Greece and Yugoslavia 'terrorists' and used terror tactics to destroy these movements and keep the population subservient. Following the end of the second world war, terrorist violence appeared in campaigns in Palestine, Kenya, Cyprus, Algeria, Angola, and Mozambique. Here, it proved successful in accelerating the departure of colonial powers, even though it was widely condemned. Particularly notable among these cases were the Irgun, which bombed the King David Hotel in 1946 to force the British to withdraw from Palestine, and the FLN which selectively used terrorism against the French military and settlers in order to convince Paris to allow Algeria to declare its independence. The ideology of these revolutionary movements was often nationalist and Marxist or some combination thereof. Popular tactics during this wave of terrorism included kidnapping and hostage-taking, as well as some criminal activities like bank-robbing.

The third major wave of terrorism (1960s–1970s) was marked by its international scope and focus. This was facilitated by a number of important factors, not the least of which was the advance of media technology which allowed attacks by terrorists, along with their messages, to be broadcast instantly to much of the world. Seminal events in this wave of terrorism include hijackings of five airliners in 1970s by the Popular Front for the Liberation of Palestine (PFLP) and the Black September incident, when PLO terrorists killed 11 Israeli athletes at the 1972 Olympic Games in Munich. This example was followed by a number of Marxist groups in Western Europe (such as the Red Army Faction and Red Brigades) as well as national secessionist movements (such as the PKK in Turkey). The idols of this movement were revolutionaries like Che Guevara, and also prophets of the use of demonstrative violence such as Carlos Marighella, whose 1969 *Minimanual of the Urban Guerrilla* became enormously influential. Despite their emphasis on the need for violence as a form of revolutionary provocation, terrorists in the third wave of terrorism did not seek high levels of casualties, but rather saw the violence as a form of spectacle and symbolic communication. They were also often supported by state sponsors, such as the Soviet Union and Iran, in order to further the foreign policy objectives of those states.

The fourth wave of terrorism began following the end of the Cold War and has continued to the present day. There are three trends noticeable in the current wave of terrorism. The first is that the contemporary wave of terror is motivated by religious or transcendent sentiment, in many cases an uncompromising interpretation of Islam, but often married to practical objectives. Notable examples of this motive include Hamas in the Palestinian territories, GPSC in Algeria, Hezbollah in Lebanon, as well as al Qaeda and its branches in North Africa, the Middle East, and Asia. But it is worth pointing out that religious terrorism is not confined to Islam; the early twenty-first century has seen a significant increase in membership for the Christian

identity movements and fundamentalist Hindu and Jewish groups. The second major trend clearly evident in this wave of terrorism is an increasing casualty rate for attacks. Whereas terrorists in the third wave wanted, as Brian Jenkins remarked, a 'lot of people watching, not a lot of people dead,' terrorists in the fourth wave appear to want both. The fourth wave of terrorism has become bloodier, with extremist groups like al Qaeda proving willing to kill large numbers of people in pursuit of their objectives. The first indication of the increasingly indiscriminate nature of terrorism in this wave was the Aum Shinrikyo group's chemical weapons attack on a Tokyo subway in 1995. Subsequent terrorist spectacles – such as the 1998 bombings of US Embassies in Kenya and Tanzania, the September 11th attacks, and the Madrid bombings (2004) – and the increasing use of tactics like suicide bombings and improvised explosive devices (IEDs) – have led to much higher casualties. Moreover, terrorist organizations have proven willing to kill large numbers of civilians in so-called 'soft targets' in order to achieve their objective. The siege of a primary school by Chechen separatists in Beslan, North Ossetia, which led to the death of 377 people, including 186 children, is an illustrative example. Similarly, the willingness of groups like al Qaeda in Iraq (AQI) to launch indiscriminate attacks on civilian targets is remarkable, for contrary to the approach of many insurgent or guerrilla groups, it appears less concerned with winning the support of the population than with fomenting chaos and civil war. Finally, terrorist organizations within this wave have been less dependent on state support and have relied more on fundraising, often from religious charities and criminal activity than their predecessors. The fourth wave of terrorism is a dangerous evolution of the phenomenon because it is largely comprised of entrepreneurial and self-organizing groups committed to the use of indiscriminate violence on a large scale.

### Types and Tactics of Terrorism

As the history of terrorism indicates, there are many different types of terrorism, many of which have unique features and characteristics. As a rule, terrorist acts demonstrate common characteristics based on two criteria: (a) their motive and self-ascribed source of legitimacy (e.g., religious, ideological, separatist) and (b) the type of perpetrator (state vs. nonstate). The motive of a terrorist organization matters for a number of reasons, not the least of which is that it shapes the goals that the organization pursues and its tactics. National-separatist terrorist organizations – that is, those focused on liberation of their home countries or regions – tend to have limited goals and be more selective in their employment of violence. Their goals are, as Paul Wilkinson described them, 'corrigible' because they are focused on reforming the system to meet their political demands, even if their demands are as extreme as outright secession from the state itself. For example, the Irish Republican Army used terrorist violence against Unionist Protestants and British officials at various points during its campaign, but only on occasions resorted to the indiscriminate attacks on civilians (e.g., the Canary Wharf bombings in 1996). Ideological and religious groups – such as the anarchists, Red Brigades, and al Qaeda – tend to be motivated by more

expansive goals, and seek the overthrow of the existing system. In this respect, they are revolutionary, for they are seeking not just the inclusion of specific political demands within an existing system but also the fundamental transformation of the system itself. For this reason, they tend to be less selective in their use of violence, and more willing to resort to suicide bombing and other mass-casualty attacks than their national-separatist counterparts.

There are a number of hybrid organizations which demonstrate features of both the national-separatists and religious-ideological archetypes. For example, Hamas is a terrorist organization committed to the violent destruction of Israel and its explicit source of legitimacy is Islam. Its leaders see themselves as leading a religiously motivated resistance movement. At the same time, however, Hamas has proven to be occasionally pragmatic in its willingness to forswear tactics like suicide bombings during its periods of cease-fire with Israel, and may be willing to be politically more accommodating in the future. Similarly, Hezbollah – literally the Party of God – is a religious terrorist organization that formed as a resistance movement during the Israeli occupation of Lebanon. While it employs terrorism and sees itself as an organization which draws strength and legitimacy from Islam, it has also been willing to negotiate cease-fires with Israel and participate in normal politics in Lebanon. On the other side, some national-separatist organizations like the LTTE (also known as the Tamil Tigers) are willing to employ tactics (such as suicide bombings) predominantly used by religious organizations.

Beyond this principal distinction lie two additional types of nonstate terrorism. The first is single-issue terrorism, which consists of individuals or small groups committed to the use of violence over a single policy issue. These organizations are highly ideological, but also more discriminate in the use of violence than traditional revolutionary organizations like the Anarchists. Examples of single-issue terrorist groups include the animal liberation front (ALF) and the earth liberation front (ELF). These groups employ attacks on targets of symbolic importance – for example, bombings of logging industry sites or medical facilities involved in research on animals – but are typically more careful to ensure that casualties are nonexistent or limited. Additionally, there is what might be called ‘idiosyncratic’ terrorism – violence conducted by individuals for causes without popular support or even acknowledgment. A signature example of idiosyncratic terrorism is Theodore Kaczynski (also known as the Unabomber), who sent 16 bombs to civilian targets (usually universities or airlines) between 1978 and 1995 in protest to modern society’s reliance on technology.

The second major category, state terrorism, can be broken down into three categories. Traditional state terrorism occurs when a government uses violence and repression to eliminate its enemies and keep the rest of the population in check through the use of fear. Examples of traditional state terrorism include Nazi Germany and the Soviet Union under Stalin, and also more recent cases such as Cambodia under Pol Pot and Afghanistan under the Taliban. State sponsorship of terrorism occurs when a government offers funds, weapons, or political support to a terrorist organization in order to further the government’s foreign policy objectives. Iran’s support of Hezbollah in Lebanon is a classic case of direct state sponsorship. State

sponsorship of terrorism can also be indirect if the government does not adequately stop its population from supporting a terrorist movement (i.e., United States’ reluctance to crack down on funding for the IRA in the 1970s, or Saudi Arabia’s unwillingness to stop charitable fundraising in support of al Qaeda) or if the government lacks the capacity or will to uproot and destroy the terrorist organization (i.e., al Qaeda and the Taliban in Afghanistan). Finally, prostate terrorism consists of nonstate actors who act on behalf of a government (i.e., militias and defense forces). In some cases, they are supported by the state (e.g., death squads in Guatemala) and in others tolerated or even opposed by the government they claim to support (e.g., the Ulster Volunteer Force (UVF) in Northern Ireland). [Table 1](#) identifies the types of terrorism along both of these dimensions, as well as key features of attacks within each type.

It is important to stress that these types of terrorism are conceptual distinctions which are often less clear in practice. As noted, some organizations cut across multiple boundaries. For example, Hezbollah is a state-sponsored terrorist organization that has features of both religious and national-separatist organizations. Groups like the IRA have in some cases claimed to be nationalists but have employed religious iconography and flirted with ideological movements, including Marxism. Classifying terrorist groups into these types is a useful first step for research but often raises more questions than it answers.

### What Makes a Terrorist? Approaches and Advances in the Study of Terrorism

Both in popular discourse as well as in academic inquiry, the kinds of questions that are frequently asked about terrorism often focus on the motives of the terrorists themselves. For instance, it is not at all uncommon to hear questions such as ‘why would someone engage in terrorism?’ or ‘what makes someone a terrorist?’ More recently, these questions have been supplemented with questions of process – ‘how’ does someone become a terrorist? Further, the question of how someone leaves terrorism behind, as articulated by scholars such as John Horgan, both in terms of the underlying motivations as well as the practical matters, is of increasing interest to both researchers and practitioners alike.

Historically, research in the still-developing field of terrorism studies had sought to establish key factors and elements that when considered in summation might effectively serve as the ‘profile’ of a terrorist. However, and in relatively short order, the sheer magnitude and difficulty of such a task was made clear, and empirical evidence to establish such a profile has yet to be established. In fact, the current consensus in the discipline is that a search for a profile based on some specific combinations of variables is destined to be a wasted and fruitless effort. While it is possible to start an analysis at the occurrence of a terrorist action or event and work backward, this type of analysis can only give a limited understanding about a particular set of perpetrators, motives, and circumstances. This type of analysis may also provide insights about the interpersonal and group dynamics that were especially influential on a given actor at a given point in time. However, trying to use an understanding of particular terrorists, and particular

**Table 1** Types of terrorism

|                             | <i>Description</i>                                                                                             | <i>Types of goals</i>                     | <i>Common tactics</i>                                                      | <i>Select examples</i>                                                |
|-----------------------------|----------------------------------------------------------------------------------------------------------------|-------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <i>Nonstate terrorism</i>   |                                                                                                                |                                           |                                                                            |                                                                       |
| National-separatist         | Armed groups who seek either autonomy or independence from an existing state                                   | Reform of existing government or policies | Bombings, assassinations, reprisals                                        | IRA, ETA, Irgun, FLN, PKK, Tamil Tigers, PLO                          |
| Religious                   | Armed groups who use fundamentalist interpretations of faith to challenge regimes or policies                  | Transformative and/or pragmatic           | Bombings, especially suicide bombings, assassinations, symbolic attacks    | Hamas, Hezbollah, al Qaeda, Christian Identity groups                 |
| Ideological (revolutionary) | Armed groups who seek the overthrow of an existing regime to produce fundamental political change              | Transformative                            | Bombings, assassinations, symbolic attacks                                 | Anarchists, Red Army Faction, Baader Meinhof, Red Brigades            |
| Single issue                | Small groups or individuals committed to reform of a single moral or political issue within the existing state | Reform of policies or social practices    | Bombings, symbolic attacks, targeted assassinations                        | Earth Liberation Front, animal rights groups, antiabortion terrorists |
| Idiosyncratic               | Small groups or individuals organized around a set of highly personalized beliefs or goals                     | Variable                                  | Bombings, symbolic attacks                                                 | Unabomber                                                             |
| <i>State terror</i>         |                                                                                                                |                                           |                                                                            |                                                                       |
| State terrorism             | Government which engages in systematic violence against its own population or that of another state            | Repression and/or elimination of enemies  | Assassinations, reprisals, torture, detention, psychological warfare       | Nazi Germany, Soviet Union (under Stalin), Cambodia (under Pol Pot)   |
| State-sponsored terrorism   | Governments which support or subsidize terrorist organizations in other states                                 | Weaken foreign enemies                    | Provision of material aid (such as weapons or funds) and political support | Iran's support of Hezbollah and al Asqa Martyr's Brigade              |
| Prostate terrorism          | Armed groups who use violence in support of a state's policies                                                 | Support of status quo                     | Assassinations, reprisals, symbolic violence                               | Ulster Volunteer Force, armed Israeli settler groups                  |

events, to generalize in a way that affords predictive value in identifying potential future terrorists has been largely unsuccessful. Part of this difficulty is due to the fact that predicting whether a specific individual will engage in violence or criminality is exceedingly difficult, if not impossible. Thus, in the field of terrorism studies, the most comprehensive analyses have been able to identify a compelling range of preconditions that have the distinct potential to increase the likelihood of terrorism, without affording specific predictive ability with regard to specific actors or specific situations.

Obtaining data and evidence to address the question of how someone becomes active in terrorism is fraught with problems and challenges as well. First, the nature of the problem of terrorism makes it inherently difficult to study. Because of its very secretive and illegal nature, identifying a specific actor who would harm noncombatant civilians is not feasible, especially in the context of research. Second, while there has been a massive increase in the publication of books and articles about terrorism, it is still relatively small as an area of academic research and topic specialization. Finally, the gap between the open source information available to academic researchers focusing on terrorism and classified information presents additional difficulties for establishing a comprehensive and holistic understanding of the phenomenon.

An additional feature of terrorism that further complicates its study is the dynamic nature of the topic under consideration. For instance, one may be interested in understanding motivations for terrorism, in a broad sense. However, there are

a multitude of reasons for involvement that are likely to change over time. It is becoming increasingly well recognized within the community of terrorism researchers and scholars that the reasons that one would become involved in terrorism are likely to be very different from the reasons that one would remain engaged in terrorism. As an example, imagine a situation in which an individual seeks to become involved in activities to support the global jihad. At several stages in this process, the individual will likely have to participate in a range of more mundane sorts of activities that may not seem to him to be particularly exciting or enticing. However, also along this path, that individual is likely to make new acquaintances, or share key experiences with some friends with whom he initially started his involvement. At this point, motivations are likely to have some core elements of wanting to avoid disappointing friends, which may serve to compel a continuation of their activities and training – less for reasons of hatred for an abstract out-group, and more for reasons of affiliation and affection for members of their in-group. These motivations can be readily understood from a group dynamics perspective, but hold somewhat less cache when the goal is to uncover the key factors that make someone a terrorist.

As in so many other forms of interpersonal and intergroup violence such as genocide, some of the key factors that have emerged from the study of terrorism suggest the importance of many mundane processes of influence, compliance, and obedience, to name but a few. When considered together, these rather normal processes can lead to potentially



devastating actions and consequences. To date, there have been some significant advances that have applied classic and current work from a range of disciplines including psychology to the study of radicalization in the context of terrorism in particular.

### Individual and Group Level Factors in Radicalization and Terrorism

From a psychological perspective, there is little evidence to suggest that terrorists have abnormally high levels of mental illness or psychopathology; in fact, research on the topic has shown no difference between terrorists and other members of the population. What does emerge from this research is that terrorists have purpose, intent, commitment, and conviction. In addition to research addressing individual-level psychological factors, a wide range of external factors such as global poverty, inequalities in health care, education, and access to the basic requirements of food, water, and shelter have been researched as well. In general, structural factors such as those mentioned here may constitute background conditions in which recruiting, indoctrinating, and motivating individuals toward terrorism may become increasingly likely. However, this is not necessarily true for all terrorists, or even all types of terrorism.

Some scholars have examined the link between grievances and traumatic experiences and the development of terrorism. This area of research has been able to examine interview data with people who had been involved in terrorism, and has provided rich narrative detail in which very personal accounts can be used to supplement the more commonly employed methods of examining macrolevel trends or incident databases. Interview data capture a significant depth of experience and the reasons for involvement in terrorism as recollected by the actors themselves. However, there are critical limitations in broadly applying findings from retrospective accounts and narratives to other actors, situations, and contexts. Thus, while interview data have not served as a solid empirical basis for developing valid and reliable predictive models, they have provided a veritable treasure trove of insight about recurring themes in individual-level factors in terrorism.

### Stage Models of Terrorism

Several psychological models posit that there are a series of stages or levels that individuals progress through as they become increasingly radicalized toward terrorism. Fathali Moghaddam's 'staircase model' posits that terrorism can be viewed as sequential progression from lower floors to higher floors on a staircase that gets increasingly narrow the further one progresses. Clark McCauley's 'pyramid' model positions terrorists as the apex of a pyramid composed of a general population, passive supporters, and active supporters. Here, terrorists are a very small portion of the overall population the pyramid represents. Both of these models offer a conceptual foundation for distinguishing between those who may passively or actively support terrorism, and those who might take a more direct role. However, it should be noted that the process by which one becomes radicalized toward terrorism is most often viewed as fluid and dynamic.

### The Power of Social Networks in Radicalization and Recruitment

Of central importance to understanding the modes of recruitment and radicalization is the way in which individuals and small groups become radicalized toward the use of violence. Marc Sageman studied what he termed 'the global salafi jihad' and uncovered critical aspects of the core membership of the al Qaeda terrorist network that linked individuals together into small groups, through the sharing of core formative experiences (e.g., time spent in Afghanistan in the period of the Soviet invasion and occupation), as well as through some more mundane – yet important – daily experiences. One of the key findings in this analysis was that small group dynamics had a very important role in the radicalization process. In fact, the detailed descriptions that Sageman provides of the global jihad, including its networks, and more detailed biographical characteristics of its membership show that the experience of poverty, lack of educational achievement were not causal factors for those who became jihadis. In fact, this group appeared to be fairly well educated, and from a middle to upper-middle socioeconomic status. One thing that this analysis of those involved in the global jihad illustrates is the importance of context. Certainly, some of the background characteristics and motivational factors for those who get involved in the global jihad will differ from those who get involved in more local-level groups. For example, Ariel Merari notes in his review of suicide terrorism that in fact, among Palestinian suicide terrorists, the socioeconomic profiles correspond to those of the general Palestinian population, and that suicide terrorists even had slightly higher levels of education. In sum, much of the available data serve to contradict some popular assumptions about what causes people to engage in terrorism, while emphasizing the importance of social bonds and interpersonal relationships.

### The Importance of Leaders

There are several key examples of groups that have strong, charismatic leaders who have been essential to both the structure and function of the group. In Sri Lanka, the largely Nationalist-Separatist Liberation Tigers of Tamil Eelam was led by Velupillai Prabhakaran, and successfully mounted a protracted campaign against the Sri Lankan government, including a significant series of suicide attacks, from the mid-1970s until their ultimate defeat in 2010. In Peru, The Sendero Luminoso (or 'Shining Path') was led by Abimael Guzman, who also went by the moniker of 'Presidente Gonzalo.' After Guzman's capture and arrest in 1992, the group was essentially stripped of its capacity to pose a serious and continued threat to the Peruvian government. In Turkey, the Kurdish workers party (PKK) was led by Abdullah Ocalan, whose leadership was an essential component of the groups cohesiveness. And in Japan, Shoko Asahara led Aum Shinrikyo, a cult-like group that demanded total loyalty from its members, and most infamously mounted a sarin gas attack against the citizens of Tokyo, Japan, by targeting its subway system. Interestingly, the choice of sarin reflected Asahara's idiosyncratic interest in using poisons. Following the 1995 attack, a series of arrests of Aum Shinrikyo's members, including Asahara, left the group in disarray. In 2000, the group changed its name to Aleph, and has

fractioned as a result of disagreements within factions of the group and a lack of clear leadership of the kind that Asahara offered, and the absolute loyalty he demanded. Each of these leaders represents a very distinct type of organization; however, the commonality that these groups share is that the leadership was a core element of each group's ability to function. Thus, continued consideration of the dynamic relationship among leaders and followers will complement the developing interest in emergent social networks, and the potential for 'leaderless' terror networks.

### The Role of the Media

It has long been noted that terrorist organizations thrive on access to the media. British Prime Minister Margaret Thatcher famously observed that terrorists require the 'oxygen of publicity' in order to succeed and spread their message. For this reason, terrorist organizations have been particularly attuned to the needs of traditional media (such as newspapers, television, and radio) in order to maximize the impact of their attacks. As Brian Jenkins has argued, 'terrorism is theater,' with terrorist organizations in some cases planning their most spectacular attacks to have maximum media impact, especially on television. The visual imagery of terrorist attacks – for example, a hijacking or a hostage video – amplifies the effect of the violence and has a dramatic impact on media coverage. The hijacking of TWA Flight 847 proved a case in point, with the media broadcasting an average 28.8 news segments per day during the duration of the crisis. Similarly, the events of September 11th commanded days of television coverage and made Osama bin Laden a household name virtually overnight. While the coverage of terrorist events is rarely positive, it often dramatizes the events themselves and focuses on the human interest aspect of the crisis, thus reinforcing the notion – as the terrorists intended – that such attacks can occur anywhere at any time. The unintended effect of the volume of media coverage is to amplify the fear that would be the natural result of the terrorist act. The clever use of the television and radio media by terrorist organizations also places enormous pressure on governments to respond, which may in turn goad them into over-reaction. The advent of so-called 'new media,' including the internet, has further transformed the way that terrorist organizations can interact with their supporters and the wider public. The nonhierarchical structure of internet communications – that is, the fact that anyone can post a message without going through an editor or even a filtering process – offers an unprecedented opportunity for terrorist organizations to communicate their message to the public. This could be clearly seen in the raft of video and audio messages issued by bin Laden, Ayman al-Zawahiri, and other leading figures in al Qaeda. Such videos, posted on file-sharing sites and other open forums, are difficult to track and counter, as they can spread rapidly to multiple sites across the internet. A wide range of terrorist organizations, including the Tamil Tigers, Hamas, and Hezbollah, have now set up official or quasi-official web sites, often with sophisticated internet content, chat rooms, and well-produced videos to disseminate their messages. On top of these web sites are a range of unofficial but supportive web sites, often located in little-noticed host servers located throughout the

world, where supporters of the organization can discuss their activities and exchange information. Counterterrorism officials also believe that web sites, chat rooms, and blogs can be used tactically for the dissemination of operational orders to cells planning an attack.

The internet has also been used for radicalization of potential recruits and for popularizing terror attacks to a wider audience. The low-cost barriers to entry on the internet have facilitated the rise of a number of charismatic figures who offer religious and historical instruction of often dubious quality, as well as a compelling interpretation of events, to a wide audience of potential recruits. For example, the Yemeni-American cleric Anwar-al Awlaki has recorded numerous audio and video recordings of his sermons, which demonize the West and exhort Muslims to engage in terror attacks against the United States and its allies. These recordings of his sermons are widely available on the internet, and there is some evidence that those engaged in terror attacks – including the 9/11 attacks and the failed Christmas Day bombing of Northwest Flight 253 in 2009 – have been directly influenced by his call to action. The internet has also proven to be successful in popularizing terror attacks, often with graphic imagery, to generate sympathy and produce new recruits. The Iraqi insurgents, for example, often posted videos of beheadings online; a number of European terrorist suspects reported being influenced by graphic images of fighting in Afghanistan and Chechnya. Terrorist organizations have also recently proven highly innovative in their use of more sophisticated forms of 'new media.' For example, al Qaeda has produced a number of online Arabic and English language magazines, often with high production values, in a deliberate appeal to youth recruits. One of the most striking recent trends has been the production of nasheeds, online songs, and music videos that often emulate Western rap and hip hop styles, in an effort to glorify the actions of those who participate in violent jihad and encourage others to follow suit.

### Conclusion

The study of terrorism is a growing area of focus, as threats continue to develop, evolve, and change. In this field, there are multiple conceptualizations of terrorism that are often reflective of differing missions. Governments, agencies, academics, nongovernmental organizations, and others will likely continue to face the inherent challenges of working across these areas, while developing the background and capacity to face emerging threats such as so-called 'cyber-terrorism' which would ostensibly target critical infrastructures through finding and exploiting key vulnerabilities. If current trends persist, research in terrorism will continue to cross disciplinary boundaries to develop a more cohesive and coherent understanding of the multifaceted problem of terrorism.

*See also:* Aggression; Anger; The Clinical and Cognitive Psychology of Conflict; Forensic Psychology in Contemporary Society; Group Dynamics; Leadership; Motivation; Violence; Media Influence on Behavior; Prejudice, Discrimination, and Stereotypes (Racial Bias); War.

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- [www.informaworld.com/dac](http://www.informaworld.com/dac) – Dynamics of Asymmetric Conflict: Pathways Toward Terrorism and Genocide.
- <http://www.start.umd.edu/gtd/> – Global Terrorism Database.
- <http://www.icst.psu.edu/index.shtml> – International Center for the Study of Terrorism, Pennsylvania State University.
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- <http://www.start.umd.edu/start/> – National Consortium for the Study of Terrorism, University of Maryland.
- <http://www.rand.org/nsrd/projects/terrorism-incidents.html> – RAND Database of Worldwide Terrorism Incidents.
- <http://www.tandf.co.uk/journals/tf/1057610X.html> – Studies in Conflict and Terrorism.
- <http://www.tandf.co.uk/journals/titles/09546553.asp> – Terrorism and Political Violence.
- <http://www.terrorismanalysts.com/pt/> – Terrorism Research Initiative/Perspectives on Terrorism.
- <http://icrs.info/index.php> – The International Center for the Study of Radicalization, King's College, London.
- <https://wits.nctc.gov/FederalDiscoverWITS/index.do?N=0> – Worldwide Incidents Tracking System.

## Test Behavior

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### Glossary

**Cognition** Thought or mental processes involved in perception, attention, memory, judgment, decision-making, problem-solving, or other mental operations.

**Formative assessment** Instrument or procedure conducted prior to and/or during a course that assesses students' skills for the purpose of planning instruction for those students.

**Metacognition** Thought or mental processes involved in the monitoring and/or strategic regulation of other cognitive processes.

**Summative assessment** Instrument or procedure conducted following course instruction that assesses

students' mastery of the knowledge and/or skills taught in the course.

**Test** An instrument (along with a set of procedures) that results in a score, capturing information about the knowledge, skills, attitudes, or other attributes of an individual or social group.

**Test-wiseness** An examinee's ability to use characteristics of the test and/or test situation independent of the construct(s) being measured to improve his or her observed score.

**Validity** The degree to which test scores serve as an appropriate indicator of interpretations made with respect to the proposed uses of a test.

### Introduction

Recent years have seen a rapid growth in the number and variety of assessments administered in educational, psychological, and vocational settings throughout the world. In some countries, children as young as 5 years old begin taking tests in school and grow up regularly taking many different types of assessments for much of their lives. The importance of testing should not be underestimated as test scores are used by parents, educators, school admission counselors, potential employers, psychologists, or test takers themselves to make decisions regarding an individual's educational and career development or clinical status. And the results from tests, aggregated across groups, are also frequently used to shape public policy in a number of countries. The incidence, regularity, and importance of testing can either directly or indirectly influence the behaviors of examinees in myriad ways that may, in turn, impact test performance and the interpretation of test scores.

Behaviors that enable individuals to perform to the best of their knowledge and capabilities in a test situation help to ensure that the test serves as a valid indicator of the construct intended to be measured. By the same token, test validity may be compromised when individuals either underperform in the assessment (say by succumbing to high levels of anxiety and stress) or overperform (say by applying test-taking strategies that enable them to successfully guess correct answers). It is therefore critical to better understand both how testing shapes behavior and how behavior influenced in the test situation.

Test developers, test administrators, and test takers may limit such considerations to specific behaviors displayed in the context of a test situation. However, test behaviors encompass a wider range of human thought and actions that extend well before or after an examinee takes a particular assessment. That is, prior to taking a test, certain factors may affect the behavior of individuals as they anticipate and/or prepare

for an upcoming assessment just as certain factors influence behavior during test situations. Moreover, taking a test influences the subsequent behavior of an individual.

The purpose of this article is to provide an overview of the topic of test behavior, focusing primarily on testing in educational settings, though the principles are broadly applicable to all testing applications. Our aim in writing this article is to paint test behavior with a fairly broad brush, such that we do not get too involved in the details of research studies or theoretical discussions. (The curious reader can find a number of references, at the end of this article, that we have selected to address these issues.) So, we first define some broad distinctions and key terminology related to test behavior.

Next, we discuss important factors, highlight key empirical findings, and raise general questions about the aspects of behavior associated with testing. Specifically, this article is organized according to the types of behavioral factors assumed to operate in the test situation, which include physical, cognitive, metacognitive, individual difference, and social factors. In discussing each factor, we consider behaviors that occur in anticipation of, during, and following a test situation, as well as emphasize the reciprocal relationship between testing and behavior. Just as testing can impact behavior, advances in our understanding of behavior can influence the manner in which tests are developed and administered as well. We end with a set of conclusions and some suggestions for future research directions that the reader might profitably explore.

### Tests: Types and Purposes

To address the general question of how testing influences behavior, it is necessary to consider particular characteristics of the test situation itself. First, what type of test is being administered? Tests come in many different forms, depending upon the purpose of the assessment. In the classroom,

instructors may provide students with formative or dynamic assessments, which may include quizzes or other tasks designed to gauge students' knowledge and understanding of a particular subject matter and guide subsequent instruction. To the extent that such tests are used to identify and correct knowledge gaps and misunderstandings, they are also referred to as diagnostic assessments. By contrast, static or summative assessments, such as end-of-chapter, final, or standardized state tests, are designed to measure what students have learned in a particular domain through the course of instruction. These are but one of a series of taxonomies available for testing. For example, within the above mentioned assessment, tests may also be norm-referenced, which means that an individual's performance is measured in relation to that of a reference group (e.g., individuals of the same age, grade level, or socioeconomic background). Alternatively, criterion-referenced assessments measure individual student performance against a particular standard, which is typically defined by educators and policy makers as a task or body of knowledge that students are expected to perform or possess.

Additional test characteristics that may impact behavior are the format of the test questions and the physical and/or social conditions of the test situation. For instance, how individuals prepare for and react to taking a multiple-choice test may differ in myriad ways from their preparation and reaction to tests containing short answers or essay questions, often referred to as open-ended or constructed response tests. How individuals behave in relation to a test situation may also depend upon the modality of test presentation (e.g., aural vs. visual, computer vs. paper-and-pencil), test-takers' responses (e.g., oral vs. handwritten vs. keypad), and whether time limits are generous or strict.

It is important to consider contextual factors as well. Are students testing themselves in an informal self-guided manner, or are they being given a more formal assessment designed and administered by others? Is the test given to individuals in a private or public setting? Is the test administered to individuals alone or is it done in collaboration with other test-takers? Is the test taken in the same location where students originally learned the subject matter in which they are being assessed? Are the consequences of successful or poor performance on the test perceived to be great (high-stakes test situation) or relatively insignificant (low-stakes test situation)? These are some of the questions that underscore the intricacies of how specific features of test situations may influence behavior.

Of course, just as the specific type, format, or context of a test may affect behavior, so too it is necessary to specify what aspects of behavior and its underlying mental processes are influenced by testing. Behavior, broadly defined, is neither a monolithic construct nor is it limited to observable, external responses, but rather, it encompasses a wide range of physical, mental, and even social factors. These factors include (1) physical or physiological factors, which refer to the physical state of the test taker as well as the physical conditions of the testing environment; (2) cognitive factors, which typically refer to mental activities such as human perception, attention, and memory; (3) metacognitive factors, which refer to the mental activities associated with individuals' attempts to monitor their own knowledge, understanding, and skills in a particular domain; (4) individual differences, which include psychological

constructs such as personality, emotion, interest, and motivation; and (5) social factors. Of course, this typology of factors is by no means exhaustive; however, it provides a useful framework for highlighting some of the complicated effects that testing can produce on the different measures of test-takers' thoughts and actions.

### Physical and Physiological Conditions

Ask almost any parent or educator or consult any one of the numerous guidebooks and Web sites that offer test-taking tips, and they will invariably tell you that to best perform on a test, examinees must feel comfortable, relaxed, well-fed, and rested. The common presumption is that individuals who are ill, tired, hungry, or otherwise uncomfortable will perform poorly on a test. This is, for instance, why examinees are often advised to get a good night's sleep and eat a nutritious meal replete with protein and carbohydrates before a test. This is also why many assessments are administered in quiet environments that provide adequate lighting, ventilation, moderate temperatures, and comfortable seating.

Despite the common acceptance of these practices, numerous studies have actually shown that physical conditions that may be somewhat uncomfortable or even distracting to examinees have little or no impact on the test performance. This is especially true in high-stakes test situations. For many test takers, moderate changes in noise levels and temperatures may increase their arousal, which may, in turn, enhance test performance.

What is less well known is the subtle ways in which the physical and temporal context of a test situation may influence behavior. For instance, there is some (albeit limited) empirical evidence showing how individuals vary in terms of their sleep and wake schedules and how this may impact test performance in meaningful ways. Morning people who are most alert during the early periods of the day may perform worse on a test administered in the late afternoon. Conversely, evening people may perform worse on a test given too early in the morning.

Laboratory and classroom-based studies have also corroborated the notion that examinees may best prepare for a test by practicing older tests under physical conditions that are similar to those of the upcoming test. For example, in a famous psychology experiment, divers studied lists of words while standing on a beach as well as underwater, and then they attempted to recall the words in either environment where the lists were originally learned, or in the alternative environment. It was found that lists learned underwater were best recalled underwater, and vice versa.

Researchers have posed similar questions of learning in educational settings. Should students be tested in the same classroom in which they learned the subject material to be tested? Is it important for students to be in the same mood or physical condition during testing as they were in during learning? To date, there is some evidence to suggest that the physical context and mental state in which a person prepares for an upcoming test does matter, but the impact of these factors is often found to be fairly small, so definitive answers to these questions await future research.



## Cognitive Processes and Strategies

From the moment individuals are informed that they will be given a test, or when they decide to take a test of their own accord, examinees begin to engage in anticipatory thoughts and actions that may occur minutes, days, or even years prior to actually taking the test. This is especially true for high-stakes assessments where test scores play an important role in decisions that affect the academic and career prospects of test-takers. Whether and how individuals prepare for upcoming tests can have a significant influence on performance outcomes. Moreover, performance in test situations depends and may have an enduring impact upon a variety of conscious and unconscious mental processes involved in perception, attention, memory, problem-solving, judgment, and decision-making.

### Test Expectancy

The starting point in the process of test preparation is becoming familiar with the form and contents of the upcoming test. Thus, when individuals are informed about the exact type of test they will receive on the subject that they have been asked to learn, they focus better on their preparatory study on important information. As a result, final test performance will be improved relative to examinees who have a vague idea of the upcoming assessment. Indeed, students often ask their instructors at the beginning of a course about what type of exams they should expect. But, does it really matter if students are told that they will be given a multiple choice, short answer, or essay exam, even if they end up taking a different type of test?

The answer to this question depends upon the context. In one set of studies, participants were asked to study lists of words with the expectation of taking a final test of their memory. While one group of participants expected a final recall test (e.g., write down as many words as you can remember from the study list), another group expected a recognition test (e.g., was this word on the previously studied list or not?). It was found that the expectation to take a recall test produced superior memory performance on final tests of both word recall and recognition than the expectation to take a final recognition test. However, the advantage of expecting a recall test cannot be generalized because it has failed in classroom settings with educationally relevant study materials and test formats. Instead, examinees tend to perform best on the specific type of test they expect to take, be it a multiple choice, short answer, or essay examination.

How knowledge of the upcoming test is utilized by examinees to prepare for the test depends upon a host of other factors, including (1) the perceived stakes of the test; (2) examinees' current knowledge in the domain to be tested; (3) examinees' self-assessment of their own knowledge and skills; and (4) the personality of the examinee. For example, the psychological expectation of taking high-stakes assessments may, at one extreme, compel some examinees to devote years of time and effort to test preparation, whereas others at the other extreme may take the test with little or no advance preparation. By contrast, even when examinees anticipate a low-stakes assessment, such as in-class quizzes that count relatively little toward final course grades, conscientious or highly

motivated students may still spend considerable time reviewing notes or old exams beforehand.

### Test Preparation

When examinees do know what to expect, how should they best prepare for the upcoming test? In general, individuals who repeatedly practice or are taught the skills and information to be assessed well in advance of the upcoming test will perform better than examinees who have not engaged in such preparatory activities. These activities include taking practice on similar tests or old forms of the specific upcoming test. In addition, this involves learning test-wisness skills – strategies that enable examinees to maximize performance in a wide variety of test situations. For example, if a test-wise student is unsure of an answer to a multiple-choice question, a rational strategy might be to eliminate one of the distractors in that question if it appears to be the correct answer for another question in the test.

Researchers have identified test-wisness strategies that are independent of test construction. These include using time well, avoiding avoidable errors, and using deductive reasoning. Test-wisness strategies that are dependent upon the test construction also exist. These include answering questions by taking the construction of other questions into consideration, taking into account the intent of the test creator and using cues (such as answer length) to help determine the correct answer. Research has demonstrated that students high in test-wisness tend to perform better on tests. While the benefits of coaching in test-wisness skills are considered applicable to many test situations, their effectiveness in specific situations often depends upon the test takers' knowledge and skills within the assessed domain, as well as their knowledge of the design and purpose of the test. Also note that in many high-stakes situations, the efficacy of these test-wisness strategies may be diminished as assessment developers are instructed to avoid precisely the elements that are being coached (e.g., to keep all answers at a similar length, to avoid giving away information in other items).

In terms of learning the particular domain of knowledge and set of skills to be tested, two general theoretical principles derived from laboratory studies of human learning and memory are worth highlighting: transfer appropriate processing and encoding specificity. According to these principles, practicing the types of problem-solving strategies and mental operations under the same conditions as the upcoming test will enhance final test performance. Conversely, any mismatch between learning and testing conditions may lead to poorer performance, such as might be the case of a teacher who encourages students to engage in study strategies that promote a deep conceptual understanding of the subject matter, but then gives students a multiple-choice test that emphasizes recognition of isolated facts.

Just as one of the best ways to prepare for a test is by practicing taking similar, older tests, testing can also have positive effects on learning and subsequent test behaviors. Numerous studies in the psychology literature have shown that testing not only assesses a person's knowledge but can also transform it by rendering it more resistant to forgetting over long term as compared to restudying the information. This finding, known as the testing effect, has been

demonstrated in educational settings using a wide range of study materials among various test-taking populations. More importantly, taking a test may bestow additional benefits on subsequent learning. Testing can provide students and instructors with rich feedback regarding their own strengths and weaknesses that, in turn, will aid future study and instruction by identifying areas that require more study or instruction time and effort, as well as areas that are well learned, and therefore, require less attention. This is the primary aim of formative assessments. In addition, there is some empirical evidence that testing can enhance the long-term retention of non-tested information that is conceptually related to previously tested knowledge, as well as permit better transfer of learning by improving performance on future tests that assess new knowledge domains.

### Biases and Heuristics in Responding

Despite an individual's conscious efforts to prepare for and perform well during a test, actual test performance may be unwittingly influenced by psychological factors that are difficult to overcome. In particular, naïve strategies or cognitive biases can have a significant impact on human performance in various judgment and decision-making tests. One naïve strategy, or heuristic, students often use, and one that is often taught to them by their parents and teachers, is to stick to their 'first instinct.' Previous research has demonstrated that three out of four students believe that changing one's answer usually leads to the choice of incorrect answers.

Not only do students hold this belief, research has demonstrated that a large percentage of college professors also believe that it is better to stick to one's first answer than to go back and change it. This conventional 'wisdom,' however, is wrong. A change answer is more likely to be correct than was the original answer. Nevertheless, most students tend to continue to believe that sticking to one's first answer is a wise strategy. Why does this occur? Recent research has found that one reason people hold this erroneous belief is that answers that are changed from correct to incorrect produce frustration and are thus more memorable than answers that are changed from incorrect to correct. As such, students tend to overestimate the frequency of the incorrectness of answers that have been changed.

### Metacognition

In contrast to the accepted wisdom of what individuals should do to learn specific content and prepare themselves for test situations, many studies have found that individuals demonstrate poor ability to judge what are the best learning strategies to adopt; how well they know, understand, or remember subject matter; and how to best allocate their study time and effort. Left to their own devices, people tend to select the easiest, least effortful learning techniques and apply them in an inefficient manner.

Of course, the accuracy of metacognitive judgments or self-assessments varies considerably across individuals, with some people being much better attuned than others to their general strengths and weakness, as well as to identifying specific gaps

in knowledge and understanding. The accuracy of self-assessments also varies with respect to domain. For instance, people are usually overconfident in their ability to perform tasks that assess their knowledge and comprehension of subject matter, but they tend to be underconfident in their ability to perform sensory or perceptual tasks.

Who tend to assess themselves most accurately? Perhaps not surprisingly, good students tend to be more accurate in their self-assessments than do poorer ones. That is, good students tend to be able to more accurately predict the grades that they will receive on future tests. In contrast, poorer students tend to be overconfident about the grades they will receive. Although one might predict that poor students' overconfidence would be remediated when they receive disappointing feedback about test scores, this does not seem to be the case. Research has demonstrated that poor students remain very overconfident even after they receive negative performance feedback.

The fact that poor students tend to be overconfident can have important implications for their test-taking behavior. While good students with accurate self-assessments will have a good idea of just how much they should study poor students will tend to spend an insufficient amount of time studying because they are overconfident. This may lead poor students to continue to perform worse in tests than their peers with more self-awareness.

Inaccurate self-assessments have detrimental effects not only on those students who overestimate their ability but also on those who underestimate their ability. One recent line of research theorized that both students who have a tendency to overestimate their test performance and those who have a tendency to underestimate their test performance are motivated to practice ineffective study strategies so that their future test performance will be less diagnostic of their actual ability. Put in another way, those who underestimate themselves do not want a poor test performance in the future to confirm their negative self-view. Thus, they practice self-handicapping strategies (purposely placing obstacles in the way of performance) when studying for tests to avoid this confirmation. In essence, the self-handicapping allows them to tell themselves that their poor test performance was a result of self-handicapping rather than low ability. Furthermore, those who overestimate themselves do not want a poor performance in the future to threaten their inflated self-view. Thus, they also practice self-handicapping when studying for tests. These predictions have been verified in both experimental and nonexperimental studies. In general, these studies suggest that both overestimators and underestimators (a) choose to study in a noisy, rather than a quiet, study environment and (b) spend less time studying than do students who are accurate in their self-assessment. Thus, the former tend to perform worse on subsequent tests and also have lower grade point averages than the latter group of students.

The ways in which students typically study for tests can also lead to overconfidence in estimates of how well a subject has been learned. Research demonstrates that distributed studying (studying over several sessions) leads to better retention of material than does massed studying (studying a lot over a single period). However, students tend to practice massed studying to a much greater extent than distributed studying. Why is this? One reason offered to account for this

phenomenon is that most students are not diligent at planning their study time in advance. Another reason is that students tend to be overconfident in the amount of material they retain when studying in a massed way. Although students do not retain material well with massed studying, they do tend to learn material quickly in massed studying. The problem is that they also forget very quickly. However, students tend to falsely estimate that material that is learned quickly will also tend to be remembered for a long period of time. Thus, they tend to overuse massed studying, which leads to overconfidence in the ability to remember the material they studied when they are taking the exam.

Other researches also demonstrate that students are overconfident about the extent of their understanding of what they have read. For example, several research studies in which students read a passage and are then asked to predict how well they can answer questions about the passage they have just read have been conducted. Next, they are asked to actually answer a series of questions about the reading passage. The correlation between predicted and actual performance tends to be low, providing evidence that students do not fully comprehend the reading. This finding has implications for studying for tests: many students spend an insufficient amount of time on reading materials relevant to the test.

Finally, there is also evidence that confidence can be thought of as an individual difference factor. Thus, some students consistently display more confidence in their chances of succeeding in an exam than do other students. Additionally, male students tend to be more overconfident than female students. As stated earlier, this can have important implications for test preparation behavior, with overconfident students displaying a tendency to understudy for tests.

### Improving Self-assessment

What steps can individuals take to improve the accuracy of self-assessments and thereby develop good test preparation habits? One effective strategy is to teach students to stop periodically and check their understanding of their reading. One possible way to do that would be to give occasional self-quizzes during study times. Quiz questions that were answered incorrectly can be used as cues that a reading passage was not fully understood. Furthermore, students can become more accurate in their self-assessments by comparing themselves to students who achieve good grades. One possible way to do this would be to join a study group that consists of high-achieving students. Finally, another way students can gain a more accurate self-assessment is to have a fellow student rate them. Peer-ratings tend to be highly correlated with teacher-ratings, and thus, can be a useful piece of information for students who desire to accurately assess their level of class knowledge. This information can then let the students know how much they should be studying for the upcoming tests.

### Individual Differences

Behavior is highly context-dependent. For instance, the average person will behave in a much more sociable way while attending a party than while attending a funeral. Indeed, it is not difficult to

imagine that most funeral attendees would be quite shocked to see a person smiling, talking, and generally having a good time while attending the funeral of a loved one. However, although typical behavior changes dramatically between contexts, people can still be differentiated on basis of their typical behavior within contexts. A very outgoing person will tend to be more talkative than a shy person at both a party and a funeral.

The same can be said of students' test-taking behavior. Although students' test-taking behavior is similar overall, there are still important differences between individuals that can predict test-taking behavior. These differences include personality, test anxiety, coping, and cheating.

### Personality

Among researchers, there is now overwhelming consensus that personality consists of five factors and that people vary in how much they display each of these factors. The five factors are (1) openness to experience, (2) conscientiousness, (3) extraversion, (4) agreeableness, and (5) emotional stability. These factors are highly predictive of several behaviors, including test behavior. For example, some personality factors predict procrastination, which in this case means consistently delaying studying for tests. Often, this is accompanied by a sense of anxiety and dejection. Research has revealed that conscientiousness and emotional stability predict procrastination. That is, conscientious and emotionally stable students tend to procrastinate on studying for exams to a lesser extent than students who are less conscientious or emotionally stable. Furthermore, conscientiousness is the single strongest predictor of procrastination among these five personality traits.

Not only do highly conscientious students tend to procrastinate less than their less conscientious peers, they also tend to study more for tests. The finding that conscientiousness predicts grades at all levels of education is now well established in the research literature. This is true with the case of intelligence too. Additionally, none of the other four personality factors comes close to the predictive power that conscientiousness has in predicting test performance.

### Test Anxiety

In addition to feeling anxious about procrastination, students may also feel anxious about the test itself. Much research evidence that suggest that students vary on the amount of anxiety they feel about test situations and that this anxiety can negatively impact test performance has accumulated. Although test anxiety may have its greatest impact during the actual test, it can also have an impact during the test preparation stage and after the test is over. It is generally agreed upon that test anxiety consists of four components: (1) *worry* – cognitive concerns related to poor performance on the test, (2) *test-irrelevant thinking* – thoughts that take one's attention away from the test, (3) *tension* – feelings of distress, uneasiness, fear, and panic during tests, and (4) *bodily reactions* – the tendency of test situations to elicit heightened activation of the sympathetic nervous system.

Students with high test anxiety and are studying for tests may experience a great deal of worry, thoughts that are irrelevant to the test, physical tension, and other negative bodily reactions

(e.g., sweating, increased heart rate) when thinking about the test. As a result, they may find themselves unable to fully concentrate on their test preparation and may practice ineffectual coping behaviors, such as avoiding thinking about the test altogether, to deal with this anxiety. As a result, students with high test anxiety may come underprepared for the test.

Several studies have found that test anxiety is consistently negatively correlated with test performance and that worry and test-irrelevant thinking have a stronger negative relationship with performance than tension and bodily reactions. It is possible that worry and test-irrelevant thinking impair test performance by reducing the amount of cognitive resources necessary to successfully complete a test. For example, working memory and concentration is impaired when students worry about failing the test rather than pay full attention to test items.

Finally, test anxiety may continue to influence student behavior after the test, as highly test anxious individuals will not simply stop worrying about the test once it is completed. Rather, they may continue to worry, feel tensed, and experience negative bodily reactions until they receive their grade (and possibly even after). The worry, tension, and negative bodily reactions they experience after completing a test can serve to further deplete cognitive resources available for subsequent tests, thus creating a vicious cycle whereby anxiety reduces test performance, which in turn creates anxiety and further reduces performance in following tests.

### Coping

Students can use several coping mechanisms to deal with the stress and anxiety that come with taking tests. People tend to cope with stress and anxiety in one of the three ways. *Problem-focused coping* refers to efforts to alter the stressful situation itself. For instance, the stress and anxiety of an upcoming test can be minimized by studying for the test, thus eliminating the stress-inducing power of the test. *Emotion-focused coping* refers to efforts to reduce one's response to the stressful situation. In this case, the stress of an upcoming test can be reduced by imagining all the positives that will come from successfully completing the test – thus, the meaning of the test is reframed from a negative one to a positive one. Finally, there is *avoidance-oriented coping*, in which the stressor is avoided altogether. Thus, the stress of an upcoming test can be avoided by doing something that takes attention away from the test, such as going out with friends or watching television instead of studying.

Although results of research on the relation of coping to test performance are not entirely consistent, some research has found that both problem-focused and emotion-focused coping are positively related to students' test performance. Other research have found that optimism concerning performance in tests is related to problem-focused coping, that pessimism is related to avoidance-coping, and that these relationships are mediated by motivation. Thus, more optimistic students tend to be more motivated to succeed on the test and thus deal with the stress and anxiety of test situations by using problem-focused coping or studying more. In contrast, pessimistic students tend to be less motivated to succeed on the test and thus deal with the stress and anxiety of

test situations by using avoidance-coping or doing things to take their attention away from the test.

### Cheating and Its Correlates

An unfortunate fact of testing is that one behavior that can improve student test scores is cheating. After all, it is often much easier to get an answer correct by peeking at your neighbor's test than by spending hours studying. The decision of a student to cheat is determined by a multitude of factors, and recent research has identified a few of them. For example, research has found that *subjective norms* predict the intention to cheat on exams. Subjective norms refer to how others who are important to you (e.g., family, friends) feel about the behavior. Thus, for example, students are more likely to intend to cheat on exams if their friends also cheat on, or approve of cheating on, exams. Students' sense of *moral obligation*, or the belief that cheating would be morally wrong, also predicts their intention to cheat. Finally, *perceived behavioral control* also predicts cheating on tests. Perceived behavioral control is a student's perceived capability to cheat. A student who believes that he or she can easily cheat without being caught is more likely to cheat than one who believes that cheating without being caught will be difficult.

### Social Factors

Although assessments are typically designed to test characteristics of individuals in isolation from others, social factors can have a significant impact on individuals' test behaviors. For example, the number of examinees taking the same test in one location may affect individual performance due to feelings of competitive motivation aroused (or diminished) in a group setting. Some researchers have observed that in high-stakes test situations, increasing the number of competitors in a test-taking group lowers individuals' motivation and effort, which may worsen performance. By contrast, there is a significant increase in individuals' motivation and effort in small test-taking groups.

Laboratory research has also provided evidence that performance on tests can be harmed by the fear that one will confirm the notions of a negative stereotype that exists about one's cultural group. For example, there is a stereotype that African Americans are intellectually inferior to other ethnic groups. Several studies have indicated that African Americans are concerned that their poor performance on a test will tend to confirm this stereotype. This finding suggests that for an African-American student, taking a test described as a test of intelligence may engender anxiety that can harm test performance.

This phenomenon is referred to as *stereotype threat* and is not unique to African Americans. For instance, Latinos perform more poorly than whites when a test is described as diagnostic of intelligence, and white men perform worse on a math test when they are told that their results will be compared to the results of Asian men. These effects are especially prevalent when a person's attention is called to the negative stereotype. It is important to note that there is very little evidence that stereotype threat effects exist outside of laboratory studies. More research is necessary to determine whether stereotype threat exists in important real-world test situations, such as when students take the SAT or ACT.

## Summary

There are a variety of physical and psychological factors that can determine whether and how individuals prepare for and perform during an upcoming test. The factors include, but are not necessarily limited to, the expectancy of the future test, examinees' perceived and actual knowledge and skill level in the domain to be assessed, and personality characteristics, such as examinees' level of interest, motivation, and conscientiousness, as well as the physical, temporal, and social context of the test situation.

Individuals may best prepare for a test by practicing on similar tests or by solving problems that require the mental operations and skills to be tested under conditions similar to the actual test situation. Examinees may also benefit from familiarizing themselves with test-wiseness skills, depending upon the design and purpose of the test, and soliciting feedback regarding their knowledge and/or skills from peers and educators. Despite an individual's conscious efforts to physically and mentally prepare for and maximize performance during a test, his or her behavior may still be unwittingly influenced by ingrained biases or beliefs. In addition, taking a test itself can both directly and indirectly influence the future thoughts and actions of examinees. Testing can provide examinees with feedback that can promote optimal subsequent study and test preparation, as well as directly improve measures of long-term retention and learning.

In addition, just as testing influences behavior in myriad ways, advances in our understanding of behavior affect test development and administration. As mentioned earlier, the efficacy of test-wiseness strategies may be diminished in many high-stakes situations because assessment developers are instructed to avoid precisely those that are being coached. Test developers also strive to ensure that all test takers can perceive, understand, and solve test questions in the manner in which the questions are intended to be solved. Moreover, recent years have seen increased interest in the development of 'cognitive diagnostic' assessments that are designed to measure test takers' strengths and weaknesses in specific cognitive skills and functions. The challenge of future research in test development is to create assessments that not only advance

educational or psychological measurement, but that in so doing, also promote the most beneficial test behaviors.

*See also:* Academic Achievement; Anxiety and Fear; Cognition and Personality; Cognitive Bias; Human Intelligence; Memory; Motivation; Problem Solving; Self-Efficacy; Self-Esteem; Studying.

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## Tickling

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### Glossary

**Affect** Feeling or emotion.

**Duchenne smile** A smile, usually elicited during positive emotions, that includes upturned lips accompanied by a crinkling of the skin around the eyes.

**Fixed action pattern** A stereotyped sequence of behaviors that is triggered by a releasing stimulus.

**Gargalesis** Laughter-inducing tickle elicited by a somewhat strong pressure repeatedly applied to certain ticklish areas of the body. This form of tickle cannot be self-induced.

**Knismesis** Type of tickle that is elicited by a light movement across the skin and is not usually associated with laughter. The sensation can be readily produced in the self.

**Ontogeny** Development.

**Reflex** An unlearned, involuntary, automatic response.

Almost everyone has at some time been tickled by a friend or relative. Tickling is a favorite method used by parents to get their infants to laugh and young couples often include tickling in their courting behavior. Given its common occurrence, tickling might seem like a rather simple straightforward social behavior. However, a closer examination of the phenomenon of tickle reveals a number of peculiarities. The fact that a physical touch can produce smiling and laughter – responses that are normally elicited by psychological stimuli such as comedy – is odd, in and of itself. However, it becomes even more puzzling when one considers that despite outwards signs to the contrary, many people report that they do not enjoy being tickled. Another peculiarity is that one cannot make oneself laugh via self-tickling.

The mysterious nature of tickle has been pondered for over two millennia by some of the greatest minds in history including Aristotle and Plato, Galilei Galileo, Francis Bacon, and Charles Darwin. Despite the long history of interest, the empirical research on tickle is rather scant, but has been growing in the last decade or so. This article will discuss both the theories and empirical research that exists on tickling, particularly focusing on issues surrounding the smiling and laughter it induces.

### Two Forms of Tickle: Knismesis and Gargalesis

The English word ‘tickle’ seems to refer to at least two rather distinct, although perhaps not mutually exclusive, phenomena. One is the peculiar sensation, sometimes characterized as a moving itch, caused by a very light movement across the skin. This type of tickle can easily be elicited almost anywhere on the body by moving one's finger lightly across the skin. The annoying sensation can outlast the stimulation by many seconds, and creates an intense desire to rub or scratch the tickled surface (doing so seems to terminate the sensation). Of note, this form of tickle rarely makes people laugh. By contrast, the tickle that causes laughter usually requires a heavier pressure repeatedly applied to specific areas of the body such as the armpits or ribcage. The distinction between these two types of tickle was noted as far back as 1897 by the prominent late nineteenth century psychologist G. Stanley Hall in the *Dictionary of Psychological Medicine*. Hall and his colleague,

Arthur Allin, suggested that the light tickle be called ‘knismesis’ and the laughter-inducing heavier tickle, ‘gargalesis.’ The distinction between these two types of tickle, however, seems blurred when one considers the feet. Deep pressure to the foot produces a sensation of massage for most people, while a somewhat lighter touch often produces laughter.

Knismesis seems clearly different from the arguably more mysterious gargalesis. For one thing, as noted above, knismesis generally does not produce laughter, which in many ways is the most perplexing aspect of tickle. Second, people can readily elicit the sensation of knismesis in themselves, however, they cannot successfully produce gargalesis in themselves (i.e., tickling oneself does not elicit laughter).

Finally, it seems easy to imagine an evolutionary function for knismesis: the annoying sensation prompts one to scratch or rub the tickled spot, thereby removing insects or parasites that might be crawling on one's body.

### Tickling in Nonhumans

Knismesis, the response to very light touch, appears to be widespread across many mammals. The reactions of a dog scratching its side at a flea, or a cat flicking its ear at a mite are commonplace.

Gargalesis may not be as frequent in the natural world as knismesis, but work by primatologists suggests that chimpanzees and at least some other primates such as gorillas tickle each other in the course of rough-and-tumble play, producing what seems to be a nonhuman primate equivalent of laughter. A chimpanzee's laugh sounds different from a human's laugh – it is more of a breathy panting sound. This panting, accompanied by a relaxed open-mouth and quivering lower jaw, appears to be the phylogenetic precursor of human laughter. There is little doubt that tickling can induce such reactions in young apes.

Researchers working with rats have also noted that the rapid movement of human fingers on the back of the neck of juvenile rats causes the rats to emit high-frequency ultrasonic vocalizations. A number of researchers have referred to this as rat tickling, but it is unclear whether it bears any relationship to the tickle response of humans.

## Ontogeny of Tickle

Newborns do not laugh. In fact, babies do not begin showing laughter until around 4 months of age. Their laughter in response to being tickled is even a bit more delayed – usually emerging around 6 months. Various views have been offered on the connection between the development of humorous and ticklish laughter.

One hypothesis is that ticklish laughter is itself a conditioned response that emerges out of other humorous play. Perhaps children laugh when tickled because tickling has always taken place in playful situations in which laughter is already occurring. This repeated pairing could lead to Pavlovian conditioning whereby laughter then becomes associated with tickling movements, even when not paired with other humorous situations. Another possibility is that children laugh when tickled because of the laughter of the tickler which creates some contagious loop (e.g., a parent's laughter causes the child to laugh which increases the parent's laughter, and so on).

In the 1940s, Clarence Leuba from Antioch College came up with a clever way to test whether laughter in response to tickling would emerge even if tickling were never paired with other laughter-inducing play or with laughter from the tickler. His subjects were two of his own babies. From the beginning of each infant's birth, Leuba and his wife deliberately refrained from tickling their children during playful situations. All tickling took place by Leuba while he wore a mask that obscured any possible facial expressions to ensure that the infants would not associate tickling with smiles and laughter. Despite all this, Leuba found that ticklish laughter emerged in both infants around the age of 6 or 7 months. Although this study has limitations, it suggests that laughter from tickling does not emerge because of tickling being paired with other humorous or pleasant stimuli.

Others, such as Alan Fridlund from the University of California at Santa Barbara, have suggested the reverse causal sequence – perhaps humorous laughter emerges from ticklish laughter. Babies differ in the degree to which they respond to tickling. Parents of easily tickled babies are more reinforced for engaging in tickling (i.e., their infants' laughter is a positive experience) which probably leads them to do it more often. Such play then might be extended to include other forms of humorous physical interactions and eventually to mental stimuli, thereby leading offspring to laugh at humor as well. Such a view, however, has difficulty accounting for the fact that ticklish laughter appears to develop slightly later than laughter that emerges from first primitive forms of humor (e.g., playful menacing such as 'I'm going to get you').

## Positive Emotion and Tickle

The fact that smiling and laughter occur during tickling and during humor has led many writers to assume that the two reflect the same positive emotional state. One prominent champion of this view was the father of evolution, [Charles Darwin \(1872\)](#), who noted that "the imagination is sometimes said to be tickled by a ludicrous idea; and this so-called tickling of the mind is curiously analogous with that of the

body" (p. 199). Darwin pointed out several similarities between tickle and humor. First, he claimed that in order for either to elicit laughter, one must be in a pleasant hedonic state. He wrote "in this case, [humor] and in that of laughter from being tickled, the mind must be in a pleasurable condition; a young child, if tickled by a strange man, would scream in fear" (p. 199). Second, he noted similarities in the elicitors of each state, "The touch must be light' in tickle and 'an idea or event must not be of grave import' in humor. Finally, he pointed out that an element of surprise is required to elicit laughter to jokes or to humor. In essence, tickle was simply a physical joke. Many contemporary writers on this topic echo the view that ticklish laughter and smiling are signals of a positive affective state.

My colleague, Nicholas Christenfeld, and I examined the relationship between tickle-induced laughter and humor-induced laughter in the laboratory. Previous research had found a warm-up effect for humorous laughter: jokes that occur later in a series are funnier than those that occur earlier (presumably this is why 'warm-up' comedians give performances on stage before the top comedian does his or her routine). We reasoned that if ticklish laughter and humorous laughter reflect the same psychological state, there ought to be a 'warm-up' effect that transfers from tickling to humor and from humor to tickling. To examine this, subjects watched a videotape composed of the highlights of several comedy routines. They reported finding the comedy humorous and readily laughed and smiled while watching it. The connection between this type of laughter and that of tickling was tested by having a researcher tickle subjects either immediately before watching the comedy tape or immediately after watching the tape. Subjects laughed, smiled, and wiggled when tickled, but they did so to the same extent regardless of whether they had first been 'warmed up' with the comedy tape. Likewise, having just been tickled did not make people laugh more while watching the funny film. The lack of a warm-up effect between humor and tickle lends some support to the hypothesis that tickling-induced laughter is not simply a form of humorous laughter.

Another recent experiment also suggests that the tickle-induced smiling need not reflect positive affect. The proposition that the tickle response is due to humor has been based largely on the assumption that the smiling that is elicited during tickling is indeed the same as that which occurs during amusement. The facial expression that occurs during positive emotion usually includes two muscle movements: the upturned lips or smile (produced by contraction of the zygomatic major), and a crinkling of the eyes (produced by contraction of the orbicularis oculi). This type of smile has been named the 'Duchenne' smile, after a French physician from the 1800s who studied facial expressions and noted the importance of the eyes in conveying positive affect.

To determine whether tickling produces similar facial displays as humor, Nancy Alvarado and I conducted a detailed microanalysis of the facial displays of subjects while they were being tickled. Although Duchenne smiles were sometimes elicited during tickling, the smiling was different from that of humorous smiling in several ways. Some people showed Duchenne smiles while being tickled even though they did not report feeling pleasant emotion (i.e., happy or amused). In fact, for some of these participants, Duchenne smiling was

associated with finding the tickle sensation unpleasant. Moreover, people who said that they generally enjoyed being tickled did not display more Duchenne smiles than people who generally did not like being tickled. The dissociation between smiling and self-reported positive affect during tickle provides some support for the hypothesis that Duchenne smiles during tickling can occur even when people are not feeling positive emotion.

Thus, several findings suggest that ticklish smiling need have no closer an association to merriment and mirth than crying when cutting onions has to sorrow and sadness. However, such a conclusion does not imply that positive emotions never occur during tickling, just that positive affect is not required.

### Sociality of Tickling

A great number of writers across the ages have argued that the interpersonal context, including beliefs about who is doing the tickling and why, plays an indispensable role in whether or not tickling will induce laughter. For example, it is often assumed that the tickling must be done in a playful way with benign intent by someone that is not only known but also liked. Such ideas clearly have intuitive appeal, particularly since they would appear to provide a possible account for one of the greatest mysteries of tickling – why can't one elicit ticklish laughter in oneself? The answer, according to an interpersonal account, is that tickle-induced laughter, at the very minimum, requires the belief that another person is doing the tickling.

So how might one test this idea? One possibility would be to build a fully automatic tickle machine and see if it could make people laugh. At first blush, this might seem to be the perfect way to test whether tickle-induced laughter requires an interpersonal context. After all, if such a machine made people laugh, it would suggest that ticklish laughter does not require another person. However, if people did not laugh in response to the machine, one could never be certain whether the lack of laughter was due to their knowledge that it was a machine or the failure of the device to accurately mimic movements of a human hand.

To get around this problem, my colleagues and I created a 'mock' tickle machine in the laboratory using a robotic-looking plastic hand, a vacuum cleaner hose, and a nebulizer (a device used for asthma) to provide sound effects. Then, in an experiment, subjects were blindfolded and told that they would be tickled twice, once by the machine and once by the experimenter. In reality, the machine was not actually capable of movement. Instead, all the tickling was done by a research assistant, who was hidden under a cloth-draped table near the subject. The assistant was careful to perform the tickling the same way throughout the experiment, thereby allowing assessment of whether the belief that the tickling is being performed by another person is essential to elicit laughter. To decrease the interpersonal context even more, for half of the subjects, the experimenter left the room during the machine-tickle phase.

It turns out that subjects readily smiled, laughed, and wiggled when tickled by what they believed to be a fully automated mechanical device, and did so to the same extent as

when they thought they were being tickled by a person. Furthermore, these reactions were not diminished even when the subjects believed that the experimenter had left the room and that they were entirely alone with the machine. Self-reports of tickle intensity were also the same regardless of who was supposedly doing the tickling. These findings provide rather compelling evidence against the popular notion that ticklish laughter requires the belief that another person is performing the tickling. (Careful probing at the end of the experiment confirmed that subjects truly believed that the machine had tickled them.)

### Automatic Response

As described above, the handful of empirical studies on ticklish laughter suggest that it is not a response driven by positive affect nor does it require an interpersonal context. So what does underlie gargalesis?

The data that exist seem most amenable to the view that gargalesis is a relatively automatic, low-level physiological response. This general view is consistent with the writing of G. Stanley Hall and Francis Bacon and has been advocated by several researchers in more recent times. Findings to date have not revealed exactly what mechanism controls the response but likely candidates are that it is a type of complex reflex or fixed action pattern. In literature on human behavior, the term, fixed action pattern, is sometimes replaced with terms such as species-characteristic or species-typical stereotyped motor pattern requiring a particular releasing stimulus. The boundaries between reflexes and other species-typical behavioral dispositions remain controversial. Reflexes are distinguished from fixed action patterns based on their graded character: the more intense the stimulation the more intense the response. It currently is not known whether ticklish laughter shows an all-or-none character like a fixed action pattern or a graded response to the magnitude of stimulation as with the typical reflex.

If gargalesis is some type of complex reflex or species-typical stereotyped behavior, then why can we not elicit it in ourselves? After all, we can tap our own knees and produce the knee-jerk reflex. There are, however, other reflexes that one cannot elicit in oneself – startle being a prime example. Startle and tickle appear to share some features. Both appear to require some element of unpredictability or surprise – one can no more tickle oneself than startle oneself (at least, not without the use of some external device such as a gun). The two states also produce facial expressions that resemble the types of expressions elicited during emotion, but are arguably not emotional states in and of themselves. The proposition that tickle is a reflex, or other kind of innate stereotyped motor pattern, does not imply that the tickle response is unmodifiable or unaffected by mood or other psychological states. For example, the startle reflex can be potentiated by negative emotion while the opposite effect is produced by positive emotional states and even by a faint warning signal. Despite the name, 'fixed action patterns' also permit substantial variability in behavior.

There is also another explanation consistent with gargalesis being a low-level physiological process and with one not being able to produce it in oneself. Lawrence Weiskrantz and his

colleagues, in a paper that appeared in *Nature* in the 1970s, suggested that the neurological processes observed in vision might provide an answer. When the eyes dart from one focal point to another, the world does not appear to jump because the brain takes into account that it has issued a command (efferent signal) to move the eyes. Weiskrantz and colleagues reasoned that similarly when the brain issues the command to self-tickle, it sends a message to cancel the sensation of ticklishness. Thus, what is sometimes termed exafference (stimulation uncorrelated with a motor command) may be required to elicit the tickle response.

## The Unpleasant Side

Socrates proposed that although tickling could induce pleasure, to a greater degree it elicited pain. Bacon suggested that “tickling is ever painful, and not well endured” (p. 161). There also have been stories across the ages of people being tortured to death using nothing but unrelenting tickle. Whether victims can actually die from tickle alone is not known. However, there is little doubt that prolonged tickling can be highly disagreeable.

Research with college students suggests that even short bouts of tickling can be unpleasant for some people. Detailed coding of the facial displays during tickle, suggest that several movements are similar to those that occur during pain, including wrinkling the nose, raising the upper lip, and grimacing. Furthermore, such facial displays can occur while people are simultaneously smiling.

It is often assumed that tickling is a more pleasant sensation for children than for adults. However, there are several reasons to question this. For one, childhood is often when the displeasure of ‘tickle torture’ is discovered. Generations of children have found that holding one another down and engaging in relentless tickling is an effective way to torment a sibling or playmate. While children sometimes seek out tickling, it may be incorrect to assume this means that the sensation itself is pleasurable. Children also take part in games in which parents play at startling or menacing them. Presumably, such behaviors do not indicate that children enjoy startle or fear. A combination of thrill-seeking and pleasure in tactile contact might lead children to seek out what is still an intrinsically aversive sensation.

## Physiology

The neural mechanisms that are responsible for the tickle sensation are not well mapped out, but touch and pain fibers are two possible candidates. Work on the receptors involved in tickle focuses almost exclusively on knismesis, usually elicited by brushing a piece of cotton wool on the skin of an animal or person. Yngve Zotterman, a pioneer in cutaneous sensation research, used this method on cats while recording action potentials of nerve fibers, and concluded that light tickle depends, at least partially, on pain fibers. Responsiveness to tickle elicited by cotton is also reduced in patients who have had tracts of pain fibers in their spinal cords severed as a treatment for intractable pain. However, gargalesis may rely

on different pathways given that tickle-induced laughter is retained in at least some patients who have lost pain sensation due to similar spinal-cord surgery.

Knismesis seems to also depend on touch fibers: when limb circulation is arrested, sensitivity to touch and tickle is eliminated before pain sensitivity. However, the density of touch receptors is not likely to explain the susceptibility of different body parts to tickle, because the areas most responsive to tickle do not show any obvious advantage in touch sensitivity or in tasks requiring people to tell whether they are being touched on one or two nearby points. For example, the palm is more sensitive to touch than the sole of the foot, but the latter is more ticklish.

Other research has attempted to explore differences in brain activity using the technique of functional magnetic resonance imaging (fMRI) during self-generated and externally generated tickle. Such work has exclusively looked at knismesis which, since it can be produced readily in oneself, is unlikely to inform us much about why we cannot produce ticklish laughter in ourselves. Given the requirement to remain still during fMRI scanning, it is doubtful whether such measures will be a good tool for studying gargalesis as laughter disrupts the imaging.

## Functional Theories

Several theories of why humans may have evolved a tickle response have been offered, although providing evidence for such functional explanations remains a challenge.

One hypothesis is that tickle evolved to promote protection of areas that would be most vulnerable during arm-to-arm combat. The idea is that ticklishness in such areas motivates one to protect these areas and thereby confers an adaptive advantage (i.e., increased ones ability to survive and reproduce). This provides a possible explanation for the pulling away and fending off movements frequently encountered during tickling. However, it does not account for why the hands and fingers, which are quite vulnerable in hand-to-hand combat are not very ticklish, nor why people laugh and smile during tickling.

Another functional account, alluded to earlier, focuses on the smiling and laughter during tickling. Humans find such expressions rewarding which may facilitate bonding between parents and infants. This view, however, does not explain the defensive and withdrawal movements that occur during tickling nor why the sensation of tickle is considered unpleasant by many.

A third possibility draws on different aspects of these views: the disconnection between the inward unpleasant sensation and the outward pleasant expression may be what is adaptive. Tickle may elicit smiling to encourage others to perform the tickling and may elicit discomfort in the one being tickled in order to motivate the developing primate to avoid the tickling. This would promote rough and tumble play that may help the development and acquisition of combat or other skills that have survival benefits. Unfortunately, testing such hypotheses regarding ultimate mechanisms is notoriously difficult. Furthermore, it is always possible that tickle is not an adaptation per se but rather a by-product of a mechanism designed for some other function.

## Final Remarks

Despite 2000 years of speculation on tickle, the paucity of actual research makes it difficult to draw unequivocal conclusions about this enigmatic aspect of human behavior. However, what does seem to be emerging from research is a recognition that tickle is not merely a special case of amusement or joy. Depending on the social setting (e.g., the relationship with the tickler, the tickled person's mood) tickling may be capable of eliciting a variety of reactions, some enjoyable and some unpleasant. But, it is doubtful that the smiling observed in tickling is dependent on the positive or interpersonal aspects of the situation.

The data to date suggest that tickle is most likely a low-level automatic physiological response such as a complex reflex, fixed action pattern, or other species-typical stereotyped motor pattern. It is also possible that tickle may turn out to exemplify some class of phenomena not yet mapped out.

**See also:** [Facial Expression of Emotion](#); [Pain](#); [The Sense of Touch](#); [Touch](#).

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## Touch

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### Glossary

**Attention** Refers to the mechanisms that give rise to a temporary enhancement (or prioritization) of the processing of certain stimuli relative to others.

**Cross-modal interactions** Refer to situations in which the stimulus presented in one modality (e.g., touch) is affected by a stimulus presented in a different modality at around the same time.

**Extinction** The phenomenon whereby the presentation of a stimulus in one modality (e.g., vision) or location results in a person no longer being aware of a stimulus presented in another modality (e.g., touch) or location.

**Haptics** The term used to describe active (as compared to passive) touch.

**Prior entry** The claim that attended stimuli are perceived earlier than unattended stimuli.

### Introduction

Touch is both the largest of the senses and the first of the senses to develop. The skin, in which the majority of the tactile receptors are embedded, accounts for almost 20% of the body mass. That said, the majority of experimental research on the sense of touch has tended to focus on the perception of stimuli presented to the fingertips and hands rather than on the rest of the body surface. It is important to note that 'touch' is really an umbrella term for a number of different sensory submodalities, including everything from temperature and pressure perception through to the perception of vibration and pleasant touch. What is more, the various classes of sensory receptors are not distributed uniformly over the body surface, with certain receptors, such as those whose signal is conducted by the c-tactile (CT) afferents fibers, only being found in hairy skin. The asymmetric distribution of CT afferents, which are thought to code for the pleasant aspects of touch, and which have been shown to respond vigorously to the slow stroking of the hairy skin, perhaps hints at their original role in grooming behaviors. People's sensitivity to different kinds of tactile stimulation also varies substantially over the body surface, and, just as for the other senses, decreases substantially as one ages. Less research has been published over the years on the sense(s) of touch than on the other spatial senses, namely vision and audition; This may, in part, reflect the difficulty associated with mechanically stimulating the skin with anything more complex than the simplest of stimuli, with researchers often using small vibrators or electrocutaneous devices to stimulate participants. Some researchers (in particular, those working with the visually impaired) have also used devices such as the Optacon that allow one to present patterns over restricted areas of the skin surface using arrays of point-like tactile stimulators. There is also a large literature on the tactile perception of surface texture, though that will not be covered in any detail here.

### Information Transfer Through the Skin

Back in the 1960s and 1970s, there was a great deal of interest in the possibility of transmitting information, and even images, via the skin surface. Many researchers were, for example,

actively involved in investigating the possibilities associated with tactile-visual sensory substitution systems. The hope was that such devices might help the blind to, in some sense, 'see' once again. Some researchers even went so far as to suggest that the days of 'tactile television' might be only just around the corner! However, subsequent research soon highlighted the fact that the skin has only a very limited bandwidth for the processing of tactile information as compared to the other senses (e.g., vision and audition). And, although the blind do exhibit enhanced tactile discrimination abilities in certain sensory tasks, their ability to process sequentially presented tactile information does not actually appear to be that much better than that of the sighted, especially when a comparison is made with the tactile/haptic abilities of those sighted individuals who have practiced their tactile discrimination abilities. There have also been occasional case reports of sighted individuals who have had a phenomenal ability to process sequentially presented tactile information.

### Counting Tactile Stimuli

In the general population, however, the average untrained participant can perceive no more than two or three simultaneously presented discrete tactile stimuli when presented to the skin surface. This limitation appears to hold true no matter whether the stimuli are presented to the fingertips or elsewhere on the body surface. It is worth noting here that this limit might be due, at least in part, to some form of automatic pattern organization in the brain (i.e., one is not used to perceiving multiple independent stimuli on one's skin, but rather objects and surfaces.) The one exception to this fairly strict limit (which is significantly lower than that seen for the enumeration of visual stimuli) appears to occur when people try to judge the number of spherical balls they feel haptically in their hands. Under such conditions, people can rapidly estimate the number when as many as six balls are presented to a participant's hands.

### Memory for Touch

In the visual modality, researchers have used the partial report paradigm in order to demonstrate that people may retain some

fleeting access to sensory information that cannot be tapped when a full report procedure is used (i.e., as is typically the case in numerosity judgment studies). Researchers have recently adopted the partial report procedure in order to demonstrate that people may actually retain some access to positional information when as many as five tactile stimuli are simultaneously presented across their body surface (as compared to a maximum of only two or three stimuli in the overt numerosity judgment version of the task). Interestingly, the duration of these rapidly decaying tactile representations appears to be affected by the number of stimuli that happen to be presented (with decay occurring more rapidly as the number of stimuli presented increases).

While a number of studies have, over the years, investigated the constraints on tactile short-term memory, far less research has been directed at the study of longer-term forms of memory in the tactile modality. Indeed, it is worth noting here that the exact nature of the code (e.g., verbal, visual, tactile, or spatial) used by the human brain in order to represent tactile stimuli in long-term (as well as short-term) storage systems remains a matter of debate among researchers. In fact, researchers investigating the brain correlates of tactile memory have shown that tactile memory relies, at least in part, on the same neural networks responsible for the storage of visual information.

### Attentional Constraints on Tactile Perception

Attention constitutes a major determinant of the limitation on tactile perception in humans. To date, the majority of the tasks that were first formulated to study/highlight the attentional constraints on visual information processing have successfully been extended to the tactile modality: These include everything from tactile negative priming, through to tactile distractor congruency effects, and from tactile change blindness through to the tactile attentional blink. What is more, the majority of these attentional limitations on information processing in humans have now also been demonstrated in a cross-modal setting as well, primarily involving interactions between tactile and visual stimuli.

While tactile stimuli are frequently presented to the passive (i.e., unmoving) skin surface of a participant in the laboratory, in real life, one's tactile perception is far more likely to involve active haptic exploration instead. There has been a long debate in the scientific literature between those who believe that active and passive touch are essentially the same and those who believe that there are fundamental differences between these two kinds of tactile perception. The consensus view though currently appears to be that there is far less difference than one might expect. What is certainly true is that a person's ability to perceive tactile stimuli is impaired during the execution of voluntary action. This form of touch blindness (or numbness) has been demonstrated to affect performance both in psychophysical discrimination tasks and in tasks involving tactile change detection. So, for example, in one recent study, participants executed a movement toward a given target stimulus while trying to compare the intensities of two stimuli, one presented to the moving hand and the other to the stationary hand. Tactile sensitivity decreased on the moving hand during movement execution, but not during the movement preparation

and postmovement periods. Results such as these therefore lend support to the view that sensory suppression takes place whenever one executes an action.

### Spatial Tactile Attention

Tactile perception is also affected by spatial attention. People can either voluntarily choose to attend to the tactile stimuli presented to a certain part of their body, or else their attention can be captured automatically by a sudden tactile stimulus that happens to be presented there unexpectedly (e.g., as when someone suddenly taps the back of one's shoulder.) However, such shifts of spatial attention (both endogenous and exogenous) really need to be considered in a multisensory context, since the sudden presentation of auditory or visual events has also been shown to draw a participant's tactile attention to any part of their body that happens to be placed close by. Similarly, the sudden presentation of a task-irrelevant tactile stimulus is now known to give rise to an exogenous shift of auditory and visual attention to the cued location, or side as well. Endogenous spatial attention also appears to be coordinated across the senses such that people find it difficult to focus their tactile attention on one location while attending visually or auditorily to another location. Researchers have now started to investigate how these two forms of tactile spatial attention (i.e., exogenous and endogenous) interact.

Over the last few years, cognitive neuroscientists have made great progress in terms of understanding the neural mechanisms responsible for the orienting (both voluntary and stimulus-driven) of tactile spatial attention. For example, neuroimaging research has highlighted the importance of the parietal cortex as well as the early somatosensory cortex (e.g., SI, SII, and SIII) in the endogenous orienting of tactile spatial attention.

### Attending to the Sense of Touch

However, over-and-above any ability to focus tactile attention on a specific *spatial* location, people can also selectively direct their attention toward the tactile modality (i.e., rather than to the visual or auditory modality, say). In one study on this phenomenon, the participants were presented with a random sequence of tactile, visual, and auditory targets from one of the two locations on either side of the fixation. The participants had to make speeded left/right spatial discrimination responses to the targets regardless of the sensory modality in which they were presented. The three target modalities were presented equiprobably in the 'divided attention' blocks. In the other blocks of trials, the probability of target stimuli being presented in a particular modality (touch, audition, or vision) was increased in order to encourage the participants to focus their attention on that particular sensory modality. Participants responded more rapidly (and somewhat more accurately) to the tactile targets in the 'attend touch' blocks than in those blocks where their attention had been directed to either the auditory or visual modality instead. These results therefore show that people can voluntarily (i.e., endogenously) direct their attention toward touch and that this enhances their ability to respond to tactile stimuli. Interestingly, this and

other studies have now shown that people appear to find it more difficult to shift their attention toward, or away from the tactile modality than they do to shift their attention between the auditory and visual modalities. Other researchers have shown that attending to olfaction (i.e., expecting a smell) can also impair a person's ability to respond to tactile stimuli as well. It therefore appears as though there is some form of shared attentional resources that can be allocated preferentially to the processing of the stimuli presented in a particular sensory modality. The sudden presentation of a task-irrelevant tactile stimulus can also lead to an *exogenous* shift of a participant's attention toward the tactile modality.

Attending to the tactile modality, or to the location at which a tactile stimulus will shortly be presented, speeds up the perceived time of arrival of the attended stimulus as compared to other stimuli presented in a relatively less attended modality or location (this phenomenon is known as '*prior entry*'). There has been a growing interest over the last decade or so in the study of the neural underpinnings of such behavioral effects of attention on tactile perception. Indeed, the results of a number of studies now show that the attentional selection of tactile information can occur at very early stages of neural processing, such as in the somatosensory regions of the parietal cortex (i.e., in S1 and S2).

### Tactile Perception and Attention Following Posture Change

One's posture changes on a regular basis: sometimes, for example, one's left hand may be crossed over to the right of the body while the right hand is placed on the left. Several studies have now demonstrated that both exogenous and endogenous shifts of spatial attention appear to operate on representations of space that are updated whenever one's posture changes. Thus, a sudden tactile stimulus presented to the left hand has been shown to draw a participant's visual attention to the left when the hands are uncrossed, but to the right side of space when the hands are crossed over at the midline. One of the only conditions in which one's brains appear to get confused about the location (and/or timing) of touches presented to the body occurs when the hands are crossed over the midline, and one stimulus is presented to each hand in rapid succession. Under such conditions, participants appear to systematically confuse the two stimuli when they try to report which tactile stimulus was presented first. Interestingly, this appears to reflect a confusion between visual and somatotopic frames of reference for coding the location of tactile stimuli, since the congenitally blind are not confused by this particular postural manipulation. What is more, the sighted show a much reduced crossed-hands deficit if they cross their hands behind their backs (i.e., in a part of space that they normally do not see).

### Tactile Awareness

Over the last few years, there have been many attempts to determine the cognitive and neural correlates of one's

awareness of visual events. By contrast, this topic has received far less interest from those researchers working on touch. The latest research now appears to show that there is a close relationship between spatial processing and access to consciousness of tactile stimuli. For example, decreasing the spatial distance between the hands results in an increase of the time necessary for participants to determine which stimulus is presented first. Similarly, crossing the arms over the midline has been recently demonstrated to be effective in decreasing the perceived intensity of somatosensory stimuli delivered to the back of the hands. But there is still a long way to go to determine with any precision the neural correlates of one's awareness of tactile stimuli, although a few insights have been gained in the last few decades.

Activation of unimodal sensory areas is necessary but not sufficient for an awareness of touch to arise. For example, the neural responses of the primary somatosensory areas have been found to correlate with the physical intensity of the stimuli delivered to the skin but not with a person's awareness of those stimuli. It is now becoming clearer that interactions between primary sensory areas and certain areas of the brain responsible for multisensory and spatial processing (such as the posterior parietal cortex) might play an important role here. Recent debate concerning the neural correlates of tactile awareness relates to the question of whether or not tactile processing can rely on anatomically separated pathways for explicit and implicit information processing, just as has been shown to be the case for visual processing. As far as this topic is concerned, the presence of a phenomenon that can be considered analogous to 'blindsight' in the visual modality has now also been described in touch (i.e., blind touch). This would appear to suggest the presence of independent pathways for the processing of tactile information in the brain. In fact, it has been shown that patients suffering from a loss of tactile sensation (due to a brain lesion) are nevertheless still sometimes able to correctly point the position of a tactile stimulus delivered to their deafferented limb.

### Cross-Modal Interactions Between Touch and the Other Senses

No discussion of the sense of touch would, however, be complete without some consideration of how touch interacts with the other modalities in terms of one's perception of the objects that one hold and feel. Here, the majority of evidence published over the last 70 years has shown that vision tends to dominate over touch in the perception of the size and shape of the objects one haptically interacts with. Vision also dominates over touch in the perception of position and in the perception of the direction of apparent motion. Under certain conditions, the presentation of a visual stimulus can even lead to the extinction of a participant's awareness of (or at least their ability to report) a simultaneously presented tactile stimulus. While such effects have traditionally only been reported in patients suffering from clinical extinction, researchers have recently observed a very similar phenomenon in normal participants. In one recent study, participants were given one response key to press in order to respond to tactile stimuli

and another key to press to respond to visual stimuli. Finally, they also had to respond to the relatively rare occurrence of bimodal target trials by pressing both response keys (or under certain conditions, a third response key). The results showed that participants failed to respond to a number of the tactile stimuli on the bimodal trials while rarely, if ever, missing the clearly suprathreshold tactile stimuli on the unimodal trials. The latest evidence shows that tactile/haptic stimulation can also help resolve ambiguous visual displays such as when viewing the Necker cube, or when experiencing binocular rivalry.

The only areas in which tactile inputs regularly dominate over visual inputs occurs under conditions of intersensory conflict, when people have to judge fine surface textures and when making temporal judgments. So, for example, people will often report that a single visual stimulus presented briefly on the periphery of the visual field as having flashed twice if two or more tactile stimuli are presented at the same time. By contrast, participants have no problem reporting the actual number of stimuli presented correctly when no tactile stimuli are presented.

When the senses of audition and touch are put into conflict, the result generally turns out to be a much more evenly balanced weighting of the two senses than that seen when vision and touch are put into conflict. That said, a number of studies have demonstrated that the perception of surface texture can be modulated simply by changing the sound that people hear when they touch it. Even smell has been shown to influence texture perception: That is, people rate fabric swatches as feeling significantly softer when rubbed between the fingertips while smelling a pleasant fragrance than when smelling an unpleasant fragrance instead. Given that the majority of one's perception is multisensory, and given the ubiquitous nature of multisensory interactions in human information processing, many researchers are increasingly coming to the conclusion that it may not make that much sense to focus all of one's efforts solely on studying tactile perception in a unimodal setting.

### The Affective Aspects of Touch

It is important to note that the sense of touch may be particularly important in terms of its affective contribution to one's sense of well-being. Indeed, the sense of touch has been shown to provide a very powerful means of eliciting and modulating the emotional responses of humans. In fact, it has been argued that interpersonal touch tends to provide the most emotional of one's tactile experiences. However, that said, the study of the more interpersonal and emotional aspects of touch have been rather neglected by cognitive neuroscientists in recent years. Interpersonal touch is important for one's well-being; this is certainly clear from the evidence reported so far. However, researchers will need to try and understand how tactile contact really works in affecting people's behavior. That is, what are the cognitive and neural mechanisms underlying these effects? And how can one exploit these particular characteristics of the tactile modality for applied and clinical purposes? Scientists are now moving toward answering these questions, for

example, by showing that certain parts of the brain, such as the orbitofrontal cortex, respond specifically to 'pleasant touch' or that back-rubbing and hugs induce the release of oxytocin (a hormone involved in social-bonding behavior). Studying the cognitive and neural correlates of interpersonal touch, together with the more cognitive aspects of tactile perception more generally therefore constitutes a particularly important area for future research on the sense of touch.

### Touch: What the Future Holds

In the coming years, research on the sense of touch looks set to grow. This is both because of the increased ability to present complex haptic stimuli offered by haptic virtual reality devices and an ever-growing variety of human-machine interfaces, and because of the increasing stimulation of the sense of touch in modern technology – for example, in everything from mobile phones to touch screen displays, and from cars that vibrate their drivers through to vibrating belts that inform their users of where North lies. Moreover, it is also worth noting that the sense of touch has started to be exploited in the last few years by an increasing number of marketers in order to make their products more appealing to the customer.

*See also:* Attention; Memory; Memory, Neural Substrates; Spatial Perception; The Sense of Touch; Visual Perception.

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# Uncertainty

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## Glossary

**Ambiguity** A special kind of uncertainty. A concept or proposition is ambiguous if it has two or more distinct possible meanings.

**Fuzziness** A special kind of vagueness that refers to graded degrees of membership in a set.

**Ignorance** A is ignorant from B's viewpoint if A fails to agree with or show awareness of ideas which B defines as actually or potentially valid. Ignorance has a passive sense (being ignorant of X) and an active sense (ignoring X).

**Irrelevance** X is considered irrelevant iff X is considered unrelated to Y. Irrelevance therefore leads to X being ignored when considering Y.

**Nescience** A complete lack of knowledge.

**Risk** Composed of ignorance and the prospect of loss. In economics, risk is composed of probability and the prospect of loss.

**Uncertainty** A special kind of ignorance, namely incompleteness of information. There are nonprobabilistic as well as probabilistic kinds of uncertainty.

**Vagueness** A special kind of uncertainty. A concept is vague if its possible meanings extend over a range on a continuum.

Uncertainty may be defined as a particular kind of unknown, namely incompleteness of information. Incompleteness, in turn, can take various forms, such as simple absence, ambiguity, or even probabilistic uncertainty. Uncertainty, above all, is a mental state, and it can arise either from incomprehension (not understanding an entity or event) or indecision (not knowing what to do). The human sciences have issued two broad streams of theory and research on uncertainty. One of these springs from the psychology of judgment and decision making and behavioral economics. The other stems from sociology and social anthropology. This article incorporates both in its overview. Most of the work on uncertainty has focused on incomprehension although in recent years indecision has been paid more attention, especially in psychology and behavioral economics.

## Concepts and Definitions

Uncertainty is a topic that does not fall neatly within a single discipline. Instead it sprawls across a considerable variety of disciplines, professions, and problem domains. Many disciplines and professions have (often implicit) assumptions and beliefs about the unknown, but these are not integrated with one another. Consequently, there is no cogent, readily identifiable body of literature on uncertainty. It is also difficult to communicate clearly about uncertainty, and the scattered literature on this topic understandably lacks an agreed-upon nomenclature. The absence of a standardized terminology for this domain thwarts sophisticated work.

Nevertheless, several disciplines have proposed terminologies for uncertainty and related concepts. Some have also produced worthwhile distinctions among kinds of uncertainty, and even attempt at exhaustive classification systems. We begin by briefly reviewing these attempts at nomenclature, definitions and taxonomic schemes.

## Terminology and Classification

Let us start by considering a term for the overarching concept in this domain. An early proposal is the German word 'nicht-wissen,' whose English equivalent is 'nonknowledge.' A related, if less common, term is 'nescience' (total ignorance). Outside the social sciences the most popular general term seems to be 'uncertainty.' This is the case, for example, in psychology, economics, and engineering. Still another alternative is 'ignorance' itself, which I will use as the overarching term in this article, taking 'uncertainty' to be a subset term when it is necessary to make that distinction.

A major problem in choosing a name for the unknown and attaching a definition to it is that we cannot avoid making claims to know something about who is ignorant of what. Any claim about ignorance entails a knowledge-claim regarding the nature of said ignorance. A definition that seems to handle these problems reasonably well is as follows: A is ignorant from B's viewpoint if A fails to agree with or show awareness of ideas which B defines as actually or potentially valid. This definition allows B to define what she or he means by ignorance. It also permits self-attributed ignorance, since A and B may be the same person. Most importantly, it incorporates anything B thinks A could or should know (but doesn't) and anything that B thinks A must not know (and doesn't). B's notions about ignorance may be as context-dependent and subjective as required.

The intuition that there might be different kinds of ignorance has motivated a number of scholars to propose various distinctions and taxonomies. One of the most popular distinctions is absence or neglect versus distortion. Another common distinction is reducible versus irreducible ignorance. The term 'negative knowledge' has been proposed to encompass knowledge of the limits of knowing, mistakes in attempts to know, things that interfere with knowing, and what people do not want to know. A fourth distinction in some languages is

between the active voice (ignoring) from the passive voice (being ignorant).

Several taxonomies of ignorance have emphasized distinctions that operate at a meta-level rather than describing the nature of different kinds of ignorance per se. The most popular distinction is between knowing that we don't know (conscious ignorance) and not knowing that we don't know (meta-ignorance). A related distinction is between knowing that we know something versus not knowing that we know it (tacit knowledge).

Some disciplines have produced relatively sophisticated and productive distinctions among special kinds of ignorance and uncertainty. In mathematics, besides at least three major schools of probability theory, several different kinds of uncertainty formalisms have been proposed such as fuzzy set theory, belief functions, and imprecise probability theories.

The most useful high-level distinctions that have emerged from the human sciences are threefold. First, the meta-level concepts of meta-ignorance versus conscious ignorance are crucial. Second, there is the important distinction between ignorance and 'negative knowledge' in the sense of knowledge about the limits of what can or should be known. Finally, the active versus passive voice distinction is important. The active voice (to ignore) shall be referred to as 'irrelevance' and the passive voice (to be ignorant of) as 'error.'

Lower level distinctions among kinds of error that have proven useful are as follows. Error may arise either from incomplete or distorted views, or both. Distortion may consist of a systematic bias or inaccuracy (e.g., under- or overestimation), or confusion (mistaking one thing for another). Incompleteness in kind is outright absence of information, whereas incompleteness in degree constitutes what we shall term 'uncertainty.' Uncertainty, in turn, includes probability, vagueness, ambiguity, and conflict. These are terms we shall explore further.

Aside from a priori distinctions and classifications, how can we assess what other distinctions are worth making, especially those intended to represent localized meanings and usages? I suggest four criteria, namely whether candidate kinds of ignorance or uncertainty:

1. Are consistently distinguished from other kinds when referred to in communication by members of the same linguistic community;
2. Are accorded statuses or roles distinct from other kinds in the same situations or for the same purposes in social interaction;
3. Produce different social consequences for those to whom they are attributed; and/or
4. Are (dis)preferred to other kinds.

These criteria are useful in helping students of uncertainty to remember that lawyers use 'probability' differently from statisticians, that for many people conveying outright misinformation (i.e., distortion or lying) is morally worse than conveying vague or partial information, and so on.

### Schools of Probability

Many reviews of probability theories divide schools of probability into three camps: logical or a priori probability,

frequentist probability, and Bayesian probability. All three schools agree on the probability calculus; where they differ is on the basis and scope of probability. The a priori theory is exemplified in games of chance, where idealized fair gaming devices such as dice and cards are employed for bets on outcomes whose probabilities are known beforehand. Probabilities of this kind are based on the principle of indifference, which defines the probability of an event as the ratio of 'favorable' cases to the number of all 'equipossible' cases.

The frequentist theory begins with the premise that under repeated trials under identical conditions, the probability of an event is estimated by the relative frequency with which it occurs out of the number of trials. According to various versions of the strong law of large numbers, the relative frequency converges to the true probability as the number of trials tends toward infinity.

Neither the a priori nor the frequentist frameworks admit such concepts as the probability of a unique event or a subjective probability. Both approaches limit the scope of probability theory to 'objective' likelihoods of repeatable events. The Bayesian theory does extend probability to subjective appraisals and unique events, by identifying subjective probabilities with degrees of belief that obey the laws of probability. For events whose likelihood can be assessed by accumulating evidence (e.g., via repeated trials), Bayes' theorem is employed to update prior probability judgments on the basis of new (perhaps objective) evidence.

In the 1970s and 1980s, the Bayesian approach gained prominence in fields concerned with the mental representation of uncertainty, such as cognitive psychology, behavioral economics, artificial intelligence, and knowledge engineering. Subjective Bayesians claim their approach ensures that decision makers behave rationally in accordance with their beliefs about event likelihoods. This claim is based on an extensive normative framework for decision making under uncertainty, subjective expected utility (SEU) theory. The central tenet of this theory is that the expected utility of an event is its 'utility' multiplied by its probability. Utility is presumed to be a scalar quantity (e.g., money), and a rational agent chooses the option that maximizes their expected utility. For instance, given a choice between a gamble with probability of 0.5 of getting \$20 and a gamble with probability of 0.25 of getting \$32, the choice that would maximize expected utility is the first gamble ( $0.5 \times \$20 = \$10$ , whereas  $0.25 \times \$32 = \$8$ ).

Until the 1990s, frequentist probability theory dominated statistical theory and applications, partly due to its familiarity for statisticians and partly because of the seemingly impractical computational demands of Bayesian statistical modeling. This state of affairs changed with increases in computing power and the development of Markov Chain Monte Carlo methods for Bayesian models. These developments enabled the application of Bayesian methods to complex models. Currently, Bayesian statistical modeling is increasing in accessibility and popularity.

Uncertainty research in psychology and behavioral economics over the past four decades has featured extensive comparisons between the SEU framework and the ways that humans think about probability (see section 'Perception and Judgment'). For some time, SEU was considered the arbitrator of 'rational' decision making and, therefore, Bayesian probability theory was

the normative standard for uncertainty judgments. As we shall see in section 'Perception and Judgment,' recent developments have shifted away from both of these positions.

### Nonprobabilistic Uncertainty

The claim that there is more to uncertainty than probability has a fairly lengthy history. One of the earliest is Max Black's classic distinctions among vagueness, generality (or nonspecificity), and ambiguity. An earlier distinction was drawn by Keynes and Knight between 'risk' (where probabilities are known) and 'uncertainty' (where probabilities are imprecise or unknown).

During the past four decades there has been a rapid proliferation of alternative frameworks for dealing with uncertainty in formal or mathematical ways that depart from standard probability theory. Fuzzy set theory, rough sets, and fuzzy logic have been developed as frameworks for dealing with vagueness and related kinds of nonprobabilistic uncertainty. The primary claim for fuzzy set theory is that it handles categories (sets) in which items can have partial membership (e.g., a 'reddish' color or a 'tall' person). Likewise, fuzzy logic permits degrees of truth to be attached to propositions.

Probability theory itself has been generalized to incorporate vagueness, mainly by extensions to 'imprecise' probabilities. Formalisms of this kind include possibility theory, Dempster-Shafer belief theory, and several theories of imprecise probabilities that incorporate these two as special cases. The past two decades have seen the establishment of these frameworks on firm axiomatic foundations and an increasing number of applications. Nevertheless, these developments have been controversial at times and there are ongoing debates over what properties generalized probability theories should have.

### Perception and Judgment

Psychology is one of the few disciplines that attempts to account for how people perceive and respond to uncertainty. These accounts have been useful in behavioral economics, management science, risk management, and a host of other areas. Psychological theories about uncertainty fall into two groups: how people manage in an uncertain world, and how people manage uncertainty itself. This section deals primarily with the latter.

There are, broadly speaking, three traditional normative orientations regarding how people deal with the unknown in psychology, and each has its roots in particular theoretical developments. Perhaps the oldest is the 'Knowledge Seeker,' originating in the psychoanalytic canons for the well-adjusted individual and found in most branches of ego psychology. This view extols the person who seeks novel information and experience, is open to full and honest communication, can tolerate uncertainty and even ignorance in the short run in order to gain knowledge, and who is not defensive about prior beliefs.

The second tradition, the 'Certainty Maximizer,' focuses on the debilitating consequences of uncertainty, unpredictability, and uncontrollability for the affective, cognitive, and physiological capabilities of the affected organism. Most of the evidence for this viewpoint originates from research on learning and adaptation. But an entire set of emotion-based theories

also assumes that anxiety is a consequence of uncertainty. Likewise, several social psychological and communication theories of human interaction assume that people are motivated to reduce uncertainty. Thus, there is a natural tension between this tradition and that of the 'Knowledge Seeker.'

The third tradition, the 'Intuitive Statistician-Economist,' originates from psychophysics, perception, and cognitive psychology, and reflects information processing models of cognition. It is primarily concerned with criteria for rationality in judgment and choice, and the dominant normative viewpoints have been the probability theory and a view of humans as being hedonic (seeking pleasure and avoiding pain) by nature. This view has a lot in common with neoclassical economics. 'Rational' decision makers estimate probabilities, quantify utilities, and make choices according to the precepts of SEU. Given this prescriptive benchmark, much of the research in this tradition has focused on judgmental and decisional errors, in the sense of deviations by people from this allegedly rational prescription.

Psychological research on judgment and decision making under uncertainty has stimulated lively debates about the nature of rationality and the extent to which humans can be shown to be rational or irrational. Proponents of the view that humans are not rational fall into the 'heuristics and biases' camp, and their primary claims are that the mental shortcuts to reasoning (heuristics) that people use cause them to fall prey to irrational tendencies (biases). The 'bounded rationality' camp, on the other hand, characterizes human judgment as rational under the constraints of limited time and cognitive capacity, employing 'fast and frugal' heuristics to cope with such constraints. Moreover, some members of this camp claim that many so-called heuristics are adaptive, because they exploit correlated structure in the environment. Finally, in recent times more attention has been paid by some researchers to the role of emotion in guiding judgments and decisions. Their major claim is that emotions may be essential for making good decisions under uncertainty.

### Judgmental Biases and Errors

The 'heuristics and biases' style of research on uncertainty judgments peaked in popularity during the 1980s, with popular treatments appearing in the subsequent two decades. One textbook during this time identified 27 cognitive errors in human judgments about uncertainty. In a few countries, proposals were even mooted to incorporate corrective training in probability judgments into educational curricula.

One class of biases and errors pertains to selective neglect of relevant information. This class includes ignoring or discounting negative and/or disconfirming evidence (confirmation bias), ignoring base-rate information about probabilities in favor of less relevant information (base-rate fallacy), and ignoring sample size in accounting for variation (sample size fallacy).

A second class pertains to judgments regarding random processes. The most famous is gambler's fallacy, an underestimation of the length of runs in random processes coupled with a belief that random variation 'balances out' in a self-correcting fashion. A related phenomenon is the underestimation of subjective confidence interval widths, yielding overconfidence when these confidence intervals are used for prediction. Several studies of gambling behavior have also found that at least

some people believe they have control over random events (e.g., in games of chance). Set against these findings is another collection of studies demonstrating that people are too conservative in readjusting their estimates of an event's likelihood when presented with new evidence (anchoring and adjustment). However, during the 1990s several studies found that humans are able to make fairly accurate short-term predictions of low-dimensional deterministic chaotic processes, from which it was suggested that people respond to random processes as if they are a particular kind of chaotic process.

A third kind of error concerns conditional probabilities and probabilities of compound events. The most famous of these is the 'conjunction fallacy,' a violation of the rule that  $P(A \& B) \leq \min(P(A), P(B))$ . Other well-established examples include the disjunction fallacy and violations of additivity (the rule that probabilities of an exhaustive set of mutually exclusive events must sum to 1).

Finally, framing effects have been found demonstrating that people can be risk-averse in one context but risk seeking in another. The best known of these are described in prospect theory, which holds that people generally are risk-averse under potential gains but risk seeking under potential losses. Some researchers have presented evidence that people's risk attitudes can differ depending on substantive domains (e.g., recreation vs. finance), whether the risk was voluntarily undertaken, and who may bear the consequences.

### Explanations of Probability Judgments

Accounts of and explanations for probability judgments focus on three main topics: omissions and neglect (e.g., base-rate error), distortions or poor estimations, and priming or anchoring of judgments. The 'availability' and 'representativeness' heuristics are primarily attempts to explain why people ignore base-rate information and logical constraints on compound probabilities. The availability heuristic is defined as assessing the probability of an event by the ease with which instances of it can be retrieved, imagined, or associated. The representativeness heuristic is the judgment of probability based on how prototypical an event is of its parent class or how similar it is to such a prototype. Both of these accounts have been criticized for being too vague and not connected to theories of human information processing.

Another type of account that focuses on distortions in probability judgments is a probability weighting model. The original version of prospect theory, for instance, posited that people overweight low probabilities and underweight high probabilities. Rank-dependent expected utility theory provides an alternative probability weighting model, in which the weights are determined by the rank order of the consequences of an event, rather than by how extreme their probabilities are. Probabilities of extremely bad or good events tend to be overweighted. Cumulative prospect theory incorporated the central innovation in the rank-dependent framework, namely the transformation of the cumulative distribution function instead of the density function. A primary goal of both theories is retaining aspects of rationality (e.g., stochastic dominance) while being more descriptively accurate than SEU (e.g., accounting for people being risk seeking in one condition and risk-averse in another).

A third kind of explanation focuses on priming or anchoring of probability judgments. An early example of such accounts is research beginning in the late 1970s on the 'catch-all underestimation bias,' a tendency to underestimate the probability of events that are not explicitly described but instead bundled together into a catch-all category. Support theory generalized this idea to a nonextensional account of probability judgments. The basic premise is that higher probability is given to events that can be 'unpacked' into greater numbers of specific instances or subtypes.

Some recent work has attempted to account for the related phenomenon of 'partition priming.' A sample space partition concerns the division of the space into a set of exclusive events (e.g., two vs. five possible events). Given such a partition of  $K$  possible events and no other information, people invoke the principle of indifference to anchor their probability estimates of each event on  $1/K$ . Experimenters have found that even when a 'correct' partition exists, people can be primed with an alternative partition ( $J$  alternatives, say) to anchor around  $1/J$  instead of  $1/K$ .

### Judgment Research on Nonprobabilistic Uncertainty

There is a scattered literature exploring the psychology of human responses to nonprobabilistic kinds of uncertainty. These include delay (as in delayed outcomes), ambiguity, and more recently, conflict and state space ignorance. Concurrently, there are debates over whether people respond to these alternative kinds of uncertainty just as they do to probabilistic uncertainty or as if these are truly distinct varieties. The following criteria have been proposed for distinguishing among kinds of uncertainty:

1. Normative: Can a case be made that a rational agent would equate one 'kind' of uncertainty with another versus distinguishing between them?
2. Behavioral/consequentialist: Does one 'kind' influence responses independently of another 'kind'?
3. Correlational/predictive: Are orientations toward one 'kind' correlated with orientations toward another? Do different variables predict one kind than those predicting another?
4. Sociocultural: Do social or cultural norms distinguish one 'kind' from another?
5. Neurological: Are different structures in the brain entrained by different 'kinds'? Does damage to one structure disable people from dealing with one 'kind' but still allow them to deal with another?

We shall consider delay first. Behavioral studies of choice under uncertainty operationalize uncertainty in two ways: reward variability and reward delay. The link between reward variability and probabilistic uncertainty is straightforward, but the link with delay perhaps is not quite as obvious. Generally, humans (and other animals) behave as if the consequential magnitude of an outcome is larger if it happens sooner than later. So good outcomes seem better and bad outcomes seem worse, the sooner they occur. The corresponding analogy is that immediacies are certainties and delays are uncertainties. Thus, outcomes are discounted temporally in much the same way that they are discounted probabilistically. Economists



have long maintained that temporal discounting is reasonable (or at least not irrational).

The strongest thesis for a direct analogy between delay and probability is that delay exerts the same kinds of influences that probability does. For example, temporal discounting predicts that people (and other animals) will be risk-averse for delayed gains and risk seeking for delayed losses. Empirical evidence for this parallels findings of similar effects on risk orientation due to probabilistic uncertainty as in prospect theory. That said, there are also recent studies and theoretical developments suggesting that intertemporal effects on decisions do not always parallel the effects of probabilistic uncertainty, and research in this vein has increasingly taken a separate course.

Now let us turn to ambiguity. Ellsberg's classic paper showed that people can be influenced to prefer to bet on a gamble when they know the probabilities exactly or to bet on a gamble when the probabilities are not known exactly, even though according to the standard SEU arguments they should have no preference between those gambles. Usually, people prefer known probabilities when they stand to gain by betting, but may prefer unknown probabilities when they face a prospect of loss. An obvious explanation for this preference pattern is that when probabilities are imprecise people adopt a pessimistic stance toward those probabilities but several other explanations have been promoted, including one that links attitudes toward ambiguity with those toward variability of consequences.

A few recent studies have extended the study of nonprobabilistic uncertainty to include uncertainty arising from conflicting information and from ignorance of the state space (i.e., not knowing about all possible outcomes). There is evidence that conflicting information is responded to as if it differs from other kinds of uncertainty, in that two ambiguous but agreeing messages from two sources are preferred over informationally equivalent, precise but conflicting messages from two equally believable sources. People are conflict averse in the sense that they behave as if conflict is a more consequential kind of uncertainty than ambiguity. Likewise, there are empirical demonstrations that people disprefer state space ignorance to ambiguity. However, a few recent experiments have failed to replicate both sets of findings in their entirety. This is still a new and generally unexplored topic of research.

## Neuroeconomics

Since the mid-1990s, a confluence of research and theory from psychology, behavioral economics, and neuroscience has generated the new subfield called 'neuroeconomics.' While still in its infancy, this area holds the potential to contribute substantially to our understanding of human decision making under uncertainty. One of the most rapidly growing streams of neuroeconomic research focuses on how the brain processes uncertainty. This line of research began when single-unit recording studies in nonhuman primates indicated that neurons can convey information about the expected values of alternatives in a decisional task and neuronal activity can predict an individual's choices.

Neural imaging studies thus far suggest that the area most activated by uncertainty in stimuli is the frontomedian cortex, particularly when probabilities are involved. Some researchers

have also observed that when uncertainty about outcomes cannot be analytically dealt with (e.g., under severe time constraint) then the lateral prefrontal and parietal regions become more active instead of the frontomedian cortical region.

Neuroeconomics and related developments in psychology were launched by two nearly simultaneous discoveries. One was the identification of a 'reward center' in the brain, the key realization being that specific neural structures are recruited when people assess potential consequences of the alternatives in a choice set. The other was the 'somatic marker hypothesis,' which proposes that emotions play an essential role in decision making. Up to the mid-1990s, affect was disregarded by decision researchers or considered a debilitating influence on decision quality. This view changed with the finding that neurotrauma patients with damage to the frontomedian cortex but unimpaired reasoning ability nevertheless were unable to make high-quality judgments and decisions.

Around the same time, some researchers raised the possibility that 'social' uncertainties may differ from uncertainties lacking a social component. The generative studies were conducted on neural activation while subjects play social dilemma games such as Prisoner's Dilemma. An important finding is that activity in some cortical areas is increased during interactions with human opponents but not during similar interactions with computer-simulated opponents. This finding raises the possibility that human responses to uncertainty generated by other humans are distinct from responses to uncertainty from nonhuman sources.

Finally, recent studies comparing brain activity under risky versus ambiguous decisional tasks suggest that the regions activated may depend on the type of uncertainty. One such study found that ambiguity resulted in stronger activation in the lateral orbitofrontal cortex and the amygdala, while risk activated the striatum and precuneus. Behavioral performance on this task in orbitofrontal lesion patients corroborated these claims. Studies that compared risk and ambiguity also have found that preferences toward different types of uncertainty correlate with activation in different brain regions. For instance, activation of the posterior parietal cortex was predicted by risk preference, whereas activation in the lateral prefrontal cortex was predicted by ambiguity preference.

Evidence that different neural structures are activated to deal with different kinds of uncertainty indicates that the 'kinds' are distinct in ways that do not depend entirely on cultural or social factors. Thus, this line of research can fill gaps in our understanding of how and why people think and act as if there are different forms of uncertainty.

## Social Constructions of Uncertainty

Up to this point, we have dealt exclusively with theories and studies of uncertainty that are asocial. These theories implicitly treat uncertainty as if its source is external or intra-subjective. Another tradition approaches uncertainty as being socially constructed. This section deals with that tradition. First, however, we must dispense with a blind-spot concerning uncertainty and its effects. Most popular conceptions of uncertainty have a negative cast to them (e.g., uncertainty is impotence whereas knowledge is power). Of course, there are excellent



reasons in many circumstances to be negatively disposed toward uncertainty. Nevertheless, uncertainty can motivate people positively as well as negatively. People find uses for uncertainty and do not always want to be rid of it. Indeed, they can be motivated to create uncertainty, not only for others but for themselves as well. Contrary to the view of ignorance and uncertainty as primarily negative, human engagement with ignorance or uncertainty is almost always a mixed-motive enterprise.

### **Socially Constructing the Unknown**

It may be very difficult to know anything directly about our own or anyone else's ignorance, but it is not as hard to find out about people's representations and accounts of ignorance. Moreover, those representations and accounts are important because ignorance, like knowledge, is in large part socially constructed. Most of the literature on uncertainty in disciplines such as economics, psychology, and (to a lesser extent) sociology presupposes agreement among all stakeholders on what is known and what is not known. Yet it seems obvious that the behavior of a dugong in waters off Cape York Australia will convey rather different 'information' to a marine biologist and a Torres Strait Island fisherman. They might even agree that each 'knows' different things about dugongs. But on some points they may dispute each other's knowledge and/or ignorance claims, and part of the basis for those disputes will be what 'knowledge' or 'ignorance' can consist of, and indeed what can and cannot be 'known.'

Everyday ideas about the unknown come from two sources: commonsense realism and commonsense sociality. Commonsense realism encompasses everything we believe or think about how the nonsocial world works, including sacred as well as profane domains. Commonsense sociality refers to our beliefs about the social world and includes our theories of mind. Both kinds of common sense are essentially realist. Regardless of the ontological or epistemological positions adopted by scholars and researchers, many laypersons are ontological realists.

Commonsense ontological realism enables us to understand many of the uses people have for uncertainty and how they go about creating and maintaining it or responding to it. The backdrop most of the time includes the assumption that there is an independent reality that provides the true state of any conceivable unknown. For example, it makes no sense to decide whether or not one would like to know the date and manner of one's demise unless one believes that such things are preordained and therefore knowable. A similar basis underpins the economics of attention, the social control of curiosity, and other pertinent social norms and cultural practices governing who is supposed to know what and when they are supposed to know it.

### **Ignorance, Uncertainty, and Social Capital**

Until fairly recently, the social sciences widely shared a 'Pollyanna' perspective, in which the default assumption was that unshared knowledge, miscommunication, and misunderstanding are pathological and in properly functioning social settings would be absent or eliminated. Some early dissidents

from this perspective observed that many important kinds of social interactions and arrangements would be impossible without some unshared perceptions, omissions, secrets, and even deception by the participants. Others pointed to the ways in which unshared information and uncertainty are arranged and manipulated to establish or maintain power relations. For instance, research into the tobacco industry's efforts to manufacture doubt about the hazards of tobacco presents an exemplary case study of the use of pseudoscience by an industrial giant to protect and expand its investments. In this section we review some of the major uses of ignorance and uncertainty and their roles in social life.

Ignorance and uncertainty underpin certain forms of social capital. Four examples are specialized knowledge, privacy, trust, and politeness. The first two exemplify multilaterally negotiated ignorance arrangements as opposed to unilateral ones such as secrecy or deceit. The second pair, trust and politeness, are examples of social relations and modes of social conduct that mandate or even require ignorance.

Specialization is a social ignorance arrangement. Aside from its obvious basis in cognitive limitations and expanding knowledge bases, specialization is an example of risk spreading in three respects. First, no participant has to take on all of the risks of direct learning (vs. vicarious learning which is less risky). Second, the risk of being ignorant about crucial matters is spread by diversifying ignorance. Third, the risks associated with the consequences of bearing knowledge (e.g., responsibility or culpability) also are diversified.

Likewise, privacy also is a socially mandated arrangement involving voluntarily imposed uncertainty and ignorance. Privacy often has been construed as control over access by others to information, mainly about the self. The most common motives for privacy are quite obvious, amounting to freedom from surveillance and exploitation.

There is widespread agreement among scholars that trust carries with it some form of risk or vulnerability. An important component of that risk is a requirement that the truster remains partially ignorant about the trustee. Trust relationships (e.g., friendships) entail a specific kind of privacy. If a person believes another is monitoring them or insisting that they self-disclose or account for their actions, that person will infer that the other does not trust them.

Polite or civil social interaction is another example of social relations that depend on ignorance. In polite conversation, conversationalists do not expect to deal in the truth, the whole truth, and nothing but the truth. Polite conversational strategies include disinformation (e.g., presenting a false impression of approval) and referential abbreviation (particularly vagueness and ambiguity or even outright omission, as in tactful utterances).

The literature on organizations and management has long given uncertainty a prominent place, although the treatment of 'uncertainty' itself has been rather muddled. Classical frameworks for management science during the 1950s and 1960s advised managers to eliminate or absorb uncertainty. The most popular remedies included buffering, smoothing, forecasting, and various forms of strategic planning. These remedies primarily amounted to formulating plans to weather uncertain times and/or strategies for mitigating negative consequences to the organization.

Most of the early findings in studies of how organizations deal with uncertainty could be summed up in the phrase 'uncertainty avoidance.' In addition to protecting the organization, motives for avoiding uncertainty included maintaining control and avoiding discreditation, adverse publicity, or controversy.

The 1970s and 1980s saw a more tolerant view of uncertainty in this literature. Evidence began to emerge that not all managers were risk-averse. Some high-performing managers were found to strategically select uncertain environments in which they could have a competitive edge or scope for entrepreneurship. Likewise, some studies revealed strategies employed by organizations to increase uncertainty for competitors in order to gain an advantage. Finally, critics of conventional control and regulation practices pointed out that tolerance of ignorance and uncertainty has potential benefits for organizations, in the form of a local culture of innovation and entrepreneurship, as well as the kinds of social capital discussed earlier.

### Risk, Uncertainty, and Public Culture

Research on risk perception arose during the 1970s, mainly in response to environmental concerns in Western nations. Much of the initial research was conducted by social and cognitive psychologists, with anthropology, sociology, and allied fields becoming involved during the 1980s and 1990s. There has been relatively little communication or integration between the cognitive psychological and sociocultural approaches to this topic.

Two widely debated sociocultural approaches to risk emerged during the 1990s. The first uses a 'worldview' concept, positing that human attitudes toward risk and danger vary systematically according to cultural orientations, assumed to be individualist, fatalist, hierarchist, or egalitarian. These orientations are held to strongly influence people's risk responses as well as attitudes toward the environment.

The second approach invokes the concept of a 'risk society.' The central claim is that modern technological developments have resulted in the emergence of new all-pervasive and invisible risks, also characterized as beyond the ken of laypeople. The focus of the 'risk society' perspective is on deep and globalized forms of uncertainty and ignorance, arising from major technical and environmental risks (e.g., climate change, pollution, or mass extinctions) and how they have transformed the social landscape in terms of opportunities, threats, benefits, and costs.

A third approach that links psychological and sociocultural approaches is the social amplification of risk framework. The primary subject of this approach is to explain why particular risks become a focus of concern in society while others are ignored. This framework does not deny the reality of hazards but investigates how these are transformed in the public consciousness via their amplification or diminution by psychological and sociocultural processes.

Somewhat related to the social amplification of risk framework is a critical literature that has emerged in the past decade as commentary on the increasingly risk-averse and litigious orientation of some Western societies. Writers and researchers in this vein have documented how risk and blameworthiness have become strongly linked under the rubric of democratic ideals such as accountability and transparency.

### Managing Uncertainty: Tradeoffs and Dilemmas

A crucial mistake in many perspectives that privilege knowledge over ignorance is the failure to realize that knowledge seeking and possession are not costless. The early literature on foraging behavior is pioneering in this regard, taking into account the energy and time costs entailed for an organism to try its luck in a different patch from the one it is familiar with. Information seeking and processing takes time, effort, and cognitive resources. Information seeking can also incur social costs. Directly interrogating someone, for example, is socially inappropriate or risky in many circumstances and prohibitively so in some cultures if the subject of interrogation has sufficiently high status.

Let us consider the tradeoffs involved in possessing information and knowledge, starting at the cognitive level. Ignoramuses are not always worse off than knowledgeable folk; in fact it can be demonstrated that under some conditions they are better off. Imagine for a moment that humans were endowed with the ability and a compulsion to indiscriminately absorb all information that came their way and retain all of it for a lifetime. It is well known that higher cognitive functions such as abstraction or even mere classification would be extremely difficult. Information acquired decades ago would be as vividly recalled as information acquired seconds ago, so older memories would interfere with more recent and usually more relevant recollections. Thus, forgetting is just as important as remembering for adaptively selective information processing. In effect, memory behaves as if it is betting that the less frequently and recently a piece of information has been retrieved, the less likely it is to be needed and therefore the better off the memory is without it.

Recent psychological research on the recognition and fluency heuristics, both of which require partial ignorance, also are instructive. To understand the recognition heuristic, consider the question: 'Which city has the larger population, Pasadena (California), or Pasadena (Maryland)?' If we do not know the populations of those two cities then we must rely on something else we know about them. The recognition heuristic says that if we recognize one city (most likely Pasadena, California) and not the other then we choose the recognized city. In this case we would make the correct choice (as I am writing this, Pasadena California contains about 145 000 people whereas Pasadena Maryland has about 12 000). Several studies have demonstrated that a greater number of correct choices (e.g., which of a pair of German cities has the greater population) can be made by ignorant decision makers (e.g., American university students) than by more knowledgeable decision makers (e.g., German citizens). The fluency heuristic is quite similar, stipulating that the city that is more fluently or rapidly recalled will be the one selected.

However, gaining an appreciation of the mixed-motive nature of engagement with ignorance and uncertainty, there is no substitute for examining some examples of real-world tradeoffs and dilemmas.

- 'Collingridge's dilemma' actually is a tradeoff. The less well-entrenched a system is and the shorter the time it has been operating, the more easily and inexpensively it can be changed; but the greater is our ignorance of its likely effects or problems. By the time ignorance of those

effects has been reduced, it is too expensive and difficult to change the system. In this tradeoff, time is both knowledge and money.

- The 'info-glut' dilemma is a genuine dilemma of the common-pool resource kind. Any stakeholder with an educational or persuasive interest will wish to broadcast its message in a public forum. Too many messages in an unregulated forum, however, may result in the public tuning out messages altogether. The scarce resource in this case is not information or knowledge, but attention.
- 'Mattera's dilemma' is an example of a conundrum in social regulation that has both tradeoff and dilemmatic components. The tradeoff arises from the fact that a regulatory climate favoring creativity and entrepreneurship requires the toleration of ignorance in the service of freedom. Insistence on full knowledge and control eliminates the latitude needed for creativity and entrepreneurship. The dilemmatic component arises from the fact that the greater the attempts to regulate behavior, the more reactive people become and the more they attempt to generate ignorance in the would-be controllers by withholding information or giving false information. If both parties pursue their self-interests then the end result is a system of constraints and controls built on disinformation.
- The 'indemnity' dilemma is a mixture of a collective tradeoff and a public goods dilemma. Play, games, fun, volunteering, and various other public goods require at least some risk-taking. However, a risk-averse public, aided by opportunistic lawyers and profit-oriented insurers, can create a litigious market in which public goods like fun and voluntarism are unaffordable or simply outlawed.

In conclusion, the roles played by knowledge and ignorance are not merely mirror images of one another. Moreover,

ignorance and uncertainty are neither negative nor marginal aspects of the human condition. They are essential to what makes us human.

**See also:** [Cognitive Bias](#); [Decision Making \(Individuals\)](#); [Judgment](#).

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# Violence

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## Glossary

**Adoption studies** Research wherein a child with one set of biological parents and a different set of psychological parents is studied.

**Biological environmental influences** Events that affect a person biologically but are not encoded into the person's DNA.

**Concordance rates** The frequency with which one twin is diagnosed with an illness, when the other twin is also diagnosed with the same illness.

**Cortisol** The hormone that regulates our body's reaction to stress.

**Genetic influences** The biological blueprints for behavior that are contained in a person's chromosomes.

**Imitation** A theory that states that children may learn to be violent by imitating an adult's aggression.

**Minimal brain dysfunction or minimal brain**

**damage** Very low levels of brain dysfunction, theoretically affecting behavior, emotions, learning, or memory.

**Neurotransmitters** Chemicals secreted by the brain, some of which have been linked to aggression.

**Paranoid misperceptions** Attitudes or belief systems that misinterpret ambiguous circumstances as signs of danger where none actually exists.

**Resilient** The state in which a person is likely to resist developing a disorder.

**Serotonin** One of the monoamines, low levels of which have been implicated as related to aggression.

**Testosterone** One of the *androgens*. A male sex hormone that is associated with aggression.

**Vulnerable** The state in which a person is likely to develop a disorder.

Violent crimes can be as baffling as they are repelling. In England, two 10-year-old boys lured a 2-year-old away from his mother at a shopping mall; they took him down to the local railroad tracks, where they beat him to death and left his body to be run over by a train. In the United States, a group of teenagers shot and killed a man whose car they were stealing – even though the man had willingly handed over his car keys and was not resisting the theft in any way. In Massachusetts, a group of young teenage schoolgirls planned to murder their English teacher because she was too 'strict.'

To understand the causes of violence, it is not always enough to understand the external circumstances that often drive other types of criminal behavior. It is true that violence sometimes results from factors such as an individual's desire for financial gain or from an individual's repeated exposure to violent behavior in his or her social environments. Sometimes, however, it also happens in an apparently motiveless fashion. *Violence is never truly without motive*, but its motives may be so complex and elusive that it *appears* motiveless. In all cases, particularly in cases of violence that appear to have no motive, internal or individual factors may be critical in understanding the cause of such behavior. A variety of different biological and psychological influences and mechanisms have been considered over the years. I summarize them here and attempt to construct a more comprehensive model of the causes of violent behavior.

## Biological Perspectives

### Types of Biological Influences

There exists a mistaken tendency to use interchangeably the terms *biological* and *genetic*. In fact, genetic influences are only

one type of biological influences on behavior. There are (at least) two different types of biological influences: genetic influences and biological environmental influences. *Genetic influences* refer to the blueprints for behavior that are contained in a person's chromosomes. Chromosomes contain deoxyribonucleic acid (DNA), the genetic material a person inherits from his or her biological parents, which is referred to as his or her *genotype*. An individual's *phenotype* is the outward expression of his or her genotype.

*Biological environmental influences*, unlike genetic influences, are events that affect a person biologically but are not encoded into the person's DNA. For example, consider a head injury from a car accident, which subsequently changes the victim's personality. The head injury is unmistakably a biological environmental influence. But no genotype determines that someone will have a car accident; however, such an accident, and its accompanying head injury, can still have an important biological effect on the person's behavior.

### Modern Biological Theories

Some children who are exposed to violent psychosocial environments do become violent; many other children who are similarly exposed do not. This fact has led researchers to hypothesize that some children are *vulnerable* to noxious circumstances, whereas others are *resilient* or *invincible* – that is, resilient children survive and cope well despite terrible circumstances. What makes one child resilient and another child vulnerable? Most recent reviews point to a variety of interventions and settings (family, school, medical care) that help increase resiliency in children. One study pointed out that afterschool and general school participation seems to increase

resiliency. Another possible difference between resilient and vulnerable children is their biology. Perhaps unfortunate genetic influences or biological environmental influences serve to weaken some children – thus making them vulnerable. On the other hand, perhaps positive biological influences strengthen some children – thus making them resilient. The fact that children are differentially vulnerable suggests that biology may be an important difference among violent versus nonviolent people.

Another piece of evidence has emerged that supports the importance of biology as one cause of violence. In the past few decades, researchers have conducted longitudinal studies that track the same group of people over long periods of time, usually years. Several important studies have found that aggressive behavior is (in some children) a stable characteristic from very early childhood until adulthood. Both boys and girls may show that stability of aggression, which seems to increase as the child grows. When a behavior begins very early in life, before a child has been exposed to any psychological environment for a lengthy period of time, it likely that this behavior is strongly influenced by biological factors. Thus, the evidence from longitudinal studies suggests that early biological factors (such as genetic influences or early biological environment) may operate during an individual's entire lifetime to affect his or her tendency to be violent.

In summary, there are two major pieces of evidence that suggest the importance of biology as well as learning: (a) the early emergence of aggressive behavior as a stable characteristic in some individuals, and (b) individual differences in vulnerability to noxious environmental influences (such as having violent parents). The question that remains is: What biological influences are important in making a child more or less vulnerable to poor psychosocial environments?

### Physiology and Anatomy

One type of biological factor that might influence the development of violence is *anatomical differences* between the brains of violent individuals and those of nonviolent individuals – in shape or matter.

One type of anatomical difference that has been studied in relation to violence is the presence of a brain tumor. A brain tumor is an uncontrolled growth mass in the brain. There are two types of brain tumors: those that actively destroy healthy brain tissue, and those that cause problems by compressing brain tissue until it is unable to function normally. Brain tumors, which offer gross (large) insults to brain integrity, undoubtedly cause changes in behavior, including personality changes. A few violent criminals have been found to have brain tumors upon autopsy. Some testing has also found brain dysfunction in forensic populations. One study found a high incidence of focal (i.e., small and localized) abnormalities in the left hemisphere of violent individuals who also tended to be mentally retarded or epileptic or who had suffered from earlier brain damage. A more recent case study noted that in a 16-year-old boy, a tumor was associated with several different behavioral problems, including aggression and mood swings. In general, however, there was no relationship between EEG abnormalities and violent behavior. The pattern of this research suggests that while focal

abnormalities such as tumors might exacerbate violence in some individuals (probably those who have multiple impairments), in general they are not a typical cause of violent behavior. The earlier findings of tumors had caused some excitement in the scientific community; these individuals raised the possibility that extreme, senseless violence may be due, at least in part, to brain tumors that radically affect normal brain function, or that worsen more subtle brain deficits. In reality, however, this scenario would only fit a small number of violent offenders. Most violent offenders do not have brain tumors, and research in this area suggests strongly that brain tumors (and other types of massive brain damage) are not an important factor in the etiology of the bulk of violence. To date, the hypothesis that violence is due to massive brain dysfunction appears to have little support, and autopsies of chronically violent offenders usually find no noticeable (i.e., major) brain damage.

However, not all damage to the brain is massive. Damage to the brain ranges from extremely minimal to extremely major. Most cases of brain damage are at the minimal end of the spectrum, although it is the major cases that are the most noticeable.

### Minimal brain damage

Also called *minimal brain dysfunction*, minimal brain damage does not 'look' like major brain damage. A person with minimal brain dysfunction will not have 'obvious' brain damage; however, minimal dysfunction may affect behavior, emotions, learning, or memory – that is, the more subtle (or 'higher') functions of the brain. For example, although major brain damage might result in severe mental retardation, minor brain dysfunction might result in a learning disability that would not necessarily affect intelligence in any way (e.g., dyslexia). Because we know that minimal brain dysfunction appears to be related to problems such as learning disorders and hyperactivity, it is logical for scientists to be interested in the possibility that minimal brain dysfunction is related to behavioral problems like violence.

### Minor physical anomalies

Interestingly, a series of studies has found a relationship between minor physical anomalies (MPAs) and childhood behaviors related to adult aggression (such as hyperactivity), and criminal violence as an adult. Studies of children with behavior disorders related to delinquency often find that the children have high numbers of MPAs. One longitudinal study followed 170 Montreal (Canada) boys from kindergarten through adolescence; they were examined at age 14, when their MPAs were assessed. This study found that MPAs were related to an increased risk of violent delinquency by age 17, as measured by both self-report and official records, although MPAs were not related to property offending. Another study, which followed children from birth until adulthood, found that subjects with high numbers of MPAs as children were at significantly higher risk of recidivist, violent criminal activity as adults. Another research, taking advantage of more recent and sophisticated imaging scans to examine brain tissue more directly, has found this type of minimal damage in the scans of violent individuals.



### Neuropsychological testing

MPAs are only one indirect way of assessing minor brain dysfunction. A second way is *neuropsychological testing*. Researchers have administered neuropsychological tests to violent criminals, and have found evidence that such individuals often have subtle brain impairments. One study found that a low score on a neuropsychological frontal lobe task predicted aggressiveness among 72 white males. Studies on children have found links between behavior problems, aggression and acting out, and neuropsychological abnormalities. An in-depth study comparing chronic violent offenders to nonviolent offenders found that the violent offenders were significantly more likely to demonstrate a number of indicators of abnormal neuropsychological function, including head injuries, seizures, headaches, hypoglycemia, dizziness, poor coordination, and speech and vision problems. Furthermore, subjects with poor neuropsychological functioning, particularly in the frontal lobe region, are more aggressive when provoked. Hoaken's (2007) study of violent individuals with frontal lobe damage found that such damage appears to affect 'executive functioning' in the brain (which may, in turn, be related to aggression) and the perception (or misperception) of facial expressions. Other studies have also linked frontal lobe dysfunction and antisocial behavior.

### Head injury

A third way of measuring minor brain dysfunction is through studying the medical history of a person to reveal head injuries that did not result in gross brain damage. One study compared 27 control children to 27 children who had suffered brain injuries. The children who had suffered the injuries were significantly more likely to show problems with aggression and antisocial behavior; this was true even for the eight children who showed mild brain injuries. Ommaya and his colleagues studied military discharges and found that individuals with mild brain injuries were much more likely than others to be discharged for 'behavioral' reasons, including criminal convictions. One bizarre case was recently presented at a meeting of the American Academy of Physical Medicine and Rehabilitation. The case involved a 47-year-old graphic designer, having no history of psychological problems or antisocial behavior, who suffered a mild head injury and developed impulsive behavior including property crimes.

Researchers, like Dorothy Otnow Lewis of New York University, have combed the medical histories of some of the most violent people in our society. Lewis and other researchers have found that the medical histories of violent delinquents reveal unusually high levels of head injuries. How does brain injury lead to more aggression? More recent research has begun to suggest pathways. One study noted that pediatric patients with a history of brain injury evidenced more frustration, which in turn led to more aggression. Another study linking brain injury and aggression found that frontal lobe damage and the misperceptions of facial expressions were key.

In summary, although both major and minor brain damage may cause violence, the weight of the evidence suggests that the most important type of brain dysfunction in people who are chronically violent and criminal is minimal brain dysfunction. Although it is almost certain that most people with minimal

brain dysfunction will never be violent, a noticeably high number of repeat violent offenders show some level of brain dysfunction (usually minimal).

### Neurotransmitters

Several psychological disorders, such as schizophrenia, are at least partially caused by too much or too little of one type of neurotransmitter or another. A logical question, therefore, is whether violent behavior is related (at least in part) to the level of certain neurotransmitters in the brains of violent people.

As stated previously, there are many different types of neurotransmitters in the brain. However, monoamine neurotransmitters have been most significantly linked to aggression. Research has linked low levels of serotonin with violence, particularly with impulsive aggression. Of the monoamines, low levels of *serotonin* have been implicated most strongly in recent research. One study of rhesus macaque monkeys found that low levels of a serotonin metabolite were found in dominant monkeys and that levels in general were negatively correlated with aggression. This study pointed out that low levels of serotonin were, in fact, adaptive for some monkeys in that it enabled them to attain a dominant status. Studies in humans, however, have generally failed to note positive results of low levels of serotonin. One study of adolescent boys with conduct disorders (CDs) found a negative correlation between their levels of serotonin and the severity of their violent offending. The study found that this relationship was particularly strong in boys with childhood onset of CDs (as opposed to boys whose CDs did not emerge until adolescence). Another recent study injected both male and female subjects with a serotonin-releasing agent, but interestingly found that although a link between hostility, aggression, and low serotonin was found, it was only noted in male subjects. Stanley et al. (2000) studied serotonin levels in 64 psychiatric patients with a variety of diagnoses. She found that serotonin levels were lower in aggressive subjects – and that this was true for all types of psychiatric diagnoses. The researchers also noted that impulsivity was also linked to serotonin function. This suggested that possibility that aggression and impulsivity may share common biological roots. Yet another study linked serotonin levels to aggression *other* than interpersonal aggression: New and her colleagues found an association between low levels of serotonin and self-injurious, suicidal behavior in a sample of personality-disordered, suicidal subjects.

Other studies have found data that indirectly implicates serotonin function. Davidson and Putnam studied 500 violent individuals through a study of their brain scans and found a high rate of defects in the prefrontal cortex – an area that regulates serotonin function.

### Hormones

Two hormones have been the focus of most research on aggression and criminality: *testosterone* and *cortisol*. Testosterone is one of the male sex hormones, called *androgens*. Both males and females secrete androgens, but males secrete a much greater quantity than do females. Androgens are frequently cited as an important cause of aggressive behavior, particularly intermale aggression. What is the evidence that this is true?

A 1995 study of 692 male prisoners compared those who had committed sexual and violent crimes with those who had committed only property crimes on salivary testosterone levels. Interestingly, the higher testosterone levels were associated both with sexual and violent offending as well as with generally more intractable and confrontational behavior – what might, in another interpretation, be seen as dominance behaviors. Dabbs and Morris (1990) found a wide variety of behaviors marking the high-testosterone males, of which more sexual and violent offending was only one. A more recent study continued this trend, finding an association between testosterone levels and aggression (although this association was noted only in males).

A study of 13 elderly men suffering from dementia, however, found that while testosterone was related to aggressive behavior, it was not found to be related to agitated and confrontational behavior.

In 1996, Terry Banks and James Dabbs, Jr., published a study in which they compared the testosterone levels found in young adult delinquents to levels found in a group of college student controls. The researchers compared 36 students to 29 delinquents, and matched them for age, sex, and race. Some of the delinquents had drug offenses and some had violent offenses. Generally, the violent offenses tended to be milder, although two subjects had committed homicide. Banks and Dabbs found that the delinquent subjects had higher testosterone levels than the student controls. Furthermore, this was true for both male and female offenders.

Again, some inconsistencies emerge. For example, a Spanish study of preschoolers uncovered slightly different findings. Sanchez-Martin et al. studied 28 male and 20 female preschoolers. They examined the children's play behavior via videotaped sessions. The play was 'free play,' that is, not scripted activities. Finally, the researchers measured salivary testosterone in the children. Interestingly, although they did find a significant relationship between hostile aggression and testosterone in male children, they found no such association in female children (unlike Dabbs' research, above). They also found no association between testosterone and the tendency of a child to engage in playful (not hostile) aggression.

Another study of domestic violence also found an association between testosterone and aggression. Soler and colleagues studied 54 men from low socioeconomic backgrounds. They asked these men to self-report on their aggression levels with their domestic partners and a high percentage reported some form of verbal or physical aggression. Further, testosterone levels were significantly correlated with these types of self-reported aggression. Of course, since this study utilizes self-report measures of aggression, it is possible that aggressive men were mistakenly included in the 'low-aggression' group if they failed to report their own violent behavior.

Finally, if high testosterone helps cause aggression, will low testosterone help reduce it? A newer way to study the impact of androgens on aggression is through the forensic use of chemical castration. This process involves the administration of the female hormone medroxyprogesterone acetate (Depo-provera) that decreases the functioning of testosterone (one of the androgens). The theory is that such an administration will decrease a male's sexual drive and permit the release of repeat sex offenders into society. Despite some anecdotal reports of

success in stopping sexual offense recidivism, clinicians have noted that chemical castration does not work in all male offenders and that as many as half are still able, despite treatment, to function sexually. Another study used a different approach: some researchers examined the impact of artificially reducing testosterone levels without castration. This experiment involved eight normal men; so, its findings may or may not be generalizable to violent criminal offenders. Loosen and his colleagues found, interestingly, that some effects were the same for all men, while other effects happened only in some of the men. For example, all eight men showed marked reductions in 'outward-directed' anger, but only half exhibited reductions in anxiety and sexual desire. Neither study really suggests that lowering testosterone, either through castration or through chemical means, is decidedly effective on violent males.

The literature that implicates testosterone as an important cause of violence may seem strong, but research is rarely as clear as it appears at first glance. There are inconsistencies. Some research points to aggression and dominance/hostility as being related to testosterone, and other research fails to find that dominance/hostility measures are related to sex hormones. Some research notes a testosterone-aggression relationship in both males and females; other research finds it only for males. Reducing testosterone demonstrated that in different men it plays different psychological roles, and there is no clear evidence that it might effectively reduce violence in all violent males. Despite this, some consistencies emerge: clearly testosterone may play *some* role in causing aggressive behavior in at least some offenders. What factors might account for the inconsistencies found in the literature above?

Paul C. Bernhardt has suggested that perhaps more than one biological factor must go wrong for testosterone to truly have a deleterious effect. He recently pointed out that although studies have linked high levels of testosterone to aggression, this relationship cannot be a simple one because successful athletes and businessmen also tend to have high testosterone levels, although they are usually not violent individuals. Bernhardt has pointed out that testosterone may be acting in accord with low serotonin in violent individuals, and that it may be this 'double whammy' that results in criminally violent behavior. He points out that serotonin, in addition to being linked to aggression, is also linked to hyperresponsiveness to bad events. Possibly, what is happening is that when a high-testosterone male is thwarted in his dominance attempts – when he fails – then if he 'hyperresponds' to this bad event, he will exude aggression. Thus, Bernhardt's intriguing theory suggests, as many other researchers have, that there probably needs to be more than one system malfunctioning to achieve a truly violent individual.

Another theory suggests that high testosterone levels might have social and psychological implications as well as biological ones, and that a person might need to be exposed to social problems *in addition* to the biological factors to develop a markedly violent tendency. Raine and his colleagues studied 1130 male and female children from the Indian Ocean island of Mauritius as part of a prospective cohort study. They found that children who were taller and heavier at age three – correlates of higher testosterone – were also more aggressive, more fearless, and sought more stimulation

then their peers. Raine speculated that these children might be expected to have suffered socially as well. For example, taller and heavier children might bully more both because they are more likely to have been exposed to more testosterone, and because, being bigger, they find it easier to be bullies. Thus, this study exposes the complex nature of human social interaction and biology. Our biology impacts us all; and in turn, it impacts our ability to socialize with other human beings which in its own turn, helps to determine our own behavior.

One final theory, and one of the most compelling, has to do with the timing of exposure to testosterone. Because higher testosterone is measured in grown men, we assume that it is *then* that it must be making its greatest impact. However, a significant body of research has implicated prenatal exposure to testosterone as a likely source of influence on brain development and thus on behavior. Fetal exposure to high levels of androgens (male-typical range or clinically high range) may affect the tendency to be violent in two ways. First, prenatal exposure to androgens appears to actually lower the tendency of a person to behave in a prosocial manner. Second, levels of prenatal testosterone are theoretically related to levels of MAO, which affects general aggressiveness and feelings of anger and frustration. Like androgens administered to transsexuals, androgens administered prenatally may also affect emotions related to aggression. A series of studies that have examined individuals who were exposed to unusually high levels of androgens prenatally has found that such persons have an increased risk of being aggressive and violent, supporting the notion that it may be androgen exposure during fetal brain development which is most critical. Finally, a fascinating study of twins studied the behavioral differences in females who had a female twin versus a male twin. Theoretically, he expected the female twins who had a male twin to hold more 'masculine attitudes' than females who had female twins. The reason for this, theoretically, was because female twins are exposed to more testosterone in utero if they have a male twin than if they have a female twin. Although there are other possible interpretations of these findings – most notably, the social influence of having a male twin – it remains possible that being exposed in utero to unusually high levels of testosterone can have an effect on brain development.

A second hormone that has been implicated more recently is *cortisol*. Cortisol is the hormone that regulates our body's reaction to stress. It is involved with the immune system and with sex hormones as well. A few studies have linked low levels of cortisol with a tendency to be aggressive. For example, one study looked at 38 boys, aged, 7–12, who had been referred to a clinic for behavior problems. The boys were enrolled in a long-term study and their behaviors were recorded for 4 years, based on reports from their teachers and parents. There were also some reports from the boys themselves and some from their peers. Finally, the researchers also studied levels of cortisol in the boys' saliva. Low cortisol was associated not only with aggression in general but also with boys who were the *most* aggressive and who showed aggressive symptoms the *earliest* during the study years. Boys who had higher cortisol levels were spread across categories – some exhibited symptoms earlier, some later. But of the boys in the low-cortisol group, almost every one exhibited aggressive symptoms by age 10. Thus, while low cortisol levels indicated that a child would

develop an earlier onset of aggression, having a higher cortisol level did not protect from also developing an earlier onset – at least, it only protected some children.

Another study found similar results. Kathleen Pajer and her colleagues studied 47 adolescent girls with CD and 37 controls. They measured cortisol in all subjects, and found that the subjects with CD had significantly lower cortisol levels, relative to the control subjects. This was found even when they controlled for probable confounds such as age and socioeconomic status. Stress may also mediate the relationship between cortisol and aggression, and other research has noted that cortisol levels were significant in explaining discrepancies in twin studies.

In summary, evidence suggests that hormones play a significant, but not a simple, role in determining violent behavior. This is not surprising, since hormones are known to impact many human behaviors, and in every case they have a profound, complex impact which is mediated by a variety of variables – both biological and social.

## Genetics

For decades, researchers have searched for the 'aggression gene.' In one Dutch family with at least 14 men with strong violent tendencies, researchers did find a genetic mutation on the X chromosome. Despite such cases, the majority of researchers agree that violence does not appear to be a behavioral tendency that is transmitted via a simple, directly acting gene. In any case, it is clear that if genetic bases for aggression and violence exist, they are clearly mutable and changeable by a person's psychological environment; the 'old idea' that genetics determines one's behavior *absolutely* is clearly mistaken.

The case for genetics as a cause of aggression and adult criminal violence has to be pieced together from a number of different areas of study. First, we know that children with violent parents do have a higher tendency to be violent themselves. In fact, one study that found that adolescent murderers tend to have violent fathers suggested that genetics might be an important cause of the teenagers' aggression. Despite this earlier research, however, the field needs to make the critical distinction between biological *heredity* versus family psychology. Parents provide a psychological, as well as biological, environment for their children. What do parents teach their children, and what do they pass to them through their genes?

## Twin studies

Twin studies are studies that typically compare identical (monozygotic) to fraternal (dizygotic) twins. Identical twins are the only human beings alive who are genetically identical. Fraternal twins are genetically siblings only; they carry similar genes, as siblings do, but not identical genes as identical twins do. Therefore, if a behavior is found more common in both identical twins and less commonly in both fraternal twins, then one conclusion is that that behavior may be genetically heritable. This is called 'concordance.' Hudziak and his colleagues, who studied 492 twin pairs (comparing identical to fraternal twins), completed one classic twin study on aggression. The researchers surveyed the twins' parents about a broad range of behaviors, including aggression, and then cross-checked to see if aggressive behavior was more commonly

found in both identical twins then in both fraternal twins. Indeed, that was precisely what they found, and the researchers estimated that, in their sample, genetics accounted for 70–77% of the variance in aggression. Another study of twins and triplets found an astonishing 96% heritability among 9- and 10-year olds for antisocial and aggressive behaviors (based on behavior ratings from the subjects themselves, their teachers, and their caregivers). Such a finding suggests a strong genetic influence on aggression.

Another twin study compared 183 monozygotic (identical) with 64 dizygotic (fraternal) twins. They found not only that individual measures of aggression were heritable – that is, more commonly found in both identical twins – but also that the same genotype might produce a variety of aggressive behaviors. Twin studies are compelling, but they suffer from a common flaw: not only do identical twins share genes, but also they often share an environment that treats them similarly. Because of this, identical twins are not the perfect genetics–environment experiment. Another method, which seeks more fully to separate genetics from psychological environment, is the method known as adoption studies.

### **Adoption studies**

Adopted children are children who have one set of biological parents, and a different set of psychological parents. By comparing the children's behavior with that of both their adopted parents and their genetic parents, it is possible to ascertain what behaviors are genetically inherited and what behaviors result from family environments.

Earlier studies, which studied children prospectively in long-term studies, found that adopted-away children are as aggressive as their adopted parents are, rather than as their biological parents are. In a more recent study, researchers used a different design and obtained somewhat different results. Instead of studying child–parent behavioral traits, they studied how similarly siblings behaved. They compared 221 pairs of biologically unrelated siblings to 111 pairs of biologically related siblings. All the children were adopted, but the biologically related siblings should show a higher concordance of aggression and crime if such behavior is genetically heritable.

The researchers found mixed results. While both aggression and delinquency were heritable, aggression was much more heritable than delinquency. Genetics accounted for 70% of the variance in aggression (similar findings to those of the twin studies) but only 39% of the variance in delinquency. This suggests that earlier research, which studied official records of delinquency, might not have been off-target. It is certainly plausible to find different degrees of heritability for aggression *per se*, versus official criminal records of offending – two measures of behavior which are clearly not the same thing. Some researchers have argued that earlier adoption studies do not rule out genetic influences, but rather point out that they are strongly mediated by environmental influences.

### **Heritability of disorders related to violence**

Studying the heritability of disorders linked to violence is an indirect method of studying the heritability of violence itself. Attention deficit disorder/hyperactivity (a disorder with strong

ties to adult violence) may be heritable. Sherman examined 576 twin boys between the ages of 11 and 12 and found that the data demonstrated that hyperactivity, impulsivity, and inattention were behaviors significantly influenced by genetics. Another study compared the biological and the adopted relatives of these children for indications that they, too, had ADHD. They found that while only 6% of the adopted parents had ADHD, 18% of the biological parents of ADHD children exhibited ADHD symptoms.

CDs are another set of childhood disorders that are strongly linked to adult crime and violence. Studies examining this disorder have also found evidence for its heritability. One twin study examining 2682 adult twin pairs revealed substantial concordance for CD among identical twin pairs. Another twin study on the heritability of CDs found similar results. Again, researchers studied 43 monozygotic ('identical') and 38 dizygotic ('fraternal') same-sex twins. They surveyed the twins about their antisocial behaviors and found that behaviors indicative of CDs were more concordant in identical twins. The researchers concluded that these behaviors have a significant heritable component.

Finally, Frederick Coolidge and his colleagues compared 70 identical and 42 fraternal twins between the ages of 4 and 15. They were seeking to uncover the causes of a range of behavior disorders, and found that several of these disorders were significantly more concordant in identical twins. CD was in fact one of the disorders most strongly influenced by genetics – Coolidge estimated that it demonstrated a heritability of 68% (very consistent with past research).

In summary, much of the data on the genetic basis of violence is suggestive of a significant, but not total or direct, heritability. Twin studies are interesting but cannot be definitive, since they do not separate the effects of psychological environment and genetics. Adoption studies are mixed; and studies that are indirect in nature – that is, which do not study violence directly but study other disorders related to it – suggest a heritability index of approximately 70%. In general, the data suggest that there must be a heritable component of violence; perhaps impulsivity, hyperactivity, or aggressive tendencies are genetically transmitted; but clearly, this is not a simple or direct relationship. Even if one were to broadly apply the heritability estimates of 70%, such a number would imply that 30% of the reasons for people becoming violent is unrelated to genetics. As with most behaviors in human beings, no one simple answer suffices.

## **Other Psychological Perspectives**

### **Hostile Interpretation of Ambiguous Events, or Cognitive Distortions**

Are paranoid misperceptions rare among violent individuals? One theory suggests that such biased misperceptions may in fact help explain why some people are violent. Indeed, as the theory goes, under certain circumstances, aggression may be a normal and adaptive response. This may particularly be the case when an individual is faced with hostile or threatening forces, and violence is perceived as a necessary response. Given that a hostile environment might provoke an aggressive response in



almost anyone, some researchers have investigated the possibility that violent individuals are not people who inappropriately choose violence; rather, they are people who inappropriately perceive hostility where most people would not.

Dodge studied aggressive and nonaggressive children, and found that aggressive children have two perceptual tendencies that nonaggressive children lack. Aggressive children were more likely to believe that other people had hostile intentions; and they were more likely to evaluate the results of aggression positively. One study furthered this by comparing reactive to proactive aggression. This study examined how children's cognitions develop and maintain aggression of two different types, and found that hostile biases were particularly characteristic of reactive-aggressive children.

Dodge and colleagues also studied adolescent offenders in a maximum-security prison and found that although these biases were also found in this population, they were only found in undersocialized delinquents. This line of study sheds some light on why it may be so difficult to treat violent offenders. Trying to teach such offenders to be nonviolent may in fact be trying to teach them to react nonviolently to what they perceive to be intensely threatening situations. For example, imagine that you are standing in a field holding a gun, and an elephant is charging toward you at full speed with his tusks aimed right at you. Trying to teach violent offenders to be nonviolent might be like trying to teach them not to shoot that elephant, even though there is every indication that that elephant is deadly.

Other research has noted similar findings. Some of Dodge's later research also found that both moderately and severely aggressive children have a number of problems with 'social cognition,' among them, attributional biases. Another study compared 27 aggressive to 27 nonaggressive boys and examined the way these boys recalled and recognized information. The boys were given a series of ambiguous and unambiguous sentences, and tested for how well they remembered the sentences. Some of the sentences had aggressive content and some did not. The main difference they found between these two groups of boys was that the aggressive boys were significantly better at recognizing the aggressively slanted items. Salzer Burks et al. conducted a longitudinal study, following a group of children from Kindergarten through the eighth grade. In this study these colleagues examined what immediate factors preceded aggression in children. They found that children with biased 'knowledge structures' (i.e., memories which emphasize hostility) process information in a more negatively biased way and are more likely to develop stable negative cognitive biases and stably aggressive behavior.

Other similar studies have found that aggressive children attribute fewer positive intentions to people in problem-solving scenarios and that sexually aggressive men use a 'suspicious schema' in interpreting women's statements. Hoaken, Allaby, and Earle's research went farther and associated the cognitive misperceptions with damage to the frontal lobe, and problems with executive functioning (providing a possible pathway for the misperception of facial expressions, at least). Finally, Downey and Walker looked more closely at this phenomenon and noted that attributional biases did not appear to

mediate the link between high risk and aggression, but rather, appeared to serve as a protective factor against aggression. That is, children who are at high risk for violence – for example, children who have been abused – are not at even higher risk if they also make biased attributions. Rather, those children who do not make biased attributions are at lower risk of becoming aggressive, even if they have been abused. In other words, making accurate rather than biased attributions may be a protective factor that makes children resilient.

Other research has examined different types of violent offenders and has found cognitive misinterpretations and biases that appear to be specific to the type of offense. For example, rather than making general, nonspecific hostile misinterpretations, adults who commit child abuse tend to misinterpret children's behavior. Specifically, they tend to regard children's misbehaviors as more intentional than they really are – possibly paving the way to righteous anger and abuse. Sexually aggressive men, rather than suffering from blanket distortions, may differ from other men primarily in their distortion of women's communications. As research continues into the factor of cognitive distortions, it becomes increasingly likely that violent offenders may be individuals who distort perceptions in such a way that it predisposes them to behave in certain, specific criminal ways.

All violent feelings produce in us a falseness in our impressions of external things. (John Ruskin)

**See also:** Aggression; Alcohol: Psychosocial Effects; Anger; Brain Chemicals: Global Projections of Ancient Aromatic Neurotransmitters; The Clinical and Cognitive Psychology of Conflict; Conflict Communication; War.

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## Visual Motion Perception

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### Glossary

**Aperture problem** A problem in determining the true direction of motion of an object contour that is faced by any localized motion sensor that detects motion through an aperture-like receptive field.

**Bistable motion** Motion is said to be bistable when the brain periodically switches between two alternative percepts of the same motion stimulus. For example, percepts of moving plaids or of pairs of random dot patterns can alternate between at least two possible percepts.

**Complementary computing** The brain uses parallel cortical processing streams to compute complementary properties of visual inputs. Complementary processes are akin to puzzle pieces that must both be computed, and fit together, to complete a puzzle. For example, visual boundaries and surfaces are computed using complementary computational properties, and need to interact for either of them to be computed properly.

**Directional grouping** This process enables spatially distributed motion signals to be grouped into a coherent percept of object direction and speed. Formotion binding and motion capture preprocess form and motion signals before the stage of directional grouping solves the aperture problem.

**FACADE model** FACADE is a neural model that explains how the visual cortex creates a representation of Form-And-Color-And-Depth which is predicted to be complete by cortical area V4.

**Feature tracking signal** An unambiguous motion direction signal that can be computed at image features, such as object corners.

**Figure-ground separation** This process separates combinations of image features into representations of distinct object boundaries and surfaces.

**Formotion binding** A process whereby form boundaries that are computed in the processing stream from V1 interblobs to V2 pale stripes can select compatible motion signals that are computed in the processing stream from V1 to MT. Interstream interactions from V2 to MT can carry out formotion binding. The selected motion signals can then be further processed to track moving objects in depth.

**Intrinsic and extrinsic terminators** When an object intersects an occluder, the brain needs to determine which of its boundaries belong to the object and which to the

occluder. An intrinsic terminator belongs to the moving object, whereas an extrinsic one belongs to the occluder.

**Laminar cortical circuits** All neocortical cells are organized into layers, often six main layers of cells, with characteristic sublamina, in visual cortex.

**Long-range apparent motion** Long-range apparent motion creates a percept of continuous motion between discrete flashes of light that are separated in space and time. This type of motion percept can create a continuously trackable motion trajectory from moving fragments of object motion behind occluders, much as an animal running at variable speeds behind forest cover can create motion signals that are intermittently experienced.

**Long-range directional filter** The long-range directional filter has a larger receptive field than the short-range directional filter, and one that receives its preferred motion direction inputs from multiple orientations, opposite contrast polarities, and both eyes.

**Motion capture** A process that uses feature tracking motion direction signals to select the same motion direction signals from among the possible ambiguous motion direction signals along contours whose motion directions are ambiguous due to the aperture problem. Motion capture also suppresses the ambiguous motion direction signals.

When no feature tracking signals are available, motion capture enables the strongest ambiguous motion direction signals to determine the perceived object motion direction.

**Motion integration** The process whereby the brain combines spatially distributed motion signals into a coherent percept of object motion.

**Motion segmentation** The process whereby the brain separates motion signals into percepts of distinct moving objects.

**Perceptual grouping** Grouping joins together spatially disparate image features into a coherent representation of an object boundary. Edges, textures, and shading can all be grouped into object boundaries whose structure is sensitive to the spatial distribution of image features.

**Short-range directional filter** The short-range directional filter helps to selectively strengthen unambiguous feature tracking signals, relative to ambiguous motion signals, by pooling such signals within a spatially anisotropic receptive field that is oriented along the pooled direction of motion.

### Motion Integration and Segmentation

#### Aperture Problem

The brain's motion perception system solves the complementary problems of *motion integration* and *motion segmentation*. The former joins nearby motion signals into a single object, while

the latter separates them into different objects. Wallach first showed that the motion of a featureless line seen behind a circular aperture is perceptually ambiguous: given any real direction of motion, the perceived direction is perpendicular to the orientation of the line. This phenomenon was called the *aperture problem* by Marr and Ullman. The aperture problem is faced by

any localized neural motion sensor, such as a neuron in the early visual pathway, which responds to a moving local contour through an aperture-like receptive field. Only when the contour within an aperture contains features, such as line terminators, object corners, or high contrast blobs or dots, can a local motion detector accurately measure the direction and velocity of motion. For example, when the aperture is rectangular, as during the barberpole illusion, moving lines may appear to move in the direction parallel to the longer edges of the rectangle within which they move, even if their actual motion direction is not parallel to these edges. The brain must solve the aperture problem, despite the fact that every neuron's receptive field defines an 'aperture,' in order to detect the correct motion directions of important moving objects in the world. The examples of circular and rectangular apertures, or occluders, provide important cues about how the brain can often do this in the real world.

When an object moves behind multiple occluders, aperture ambiguities can again lead to veridical percepts of its real motion. Despite the fact that the object may be segmented into many visible parts by the occluders, the visual system can often integrate these parts into a percept of coherent object motion that crosses the occluders. Studying conditions under which the visual system can and cannot accomplish correct segmentation and integration provides important cues to the processes that are used by the visual system to create useful and predictive object motion percepts during normal viewing conditions.

### Feature Tracking Signals

To solve the interlinked problems of motion integration and segmentation, the visual system uses the relatively few unambiguous motion signals arising from image features, called *feature tracking* signals, to select the ambiguous motion signals that are consistent with them, while suppressing the more numerous ambiguous signals that are inconsistent with them. For example, during the barberpole illusion, feature tracking signals from the moving line ends along the longer edges of the bounding rectangle of the barberpole compute an unambiguous motion direction. These feature tracking signals gradually propagate into the interior of the rectangle. This *motion capture* process selects the feature tracking motion direction from the possible ambiguous directions along the lines within the rectangle that are due to the aperture problem. Motion capture also suppresses the ambiguous motion signals. When a scene does not contain any unambiguous motion signals, the ambiguous motion signals cooperate to compute a consistent object motion direction and speed.

This article summarizes a neural model of the cortical form and motion processes that clarifies how such motion integration and segmentation processes occur (Figure 1). This 3D FORMOTION model has been progressively developed over the years to explain and predict an ever-larger set of data about motion perception. Comparisons with related models and more data than can be summarized here are found in these archival articles.

### Neurophysiological Support for Predicted Aperture Problem Solution

In addition to model explanations of known data, the model has predicted data that were subsequently reported. In particular, Chey et al. predicted how feature tracking estimates can

gradually propagate across space to capture consistent motion directional signals, while suppressing inconsistent ones, in cortical area MT. Such motion capture was predicted to be a key step in solving the aperture problem. Pack and Born reported neurophysiological data that support this prediction. As simulated in the model, MT neurons initially respond primarily to the component of motion perpendicular to a contour's orientation, but over a period of ~60 ms the responses gradually shift to encode the true stimulus direction, regardless of orientation. Pack and Born also collected data which support the concept that motion signals are used for target tracking. Namely, the initial velocity of pursuit eye movements deviates in a direction perpendicular to local contour orientation, suggesting that the earliest neural responses influence the oculomotor response.

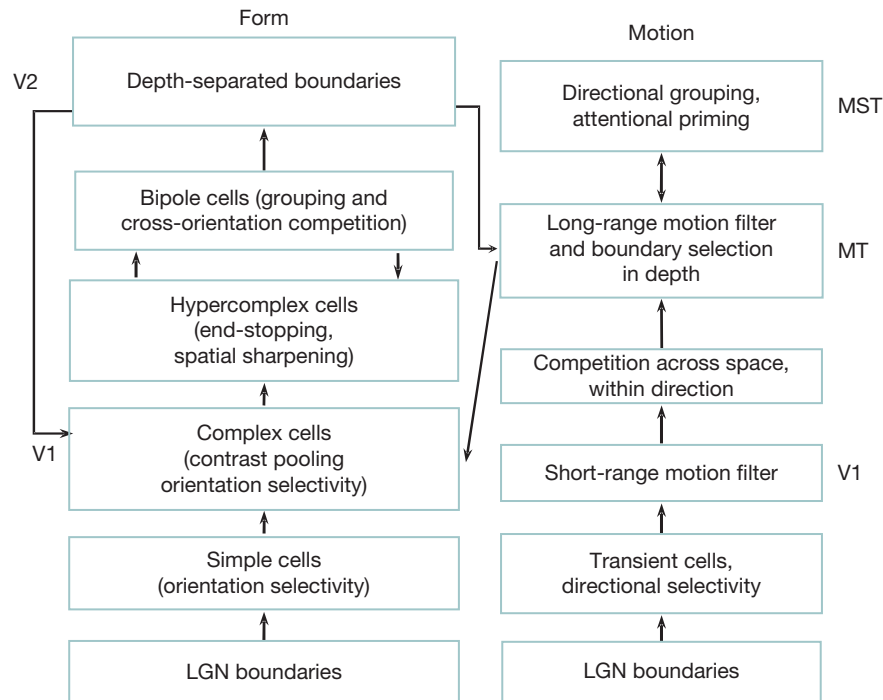
Many psychophysical data also illustrate how feature tracking signals can propagate gradually across space to capture consistent ambiguous signals. Castet et al. described a particularly clear illustration of this. Figure 2(a) summarizes their data. They considered the horizontal motion of both a vertical and a tilted line that are moving at the same speed. Suppose that the unambiguous feature tracking signals at the line ends capture the ambiguous motion signals near the line middle. The preferred ambiguous motion direction and speed are normal to the line's orientation. In the case of the vertical line, the speed of the feature tracking signals at the line ends equals that of the preferred ambiguous speed near the line's middle. For the tilted line, however, the preferred ambiguous speed is less than that of the feature tracking speed. If the speed of the line is judged using a weighted average of feature signals and ambiguous signals, then the tilted line will be perceived to move slower than the vertical line.

To further test this idea, Castet et al. also showed that the ambiguous speeds have a greater effect as line length increases when the line is viewed for a brief duration. These additional data strongly support the idea that feature tracking signals at the line ends propagate inwards along the line to capture the ambiguous motion speed and direction there. Since capture takes longer to complete when lines are longer, the ambiguous motion signals have a larger effect on longer lines. Chey et al. simulated these data, as shown in Figure 2(b).

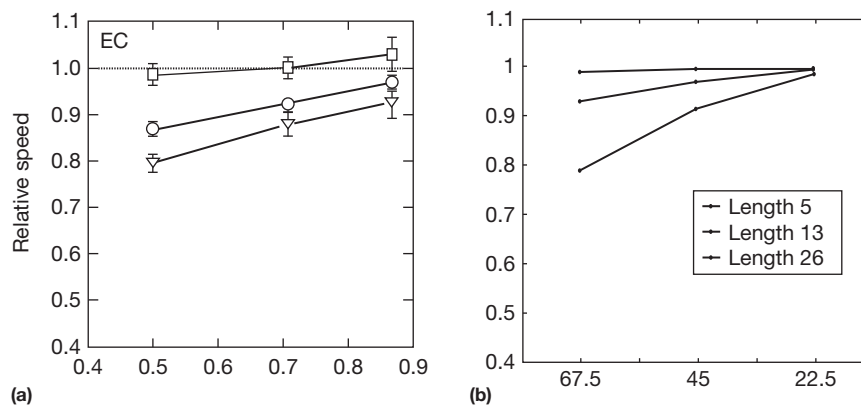
In addition to simulating data of Castet et al. on how the perceived speeds of moving lines are affected by their length and angle, Chey et al. used similar model mechanisms to also simulate, among other percepts, how the barberpole illusion is produced, how it can be affected by various configurational changes, and how plaid patterns move both coherently and incoherently. In addressing plaid pattern motion, the model provides explanations of when plaid patterns cohere or do not, how contrast affects the perceived speed and direction of moving plaids, and why the movement of so-called Type 2 patterns differs from those of Type 1 patterns. All of these data may be explained by an interaction of figure-ground separation mechanisms in the form cortical stream interacting with motion capture mechanisms in the motion cortical stream.

### Formotion Binding by Laminar Cortical Circuits

As the model name 3D FORMOTION suggests, it proposes how form and motion processes interact to generate coherent percepts of object motion in depth. Among the problems that the



**Figure 1** The 3D FORMOTION model processing stages. See text for details. Reprinted with permission from Berzhanskaya J, Grossberg S, and Mingolla E (2007) Laminar cortical dynamics of visual form and motion interactions during coherent object motion perception. *Spatial Vision* 20: 337–395.



**Figure 2** Effects of line length and orientation on perceived speed of horizontally moving lines. Relative perceived speed for three different line orientations and lengths are shown as percentages of the perceived speed of a vertical line of the same length. Part (a) shows data from Castet et al. (p. 1925). Each data line corresponds to a different line length ( $0.21^\circ$ ,  $0.88^\circ$ , and  $1.76^\circ$ ). The horizontal axis shows the ratio of the speed normal to the line's orientation relative to the actual translation speed. The three data points from left to right for each line length correspond to line angles of  $60^\circ$ ,  $45^\circ$ , and  $30^\circ$  from vertical, respectively. The horizontal dotted line indicates a veridical speed perception; results below this line indicate a bias toward the perception of slower speeds. Part (b) shows simulation results, also for three lengths and orientations. In both cases perceived relative speed decreases with line length and angle from vertical. Simulated lines use slightly different orientations from those in the experiments so that the simulated input conforms to the Cartesian grid. Reprinted with permission from Chey J, Grossberg S, and Mingolla E (1997) Neural dynamics of motion processing and speed discrimination. *Vision Research* 38: 2769–2786.

model analyses are the following form-motion (or *formation*) binding issues, which go beyond the scope of other models: How do form-based 3D figure-ground separation mechanisms in cortical area V2 interact with directionally selective motion grouping mechanisms in cortical areas MT and MST to preferentially bind together some motion signals more easily than others? In cases where form-based figure-ground mechanisms

are insufficient, how do motion and attentional cues from cortical area MT facilitate figure-ground separation within cortical area V2 via MT-to-V1-to-V2 feedback? These processes help to explain and simulate many motion data, including the way in which the global organization of the motion direction field in areas MT and MST can influence whether the percept of an object's form looks rigid or deformable through time.

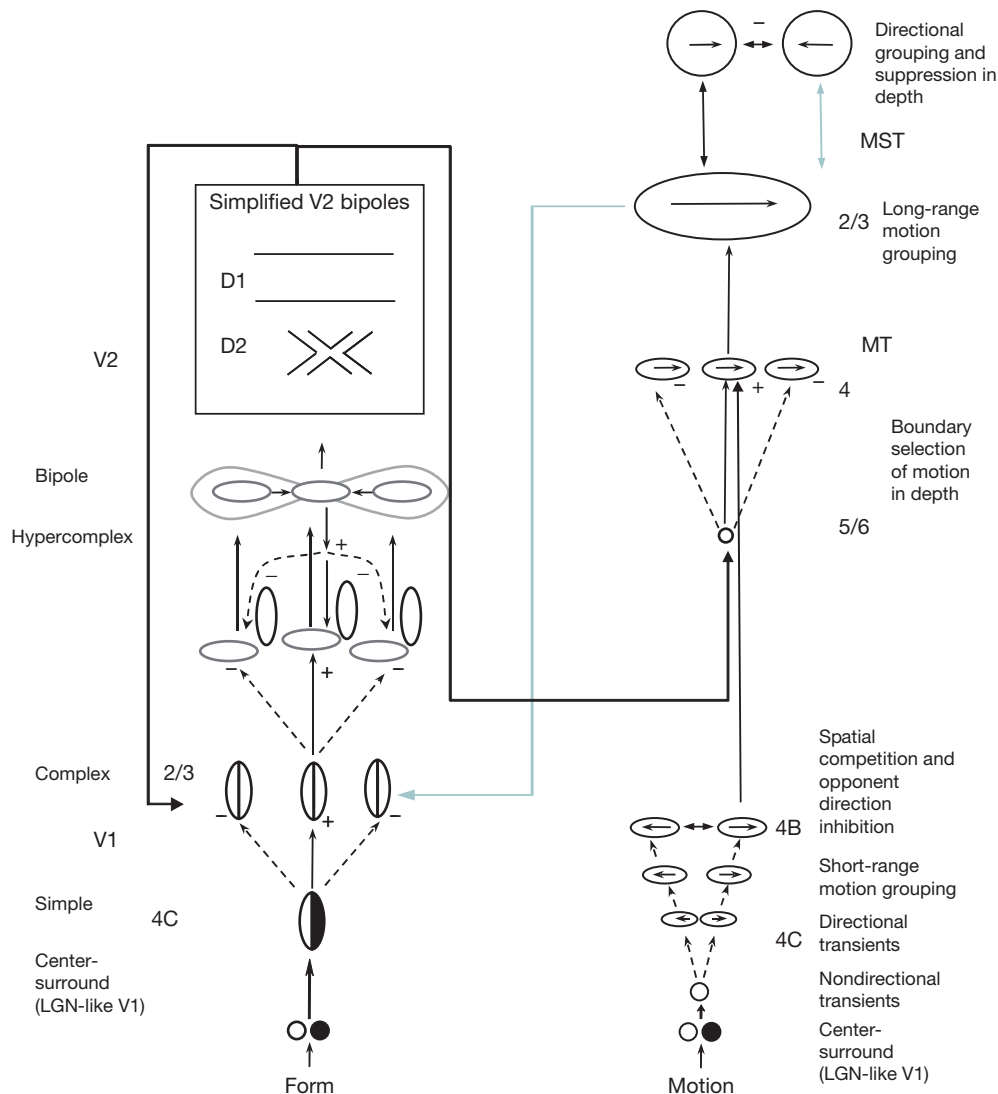
The model also goes beyond earlier motion models by proposing how *laminar* cortical circuits realize these mechanisms (Figure 3). These laminar circuits embody explicit predictions about the functional roles that are played by identified cells in the brain. The 3D FORMOTION model extends to the motion system laminar models of cortical circuits that have previously explained challenging perceptual and brain data about 3D form perception in cortical areas V1, V2, and V4, as well as about cognitive working memory, sequence learning, and variable-rate sequential performance.

### Intrinsic and Extrinsic Terminators

A key issue in data and models about motion perception concerns the assignment of motion to an object boundary when it moves relative to an occluder. How does the brain prevent motion integration across both the occluder and its occluded

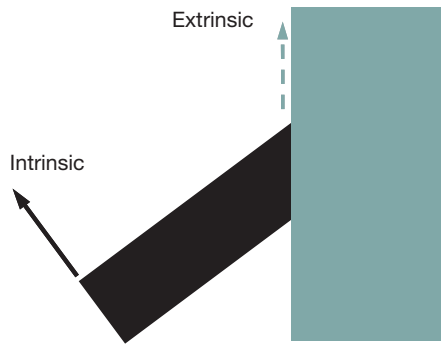
objects? In the example in Figure 4, motion of the left line end corresponds to the real motion of the line. The right line end is formed by the boundary between the line and a stationary occluder. Its motion provides little information about the motion of the line. Bregman and Kanizsa, and more recently Nakayama et al., have discussed this problem. Nakayama et al. use the terminology of *intrinsic* and *extrinsic* terminators to distinguish the two cases. An intrinsic terminator belongs to the moving object, whereas an extrinsic one belongs to the occluder. Motion of intrinsic terminators is incorporated into an object's motion direction, whereas motion of extrinsic terminators is attenuated or eliminated.

The FACADE (Form-And-Color-And-Depth) model of 3D form vision and figure-ground separation proposed how boundaries in 3D scenes or 2D images are assigned to different objects in different depth planes, and thereby offered a mechanistic explanation of the properties of extrinsic and intrinsic



**Figure 3** Laminar circuits of 3D FORMOTION model. See text for details. Reprinted with permission from Berzhanskaya J, Grossberg S, and Mingolla E (2007) Laminar cortical dynamics of visual form and motion interactions during coherent object motion perception. *Spatial Vision* 20: 337–395.





**Figure 4** Extrinsic and intrinsic terminators: the local motion of the intrinsic terminator on the left reflects the true object motion, while the local motion of the extrinsic terminator on the right follows the vertical outline of the occluder.

terminators. The 3D FORMOTION model proposed how FACADE depth-selective figure-ground separation in cortical area V2, combined with depth-selective formotion interactions from area V2 to MT, enable intrinsic terminators to create strong motion signals on a moving object, while extrinsic terminators create weak ones. The model starts with motion signals in V1, where the separation in depth has not yet occurred, and predicts how V2-to-MT boundary signals can select V1-to-MT motion signals at the correct depths, while suppressing motion signals at the same visual locations but different depths.

### Form and Motion Are Complementary

What sort of depth does MT compute? The prediction that V2-to-MT signals can capture motion signals at a given depth reflects the prediction that the form and motion streams compute *complementary* properties. The V1–V2 cortical stream, acting alone, is predicted to compute precise oriented depth estimates in the form of 3D boundary representations, but coarse directional motion signals. In contrast, the V1–MT cortical stream computes coarse depth estimates, but precise directional motion estimates. Overcoming the deficiencies of the form and motion cortical streams in computing precise estimates of form-and-motion-in-depth is predicted to occur via V2-to-MT inter-stream interactions, called *formotion* interactions. These interactions use depth-selective signals from V2 to capture motion signals in MT to lie at the correct depths. In this way, precise form-and-motion-in-depth estimates are achieved in MT, which can, in turn, be used to generate good target tracking estimates.

### This Analysis Clarifies an Otherwise Vexing Issue

Why does the brain bother to create a processing stream through cortical areas V1, MT, and MST to process motion, and a separate processing stream through cortical areas V1, V2, and V4 to process visual form? Indeed, individual cells in V1 already respond to properties of form, such as orientation, and properties of motion, such as direction. Given these shared properties at the earliest cortical stage V1, why could not a single processing stream compute both form and motion? In 1991, Grossberg predicted why this might be so, and in 2006, Ponce, Lomber,

and Born provided data that strongly support this prediction. This prediction was derived from a theoretical analysis of how the form cortical stream computes the *orientation* of form, whereas the motion stream computes the *direction* of motion.

Grossberg noted that the form stream through V1, V2, and V4 creates 3D boundaries and surfaces. In particular, 3D boundaries are computed by matching left and right eye images of visual features with similar *orientation*. The binocular disparity of these similarly oriented features is a key property that is used to compute boundaries whose interactions with surfaces can accurately represent objects in depth. This analysis predicted that the form stream can compute a precise measure of depth, but only a coarse measure of direction. In contrast, the motion stream pools over multiple orientations of an object's boundaries to compute the *direction* in which the object is moving. Pooling over orientations sacrifices the key property that the form stream needs to precisely compute depth. This analysis predicted that the motion stream can compute a precise measure of direction, but only a coarse measure of depth.

These sets of properties (precise depth, coarse direction; coarse depth, precise direction) are computationally *complementary*. Grossberg predicted how an inter-stream interaction from V2 to MT could use the depth-precise boundaries in V2 to select compatible directional motion signals in MT, and thereby overcome these complementary deficiencies to generate a precise representation in MT of moving-form-in-depth. This is what various neurophysiologists, such as Livingstone and Hubel and DeAngelis et al. had earlier reported from their recordings in MT.

### Neurophysiological Support for Form-Motion Complementarity and Formotion Capture

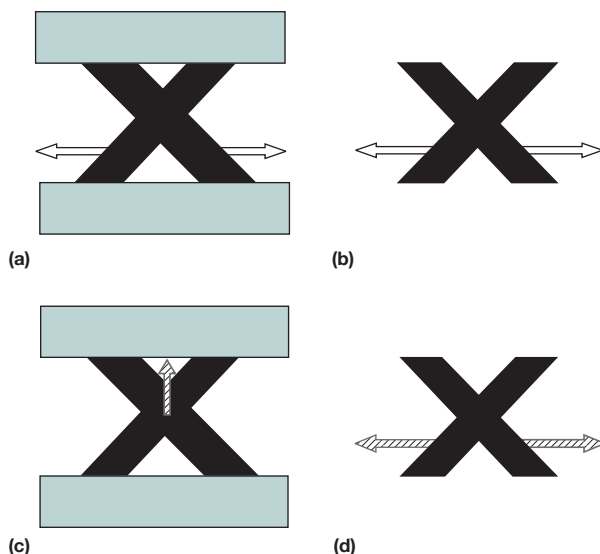
Ponce et al. reported neurophysiological data that are consistent with the prediction that V2 imparts finer disparity sensitivity onto MT: when V2 is reversibly cooled and V2-to-MT signals eliminated, depth selectivity, but not motion selectivity, is greatly impaired in MT. In other words, the predicted precise directional and coarse depth properties were hereby unmasked when V2 inputs were removed. These data do not support the alternative view that fine depth estimates are computed directly in MT.

### Induced Motion and the Role of Form in Conscious Motion Perception

Many psychophysical data support this view of motion capture. Indeed, the V2-to-MT motion selection mechanism clarifies why we tend to perceive motion of visible objects and background features, but not of the intervening empty spaces between them. For example, consider an example of *induced motion* wherein a frame moving to the right caused a stationary dot within the frame to appear to move to the left. Motion signals must propagate throughout the interior of the frame in order to reach and influence the dot. Despite this global propagation, the homogeneous space between the frame and the dot does not seem to move. The 3D FORMOTION model predicts that this occurs because there are no boundaries between the frame and the dot whereby to capture a motion signal. The model proposes that the formotion interaction whereby V2 boundaries select compatible MT motion signals may be necessary, if not sufficient, for a conscious percept of motion to occur.

### Motion-to-Form Feedback and Figure-Ground Separation of Occluded Moving Objects

V2-to-MT motion signals overcome one sort of uncertainty in the cortical computation. Another sort of uncertainty is overcome by using MT-to-V1 feedback signals. These top-down modulatory signals can help to separate boundaries in V1 and V2 where they cross in feature-absent regions. Such feature-absent signals are illustrated by the *chopsticks illusion*; see Figure 5. Suppose that attention or internal noise signals amplify motion signals of one chopstick more than the other via MST–MT interactions. This stronger chopstick can send its enhanced motion signals from MT to V1. The enhanced V1 signals can then use V1-to-V2 figure-ground separation mechanisms to separate the two chopsticks in depth. The form boundary of the attended chopstick will then be strengthened. The FACADE model explains how a stronger form boundary can appear to be nearer than a weaker one. The nearer boundary can then be completed by perceptual grouping mechanisms over the ambiguous region where the two chopsticks cross, much like an illusory contour can be completed. FACADE mechanisms also explain how the intrinsic boundaries of the nearer chopstick can be detached from the farther chopstick, thereby enabling the farther chopstick boundaries to also be completed in depth behind those of the occluding, nearer chopstick. As these boundaries are completed, they are injected back into MT from V2 to capture the corresponding motion direction signals and generate a percept of two separated figures moving in depth, one in front of the other.



**Figure 5** Chopsticks illusion: actual chopsticks motion (clear arrows, top) is equivalent in (a) and (b), with visible and invisible occluders, respectively. Visible occluders result in a coherent vertical motion percept (c, hatched arrow). Invisible occluders result in the percept of two chopsticks sliding in opposite directions (d). Reprinted with permission from Berzhanskaya J, Grossberg S, and Mingolla E (2007) Laminar cortical dynamics of visual form and motion interactions during coherent object motion perception. *Spatial Vision* 20: 337–395.

### Adaptation and Bistable Motion

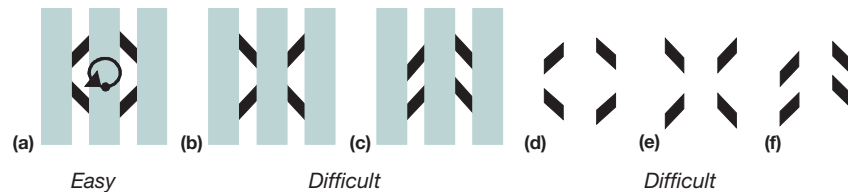
Another factor that influences motion perception is adaptation. This can be accomplished by a process of transmitter habituation, inactivation, or depression. For example, motion signals at the positions of a static extrinsic terminator can adapt and therefore become weaker through time. Moving intrinsic terminators, on the other hand, generate strong motion signals. The adaptation process hereby clarifies the computation of intrinsic motion signals on a relatively short time scale.

On a longer time scale, bistable motion percepts can occur due to the interaction of cooperative–competitive model mechanisms with habituating mechanisms when multiple moving objects overlap (Figures 1 and 3). For example, percepts of moving plaids or of pairs of random dot patterns can alternate between at least two possible perceptual outcomes. One possible outcome is a transparent motion percept, where two gratings or two dot-filled planes slide one over another in depth. Alternatively, if the directions of motions of the two gratings are compatible, then a percept of a unified plaid pattern may be seen, and no separation in depth occurs. Under prolonged viewing, the same display can perceptually alternate between coherent plaid motion and component motions separated in depth. The combination of 3D boundary and surface processes, augmented by habituating gating and spatial attention, can explain many bistable form and motion percepts. For example, Grossberg and Swaminathan have modeled how these processes may lead to bistable 3D percepts of the Necker cube.

### Shape and Motion Interactions Determine Object Motion Percepts Behind Apertures

Similar mechanisms can explain and simulate percepts of moving object shapes that are more complex than lines or dots. For example, Lorenceau and Alais studied different shapes moving in a circular-parallel motion behind occluders (Figure 6). Observers had to determine the direction of motion, clockwise or counterclockwise. The percent of correct responses depended on the type of shape, and on the visibility of the occluders. In the case of a diamond shape (Figure 6(a)), a single, coherent, circular motion of a partially occluded rectangular frame was easy to perceive across the apertures. In the case of an arrow shape (Figure 6(c)), two objects with parallel sides were seen to generate out-of-phase vertical motion signals in adjacent apertures. Local motion signals were identical in both displays, and only their spatial arrangement differed. Lorenceau and Alais suggested that certain shapes (such as arrows) ‘veto’ motion integration across the display, while others (such as diamond) allow it.

The 3D FORMOTION model explains these data without using a veto process. The model proposes that the motion grouping process uses anisotropic direction-sensitive receptive fields (see Figure 3) that preferentially integrate motion signals within a given direction across gaps produced by the occluders. The explanation of percepts induced by the displays in Figure 4(d)–4(f) follows in a similar way, with the additional factor that the ends of the bars activate intrinsic terminators that can strongly influence the perceived motion direction of the individual bars.



**Figure 6** Lorenceau-Alais displays: visible (a–c) and invisible (d–f) occluder cases. See text for details.

### Rigid and Gelatinous Rotating Ellipses

Motion grouping also helps to explain percepts of rotational motion using the ‘gelatinous ellipses’ display. When ‘thin’ (high aspect ratio) and ‘thick’ (low aspect ratio) ellipses rotate around their centers, percepts of their shapes differ markedly. The thin ellipse is perceived as a rigid rotating form, whereas the thick one is perceived as deforming nonrigidly through time. Here, the differences in 2D geometry result in differences of the spatiotemporal distribution of motion direction signals that are grouped together through time. When these motion signals are consistent with the coherent motion of a single object, then the motion grouping process within the model MT–MST processing stages (Figure 1) generates a percept of a rigid rotation. When the motion field decomposes after grouping into multiple parts, with motion trajectories incompatible with a rigid form, a nonrigid percept is obtained. Nearby ‘satellites’ can convert the nonrigid percept into a rigid one. Weiss and Adelson proposed that such a percept can be explained via a global optimization process. The 3D FORMOTION model shows how motion grouping can provide a biologically more plausible explanation.

Once V2 boundaries capture MT motion signals, what are they used for? One major use is for visually based navigation. For example, Browning, Grossberg, and Mingolla developed the ViSTARS neural model in which motion signals are processed through the cortical areas MT<sup>−</sup> and MSTv to track moving targets, while cortical areas MT<sup>+</sup> and MSTd use motion signals to compute heading from optic flow using computationally complementary interactions. Grossberg and Pilly showed how motion signals through cortical areas MT<sup>−</sup>, MST, and LIP can be used to probabilistically compute decisions about the direction of eye movements in response to moving dot patterns. These latter results will be discussed after the main mechanisms of the 3D FORMOTION model are summarized as a way to unify the discussion and understanding of many experimental data about the psychology and neurobiology of motion perception.

### 3D Formotion Model

The 3D FORMOTION model (Figure 1 and 3) proposes how six types of processes interact together in the brain’s form and motion systems. Because model processing stages are analogous to areas of the primate visual system, they are called by the corresponding anatomical names. (1) V1-to-MT filtering and cooperative–competitive processes begin to resolve the aperture problem by amplifying feature tracking signals and attenuating ambiguous motion signals so that the feature tracking

signals have a chance to overwhelm numerically superior ambiguous motion signals. (2) 3D boundary representations, in which figures are separated from their backgrounds, are formed in the cortical area V2. (3) These depth-selective V2 boundaries select motion signals at the appropriate boundary positions and depths in MT via V2-to-MT signals. (4) A spatially anisotropic motion grouping process propagates across perceptual space via MT–MST feedback to integrate veridical feature tracking signals with ambiguous motion signals and to thereby determine a global object motion percept. This motion capture process solves the aperture problem. (5) MST–MT feedback can convey an attentional priming signal from higher brain areas that can influence the motion capture process, and thereby influence form processing via MT-to-V1 feedback. (6) Motion signals in MT can hereby disambiguate locally incomplete or ambiguous boundary signals in V2 via MT-to-V1-to-V2 signals.

These interactions provide a functional explanation of many neurophysiological data. Table 1 summarizes anatomical connections and neuron properties that occur in the model, alongside experimental references which support those connections or functional properties. Table 1 also lists the model’s key physiological predictions that remain to be tested. As illustrated in Figures 1 and 3, these interactions are naturally understood as part of a *form processing stream* and a *motion processing stream*.

### The Form Processing System

The model’s form processing system comprises six stages that are displayed on the left sides of Figures 1 and 3. Inputs are processed by distinct ON and OFF cell networks whose cells obey membrane, or shunting, equations while they undergo on-center off-surround and off-center on-surround network interactions, respectively, that are similar to those of LGN cells. These cells excite simple cells in cortical area V1 to register boundary orientations in cells that are sensitive to a particular polarity-of-contrast. Then complex and hypercomplex cells pool across simple cells tuned to opposite contrast polarities to detect object boundaries even if their contrast with respect to a background reverses along the perimeter of the object. Then several mechanisms work together to enhance feature tracking signals while downregulating ambiguous motion signals: divisive normalization reduces cell activities where there are multiple ambiguous orientations in a region, end-stopping enhances activity at features like line-ends where feature tracking signals often occur, and spatial sharpening enhances the feature tracking advantage. These cells input to a perceptual grouping circuit in layer 2/3 of V2. Here bipole cells receive signals via long-range horizontal interactions from approximately collinear cells whose orientational preferences lie along, or near, the collinear axis. These cells are indicated

**Table 1** Functional projections and properties of model cell types and predictions

| Connection/functional property                                                            | Selected references                                                                                |
|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <i>Functional projections</i>                                                             |                                                                                                    |
| V1 4Ca to 4B                                                                              | Yabuta et al. (2001), Yabuta and Callaway (1998)                                                   |
| V1 to MT                                                                                  | Anderson et al. (1998), Rockland (2002), Sincich and Horton (2003), and Movshon and Newsome (1996) |
| V1 to V2                                                                                  | Rockland (1992), Sincich and Horton (2002)                                                         |
| V2 to MT                                                                                  | Anderson and Martin (2002), Rockland (2002), Shipp and Zeki (1985), DeYoe and Van Essen (1985)     |
| MT to V1 feedback                                                                         | Shipp and Zeki (1989), Callaway (1998), Movshon and Newsome (1996)<br>Hupé et al. (1998)           |
| V2 to V1 feedback                                                                         | Rockland and Pandya (1981), Kennedy and Bullier (1985)                                             |
| <i>Properties</i>                                                                         |                                                                                                    |
| V1 adaptation                                                                             | Abbott et al. (1997), Chance et al. (1998), (rat); Carandini and Ferster (1997) (cat)              |
| V1(4Ca) transient nondirectional cells                                                    | Livingstone and Hubel (1984)                                                                       |
| V1 spatially offset inhibition                                                            | Livingstone (1998), Livingstone and Conway (2003), Murthy and Humphrey (1999) (cat)                |
| V2 figure-ground separation                                                               | Zhou et al. (2000), Bakin et al. (2000)                                                            |
| MT figure-ground separation and disparity sensitivity                                     | Bradley et al. (1998), Grunewald et al. (2002), Palanca and DeAngelis (2003)                       |
| MT center-surround receptive fields                                                       | Bradley and Andersen (1998), Born (2000), DeAngelis and Uka (2003)                                 |
| Some MT receptive fields elongated in preferred direction of motion                       | Xiao et al. (1997)                                                                                 |
| Attentional modulation in MT                                                              | Treue and Maunsell (1999)                                                                          |
| <i>Predictions</i>                                                                        |                                                                                                    |
| Short-range anisotropic filter in V1 (motion stream)                                      |                                                                                                    |
| Long-range anisotropic filter in MT (motion) <sup>a</sup>                                 |                                                                                                    |
| V2 to MT projection carries figure-ground completed-form-in-depth separation signal       |                                                                                                    |
| MT to V1 feedback carries figure-ground separation signal from motion to form stream      |                                                                                                    |
| MST to MT feedback helps solve aperture problem by selecting consistent motion directions |                                                                                                    |

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<sup>a</sup>Although Xiao et al. found that some MT neurons have receptive fields that are elongated along the preferred direction of motion, there is no direct evidence that these neurons participate preferentially in motion grouping.

by and-gates the figure-8 shape in **Figure 3**. They act like statistical and-gates that permit grouping only when there is sufficient evidence from pairs or greater numbers of inducers on both sides of the cell body. Grouping completes and sharpens object boundaries. It includes a stage of cross-orientation competition that reinforces boundary signals with greater support from neighboring boundaries while weakening spatially overlapping boundaries of nonpreferred orientations. Boundaries are assigned into different depths, as follows.

### Perceptual Grouping and Figure-Ground Separation of 3D Form

The FACADE model shows how the boundary completion process within the pale stripes of V2 can automatically initiate separation of extrinsic versus intrinsic boundaries in depth without positing separate mechanisms to compute T-junctions. Indeed, one cue for extrinsic versus intrinsic boundaries is occlusion in a 2D image at a T-junction, as illustrated in **Figure 4**, where a moving black bar intersects a stationary gray rectangular occluder. The top of the T belongs to the occluding gray rectangle, while the stem belongs to the occluded black bar. Bipole long-range excitatory horizontal interactions can strengthen the boundary of the gray occluder where it intersects the black bar, while short-range competition (**Figure 3**) weakens, or totally inhibits, the boundary of the black occluded bar where it touches the gray occluder. This *end gap* in the black boundary initiates the process of separating occluding and occluded boundaries.

In other words, perceptual grouping properties are predicted to initiate the separation of figures from their backgrounds, without the use of explicit T-junction operators. This prediction has received support from psychophysical experiments. The figure-ground separation process enables the model to distinguish extrinsic from intrinsic terminators, and to thereby select motion signals at the correct depths.

Qualitative explanations and quantitative computer simulations of 3D figure-ground separation during perception of static images were provided using the laminar cortical circuits of the 3D LAMINART model by Fang and Grossberg, who simulated 3D surface perception in response to dense, sparse, and occluding stereograms. Grossberg and Yazdanbakhsh simulated stable and bistable transparency and 3D neon color spreading. The nonlaminar circuits of the FACADE model were earlier used by Kelly and Grossberg to simulate such percepts as Bregman-Kanizsa figure-ground perception, Kanizsa stratification, and lightness percepts such as the Munker-White, Benary cross, and checkerboard percepts. In 3D FORMOTION analyses of figure-ground separation of moving targets, a complete simulation of all form and motion computations was computationally prohibitive. Instead, to reduce the simulation computational load, Berzhanskaya et al. used the following approximation: As soon as T-junctions were detected by the model dynamical equations, V2 boundaries were algorithmically assigned the depths that a complete figure-ground simulation would have assigned to them. In particular, static occluders were assigned to the near depth (D1 in **Figure 3**) and lines with extrinsic terminators were

assigned to the far depth (D2 in [Figure 3](#)). These V2 boundaries were used to provide both V2-to-MT motion selection signals and V2-to-V1 depth-biasing feedback. While V2-to-V1 feedback is orientation-specific, the V2-to-MT projection sums boundary signals over all orientations, just as motion signals do at MT.

### Motion Induction of Figure-Ground Separation

When form cues are not available to initiate figure-ground separation, motion cues may be able to do so via feedback projections from MT to V1 ([Figures 1](#) and [3](#)). Such a feedback projection has been studied both anatomically and electrophysiologically and it can benefit from attentional biasing within MT/MST. As explained above, this mechanism can help to separate chopsticks in depth (see [Figure 5\(b\)](#)). Focusing spatial attention at one end of a chopstick enhanced that chopstick's direction of motion in MT and MST. Enhanced MT-to-V1 feedback selectively strengthened the boundary signals of the corresponding chopstick in [Figure 5\(b\)](#) enough to trigger its boundary completion across the other chopstick via V1-to-V2 interactions. This operation also initiated figure-ground separation that assigned the now occluded chopstick to a farther depth. Then, by closing the V2-to-MT loop, these two overlapping but depth-separated bars can support depth-selective motions by the chopsticks in opposite directions.

## The Motion Processing System

The model's motion processing stream consists of six stages that represent cell dynamics homologous to LGN, V1, MT, and MST ([Figures 1](#) and [3](#), right).

### Level 1

ON and OFF cell inputs from Retina and LGN, which are lumped into a single processing stage, activate model V1. These inputs are not depth-selective. In response to a 2D picture, this depth-selectivity will come from figure-ground separated V2 boundaries when they select consistent motion signals in MT.

Both ON and OFF cells have a role to play. For example, if a bright chopstick moves to the right on a dark background, ON cells respond to its leading edge, but OFF cells respond to its trailing edge. Likewise, when the chopstick reverses direction and starts to move to the left, its leading edge now activates ON cells and its trailing edge OFF cells. By differentially activating ON and OFF cells in different parts of this motion cycle, these cells have more time to recover from habituation, so that the system remains more sensitive to repetitive motion signals.

### Level 2: Transient cells

The second stage of the motion processing system consists of nondirectional transient cells, inhibitory directional interneurons, and directional transient cells. The nondirectional transient cells respond briefly to a change in the image luminance, irrespective of the direction of movement. Such cells

respond well to moving boundaries and poorly to a static occluder because of the habituation of the process that activates the transient signal. Adaptation is known to occur at several stages in the visual system, including retinal Y cells and cells in V1 and beyond.

The nondirectional transient cells send signals to inhibitory directional interneurons and directional transient cells, and the inhibitory interneurons interact with each other and with the directional transient cells ([Figure 7](#)). The directional inhibitory interneuronal interaction enables the directional transient cells to maintain their directional selectivity at a wide range of speeds. This selectivity is predicted to be due to the inhibitory interneurons, and goes beyond the capabilities of the classical Barlow and Levick model of transient cell activation. The predicted interactions in this model circuit are consistent with retinal data concerning how bipolar cells interact with inhibitory starburst amacrine cells and direction-selective ganglion cells, and how starburst cells interact with each other and with ganglion cells. The possible role of starburst cell inhibitory interneurons in ensuring directional selectivity at a wide range of speeds has not yet been tested.

A directionally selective neuron fires vigorously when a stimulus is moved through its receptive field in one direction (called the preferred direction), while motion in the reverse direction (called the null direction) evokes little response. This type of directional selectivity was first modeled by Barlow and Levick. Mechanisms of direction selectivity include asymmetric inhibition along the preferred cell direction, notably an inhibitory veto of null-direction signals.

As noted above, after the transient cells adapt to a static boundary, then boundary segments that belong to a static occluder – that is, extrinsic terminators – in the chopsticks display with visible occluders ([Figure 5\(a\)](#)) produce weaker signals than those that belong to the continuously moving parts of the chopstick. On the other hand, in the invisible occluder chopsticks display ([Figure 5\(b\)](#)), the horizontal motion signals at the chopstick ends will continually move, hence will be strong, and can thus significantly influence the conscious motion percept.

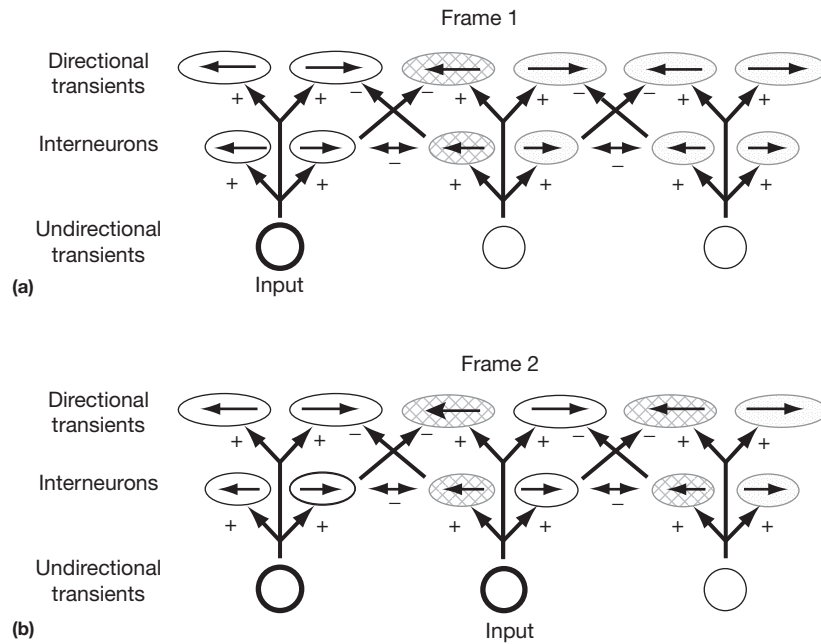
### Level 3: Short-range filter

A short-range directional filter ([Figure 3](#)) helps to selectively strengthen unambiguous feature tracking signals, relative to ambiguous motion signals. Cells in this filter *accumulate evidence* from directional transient cells of similar directional preference within a spatially anisotropic region that is oriented along the preferred direction of the cell. Short-range filter cells amplify feature tracking signals at unoccluded line endings, object corners, and other scenic features. The short-range spatial filter, followed by competitive selection, eliminates the need to solve the *feature correspondence problem* that various other motion models use, such as Reichardt and Elaborated Reichardt models.

### Level 4: Spatial competition and opponent direction competition

Two kinds of competition further enhance the relative advantage of feature tracking signals. These competing cells are proposed to occur in layer 4B of V1 ([Figure 3](#), bottom-right).





**Figure 7** Schematic diagram of a 1D implementation of the transient cell network showing the first two frames of the motion sequence. Thick circles represent active unidirectional transient cells while thin circles are inactive unidirectional transient cells. Ovals containing arrows represent directionally selective neurons. Unfilled ovals represent active cells, cross-filled ovals are inhibited cells and gray-filled ovals depict inactive cells. Excitatory and inhibitory connections are labeled by '+' and '-' signs, respectively. Reprinted with permission from Grossberg S, Mingolla E, and Viswanathan L (2001) Neural dynamics of motion integration and segmentation within and across apertures. *Vision Research* 41: 2351–2553.

Spatial competition among like-directional cells of the same spatial scale further boosts the amplitude of feature tracking signals relative to those of ambiguous signals. This happens because feature tracking locations are often found at motion discontinuities, and thus get less inhibition than ambiguous motion signals that lie within an object's interior. Opponent-direction competition also occurs at this processing stage, with properties similar to V1 cells that may play this functional role.

Data of Pack et al. support properties of cells at this model stage. In their data, V1 cells exhibit suppression of responses to motion along visible occluders. Suppression occurs in the model due to the adaptation of transient inputs to static occluding boundaries. In addition, V1 cells in the middle of a grating, where ambiguous motion signals occur, respond more weakly than cells at the edge of the grating, where intrinsic terminators occur. Model spatial competition between motion signals emulate this property through its properties of divisive normalization and endstopping. Together these properties amplify directionally unambiguous feature tracking signals at line ends relative to the strength of aperture-ambiguous signals along line interiors, which compete among themselves for normalized activity at their position.

#### Level 5: Long-range filter and formation selection

The long-range directional filter pools together motion signals with the same, or similar, directional preference from moving features with different orientations, contrast polarities, and eyes. These motion signals are carried from model layer 4B of V1 input to model area MT. Its cell targets may be considered

true directional cells which combine evidence from multiple informational sources. These cells have directionally-sensitive properties in the motion stream through MT that are computationally homologous to those of orientationally sensitive complex cells in the form stream through V2. It will be interesting to see if future studies of cortical evolution and development support the idea that these cells share an underlying computational design that is later specialized for motion or form processing.

Area MT also receives a projection from V2. As described above, this V2-to-MT formation projection is predicted to carry depth-specific figure-ground separated boundary signals. These V2 form boundaries selectively assign to different depths the motion signals coming into MT from layer 4B of V1.

Formation selection is proposed to occur via a modulatory on-center, off-surround projection from V2 to layer 4 of MT. For example, in response to the chopsticks display with visible occluders (Figure 5(a)), motion signals which lie along the visible occluder boundaries are selected in the near depth and are suppressed by the off-surround at other locations at that depth. The selected signals will be weak because the bottom-up input from V1 habituates along the selected occluder boundary positions. The V2 boundary signals that correspond to the moving boundaries select strong motion signals at the farther depth. The on-center of the V2-to-MT interaction is modulatory to prevent it from creating motion signals at MT where none are received from V1. This type of circuit is predicted by adaptive resonance theory, or ART, to enable fast learning with self-stabilizing memory, and to focus attention on salient information. In the present case, the V2-to-MT interaction between correlated form and

motion information is predicted to be tuned by learning during perceptual experience.

Boundary-gated signals from layer 4 of MT input to the upper layers of MT (Figure 3, top-right), where they activate a directionally selective, spatially *anisotropic* long-range filter via long-range horizontal connections. The hypothesis that the long-range filter uses an anisotropic filter is consistent with data showing that ~30 % of the cells in MT show a preferred direction of motion that is aligned with the main axis of their receptive fields.

The long-range directional filter cells in layer 2/3 of MT are proposed to play a role in motion grouping that is homologous to the role played by the bipole cells during form grouping within layer 2/3 of the pale stripes of cortical area V2. As noted above, the anisotropic long-range motion filter allows motion signals to be selectively integrated across occluders in a manner that naturally explains the percepts generated by the Lorenceau-Alais displays of Figure 6.

### Long-range apparent motion and target tracking

The long-range directional filter can also help to explain many data about long-range apparent motion, which creates a percept of continuous motion between discrete flashes of light that are separated in space and time. The evolutionary utility of apparent motion may be appreciated by considering an animal running at variable speeds behind forest cover. The forest is an occluder that creates apertures through which fragments of the animal's motion signals are intermittently experienced. The mechanisms of long-range apparent motion enable the brain to group these fragments into a continuous motion percept that facilitates predictive tracking of the animal and its trajectory. Because of the Gaussian shape of the long-range filter, it can interpolate discrete flashes into a continuous trajectory that has many of the properties of long-range apparent motion, notably its ability to speed up as the distance between inducing flashes increases without a change in their delay, or as the delay between the two flashes decreases without a change in their distance. The depth-selective separation of extrinsic versus intrinsic boundaries in V2, followed by V2-to-MT depth-selective motion binding, together help to explain how the forest cover appears closer to an observer than the animal running behind it. In summary, the long-range filter helps to group motion signals across both space and time.

### Level 6: Directional grouping

The first five model stages can amplify feature tracking signals and assign motion signals to the correct depths. However, they do not explain how feature tracking signals propagate across space to select consistent motion directions from ambiguous motion directions, suppress inconsistent motion directions, all the while without distorting their speed estimates. They also cannot explain how motion integration can compute a vector average of ambiguous motion signals across space to determine the perceived motion direction when feature tracking signals are not present at that depth. The model's final stage accomplishes these properties by using a motion grouping network that is interpreted to exist in ventral MST (MSTv), which is known to be important for target tracking. This

motion grouping network is predicted to determine the coherent motion direction of discrete moving objects.

During motion grouping, cells that code the same, or similar, directions in MT send convergent inputs to cells in model MSTv via the motion grouping network. Within MSTv, directional competition at each position determines a winning motion direction. This winning directional cell then feeds back to its source cells in MT. Just as in the case of V2-to-MT signaling, this MSTv-to-MT feedback is defined by a modulatory on-center, off-surround network. It selects activities of MT cells that code the winning direction, while suppressing activities of cells that code other directions. Using this broad feedback kernel, the motion grouping network enables feature tracking signals to select similar directions at nearby ambiguous motion positions, while suppressing other directions there. In other words, motion capture occurs and disambiguates ambiguous motion positions. The use of a modulatory on-center, off-surround top-down circuit from MSTv-to-MT enables bottom-up learning from MT-to-MSTv and top-down learning from MSTv-to-MT to create and self-stabilize directionally selective motion grouping receptive fields during perceptual experience, using general ART properties.

As the grouping process cycles bottom-up and top-down between MT and MSTv, directional motion capture propagates laterally across space: Each cycle of top-down MSTv-to-MT feedback creates a region of cells in MT whose directional preference is consistent with that of the MSTv cells that activated the feedback. Then this newly unambiguous region of directional preference in MT can use the bottom-up MT-to-MSTv filter to select directionally consistent MSTv grouping cells at positions near them, and the cycle continues. In other words, motion capture emerges automatically using the feedback process that enabled stable development of directional tuning to occur. Chey et al. and Grossberg et al. used this process to simulate psychophysical data showing how the aperture problem may be solved via a gradual process of motion capture, and Pack and Born provided supportive neurophysiological data by directly recording from MT cells, as noted above.

### Ubiquitous circuit design for selection, attention, and learning

It is worth emphasizing that both the V2-to-MT and the MSTv-to-MT signals carry out their selection processes using modulatory on-center, off-surround interactions. The V2-to-MT signals select motion signals at the locations and depth of a moving boundary. The MSTv-to-MT signals select motion signals in the direction and depth of a motion grouping. ART predicted that such a modulatory on-center, off-surround network would be used to carry out attentive selection and modulation of adaptive tuning within all brain circuits wherein fast learning and self-stabilizing memory of appropriate features is needed. In the V2-to-MT circuit, a formotion association is learned. In the MST-to-MT circuit, directional grouping cells are learned. Grossberg, and Raizada and Grossberg review behavioral and neurobiological data that support this prediction in several brain systems. The Ponce et al. study supports the V2-to-MT prediction, but does not study how this association may be learned. There do not seem to be any direct neurophysiological tests of the MSTv-to-MT prediction.

## Converting Motion into Action during Perceptual Decision-Making

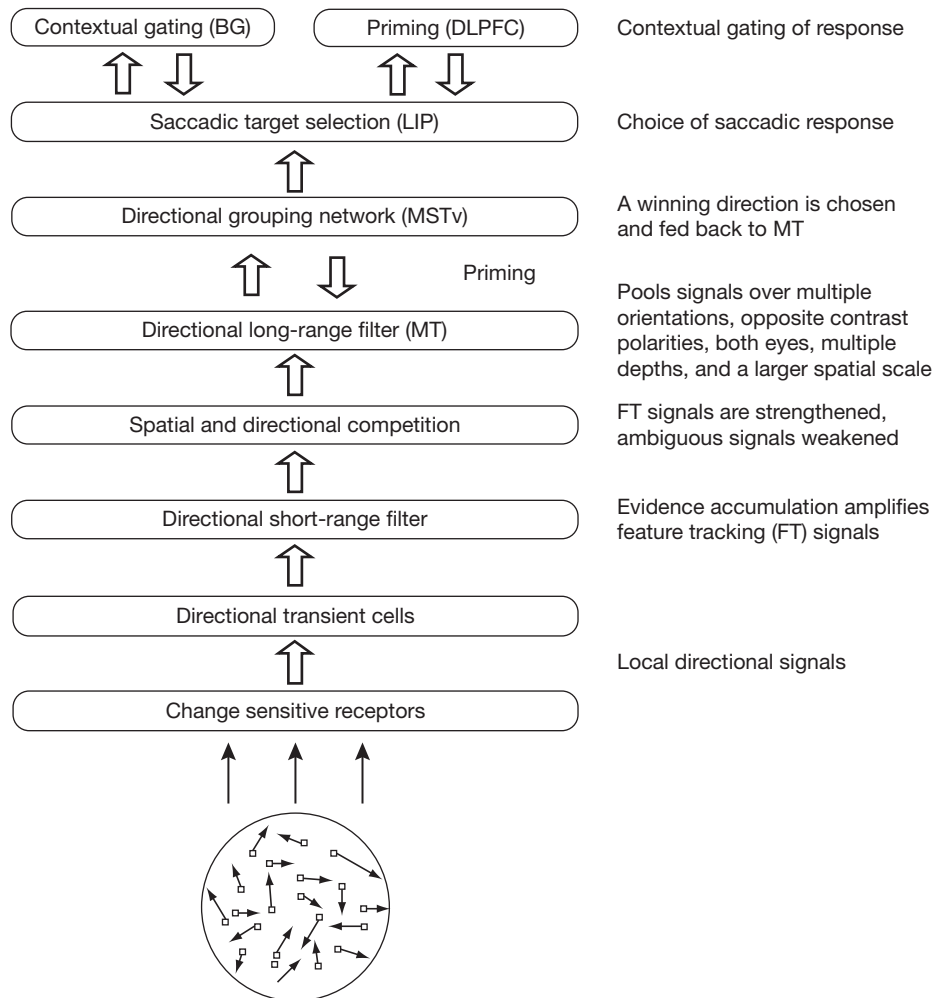
### Motion Capture in Perceptual Decision-Making

The 3D FORMOTION model sheds new light on how the brain may make motion-based movement decisions, in particular saccadic eye movements, in response to probabilistically defined motion stimuli. This example illustrates the general theme that motion may be used to drive a variety of target tracking behaviors.

It is well known that speed and accuracy of perceptual decisions and the movements that they control covary with certainty in the input, and correlate with the rate of evidence accumulation in parietal and frontal cortical neurons. Data concerning such motion-based movement decisions can be explained and quantitatively simulated by preprocessing motion stimuli with the V1–MT–MST mechanisms that are articulated in the 3D FORMOTION model before MST

activates the parietal cortex, indeed LIP, where motion direction is converted into a directional movement command that is gated by the basal ganglia (Figure 8). The model in which these processing stages are implemented is called the MOTion DEcision, or MODE, model because it clarifies challenging data about probabilistically defined motion perception and action.

The MODE model quantitatively simulates dynamic properties of decision-making in response to the types of ambiguous visual motion stimuli that have been studied in LIP neurophysiological recordings by Newsome, Shadlen, and colleagues. The most important circuits of this enhanced model already lie within the 3D FORMOTION model. Since the rate of motion capture in the MT–MST grouping network covaries with the activation rate and amplitude of LIP cells that control a monkey's observable behavior in the experiment. The model hereby clarifies how brain circuits that solve the aperture problem, notably the circuits that realize motion capture, may



**Figure 8** Retina/LGN–V1–MT–MST–LIP–BG model processing stages. See text for details. The random dot motion stimuli are preprocessed by the model retina/LGN and processed by the model cortical V1–MT–MST stream. They contextually transform locally ambiguous motion signals into unambiguous global object motion signals with a rate, amplitude, and direction that covaries with the amount of dot coherence. These spatially distributed global motion signals then feed into model area LIP to generate appropriate directional saccadic eye movement commands, which are gated by the model basal ganglia (BG). Reprinted with permission from Grossberg S and Pilly P (2008) Temporal dynamics of decision-making during motion perception in the visual cortex. *Vision Research* 48: 1345–1373.

control properties of probabilistic decision-making in real time. This is not surprising when one interprets the motion capture process as a resolution of ambiguity that selects the best consensus movement that is compatible with motion data.

### Are the Brain's Decisions Bayesian?

These results are of particular interest because distinguished perceptual and brain scientists, including Newsome and Shadlen, have proposed that perception and decision-making can be described as Bayesian inference, which estimates the optimal interpretation of the stimulus given priors and likelihoods. However, Bayesian concepts do not, in themselves, provide a way to discover the neocortical mechanisms that make decisions. The present model explains data that Bayesian models have heretofore failed to explain, does so without an appeal to Bayesian inference and, unlike other existing models of these data, generates perceptual representations in response to the moving experimental visual stimuli. In particular, the MODE model quantitatively simulates the time course of LIP neuronal dynamics, as well as behavioral accuracy and reaction time properties, during both correct and error trials at different levels of input ambiguity in both fixed duration and reaction time tasks. Model MST computes the global direction of random dot motion stimuli as part of the motion capture process, while model LIP converts a distributed motion representation in MST into a directional movement decision that leads to a saccadic eye movement. MODE hereby trades accuracy against speed, and illustrates how cortical dynamics go beyond Bayesian concepts, while clarifying why probability theory ideas are initially so appealing.

Concerning the appeal of statistical, in particular Bayesian, concepts, it should be noted that the shunting on-center off-surround networks that occur ubiquitously in the brain, and also in the 3D FORMOTION model, tend to normalize the activities across a neural network. The spatially distributed pattern of these normalized activities may be viewed as a type of real-time probability distribution. In addition, any filtering operation, such as the short-range and long-range directional filters, may be interpreted as a prior (namely, the current neural signal) multiplied by a conditional probability or likelihood (namely, the filter connection strength to the target cell). Likewise, a contrast-enhancing operation, such as the LIP recurrent on-center off-surround network that selects a winning direction from filter inputs, may be viewed as maximizing the posterior. These insights have been known in the neural modeling literature for a long time. However, as [Figures 1, 3, and 8](#) illustrate, such local processes do not embody the computational intelligence of an entire neural system that has emerged through evolution to realize particular behavioral competences, such as motion perception and movement decision-making.

### Two Movement Tasks

Newsome, Shadlen, and colleagues studied neural correlates of perceptual decision-making in macaques which were trained to discriminate motion direction. Random dot motion displays, covering a 5° diameter aperture centered at the fixation point, were used to control motion coherence; namely, the fraction of

dots moving nonrandomly in a particular direction from one frame to the next in each of three interleaved sequences. Varying motion coherence provided a quantitative way to control the ambiguity of directional information that a monkey used to make a saccadic eye movement to a peripheral choice target in the perceived motion direction, and thus the task difficulty.

Two kinds of tasks were employed, namely *fixed duration* (FD) and *reaction time* (RT) tasks. In the FD task, monkeys viewed the moving dots for a fixed duration of 1 s, and then made a saccade to the target in the judged direction after a variable delay. In the RT task, monkeys had theoretically unlimited viewing time, and were trained to report their decision as soon as the motion direction was perceived. The RT task allowed measurement of how long it took the monkey to make a decision, which was defined as the time from the onset of the motion until when the monkey initiated a saccade.

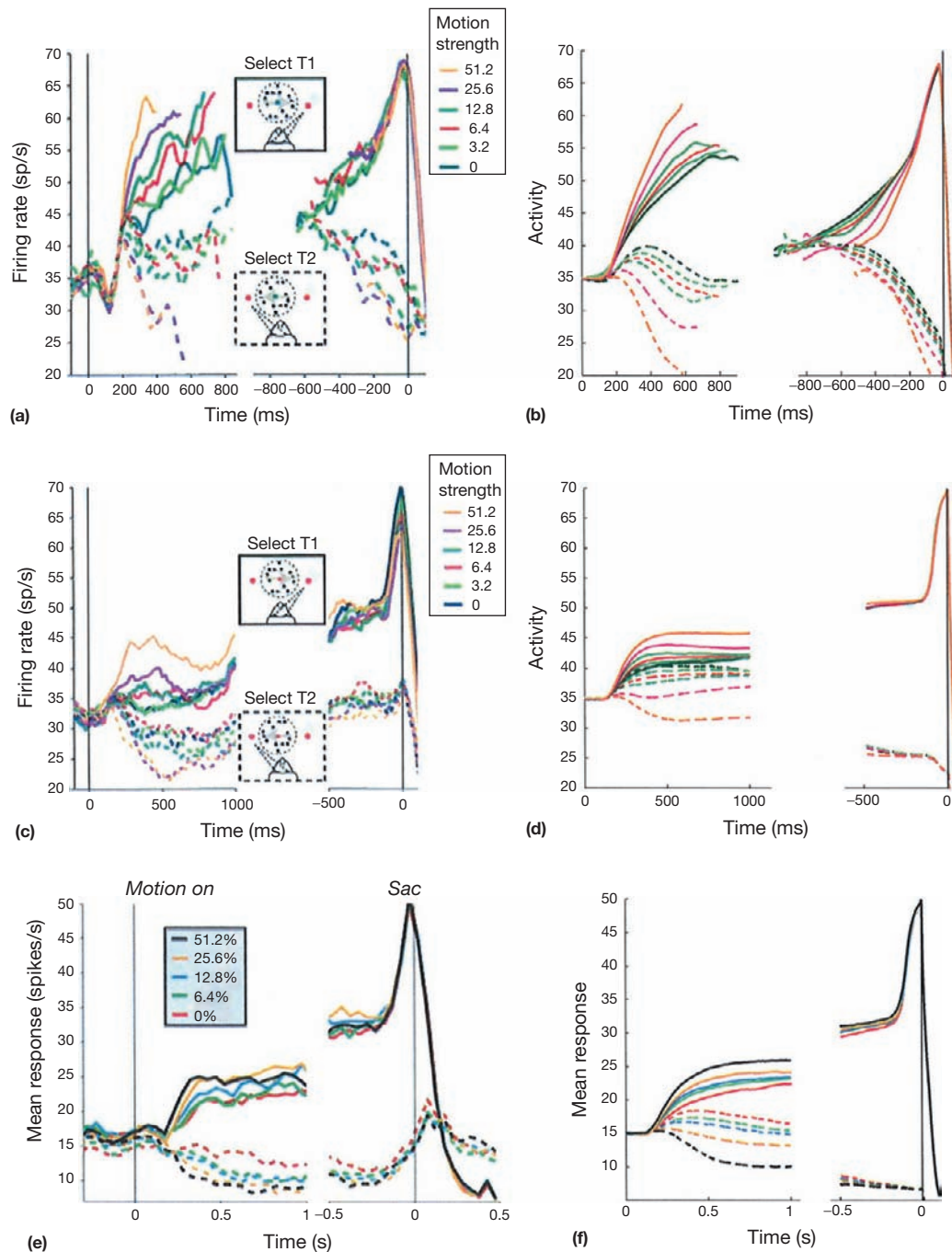
Neurophysiological recordings were done in LIP while the monkeys performed these tasks. The recorded neurons had receptive fields that encompassed just one target, and did not include the circular aperture in which the moving dots were displayed. Also, they were among those that showed sustained activity during the delay period of a memory-guided saccade task. Even though there is no motion stimulus within their classical receptive fields, these neurons still respond with directional-selectivity, probably because of extensive training on the task during which an association was learned. This property has also been observed for neurons in superior colliculus whose movement fields contain just one target.

The recorded LIP neurons show visuomotor responses. On correct trials during the decision-making period, more coherence in the favored direction causes faster LIP cell activation, on average, in both the tasks ([Figure 9](#)), and also higher maximal cell activation in the FD task ([Figure 9\(c\)–9\(f\)](#)). More coherence in the opposite direction causes faster cell inhibition in both the tasks, and also lower minimal cell activation in the FD task.

### Comparing Trackable Features with Coherently Moving Dots

There are many details that need to be carefully discussed to quantitatively explain data from this paradigm. These details should not, however, obscure the main point, which is that a clear mechanistic homolog exists between sparse feature tracking signals and sparse but coherent moving dots.

We have already discussed that, in order to solve the aperture problem, the brain needs to ensure that a sparse set of unambiguous feature tracking motion signals can gradually capture a vastly greater number of ambiguous motion signals to determine the global direction and speed of object motion. In the case of random dot motion discrimination tasks, the signal dots at any coherence level produce unambiguous, though short-lived, motion signals. Thus, individual dots do not experience an aperture problem. Despite this difference, the MODE model shows how the same mechanisms that help resolve the aperture problem can also enable a small number of coherently moving dots to capture the motion directions of a large number of unambiguous, but incoherently moving, dots. Thus, although individual dots do not experience an aperture problem, a sufficient number of randomly moving dots create informational uncertainty that creates a similar



**Figure 9** Temporal dynamics of LIP neuronal responses during the fixed duration (FD) and reaction time (RT) tasks. (a) Average responses of a population of 54 LIP neurons among correct trials during the RT task. The left part of the plot is time-aligned to the motion onset, and includes activity only up to the median RT, and excludes any activity within 100 ms backward from saccade initiation (which corresponds to presaccadic enhancement). The right part of the plot is time-aligned to the saccade initiation, and excludes any activity within 200 ms forward from motion onset (which corresponds to initial transient dip and rise). (b) Model simulations replicate LIP cell recordings during the RT task. In both data and simulations for the RT task, the average responses were smoothed with a 60 ms running mean. (c) Average responses of a population of 38 LIP neurons among correct trials during the 2002 FD task, during both the motion viewing period (1 s) and a part (0.5 s) of the delay period before the saccade is made. (d) Model simulations mimic LIP cell recordings during the 2002 FD task. (e) Average responses of a population of 104 LIP neurons among correct trials during the 2001 FD task, during both the motion viewing period (1 s) and a part (0.5 s) of the delay period before the saccade is made. (f) Model simulations emulate LIP cell recordings during the 2001 FD task. In (a–f), solid and dashed curves correspond to trials in which the monkey correctly chose the right target (T1) and the left target (T2), respectively. Cell dynamics (rate of rise or decline, and response magnitude) reflect the incoming sensory ambiguity (note the different colors; the color code for the various coherence levels is shown in the corresponding data panels), and the perceptual decision (note the two line types). For 0% coherence, even though there is no correct choice per se, the average LIP response rose or declined depending on whether the monkey chose T1 or T2, respectively. Reprinted with permission from Grossberg S and Pilly P (2008) Temporal dynamics of decision-making during motion perception in the visual cortex. *Vision Research* 48: 1345–1373.



computational problem for the visual system to solve. The intuitive idea is that the MT–MST feedback loop needs more time to capture the incoherent motion signals when there are more of them, and cannot achieve as high a level of asymptotic response magnitude when more of them compete with the emerging winning direction. In other words, the effectiveness of the motion capture process depends on input coherence. LIP then converts the distributed motion directional inputs from MST into a directional eye movement command, and thereby enables the monkey to report its decision via a saccade.

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**See also:** [Spatial Perception](#); [Visual Perception](#).

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## Visual Neglect

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### Glossary

**Anosognosia** Refers to the strange clinical phenomena commonly found in association with neglect whereby patients do not appear to be aware of or even deny their neurological and/or neuropsychological impairments (e.g., visual field deficit, motor paralysis, and/or their visual neglect). This striking lack of appropriate awareness appears specific to individual deficits (impairments) and consequences (disabilities) and was first described by Joseph Babinski to denote the loss of recognition for a hemiplegia. Typically seen in 20–30% of hemiplegics after an acute stroke, the underlying mechanisms are not fully understood, but, together with visual neglect, have been associated with poor recovery and suboptimal benefit from rehabilitation.

**Primary sensory deficits** Visual neglect symptoms are typically distinguished from primary sensory deficits such as visual field cuts (hemianopia) which can exist in isolation in terms of lesion location, eye movements, and prognosis. Although eye movement recordings have shown that hemianopic patients employ a series of stepwise saccadic eye movements which often permit them to find and fixate objects initially located in the blind hemifield, given the lesion extent in many patients, it is likely that primary deficits interact with those affecting attentional systems. Consequently, distinguishing the effects of ‘attentional disorders’ is not straightforward in such cases, given that the clinical assessments used to assess both ultimately rely on different assessments of a patient’s ability to report or otherwise respond to specific targets located on the affected side. Since neglect implies a failure in perceptual awareness in the left field, how is it possible for a patient to reliably report stimuli located in the left visual field when responding to visual field testing? Using standard confrontational testing techniques but employing different lateralized positions of gaze, Nadeau and Heilman (1991) reported a patient (without visual neglect) who showed a ‘gaze-dependent hemianopia.’ When patients directed their gaze 30° to the right (such that the left retinotopic field was now in the right hemispace vis-a-vis the midsagittal plane), they showed a marked improvement in movement detection, object naming, shape identification, and color naming over the standard condition with ‘straight ahead’ fixation. The authors concluded that the standard confrontation visual field testing in this case represented more than just a primary visual dysfunction and that the gaze direction effects arose because of the influence of attentional or intentional factors. Using confrontation assessment, Kooistra and Heilman (1989) described a neglect patient with a right thalamic and temporooccipital lesion who demonstrated a left visual field defect, in addition to neglect on standard tasks such as line

cancellation and line bisection. The authors distinguished the effects of neglect and visual field deficit by asking the patient to look to the left or the right while engaged in the visual field assessment. When testing took place with the patient’s eyes directed either straight ahead (i.e., traditional testing) or 30° toward the left, the same patient failed to report stimuli presented in the relative left visual field. However, with eyes directed 30° toward right hemispace, the visual field defect appeared to resolve, suggesting that the patient had visual neglect masquerading as a visual field defect.

**Prism adaptation** The use of prisms as a significant, albeit temporary, reduction in neglect takes advantage of the effect of visuomotor adaptation widely used since the end of the nineteenth century to demonstrate visuomotor short-term plasticity. Short-term exposure to prisms produces a lateral shift of the visual field so visual targets appear at a displaced position. Patients use wedge prisms when making pointing movements to targets placed to the left and right of their body’s midline for around 5 min. Short-term exposure produces a significant reduction in left neglect across a variety of different standard tests (line bisection, cancellation, copying, and reading). Subsequent studies have showed that these clinical benefits extend to numerous neglect-related processes such as straight-ahead pointing, visual exploration toward left hemispace, contralesional somatosensory perception, temporal order judgments, visuo-verbal tasks, wheelchair driving, postural control, and even mental representation. The neural basis for this effect has yet to be formally established, but the cross-sectional observations suggest that even after acquired brain damage, short-term exposure to visuomotor adaptation can stimulate reorganization of the neural representation of space that develops autonomously after removal of the prisms.

**Spatial neglect and conversion disorder** Although conversion disorders, by definition, are not attributed to organic disease, symptoms presenting as cognitive deficits involving amnesia, aphasia, and spatial neglect have been reported. One patient with hysterical conversion showed left spatial /neglect for more than 2 weeks on tests such as line bisection and cancellation tests in addition to presenting with hypoesthesia and weakness of the left arm and leg. Evaluated on line bisection while still experiencing neglect, the fMRI analysis showed selective activation of the posterior parietal cortex found in normals, indicating that brain systems mediating spatial attention were intact and differentially recruited despite the behavioral performance of the patient. The findings from this study (Saj, A., Arzy, S., & Vuilleumier, P. (2009)) suggest that cognitive symptoms such as selective attention may be selectively disconnected from conscious awareness to produce neglect-like behaviors seen in organic cases and may result from inhibitory

processes previously shown to be involved in the production of motor conversion symptoms.

**Spatial working memory** Spatial working memory (SWM) impairments are not uncommon among neglect patients, especially those with parietal damage, and since these correlate significantly with the degree of behavioral asymmetry on cancellation tasks, evidence of an impairment

of (SWM) has been proposed to explain the tendency of some neglect patients to repeatedly explore the same spatial locations on visual search/cancellation tasks. This finding is also in keeping with research that shows target cancellation tasks are more sensitive to neglect when the response required leaves no visible mark, providing greater memorial effort for recalling previously visited locations.

## Introduction: Clinical and Cognitive Relevance

The clinical presentation of patients who ‘ignore’ objects, events, or people on the side of space opposite their brain damage has been described in the medical literature for well over a century (see [Figure 1](#)). Although comparatively neglected prior to the 1970s, research from clinical and cognitive neuropsychology, neurorehabilitation, and cognitive neuroscience has grown significantly in the last 40 years.

Otherwise known as hemispatial neglect or hemi-inattention, visual neglect describes a complex clinical entity that features prominently in most current texts of behavioral neurology and cognitive neuropsychology. Neglect describes a striking and complex clinical phenomenon where patients with acquired brain damage (e.g., cerebrovascular accident (CVA), traumatic brain injury (TBI), and less commonly, brain tumor or neurodegenerative diseases) appear unable to attend to, or respond to, objects and people located on the side opposite their brain damage. Although visual neglect is associated with damage to both hemispheres, *left* neglect after *right* hemisphere damage is more frequent, severe, and long-lasting.

Neglect warrants clinical attention as it occurs in about 25–30% of strokes (3–5 million a year worldwide) and can have a significant impact on health and rehabilitation services. More critically, this predominately lateralized spatial bias is reliably associated with gross impairment of many activities of daily living, spontaneous ipsilesional deviation of head and eyes, slowed recovery in maintaining alertness, nonspatial deficits in attentional capacity, and impaired vigilance. For patients, these impairments have a negative influence on both engagement in rehabilitation and recovery.



**Figure 1** A caricature conveying the sense of florid visual bias involved in neglect and need for exogenous cueing. Reproduced from Cohen R (1993) *The Neuropsychology of Attention*. New York: Plenum.

While it was initially considered a unitary syndrome affecting left-sided space, over the last two decades there has been compelling evidence that neglect results from the interplay of damage to several different cognitive processes where the border between neglected space and nonneglected space is far from absolute. Moreover, the lateralized reference and use of the term ‘left’ requires comment, as it does not necessarily refer to the left of the patient’s midline, but can actually be differentially defined with respect to several different frames of reference. Many symptoms ascribed to the visual or hemineglect syndrome share little in common other than a contralesional gradient of increasing impairment, with a comparatively well-preserved performance on the ipsilesional (right) side of space.

The reasons for this asymmetric pattern (greater left-sided neglect after right brain damage) continue to be the subject of theoretical speculation. In the healthy brain, the left and right hemispheres are assumed to function in mutual competition, with neural activity for each hemisphere driving or modulating spatial attention to the opposite half of space. Normally, these opposing signals are held in balance, ensuring that the person can attend equally well to both sides of space. Damage to the right hemisphere, however, leads to a rightward bias and a left neglect that largely arises from the dominant engagement of the intact left hemisphere. The specialization of the left hemisphere for language has been proposed to explain this presentation laterality – together with the absence of such asymmetries in nonhuman primates. An alternative account is that the right hemisphere is specialized for global processing, while the left is more adapted to focus on local details. Consequently, right hemisphere damage results in more focused attentional bias (e.g., selection preference toward right-sided targets on cancellation tasks) and failure to detect and orient in the wider spatial context.

Neglect is not confined to vision and can affect personal (or body) space, peripersonal space (stimuli within reaching and grasping distance), and extrapersonal space (stimuli within walking distance). Although *lateralized* (left–right) visual neglect has attracted the most interest, comparable phenomena have been observed in nonlateralized space and other dimensions of space (radial and altitudinal neglect). Hence, varieties of neglect have been distinguished on the basis of the regions of space affected, the reference frame, the mode of output as well as the sensory modality.

Although visual neglect has clear and important clinical implications for patient recovery and long-term health care planning, much of the neuroscience interest over the past 30 years stems from the opportunity to examine the neural and cognitive mechanisms that underlie impairments of spatial and nonspatial attentional processes and study of their

behavioral manifestations. Investigations of patients with spatial neglect have contributed in no small way to our understanding of the manifold processes subserving spatial cognition. By considering traditional clinical neurological syndromes such as neglect in terms of damage to known cognitive systems, neuropsychologists have moved beyond mere symptom description and the opportunity to meaningfully link cognitive deficits to their impaired neural processes.

### Clinical Presentation and Functional Consequences

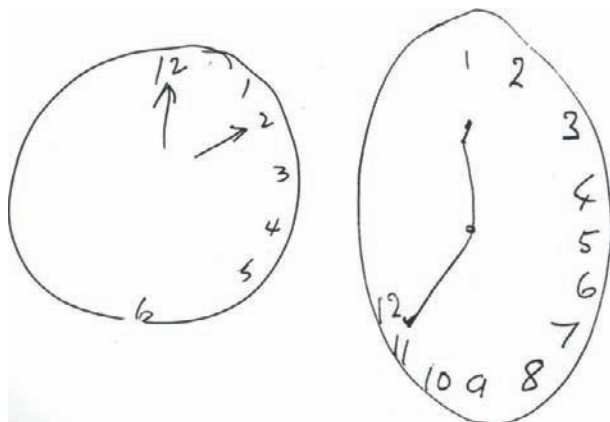
Patients vary enormously in the range and extent of 'neglect' behaviors observed, most of which have a debilitating effect on their everyday life, in particular, their attempts to negotiate wheelchairs or interact with staff. While formal assessments are useful, there is no substitute for simple observation of the patient on the ward or in their home. As a heterogeneous cluster of dissociable deficits, characterized by lateralized spatial bias, most people consider the clinical diagnosis of neglect an 'umbrella term' covering a multifaceted range of attentional, intentional, and representational deficits not directly attributable to primary sensory or motor deficits. Clinically, neglect has been shown to vary as a function of the relative size of lesion, the hemispheric location, time post onset and number and type of assessments used. Although some patients with neglect demonstrate visual field deficits, others with intact visual fields nevertheless show profound neglect on a wide range of tasks. Typical examples include where patients fail to find visual targets presented on the left side of a page, draw only the right half of a remembered image, copy the right half of a picture, and delete and/or compress the numbers on a clock face into the right half of a drawn clock (see Figures 2–4).

Examples of neglect behaviors seen on the ward include (1) failure to notice people approaching from the left; (2) failure to eat food from the left side of the plate; (3) failure to dress on, or groom, the left side; (4) omission of letters, numbers, and/or words on one side of the page when reading; (5) omission of one side of the contents of a picture when verbally describing or drawing; (6) failure to pick up coins or cards on

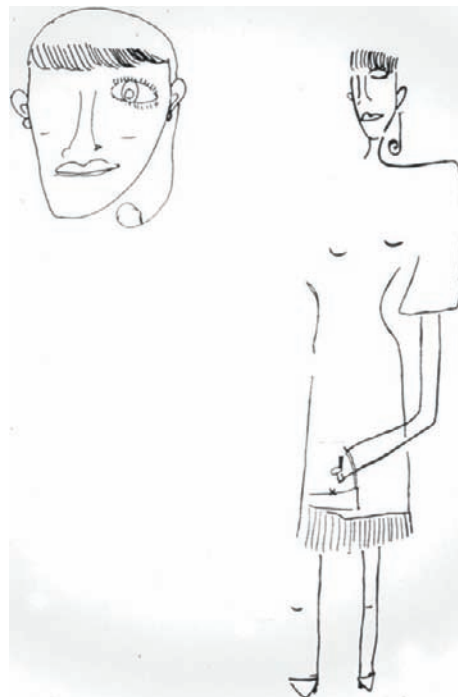
the affected side; and (7) omission, distortions, and asymmetries in spontaneous drawing and writing. Patients often inadvertently and repeatedly bump into obstacles situated on their left (door frames and chairs) with their wheelchair or while walking and show a tendency to look to right-sided details as soon as a visual scene deploys, as if the left side of space had ceased to exist in any meaningful way. In addition, such patients may ignore their own left limbs or have difficulty reaching toward the left, and fail to respond to auditory stimuli from the left or tactile stimuli presented to the left side. Even more striking, some patients omit information from the left side of an imagined scene – information that they subsequently recall when imagined on the right. In the acute stage, many patients are unaware of their deficits (anosognosia) and can obstinately deny being hemiplegic or neglectful, all of which provides for suboptimal engagement in rehabilitation.

In many patients, reading (neglect dyslexia) and writing (neglect dysgraphia) can be severely compromised by visual neglect. Patients with neglect dyslexia omit the left side of both the text and individual words. When reading single-word errors, this may involve both removal and/or partial substitution for the left sides of words. In the example in Figure 5, both errors are present.

Famous examples /illustrations of neglect seen after stroke (but unrecognized as such) from the nineteenth and twentieth centuries include Charles Dickens and Woodrow Wilson, the American President at the time of WWI. According to McManus, Dickens first recorded neglect episode occurred in 1870 when Dickens noted that "he could read only the halves of the letters of the shop doors that were on his right as he looked."



**Figure 2** Evidence of neglect on a clock drawing task from memory in the acute and postacute stages after right hemisphere stroke. From Robertson IH and Halligan PW (1999) *Spatial Neglect: A Clinical Handbook for Diagnosis and Treatment*. Hove: Psychology Press.

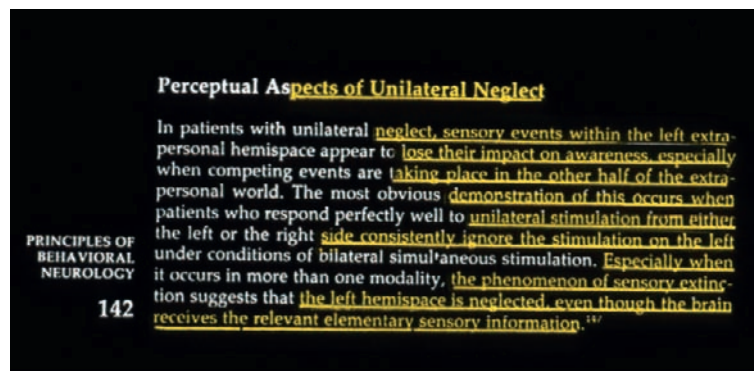


**Figure 3** Long-standing visual neglect involving the left side of the face and body in a patient fully aware of her clinical condition. From Robertson IH and Halligan PW (1999) *Spatial Neglect: A Clinical Handbook for Diagnosis and Treatment*. Hove: Psychology Press.





**Figure 4** Pre- and poststroke sketches from the work of the artist Tom Greenshields. After his stroke and in addition to other visuoconstructive deficits, the artist was unable to attend to the left side of his drawings. From Halligan PW and Marshall JC (1997) *Lancet* 350(9071): 139–140.



**Figure 5** An example of neglect in reading from a neurology textbook describing visual neglect. The (yellow) underlined text is the actual text read by the patient. Reproduced from Mesulam MM (1985) *Principles of Behavioural Neurology*, p. 142. Philadelphia, PA: FA Davis Company.

Dickens apparently noticed his problem most when reading proper names, perhaps because of the presence of contextual cues. After his stroke in 1919, Woodrow Wilson showed many features of visual neglect in association with left-sided weakness. In writing, he often omitted letters or words located on the left side of the page such that his wife had to correct much of his personal correspondence at the time.

Finally, it is worth recalling that several patients take exception to the use of the term neglect to describe their condition. Asked to provide an explanation for her 'visual neglect,' one articulate patient reported by Halligan and Marshall complained that the term 'neglect' was an unfortunate and inaccurate description of her experience. As far as she was concerned, a more accurate description was that left space and its contents did not appear to exist and hence there was nothing to neglect!

Asked to elaborate, the patient said that although she had heard the word 'neglect' mentioned, she could not understand what it meant.

I thought they were saying I was actually neglecting to look to the left. I couldn't move my eyes to the left. It was quite fixed. It was scary. I used to bump into things because I couldn't move my eyes to the left. Because I never used to look to the left at all. I knew the word 'neglect' was a sort of medical term for whatever was wrong but the word bothered me because you only neglect something that is actually there don't you? If it's not there how can you neglect it? It doesn't seem right to me that the word neglect should be used to describe it. I think they thought I was definitely, deliberately not looking to the left. I wasn't really. It was painful looking to the left. ... People think you are not looking ... you are neglecting to look but it's not there. If it's not there you are not neglecting it. I think concentrating is a better word than neglect. It's definitely



concentration. If I am walking anywhere and there's something in my way, if I'm concentrating on what I'm doing I will see it and avoid it. The slightest distraction and I won't see it.

(Halligan and Marshall, 1998)

## Assessment

Assessment and diagnosis of neglect remains important, particularly as it can be helpful in characterizing the types of neglect and predicting functional outcome. Quantifiable assessment of *within subject performance* provides indications of the range, severity, extent of recovery, and nature of presenting neglect, all of which are informative when considering and tailoring individual rehabilitation strategies. While some clinicians have developed tests and assessments that understandably focus more on functional measures by requiring patients to perform tasks, which show potential difficulties in daily life, neglect is typically diagnosed using simple (bedside) tests such as cancellation, line bisection, or copying. For clinical purposes, laterally impaired performance on any one measure, particularly on line bisection, cancellation, or copying, is usually taken as evidence of diagnosis. However, double dissociations between these tests are not uncommon (e.g., patients may omit left-sided targets from a cancellation task while at the same time bisecting lines within normal limits and vice versa), suggesting that the task demands do not overlap or are equally demanding.

Despite content, procedural differences, and double dissociations between many such tasks (e.g., physical and mental line bisection, representational or imaginable neglect, and copying), most tests justify their validity on the basis of demonstrating a predominantly lateralized task performance and by claiming to measure different aspects of the underlying deficit. Patients' asymmetries of performance on *cancellation tasks* can vary from a few left-sided omissions to cancellation of only the rightmost items depending on spatial density, content, and the number of distracters. Some patients repeatedly cancel the same right-sided items, showing a pathological 'revisiting behavior' for objects presented in the supposedly 'normal' sector of space. Patients who compensate for their deficit to some extent, will either as a result of spontaneous recovery or after rehabilitation, cancel out all the elements, but nevertheless keep starting from the right extremity of the sheet, at variance with normal participants, who most often start from the left part of the sheet. *Line bisection* is also a useful tool to discriminate between neglect and visual field defects, such as left homonymous hemianopia, which was once thought to provide an intuitive explanation for neglect. Contrary to this hypothesis, there are patients with left hemianopia but no neglect, which deviate *leftward* on line bisection. The association of left neglect and hemianopia, however, produces large rightward deviations on line bisection. When given relatively short lines to bisect (e.g., 5 cm or less), patients often paradoxically shift the bisection point leftward. The copresence of visual field defects may be a necessary condition for this cross-over effect and other neglect-related behaviors to occur. When copying a drawing, neglect patients often omit left-sided details but more rarely,

some patients actually *increase* the number and spatial extension of left-sided details.

As neglect may be present on some, but not all, tests at the same time, the use of more than one test is recommended. There are many different tests currently available, and from a clinician's perspective, administering multiple types of assessment generally improves sensitivity in revealing the intact as well as the deficits in spatial processing. One well-validated battery used internationally is the behavioral inattention test (BIT) using six 'conventional' standardized bedside paper and pencil tasks and nine more ecologically relevant behavioral subtests developed to simulate some activities of daily living.

The test, which was standardized using 50 normal subjects and 80 stroke patients, has shown itself to have high interrater (0.99), test-retest (0.99), and parallel form reliability (0.91), and is relatively simple to administer and capable of identifying problems that patients encounter in daily life.

## Neuropsychological Insights and Cognitive Mechanisms Implicated

It should be clear from the brief description so far that left neglect is not a unitary, homogeneous entity. Several reliable dissociations of patient performance have been described using different neuropsychological tasks, although it has not always proved possible to find a clear correspondence between behavioral dissociations and lesion localizations given the traditional focus on gray matter lesions and the fact that some dissociations may stem from the patient's own capacity to employ compensatory strategies.

The different mechanisms producing neglect have fostered considerable debate during the last decade. Several independent deficits, presumably interacting with one another, contribute to the range of neglect signs. These include deficits in orienting of spatial attention, in building or maintaining spatial representations, or in programming left-directed hand movements. It is also possible, however, that some deficits have more influence than others in shaping and sustaining patients' behavior. For example, deficits of spatial attention, such as an engagement of attention toward right-sided, nonneglected items as soon as the visual scene unfolds, followed by impaired disengagement from these same items have been considered key component deficits of neglect. Importantly, these deficits seem mainly to concern what are termed exogenous, or stimulus-related, orienting of attention, with relative sparing of endogenous, or voluntary, orienting. Thus, the presence and number of right-sided distracters can perturb patients' performance in a predictable way. Also, there is clear evidence that nonlateralized deficits can contribute crucially to clinical neglect. For example, processing of items presented in central or right-sided locations can be impaired in left neglect. However, it should be remembered that attentional deficits can occur after right brain damage even in the absence of clinical neglect, consistent with the idea that several deficits combine to produce clinically discernible neglect behavior.

## Attention

Attention – the cognitive process of selectively focusing on aspects of our environment while disattending to other things – is

probably one of the most important cognitive processes, given that it pervades all aspects of cognitive life and, when compromised, provides for a wide range of clinical consequences. For many researchers, the motivation for studying patients with neglect stems from the opportunity to study the effects of damage on attention as a way of gaining insights into the often subtle and less obvious ways in which complex attentional systems operate normally. The range of deficits observed stem from the fact that attention is not a single process but rather a set of interacting, albeit relatively autonomous, subprocesses vulnerable to different forms of brain damage with differing patterns of recovery. Because attention cannot be observed directly but is detected by monitoring systematic variation in performance on different attention-demanding tasks, the performance of patients with neglect provides a 'natural' experiment for elucidating the operational functions and constraints under which normal attentional systems operate. Posner's well-established covert attentional-cuing paradigm shows this well (see [Figure 6\(a\)](#) and [6\(b\)](#)).

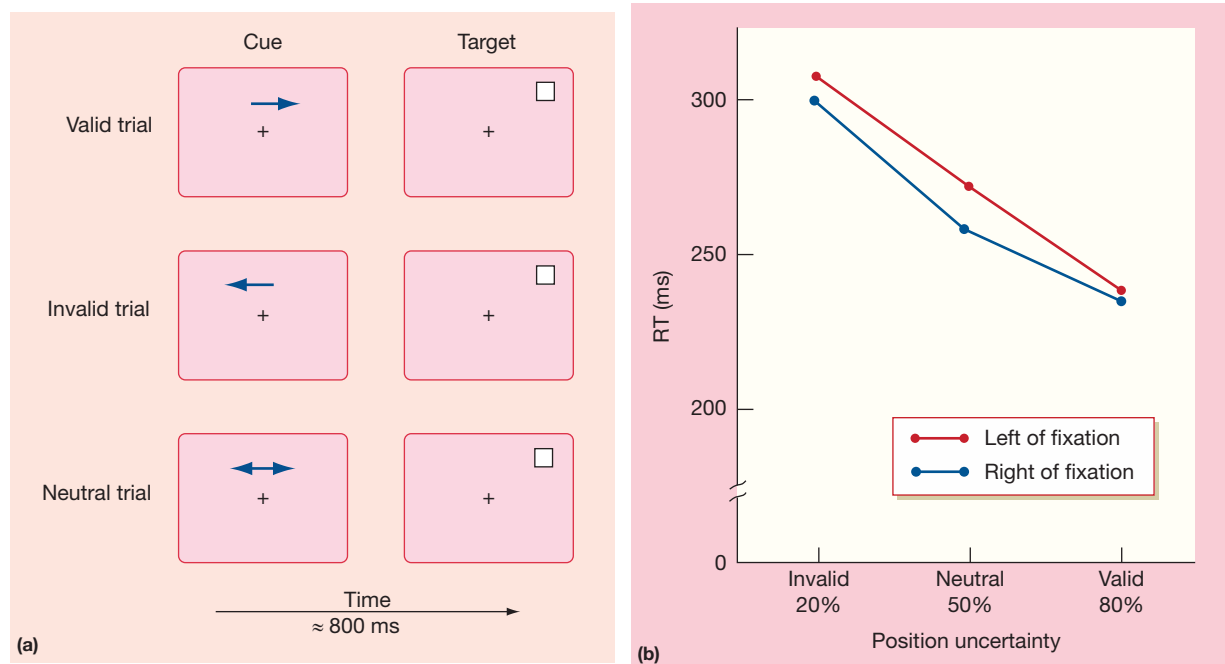
In this classic paradigm, subjects are asked to maintain their gaze at the center of a screen and press a button only when they observe a designated target appearing. Subjects have no information where on the screen this target would be, although on a number of informative trials, they would have received a directional or spatial cue as to the probable location. Attentional cues, when accurate, produced significant reductions in overall reaction time, but when inaccurate, produced significant increases. Given that all other aspects of the task remain constant, the temporal differences are attributed to the movement or allocation of spatial attention. Using this single reaction-time paradigm, Posner and others were able to

distinguish three different mental operations involved in covert orienting of attention: (1) disengaging from the current focus, (2) moving toward the target, and (3) engaging the novel target, which could be, individually or collectively, compromised by neglect. Subsequent research using this simple paradigm with neglect patients has shown that a major feature underlying severe forms of neglect is the severe imbalance in automatic orienting of attention resulting from a rightward bias, particularly evident in bilateral visual stimulation. Owing to this early orientation of attention to the right hemispace, left-sided stimuli are either neglected or attended to after a quantifiable delay, which is an index of the time-consuming reorienting of attention from the right to the left side of space.

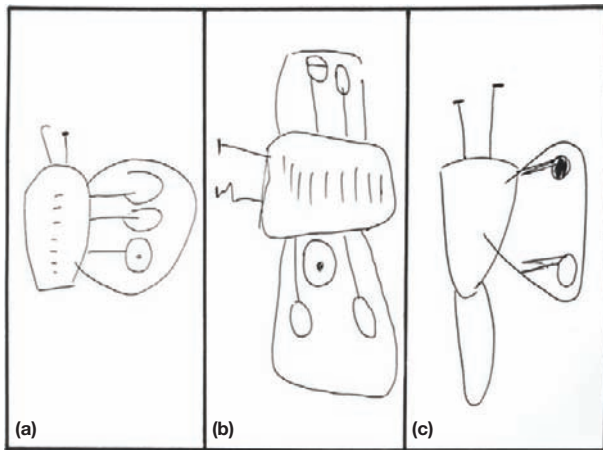
### Spatial Frames of References (Object and Space)

The brain appears to code visual inputs with respect to several spatial frames of reference and hence, the terms used to qualify clinical accounts of neglect, such as 'left' or 'hemi,' need to be clarified. The brain uses different frames for attributing up-down and left-right to spatial arrays and can be based on the direction of the viewer's gaze (egocentric) and/or the intrinsic characteristics of an object or its environment (allocentric) (see [Figure 7\(a\)](#) and [7\(b\)](#)):

1. *Egocentric space* (i.e., coding with respect to different viewer-centered frames of reference, including eye-, head-, torso-, shoulder-, arm-, and hand-centered coordinates) can be differentially affected by neglect. The extent to which these different coordinates are truly independent has yet to be established.



**Figure 6** (a) The spatial cuing paradigm of Posner and colleagues. A subject sits in front of a computer screen and fixates on the central cross. An arrow cue indicates to which visual hemifield the subject is to covertly attend. The cue is then followed by a target in either the correctly or the incorrectly cued location. (b) Results of the study by Posner and colleagues, as shown by reaction times (RT) to unexpected, neutral, and expected targets for the right and left visual hemifields. RT for expected locations are significantly faster than those for neutral or unexpected targets.

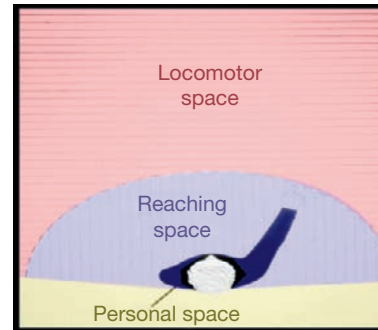


**Figure 7** In copying a picture of a butterfly positioned (a) horizontal (b) vertically, and again (c) horizontally, the neglect patient reliably omits the left wing in the horizontal conditions where the relevant wing is located to the left of the subject's egocentric mid-sagittal plane. Reproduced from Halligan and Marshall (1996).



**Figure 8** A neglect patient's copy of the top three spatially distinct images managed all the three, but consistently omitted the left side of each image. From Halligan PW, Fink GR, Marshall JC, Vallar G (2003) Spatial cognition: Evidence from visual neglect. *Trends in Cognitive Sciences* 7: 125–133.

2. *Allocentric*: Spatial position can also be coded in object-centered coordinates not dependent on the lateral or relative position of the observer. Clinical studies have reported lateralized deficits that are spatially defined in terms of an object's position relative to another object. Convincing evidence for selective damage to object-based frames of reference can be found in the drawing and copying performance of neglect patients (see Figure 8). Furthermore, object-centered coding that involves the intrinsic order of object parts (e.g., written words have a specified sequence of letters) has also been reported. This form of coding was elegantly demonstrated by Caramazza and Hillis in a left-brain-damaged patient with right-neglect dyslexia. When



**Figure 9** A simple schematic summarizing the three different regions: personal space, peripersonal space, and extrapersonal space. Reproduced from Robertson IH and Halligan PW (1999) *Spatial Neglect: A Clinical Handbook for Diagnosis and Treatment*. Hove: Psychology Press.

reading, her errors were always located on the last letters of the words irrespective of whether the words were presented horizontally, vertically, or even mirror-reversed.

### The Neuropsychological Decomposition of Space

Although psychological space appears to extend seamlessly, evidence from animal and clinical cases involving neglect suggests that it does not appear to be homogeneously represented in the brain. Embodied space can be behaviorally divided into at least three different regions: *personal space*, *peripersonal space*, and *extrapersonal space* (see Figure 9). Patients with right hemispheric brain lesions can demonstrate neglect in any, or all, of these spatial frames of reference. Typical examples of left personal neglect include failure to shave or groom the left side of the face, failure to adjust spectacles on the left side, and failure to notice the position of the left limbs and use them appropriately even when significant motor weakness is not present. By contrast, the ability to use left personal space without difficulty can be seen in the context of neglect of peripersonal space using visual search tasks where targets are located within arm's reach. Double dissociations between personal and peripersonal neglect and between peripersonal and extrapersonal space suggest that distinct neuronal circuits underlie the way the three spaces are represented in the human brain. Although the limits of peripersonal (grasping) space are normally determined by the extended reach of the arms, extending peripersonal space using rigid tools in neglect has shown that enlarged peripersonal space can become remapped as near space.

### Unconscious or Implicit Processing in Neglect

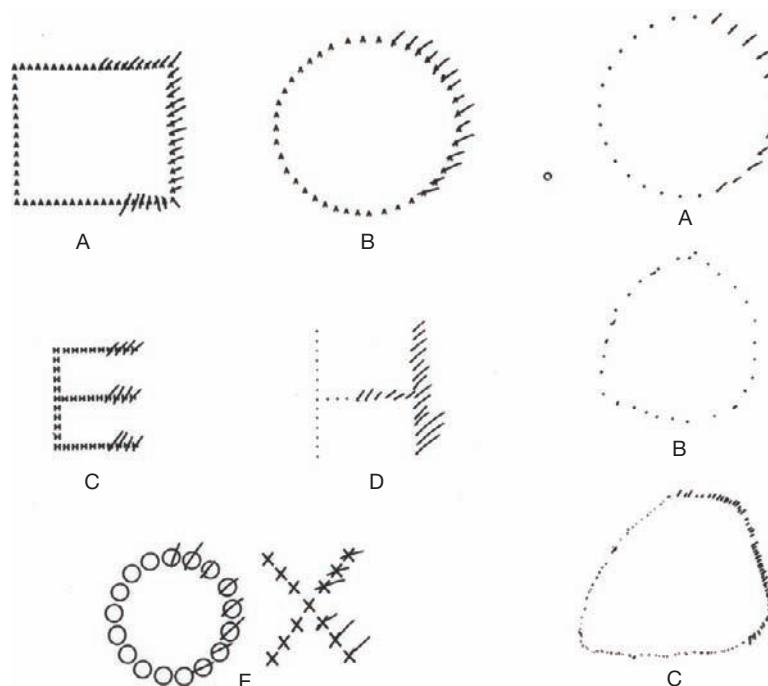
Many students of neuroscience consider neglect to be a classic disorder of visual awareness where awareness is equated with the psychological construct of attention as previously discussed. However, given the remarkable findings from blindsight, where patients show some degree of information processing when tested indirectly, one of the fascinating questions is the level or extent to which covert cognitive processing continues despite overt failure on the part of the patient to consciously report or attend to left-sided space or objects. In this way, studies of visual neglect have made a useful

contribution to the classic debate regarding the processing levels of attentional selection. According to the *late selection* view, preattentive analysis of the whole scene takes place up to and including initial recognition of the object whereas *early selection accounts* argue that only basic perceptual processing takes place preattentively and focal attention is subsequently necessary for object recognition. The key question for neglect research hinges on the cognitive level to which stimuli are preattentively processed.

Studies of visual neglect have shown that dependent on the relevance of the stimuli, preattentive processing up to the level of meaning can take place in the 'neglected' field without conscious awareness. Using cross-field matching and priming experiments, patients with neglect show significantly shorter reaction times to right field stimulus content for congruent rather than noncongruent stimuli despite denying seeing anything in the left visual field. Even on line bisection, patients with severe left neglect show implicit sensitivity to many figural characteristics of the stimulus display, confirming that preattentive visual capacities can influence explicit visuomotor performance. When requested to bisect a line located in the center of a page, most patients with neglect show a displacement of absolute magnitude that is linearly related to line length. This consistent linear performance may be explained in terms of implicit processing of the visual information on the neglected side. Thus, the neglected end of the stimulus line is covertly influencing the patient's performance in deciding the subjective center of the line.

Marshall and Halligan showed evidence of a further type of dissociation between two forms of conscious perceptual awareness – with hierarchical figures on a free vision task. In a series of experiments, they showed that some neglect patients, when

shown hierarchical drawings of shapes or alphabetic letters composed of smaller (local) features or letters in free vision, gave an accurate *verbal* description of both the global and local subfigures despite subsequently (and within seconds) showing neglect when required to cancel the smaller (local) components on the left side of the global figure and despite being able to describe the global figures accurately both before and after cancellation (Figure 10(a)–10(e) left). This 'within subject disconnection' in communication between local and global processing was found even when patients produced an accurate copy of the global figure (Figure 10(c)–right-sided figures) – a circle comprised of localized dots. Requested to cancel the same set of dots comprising the circle just drawn, patients again neglected to mark much of the left circumference of the circle. In such cases, global processing can no longer be used to direct automatic focal attention to spatial locals that require further focal analysis. Without this ability, local attention which is usually biased to the right will always represent too little of the visual world. However, once attention has been focused, the panoramic or global view appears lost to conscious awareness unless exogenously cued. When their focal attention is biased to the right as in the case of left neglect, patients are in a position to observe the absence of left-sided input. Even if selective attention can be voluntarily moved leftward, the necessary guiding framework provided by the global scale is no longer available. Consequently, patients no longer have any reason to continue to explore leftward. In these and other examples where performance within an individual patient appears normal on one aspect and grossly impaired on another involving the same stimulus seconds later, left neglect may be regarded as a partial disconnection of conscious visual awareness where residual processes of



**Figure 10** Dissociation between two forms of conscious perceptual awareness in a patient with left neglect. Reproduced from Marshall and Halligan (1995) *Nature* 373(6514): 521–523.

the impaired right hemisphere cannot be used to constrain the performance of the intact left hemisphere in performing the designated task. Collectively, these findings highlight the danger of equating phenomenological conscious experience with the operation of the perceptual mechanisms involved.

### Representational or Imaginal Neglect

Despite the traditional clinical emphasis on using visual stimuli (e.g., cancellation tasks and copying tasks), neglect can manifest itself in the absence of visual stimuli. When describing known places from memory, some patients omit details situated on the left part of the (mental) scene. In the now classic experiment, Bisiach and Luzzatti asked patients with left-sided visual neglect from Milan to imagine the famous Piazza del Duomo or central square from the vantage point of the cathedral steps in the center of the square. As expected, patients often omitted places or streets to the left side of the square taken from *that imaginal viewpoint*. However, the same patients when asked to imagine they were looking directly at the cathedral, that is, when they were required to change their imaginal viewpoint by 180°, now neglected to mention places on the side of the square previously reported – the ones that now fell to their left from the new imagined point of view. Instead, they recalled places to the right of the new imagined vantage point demonstrating that while they could imagine much of the content on both sides of imagined space, neglect was capable of adversely restricting attention to the respective right side of each imagined representation of the Piazza.

Not all patients with visual neglect show imaginal neglect, perhaps because imagined details have less attention-capturing power than real ones. Imaginal neglect can also occur in the absence of signs of perceptual neglect, either at onset or, perhaps more commonly, as a result of selective compensation for the perceptual aspects of the syndrome. Patients often learn with time (and possibly with the help of people around them) to explore more thoroughly their visual environment. However, compensation may be more difficult to obtain in the more abstract imaginal domain, which is rarely the object of rehabilitation or of more informal reminders to ‘look to your left.’

Neglect patients may also deviate rightward when engaged in the mental bisection of number lines or intervals; for example, when asked for the median number between 11 and 19, they may answer ‘17.’ In this domain as well, visual and imaginal performance can dissociate. Biased performance with mental number lines might be related to concomitant prefrontal damage and spatial working memory impairment. It would be surprising to find that all neglect patients demonstrate such a mental bias, given that people do not always imagine numbers in spatial arrangements, and even when they do, their mental maps are not necessarily oriented along the horizontal direction.

When patients are asked to use a black touch screen to represent the night sky, and to touch the locations occupied by (imaginary) stars, they put significantly more stars to the right of the screen midline, and particularly when the stars remained illuminated after the touch. However, if the screen remained black, the asymmetry was less evident. This confirms the attention-capturing influence of real right-sided visual stimuli on patients’ neglect. But perceptual influences on spatial imagery seem less relevant for casual, task-unrelated stimuli.

When patients are asked to imagine and describe the map of France with eyes open or blindfolded, performance was similar regardless of the condition. During sleep, neglect patients can show suppression of leftward-directed rapid eye movements (REMs), although there are reports of patients with left visual neglect and frequent nystagmoid REMs with alternating leftward slow/rightward fast phases, corresponding to dreams with consistent visual events, such as a train running leftward, but virtually no nystagmoid REMs in the opposite direction. The complex relationships between perception and imagery in general and concerning neglect in particular, are still difficult to predict from the available theoretical models.

### Neural Basis (Lesion Correlates)

Neglect has been long observed to follow damage to a variety of brain regions, including the parietal cortex, frontal cortex, basal ganglia, putamen, caudate, and thalamus. In keeping with the heterogeneous nature of the symptoms, patients with neglect often have relatively large lesions of the right hemisphere, likely to disrupt several functional modules. However, the precise localization and functional disruption of these lesions remain controversial, as patients’ lesions detected by CT or MRI often overlap on the inferior parietal lobule (IPL) at the junction with the temporal lobe. Conflicting evidence, however, also indicates lesions of the middle and rostral parts of superior temporal gyrus (STG), which tends to exclude a role for lesions of the temporoparietal junction. More recent studies suggest that parietal or STG dysfunction may lead to different forms of neglect (respectively, personal/extraperсонаl, or viewer-centered/stimulus centered). However, lesion overlap methods lacking spatial resolution may reflect differences in vascular territories rather than true functional architecture and do not always satisfactorily deal with multiple lesions.

Recent studies show that the previous reliance on structural CT and MRI techniques is now beginning to embrace the findings of new techniques, given the desire to understand neglect in terms of dysfunctional brain networks rather than, as previously, in terms of local damage to specialized gray matter functions.

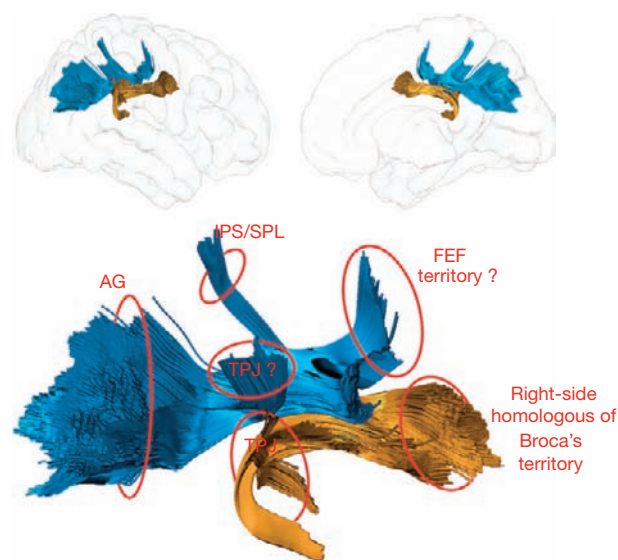
Transcranial magnetic stimulation (TMS) has been used to transiently disrupt the integrated activity of cortical networks in a relatively noninvasive fashion, which has the advantage of suggesting causal processes rather than depending on the correlative associations used in imaging studies. TMS over the left hemisphere decreases left neglect in right brain-damaged patients. Temporary inactivation of the middle/rostral portions of the STG produces nonlateralized impairments in visual search tasks. In the same study, TMS stimulation of the central sectors of the STG did not modify judgments of the length of horizontal lines (Landmark task), in contrast to inactivation of the posterior parietal cortex, which provoked lateralized effects similar to that shown by patients with neglect on the same task. A more recent study using TMS confirmed that neglect symptoms can rise not only through direct stroke damage to the right parietal cortex, but also through remote excitability changes in the intact *left* parietal cortex not directly damaged by the stroke. These findings provide further support for the influential theory that neglect occurs due to unilateral



stroke disruption of the normal attentional balance of neural activity between the two hemispheres.

Functional MRI has been employed to explore the neural correlates of subacute and recovered neglect. Four weeks after a stroke, when performing a response-timed task to lateralized stimuli, neglect patients showed a decreased activation of structurally intact frontoparietal regions in the right hemisphere (especially the intraparietal sulcus, the superior parietal lobule, and the dorsolateral prefrontal cortex), together with a robust activation of the homologous regions in the left hemisphere. Thirty-nine weeks after lesion onset, recovery of neglect signs was paralleled by the disappearance of the imbalance between the two dorsal frontoparietal attentional networks. Thus, lesions of the right temporoparietal junction may determine a functional imbalance of the superior parietal lobules and the connected prefrontal regions, which are structures important to attentional orienting, with a consequent biased orienting toward right-sided objects.

Temporary electrical inactivation of small brain region (~5 mm) stimuli performed during brain surgery to prevent postoperative deficits have also been informative. One study described the performance of two patients who bisected horizontal lines while undergoing surgical resection of low-grade gliomas. Patients deviated rightward upon inactivation of the supramarginal gyrus (the rostral subdivision of IPL) and the caudal part of the STG; however, bisection performance was accurate when more rostral portions of the STG or the frontal eye field (FEF) were inactivated. The tract of long association fibers in the white matter of this particular patient was mapped in postoperative MRI scans using diffusion tensor MRI tractography (DT-MRI), a new technique capable of tracking white matter fibers (**Figure 11**). The tract whose inactivation had brought about the maximal rightward deviation



**Figure 11** 3D reconstruction of the SLF III (in gold) and SLF II (in blue); top, lateral, and medial views of a glass brain right hemisphere; bottom, frontoparietal connections with their putative cortical projections. AG, angular gyrus; IPS, intraparietal sulcus; SPL, superior parietal lobule; TPJ, temporoparietal junction; FEF, frontal eye field. From Doricchi et al., *Cortex* (2008) vol. 44, pp. 983–995.

corresponded to the likely human homologous of the second branch of the superior longitudinal fasciculus (SLF II). This pathway connects the inferior and the superior parietal lobules, particularly the angular gyrus (BA 39), including the intraparietal sulcus (IPS), to the middle and superior frontal gyri (BA 9, 8, 46, and 6). The observation that functional frontoparietal disconnection dramatically disrupted symmetrical processing of the visual scene is consistent with many findings obtained from animal research.

A recent meta-analysis of previous lesion overlapping studies in human stroke patients demonstrated that the subcortical lesions of neglect patients invariably overlapped at or near the human homologs of the second and third branches of SLF. Disconnection between cortical modules might thus be a general mechanism of neglect. DT-MRI tractography can now be used to explore, in a standardized brain space, the relationships of white matter tracts with the lesions found in stroke patients with standard, anatomical MRI. Thus, for the first time, white matter pathways can be explored in detail in the living human brain, and the focus can shift from the impairment of cortical modules to the dysfunction of cortical networks. A recent study combined principal component analysis on behavioral tests and voxel-based lesion-symptom mapping in 80 stroke patients. Principal component analysis identified three factors, labeled as exploratory/visuomotor, perceptive/visuospatial, and allocentric/object-centered. Voxel-based lesion-symptom mapping indicated distinct brain regions for the three components: the dorsolateral prefrontal cortex for the exploratory/visuomotor component, the IPL for the perceptive/visuospatial component, and deep temporal lobe regions for the allocentric/object-centered component. In patients with severe neglect encompassing several tests, standard lesion overlap analysis disclosed a hot-spot in the hemispheric white matter, in a location consistent with the trajectory of frontoparietal pathways. Thus, components of neglect may result from damage to distinct cortical sites. However, in the most severe cases, neglect results from the disruption of large cortical networks as a consequence of damage to frontoparietal white matter connections.

These results collectively support models of neglect which postulate a dysfunction of large-scale right-hemisphere networks and an involvement of the intact left hemisphere. Parietal components of the network could determine the perceptual salience of extrapersonal objects; frontal components might be implicated in the production of an appropriate response to behaviorally relevant stimuli, in the online retention of spatial information, or in the focusing of attention on salient items through reciprocal connections to more posterior regions. The network approach might prove important for patient diagnosis because a particular form of white matter disconnection might have greater predictive value than the localization of gray matter lesions. The demonstration of anatomically intact but functionally inactivated areas might also open perspectives for treatments (whether pharmacological or rehabilitative), aimed at restoring normal neural activity in these areas.

## Recovery and Rehabilitation

Aside from the fascinating insights that research on neglect has provided for cognitive neuroscience, the reality for many

patients is that neglect is a well-recognized predictor of poor functional outcome. Studies consistently show a strong association with impaired everyday functioning. Commonly associated with left hemiplegia, the presence of left visuospatial neglect renders motor-associated deficit more severe and slows recovery in other functions, including nonspatial attention.

Although recovery occurs in a majority of patients, left visuospatial neglect continues to be severe in some patients and can persist chronically in a small number. A number of studies suggest that some forms of the spontaneous 'recovery' observed reflect compensation rather than reduction in the underlying spatial distortion. Even in some 'recovered' cases, more subtle or challenging assessments (e.g., pointing to the midpoint between two objects or performing a second attentionally demanding task) can reveal spatial distortions – some of which can be clinically apparent when patients are required to operate under more stressful conditions.

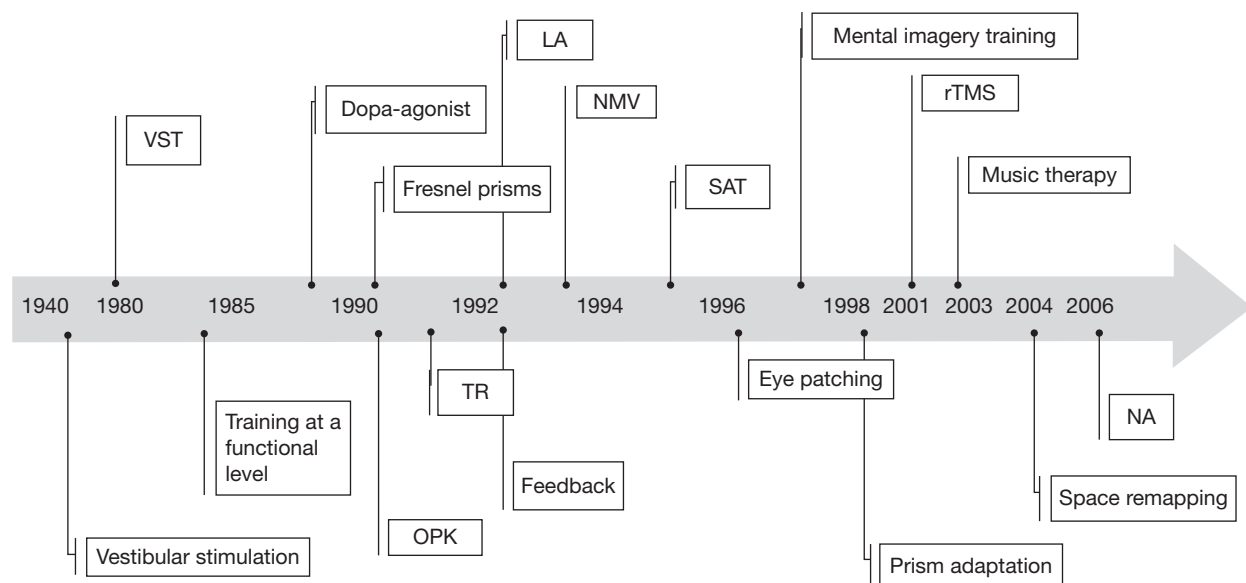
Recent functional imaging studies of patients with neglect suggest that a neurological deficit after a focal brain injury not only reflects local dysfunction at the site of injury but also involves more distributed impairment of connected, structurally intact neural systems. So, after right frontal damage, the resulting spatial attention deficits may be responsible for the abnormal activation in structurally intact dorsal and ventral parietal regions that mediate attentional operations. Consequently, the observed recovery of these attention deficits in the acute stages after stroke may be associated with restoring and rebalancing activity within these crucial regions rather than a restoration of function in the structurally affected areas. Such dysfunctions may be reflected neurally – by deactivation, disconnection, hyperactivity, or interhemispheric imbalance during task processing.

In clinical practice, neglect is typically treated by encouraging the patient to scan and search the environment or the affected body side (see Figure 1). Cueing and scanning training helps some patients on clinical tests, but these do not carry over

into self-care activities. To be effective, 'top down' treatment methods require time and effort on behalf of the staff or carer or depend on the patients becoming aware of their neglect. However, because neglect is often associated with poor insight and arousal, many patients have difficulty in maintaining compensatory search strategies throughout the day. Consequently, treatment methods that do not depend on such 'top-down' processes can be more effective.

Given the debilitating nature of neglect, many different rehabilitation interventions and compensation approaches have been developed to alleviate, reduce, or remediate left visuospatial neglect over the past 60 years (see Figure 12). Most of these are directed at restoring the damage systems involved and/or compensating for the functional consequences and while not all were theoretically inspired, their outcomes have informed theoretical developments. A variety of intervention techniques have been developed in attempts to remediate neglect; these are summarized in Table 1.

Although there are grounds for optimism, particularly in terms of short-term impairment-based effects for some of the interventions, the range and degree of disabilities borne by many patients remain high and the clinical effectiveness for the different methods in terms of long-lasting functional improvement (i.e., improvement of disabilities or handicap) remains unclear. This is not surprising, given the considerable individual response variation to such interventions and given that neglect is often just one of the several impairments. Moreover, few studies directly contrasted outcome with other interventions at a group level – or even examined for possible additive effects of combining treatments. Notwithstanding these caveats, a recent systematic review using comparative and stringent levels of evidence found that visual scanning training (VST), trunk rotation (TR), or repeated neck muscle vibrations (NMV) when associated with an extensive training program, mental imagery training, video feedback training, and



**Figure 12** Time-line of first publications for 18 different attempts to remediate visuospatial neglect. From Luaute J, Halligan P, Rode G, Rossetti Y, Boisson D (2006) Visuo-spatial neglect: A systematic review of current interventions and their effectiveness. *Neuroscience and Biobehavioral Reviews* 30(7): 961–982.

**Table 1** Brief rationale and description of different methods used to remediate neglect

| <i>Interventions</i>   | <i>Purpose/rationale</i>                                                             | <i>Mechanism</i>                |                                             | <i>Procedure</i>                                                           |
|------------------------|--------------------------------------------------------------------------------------|---------------------------------|---------------------------------------------|----------------------------------------------------------------------------|
| VST                    | Left side voluntary eye movement scanning                                            | Top-down                        | Behav. compensation                         | Left scanning exercises (sensory cueing; scanning board)                   |
| LA                     | Using the left limb as an active cueing device                                       | Bottom-up<br>Inhibitory process | Behav. compensation<br>Neural restoration   | Movements with the left paretic limb in the left part of the space         |
| Space remapping        | Space remapping toward the left neglected side                                       | Bottom-up<br>Top-down           | Cogn. restoration                           | Extension of body space using virtual reality                              |
| Mental imagery         | Reducing left representational neglect                                               | Top-down                        | Cogn. restoration                           | Visual and movement imagery exercises                                      |
| rTMS                   | Inhibition of the relative hyperactivity of the unaffected left hemisphere           | Inhibitory process              | Cogn. compensation                          | Repetitive transcranial magnetic stimulation over the left parietal cortex |
| SAT                    | Modulating spatial attention using alerting stimuli                                  | Bottom-up<br>Arousal mechanism  | Cogn. compensation                          | Repeated loud sounds stimulation                                           |
| Vestibular stimulation | Recalibrating spatial coordinates frames                                             | Bottom-up                       | Cogn. restoration                           | Application of cold water in the left external ear canal                   |
| OPK                    | Illusory rightward displacement of stimuli. Recalibrating spatial coordinates frames | Bottom-up                       | Cogn. compensation $\pm$ cogn. restoration? | Leftward moving background                                                 |
| NMV                    | Recalibrating spatial coordinates frames                                             | Bottom-up                       | Cogn. restoration?                          | Vibration of left neck muscles with electrical stimulation                 |
| TR                     | Recalibrating spatial coordinates frames                                             | Bottom-up                       | Cogn. Restoration?                          | Left rotation of the trunk                                                 |
| Fresnel prisms         | Shifting the left visual field toward the central retina                             | Bottom-up                       | Behav. compensation                         | Prisms with base directed toward patient's left                            |
| Eye patching           | Sprague effect                                                                       | Bottom-up<br>Inhibitory process | Cogn. compensation                          | Right monocular patch or right half-field patches                          |
| PA                     | Visuomotor adaptation                                                                | Bottom-up                       | Cogn. compensation                          | Adaptation to prisms requires a set of successive pointing movements       |
| Dopamine-agonists      | Stimulate perceptual and premotor systems                                            | Bottom-up                       | Cogn. restoration                           | Bromocriptine 15 mg daily for 3–4 weeks                                    |

Source: From Luaute J, Halligan P, Rode G, Rossetti Y, Boisson D (2006) Visuo-spatial neglect: A systematic review of current interventions and their effectiveness. *Neuroscience and Biobehavioral Reviews* 30(7): 961–982. Interventions: VST, visual scanning training; LA, limb activation; rTMS, repetitive transcranial magnetic stimulation; SAT, sustained attention training; OPK, optokinetic; NMV, neck muscle vibration; TR, trunk rotation; PA, prism adaptation. *Mechanisms*: behav.: behavioral; cogn.: cognitive.

prism adaptation (PA) offered the best indication of return on rehabilitation. In the case of most interventions, further randomized controlled trials (RCTs) are needed to confirm or qualify existing reports. In conclusion, there is evidence at the level of impairment to encourage further RCTs or well-designed single case studies using meaningful activity levels over longer follow-up periods; however, recognizing that neglect is a very heterogeneous condition, developing and evaluating interventions to treat the condition continue to be a clinical priority.

## Conclusion

Neglect continues to be a fascinating and challenging subject, both concerning cognitive mechanisms and its neural anatomy. Despite its clinical importance, it is the implications for understanding attention, consciousness, and perception that continue to attract neuroscience interest. Research on the functional mechanisms appears to be moving from the description of dissociations in patients' performance to the dissection of the possible component deficits and of their modes of interaction. New, high-resolution imaging techniques are providing evidence relevant to the debate on the anatomical bases of

neglect, shifting the focus from the study of cortical modules to large-scale brain networks. A large explanatory gap still separates the functional and the anatomical descriptions of neglect, but this gap is narrowing.

**See also:** [Attention](#); [Body Image](#); [Mental Imagery](#); [Spatial Orientation](#); [Spatial Perception](#); [Subliminal Perception](#).

## Further Reading

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## Visual Perception

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### Glossary

**Fourier analysis** A tool developed by the French mathematician Jean-Baptiste Joseph Fourier to determine the spatial frequencies and contrasts of the spatial variations in luminance occurring at different spatial scales and orientations in visual images.

**Functional magnetic resonance imaging (fMRI)** A noninvasive imaging technique that is sensitive to changes in the blood flow within the brain. This technique has been used most predominantly in psychology to localize different cognitive functions to different areas of the brain.

**Gabor patch** A local stimulus with a particular luminance profile, described by a Gabor function, which consists of a convolution of a sinusoidal luminance profile and a Gaussian function. Such a stimulus is characterized by a particular contrast, spatial frequency, and orientation, and is considered ideal to stimulate a single neuron in the low-level areas of the visual system.

**Natural scene statistics** The pattern of visual stimulation that reaches the retina in the real world contains certain statistical regularities. There is increasing evidence that the brain is sensitive to these statistical regularities such that it is designed to most efficiently represent visual information in the context of these natural scene statistics.

**Neuropsychological dissociation** When patients suffer brain damage that effects certain cognitive functions but not others, this constitutes a dissociation. Such dissociations can provide a powerful tool for establishing the functional independence of different aspects of cognition.

**Retina** The surface at the back of the eye that contains light-sensitive cells, which convert photons of light into electrical signals that are conveyed to the brain via the optic nerve. The retina does not contain a uniform distribution of light-receptive cells, rather the highest density of these cells is packed onto a central area of the retina called the fovea.

**Retinotopic map** Visual information is repeatedly represented in a spatially meaningful manner in the human visual cortex. These spatial maps do not reflect a one-to-one scaling between the visual angle separating different stimuli, although stimuli that are adjacent to each other on the human retina will, in general, be represented adjacent to each other on these retinotopic maps.

**Transcranial magnetic stimulation (TMS)** A noninvasive technique for transiently disrupting the neural information processing in a small area of the brain, using a strong magnetic field. It has been used as an experimental rather than a correlational technique to study the neural basis of cognitive and perceptual functions, assumed to induce localized and reversible virtual 'lesions.'

**Visual angle** The distance between visual stimuli is commonly measured in terms of the visual angle that separates these stimuli. To illustrate, two stimuli separated by 10 cm at a distance of 57.5 cm from the eye would be 10° of visual angle apart, while the same two stimuli separated by 10 cm would be separated by 5° of visual angle when located 114 cm from the eye.

*Visual perception* is not an immediately intuitive topic of scientific research. Indeed, as far as our intuition is concerned, vision is nothing more than a question of pointing the 'cameras' of our eyes at whatever attracts our attention, 'et voilà': we see. What reaches the human retina, however, is not a picture that can be directly perceived, but a spatial pattern of light that gets transformed into electrical signals via the retina's photoreceptive cells. For the human visual system, this pattern of stimulation at the retina is of little immediate value. In fact, up to a third of the human cerebral cortex is recruited in order to transform this pattern of stimulation on the retina into signals that are useful in guiding human behavior.

The study of visual perception, therefore, is the study of how the brain can transform the pattern of information on the retina into a meaningful perception of the world. Part of the challenge in developing a meaningful representation of the world from the information that reaches the retina reflects the fact that a lot of information about the world is lost, or becomes ambiguous, in the pattern of stimulation on the retina. One of the clearest examples of the ambiguity of information reaching the retina pertains to the problem of depth.

Our perception of the world automatically and effortlessly appears to us in three dimensions. However, information regarding the distance light travels before reaching the human eye is not directly encoded on the retina: a photon of light traveling 1 m or 1 km before it reaches the eye will stimulate the same cell in exactly the same manner. The visual brain, therefore, has to use numerous heuristics and assumptions in order to recover depth from this information.

Furthermore, the pattern of stimulation is not simply ambiguous, but also vast. Of the more than 2 million nerve fibers that carry information from the retina to the visual system, the brain has to rapidly extract the information that can enable it to act most effectively. Part of the means by which the brain attempts to constrain this problem is via attention, that is, the process of selectively enhancing the features of visual information processing that are most visually salient or the most useful in terms of the current task demand.

Although attention is important, there is a much more fundamental step in solving the problem of visual perception. Indeed, the brain cannot allocate visual attention arbitrarily; it can only enhance the processing of visual information along



certain predefined stimulus properties or features such as color, motion, spatial location, and certain forms of 'objecthood' or perceptual grouping. These 'preattentive' features extracted early within the human visual system highlight the first critical step in visual perception: transforming the massive array of information on the retina into an explicit representation of features that can be used to guide behavior.

### Hubel and Wiesel: Giving Vision Research an Explicit Edge

Hence, the most fundamental step in vision research is to understand how the brain rapidly makes explicit the available information that is only implicitly registered on the human retina. Probably one of the clearest demonstrations of this process, and one of the most seminal findings within vision research, comes from a series of studies by Hubel and Wiesel, in which they recorded the types of stimuli that would activate cells at different areas of the cat visual system. Hubel and Wiesel first recorded from cells in the thalamus, where the optic nerve cells terminate along the geniculostriate pathway from the eye to the cortex. They reported that cells in the thalamus fired when a circular dot was presented to the cat's retina at a particular location. After the optic radiation had conveyed the activity in the thalamus to the first area within the cortex (V1 or the primary visual cortex), however, Hubel and Wiesel found that cells no longer responded to simple dots, but to lines or edges. The information required to generate this sensitivity to edges must have been implicitly present at earlier stages of information processing (i.e., the thalamus and, indeed, the retina). However, it is not until this information is processed to the level of the primary visual cortex that basic features such as edges seem to be explicitly represented via the responses of single neurons.

Hubel and Wiesel's work was groundbreaking and inspired generations of vision scientists after them because it demonstrated that it might be possible to study how the visual system can extract features from the mass of information reaching the retina, which could play a vital role in developing a useful model of the external world that could guide behavior. Understanding exactly how early features (like 'edge detectors') might form a meaningful model of the external world is only a starting point, however. Although edges might seem like an intuitively useful starting point in representing the external world, our perception is not simply populated by edges but by meaningful recognizable objects.

One of the most famous attempts to provide a genuine model of how this transformation (from edges to objects) might take place was provided by David Marr. Some of the specifics of Marr's model have turned out to be incorrect over the last few decades (although it should also be seen to Marr's credit that he specified a model to the extent that it could be falsified). Nevertheless, what will persist as Marr's legacy to vision research is a distinction between different levels at which vision (and indeed any biological information processing system) can be analyzed. Rather than detailing the specifics of Marr's model, this article seeks to clarify the nature of human visual perception by analyzing the extraction of edges early in the visual system in terms of Marr's levels of analysis.

### Edges at Marr's Three Levels of Analysis

Marr argued that the problem of vision could be viewed simultaneously at three different levels. The first of these levels is the computational level, pertaining to the purpose of a particular process: What is the function it performs, what is the input it receives, and what is the output it has to compute? The second level refers to the algorithms that achieve a given purpose and the representations in which their outputs are stored, and the final level pertains to how these algorithms are implemented. Taking the implementation of cells representing particular edges in the early visual cortex as an example, it appears that neurons that encode similar properties (such as the orientation of the edge) to some extent cluster together. Given that neurons are connected together by axons that can vary widely in length, it is perfectly plausible that neurons performing similar computations could communicate with each other without clustering together. Understanding why this clustering of neurons with similar response properties occurs is, therefore, an important question for vision research. Indeed, understanding why neurons with similar response properties tend to cluster together could well have implications for the algorithms those neurons are executing and, indeed, the computations they are attempting to achieve. In this sense, these different levels of analysis undoubtedly constrain and influence each other. Moreover, a full understanding of visual perception should span all three levels of analysis. Nevertheless, we feel Marr's framework provides a useful means of breaking down the problem of visual perception, at least for didactic purposes.

#### Edges: Computation Level

We stated earlier that Hubel and Wiesel's work highlighted how edges could be explicitly decoded from the response properties of single neurons in the primary visual cortex. This statement requires some qualification, however, because there is in fact a wealth of evidence to suggest that even when single cells in the primary visual cortex might respond to the presentation of an edge, it does not mean that a perception of an edge is explicitly available to the organism as a whole. One recent source of evidence for this fact has been provided by advances in fMRI analysis techniques in the context of subthreshold visual perception. Using these new techniques, Haynes and Rees have demonstrated that even when the pattern of information in the primary visual cortex is sufficient to decode that an edge of a particular orientation has been presented, it does not mean that that edge will be seen by the participant. Indeed, Haynes and Rees found that they could decode the orientation of a rapidly presented stimulus without the participant ever becoming conscious of that stimulus.

This highlights that, while the primary visual cortex seems to be responsible for making explicit certain forms of information that are only implicit on the retina, it does not mean that those representations will be consciously available to us. This brings us to an important possibility: as far as the computational purpose of human visual system is concerned: seeing or conscious perception might only be part of the picture.

Milner and Goodale have argued exactly this point. More specifically, they have argued that a lot of visual processing does not serve our conscious perception of the world, but

enables us to guide manual actions to visual stimuli. Milner and Goodale's argument for this distinction between vision for perception and vision for action is seen most clearly in their case study of the patient DF. After suffering a rare form of brain damage following carbon monoxide poisoning, this patient showed a very striking dissociation: when presented with a slot at a particular orientation, she could not verbally report the orientation of the edge, but if given a piece of card to post through that slot, she was able to do so with virtually perfect accuracy. Thus, although this patient was not able to consciously report the orientation of a specific edge, she could nevertheless use that information to guide her manual actions. Milner and Goodale contrasted her performance with that of patients suffering from optic ataxia, who show the opposite dissociation: these patients can report the orientation of an edge, but they cannot correctly calibrate manual actions based on the orientation of that slot. By providing additional evidence that the processing of oriented edges is preserved in DF's primary visual cortex, Milner and Goodale have demonstrated that in her brain these edges can only be used for the purpose of guiding manual actions and not for informing conscious perception.

Milner and Goodale mapped these different functions of vision for conscious perception and vision for action to a previously characterized anatomical divide between the dorsal (upward) and ventral (downward) streams that visual information can follow after its entry into the cortex at the primary visual cortex. Ungerleider and Mishkin had already argued that these streams played distinct functional roles, but in contrast to Milner and Goodale's model, they argued that the ventral stream was responsible for identifying what a stimulus was and that the dorsal stream was responsible for representing where a stimulus was (the *what* vs. *where* model). Milner and Goodale argued instead that what and where processing is a property of both streams, but that these properties are extracted for different purposes.

The extent to which dorsal stream areas contribute solely to vision for action (and ventral stream areas to vision for conscious perception) is, however, still unclear. Indeed, this controversy partly reflects the fact that even within Milner and Goodale's model, a strict distinction between the two streams is unlikely: to some extent they must interact such that we can choose to act (using the dorsal stream) upon an object we have recognized as important (via the ventral stream). Indeed, selecting an object for action also seems to be integrally linked to (if not identical to) the allocation of attention (thought to be controlled in part by the dorsal stream) and can, therefore, influence what we see. Thus, understanding when these processes act separately and when they need to interact in the healthy human visual system is an important aim of current vision research. Nevertheless, Milner and Goodale's work highlights that even for a simple property like an edge, vision does not appear to have one ubiquitous function. Rather, the representation of an edge is exploited by different parts of the visual system for very different functions.

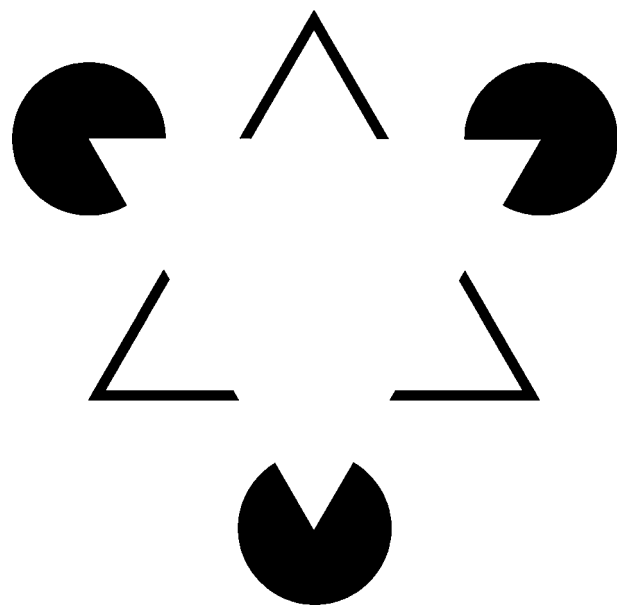
### Edges: Algorithm and Representation Level

What Hubel and Wiesel demonstrated was that a particular cell in the primary visual cortex would respond vigorously when

presented with an edge at a certain location. It is intuitive to assume, therefore (and we have, as a simplification, assumed above), that this cell represents a form of 'edge detector.' That is to say, what the firing of this cell represents is an edge. Later work has complicated this interpretation, however, in at least two ways.

The first comes from work that highlights that cells in the early visual cortex might be representing much more complicated features than physical edges. Indeed, von der Heydt and colleagues found neurons in V2 that responded to subjective or illusory contours where no physical edge is present, such as those in the Kanizsa triangle shown in [Figure 1](#). Furthermore, additional work by von der Heydt and colleagues has revealed that some cells in V2 are also sensitive to a property called border-ownership. Border-ownership pertains to the ambiguity of which surface (on either side of an edge) causes (or owns) that edge. Taking the horizontal edge of the upper-left pacman in [Figure 1](#) as an example, the black side can be seen to own the edge (i.e., a black pacman on a white background) or the white side can be seen to own the edge, thus resulting in the subjective perception of a white triangular figure on a black circle. The fact that the response of these neurons is modulated by context and figure-ground organization highlights their functional role in the interpretation of the input, which is not simply the signaling of a black-white luminance transition. A recent neurocomputational model by Kogo and colleagues has clarified this fundamental aspect of 'edge detection' and the role it plays in the context of illusory contours, border-ownership, figure-ground organization, occlusion, and surface filling-in, and highlights how seemingly higher level properties (such as surface and depth perception) play a primary role in the interactions between local edge signals to determine border-ownership.

The second complication comes from the fact that although these cells are sensitive to edges, it does not mean that we can assume they are edge detectors. These cells might reveal



**Figure 1** Kanizsa triangle.

edge-like sensitivities only because they are, in fact, encoding a closely related but distinct representation. Indeed, work following Hubel and Wiesel showed that although a given cell would fire to a particular edge, it would respond even more vigorously if presented with an oriented Gabor patch of a particular spatial frequency. Coupled with behavioral work suggesting that the early vision system might contain a range of spatial frequency channels, this finding was taken to suggest that what was being represented in the primary visual cortex was not an intuitive unit such as an edge but a Fourier transform of the information encoded on the retina. More recently, computational models have been used to argue that the representations within the primary visual cortex represent the most efficient way of encoding, at a small scale, the information reaching the retina, given the nature of natural scene statistics.

In general, this debate highlights that there is a large step between mapping the neural sensitivity of a neuron (or indeed an area of the brain revealed by fMRI) and modeling the actual nature of the representations maintained by that area of the brain.

### Edges: Implementation Level

Whatever the exact nature of the algorithms and representations within the primary visual cortex, these units are sensitive to a number of properties, such as the orientation of the stimulus and the location of stimulus presentation. These orientation and location sensitivities tend to cluster together on the cortex such that neurons sensitive to similar properties are located close to each other. In the case of orientation, for example, neurons with the same orientation preference cluster together into units about the size of a square millimeter, known as orientation columns, with bordering orientation columns being organized into a sort of pin-wheel structure. Why this should be the case is not necessarily clear.

The spatial sensitivity of early primary visual neurons is also clearly organized. In fact, the spatial arrangement of neural sensitivities forms what is called a retinotopic map, such that stimuli that are presented close together are also represented closer together on the cortex. This retinotopic map is by no means a one-to-one correspondence with the spatial pattern of information that reaches the retina. Indeed, like the famous homunculus representing the motor and sensory sensitivities of our physical body, this retinotopic map devotes a larger area of representation to the most critical part of high-acuity vision that is provided by the densely packed receptors of the fovea (an overrepresentation that is referred to as the cortical magnification factor). Perhaps in contrast to orientation sensitivities, it might seem intuitively logical that information should be arranged in a spatially meaningful manner. Such an implementation format is by no means necessary, however. A computer, for example, can store the color values of a given pixel in a bitmap at completely random locations in its memory. Indeed, if a curious engineer was exploring the sensitivities of different memory locations on a computer's hard drive, she would be astonished if she found that the physical locations representing the color values of different pixels maintained the spatial arrangement of those pixels in the image. This different pattern of implementation between human visual systems and computer memory undoubtedly points to a very different

means of computing and representing spatial location. Nevertheless, exactly why different visual properties (orientation or spatial location) cluster together is not truly understood. Importantly, this clustering is far more than a property of the primary visual cortex: throughout the human visual cortex, it appears that neurons that do similar things (e.g., represent color, faces, or motion) seem to cluster together into distinct areas. This pattern of clustering is one of the most prominent features of the manner in which visual representations seem to be implemented in the brain, and leads to a distinctive view of the human visual system as a modular and hierarchical system. Indeed, it also raises some interesting behavioral consequences and computational challenges, which might never have occurred to us as challenges, regarding how the representations in these distinct areas of the brain can combine to underlie the apparent unity of conscious visual experience, as discussed next.

### The Visual Brain as a Modular and Hierarchical System

Earlier in this article, we began to build up a picture of the manner in which the visual brain seems to be divided into functionally distinct subunits, which form part of a modular and hierarchical system. For example, we discussed the primary visual cortex's sensitivity to small edges and how they play a functional role in the coding of figure-ground organization and shape perception. In addition, we saw that the anatomical division between the dorsal and ventral streams has been argued to reflect a distinction between vision for action and vision for conscious perception, respectively. Within the ventral stream, there are, in fact, further functionally distinct areas that could be considered. Distinct functional areas have been suggested for a host of visual properties (shape, color, motion, texture) and object types (faces, body parts, scenes, tools).

Focusing on the coding of shape, a hierarchy of layers have been identified, whereby areas with increasing receptive field sizes (V1, V2, V4) code increasingly larger parts of objects (line segments, angles, corners, junctions, etc.) and eventually converge onto areas within the inferotemporal cortex (IT) in the monkey brain and the lateral occipital complex (LOC) in the human brain, where shapes and objects are coded. In parallel work in macaque monkeys and humans, by combining psychophysics with single-cell recordings and fMRI, Kourtzi et al. have demonstrated that the lower areas contribute to the perceptual grouping of edge fragments into shape percepts and Op de Beeck et al. have demonstrated that the activity in IT and LOC reflects the perceived similarity between shapes.

The apparent unity of our conscious experience would surely never lead us to the intuition that the shape of an object might be processed distinctly from the color or motion of that object. The distinct manner in which different visual features are processed can, however, influence our behavior in extreme circumstances. Anne Treisman, for example, showed that when presented with very brief images of colored shapes, participants will often misattribute the colors with the wrong shape. Furthermore, these illusory conjunctions have also been demonstrated for stimuli presented continuously to a patient with occipital-parietal damage. This patient is correctly able to identify certain motion directions, colors, and shapes but is

unable to correctly report which of these features correspond to the same object.

One might assume that after distributing the processing of different features to different areas of the brain, there would be a further area of the brain in which all these different features are represented together. However, the search for such an integration center within the brain has so far proved unsuccessful. Indeed, the first clues into the modular nature of visual information processing came from studies with patients with strange but specific changes in conscious perception. One patient might lack an ability to perceive color, for instance, or another motion. It seems quite possible, therefore, for the rest of vision to function almost as normal even after losing one module.

Although there is no one specific area of the cerebral cortex that seems to be crucial for visual processing to reach awareness, there is a network of areas associated with the control of attention, and damage to these areas can have a profound influence on conscious vision for all visual properties. For example, when damage to one of these attention control areas occurs on the right side of the brain, a syndrome called neglect is often observed. Neglect patients quite literally neglect and fail to report stimuli appearing in their left visual field. The association between attention control areas and alterations to conscious processing has led to the suggestion that the allocation of attention might be, in some sense, synonymous with the conscious experience of a particular stimulus.

However, a one-to-one association between consciousness and attention is not supported by a host of behavioral, neuropsychological, and fMRI studies. In one early example, Kentridge et al. studied the potential allocation of attention to unseen stimuli in a blindsight patient. Blindsight patients show quite a remarkable dissociation in that they are able to guess certain stimulus attributes, sometimes with a very high accuracy, for stimuli they claim that they cannot see. Kentridge et al. employed a common means of attracting spatial attention and found that when stimuli were cued with some form of flash at the location of a target that was to be discriminated, the patients would still not become conscious of the target, but their guessing rate would improve. This result, like many others of its kind, highlights that, although attention might play an important role in determining the contents of conscious visual perception, the allocation of attention cannot in and of itself be seen as sufficient.

### Interactions in the Visual Hierarchy

The processes that determine what we see, therefore, involve a combination between functional specific areas and more general areas that serve to allocate processing resources. However, the processing of a given stimulus and indeed the allocation of attention to a given stimulus, do not appear to be sufficient for that stimulus to be consciously perceived. What then is required for explicit visual perception to take place? A number of researchers have argued that the answer to this question lies in the extent to which a particular stimulus is 'fed-forward' both within the visual system, and within the brain. If we take visual form (or shape) information as an example, we have already seen that information at early stages of the visual

system, such as orientation sensitivity within the primary visual cortex, is not sufficient to lead to conscious awareness. Furthermore, not only is information in the early areas not sufficient to lead to conscious awareness, activation in higher areas is often more closely related to what people actually see.

One important means of evidencing this fact centers on the study of bistable stimuli. With bistable stimuli, the same sensory input is able to support two different perceptual interpretations. A famous example of this is the Rubin face-vase illusion. A more commonly employed paradigm for studying bistable perception, however, exploits the fact that when different stimuli are presented to each eye, the brain enters into a state of conflict between the two images, called binocular rivalry. In binocular rivalry, the brain is unable to meaningfully combine the information coming from each eye and so continually switches between a percept that is based on what is presented to one eye or the other. In this situation, therefore, although the sensory input remains the same, the brain continues to switch perceptual state. Hence, this paradigm offers a powerful tool to ask which areas of the brain are more closely related to purely sensory processing, and which areas are more associated with our conscious perception of the world. In this respect, both fMRI in humans and single-cell recordings with monkeys have shown something of a progression from early to late areas becoming increasingly related to the reported perceptual state.

Binocular rivalry is, of course, a very peculiar form of perception induced under very unusual sensory conditions. There are, however, other examples suggesting that the later stages of visual processing are more closely related to explicit perception. For instance, Williams et al. have employed recently developed pattern classification approaches to fMRI analysis to show that when participants are performing a difficult discrimination task (in which the participants make many errors), the pattern of activation in higher areas such as the LOC is more directly correlated to the participants' performance than the pattern of activation in early areas such as the primary visual cortex.

Despite the evidence that visual representations become more closely related to perceptual performance in this feed-forward sweep, there is also evidence that the feedback of information might be critical to that information being consciously perceived. This theory has been voiced most explicitly by Victor Lamme, who has argued, on the basis of single-cell recordings, that in order for figure-ground relationships to be perceived these relations have to be fed back to the primary visual cortex. Indeed, although we have emphasized above that perceptual decisions seem to be more closely related to the representations developed in higher areas of the brain, it is becoming increasingly clear that perceptual decisions made at higher levels of processing are fed back to primary visual areas. Thus, in binocular rivalry, although higher areas are more closely related to the perceptual state of the organism, it is not the case that early representations merely reflect the sensory input to the eyes. In fact, fMRI studies and single-cell recordings have demonstrated that some early representations are sensitive to the perceptual state of the organism.

Compelling evidence for feedback comes from work by Scott Murray and colleagues, in which they demonstrated that size constancy scaling effects are evident in the primary

visual system. Size constancy refers to the fact that our perception of size is not simply dictated by the size of stimulation reaching the retina (which changes continuously with viewing distance) but by the brain's interpretation of the stimulation on the retina in the context of the perceived depth. Before the size of a particular stimulus is perceived, therefore, the brain first has to work out the depth of that item, and then scale its size such that objects that are far away are in fact perceived to be larger than objects projecting an identical visual angle on the retina that are perceived to be closer. Rather surprisingly, Scott Murray et al. showed that the representation of size in the retinotopic map of the primary visual cortex did not simply reflect the retinal size of the object, but the scaling induced by two-dimensional depth cues. This suggests that the represented size of a particular stimulus on the primary visual cortex is altered by feedback to reflect the perceived size.

Of course, the critical question is: What is the role of this feedback? Are higher level interpretations merely fed back as a by-product of the higher representation, or does this process play a critical role in determining what we see? Work by Pascual-Leone and Walsh using TMS suggests the latter option may indeed be the case. Pascual-Leone and Walsh exploited the fact that TMS to the motion-sensitive area MT could lead to a perception of motion to ask whether this motion perception would be critically contingent upon feedback to earlier stages of the visual system. Rather strikingly, they found that stimulation to MT would be less likely to lead to a conscious percept if it was followed by TMS to earlier visual areas such as the primary visual cortex. Importantly, the optimal time at which TMS to the primary visual cortex would disrupt the percept following MT stimulation was not simultaneous with the MT stimulation, but fell within a critical time window (about 15–50 ms) after it. The fact that TMS to a lower area influences the ability of TMS at a higher area to lead to awareness implies that activation at the higher area has to be fed back to the lower level before it could lead to a conscious percept.

On the one hand, therefore, it seems that higher level representations seem to correlate more directly with what is consciously perceived; on the other hand, there is increasing evidence not only that the higher level representations are fed back to early areas, but also that this feedback seems to play a critical role in certain circumstances. One model that potentially reconciles these roles for feed-forward and feedback sweeps is provided by Hochstein and Ahissar's reverse hierarchy framework. In this model, they argue that visual perception automatically operates in a feed-forward manner to extract the general gist of a scene, and that our conscious perception is by default based on this 'forest before trees' level of representation. If further details are required, however, then fine discriminations can be achieved by a process of feedback that can extract the details, making up this percept at lower levels of perception.

### Active Vision

Hochstein and Ahissar's reverse hierarchy model very clearly emphasizes the role of internal computations in determining how the visual system extracts the information required to achieve a particular task. Findlay and Gilchrist would

characterize this approach to visual perception as a form of 'passive vision,' which they contrast with the 'active vision' perspective. Active vision starts from the observation that one of the clearest limiting factors in determining what we can perceive is not our ability to computationally analyze sensory input, but the low quality of most representations on the human retina. More specifically, they highlight that only the central area of the retina, known as the fovea, contains a sufficient density of receptors to perform many critical tasks. A key example here is that of reading. Although it might appear to us as if a full page of text is available in front of our eyes, well-controlled tests highlight that we are, in fact, only able to process the text a few degrees of visual angle around the fovea. Findlay and Gilchrist argue that this fundamental constraint in terms of how visual information enters the visual system necessitates the use of eye movements to solve even the most basic of everyday visual tasks.

The active vision perspective holds that while internal processes must obviously play a role, our understanding of vision will be advanced more rapidly if we focus on what they see as the most important means by which humans ensure they can extract the maximal amount of information from any given visual environment: eye movements. An important piece of evidence that motivates the active vision perspective comes from the phenomenon of change and inattention blindness. Change blindness refers to the fact that if an image is changed during an eye movement it can often be very difficult to spot very large-scale changes. The same effect can also be elicited without eye movements if some form of visual transients is added (e.g., the 'mud-splashes' paradigm), so that the transient of the to-be-spotted change does not 'pop-out.' In inattention blindness, the participants' attention is explicitly attracted to a task at certain locations in a visual scene (e.g., counting the number of basket-ball passes) resulting in stimuli at other locations going unseen (even if the unseen stimulus is as bizarre as a man in a gorilla costume). These demonstrations are seen within the active vision perspective as evidence that, although we may feel as if we can 'see' everything in front of us, this feeling is in fact an illusion, and the brain only represents a small amount of the information we receive. Indeed, this argument is often followed by the point that, in the real world, maintaining a representation of everything appearing in front of us is of little value because if we need to access that information we can simply direct the high-acuity fovea of our retina to that location and 200 ms later our visual system will receive all the stimulation it needs to extract the needed information.

Although the structure of the eye and the strategy of sampling the visual environment are undoubtedly critical factors in determining the contents of visual perception, we should avoid throwing the baby of visual representations out with the bathwater of passive vision. An eye-movement strategy, for instance, would clearly be very ineffective if it was not targeted based on the representations extracted from the current fixation. Moreover, in the change blindness paradigm, although changes are not at first consciously detected, it is often the case that there are other aspects of behavior (such as saccade landing location) that are clearly sensitive to the change, suggesting that the details of the scene are represented in the visual system at some level. Indeed, the latter finding accords with Hochstein



and Ahissar's view that the details of visual representations are not immediately accessible for conscious report but that they are nevertheless still represented at some level within the visual system.

## Concluding Comments

We started by noting that, as far as human intuition is concerned, vision is associated with our eyes, and not with our brains. If given the pattern of stimulation on the retina, however, even the most sophisticated computer programs are seriously taxed by the most basic of visual recognition tasks that the human brain performs without conscious effort. We have argued that the foremost function of vision is to make rapidly available, information that is only implicitly registered on the retina. The brain appears to solve this problem by breaking it down into distinct components such that different stimulus dimensions are extracted at different scales and for different functional purposes in different areas of the brain. This division of the process of visual perception results in a very particular modular and hierarchical structure to the human visual system, and explicit conscious vision might be achieved via feed-forward and feedback mechanisms within this hierarchy. Although extracting meaningful information from what we are currently looking at is the foremost function of vision, the limited distribution of information received on the retina means that functional human vision will only be understood by addressing the question of how we use that information to decide where to look next.

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*See also:* [The Brain](#); [Depth Perception](#); [Eye Movements](#).

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## Relevant Websites

- <http://www.gestaltrevision.be> – GestaltReVision, a research program to reintegrate Gestalt phenomena in modern vision science.
- <http://psychology.uwo.ca/fmri4newbies> – Jody Culham's website with a crash course in brain imaging.
- <http://www.michaelbach.de/ot> – Michael Bach's website with visual phenomena and optical illusions.
- <http://lite.bu.edu> – Project LITE, an atlas of visual phenomena.
- <http://vipelib.york.ac.uk/> – Viperlib, a resource library of images, movies, and presentation material on visual perception.

## Vocational Choice

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### Glossary

**Lifestyle** The integration of decisions in the realms of vocational, personal, and family relationships, and leisure pursuits that result in the attainment of an over-arching purpose or meaning in one's life.

**Vocation** One's life work entailing both paid and unpaid employment that satisfies survival as well as self-esteem, social, and spiritual needs.

**Vocational decision making** A process that not only encompasses making educational, occupational, and employment choices, but also involves making a

commitment and carrying out the actions necessary to implement these choices.

**Vocational development** The implementation of a series of integrated vocational decisions, through the life span, that provide a guiding direction to one's life work.

**Vocational problem solving** A complex set of thought processes involving the acknowledgment of a state of vocational indecision, an analysis of the causes, the formulation of alternative courses of action to achieve a state of decidedness, and the choosing of one of these alternatives.

Vocational choice may be defined in terms of the outcome of a decision-making process involving the consideration of educational, occupational, and employment alternatives at any point in time during the life span with the ultimate aim of attaining a satisfying and meaningful life. An appropriate vocational choice may be considered as one in which there is a high probability that an individual will be able to successfully perform the work and to derive a sense of personal satisfaction. Thus, the decision-making process leading to a choice involves two important aspects: (1) the cognitive and affective processes involved in making a vocational decision at any point in time, and (2) an estimation of the likelihood that a choice will result in occupational success and accomplishment as well as a satisfying and meaningful life. The text that follows examines the act of choosing a vocation from historical, psychological, and social perspectives.

### Overview and Historical Perspectives

Early accounts of the process of choosing a vocation may be traced to the turn of the century when Frank Parsons wrote in his 1909 book *Choosing a Vocation* that there were three key factors in making a career choice: a clear self-understanding, a knowledge of occupations, and the ability to draw relationships between them. He reasoned that if individuals possessed these attributes, not only would they make more effective vocational choices, but that society in turn would be better served by greater efficiency in matching persons to appropriate kinds of work. Since then, this three-dimensional model has provided the fundamental framework for the investigation of how individuals make vocational choices.

Several principal lines of inquiry emanated from this early work of Parsons. One was directed toward helping individuals acquire self-understanding through the development of measures of interests such as the Kuder Preference Record in 1946 and the Strong Vocational Interest Blank (SVIB) in 1943. The original Kuder required individuals, using a pin-punch, to choose the most-liked and least-liked activity from a series of

triads. The results of this interest inventory provided relative estimates of preference in seven areas of interest including science, computational, art, music, literature, social, and persuasive. The SVIB, on the other hand, compared one's likes and dislikes for activities to the likes and dislikes of individuals successfully employed in a variety of occupations. Since the development of these early prototypes, more refined assessments have recently evolved to relate abilities, interests, and values to occupations such as the Kuder Career Planning System, which includes interests, skills, and values assessments, the Strong Interest Inventory, and the Self-Directed Search. This direction of inquiry further led to the development and implementation of a variety of computer and web-based career guidance systems such as CHOICES Planner, DISCOVER, the Focus Career Planning System, and SIGI<sup>3</sup>.

A second line of investigation sought to help individuals to become more knowledgeable about the world of work. Occupational classification systems, traced back to the US Census Bureau's classification system in 1820, were developed to facilitate the storage and retrieval of information about related occupations. Modern classification systems include the North American Industry Classification System (NAICS), O\*NET, and the Standard Occupational Classification System. Computer-assisted career guidance systems typically utilize these classification systems in their databases and are able to link internally the results of the assessment of abilities, interests, and values to occupations.

A third line of inquiry has sought to develop psychological and sociological theories concerning how self-knowledge and occupational knowledge are integrated in the process of making vocational choices. These theoretical approaches may be categorized into three domains. The matching approach sought to identify empirical and rational linkages between measures of personality characteristics and attributes of occupations to derive possible occupational alternatives for further consideration. Cognitive information processing (CIP) is a comprehensive theoretical system that provides a framework for the sequential process of making vocational decisions. And finally, a third domain encompasses important affective,

cognitive, developmental, cultural, social, and spiritual factors that exert an influence on the decision process. These three theoretical domains will be presented in terms of their principle assumptions and propositions, most important concepts, and how the respective theoretical domains may be applied to help individuals make satisfying and meaningful vocational choices.

### Vocational Choice as a Matching Process

Vocational choice as a matching process entails the derivation of empirical and rational estimates of the congruence between measured personality factors and occupational characteristics. The goal of this approach is to provide precise information about one's self or occupations that will assist individuals in identifying appropriate occupational alternatives for further consideration in the vocational decision-making process. A fundamental assumption is that the greater the correspondence between personality characteristics and the requirements of an occupation, the greater the likelihood for attaining successful work performance and satisfaction. Important personality characteristics typically used to make predictions of success include cognitive abilities, scholastic aptitudes, interests, values, and special cognitive or psychomotor abilities. This topic is discussed elsewhere in this encyclopedia. To illustrate this principle of using measures to make the best estimates of matches between persons and occupational environments, three types of matching approaches are described, trait-factor, the Holland's RIASEC Theory, and computer-assisted career guidance systems.

#### Trait-Factor Theory

According to Robert Lent, "trait-factor models have contributed greatly to the understanding of career behaviors and to career counseling by highlighting relatively stable features of persons and environments that, if appropriately matched, are likely to lead to satisfying and satisfactory choices." From the standpoint of trait-factor theory, personality may be considered as comprising a set of theoretical constructs or dimensions that exist along a continuum from low to high. Important personality dimensions in vocational choice relate to cognitive abilities, interests, values, and cognitive and psychomotor skills. An awareness of the extent to which certain dimensions are possessed allows individuals the opportunity not only to compare the strengths of their personality characteristics relative to others, but also relative to members of norm groups as well. Such information facilitates the acquisition of self-knowledge, one of the cornerstones in the Parson model. It also provides more precise information with which to estimate the degree of match between individual characteristics and the requirements of an occupation.

A trait may be defined as an enduring or persisting personality characteristic that provides a means by which individuals can be distinguished from one another, and is manifested consistently across a wide range of circumstances or situations. A factor is considered the operational form for measuring the existence of a trait such as an intercorrelated set of test items comprising a scale on an aptitude test or an interest inventory.

Further, while traits were at one time assumed to be enduring neurologically based structures, many psychologists now believe that traits are highly influenced by learning and that they are task or situation specific. Nevertheless, while the nature–nurture aspects of traits are still unresolved, the kinds of human traits that play an important role in making vocational choices – such as interests, aptitudes, abilities, and values – do appear to be relatively stable over time.

There are several key assumptions or propositions in relating trait–factor theory to vocational choice. One is that each individual possesses a unique and stable pattern of traits that can be measured empirically. Second, for each occupation, there is a unique pattern of traits required of individuals to perform the critical duties and tasks of an occupation successfully. Third, the closer the match between a person's traits and the trait requirements of an occupation, the greater the likelihood of successful job performance and personal satisfaction. Thus, given these assumptions, if measures of traits could be developed with sufficient validity and reliability, individuals could use such information about their abilities, interests, and values to formulate appropriate occupational alternatives and to make more informed vocational choices. Measures such as the Kuder Career Planning System, the Strong Interest Inventory, the General Aptitude Test Battery, and card sorts can assist individuals in acquiring accurate appraisals of important job-related traits. A matching approach to vocational decision-making process typically involves a knowledgeable professional or other human services staff members who assists individuals in identifying possible career alternatives, locating relevant occupational information, and in formulating a plan for an occupational search strategy. In some instances, individuals may receive assistance in locating and obtaining appropriate training or job opportunities. Though some individuals in the field of vocational psychology have suggested that matching approaches are no longer viable in today's uncertain and changing global economy, and research results have been modest in their predictions, these approaches continue to play a significant role in vocational counseling interventions and practice. John Holland's work, one of the most widely researched and applied examples of matching theories, is discussed in the next section.

#### John Holland

The Holland typological theory relates personality characteristics to occupations on the basis of the old adage, "birds of a feather flock together." He extended the work of the trait and factor theorists by drawing empirical (in addition to logical) relationships between personality traits and selected occupations of which over 1300 are listed in the Occupations Finder that accompanies the Self-Directed Search. The principal theoretical presupposition undergirding Holland's work is that when individuals are classified on the basis of measured traits as belonging to a given occupational category, they can be linked to many occupational alternatives within that category. The empirical matching process enables individuals to quickly identify themselves as belonging to an occupational subgroup and to develop an array of corresponding occupational alternatives for consideration. There are several key assumptions on which Holland's theory is based:

- Most individuals can be placed into one of the six personality types: Realistic, Investigative, Artistic, Social, Enterprising, or Conventional (RIASEC). The relationship among these six personality types is portrayed in the form of hexagon (see [Figure 1](#)) in which adjacent occupational groups on the hexagon have more in common in terms of personality characteristics than groups that are opposite one another.
- There are six occupational environments corresponding to the six personality types. According to Holland, people tend to surround themselves with others like themselves and hence create environments that reflect the type they are. Thus, R-type personalities are more congruent with R-type environments than with S-type environments.
- An individual's behavior is determined by the interaction between one's personality and the environment. Thus, career phenomena such as vocational choice, career development, job satisfaction, and career advancement is influenced by the extent to which there is a match between personality characteristics and occupational environments.
- The degree of differentiation affects the strength of the match between person and the occupational environment. Differentiation refers to the extent to which one or two interests are clearly different from the others. When an individual with a high degree of differentiation is in an environment congruent with the dominant code (S, for example) and less like others (e.g., R, C, or I), the greater the likelihood of satisfaction in that environment.

The six personality types and environments portrayed in [Figure 1](#) may be described as follows:

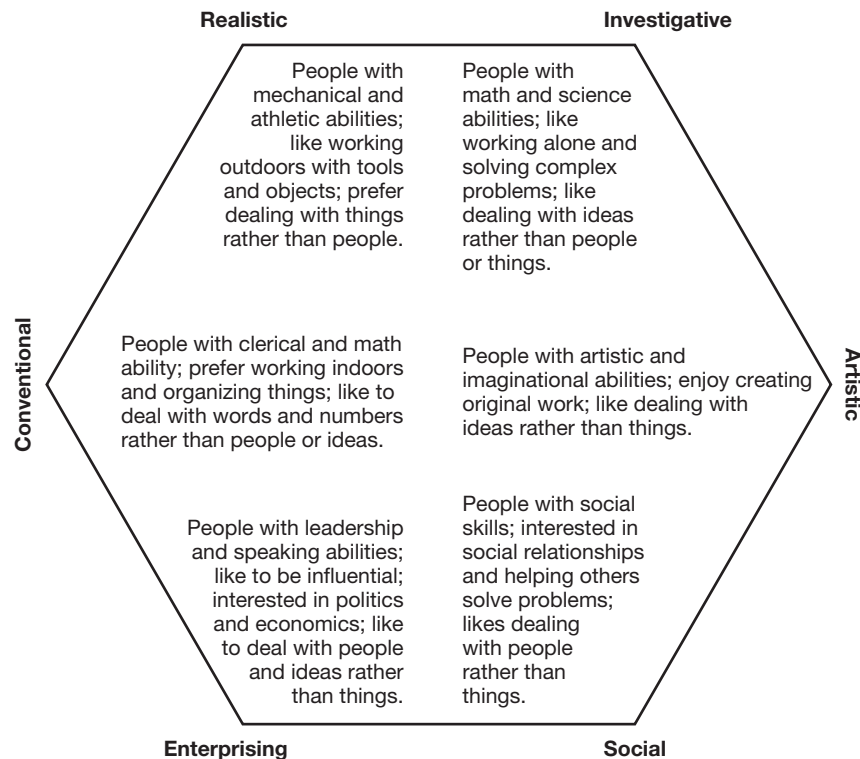
Realistic (R) personalities enjoy working with their hands, tool, machines, and they possess mechanical and athletic abilities, whereas corresponding R-type environments require manual, technical, and mechanical competencies, interaction with machines, tools, and objects, and encompass occupations such as automobile mechanic, surveyor, farmer, or electrician.

Investigative (I) people enjoy scholarly and intellectual activities and have mathematical and scientific interests, while the investigative environment demands systematic observation of physical, biological, or cultural phenomena as in biologist, chemist, medical technologist, or anthropologist.

Artistic (A) persons prefer ambiguous, free, unsystematic activities that lead to the creation of art forms or products, whereas this environment may be portrayed as unstructured and encouraging individuals to perceive the world in complex, unconventional and flexible ways as in writer, musician, artist, interior decorator, and stage director.

Social (S) personalities like to help and understand others and prefer activities that entail informing, training, curing, developing, or enlightening people, while the social environment demands manipulation or the development of others to achieve social goals as in teacher, psychologist, social worker, or the clergy.

Enterprising (E) individuals prefer activities that entail persuading others to attain organizational or economic goals and possess leadership and speaking abilities, while the corresponding environment demands the manipulation of others to attain certain economic or organizational goals as in salesperson, buyer, manager, sports promoter, and television producer.



**Figure 1** RIASEC hexagonal model. Reproduced with special permission of the publisher, Psychological Assessment Resources, Inc., from *Making Vocational Choices*, 3rd ed., Copyright 1973, 1985, 1992, 1997 by Psychological Assessment Resources, Inc. All rights reserved.

Finally, Conventional (C) people prefer activities involving the systematizing and manipulation of data, the operating of data processing equipment, and word processing machines, while the conventional environment requires the manipulation and systematizing of information as in court reporter, financial analyst, title examiner, or tax accountant.

Holland's typological theory has been operationalized through the development of the Self-Directed Search (SDS), a measure that helps individuals determine their three highest personality codes (e.g., SAE or RIE), and the Occupations Finder, a resource that helps individuals locate occupations consistent with their three-point code. The three-point codes of many occupations were derived empirically from having job incumbents take the SDS, while the three-point codes of other occupations were derived from expert consensus and job analysis. Holland and Gottfredson's *Dictionary of Holland Occupational Code* provided an even greater level of analysis for more than 12 000 occupations.

The compelling nature of Holland's theory lies in its parsimony as a theory, the ease of administration and scoring of the SDS, and the high degree of efficiency in locating potential matching occupations listed in the Occupations Finder. The predictive validity of the three-point code in terms of training performance and job performance and satisfaction varies considerably across the codes and occupations. Therefore, in vocational choice, the primary use of the SDS and the Occupations Finder should be to assist individuals in expanding their horizons of possible occupational alternatives to consider for further exploration. Following the identification of plausible occupations, individuals can obtain further occupational or educational information that would facilitate the narrowing of options and ultimately arriving at a selection of a vocational choice.

### Computer-Assisted Career Guidance (CACG) Systems

CACG systems continue to serve as a valuable resource for facilitating matching approaches to vocational choice. CACG systems provide an online interactive instructional medium that allows individuals an opportunity to assess some combination of interests, abilities, and values, to conduct a search for potential occupational alternatives, and to gain access to built-in career libraries of educational and occupational information. Some CACG systems may also include modules on such topics as career decision-making strategies, developing action-plans to implement a choice, the assessment of needs, an orientation to world-of-work information, financial aid, assistance in coping with constraints that impede vocational choice, and strategies for career decision making. Examples of some of the more prominent comprehensive CACG systems are annotated as follows to provide a representation of the technological capabilities and features of these systems:

DISCOVER, developed by the American College Testing (ACT) Program, includes a series of assessments that cover career-relevant interests, abilities, and job values. The assessment results are designed to help individuals explore career options that are a good match for them. DISCOVER incorporates ACT's Work-of-Work Map to organize occupations into six clusters, parallel to Holland's Hexagon, which further assists users in matching self-knowledge to options that fit

them best. DISCOVER is based on a comprehensive, developmental guidance process which can help users identify their strengths and needs, make good career decisions, and build a plan based on their personal profiles. The system offers current databases of occupations, college majors, schools and training institutions, financial aid/scholarships, and military options. Users can also learn how to develop good job-seeking skills through effective resumes, cover letters, job applications, and interviewing skills.

SIGI<sup>3</sup> (formerly known as SIGIPLUS) is the third generation of a CACG system that was originally developed by the Educational Testing Service, and is currently managed by Valpar International Corporation. Valpar describes the system as follows: SIGI<sup>3</sup> integrates self-assessment with in-depth and up-to-date career information that is easy to use and provides students and adults with a realistic view of the best educational and career options for their future success. The program introduces users to a decision-making paradigm, allows them to compare jobs using a grid format, offers guidelines for coping with career transitions, taking the next steps to implement career goals, and provides strategies for securing jobs in the area of one's vocational choice.

FOCUS-2, developed by Career Dimensions, Inc., is an online, interactive career and education planning system that combines self-assessment, career exploration, and decision making into one comprehensive program. According to the developer's website, FOCUS-2 helps individuals connect their interests, personality, values, and skills assessment results to identify areas of study and plan their education and career paths. FOCUS-2 includes information on more than 1200 occupations and allows users to compile their results in an online portfolio.

Even though CACG systems possess vast capabilities for the efficient storage and rapid retrieval of information, and contain information about a wide range of occupations and educational institutions, they are generally not recommended as stand-alone instruments to facilitate the making of vocational choices. The research literature suggests that even though individuals seeking career assistance express a strong liking for their experience with these systems, clients still prefer to use them as a helpful adjunct to the career counseling process with a professionally trained career counselor or other appropriately trained human services staff member. Further, the psychometric qualities of the embedded interest and related assessments, as well as the predictive validity of suggested occupations in terms of success in training programs or job satisfaction, are not widely documented with regard to evidence-based practice.

### Vocational Choice as a Decision-Making Process

We now turn from vocational choice as a matching process, which emphasizes the development of measures and technology to increase the precision and capabilities of the person-occupation matching process, to the decision making which focuses on the actual thought processes that individuals might employ in making a vocational choice. The cognitive information processing approach, which builds on earlier vocational decision-making models, is presented to represent this domain of approaches to vocational choice.



### Cognitive Information Processing

Initially, Peterson et al., in their book *Career Development and Services: A Cognitive Approach*, and recently, Sampson et al., in their book *Career Counseling and Services: A Cognitive Information Processing Approach*, introduced from the field of cognitive psychology a comprehensive perspective on vocational choice and career development. The cognitive information processing (CIP) paradigm was initially formulated in works of Newell and Simon in their book *Human Problem Solving* and from other cognitive scientists in the late 1970s. CIP concerns the thought and memory processes related to a career problem, as well as a cognitive strategy in the form of an orderly prescribed sequence of stages to resolve it. Further, in applying CIP theory to the practice of vocational counseling and guidance, the emphasis shifts from helping individuals to make an appropriate choice at a given point in time, to the acquisition of knowledge and cognitive skills to solve vocational problems and to making vocational decisions over time. Therefore, the aim of this approach is to help people become skillful vocational problem solvers and decision makers.

### Assumptions

Some of the key assumptions on which the application of CIP to vocational choice is based include:

- Making vocational choices is a problem-solving activity. A vocational problem is defined as a gap between an extant state of indecision and a desired state of decidedness with respect to career and life goals. Vocational problem solving is defined in terms of an information transformation process in which a series of thought processes are used to arrive at a course of action to remove the gap. Thus, vocational problem solving involves the transformation of information through the recognition of a gap (problem definition), an analysis of its causes, the formulation of alternative courses of action, and the selection of one of the alternatives that represents the most optimal solution. Career problems are exceedingly complex involving an ambiguous cue function, the optimization of solution alternatives, and the lack of certainty that the anticipated outcomes of the choice process will remove the gap.
- The capabilities of vocational problem solvers depend on the availability of cognitive operations as well as knowledge. An analogy can be made to the functions of the computer. Data files represent occupational knowledge and self-knowledge stored in long-term memory, while the programs are cognitive algorithms, also stored in long-term memory, which are used to transform the data into new, and more useful and meaningful forms of information. In this way, relationships between self-knowledge and occupational knowledge are formulated through a series of problem-solving and decision-making algorithms.
- Vocational development involves continual growth and change in knowledge structures. Self-knowledge and occupational knowledge consist of sets of organized memory structures called schemata (singular schema) that evolve over the lifespan. Since both the occupational world and individuals are ever changing, the need to develop and integrate these domains never ceases.
- The aim of vocational counseling and guidance is to facilitate the development of information processing skills. From a CIP perspective, vocational counseling involves providing the conditions of learning that enhance the acquisition of self- and occupational knowledge, and the development of cognitive problem-solving and decision-making skills that are necessary to cope with the inevitable occurrence of gaps between indecision and decidedness that arise in the course of a lifetime.

### Structural attributes of CIP

In order for individuals to become independent and responsible vocational problem solvers and decision makers, certain information processing capabilities must undergo continual development throughout the life span. From an adaptation of the works of Robert Sternberg, these capabilities may be envisioned as forming a pyramid of information processing domains with three hierarchically arranged domains. Two knowledge domains, self-knowledge and occupational knowledge, lie at the base of the pyramid with the decision skills domain placed above it, and the executive processing domain at the apex (see Figure 2).

Information from the respective knowledge domain is combined using the information processing skills of the decision skills domain. These skills, referred to as generic information processing skills, are configured in the form of a recursive cycle (i.e., the CASVE cycle), and they are presented in Figure 3.

They are used as a heuristic in the career decision-making process as follows:

1. Communication (C). Information is received which signals that a problem exists. One then queries oneself and the environment to formulate the gap (or discontinuity) that is the problem. It also entails getting 'in touch' with all components of the problem space including thoughts, feelings, and related life circumstances.
2. Analysis (A). The causes of the problem are identified and the relationships among problem components are placed in a conceptual framework or mental model.
3. Synthesis (S). Possible courses of action are formulated through the creation of possibilities (synthesis elaboration) and the subsequent narrowing (synthesis crystallization) to a manageable set of viable alternatives.

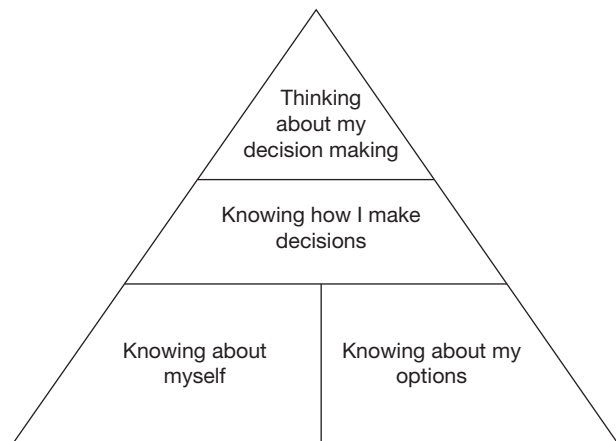
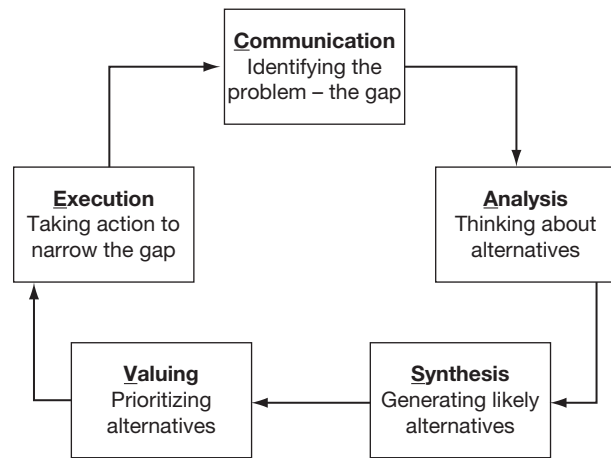


Figure 2 Pyramid of information processing.



**Figure 3** CASVE cycle.

4. **Valuing (V).** Each course of action is evaluated and prioritized according to its likelihood of its success in removing the gap and its probable impact on self, significant others, cultural group, community, and society. Through this process a first choice for a course of action emerges and the vocational problem is solved.
5. **Execution (E).** An action plan is formulated to implement the choice, which becomes a goal for the client. A series of milestones are laid out in the form of means–ends relationship that will lead step by step to the attainment of the goal. Thus, a vocational decision is made when individuals move deliberately toward a goal, such as selecting a course of study, choosing an occupation, or seeking employment in a chosen field.
6. Upon executing the plan, there is a return to the communication phase to evaluate whether the decision successfully removed the gap. If so, the individual moves on to solve succeeding problems that arise from the implementation of the solution. If not, one recycles through the CASVE cycle with new information about the problem, one's self, and occupations identified from the initial passing through the CASVE cycle.

There is yet a set of higher order of cognitive functions that guide and regulate the lower order functions in the pyramid, the executive processing domain. This domain comprises meta-cognitions that (1) control the selection and sequencing of cognitive strategies to achieve a goal, and (2) monitor the execution of a given problem-solving strategy to determine if the goal is being reached. A third vital component of this domain consists of the beliefs, assumptions, and awareness of one's self as a vocational problem solver that are necessary to effectively carry out the lower order functions of the pyramid. Dysfunctional beliefs or invalid assumptions pertaining to any facet of the respective domains will inhibit progress through the CASVE cycle and the development of career problem-solving and decision-making skills. A measure such as the Career Thoughts Inventory can be used to assess the impact of dysfunctional thinking on all components of the information processing pyramid.

A career counseling environment emphasizing self-directed exploration can be developed along the lines of the paradigm to assist individuals in progressing through the respective phases

of the vocational decision process. Self-instructional modules can be made available to assist individuals in progressing through the phases of the CASVE cycle. A comprehensive career resource center (both physical and virtual) that includes occupational information, computer-assisted career guidance (CACG) systems, and related materials, can help individuals clarify interests, abilities, and values, and formulate possible career options once they reach the synthesis phase of the decision cycle. Career advisors and counselors provide assistance in defining and analyzing the career problem, diagnosing one's capabilities as a vocational problem solver, designing individualized learning plans (ILPs) to master components of the pyramid, and achieving mastery of the paradigm so that clients use their presenting problem as an instance in becoming more proficient vocational decision makers. Further discussion on this topic is discussed elsewhere in this encyclopedia.

### Self as an Integrating Factor in Vocational Choice

Self theorists allude to higher-order cognitive processes that transcend such activities as the formulation and consideration of occupational alternatives or the making of specific vocational choices. Psychological constructs such as self-concept and self-efficacy not only provide an integrating force that bears directly on the consideration of occupational alternatives in the making of a vocational choice at any point in time, but they also span successive vocational decisions over the lifespan and give one's work and life continuity and meaning. When individuals possess positive self-concepts or a high degree of self-efficacy, vocational decisions are made as a matter of course in moving through the life span. However, the process of vocational decision making often becomes excruciatingly difficult in the presence of a negative or fragmented self-concept or when one's self-efficacy is low. Theories that emphasize the constructs of self-concept and self-efficacy are presented below to illuminate this important aspect of vocational choice.

### Self-Concept

Over his long career, Donald Super developed one of the most comprehensive theories of vocational choice. However, for purposes of this article, only the components of his theory concerning the role of self-concept are described, which incidentally constitute a major part of his writings. Some of the key propositions of his theory concerning the development of the self-concept include:

- Career development is essentially a process of developing and implementing one's self-concept, or in later writings, self-concept systems. A self-concept is the product of the integration of inherited aptitudes, physical makeup, the opportunity to play various roles, and the extent to which these roles are reinforced by peers, parents, and superiors.
- While the self-concept begins to stabilize in late adolescence, it continues to evolve throughout the life span as a result of life's experiences and making choices.
- The degree of satisfaction people attain from work is in proportion to the degree to which they are able to implement their self-concepts.

In Super's theory, the implementation of self-concepts was thought of as a matching process in which individuals related their perceptions of attributes of themselves to their perceptions of attributes of occupations. This matching process maybe static, focusing on a single vocational choice, or it can be developmental, relating a series of vocational choices to a common integrated theme. The implementation of the self-concept in making career decisions over time enhances the evolution of one's identity. Further, as one's identity develops and becomes clearer and attains a more stable and complex structure, one's self-concept becomes more positive as well.

One of the implications of self-concept theory for vocational choice is that occupational alternatives are viewed with respect to the degree to which one's self-concept varies from positive to negative, or to the extent to which it is developed in terms of its structural complexity. Negative self-concepts often restrict the formation of viable options. For example, individuals may use an interest inventory or a CACG system to generate a list of plausible options, but because of a negative self-concept, they may inappropriately reject many of them.

An immature or undifferentiated self-concept will often result in the inability to discriminate among interests such that either almost all occupations generated by an interest inventory or a CACG system may seem plausible on one hand, or very few seem plausible on the other. Undifferentiated self-concepts may also result in computers producing long, nearly randomly generated lists of occupations without focus. Finally, undifferentiated self-concepts may foster a lack of consistency among vocational choices over time. Thus, when there is no consistent self-referent to guide lower-order decision-making processes, wide-ranging and frequent changes in educational or career aspirations are a common outcome.

Another common occurrence in the vocational choice process is that even if an individual arrives at a first choice of an occupation, a person with a negative self-concept will tend to disconfirm the choice because it is perceived to be unattainable, thus fostering a state of chronic indecision. In the presence of a negative self-concept, group counseling interventions have been found to be effective, such as a job club, where individuals may express their fears and doubts while obtaining social support in the formation and exploration of career alternatives.

In recent years, Savickas has extended Donald Super's theory with regard to a role of self-concept in the implementation of vocational choice, by describing the process as one of career construction. According to Savickas, "careers do not unfold, they are constructed as individuals make choices that express their self-concepts and substantiate their goals in the social reality of work role." Client's vocational choices unfold as they impose their unique meaning on their vocational behavior and occupational experiences. Savickas suggests that the career construction perspective is not designed to replace choice theories that focus on person-environment fit, but rather it helps to integrate diverse segments, and improve career counseling practice. Individual's views about their ability to construct and implement their career goals is closely tied to the notion of self-efficacy which is described in the section that follows.

## Self-Efficacy

Bandura defined self-efficacy expectations as people's judgments of their capabilities to organize and execute actions necessary to attain specific kinds of performances. These expectations influence whether a course of action will be initiated, the amount of effort invested in the action, persistence in attaining the desired level of performance, the amount and kinds of cognitive processing, and the affective reactions when confronted with obstacles. Self-efficacy is viewed as a dynamic aspect of the self-system that is primarily domain specific and interacts with other persons in the immediate environment. The principal proposition of the theory is that accurate and strong self-efficacy expectations are vital to the initiation and maintenance of any goal-directed behavior. Bandura speculated that self-efficacy beliefs pertaining to a task may be shaped or modified by (1) perception of past performance, (2) modeling the behavior of others (3) verbal support or persuasion, and (4) emotional or psychological arousal experienced in the conduct of the task.

Hackett and Betz extended self-efficacy theory into the area of career development proposing that self-efficacy influences career decisions, achievements, and occupational adjustment. Self-efficacy beliefs have been found to be related to other career phenomena including the range of perceived options, educational attainment and persistence, career indecision, work performance, overcoming barriers imposed by gender and race, and the effects of job loss. Additionally, Hackett and Betz have found that self-efficacy is related to the extent to which females pursue traditionally male-dominated academic subjects and occupations. Following their initial work, numerous studies has been conducted that shed light on how self-efficacy beliefs develop, how they are maintained, or how they can be altered through education or therapeutic intervention. Further discussion on this topic is discussed elsewhere in this encyclopedia.

## Social Psychological Perspectives on Vocational Choice

From this theoretical viewpoint, vocational choice is seen as a process heavily influenced by the interaction with important individuals in one's social context. Social cognitive career theory (SCCT), advanced by Lent, Brown, and Hackett, is selected as one of the representatives of this domain of vocational choice theory because it speaks of the influence of background and social factors as well as self-efficacy on the vocational choice and implementation process. Krumboltz' social learning theory, on the other hand, describes how vocational choice is shaped through social learning processes. Finally, Gottfredson's theory of circumscription and compromise provides a developmental perspective on vocational choice.

## Social Cognitive Career Theory

Lent, Brown, and Hackett extended the construct of self-efficacy to formulate a comprehensive path model of career choice and occupational attainment, social cognitive career theory (SCCT), in which self-efficacy is a key component.

SCCT emphasizes the importance of background and social context influences on self-efficacy and a resulting vocational choice. In this model, one's self-efficacy is derived initially from the interactions among an individual's background characteristics, such as gender, race/ethnicity, disability/health status, personality predispositions, and contextual affordances. These background factors lead into cumulative life learning experiences, which in turn shape both self-efficacy and outcome expectations of the vocational choice process. From here, self-efficacy and outcome expectations influence the development of interests, which in turn form the basis of choice goals, which lead to choice actions, which result in educational and occupational performance, attainments, and satisfaction. Contextual influences on the choice process in the present, such as economic, parental, peer, teacher, and sibling support, may exert an impact on one's choice of goals and actions. SCCT provides counselors with a rich perspective of contextual factors and processes from which to view their clients as they engage the vocational choice process.

### Social Learning Theory

From the standpoint of social learning theory advanced by John Krumboltz, the social environment provides the context for learned behavior. Since vocational choice can be ultimately thought of as an instance of learned behavior, it can be understood from the behavioral paradigm. According to proponents of social learning theory, there are three principal types of learning: instrumental learning or operant conditioning, in which the probability of a response is altered by the frequency, recency, and intensity of events contingent upon the response; associative or classical conditioning, in which the learning is the result of the pairing of a significant event with a neutral event and the latter acquiring the power to invoke the same response as the initial significant event; and modeling, in which a behavior is acquired by observing and copying others and then being reinforced for the mimicked behavior. Krumboltz applied these principles of social learning to the realm of vocational choice. Some of the important factors that influence vocational choice and career decision making include:

#### *Genetic endowment and special abilities*

Personality characteristics such as race, gender, and physical abilities or disabilities, as well as partially determined genetically determined talents such as intellectual, musical, artistic, and kinesthetic may delimit career options open to individuals.

#### *Environmental conditions and events*

These are factors that are out of control of the individual, which may either enhance or constrain the array of career options open to individuals for consideration. Examples of such factors include the availability of jobs or educational opportunities, job entry criteria, salaries, labor laws and policies, family expenses and resources, and community resources.

#### *Learning experiences*

Every individual possesses a unique repertoire of learned responses through the interaction between one's inherited characteristics and the environment. Instrumental learning, those responses reinforced through contingencies such as grades

earned in school; associative learning, responses acquired through paired conditioning, such as attitudes toward an occupation held by someone admired or disliked, and modeling, a form of associative learning, are additional factors that influence the attractiveness of potential career options.

#### *Task approach skills*

These learned skills interpret the environment in relation to self-knowledge and world knowledge and make predictions about future events. Such skills include perceptual and cognitive processes (such as symbolic rehearsal), attention and memory, mental sets, and work habits.

#### *Self-observational generalizations*

These comprise the learned elements of self-knowledge and are general conclusions about ourselves resulting from self-observations in a variety of situations. These generalizations can be subdivided into three domains: task efficacy, the evaluation of our performances compared to others; interests, the conclusions of whether we like or dislike certain kinds of experiences; and values, generalizations about the desirability of certain behaviors.

#### *World-view generalizations*

These generalizations are conclusions, derived from instrumental and associative learning, about the social and physical environment we have experienced. Also included in world-view generalizations are the stereotypes and impressions of occupations and the occupational world.

Krumboltz' application of social learning theory to vocational choice calls our attention to the many factors in one's life history and in the environment that influence the consideration of career options and our career decisions over the lifespan. Further, while both social cognitive career theory and social learning theory are perhaps more explanatory than predictive, they nevertheless demonstrate how vocational choices throughout the life span are influenced by one's social context in the past and in the present.

### Gottfredson's Theory of Circumscription and Compromise

Linda Gottfredson's theory offers developmental and sociological perspectives of vocational choice by describing processes leading to the formulation of occupational aspirations in childhood and adolescence. Her theory addresses a fundamental question, 'Why do children seem to re-create the social inequalities of their elders long before they themselves experience barriers to pursuing their dreams?' In her theory, the processes of circumscription and compromise are enacted through four stages of child and adolescent development. The outcome of the developmental sequence is the identification of career aspirations in late adolescence that are not only preferred and acceptable, but represent an attempt to find one's niche in a broader social order.

Early in development, children begin to distinguish among occupations in the world of work according to the dimensions of masculinity versus femininity, prestige, and field of work. Individuals then arrive at an assessment of compatibility or suitability of a variety of occupations through the



consideration of factors such as perceived gender appropriateness, prestige, and the extent to which an occupation fulfills one's preferences and needs. Through the compatibility assessment, a 'zone of acceptable occupational alternatives' or 'social space' is created with a variety of occupations representing individual conclusions as to their occupational fit in society. Gottfredson contends that children may not invest a great deal of effort in career exploration and arrive at an array of suitable occupational alternatives that are merely 'good enough' or 'not too bad,' but may not be their 'best choices.' Further, individuals may become indecisive when the array of options within their zone of acceptable alternatives is undesirable.

The process of *circumscription* involves the elimination of unacceptable options that are in conflict with the self-concept. Children begin eliminating occupational alternatives as soon as they are able to perceive essential differences among people and lives. The circumscription process is guided by five principles: (1) the capacity to understand and organize complex information about themselves and the world; (2) the belief that occupational aspirations enhance one's self-concept; (3) the ability to discriminate among people regarding key variables of gender and prestige and to integrate these distinctions into their self-concept; (4) the elimination of options is influenced by the growing complexity and clarity of the self-concept; and (5) the process is gradual and transitions from one stage of development to the next are not immediately obvious. These principles are enacted through four stages of development, described as follows.

#### **Stage 1: orientation to size and power (ages 3–5, preschool)**

This stage reflects the onset of object constancy in cognitive development in which children are able to classify people in terms such as big and powerful versus little and weak, and they are able to perceive size differences between themselves and adults. They are also able to recognize occupations as adult roles and that they too will one day become working adults.

#### **Stage 2: orientation to sex roles (ages 6–8, elementary school)**

At this stage, children become aware of male and female sex roles and interpret sex role stereotypes as behavioral imperatives. Their occupational aspirations (e.g., such as firefighter, truck driver, or doctor for boys, and nurses or teachers for girls) reflect gender appropriateness. During this stage, children develop their 'tolerable-sextypic' boundary condition in forming the zone of acceptable occupational alternatives. One must be mindful that culture can influence children's sex-typing of occupations.

#### **Stage 3: orientation to social valuation (ages 9–13, middle school)**

Here, children become more aware of social class by age 9 and prestige by age 13. Occupations that do not meet with the approval of their social reference group are eliminated from further consideration. Moreover, occupations not in line with their perceived ability level to attain them are also discounted. Thus, the considerations of social class and ability form the 'tolerable level' lower-level boundary condition in the zone of acceptable alternatives such that occupations that are perceived below this level are eliminated. Children also establish an

upper boundary condition, the 'tolerable-effort level,' which reflects the maximum effort they are willing to exert and the risk of failure they are willing to accept in pursuing an occupation. Occupations exceeding the tolerable-effort boundary are also excluded from the zone of acceptable alternatives. While circumscription reduces the cognitive load in considering an array of occupations, it can also lead to the foreclosing of potentially socially and financially rewarding aspirations.

#### **Stage 4: orientation to the internal, unique self (ages 14 and beyond, high school and beyond)**

At this stage, adolescents are better able to engage in abstract thought, and they become more introspective and self-aware. They tend to explore occupations that are congruent with their emerging sense of self and can engage in the consideration of interests, abilities, and values. They are also able to discriminate between idealistic aspirations and realistic aspirations as modulated by accessibility. Further, adolescents shift from the process of eliminating occupations from the zone of acceptable alternatives by embracing options that are most preferred and acceptable. Here, the process of *compromise* is introduced in which adolescents may be required to choose among minimally acceptable alternatives as preferred options are eliminated from consideration due to reality factors such as accessibility, required abilities, and social and financial resources.

The particularly noteworthy contribution of Gottfredson's theory to vocational choice lies in describing how and when career aspirations are formulated, evaluated, and either included or dismissed from an array of viable career alternatives during childhood and adolescence. At this stage of development, individuals should be encouraged by parents, teachers, counselors, and people important to youth to engage in effortful cognitive processing in career exploration and to not dismiss occupations because of misperceived barriers. Somewhat unfortunately, there has not been a great deal of research on Gottfredson's theory and the research that has been reported is modest in its support of her propositions. Nevertheless, her theory takes an important place in the vocational choice literature by addressing developmental and social aspects in the formulation of career aspirations that eventually lead to life-determining vocational choices.

### **Special Considerations**

Race, gender, ethnicity, age, family background, socioeconomic status, and physical disabilities all may be considered as contextual 'background factors' that bear on the vocational choice process and outcome. All of these factors can actively influence such career phenomena as stereotyping, academic self-confidence, fear of success or failure, levels of career aspiration, mastery strivings, career commitment, risk-taking attitudes, work motivation, and opportunities for employment and advancement in the work place. Such factors also influence the development of one's personality structure that forms the basis of identity, knowledge structures of the world of work, meanings that are derived from work, the ways life and career problems are framed, the thought processes used to derive career options and evaluate their prospects, and one's view of personal success.



Differences among individuals in background factors such as race, gender, ethnicity, age, disability, and socio-economic status, and their effects on vocational choice can perhaps be understood from the standpoint of culture. From a vocational development perspective, culture is defined as a system of beliefs, values, customs, and institutions shared and transmitted by members of a particular society, from which people derive meaning from their work, love, and leisure activities. Further discussion on this topic is discussed elsewhere in this encyclopedia. Thus, each factor may be thought of as contributing to forming a basis for belonging to a certain subculture of society, each sharing its unique values, beliefs, and vocational orientations. The following assumptions regarding cultural differences may be applied to how these background factors influence vocational choice:

1. Culture is a determinant of meaning. Each subgroup possesses its own meanings regarding the nature of work itself, the relation of work to family and leisure, and the relative importance of intrinsic and extrinsic motivational factors.
2. Culture as determinant of communication. Misunderstandings between members of different cultures occur not because people use different vocabularies or languages to describe the same constructs, but because common words are used with different semantic meanings and because different cognitive reasoning processes are used to arrive at truth. Thus, the pragmatic aspects of human communication influence not only internal thought processes involved in making individual choices, but also interactions within and between members of different subgroups. As our society moves toward a more pluralistic work force, the pragmatics of human communication will play an increasingly important role in maintaining productive work groups.
3. Cultural relativity. Even though there are differences among cultural subgroups, no subgroup is objectively superior to another. Further, we come to know our own subgroup through the formation of contrasts between one's own and others. Thus, instead of differences serving as a basis for dividing people and forming barriers to access and opportunity, differences should become vehicles to higher understandings of ourselves, our groups, our work, and our society.

Differences among individuals, as determined by membership in subgroups or cultures, introduce important factors in shaping one's identity, and therefore how vocational choices are made and integrated over the lifespan.

## Summary

Vocational choice, as a field of inquiry in psychology, has received the attention of theorists and researchers for more than a century and has been driven by a very practical issue, namely, how can individuals secure meaningful and satisfying work in which they can become productive members of pluralistic and free society? The theoretical approaches vary in terms of descriptive, explanatory, predictive, and heuristic emphases. For example, the trait and factor theories emphasize prediction and applications in the use of technology, decision theories function as process heuristics, while self theories and

social psychological theories are descriptive and explanatory. All approaches are useful and provide essential perspectives for practitioners of the science of vocational psychology and the craft of vocational counseling. As Sampson suggests, we can avoid the unnecessary divorce between varying approaches to vocational choice and integrate the best of each perspective in order to meet the needs of clients across varied settings. Some of the emerging issues in the field of vocational choice include the expanding of a theoretical and research base on the influences of gender, culture, ethnicity, and physical disabilities on vocational decision-making, job satisfaction, and job performance. Moreover, the role of mental health in vocational choice, the optimal use of technology, and ascertaining how knowledge structures, cognitive skills, and attitudes can be developed through education, guidance, and counseling interventions are additional important avenues of research in the twenty-first century. Blustein has suggested the need to focus on a 'psychology of working' that broadens our perspective to include groups of individuals whose volition of choice has been restricted or nonexistent. Expectations are that the field will continue to evolve as the ability to make vocational choices becomes an increasingly important survival skill in a rapidly changing society – a society wrought by powerful international forces moving us toward greater pluralism in the labor force, a peacetime market economy leading to increased global interdependence, an expanding and aging population, and an ever greater use of technology in the production of goods and services.

**See also:** Adolescence; Career Development; Classical Conditioning; Clinical Psychology: An Information Processing Approach; Decision Making (Individuals); Episodic Memory; Operant Conditioning; Personality Assessment; Problem Solving; Self-Efficacy; Semantic Memory.

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# War

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War is the father of all and the king of all; and some he has made gods and some humans, some bond and some free.

Heraclitus of Ephesus, c.500 BC

Warfare is only an invention – not a biological necessity

Margaret Mead, 1940

Across the social and behavioral sciences, there are not many topics as important to the functioning of human societies and as surrounded by controversy as warfare. In this article, an attempt to synthesize research on warfare from anthropology and psychology and also history and sociology to a lesser extent has been made to address four basic questions:

1. Is the propensity to make war innate to human nature?
2. What is the role of warfare in the evolution of human societies?
3. How is warfare collectively represented in the psyche or mentality of people?
4. What is the relationship between warfare and individual and collective psychological functioning today?

## The Anthropology and Archeology of Warfare: Is the Propensity to Make War Innate?

To begin with, it is important to situate this debate in the context of the prevailing wisdom of archeologists and cultural anthropologists working on warfare. As exemplified by the opening quotation by Margaret Mead, they would mostly adopt the position that warfare is mainly a recent phenomenon, dating back to the last 10 000 years or so since the development of complex hunter-gatherer and/or agricultural societies, and likely much later in many regions of the world. In the last two decades or so, however, there has been significant movement against this orthodoxy, with an increasing weight of evidence arguing that use of collective violence among simple hunter-gatherer societies, while on a small scale typically not identified with the term 'warfare,' nevertheless bears many characteristics similar to warfare in more complex societies with larger populations.

Twenty years ago, there were few references to turn to on the subject of prehistoric warfare beyond Robert Carneiro or Andrew Vayda. Apart from Carneiro's conviction that warfare drove cultural evolution as successful leaders built chiefdoms, then states, and Vayda's detailed discussion of how Maori wars were fought, the archeology of warfare was not well developed. That has changed dramatically after Lawrence Keeley's 1996 book *War before Civilization* collected the available evidence and argued that anthropologists and archeologists had pacified the human past by downplaying the evidence of prehistoric and traditional warfare. Keeley further argued that in cases

where war was undeniable, there has been a strong tendency to classify it as a mere ritual and differentiate it from warfare in complex societies. Numerous archeologists have taken on this 'call to arms' and produced a robust alternative reading of warfare at the dawn of human society.

Consequently, a majority of archeologists who study prehistoric chiefdoms or states now give at least some countenance to warfare as an important factor in their structure and evolution. But for a variety of reasons, and despite much evidence to the contrary, the small-scale societies of foragers (especially the most mobile hunter-gatherers) are considered by many, if not most anthropologists, as inherently peaceful with low levels of violence or warfare. This is a glaring omission because it is central to a key unanswered question regarding warfare: when and why it originated. Some have argued that it is in our genes; others have argued that its roots are in social competition inherent in even small populations; and still others have argued that war did not arise until dependence on agriculture led to greater resource accumulation that allowed increased competition between groups directed by leaders. Thus far, there has been no firm resolution to this issue, but there is significant intellectual activity brewing.

## Hawks and Doves

Keith Otterbein is an influential cultural anthropologist who has produced a colorful dichotomy of two species of scholars with views on this subject of war. Hawks believe that war has always been with us since before the first recognizable hominids. Doves believe that warfare is fairly recent, and is mainly associated with the spread of more complex societies such as large chiefdoms, early states, and especially, colonial empires.

It is really not too hard to stretch the Hawks-Doves scheme to make it congruent with one of the oldest debates in Western social science as exemplified by Hobbes and Rousseau. In *Leviathan*, Thomas Hobbes stated his famous case that life for our ancestors was 'nasty, brutish and short.' Jean-Jacques Rousseau championed the other side that humans were not very nasty or brutish at all until civilization came along and ruined everything. This is a high-profile debate that has attracted the interest of many scholars of many disciplines and has significant investment on both sides.

The most notable hawk among physical anthropologists is Richard Wrangham of Harvard University. Apart from his scholarly writings, he hit a lot of nerves with the popular book he coauthored with Dale Peterson, *Demonic Males: Apes and the Origins of Human Violence*. He has been on television frequently, gives popular lectures, and takes an awful lot of flak from Doves. His view is that the documented group violence exhibited by chimpanzees is an accurate glimpse of the distant hominid past as well. His argument is that humans are

adapted for violence, and in particular that it is male humans who are selected for coalition-based fighting:

That chimpanzees and humans kill members of neighboring groups of their own species is . . . a startling exception to the normal rule for animals. Add our close genetic relationship to these apes and we faced the possibility that intergroup aggression in our two species has a common origin. This idea of a common origin is made more haunting by the clues that suggest modern chimpanzees are not merely fellow time-travelers and evolutionary relatives but surprisingly excellent models of our direct ancestors. It suggests that chimpanzee-like violence preceded and paved the way for human war, making modern humans the dazed survivors of a continuous, 5-million habit of lethal aggression.

Though, as Smith pointed out, both Freud and Einstein thought that the war was innate to humans, this is obviously a controversial position. Many objectors do so explicitly on the argument that it would mean that war is likely to always be with us and nearly impossible to avoid, an emotional rather than logical point, that could for example be countered by our peaceful ape near-relations, the bonobo. Hence, Wrangham and Peterson's position could be considered speculative. Many scholars shy away from any suggestion that humans, and especially males, are biologically driven to be violent. However, new research reveals evidence of the biological bases of human behavior with regularity. Hence, we should not reject this position out of hand just because it would lead to the conclusion that war in the future may be difficult to avoid given biological tendencies in our species. But there is also a need to carefully consider the discourses used to promulgate such findings, because in this area, description can easily veer into prescriptions for political elites and mass media.

The best known archeological hawk is Lawrence Keeley. His book arguably caused a paradigm shift in archeology. A second prominent archeological hawk would be Steven LeBlanc, also of Harvard University. He, like Wrangham, also teamed up with a popular writer to produce the hawkish, *Constant Battles: The Myth of the Peaceful, Noble Savage*, whose title proclaims its content. Hawks of a variety of disciplines rely heavily on Wrangham, Keeley, and LeBlanc to argue that war has been around for a long time.

*War in Human Civilization*, a recent book by Azar Gat, is a good example of a multidisciplinary approach in which military history plays a dominant role. The author looked over the available evolutionary, archeological, and ethnographic evidence and concludes that violent aggression has been with us for at least 2 million years (the origin of the genus *Homo*) and that it is primarily caused by resource scarcity. He also points out that violence and war have many proximate causes such as prestige, revenge, sorcery, use of narcotics, and so on, but underlying it all is the ultimate issue of competition for resources. Even the simplest hunter-gatherer societies, he argues, have high rates of mortality from violent conflict resulting from competition for reproductive success and territory.

A second recent popular hawkish work is *The Most Dangerous Animal: Human Nature and the Origins of War* by the philosopher David Livingstone Smith. He accepts the evolutionary view of innate aggression in humans and also agrees that the ultimate cause of this is competition for reproductive success and resources. He thinks that humans are naturally aggressive, xenophobic, and nepotistic. But he also thinks that humans

are evolved to dread killing, and are inherently self-deceptive and that this conflict must be understood to solve 'the puzzle of war':

The track record of our species shows, beyond a shadow of a doubt, that we are extremely dangerous animals, and the balance of evidence suggests that our taste for killing is not some sort of cultural artifact but was bred into us over millions of years by natural and sexual selection. But we have also seen that there is something in human nature that recoils from killing and pulls us in the opposite direction. These contrary dispositions exist side by side within us, and any explanation of war must honor the tension between them. It is incorrect to claim, without qualification, that we are killer apes, but to say that we are essentially peaceable is every bit as misguided. We are *ambivalent* about killing, and it is impossible to understand the relationship between war and human nature without taking this into consideration. (Smith 2007, p. 161)

An influential and ardent dove is the cultural anthropologist Douglas P. Fry, whose book *The Human Potential for Peace: An Anthropological Challenge to Assumptions about War and Violence* is aimed at the general reader to counter popular hawks like Wrangham and Keeley. He accepts that warfare is very common indeed over the past 4000–6000 years and in both agricultural and complex hunter-gatherer societies. But he argues that foragers are characterized by low levels of violent conflict between groups, though he acknowledges high rates of homicide and medium levels of feuding. He is adamant that feuding between kin groups should not be conflated with warfare, which he sees as being conflict between communities. He reanalyzes previous cross-cultural studies of warfare and concludes that most hunter-gatherer societies were peaceful with essentially zero warfare. His book attempts to show that "nomadic foragers, living a weakly partitioned or unpartitioned social world, perceive homicides and lesser disputes in terms of individual grievances, not as occasions for making war, group against group." Key here are definitional issues: whereas hawks view violence in forager societies as proto-warfare because group-size is necessarily small, doves view this as a fundamentally different form of violence because of alternative organizational and ideological/interpretive features.

The most well-known cultural anthropologist on the dove side would be R. Brian Ferguson of Rutgers University. One of the few anthropologists to work extensively on warfare in the 1980s, his most polemic work thus far is his contention that much tribal warfare can be attributed to changes wrought by European encroachment in the last few centuries. This has been a fairly persistent strand of scholarship, where warfare is blamed on the encroachment of modernity rather than inherent to the indigenous society.

Jonathan Haas might be held up as a dove archeologist. He argues that the archeological record of the Southwest shows that warfare was common only after climatic changes and population increase in the last thousand years. This is perhaps a view shared by the majority of current anthropologists: that warfare is a cultural phenomenon dependent on social organizational features interacting with environmental scarcity. They hold that warfare is an instrumental and adapted rather than inherent feature of human society.

While it is obvious that drawing conclusions in this area is fraught with controversy, there are some major points worth commenting on. First, Rousseau's idea of a noble, peaceful

savage separate and distinct from the corrupted and violent human beings recorded in history today cannot be sustained by the available evidence. Second, environmental factors like population density and resource availability, and social factors like norms and meanings play important roles in the prevalence and organization of murderous violence. Murderous violence, whether it is labeled as interpersonal and treated as a different phenomenon from warfare, or whether it is considered as a form of proto-warfare adapted to low infrastructure conditions in forager societies, appears to be part of the human condition. The key is how big a part, how much it varies, and the relationship of this variation to the evolution of human societies over time.

### What is the Role of Warfare in the Evolution of Human Societies?

While there is a fairly long history of the anthropology of warfare and conflict, the most influential thinkers in cultural anthropology in recent times are Raymond Kelly and Keith Otterbein. Neither can be placed squarely in the camps of hawks or doves, their views are more subtle, but they tilt toward the view that warfare is a cultural formation triggered by environmental circumstances.

Kelly recently published *Warless Societies and the Origin of War*, in which he presented “a general model for the initial evolution of war that is grounded in the comparative analysis of ethnographic data and then to apply this to the interpretation of pertinent data in the archaeological record” (p. ix). He used case studies from the limited set of ethnographically identified ‘peaceful’ or ‘warless’ societies, as well as those from societies with frequent incidence of warfare in order to identify key differences or thresholds in sociocultural context. It was this change in context, according to Kelly, that pushed societies toward warfare in the human past. He believes that warfare was rare until the development of fairly complex segmented societies where group members perceive the killing of one of their own as an attack on the entire group. Kelly views the ‘calculus of social substitutability’ as key to the transformation of violence into an instrument of the social group. Since he classifies human societies during the Upper Paleolithic (~35 000 years ago) as unsegmented societies, he concludes that warfare was rare until later in human history.

Otterbein has published on the anthropology of warfare for several decades, but his latest book, *How War Began* (2004), claims that both sides are right to an extent. His argument is that the hawks are correct that our early hominid history was competitive and warlike. He thinks this was largely because of competition over hunting game, and helped our species to expand at the expense of Neanderthals and other Archaic *Homo sapiens*, and indeed throughout the world. In contrast to Kelly, Otterbein thinks that the origin of agriculture led to millennia of peace – that is, that farmers do not fight. War then arose a second time AFTER the development of expansionistic complex chiefdoms and states. He utterly denies a role for warfare in the origin of complex social groups; it was solely a *result*, not a *cause* for the origin of the chiefdom or state.

This is a controversial position because, as Allen and Arkush have noted, war can be the cause or the consequence of the

evolution of complex societies. Otterbein ignores arguments made by Mesoamerican archeologists that warfare was a key factor in the origin of the Zapotec chiefdom and state in Mexico’s Oaxaca Valley. He similarly dismisses data from the Old World and South America. In sum, Kelly and Otterbein provide some important ideas and hypotheses regarding the origin of war, but they have not treated all evidence equally. Where they often seem weakest is when they stray from ethnographic data and speculate about the more distant forager past.

### Unilineal and Multilineal Theories of Cultural and Societal Evolution

It is likely that unilineal theories about warfare and human society as articulated by Kelly and Otterbein will never quite satisfy, because the role that warfare plays in the evolution of even simple societies depends on its interaction with other fundamental factors, including population density and resource scarcity, available technology, ideology/meaning, social organization, and economics. The contingent nature of the interplay of these factors becomes even more complex if we move beyond forager societies to the role that warfare plays in cultural evolution across a broad range of human societies. It is fair to say that in some periods, as in the age of colonial empires or at the dawn of the European nation-state, warfare was considerably more central to cultural evolution than during other periods.

In recent years, unilineal or ‘grand’ theories of cultural evolution have been challenged and to a significant extent undermined by multilineal theories in anthropology and sociology. Within the multilineal theories that have arisen to account for the diverse evolutionary trajectories that have actually been observed and documented over time and space, warfare is accorded a central role as *one* of the causal factors that drives cultural and societal change, but it is not accorded hegemony as *THE ONE* as suggested by the opening quotation by Heraclitus. There is a deepening understanding of society as a dynamical system, where causal change can come from a number of independent factors, and feedback between them can significantly alter the character of the impact of these causal factors on one another and on the society at hand. A cause can look like an effect at a particular moment in time in a particular society and vice versa. There is a need to look at the evidence broadly, through time, and as reflected in myriad case studies.

The materialist approach taken by Johnson and Earle is to analyze warfare, and particularly the costs, benefits, and opportunities of warfare in the framework of a political economy. In their model, intensification is the primary engine of sociocultural evolution: it is population growth and technological development that are the drivers of social change; at the initial stages of the evolution of cultural complexity, a political economy emerges in response to the material needs of subsistence-oriented families. The decisions made by these networks of families, often under the direction of their most influential members, to manage the challenges of intensification like problems of procuring food, or the risks of raiding and warfare, or inefficiencies or deficiencies in resources or resource usage, determine societal features like social stratification and political and economic formations.



War in this model is motivated by resource competition, and is in effect characterized as an instrumental activity that can become profitable when populations reach particular densities and resources/technologies are sufficiently rich to warrant the use of violence to monopolize/defend or to attack/co-opt the surpluses derived from them. The very purpose and definition of warfare changes with intensification: in simple societies with low population densities, collective violence is often aimed at driving away other people, whereas in more complex societies with higher population densities the conquest and incorporation of other groups within one's own collective becomes the objective and definition of collective violence. With increasing complexity comes increasingly sophisticated political and economic formations like bureaucracies, armies, noble families, banks, etc. that again change the political and ecological landscape on which warfare acts as a cause and an effect of cultural evolution. The level of abstraction in this model is necessarily high, but even so not all researchers would agree that intensification can serve as the motor for sociocultural evolution across the broad range of human societies over time.

A more definitively multilineal model of sociocultural evolution is Mann's *Sources of Social Power*. In this magisterial work, societies are conceived as four types of organized power networks: ideological, economic, military, and political. Each form of power is sourced in different aspects of the human condition. Ideology is our propensity for meaning-making, where monopolizing social norms and rituals are a route to power. Economic power "derives from the satisfaction of subsistence needs through the social organization of the extraction, transformation, distribution, and consumption of the objects of nature." Political power "derives from the usefulness of centralized, institutionalized, territorialized regulation of many aspects of social relations." Finally, central to this article, military power derives "from the necessity of organized physical defense and its usefulness for aggression." Each one of these is conceptualized as an autonomous power base capable of causing sociocultural change, and offering different potentials for constructing societies.

Mann describes military organization as concentrated-coercive, whether in war or in peace. Concentration of force is key to the power of military means to change society, through such wrenching events as regime changes or conquest. According to Mann, military forms of organization are much better suited to concentrated tasks like defeating or terrorizing an enemy, building fortifications, or controlling transport channels than dispersed tasks like bringing in harvests or making sure there are plenty of supplies of livestock. Military power has an extensive reach far beyond its ability to exert control. Raiders like the Mongols or Vikings were able to terrorize and extract surplus from other populations but not control them because their military means far exceeded their political, ideological, and economic power. In Mann's model, war is a powerful driver of sociocultural evolution, but without concurrent political, ideological, and economic power it cannot consolidate enduring societal formations.

The interaction between politics, ideology, and war can be illustrated with some quick examples. In the age of empires, military force was able to impose a top-down system

of control to extract tribute and high-level obeisance, but the daily lives of ordinary people were often unaffected by who ruled over them. More enduring empires like the Qin and Han dynasties in China used ideological and political innovations like a shared script and sophisticated bureaucracy to consolidate the changes wrought by war; the Spanish empire brought in Catholicism as a consolidator of its conquest of the New World. In a subsequent era, Tilly argues that war made the nation-state in Europe, and the nation-state thrived on war. War opens doors to societal change, but other sources of power are required to consolidate those changes.

### How is Warfare Collectively Represented in the Psyche or Mentality of Peoples?

Popular representations of history are simpler. They appear to position wars as the most important events in world history. Liu et al. used open-ended nominations of the most important events in world history by more than 2000 university students to find that World War II was considered as the most important event in world history among 23 of the 24 societies surveyed. Overall, between 30% and 58% of events (45% on average) nominated across cultures concerned warfare and collective violence. Hence, in free response formats among educated young people, warfare (together with politics) constituted the key events in the collective remembering of history. They are the makers and breakers of society according to these lay accounts. Advances in technology and commerce were far less salient in free recall.

This hegemony of politics and war in free recall of important events and leaders suggests that lay people share a view of history as a product of violence. However, in studies based on closed-ended ratings, war- and politics-related events were less privileged. The salience of WWII was to a large extent confirmed as this war was considered as more important than former or more recent wars or revolutions. Yet, in general, war- and politics-related events were not perceived as more important than socioeconomic trends like the Industrial Revolution. Moreover, agreement with statements which describe the content of history as being related to wars and politics was lower than the agreement with the idea of history as being related to socioeconomic progress and technological development. Even if wars are more vivid in free recall, social-structural factors are recognized as important and prevail in more reflexive thinking about history.

Studies focused on a single country reveal the centrality of warfare in the collective remembering of the history of a nation: the birth of a nation is often accompanied by collective violence, and frequently this violence is commemorated as part of the narrative of the birth of a nation as in the Fourth of July celebrations in the United States; recent instances of collective violence like 9/11 are also privileged.

In this context of nationalities in conflict, wars are depicted as necessary and just and even religion is used to justify war ('In God We Trust' was a slogan used by both sides in WWI). An analysis of official documents in nineteenth- and twentieth-century Europe (mainly focused on Germany and France)

found the following common features of representations of past wars: 'Our' shameful past war episodes are concealed; 'our' heroes, martyrs, and epic battles are acknowledged and remembered; our internal conflicts and crimes are forgotten. Recalling past persecutions and martyrs imposes the duty of fidelity and justifies revenge against evildoers. References to others as victims, civilians killed, and suffering are concealed. In fact, aggression against enemies is a manner to repay injuries suffered by the nation or nation's ancestors. War becomes a legitimate form of honoring the memory of ancestors and victims. Unacceptable elements of the actual behavior of 'our' soldiers (cruelty, rape, cowardly) tend to be omitted from formal and informal representations of the war and collective memories. This idealized propaganda image of a 'good' soldier, a combination of patriotism and manliness, loyalty to the collective, and professional skill, was shared by combatants to an extent. Most soldiers remember war as a negative but normalized experience – more positive in the case of victorious armies, like the Red Army, and more negative in the case of defeated armies, like the German Army. Even in the case of defeated nations, like Germany and Japan after WWII, people share and remember their own suffering, but conceal, silence, or ignore other people's suffering.

### What is the Relationship Between Warfare and Individual and Collective Psychological Functioning Today?

We close this article with a consideration of the impact of warfare on contemporary psychological functioning. Put simply, recent available evidence suggests that normal soldiers in battle commit atrocities. For instance, Browning describes how a group of German 'Ordinary Men' become mass murderers in Poland during WWII, from shooting innocent men, women, and children to clearing out the ghettos of Jews and ensuring they boarded trains to concentration camps. During WWII, American, British, and Canadian troops killed German POWs and wounded soldiers, used soldiers belonging to the German Wehrmacht or Waffen SS as human shields, and forced them to walk through minefields. In Vietnam, American soldiers treated the civilian population as targets to be killed, terrorized, and sexually abused. Few of the veterans interviewed regarded killing civilians as wrong. During WWII, the behavior of the Soviet soldier on German territory included widespread rape and looting.

However, at the same time, millions of men and women in the armed forces of even the world wars never saw combat and only a small percentage actually killed the enemy. Studies suggest that only a minority fight and that human beings resist killing members of their own species. Based on his postcombat interviews, Marshall concluded that only 15–20% of the individual riflemen in World War II fired their weapons at an exposed enemy soldier. The great majority of individual combatants throughout history appear to have been unable or unwilling to kill, even if their training was successful in increasing rates of participation (at the price of increasing rates of posttraumatic stress disorders among soldiers).

Given the horror of war, we review psychological explanations of participation in combat, and particularly participation in war crimes, killing of noncombatants, genocide, and the systematic rape of women.

- (1) *Selection*: The classical explanation that psychopaths are recruited as soldiers and a fringe minority of 2–3% perform most war crimes does not receive widespread support. Ninety percent of European armies in WWI and WWII were composed of nonvolunteers. The best killers in armies are men whose outward personalities were modest and sensible. Documented cases of German mass murderers have included not just Nazi fanatics but ordinary middle-aged men of working-class background who were neither specially trained nor volunteers. Most were old enough to have grown up before the rise of Fascism, and knew perfectly well the moral norms of German society before the Nazis.
- (2) *Brutalization by war*: Evidence for the idea that in war men are traumatized by having to kill others, and then permanently brutalized by the experience as an explanation for wartime atrocities is also inconclusive. The battle stress of the soldiers or psychological stress caused by the bloody battles and atrocities has been used to explain the rape of German women by Red Army. However, this idea of war leading to brutalization through combat doesn't explain Reserve Battalion 101 under the Nazis since they didn't experience action before participating in genocide. Moreover, evidence suggests that fear of dying, not fear of killing, is the most debilitating emotion for soldiers, inducing high levels of trauma. Most veterans seem to have been able to distinguish clearly between the act of killing on the battlefield – even casual atrocities against enemy wounded or prisoners – and killing in civil society. As a result, they seldom seemed brutalized by combat, particularly if they were on the winning side. Bourke suggests that the most hardened battlefield killer was able to adjust to civilian life with little evidence of trauma.
- (3) *Ideology of just war and indoctrination*: Racial stereotypes or images of the enemy as subhuman, primitive, childlike, and animalistic play a significant role in wartime and warfare and its collective remembering. In WWII, some Americans thought of the Japanese as monkeys and Japanese thought of the Americans as large apes. On the Eastern Front, Germans thought of fighting against subhuman Slavic bolsheviks. The dehumanization of the enemy makes possible a war of extermination and the devastation of civilian populations – in fact, war on the Eastern Front and in Asia provoked higher casualties than in the West front in WWII.
- (4) *Following orders and obedience to authority*: Ordinary people will more than likely follow orders, even those they might personally question, when they perceive these orders as originating from a legitimate authority. Milgram's experiments produced findings that mirrored historical facts. Direct proximity to the horror of the killing significantly increased the number of men who would no longer comply with orders. Distance from victims facilitates compliance, as when with the division of labor and removal of

the killing process to concentration camps the men felt scarcely any responsibility at all for their actions, just as in his experiments on destructive obedience. Desensitization and routinization of killing explain how men slowly escalated their participation in killing. Veterans attest to the difficulty of killing face to face for the first time, but the act of killing escalates willingness to do violence. Studies show that once a person complies with a small request (e.g., hitting unarmed prisoners or civilians), he will be more likely to comply with a more substantial request which is related to the original request (e.g., firing on these people and participating in war crimes). The idea is that the initial commitment on the small request will change one's self-image, therefore giving reasons for agreeing with the subsequent, larger request. Slow escalation of hurting others is a slippery slope in which each act of aggression becomes a reason for more aggression. Similar processes may occur during war.

- (5) *Conformity*: One of the classical explanations of the ability of the German Army to keep fighting despite terrible losses was ingroup cohesion and conformity. Soldiers fight for their buddies and to survive. In the case of wartime mass murders, Browning concludes that if a member of this group refused to kill, he was refusing his share of an unpleasant collective obligation. In the case of Germany in WWII, Soviet soldiers who refused to take part in rapes were treated at best with suspicion, and at worst could be shot by their drunken comrades. A few Vietnam veterans who could not take part in atrocities later confessed to feelings of inadequacy, of letting down their comrades. Even if war is a negative experience, there are also positive facets, like pleasures of comradeship and the glimpses of extraordinary courage.

Taken together, racial stereotypes and indoctrination, obedience to authority, escalating commitment, peer pressure, and group dynamics when placed in a coherent group setting explain why soldiers commit war crimes or engage in destructive obedience, even if they find these actions morally reprehensible.

## Conclusion

War may not be the father of all things, but across cultures it is imagined by lay people and theorized by experts as one of the key drivers of history and as a maker of nations. There may not be definitive evidence as to whether the propensity to make war is innate, but there are strong intimations that recourse to collective violence is as old as human society itself. Warfare interacts with other fundamental drivers of societal evolution like economics, technology, politics, and ideology as a vehicle of concentrated force, making it much more effective as an agent of culture change in some eras than others. No simple psychological explanation like selection or brutalization explains willingness to kill in war or commit war crimes, but rather a complex of societal and psychological factors, like the propensity to glorify and sanitize warfare, ideologies legitimizing war and dehumanizing the enemy, negative stereotypes, a willingness to obey commands especially of a graduated

nature, conformity and the desire for comradeship, combine to create a pressure cooker for societies and the individuals within them that make war a frighteningly powerful and unfortunately prevalent element of human experience.

*See also:* [Conformity and Obedience](#).

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## Word Retrieval

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### Glossary

**Alzheimer's disease** A type of age-related dementia in which word-retrieval problems are a prominent symptom.

**Aphasia** Language impairment due to brain damage; aphasia can impact language production, resulting in difficulty initiating speech and fragmented phrases, and language comprehension, resulting in difficulty understanding language.

**Connectionist models** Models of memory and language systems in which pieces of information are represented by nodes that are connected to one another in a network through which activation is transmitted.

**Mental lexicon** Within memory, the stored representations of the meaning, sounds, and syntax of all known words.

**Phonology** Individual sound units are called phonemes, and the set of phonemes that together form a word are described as the word's phonology.

**Semantics** Aspects of the meaning of a word.

**Slips of the tongue** Word-retrieval errors in which an incorrect word or phoneme is produced or a word or phoneme is mispronounced.

**Tip-of-the-tongue (TOT) states** Frustrating failures of word retrieval in which a word's meaning is accessed but its sounds are not retrieved. Sometimes partial phonological information is available to speakers having TOTs.

**Word retrieval** The process of accessing a known word from memory to express a specific linguistic concept. Also called lexical retrieval.

Word retrieval, also called lexical retrieval, refers to the cognitive process by which we identify, access, and produce an individual word in order to express an idea or concept during communication. Lexical retrieval often occurs as a subcomponent of production of larger units of language, such as sentences. It is an important and interesting cognitive skill, one which people use thousands of times per day with a great deal of success. When errors in lexical retrieval do occur, they tend to be of predictable types, and these regular patterns of errors have been very influential in understanding the processes underlying accurate lexical retrieval. This article presents major models of lexical retrieval, discusses some types of errors that are committed by all people during word retrieval, and reviews findings from some populations for whom word retrieval is different or especially problematic.

### The Mental Lexicon

Words are stored in a system called the mental lexicon, which contains information about the meaning, grammatical structure, and sounds that comprise each word that an individual knows. For most adults, the mental lexicon contains tens of thousands of words. During normal conversation, people produce two to three words per second, indicating that lexical retrieval is a very frequently used skill. However, researchers have found that we make speech errors only once or twice out of every one thousand words spoken, highlighting the general effectiveness of our word-retrieval system. While word-retrieval processes are critical to both spoken and written language, this article will focus on lexical retrieval during spoken language production.

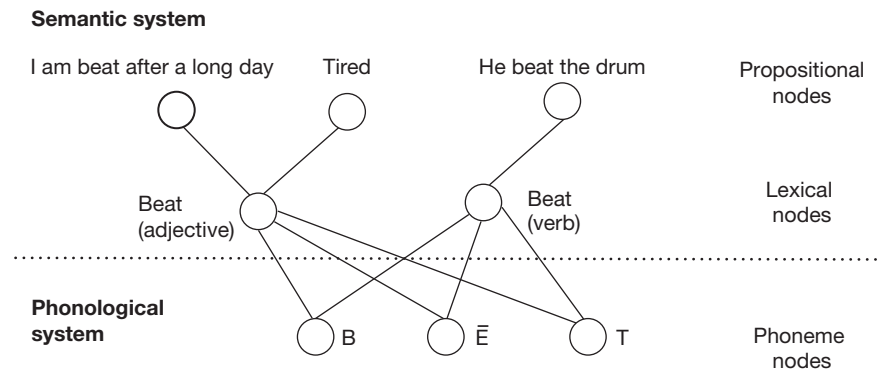
The mental lexicon enables us to combine pieces of information to make complete and coherent thoughts, utterances, or written ideas. There are different types of information stored

in association with each word in the mental lexicon. The first type of information is the precise concept associated with any given word, better known as the *semantics* of the word. When an idea comes to mind that a speaker wants to express, an array of words that fit that concept are identified from the known vocabulary. The speaker must determine what type of word is needed, including the word's specific connotation and its grammatical class (i.e., noun vs. verb). At this point, the precise term to be retrieved from the mental lexicon, sometimes called the *lemma* or *lexical node*, has been specified and selected. It is generally agreed that following specification of the exact term to be retrieved, speakers commence retrieval of the word's *phonology*, or the sounds that comprise the word. In other words, virtually every model of word retrieval has separate representations for the semantics of a word and for its phonology. The word-retrieval process is successfully accomplished only if selection of a word from the lexicon matches the desired concept, and then the phonology of that word is correctly retrieved and produced. As indicated previously, these processes occur very quickly, and lexical retrieval is generally very accurate as well as efficient.

### Models of Word Retrieval

There are several models that detail very specifically how the word-retrieval process happens during everyday speech. *Connectionist models* are a popular framework in which to explain lexical retrieval. They are called connectionist because they propose a network of connections between different systems in the mental lexicon. Specifically, these models stipulate that activation spreads between semantic and phonological systems to allow access to information, and that when all the necessary information has been activated, word retrieval is complete. In several connectionist models, the representations





**Figure 1** An example of representations of the semantic and phonological systems in an interactive activation model.

of pieces of information that constitute a word are called *nodes* (see [Figure 1](#)). Frequently, models of word retrieval capture the explanation of how nodes in the mental lexicon are accessed by discussing two separable stages. In the first stage, selection of word units occurs. The second stage involves retrieval of phonological forms that map onto the desired term.

Words (and the lexical nodes which represent them) are usually described as one type of information within the *semantic system*. The nodes in this system represent information about concepts that correspond to specific words (see [Figure 1](#) for examples). In English, as in many other languages, it is possible for many words to be associated with one concept. For example, the concept of being tired can be expressed with various words that are nearly synonymous with *tired*, including *sleepy*, *exhausted*, *drained*, or *beat*. Additionally, multiple concepts, including lexical items for differing parts of speech, can be associated with one word. For example, *beat* can be used different ways in sentences such as *I am beat after such a long day*, *He beat the drum*, *It beats me why she did that*, or *This song has a strong beat*. Each of these concepts is represented by a unique lexical node, even if there are synonyms or multiple meanings for that lexical item.

As thoughts occur to a speaker, nodes representing semantic information are accessed. This is the least understood aspect of lexical retrieval: Why people have thoughts, and how they are translated into linguistic form, are questions for which the field of psycholinguistics has no current satisfactory answer. However, once a linguistic plan is conceptualized, there is general agreement that activation of nodes within the semantic system will spread to nodes for specific lexical entries. Not only should the content of the node accurately represent the desired concept, but also the node must be from the correct grammatical class. In the previous example about beating the drum, *beat* is used as a verb, but in the example about the song, *beat* is used as a noun (see also [Figure 1](#)). The lexical node from the correct syntactic category that receives the most activation will be selected for further processing.

Another system contains the rules of the language regarding how the sounds of a word are structured, including the number and types of syllables in a word, as well as how many and which sounds it contains. This is referred to as a *lemma* or *lexical node* (see [Figure 1](#)). Once the information about the concept and structure of a word is selected, the activation from nodes in this system spreads into the phonological system.

The nodes in the *phonological system* contain information about the specific sounds of a word (in [Figure 1](#), the examples are individual phonemes, although syllable nodes and phoneme feature nodes are also sometimes included in this system). For accurate production, the correct word for a given concept must receive the most activation and be selected, and the correct phonology for that word must be activated.

The process of producing words that correspond to thoughts is described as top-down, which means that higher levels of the network are accessed first. Specifically, the semantic system is the first to be activated. This activation then spreads down to lexical nodes in the network, and finally down to nodes in the phonological system that ultimately indicate what sounds to produce. Speaking, writing, and unspoken linguistic thought are all potential output from this production process. Most models describe connections as bidirectional, allowing the spread of activation both top-down and bottom-up across lexical systems. Thus, comprehension processes (e.g., reading and listening) are bottom-up, input processes that rely on the same connections. When an individual encounters sounds (or spellings) that make up a word, they engage bottom-up processing to activate the meaning of the words they have heard or read.

## Factors Influencing Word Retrieval

Several factors have been determined to influence how quickly and efficiently the word-retrieval process occurs. The first variable thought to affect the strength of the connections, and thus the amount of activation transmitted between systems, is how frequently a particular piece of information is accessed. Words or sounds that are used more often are accessed at a faster rate and with fewer errors than items that are not used often. For example, the word *piano* is more readily available for retrieval than the word *dulcimer*; both are instruments, but most people use the term *piano* more often than *dulcimer*. The age at which a word is first learned and used, or the age of acquisition, can also influence retrieval processes. This is probably partly due to the fact that high-frequency or common words tend to be among the first words that children learn, and then those items are used more often across one's lifespan. Additionally, how recently a word has been produced or encountered will also impact its accessibility. This benefit of recent processing

can occur even without awareness of having seen or heard a word, so that nodes that have been used recently can facilitate word retrieval without the speaker's knowledge. Relatedly, verbs appear to be less susceptible to retrieval failures than nouns, perhaps because verbs have higher average frequencies than nouns. Grammatical class may play an important role in word retrieval and should be further explored.

A word's *neighborhood*, or the set of words in an individual's mental lexicon that are phonologically similar to that word, can also influence retrieval ability. For example, when considering the target word *dog*, members of its phonological neighborhood include *fog*, *log*, *dot*, and *dock*. Neighborhood structures have been conceptualized in two ways. The first is referred to as neighborhood density, which is determined by the number of words that are phonologically related to a given target word. The second factor that has been examined is neighborhood frequency, which involves how often the phonologically similar words (i.e., the neighbors) occur in the language. It has been proposed that similar-sounding words may compete with one another, a process referred to as blocking. According to this idea, a target with a dense neighborhood composed of frequently used words will have a greater amount of competition during selection, which should slow the process of retrieving and producing a given target word. Other theories suggest that having many similar-sounding, frequently used words will strengthen connections to a target word's phonological components. Under this approach, words would benefit from these neighbors during the retrieval process. Recent experiments have shown a facilitative effect of large, dense neighborhoods, such that target words with greater neighborhood density and frequency are produced more quickly and with fewer errors than words that have few phonological neighbors.

Another factor that influences the facility of word retrieval is *gesturing*. During normal conversation, individuals frequently use gestures in addition to vocalized speech in order to convey a concept. Gesturing is believed to help the word-retrieval process and eventual production because it increases the activation of the information contained in the mental lexicon. The benefits of gesturing may be greater for some individuals than for others. For example, people with lower verbal abilities may rely on gesturing to supplement speech more than those with higher verbal abilities. On the other hand, it may be that increased verbal ability results from increased production of gestures. Some research has shown that differences between groups of participants with varying verbal abilities may be reduced if the groups are made to gesture equally often. One possibility is that using gestures enhances the capacity for processing by maintaining task-relevant information in working memory.

Research has shown that prohibiting gesturing during word retrieval can increase failures. Participants instructed to keep their hands still have evidenced greater rates of tip-of-the-tongue states (TOTs) and decreased correct responding. This may indicate a direct benefit of gesturing on word-retrieval processes. Alternatively, it may merely demonstrate that holding still is difficult for people, in effect requiring them to divide their attention between the word-retrieval task and the instructions to not gesture. Regardless of this potential criticism, the bulk of research indicates a facilitative role for gesturing in word retrieval.

## Problems in Word Retrieval

Given the amount of information contained in the mental lexicon, and the complexity of the system, it is surprising that lexical retrieval is generally error free. However, problems do occur and can be quite frustrating. Research on errors in word retrieval is vital to understanding the underlying language system and how it functions correctly. Exceptions to the general rule of accuracy allow a better understanding of the processes involved in successful lexical retrieval, as well as when and why they sometimes fail.

### Tip-of-the-Tongue States

The most extreme form of word-retrieval error is a complete failure, or a temporary inability to produce a well-known word, which is referred to as a TOT experience. It is important to note that TOTs are different from not knowing a piece of information and that TOTs reflect inaccessibility of the desired term. In other words, the individual knows the information but simply cannot retrieve it at the moment. TOTs can be extremely frustrating, and when the target word for which a person has been searching is ultimately retrieved (i.e., when the TOT is resolved), it comes as a tremendous relief to the speaker.

TOTs were initially described by William James in the late nineteenth century, and they occur in virtually every known language, but the first systematic study of TOTs was conducted fewer than 50 years ago. The TOT phenomenon has been explored using both diary studies and experimental methods. Participants in diary-based research report their naturally occurring TOTs on specific forms, which they fill out over the course of several weeks. Participants in these studies indicate having TOTs one to four times per week, with rates increasing throughout adulthood. Researchers have also utilized laboratory manipulations to study TOTs under more controlled circumstances. When TOT states are examined in experiments, researchers are able to probe the participants for more information about their TOT experiences, as well as to manipulate aspects of the context in which retrieval is attempted. Both naturalistic observations and laboratory experiments provide useful information about the failures, and researchers have been able to gain a fairly comprehensive understanding of the process of TOTs and word retrieval by using a combination of methods.

Among studies that have experimentally induced TOTs, most have used definitions of commonly known, but infrequently produced words (e.g., *nepotism*; *sextant*), as these are the types of lexical items most likely to yield TOTs. Other studies have shown pictures of famous individuals to induce TOT states for their names, an effective choice because proper names appear particularly likely to elicit TOT responses. Across these different types of stimuli, certain characteristics have been consistently found in participants' TOT states. For example, individuals in a TOT state often report a strong sense that they know the word, despite the inability to produce it at the moment. Ratings of feeling-of-knowing, or how imminent they believe retrieval to be, are related to the likelihood of subsequent recognition of the target word. Participants report that the TOT target is a word they have successfully produced

on previous occasions, and they are frequently able to provide some partial information about the target they are searching for, including its initial or final letters or phonemes, the gender of the desired term (in gendered languages, e.g., Italian), and the number of syllables and syllabic stress pattern of the target word. TOT states are sometimes accompanied by other words that come to mind repeatedly. The speaker knows that these persistent alternates are not the target word they seek, but cannot stop the words from entering consciousness. These alternate words may share similar sounds, meaning, and grammatical class with the target word, and often induce the subjective feeling that they are blocking retrieval of the desired term. Some early TOT research showed that phonologically similar words can act as competitors to block retrieval, but these studies have been widely criticized (e.g., target words in some experiments were not counterbalanced across conditions, limiting the conclusions that can be drawn). At present, there is a paucity of experimental evidence for the notion of blocking as a cause of TOT states.

As an alternative to blocking, connectionist models of lexical retrieval (as described earlier) postulate that TOTs occur when connections between nodes are too weak to transmit sufficient activation to all of a word's phonological nodes. Under these models, failure to transmit adequate activation to every phonological node of a word means that the speaker will be unable to produce the target word. When a subset of the phonological nodes for the target are activated, individuals are able to provide these pieces of partial information about the target word (e.g., initial phoneme; number of syllables). However, if no phonological nodes receive sufficient activation, no partial information can be reported.

TOTs are believed to be resolved when connections are strengthened and phonological nodes receive adequate activation. Encounters with other words that share phonology with the target word strengthen connections to and from all connected nodes, which can increase the activation of the target word's phonology and result in successful retrieval. This mechanism appears to play a critical role in spontaneous resolutions (i.e., when the target word 'pops' into mind while retrieval is no longer actively being attempted). It has recently been shown that in order for a phonologically related word (or *prime*) to facilitate TOT resolution, the prime must be from a grammatical class different from that of the target word. If it is from the same class, the prime receives the most activation, and resolution of the TOT is delayed until its activation has subsided. For example, if an individual has a TOT for *trellis*, which is a noun, encountering another noun, such as *trend*, as a phonological prime will delay resolution. On the other hand, having a phonological prime from a different grammatical class, such as the verb *tremble*, is helpful in resolving the TOT.

### Slips of the Tongue

Another type of word-retrieval error is a *speech error* or *slip of the tongue*. Unlike TOTs, these are not complete failures, because a word is retrieved and produced. Rather, slips of the tongue involve production of an incorrect word or sound, or a mispronunciation of an intended word. Naturally occurring speech errors are notoriously difficult to code because the speaker's intent is not always clear; so, as with TOTs, laboratory

methods have been developed for inducing slips of the tongue. Together, laboratory and naturalistic sources of speech error data have indicated that there are two major subclasses of slips of the tongue: *contextual errors* (which are influenced by other elements in the intended utterance; see many examples below), and *noncontextual errors* (which are influenced by information outside the components of the intended speech, such as irrelevant thoughts or nearby conversations).

Speech errors can involve entire words, or phonological components within words. Word-level errors can be of several subtypes, including: substitutions of words in the utterance, additions of unintended words, deletions of intended words, and shifts in the order of intended words. More specifically, exchanges are a type of substitution error that involve swapping the planned position of two intended words (e.g., producing *the table is on the napkin* instead of *the napkin is on the table*). Perseverations are another type of substitution in which a previously produced word is repeated (e.g., producing *the glass is in the glass* instead of *the glass is in the sink*). Anticipations occur when a word that is planned for a later part of the utterance is produced earlier than intended (e.g., producing *my yard is near the yard* instead of *my dog is near the yard*). Another type of word-level error is an addition, which occurs when information that is relevant, but unintended, is added to speech (e.g., producing *the old cat is aging* instead of *the cat is aging*). A deletion is the omission of an intended word (e.g., producing *my house was nice* instead of *my previous house was nice*). A blend is an utterance that combines two planned words into a single utterance (e.g., producing *I am totally responsible for this error* instead of *totally* or *solely*, either of which would be appropriate). For word-level slips, the lexical items that change places or intrude are usually from the same grammatical class and are also frequently phonologically similar to one another.

The types of errors that occur at the phonological level are similar to word-level errors. For example, phonological-level exchanges are when incorrect sounds are substituted for intended portions of a word (e.g., producing *flaid plannel* for the intended *plaid flannel*). When this type of exchange results in real words (e.g., producing *flea of my cat* instead of *key of my flat*), the error is called a Spoonerism (named after a man famous for making such errors). Anticipations and perseverations occur at the phonological level, but the duplication consists of phonemes within the word, rather than whole words (as in word-level errors). Elisions are omissions of one or more sounds in an intended word (e.g., producing *back cat* instead of *black cat*). Interestingly, phonological-level slips evidence a lexical bias, meaning they tend to create real words (e.g., misproducing *bed barn* for *red barn*, as opposed to misproducing *red ram*). Probably, errors that form real words are less likely to be noticed and corrected prior to their production. Phonological speech errors also demonstrate a positional constraint, such that word beginnings replace other word beginnings and word endings replace other word endings, rather than beginnings replacing endings or vice versa.

When applying the findings on speech errors to theory development, researchers have determined that word-level and phonological-level anticipation errors indicate that planning precedes production but is not completed before production begins. When individuals are able to correctly

produce portions of the word (e.g., its initial and final sound), this reveals weakened connections among some, but not all, of the phonological components. Together, the data on TOTs and slips of the tongue suggest that semantic and phonological systems really are separable.

## Word Retrieval in Specific Populations

Studying groups of people for whom lexical retrieval is different, is undergoing change, or is problematic has improved understanding about word retrieval in general. Specifically, research has explored the development of lexical retrieval processes in children and in bilinguals, as well as changes that occur in older adulthood. Problems in word retrieval are evidenced in individuals suffering from age-related dementias (such as Alzheimer's disease (AD)) and some types of aphasia. In this section, we consider word retrieval in these specific populations.

### Childhood

Children represent a special population because word-retrieval processes begin to develop during childhood. At around 18 months of age, children typically begin to demonstrate a tremendous growth in their ability to name objects. Researchers studying development suggest that during this time period, children exhibit significant progress in acquiring semantic and conceptual information. Some linguists assert that there is an advantage for acquiring nouns, including concrete nouns and proper names, over other types of words, such as verbs. According to this hypothesis, nouns are acquired more easily due to the transparent nature of their relationship to the world. Research has confirmed that children learn new nouns more quickly than new verbs, and nouns are produced more often than verbs by young children learning to speak. It has also been shown that among nouns, words for more unique concepts (e.g., animate objects) are most easily learned.

Interestingly, during this early stage of language acquisition, there is a noticeable increase in word-retrieval errors. It is often difficult to study word-retrieval failures per se in children because to suffer a true retrieval failure, the word must be correctly and completely known to the child. Researchers have found that children's errors in word retrieval frequently involve incorrect extensions and applications of knowledge they have about certain words to new words that appear to share some relevant characteristics. There are also instances where a child does know the correct word and has previously been successful in production, yet he or she retrieves and produces an incorrect word. Additionally, children demonstrate increased use of fillers and empty words in speech, as well as longer pauses, and increased word substitutions and word repetitions. These difficulties seem to indicate inaccessibility of target words.

Children have shown an increased susceptibility to word-retrieval errors during a period of rapid growth in the rate of acquisition for new words. It is suggested that this reflects weak connections for representations of these newly acquired words. During the time of intensive acquisition of new words, there may be an increased amount of competition among lexical

items. This increased vulnerability (due to infrequent use and/or to greater competition) leads children to have a large number of word-retrieval errors. As children repeatedly use words over time, the transmission of activation is increased and the rate of errors declines.

Word retrieval is recognized as an important component of language processing and cognitive development, but there remain relatively few studies of children's experiences with word retrieval. It has been suggested that models of adult retrieval may not adequately address the children's experiences during this very important developmental phase. Therefore, theoretical development may be necessary to provide a greater understanding of children's word-retrieval processes.

### Bilinguals

A speaker's complete fluency in a second language is another important variable in understanding the process of word retrieval. The role of bilingualism in lexical retrieval should vary depending on the speaker's degree of fluency in each language, his or her degree of use of each language, and the age at which each language was acquired. Typically, adults who are true bilinguals learned both languages during childhood, and we focus here on this population, as opposed to people who have learned a second language to a lesser extent or later in life. When a bilingual individual speaks in one language, lexical representations for the same concepts might also be activated in the language they are not using. If they are, their activation could result in word retrieval in the incorrect language or might lead to other types of errors. The notion that representations of both languages may be active at the same time during speech production is referred to as *parallel activation*. If there is parallel activation, bilingual speakers must have a way to determine which language to use in the current situation.

Studies of word-retrieval errors involving both languages have provided evidence for parallel activation. In research testing semantic interference effects in monolinguals, participants see a picture (e.g., of a car) that appears with a semantically related distractor word (e.g., *train*) typed on or near the picture. Other participants see the same picture along with a word that is semantically unrelated to the picture (e.g., *fruit*). Monolinguals are slower to name the picture when the distractor word is semantically related than when it is unrelated. The bilingual version of this paradigm entails having participants name the pictures in one language while seeing distractor items in their other language. Many studies report semantic interference effects, indicating that activation of semantic and lexical information in one language spreads to the other language.

Other research had bilingual participants name target pictures in one language while they were presented with a phoneme. Their task was to indicate whether that phoneme was included in the name of the target. The phoneme was never present in the target word in the response language, so the correct response was that the phoneme was not present. However, on some trials the phoneme was part of the other-language translation of the target. Participants had more difficulty rejecting the phoneme when it was present in the second-language translation of the target word, again indicating that both languages must be activated during the task.



Another line of research involves speech errors of bilinguals. There are two relevant types of errors: when a word from one language is produced when the speaker is actually intending to use the other language and when the intended word and its translation in the other language are blended together. The fact that these types of slips occur seems to indicate that both languages are (at least sometimes) activated at the same time, which can lead to errors in the retrieval and production of the target word.

A recent review detailed criticisms of these findings related to parallel activation and determined that results to date are inconclusive. There exist reasonable alternative explanations for all of the findings just described, and there are methodological limitations to the research. Some of the weaknesses of research on word retrieval in bilinguals can be resolved if the notion of competition is removed from models of lexical retrieval. Taken together, the preponderance of evidence regarding lexical retrieval in bilingual speakers supports interactive connectionist models of word retrieval.

### Older Adulthood

Research has shown that many cognitive processes change with age. However, verbal abilities have been shown to be relatively preserved in healthy aging. Word retrieval is one aspect of language where this is not the case: older adults' word retrieval is slower and less accurate than young adults'. For example, it takes older adults more time to produce names for pictures or definitions of an object, and they produce more pauses and hesitations in their speech, presumably reflecting problems retrieving desired words. They report more TOTs than young adults in both diary and experimental studies, and they produce more speech errors (particularly of specific types) than young adults. They generate more ambiguous references (e.g., using *he* instead of producing a specific man's name) than young adults do in conversation. These difficulties with word retrieval suggest declines in the access of phonological information. The ability to formulate concepts to express seems to remain intact with age; yet older adults show an inability to map these concepts onto the necessary phonological forms for production.

One class of theories explains the retrieval deficits of older adults by positing general slowing of cognitive processes with increasing age. The theories propose a slower speed of cognitive functions regardless of the task at hand, and have been supported by findings that older adults perform more slowly than young adults on many cognitive tasks. However, these theories cannot account for asymmetric effects of aging on language. That is, while deficits occur in the output processes of language production, input operations (i.e., language comprehension processes) appear to remain relatively intact.

Connectionist models (described earlier) can better account for asymmetrical effects of aging across different cognitive processes. As explained, these theories detail connections between networks of the language system, and the strength of these connections determines how much activation spreads across systems, and therefore, what information is retrieved. According to these theories, aging is an additional, separate variable thought to weaken connections among nodes. Because the production of language (an output process)

utilizes top-down processing, it is more vulnerable to reduced spread of activation into the phonological system of the network. This is because each phonological node must receive activation from only one connection before becoming accessible. On the other hand, information in the semantic system receives converging activation from all associated pieces of information, which compensates for any particular connection being weakened. In other words, when phonological information is provided to an individual during the perception and comprehension of language (i.e., input process), there are small or no effects of aging, as opposed to substantial age-related deficits found on production tasks. Connectionist models predict this asymmetry for aging effects, which has been confirmed by empirical evidence.

Many studies have examined age differences in the TOT experience. Older adults have more TOTs than young adults, partly because with increasing age, there is potential that the target word has not been produced for a longer period of time. It has also been suggested that older adults have more TOTs because they know more words and have to 'filter' through all of them to retrieve the correct word; however, evidence indicates that this is not the case. Older adults frequently describe their TOTs as a complete void of phonological information, still accompanied by a sense of imminent retrieval and frustration. They access relatively little partial information about the target word, and have fewer persistent alternate words come to mind than do young adults. In some experiments, TOT resolution rates have been shown to be similar for young and older adults, and priming of TOT resolutions has been shown to be similarly effective for young and older adults.

One particular aspect of retrieval that is unduly affected by aging is the ability to retrieve proper names. Names of individuals are especially difficult to retrieve in comparison to other information, such as the person's profession, and the age difference in TOTs for known names is much larger than for known occupations. According to connectionist models, this is because there are fewer connections between information about an individual's name than between information about his or her profession. Deficits in the transmission of activation to these pieces of information are even greater in older adults than in younger adults, resulting in more name retrieval failures and slowed production for older compared to young adults.

### Age-Related Dementia

Alzheimer's disease (AD) is one example of dementia whose prevalence increases with age. A diagnosis of AD can be confirmed only during autopsy, where it is determined by finding cellular changes in the brain. The beginning phases of this disease frequently look like typical age-related changes, such as forgetfulness. As more indications of cognitive decline begin to surface, a neurologist can do behavioral and cognitive assessments to determine if an individual is likely experiencing AD. The course and duration of the disease is quite variable, but individuals show some declines in cognitive functioning, including memory deficits, declines in fluid intelligence, and changes in temperament and behavior.

During the early stages of the disease, the individual with AD may begin to show some pronounced difficulty in naming



objects or people. They usually struggle more than healthy older adults do with the production of low-frequency words or complex sentences, and unlike healthy older adults, language comprehension may also be compromised. As the disease progresses, the individual may begin to show more severe deficits in comprehension and his or her speech may become more fragmented. The processing of semantic and lexical information is especially affected by AD, despite being unaffected in healthy older adults, and severe word retrieval deficits are a hallmark of AD and other age-related dementias.

## Aphasia

Aphasias are language disorders resulting from damage to particular areas of the brain. There are many varieties of aphasia, each linked with different types of language deficits. The location of brain damage predicts which specific functions will be affected. For most people, the areas of the brain associated with language are on the left side. Damage to these areas may be caused by stroke or traumatic brain injury, in which case there is an acute onset of symptoms. Alternatively, aphasia may develop over time, such as in the case of a brain tumor.

There are two main categories of aphasia. The first is nonfluent, or expressive, aphasia, of which Broca's aphasia is a well-known type. Individuals experiencing nonfluent aphasia are typically able to understand the speech of others, though they may struggle with particularly fast speech or symbolic language. During the production of language, they often speak with short, fragmented phrases, and they appear to expend a great deal of effort to retrieve and produce words. Speech of these aphasics is usually comprehensible, with the omission of only function words (e.g., articles such as *a* or prepositions such as *to*).

The other main class of aphasia is fluent, or receptive, aphasia, with the best-known type being Wernicke's aphasia. In this type of aphasia, the individual typically struggles with understanding the speech of others, as well as understanding their own speech production. For example, persons with receptive aphasia may produce long sentences that are difficult to understand, frequently adding unnecessary words, substituting incorrect words, producing words in the incorrect order, or producing things which are not words. Even though they produce a great deal of speech, their word-retrieval processes are not functioning correctly.

One benefit to studying these language disorders, as with studying speech errors in healthy speakers, is that it improves our understanding of language systems. The different types of aphasias (i.e., receptive vs. expressive) imply that the connections between meaning and sound may be damaged in one direction but not the other. Additionally, studies examining the retrieval errors that occur in different types of aphasias have often supported interactive activation models of lexical

retrieval. Various interventions, such as increased gesturing or provision of a semantic context, are being explored as treatments for retrieval problems in patients with a variety of aphasic disorders.

## Conclusion

In this article, we have described the processes involved in lexical retrieval, or the ability to produce individual words. We discussed major theories of lexical representation and production, and described some of the factors known to influence the accuracy and efficiency of word retrieval. We also discussed two major classes of word-retrieval errors: TOT states and slips of the tongue. Finally, we described word-retrieval processes in various populations, such as bilinguals, older adults, and people with aphasia. There remain many questions to be answered by future research. For example, further development of theories of successful word retrieval, perhaps incorporating underlying neurological mechanisms, is warranted. Also, research should continue to address the retrieval of words from various grammatical classes (not just nouns), and should expand current knowledge about word-retrieval processes in bilingual speakers and in children. These and many other questions remain under investigation by word-retrieval researchers worldwide.

*See also:* Aging and Cognition; Aphasia; Bilingualism and Multilingualism; Gestures; Language Development.

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## Work Efficiency and Motivation

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### Glossary

**Attitudes** A state of mind or feeling about objects, people, or events often expressed as a like or dislike.

**Commitment** The degree to which an individual identifies with and is involved in a particular activity or organization.

**Efficiency** Acting in such a way as to use a minimum of time, money, or unnecessary effort, and the ratio of effective output to the input required to achieve it.

**Effort** The use of energy to do something; exertion.

**Goals** End results toward which human activity is directed.

**Motivation** Effort expended to perform work.

**Paradigm shift** Situations when an individual, team, or organization tackles a problem with radically innovative solutions rather than taking a step-by-step approach.

**Persistence** Directed effort over time.

**Satisfaction** Contentment derived from a relationship or a level of living or working.

**Stress** The body's reaction to a demand, or a physical or an emotional situation that causes imbalance.

**Work** Physical or mental effort expended to produce or accomplish something.

Work efficiency and motivation emerged as concerns of managers and researchers in the twentieth century and continues through the twenty-first century. From its beginning in the United States with the assembly-line efficiency studies of Frederick Taylor, this area of study has grown into a sophisticated science applicable to all organizations. His work is updated with new applications such as the Japanese-influenced 5S Concept discussed in this essay. The interest in the topic has emerged because of the recognition that successful organizations need people who are motivated and efficient, challenged but not overly stressed. As the pace of change accelerates, paradigm shifts are taking place. There is not always time for a step-by-step approach to increase productivity. Less clutter, physical and mental, may be part of the solution. How to increase motivation and efficiency in workers are on-going issues throughout the world. It would be difficult to find a recent research journal or book on industrial psychology, organizational behavior, family relations, or management that does not address these issues.

### Introduction

There are two levels to this discussion: societal and individual. Society is rapidly changing as evidenced by technological innovation and adoption affecting time management and worker availability and shifting demographics. Globally, the Internet, text messaging, and cell phones have revolutionized communication and impacted lives beyond measure. In the United States, the number of households has increased significantly but the number of people per household has decreased significantly (Goldsmith, 2010). It is predicted that the 2010 census will reveal that the most prevalent household type will be a married couple without children followed by a single person household. This demographic pattern is also seen in other developed nations. So what has happened in the work and family discussion of impacts on work efficiency and motivation is a switch from using the term 'work-family balance' to more usage of 'personal-professional life balance' as evidenced

in this international journal article title 'Sacrificing personal or professional life? A gender perspective on the accounts of retail managers' (Broadbridge, 2009).

A unified treatment of work efficiency and motivation must explore the phenomenon of human behavior at the individual level. Each individual is unique, and placed in similar situations all people do not act alike. However, certain fundamental consistencies that underlie behavior can be identified, measured, and predicted. This predictability allows for the systematic study of human behavior. The aspects of behavior to be discussed in this article are work efficiency and motivation.

### The Nature of Efficiency

Many practical problems are associated with how efficient workers are. The overall productivity (output) of an organization is linked to the way workers perform. How to encourage efficiency and maintain high-quality performance in workers are problems for everyone from line foremen to company presidents. This problem permeates all organizations, large or small, for profit or nonprofit. Since the 1940s, the emphasis shifted from increasing efficiency to increasing effectiveness as a means for boosting productivity. For example, a department store is considered effective when it successfully meets the needs of its shoppers. It is efficient when it can do this and still keep costs low. Thus, a store is most effective when it attains its sales or market share goals in a productive and efficient manner. The emphasis is not purely on making the most number of sales in record time, but on making sure that the sales are well handled, to encourage repeat business, and good 'word of mouth.' The concept of effectiveness implies a concern for the long haul as well as for short-term gains. The roots of efficiency studies that eventually led to the more global concept of effectiveness can be traced to the early 1900s when Frederick Taylor proposed scientific management principles designed to maximize production efficiency. The goal of these principles was to eliminate wasted time and motion in

repetitious work, especially assembly-line work. By carefully studying the most efficient ways jobs could be performed and implementing changes to increase efficiency, he was able to achieve productivity improvements from 200 to 300%. Naturally, Taylor became the favorite of managers, but drew criticism from some workers who felt his methods depersonalized production. Because of his contributions, Taylor is often called the father of management or the father of time and motion studies.

Eventually, his methods were criticized more because many previously creative, personally satisfying jobs became routinized and boring leading to increased absenteeism, and in some cases disruptive and even destructive behavior by employees. In highly routinized jobs, workers can begin to feel like 'cogs in a wheel' rather than as intelligent, skilled human beings. Managers who are aware of this problem try to resolve the creativity/efficiency conflict through a variety of ways. Most typically, jobs are redesigned to make them less routine and more meaningful. For example, encouraging team work stimulates workers' interest in their jobs and increases productivity. Rotating tasks are another means to keep work interesting. Ultimately, organizations need to develop a strategy and a structure that address the needs of its workers as well as its clientele. By the 1940s and 1950s, concern for the plight of the individual worker became the subject of many management and industrial psychology studies. During these decades, worker motivation became increasingly recognized as a contributor to productivity.

In the 1970s inflexible work hours and health effects from stress overload became topics considered by many to be primarily women's issues, but as time passed it was clear that the either-or of work and personal/family life was an issue for both men and women (Broadbridge, 2009). Stress can be internal (arising from personal thoughts, worry) or external such as the sudden appearance of a belligerent boss (Goldsmith, 2007). There is an emerging literature on the emotions in the workplace and the transactional approach to the stress process. Closely allied to the subjects of stress, efficiency, and effectiveness is the concept of motivation to be discussed next.

## **The Nature of Motivation**

Motivation comes in many forms and should be addressed within the over-arching economic climate. The word motivation was originally derived from the Latin word 'movere,' meaning 'to move.' In management theory and practice, motivation refers to movement and also direction, vigor, persistence, creativity, and sustained energy. To increase worker motivation, employers can choose from several methods. Some of these are enriching job skills through workshops, on-the-job training, travel and international assignments, sabbaticals, workplace seminars, courses, job rotation, and other forms of job/skill enrichment or by providing promotions, bonuses, or raises. Complications arise from the fact that what motivates one worker might not motivate another. The skilled manager tries to match the person with the most appropriate type of motivation. Keeping job skills up-to-date and providing a stimulating workplace are two ways that usually ensure a continual reservoir of highly trained, motivated employees.

Regarding the economy, with the downturn in recent years many organizations had to let go of workers and furlough the

ones remaining. Furloughs can mean working for several days or weeks a year without pay or in some cases, not having to come into work but not being paid (this might be during nationally recognized holidays or on days selected by the employer or the employee with approval of the manager). Firings, reduced hiring, overloads, and furloughs affect worker morale, on the other hand, it motivates many employees to work harder, happy to have a job during hard times. In many industries during the economic downturn, services to customers improved and employee retention was not a problem, motivation took a back seat to survival.

The previously mentioned methods to motivate employees are all extrinsic. In other words, they describe ways employers or managers (outside sources) can motivate workers. Another form of motivation is intrinsic. In intrinsic motivation, the effort, comes from within the worker. The concept of intrinsic and extrinsic motivation provides many puzzles for human behaviorists. Origin is one. Some individuals need very little external push to work harder while others seem to need a lot. Are the differences caused by genetics? By childhood experiences? By early work experiences? Another puzzle is how to stimulate intrinsic motivation. Studies on intrinsic motivation date back to the 1920s, but the concept became more widely known in the 1950s. Intrinsic motivation implies enjoyment in an action, a feeling of being totally immersed by an activity. Far more is known about extrinsic than about intrinsic motivation. It is generally agreed that to increase productivity, organizations need to tap both intrinsic and extrinsic motivation. Since motivation appears to be affected by both personal and situational factors which interact with one another, managers need to address both sets of factors. Many previous studies on motivation have centered on three main concerns: (1) what motivates or energizes human behavior, (2) how this behavior can be stimulated and sustained, and (3) what organizations can do to initiate, direct, and channel motivation. The rest of the article addresses these concerns.

## **Central Issues in Efficiency and Motivation**

One specific efficiency issue, efficiency versus effectiveness, has already been discussed. Generally, organizations today stress effectiveness. Also the problems inherent in overemphasizing efficiency and routinization and underemphasizing creativity and individualism in jobs have been mentioned in the Frederick Taylor discussion. A more central issue germane to both efficiency and motivation is how to stimulate and reward people who work hard.

## **Influences**

Why is it that some workers can be depended on to work hard while others cannot? There are many influences on worker efficiency and motivation. The most basic ones are personality, heredity or history, environment, and situations. Personality, the qualities, traits, and personal characteristics of a person, appears to be a result of both heredity and environment. The way it is enacted depends on the situation in which people find themselves.

Probably the best known theory of motivation was developed by psychologist Abraham Maslow. He hypothesized that each individual has a series of needs ranging from lower order needs to higher order needs. He called this series a hierarchy of needs. The lower order needs include physiological needs (i.e., thirst, hunger, shelter) and safety (i.e., security, safety from danger). The higher order needs include love (i.e., affection, acceptance), esteem (i.e., respect, admiration, status), and self-actualization (i.e., the development of full potential, fulfillment). According to Maslow, physiological needs have first priority and must be partially met before a person can fulfill higher order needs. All people seek to fulfill their needs, but each individual fulfills them in a different way.

Given this hierarchy, an organization that wants to motivate an employee should try to assess where that person is on the hierarchy and focus on satisfying that level of needs before proceeding to the next level. For example, during a recession or a period of down-sizing, the emphasis should be on safety needs (level two). During high growth times, the emphasis may shift to esteem or self-actualization (levels four and five).

Motivation can be envisioned as a process that originates with unsatisfied needs. Unsatisfied needs lead to tension which in turn stimulates drive and search behavior. The process ends when needs are satisfied and tension is reduced.

An individual as well as an organization can seek to influence the motivation process. Ideally, individual needs should be compatible and consistent with organizational needs. Unfortunately, it is not unusual for these needs to not match and to prove counterproductive. For example, a worker may be seeking solutions to problems which no longer hold importance for his or her manager. Communication and a shared vision are the keys to creating the right fit between individual effort and organizational output.

By the 1960s a philosophical shift was taking place in the field of organizational behavior. The human factor became an even more important subject of study than it had been previously. Jobs were no longer looked at as strictly technical, but as sociotechnical systems. This approach took into consideration the individual's response to their job as well as to the actual mechanics of the job. Technical tasks were viewed within the greater context of the work culture and environment. The narrowly defined concept of scientific management, that is, efficiency first and foremost, gave way to a much broader definition of management and all its permutations.

For example, in 1960 Douglas McGregor suggested in his book *The Human Side of Enterprise* that the manager's view of the nature of human beings is biased toward two main groupings of behavior assumptions which he labeled Theory X and Theory Y. Theory X assumes that the lower order needs identified by Maslow dominate the individual so that under Theory X, the assumptions held by managers are:

1. Employees inherently dislike work and will avoid it if they can.
2. Since employees dislike work, they must be coerced, controlled, directed, or threatened with punishment to put forth adequate effort toward the achievement of organizational objectives.
3. Employees will try to avoid responsibilities and seek security and direction whenever possible.

The assumptions underlying Theory Y are:

1. Employees view work as being as natural as rest or play.
2. Employees will exercise self-direction and self-control if they are committed to organizational objectives.
3. Employees are committed to objectives that are related to the rewards associated with their achievement.
4. Employees under normal conditions seek responsibility.
5. Most employees will exercise a relatively high degree of imagination, ingenuity, and creativity.
6. Under the conditions of modern life, most employees' intellectual potentialities are only partially utilized.

McGregor thought that Theory Y assumptions were more valid than Theory X. He believed that most people would thrive on opportunities for growth, challenging jobs, good interpersonal relations, and responsibility.

Motivation took on a more complicated formula with the introduction of the motivation-hygiene theory of psychologist Frederick Herzberg. He asserted that intrinsic factors such as achievement, recognition, responsibility, and growth were related to job satisfaction whereas extrinsic factors were more associated with dissatisfaction. A person's attitudes, therefore, have a great deal to do with that person's satisfaction and job success.

Just as with Taylor, the theories of McGregor and Herzberg have their detractors. For example, Herzberg's theory is criticized for emphasizing satisfaction over productivity and McGregor's for being too simplistic. However, all three theorists along with Maslow have had an enormous impact on the way organizations manage workers and design jobs. There are a number of newer theories that fall into the following categories: (1) needs, (2) goal-setting, (3) reinforcement, (4) equity, (5) expectancy, and (6) stress and fatigue. Due to space limitations not all can be sufficiently addressed in this article. What they have in common is that they try to explain and predict motivation, and many build on the works previously cited.

The field of psychology has always had a strong influence on the theories, research, and applications in organizational behavior. As an example, the roots of needs theory can be traced to Maslow's hierarchy of needs and those of reinforcement theory to the work of Harvard psychologist B. F. Skinner. Since Skinner found that rewards are most effective when they immediately follow the desired response, his research influenced when and how managers rewarded positive work behaviors.

Probably of the six theory categories listed, the one most relevant to the subject of motivation is expectancy theory. According to this theory, a person's motivation is a function of (1) matching effort to performance expectancies, (2) matching performance to outcome expectancies, and (3) the perception of attractiveness of outcomes. Satisfaction is conceived as a result of performance rather than a cause of it.

### Job Attitudes and Performance

Attitudes are thoughts or feelings (positive or negative) about objects, people, or events. For instance, people like or dislike opera. They also like or dislike certain aspects of their work. People have thousands of attitudes, but for the purposes of this article the focus will be on job attitudes, specifically, job satisfaction, involvement, and commitment.



Job satisfaction refers to the general attitude people have about their jobs. There are many measures of work satisfaction. Most attempt to determine whether workers are challenged in their work, feel adequately compensated, rewarded, and comfortable in their work environment including the physical facilities and interpersonal relationships. Job involvement has to do with how strongly people identify with and really care about the work they do. Commitment refers to how much the person identifies with the overall organization. Research indicates that high job involvement and commitment result in lower absenteeism and job turnover. Job satisfaction, involvement, and commitment are all subject to change, but usually people strive to maintain a consistency or balance in their attitudes and behaviors. This is consistent with McGregor's Theory Y discussed earlier; most people want to do well at their work.

In regard to performance, individuals are motivated if they can see that their performance is appreciated, noted, and rewarded. They need to know what the organization's performance expectations are and what the outcomes of their individual performance will be. Unclear objectives and a lack of consistency or confidence in the organization to define and recognize good performance will decrease worker motivation, and productivity may suffer.

A new managerial organizing principle for workplaces which has been found to improve performance is called the 5S concept. The name comes from a list of five Japanese words which when loosely translated into English become five words beginning with the letter 'S':

- *Sort*: Order items and activities (prioritize)
- *Straighten*: Arrange
- *Shine*: On task completion, clean and restore
- *Standardize*: Consistent methods will increase order, save time
- *Sustain*: Afterwards, maintain, reduce waste, evaluate

An example of the 5S concept in practice is when a hospital was reconfigured and stethoscopes were put in drawers marked 'stethoscope' rather than placing them on desk tops or hooks. Afterward every doctor and nurse knew where to find them, sounds simple, but it saved time (and perhaps lives) and lessened clutter. Efficiency experts are brought in to factories and multistory office buildings to make them more consistent and systematic using the 5S concept. This works particularly well in shared work spaces such as production lines and in the media with 24-h news where no one 'owns' a desk.

### Diversity in the Workplace

In the 1990s, a concern emerged about how well past motivational and efficiency theories fit the changing composition of the workforce. The growing number of women, minorities, and older workers in the labor force led organizations to reassess previously held notions about workers and their motivations. Appropriate changes in reward systems have begun to be implemented. As one example of a policy responsive to changes in the work force, the popularity and pervasiveness of flextime (flexible hours of work arrival and departure) can be partially traced to the growing number of working parents who are trying to balance work and family responsibilities.

By 2010, white non-Hispanics in the United States will constitute 54% of the population under the age of 18. In the ten largest cities, no ethnic or racial group will have a clear majority. The urban work force will become increasingly diverse.

The recognition of diversity in the workplace has brought to question the notion that an organization has a uniform culture to which all employees subscribe. Typically in organizations there is a dominant culture and several subcultures. A subculture is a set of values and attitudes held by a minority of the organization's members. Subcultures may fall along the lines of specializations, interests, or in a variety of other ways. Subcultures can weaken and undermine an organization, but more likely they will ascribe to and support the values of the dominant organization culture while seeking to maintain their own identity.

Respecting diversity and working with it rather than against it will be the key to the continued success of organizations. In order to remain competitive, employers are making an effort to recognize, recruit, and manage an older and more culturally and racially diverse work force. While practical applications are moving ahead, research on workplace diversity in relation to motivation and efficiency is in its infancy.

### Motivational Techniques

The concept of goal motivation is used to explain how direction, effort, and duration/persistence affect goal-setting. Goals direct action and behavior. It has been established that higher goals produce higher performance. If goals are set too low they are not motivating enough. Conversely, goals set unreasonably high can be frustrating. Thus, finding the right level of goals is a management problem. The words 'duration' and 'persistence' refer to directed effort over time, a relentless, driving behavior. Goal commitment implies a determination to continue goal-seeking. Research indicates that self confidence and previous success at achieving goals positively affect a person's future goal commitment and achievement.

Technique refers to the systematic procedure for accomplishing a task. Motivational techniques, therefore, are procedures that stimulate a person to accomplish a work task. Goal-setting is one technique for motivating workers.

### Goal-Setting

In 1968, Edwin Locke published a paper that is considered to be the seminal work on goal-setting theory. He wrote that people strive to attain goals in order to satisfy their emotions and desires. Although goal-setting is an important motivational stimulus, the concepts of needs and values are also fundamental concepts of work motivation according to Locke.

More recently, researchers and theorists have concluded that goals direct and focus attention onto certain task requirements, away from conflicting or alternative actions. Thus, goals direct behavior and provide a framework for a strategy of performance. Sometimes intentions and goals are used interchangeably, but they are different in that intentions may be theoretical (a person plans or intends to do something) whereas the word goal implies action. In the terms 'goal attainment' and 'goal achievement,' an end result is assumed.



Before goals can be achieved, they need to be set. Research on goal-setting falls into the following categories: (1) specific versus general, (2) difficult versus easy, (3) owned or shared versus imposed, and (4) timely feedback and progress toward goals. The results of the research indicate that specific, challenging, and owned or shared goals are preferred. The degree of persistence applied to goal pursuance is closely linked to ultimate achievement. And in the end, timely and appropriate feedback is preferable to no feedback. Workers want to know the results of their efforts.

Organizations put a great deal of energy into setting goals and motivating workers to achieve organizational goals. At the same time, workers have personal goals they are trying to achieve. Two examples of worker goals are the opportunity to learn more and move ahead. Organizations try to match worker's needs with organizational needs-enhancing work satisfaction and output for both.

In the 1980s, American business embraced a Japanese business practice called total quality management (TQM). One of the techniques in TQM relevant to goal-setting is the widespread use of quality circles (QCs). In QCs, a group of employees regularly meets to identify and solve work-related problems.

Their focus is on increasing productivity and meeting department and organizational goals. Improvements are suggested. A group leader reports the proposed improvements to higher management. Steering committees sort through the suggestions and implement the ones they consider viable. With QCs it was thought that everyone benefits from the increased communication between the various levels of the organization and the cooperative spirit generated by teamwork.

By the 1990s, some drawbacks to QCs and TQM were uncovered. This form of management involves many meetings and a lot of paperwork that is time consuming. Some of this time was taken away from the basic organizational functions of serving customers and producing goods. Consequently, TQM and QCs are being reassessed. Research continues to try to determine in what situations, settings, and organizations QCs and TQM are most effective.

### Reward Systems in Organizations

A review of the literature reveals the importance of rewards in the relationship between motivation, satisfaction, and work performance. Lyman Porter and Edward Lawler developers of the Porter Lawler motivation model recommend that organizations make sure that their reward policies are closely linked to performance. This is suggested because the individual worker's job satisfaction is derived from the difference between the amount of rewards he or she receives and the amount he or she expects to receive. Job satisfaction represents an attitude, positive or negative, rather than a behavior. Zellars et al. (2004) point out the relationships among attributes such as emotions and problem solving to coping with what goes on in organizations.

Equity is an important part of job satisfaction. Employees want pre motion and pay systems that they perceive as just, equitable, and fair. Individuals who perceive reward decisions as unambiguous and consistent with their expectations will likely report satisfaction with their job.

Closely linked to the concepts of intrinsic and extrinsic motivation discussed earlier are the concepts of intrinsic and extrinsic rewards. The pleasure or value a person derives from the content of work itself makes it intrinsically rewarding. Rewards received from the work environment, the organization, are extrinsic. A company-paid car is an extrinsic reward, whereas the feelings of personal satisfaction from a job well done are intrinsic. Intrinsic rewards may stem from greater job freedom and discretion, more interesting work, opportunities for personal growth, and more participation in decision making. There are dozens of extrinsic rewards ranging from assigned parking spaces to profit sharing. To be most effective, rewards should be individualized to meet each person's needs. One employee might value a flexible lunch hour so he can swim every day in the nearby university pool while another employee may put more value on a paneled office with a large desk. Rewards can be used by organizations to recognize an employee's past achievements or to direct him or her toward certain future achievements.

### Concluding Remarks on Efficiency and Motivation

Observing and commenting on human behavior is a fundamental and enduring subject for the novice as well as the professional. This article explored how organizations try to direct employee behavior toward higher productivity. The theories discussed in the article reveal that there is not one, singular all-purpose way to motivate workers or to make an organization more efficient. Generally it is agreed that satisfied, motivated workers are more productive than dissatisfied, bored workers. Organizations try to identify, recognize, and reward productive workers. Research reveals that rewards should be consistently and fairly distributed. The ultimate organizational behavior goal is a happy/productive/consistent worker-not one alternating between despair and elation. Rewards should not produce ups and downs, but a secure feeling that efforts are noted and rewarded, if not immediately, then soon.

Since its beginnings in assembly-line management, the concept of efficiency has given way to a broader view of productivity encompassing effectiveness and worker satisfaction. The effective organization sets goals and keeps in mind the different levels of job needs of its workers. Organizations in the future will make fuller use of the skills, diversity, and motivational potential of their human resources and more effectively integrate ever-changing technology to their advantage.

*See also:* Career Development; Decision Making (Individuals); Organizational Behavior.

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